CHAPTER 4

# Quebrada Tacahuay and Early Maritime Foundations on Peru's Far Southern Coast

SUSAN D. DEFRANCE

Quebrada Tacahuay represents one of the oldest expressions of maritime adaptations in the Americas, with initial deposits dating to the Late Pleistocene and minor reoccupation of the site during the Early and Middle Holocene (deFrance 2002; deFrance and Umire 2004; deFrance et al. 1998, 1999, 2001; Keefer et al. 1998, 2003). Representing an ancient specialized activity site dating to more than 10,500 (rcyr BP) and focused on the exploitation of marine avifauna, the oldest contexts of human use at Quebrada Tacahuay are also intriguing because of the nature of their preservation, discovery, and archaeological investigations. Although many areas of the Andean littoral may have been occupied during the Late Pleistocene, only those relatively few sites located on land surfaces where the coastal shelf is very narrow survived rising sea level at the end of the Ice Age (Richardson 1998). In addition, preservation of the oldest anthropogenic deposits at Quebrada Tacahuay is the result of burial by a massive debris flow that was triggered by an ENSO paleoclimatic event (deFrance and Keefer 2005; Keefer et al. 1998, 2003). Subsequent flood events, as well as natural accumulations of aeolian sands, further sealed the deposits.

Although minor human reoccupation of the area occurred, the deposits were unknown until exposed in the mid-1990s during construction of a coastal highway connecting the southern Peruvian cities of Ilo and Ite. Survey of the region identified the deeply buried occupation within a series of road cut and water main profiles. Researchers conducted archaeological and geological investigations of the site in 1996, 1997, 1998, and 2001, with the last field season being the most extensive (deFrance 2002; deFrance et al. 1998, 1999, 2001; Keefer et al. 1998).

The 1997 and 1998 field seasons recovered unequivocal evidence of subsistence specialization in the use of marine resources, particularly marine birds and lesser quantities of shellfish and fish, as well as the production and use of tools made with stone from local coastal sources (deFrance et al. 2001; Keefer et al. 1998). However, the nature of these investigations was very limited because the archaeological deposits were buried under 2–3 m of sediment. The 1997 and 1998 field seasons consisted primarily of collecting volumetric samples of exposed cultural material and geological sediments, and very limited spatial excavation in the traditional archaeological sense. The objective of the 2001 field season was to move beyond the realm of subsistence and to recover data that would increase our understanding of the range of social phenomena associated with these early coastal inhabitants.

While documenting the existence of early maritime adaptations is a useful endeavor, much remains unknown about the cultural dynamics of these early populations. For example, did activities other than food processing and preparation occur at the site? Did the site hold evidence of structures or other cultural refuse that would elucidate the nature of coastal settlement and littoral adaptation? To address these questions, the 2001 field season activities focused on excavating large blocks to expose areas that might contain features (e.g., post molds from structures, human burials, non-food-processing contexts) and possibly new types of cultural material (e.g., nonlithic material or stone tools made of material from distant sources, additional bone tools other than the single worked mammal rib found in 1998) that would help characterize the range of site activities and behaviors.

Whereas previous investigations had primarily studied the stratigraphic units in profile view only, the 2001 methodology resulted in excellent horizontal exposure of the contacts between cultural and geological units. These large-scale excavations were successful in exposing two discrete cultural deposits (Unit 4c3 and Unit 5B) postdating the earliest occupation that were visible only in very limited fashion in the road cuts and water line profiles. The excavation of the Late Pleistocene occupation was also successful in exposing horizontal areas of occupation with dense subsistence and lithic refuse, as well as five discrete hearth features, some of which were buried and overlain with cultural material, indicating reuse of the site rather than a single-use episode. Large spatial excavations also exposed discrete geological strata (e.g., water-laid deposits and volcanic tephra) below the human occupation that were difficult to see in profile only. However, no new feature types or activity areas were identified in the oldest deposits, which supports the view that the site was largely an extractive locale where a limited range of activities took place, with the population residing elsewhere (deFrance et al. 2001, in press). Although no new types of features or activity areas were identified, the ability to excavate features in their entirety rather than from profiles was productive, particularly in regard to the recovery of archaeobotanical remains, especially fuel woods, and in understanding the depositional history of the site, as well as the recovery of additional subsistence remains. In this chapter I discuss the methods and results of the 2001 field season, how Quebrada Tacahuay broadens our understanding of some of the earliest inhabitants of the central Andean littoral, and research questions that can be addressed with the excavation of other early sites.

## SITE SETTING AND ENVIRONMENTAL HISTORY

Quebrada Tacahuay (17.8° S latitude, 71.1° W longitude) is located approximately 30 km south of Ilo, Peru, on the distal end of a broad alluvial fan (Figure 4.1). Today, the deeply incised quebrada channel that drains the prominent fan is characterized by diverse Quaternary deposits, including course-grained flood and debris flow deposits with lenses of aeolian sands and volcanic tephra (Keefer et al. 2003:43). At the time the site was occupied it was approximately 0.7–0.9 km farther from the shoreline, and the quebrada channel was significantly shallower. Today the site is 0.3–0.4 km inland on a terrace overlooking a semilunate sandy and rocky shoreline that is bracketed by the rocky headlands of Punta Icuy to the north and Punta Picata to the south. With sea level 60–70 m lower when this site was first occupied (Bard et al. 1996) the bay habitat would have been significantly more protected, making it an appealing location for human exploitation.

Today the coastal climate is hyperarid, with rainfall averaging less than 5 mm per year (McCreary and Koretsky 1966, cited in Satterlee 1993). Sediments and deposits indicate that similar hyperarid climatic conditions have prevailed since the end of the Pleistocene (i.e., as manifested by lack of vegetation, little soil development, few organic inclusions, and desiccation cracks in-filled with aeolian sands) (Keefer et al. 2003:69). The nearest rivers to Quebrada Tacahuay are the Ilo, to the north, and the Locumba and the Sama to the south. These rivers have their source on the western slope of the high Andes, where their flow originates in lakes and in precipitation that mostly occurs from December to March. In their lower courses, these rivers traverse the hyperarid coastal desert. Flow diminishes throughout the year after the end of the highland rainy season, and before the completion of a recent irrigation project, the surface channel of the lower Ilo River was dry for most of the year below an altitude of approximately 1200 masl. However, aquifers that also have their source in the Andes provide water to a series of coastal springs that emerge in the foothills of the coastal cordillera at the interior margin of the coastal plain. In the prehistoric past, the main channel of the Ilo would have been seasonally dry, with water available only during the austral spring, when highland rainfall and snowmelt recharged the system. Although the water available in coastal springs was also tied to highland rainfall

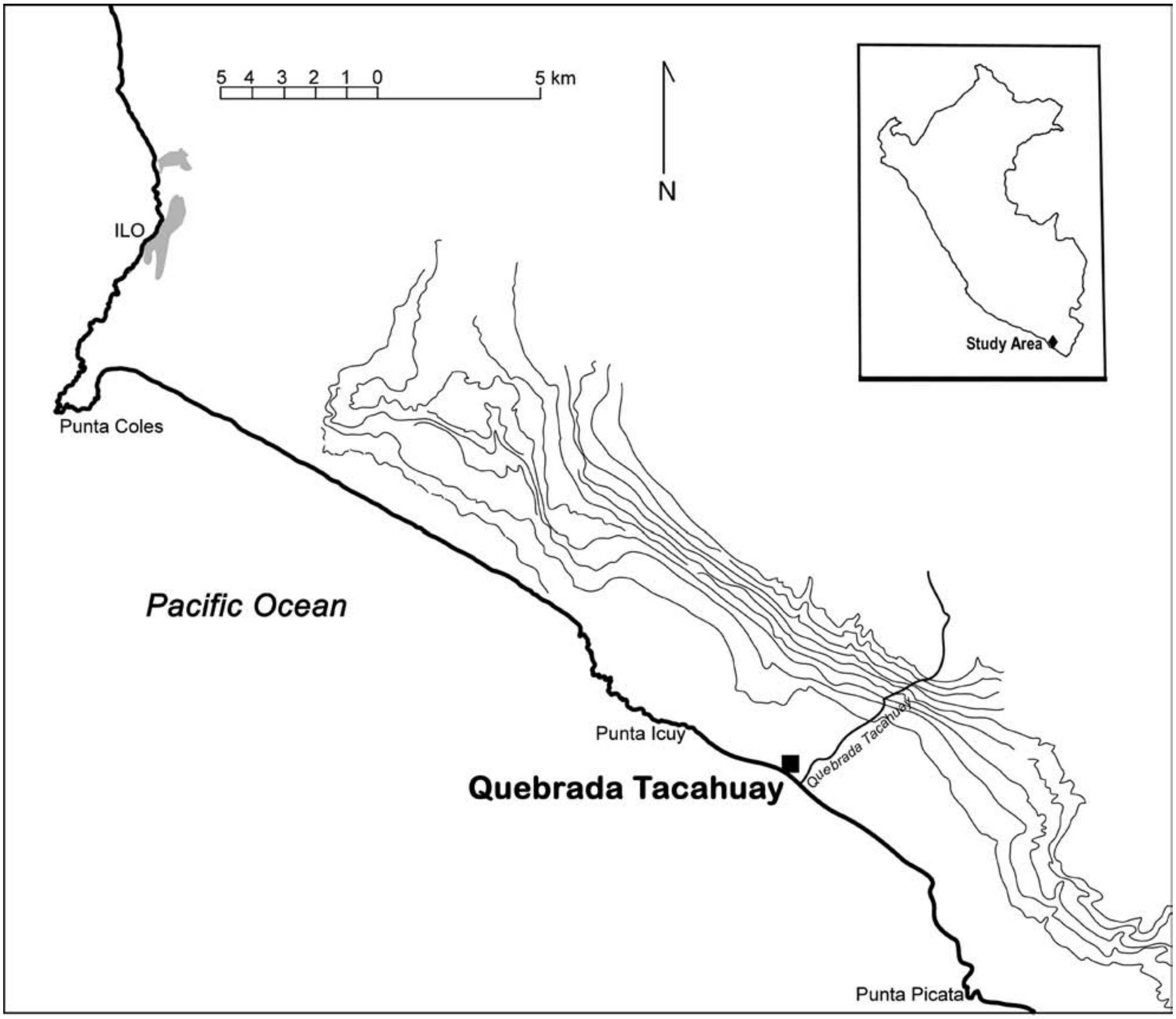



**Figure 4.1.** Site location of Quebrada Tacahuay in southern Peru.

patterns, a study of modern discharge patterns indicates that some springs generate water throughout the year, while others are seasonally dry (Clement and Moseley 1991).

At Quebrada Tacahuay, evidence for a coastal spring includes the presence of the main channel, paleochannels within the sedimentary sequence, and water-lain silts within the geological stratum containing the Late Pleistocene occupation materials (Keefer et al. 1998, 2003). These silts also suggest pluvial runoff, possibly as a result of minor El Niño activity. In the absence of a major tributary and with an inadequate supply of rainfall for human survival, the lack of fresh water might have been a significant limiting factor in human settlement if the spring did not generate water throughout the year (deFrance in press). The presence of potable water probably attracted inhabitants to this area even though it was some distance from the coast at the time of earliest occupation. Unfortunately, we have no data on whether the Tacahuay spring was seasonal or not.

The only circumstance under which significant amounts of precipitation fall on the Andean coastal plain is associated with El Niño events. The typically torrential rainfall produced by El Niño events on this arid landscape generates severe flooding and the transport of huge amounts of sediment across the landscape. On a global scale, the Pleistocene antiquity of El Niño dates to more than 100,000 years ago (Tudhope et al. 2001). A synthesis of El Niño flood event frequency based on geological survey, sediment analyses, and historical and modern records for the Ilo region, including the deposits at Quebrada Tacahuay, indicates that El Niño events have been producing floods and debris flows there with variable frequencies during the Holocene and Late Pleistocene, with the oldest dated deposit being about 38,000 years old (Keefer et al. 2003); older, undated deposits of similar character suggest that El Niño has been affecting this region far longer than that. Differing frequencies of the dated sedimentary deposits suggest a period of high El Niño activity in the Early Holocene, followed by a mid-Holocene weakening or hiatus in activity and the subsequent resumption of moderate to high activity in the Late Holocene, after about 4600 rcyr BP (Keefer et al. 2003). These data underscore the differing intensity of events associated with El Niño, from small-scale perturbations to catastrophic Mega-Niños.

At Quebrada Tacahuay, two massive debris flow deposits dating to the Late Pleistocene and Early Holocene are greater in scale than the most severe recent ENSO events (i.e., those of 1982–1983, 1992–1993, and 1997–1998). One of these, Unit 7, was inferred to have been produced by an El Niño event that occurred shortly after a high-magnitude earthquake that destabilized large amounts of sediment (Keefer et al. 2003:70). The mid-Holocene hiatus in El Niño activity present at Quebrada Tacahuay has been documented in other areas of the Andes in association with human settlement and is also corroborated by paleoclimatic evidence from geographic regions outside the Andes (see Keefer et al. 2003 for a review). Although the modern periodicity of El Niño activity appears to have emerged within the last 5,000 years, El Niños have far greater antiquity.

At Quebrada Tacahuay the Upper Series of strata (Units 1–9) as defined by Keefer et al. (1998, 2003) is of archaeological relevance, with deposits that date from approximately 4500 rcyr BP to the Pleistocene and contain evidence of human occupation (Units 4c3 within Unit 4, 5, and 8). Keefer completed the characterization of the geological history of sedimentation in collaboration with the archaeological investigations using the exposed road cut and water main profiles during the 1996, 1997, and 1998 field seasons, as well as with an assessment of the area following the June 23, 2001, earthquake.

A massive ENSO-induced debris flow (Unit 7) buried the earliest human occupation (Unit 8) under as much as a meter of sediment. Radiocarbon assays from archaeological contexts above and below the debris flow bracket this event sometime between 10,290 and 10,090 rcyr BP (deFrance et al. 2001). Sediment analysis indicates that the debris flow was viscous slurry characterized by a large sediment load moving relatively slowly and in laminar fashion, rather than a rapidly moving, turbulent liquid flow (deFrance and Keefer 2005). Consequently, the debris flow sealed the initial anthropogenic deposit instead of scouring it. Some avian skeletal material on the surface was pushed down into the base of the debris flow, while those elements already covered with windblown sands were protected.

A second, thinner debris flow (Unit 6) is interpreted as having been deposited relatively quickly after Unit 7, based on the radiocarbon dates that bracket the two units (Keefer et al. 2003). Minor human occupation occurs in Units 4 (Unit 4c3) and 5. Additional sheetflood and debris flow deposits accumulated at the site and further sealed and buried the earliest anthropogenic deposit under 2–3 m of sediment (Keefer et al. 1998, 2003). After the deposition of Unit 1 more than 4500 rcyr ago, the quebrada downcut its channel several meters to its present elevation. Subsequently, no further sedimentation was deposited across the site.

## ARCHAEOLOGICAL INVESTIGATIONS

### *Previous Studies*

In 1996, shortly after construction of the coastal highway, Michael Moseley, David Keefer, and Dennis Satterlee identified the recently exposed archaeological deposits at Quebrada Tacahuay while examining land surfaces and geological deposits in the region. A single radiocarbon date from a hearth eroding from one of the water main profiles revealed the antiquity (10,770 rcyr BP) of an anthropogenic deposit of butchered and processed marine birds within an aeolian sand lens (8–40 cm in depth). Archaeologists conducted limited research at the site in both 1997 and 1998 (Keefer 1998; deFrance et al. 2001). The focus of these projects was to identify the nature of the early human use of the site, particularly the nature of subsistence activities. These investigations primarily entailed collecting volumetric samples from along the exposed road cut and water main profiles; minimal horizontal excavations conducted in 1998 revealed the presence of well-preserved avifauna and lithic refuse (Keefer 1998; deFrance et al. 2001).[2] Small hearths were identified and partially excavated from profiles; however, the 1998 horizontal excavations did not reveal any in situ features. The collection and analysis of fine-screened (1/16-inch, 1.8-mm mesh) volumetric samples in both 1997 and 1998 and the limited spatial excavations were successful in recovering abundant faunal refuse, a variety of unifacial lithic tools, and large quantities of debitage, as well as carbonized plant remains appropriate for radiocarbon dating. These data sets provided incontrovertible evidence for a specialized maritime economy focused on the exploitation and processing (i.e., butchering, cooking, consumption) of numerous cormorants and boobies, with lesser use of several species of finfish and limited use of marine shellfish. Faunal remains also included some seal or sea lion remains, indicating either active hunting or scavenging of marine mammals. Coastal stone sources provided chalcedony for the production of expedient cutting and scraping stone tools. The site's inhabitants did not consume any terrestrial resources of dietary consequence, nor did they obtain any material (e.g., stone, other raw materials) from other elevations or habitats. The site is interpreted as a specialized maritime extractive and processing locale that was preserved owing to its burial by the catastrophic if fortuitous paleoclimatic events (deFrance and Keefer 2005; Keefer et al. 1998, 2003; deFrance et al. 2001).

Despite having established the pattern of faunal exploitation, the predominant technology, and the chronological placement of the site's deposits, little else was known about the nature of the site occupation and the earliest coastal inhabitants. The excavations had recovered cultural materials but, being limited, had not defined the context of their use and behaviors other than faunal processing and preparation. The nature of coastal residence was also unknown. Did the inhabitants reside at this locale for any duration, only seasonally, or was it a single-use site where a large quantity of birds and some other fauna had been dispatched, processed, and consumed?

## *The 2001 Excavations*

The 2001 season consisted of the excavation of four 5 × 5-m square blocks in areas where previous investigations had recovered abundant cultural material from Unit 8 deposits exposed in various profiles (Figure 4.2). To reach Unit 8, we excavated 2–3 m of largely sterile overburden using picks and shovels. Although excavation with heavy machinery might have expedited this process, we elected to use hand excavation in order to document the changes in geological strata.[3] Hand excavation also ensured that other ephemeral cultural deposits (in Units 4c3 and 5B) more deeply embedded in noncultural levels would be identified and not destroyed if they were encountered. Once intact cultural deposits were identified, the block was subdivided into 1-m squares. As in previous seasons, all the material was screened with 1/16-inch (1.8-mm) mesh, and we saved it to be sorted in the field lab.

The excavation of the four blocks had varying degrees of success in locating unique cultural materials. Block 1 (see Figure 4.1) was placed in an area along the small profile designated 1A where previous excavations recovered a large quantity of lithic debitage and some tools in Unit 8. Following the excavation of Unit 1 in Block 1 we uncovered a very thin scatter (5 cm maximum depth) of marine mussel shell (*Choromytilus choros*) at the contact between Units 1 and 2. This scatter had not been identified previously in any of the profiles or excavations. There was no cultural material with the scatter. Although the shell lens was not dated directly, the dates of Units 1 and 2 place the deposit sometime between 4500 ± 60 and 7920 ± 80 BC. Once we exposed Unit 8 deposits we found only a small quantity of subsistence remains and lithic debris. A southern extension of the excavation (0.85 × 2 m to the profile edge) in the area of Profile 1A recovered some additional stone artifacts, but not a discernible workshop area. If a workshop with more defined features existed in this area, it was apparently destroyed when site sediments were removed with the construction of the water main. Within Block 1 and the extension, the Unit 8 deposits contained a variety of faunal remains, predominantly cormorant and booby remains, but also several elements of pelican and a small number of marine mammal elements, either seal or sea lion.

Block 2 was located northeast of Profile 1 near where the first hearth was sampled and where we excavated a 2 × 1.5-m context in 1998 (see Figure 4.1). At the surface of Unit 4 we uncovered a thin, amorphous scatter (maximum dimensions 1.54 m east-west × 1.45 m north-south) of mussel shell (*Choromytilus choros*) and charcoal along the east wall. The lens did not contain any cultural material or faunal remains other than the shell. This cultural deposit is also present in Profile 4; however, the shell lens is not found across the site and was encountered only in this excavation. A single AMS date on charcoal produced a date of 9010 ± 40 rcyr BP (Table 4.1). Once Unit 8 deposits were unearthed in Block 2, we found a thin scatter of cultural material, but no cultural features or concentrations of refuse. However, once we excavated Unit 8 and exposed the silt lens (Unit 8C) and the sterile Pleistocene deposits of Unit 9, we uncovered the remnant of a small stream channel running roughly east to west through the block

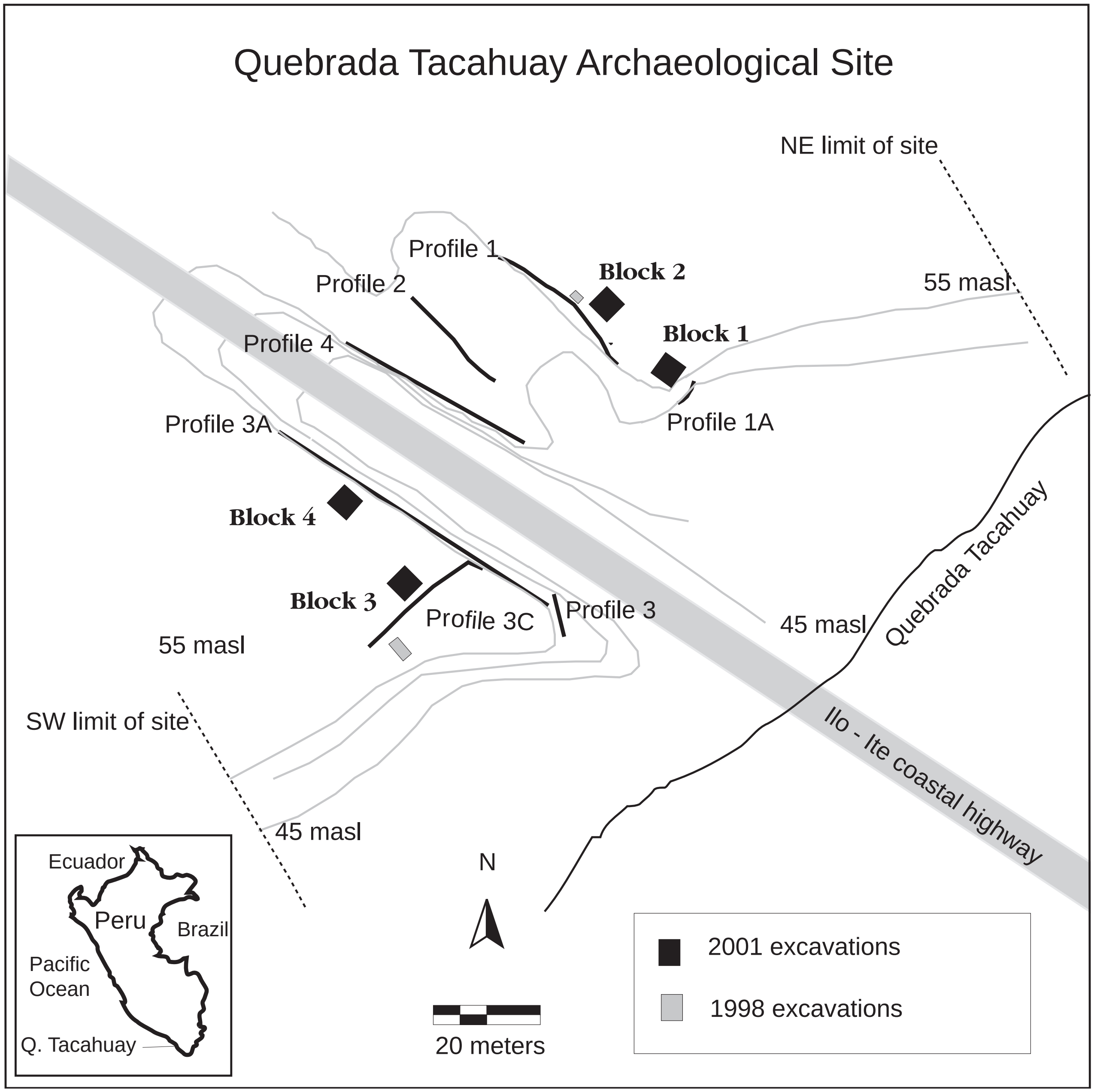



**Figure 4.2.** Site map indicating location of 2001 and previous excavations.

(Figure 4.3). Water-lain sediments indicate that the channel carried either spring or pluvial water prior to the accumulation of the aeolian sands in Unit 8.

Block 3 proved to be the most productive in regard to cultural materials. This block and Block 4 were located on the coastal (south and west) side of the highway (see Figure 4.1). Block 3, adjacent to Profile 3C, contained very well-preserved archaeological deposits of both Unit 5 and Unit 8. Unit 5, an aeolian sand with silt, was unearthed below Unit 3 (Unit 4 deposits do not occur in this area of the site). In road cut profile view, Unit 5 is homogeneous; however, in excavation, the stratum consists of two distinct sand lenses, an upper level of dense sterile sand approximately 8–10 cm deep (Unit 5A) and a second layer of less compact sand with gravel and cultural material (Unit 5B) approximately 16–18 cm deep. Unit 5B contains abundant remains of land snails, *Scutalus* sp.; however, these small snails are considered a nonfood species found in association with human-generated garbage. In Andean desert habitats

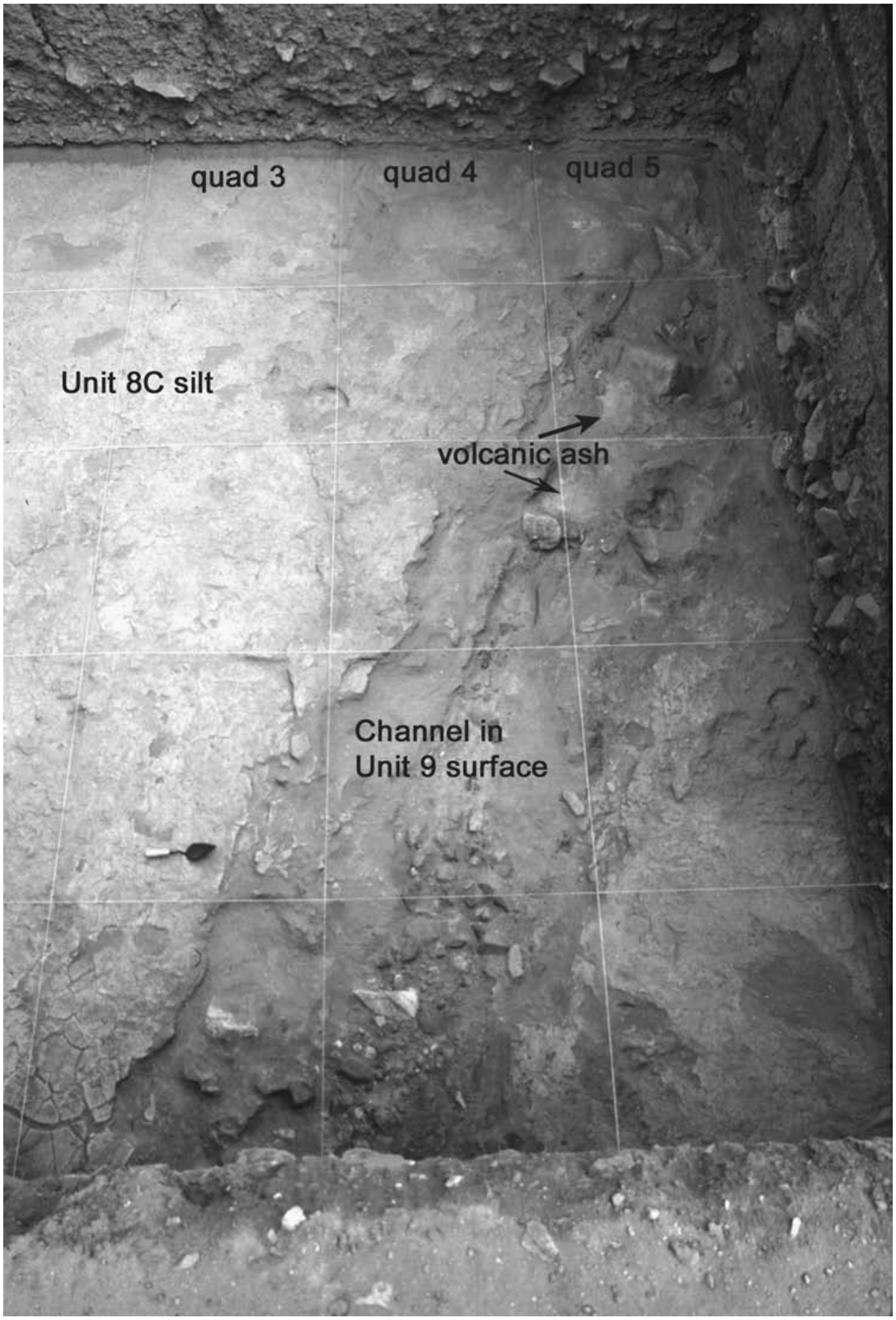



**Figure 4.3.** Remnant channel in Block 2, Unit 9 surface.

many terrestrial snails remain dormant until there is sufficient moisture to support the growth of the population (see Craig 1992). The abundance of land snails with human refuse suggests there was greater moisture at the time Unit 5B was deposited; however, we have no other data to corroborate this hypothesis. Once we reached the surface of Unit 5, the entire block was sectioned into 1-m quads. Cultural material recovered from Unit 5B includes chalcedony and basalt flakes, as well as a coastal block scraper. Also present are vertebrate and invertebrate subsistence remains. One archaeological feature, an amorphous hearth, was excavated along the north wall of the block (see Table 4.1). There was no evidence of surface preparation for the hearth.

**Table 4.1.** Description of features excavated in the 2001 field season.

| Feature No. | Location | Unit | Quads | Dimensions | Depth Below Surface (BS) and Feature Depth | Function | |
|---|---|---|---|---|---|---|---|
| 1 | Block 3 | 5B | 5, 10 | 1.92 m E-W × 0.92 m max. N-S | 1.75 m BS, 12 cm — 5 strata | Hearth | Charcoal, vertebrate fauna, marine bivalves, with *Scutalus* sp. terrestrial gastropods |
| 2 | Block 3 | 8B | 3, 4, 8, 9, 13 | 1.76 m E-W × 1.12 m N-S | 2.44 m BS, 18 cm — 7 strata | Hearth | charcoal, fragmented marine bird and marine fish elements, marine mollusks, and chalcedony tools and refuse, and a rosy quartz utilized flake. |
| 3 | Block 3 | 8B | 10 | 0.71 m E-W × 0.36 m N-S | 2.45 m BS, 4 cm — no internal strata | Hearth | charcoal, complete and fragmented marine bird elements, lithics |
| 4 | Block 3 | 8B bajo | 7, 8, 12, 13 | 1.67 m E-W × 1.22 m N-S | 2.44 m BS, 5 cm — 2 strata | Hearth | charcoal, complete and fragmented marine bird elements, marine bony fish elements, two chalcedony scrapers, several smaller flakes |
| 5 | Block 3 | 8B | 17 | 0.26 m E-W × 0.37 m N-S | 2.29 m BS, denser at 2.44 m BS, 29 cm — 4 strata | Hearth | dense carbonized botanicals, complete and fragmented marine bird elements |
| 6 | Block 3 | 8B bajo | 11, 12 | 0.55 E-W × 1.5 m N-S | 2.47 m BS, 20 cm — 2 strata | Hearth | small concentration with scatter of ash and charcoal, some marine bird elements |

*Note:*
Feature 1 contained charcoal, vertebrate fauna, marine bivalves, with *Scutalus* sp. terrestrial gastropods, and a chalcedony coastal block scraper. Features 2–6 contained charcoal, ash, complete and fragmented marine bird and marine fish elements, and small quantities of marine mollusks. Features 2 and 4 also contained chalcedony lithic tools and refuse, and one rose quartz flake (Feature 2). Feature 5 was the most compact, with a dense mat of burned botanical material.

Following the excavation of Unit 5B we used picks and shovels to excavate the Unit 7 debris flow deposits. (Unit 6, a thinner ENSO-generated debris flow, was not found in this part of the site). Once Unit 8 deposits were exposed, we again established the 1-m grid system for the block. Although the sand matrix within Unit 8 remained uniform, we defined and excavated four discrete subunits of cultural material that were distinguished both by the degree of bone fragmentation or completeness and by their stratigraphic location and burial by the unit sands.

The layer of bone fragments found in the surface of Unit 8 and cemented into the base of Unit 7 was designated Unit 8A. These specimens had not been buried by wind-blown sands prior to the debris flow event. A deeper layer of buried bone elements, Unit 8B, included many complete skeletal elements some of which were partially articulated (e.g., ulnae and humeri, several cervical vertebrae, scapula and coracoid, phalanges). Since Unit 8C was previously assigned to a sterile flood deposit within the Unit 8 sands (deFrance et al. 2001), Unit 8B was subdivided further. We designated subsequent levels of complete and fragmented bone as Unit 8B Level 2, and a deeper level of bone and cultural features largely buried by sand as Unit 8B bajo (lower).

Unit 8B contains five hearths: Features 2, 3, 4, 5, and 6 (Figure 4.4 and Table 4.1). Features 4 and 6 were buried by sands and occur at slightly deeper elevations than Features 2, 3, and 5; therefore, the contextual designation Unit 8B bajo was used to distinguish the stratigraphic location of Features 4 and 6. All of the features were partitioned and excavated in two halves to expose the feature profiles. As was the case with Feature 1 in Unit 5B, there was no surface preparation for the features; they are not defined by rocks or other material but rather consist of lenses of ash, charcoal, and burned and unburned bird bone. One of the more compact hearths, Feature 5 consisted of a roughly circular, compact deposit with several strata, including a lens of dense burned botanical material (see Figure 4.4). The other hearths also contained varying amounts of bird bone, bony fish remains, some marine shell, and stone artifacts/chipped stones.

Since sands buried at least two of the features, they are stratigraphically slightly deeper than the other hearths. However, it was not known if this difference

This is the wrong figure. Move this to p. 67. Put here image now on p. 63,

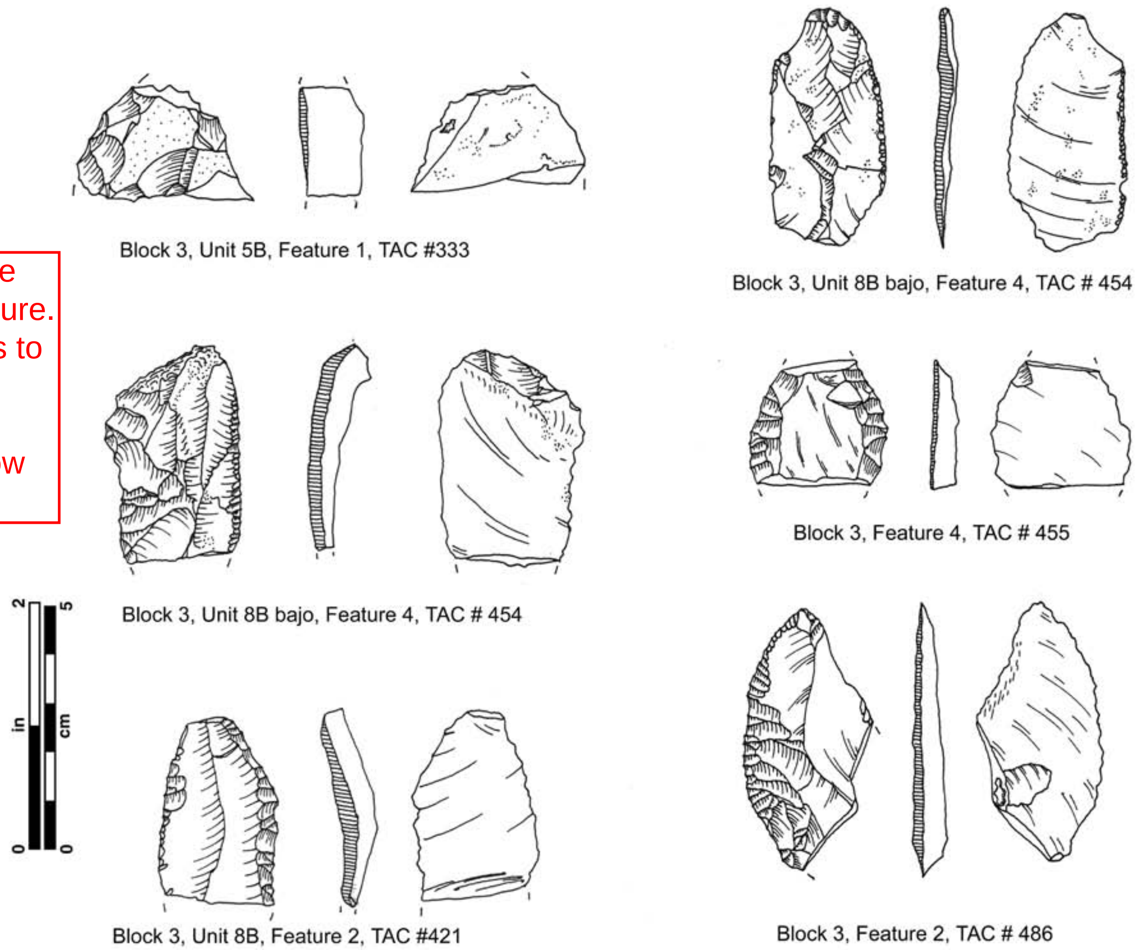



**Figure 4.4.** Features present in Block 3, Units 8B and 8B *bajo*.

in depth translated to distinct depositional events separated temporally. The quantity and distribution of material across the site did not suggest a single episode when large numbers of birds were dispatched, processed, and consumed (i.e., an event analogous to Olsen-Chubbock for marine birds); however, the time depth involved was unknown. Efforts to radiocarbon date the subunits within Unit 8 were not successful.[4] Nevertheless, the accumulation and burial of some features by wind-blown sands indicates reuse of the site rather than a single depositional event.

Other than the hearths, the cultural materials are similar to those identified previously in Unit 8. Abundant marine bird remains and lithic material are common. Some scraping or cutting stone tools made of chalcedony are present. Some basalt and rosy quartz flakes are present, but we found no exotic lithic material.

Block 4 is located west of Profile 3A (south and west of the coastal highway). We believed this to be a high-probability area for the recovery of cultural material since we had recovered lithic tools from the adjacent profile. In contrast to the Unit 5 deposits in Block 3, Unit 5 sands in Block 4 did not contain cultural material. The Unit 8 deposits containing cultural material (Unit 8A) were extremely shallow. All of the cultural material was restricted to an 8- to 10-cm sand deposit with some fragmented bird bone and five fragments of marine mollusks. No other artifacts were found in this block.

Although there was very little cultural material present, the geological deposits within Unit 8 included at least two red silt flood deposits (Unit 8C and Unit 8C1) that represent either pluvial sediments or very mild ENSO sediment flows. Unit 8 sands containing no cultural material separate the two minor flood events. Also present was a thin deposit of volcanic tephra present in Block 1 and elsewhere. This tephra is discontinuous across the site but visible in several profiles. Efforts to correlate the volcanic ash at Quebrada Tacahuay with a known Late Pleistocene volcanic eruption were not successful.[5]

In addition to the excavation of the four blocks, cultural deposits from a recently exposed profile were systematically investigated as part of the 2001 field season. The 1997–1998 El Niño caused a washout of the coastal highway at Quebrada Icuy north of the site. The Peruvian Transportation Ministry removed deposits from Tacahuay for use as road fill in 1998 and again sometime between 1998 and 2000. These operations resulted in exposure of Profile 3C (parallel to Profile 3B, which was sampled in 1998) (see Figure 4.2). The profile exposed only the strata from the ground surface to the top of Unit 8. The majority of Unit 8 deposits remained covered. Although Unit 8 cultural deposits remained unexposed, the new profile provided excellent exposure of Unit 5. Faunal remains, chipped stone, and charcoal from Unit 5 were eroding from the deposit onto the surface of Unit 7.

We partitioned the best-preserved portion of the profile into fourteen 1-m sections. All of the cultural material on the surface of a 14-m section was recorded and collected. Loose fill on the slope of Unit 7 was collected and screened. Once the profile had been cleaned of loose material, small volumetric samples of the intact portion of Unit 5 were collected from nine 1-m sections. The volumes collected ranged from 3.0 to 6.0 liters. All of the material was fine-screened and collected for lab sorting. Profile 3C contained a fair quantity of cultural material, including chipped stone, marine shell, vertebrate faunal remains, and charcoal. *Scutalus* sp. shells are common throughout the profile. These data complement the findings from the excavation of Unit 5B in Block 3.

### *The 2001 Results*

Five additional radiocarbon dates were generated from samples collected in 2001 (Table 4.2, Figure 4.5). One date was from the thin mussel shell deposit (Unit 4) uncovered in Block 2. Two dates were from Unit 5 cultural deposits, including one date from Feature 1 and one from Profile 3C. Two additional dates from Unit 8 deposits are within the time range of previous samples.[6] When all of the radiocarbon dates from the cultural deposits are compared, it is evident that human use of the quebrada occurred during the Late Pleistocene and Early Holocene (Figure 4.5). Although we did not obtain a chronometric date from the thin mussel shell scatter present in Block 1, this appears to be a localized deposit (i.e., it is not found in any other area of the site). The shell scatter was deposited prior to Unit 1 (4559 rcyr BP), and therefore may be roughly contemporaneous with Unit 2 (7920 rcyr BP) and the only date from Unit 4c3 (7990 ± 80 rcyr BP) (see Keefer 2003 for a discussion of the relationship between Units 2 and 4).

The larger-scale excavations from 2001 support previous findings regarding maritime economy and subsistence. The site exhibits evidence of specialized extraction and processing of large numbers of marine birds and minor use of other coastal resources. The marine fauna identified from Unit 8 deposits in both Block 3 and from the southern extension of Block 1 is consistent with that found during the 1997 and 1998 field seasons (Table 4.3) (deFrance 2005). As was found during previous seasons, several avian elements (n = 191) and two marine mammal specimens bore evidence of butchering. There is no use of terrestrial resources that can be considered food items. The remains of small-sized reptiles (e.g., lizards and snakes) are present, but these are not considered to have been food refuse. Following the El Niño event that buried the Unit 8 deposits, human reoccupation of the area (Unit 5) was characterized by less use of marine birds, no use of marine mammals, and greater exploitation of marine finfish and shellfish (Tables 4.4 and 4.5). Shellfish use is more varied and includes taxa not consumed during the earliest use of the site (e.g., false abalone, limpet, chiton). All three of these are common on rocky shorelines. Interestingly, the Unit 5 deposits also contain the remains of lorna (*Sciaena deliciosa*), which is also the most common bony fish in the deposits from Quebrada Jaguay, an early maritime site more than 200 km north of Tacahuay (Sandweiss et al. 1998; McGinnis 1999). The remains of one small canid, a probable fox, are the only evidence for a terrestrial mammal. Foxes are not a significant subsistence item in later time periods and the Tacahuay specimens do not contain butchering evidence; therefore, these remains are not interpreted as food refuse.

The lithic assemblage from the earliest occupation contains eight chalcedony unifacial cutting/scraping tools (Figure 4.6). Also present are nonutilized rose quartz (n = 6) and basalt flakes (n = 4). We recovered two basalt cores and one basalt hammerstone. The Unit 8 deposits contain abundant debitage, primarily small chalcedony retouch, use, and thinning flakes (n = >900). The Unit 5 deposits contain utilized (n = 1) and nonutilized (n = 5) chalcedony flakes, as well as a small

This is the wrong image. Move this to p. 61 (as Fig. 4.4).
Put here the image now on p. 67

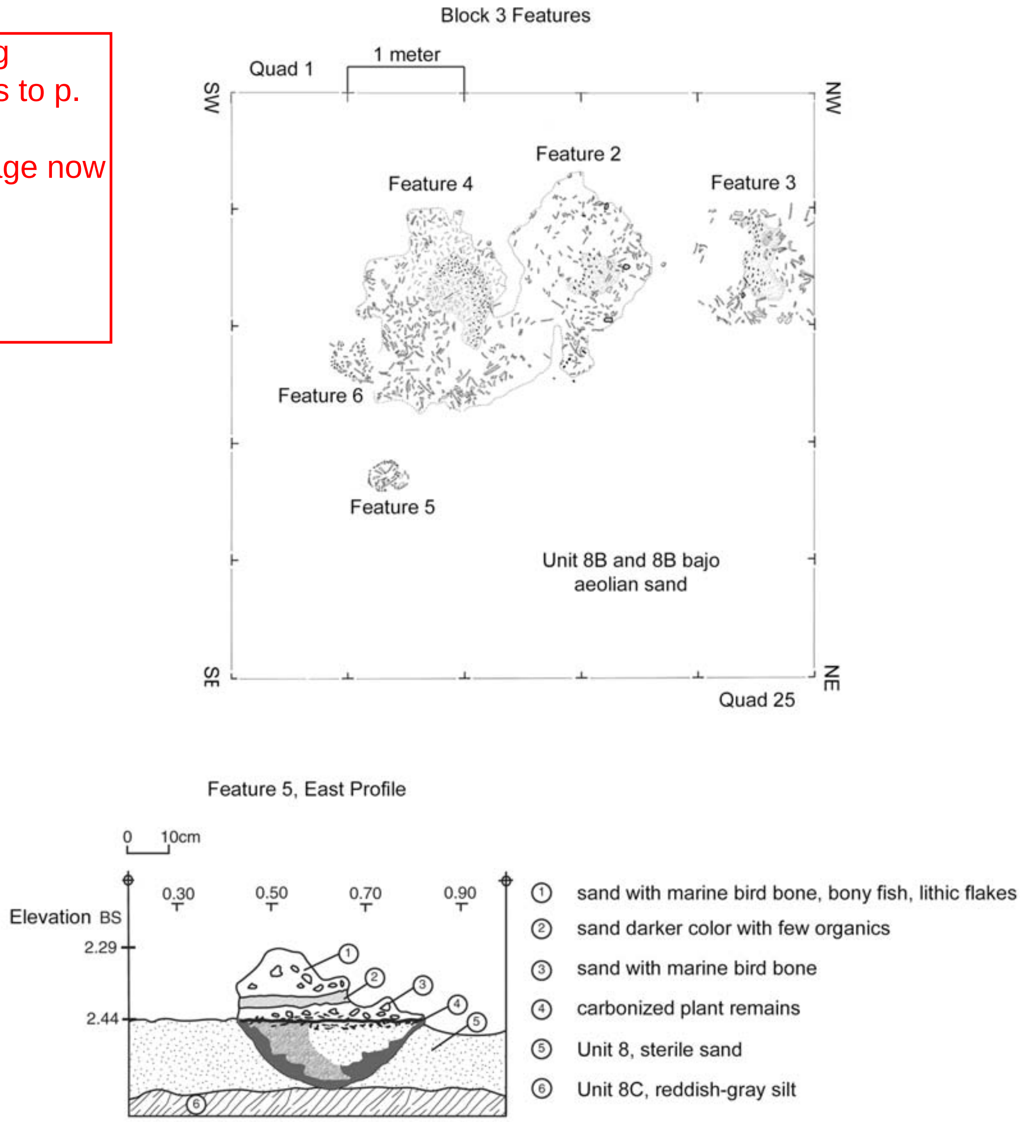



**Figure 4.5.** Composite profile indicating cultural strata and associated radiocarbon dates ([1]dates are from Keefer et al. 1998; [2]dates are from deFrance et al. 2001). All cultural materials (Units 4, 5, and 8) are within aeolian sand deposits. A choro mussel shell lens present in Unit 4c3 is not depicted in this profile.

**Table 4.2.** Radiocarbon dates from stratigraphic contexts at Quebrada Tacahuay.

| Context (Profile or Block/Unit)[a] | $^{14}C$ yr BP | Calibrated 2-σ Ranges cal yr BP | Sample No. and Technique[b] | $\delta^{13}C$ | Material |
|---|---|---|---|---|---|
| Block 2, Unit 4 | 9010 ± 40 | 10,230–10,150 | 172,615AMS | –22.9 | Charcoal |
| Block 3, Unit 5B | 9850 ±150 | 11,950–10,970 | 159,921Conv. | –25.6 | Charcoal |
| Profile 3C, Unit 5B | 10,050 ± 90 | 12,280–11,230 | 160,707AMS | –22.2 | Charcoal |
| Block 3, Unit 8B bajo | 10,660 ± 80 | 12,960–12,340 | 160,706AMS | –20.4 | Charcoal |
| Profile 1A, Unit 8 (1998) | 10,690 ± 60 | 12,960–12,380 | 172,645AMS | –25.7 | Charcoal |

*Note:* All radiocarbon dates were calibrated using INTCAL98 (Stuiver et al. 1998) and are expressed as 2 sigma ranges. All dates have been corrected for isotopic fractionation.

[a] Profile refers to exposed roadcut or water line cut; Block refers to an excavation context; Unit refers to either a geological or an archaeological stratigraphic level.

[b] All dates run by Beta Analytic, Inc.

**Table 3.** Fauna identified from Blocks 1 and 3, Unit 8.

| Scientific Name | Common Name | NISP | MNI | Wt. (g) |
|---|---|---|---|---|
| Chiroptera | Bats | 1 | 1 | <0.1 |
| Rodentia unidentified | Rodents | 28 | 3 | 0.6 |
| *Arctocephalus* sp. | Southern fur seal | 5 | 1 | 42.6 |
| *Otaria* cf. *flavescens* | Southern sea lion | 1 | 1 | 25.9 |
| Otariidae/Phocidae | Eared seals/sea lions | 2 | 1 | 1.6 |
| Pinnipedia | Seals, sea lions | 2 | 0 | 1.6 |
| Mammal unidentified (sm) | Unidentified small mammal | 7 | 0 | <0.1 |
| **Total Mammalia** | | **46** | **7** | **72.3** |
| Tinamidae cf. *Crypturellus* sp. | Tinamou | 4 | 1 | 0.9 |
| *Pelecanus* sp. | Pelican | 83 | 5 | 55.8 |
| *Phalacrocorax* sp. | Cormorant | 2,023 | 28 | 1,818.3 |
| *Phalacrocorax bougainvillii* | Guanay cormorant | 346 | 40 | — |
| *Sula* sp. | Booby | 1,214 | 40 | 771.7 |
| Phalacrocoracidae/Sulidae | Cormorant/booby | 413 | 0 | 52.8 |
| *Calidris* sp. | Sandpiper | 5 | 2 | 0.2 |
| Passeriformes | Songbirds | 2 | 2 | 0.1 |
| Passeriformes/Fringilliformes | Songbirds/finches | 1 | | <0.1 |
| Aves unidentified | Unidentified birds | n/c | 0 | 2722.8 |
| **Total Aves** | | **4,091** | **118** | **5,422.6** |
| Lacertilia | Lizards | 5 | 1 | <0.1 |
| Reptilia unidentified | Unidentified reptiles | 1 | 0 | <0.1 |
| **Total Reptilia** | | **6** | **1** | **0.0** |
| Tetrapoda unidentified (sm) | Unidentified small tetrapods | 14 | 0 | 1.5 |
| Clupeidae | Sardines, shad, herring | 3 | 1 | <0.1 |
| Clupeidae/Engraulidae | Sardines, shad, herring/anchovies | 7 | 0 | <0.1 |
| Engraulidae | Anchovy | 1,507 | 31 | 1.3 |
| Carangidae/Sciaenidae | Jack/drum | 1 | 1 | 0.3 |
| Cf. *Mugil* sp. | Cf. mullet | 2 | 1 | 0.2 |
| Cf. Sciaenidae/Carangidae | Cf. drum/jack | 1 | 0 | 0.1 |
| Osteichthyes unidentified | Unidentified bony fishes | 1,497 | {3} | 18.0 |
| **Total Osteichthyes** | | **3,018** | **34** | **19.9** |
| Vertebrata unidentified | Unidentified vertebrates | n/c | | 1025.8 |
| **Total Vertebrata** | | **7,175** | **160** | **6,542.1** |
| *Choromytilus chorus* | Choro mussel | 4 | 1 | 0.9 |
| *Mulinia* cf. *edulis* | Clam taquillas | 1 | 1 | 2.2 |
| *Semele* cf. *corrugata* | Round clam | 1 | 1 | 4.1 |
| Veneridae | Venerid clam | 1 | 1 | 1.0 |
| Bivalvia unidentified | Unidentified bivalve | 47 | 0 | 7.2 |
| **Total Bivalvia** | | **54** | **4** | **15.4** |
| Mollusca unidentified | Unidentified mollusks | 269 | 0 | 6.4 |
| **Total Invertebrata** | | **323** | **4** | **21.8** |
| **Sample Total** | | **7,498** | **164** | **6,563.9** |

**Table 4.4.** Fauna identified from Block 3, Unit 5B.

| Scientific Name | Common Name | NISP | MNI | Wt. (g) |
|---|---|---|---|---|
| Canidae cf. *Pseudalopex sechurae* | Desert fox | 18 | 1 | 3.1 |
| Rodentia unidentified | Rodent | 75 | 2 | 0.2 |
| Mammal unidentified | Unidentified mammal | 30 | | 1.3 |
| **Total Mammalia** | | **123** | **3** | **4.6** |
| Cf. Passeriformes | Cf. songbirds | 2 | 1 | <0.1 |
| Aves unidentified (medium-sized) | Unidentified birds | 46 | 1 | 6.3 |
| **Total Aves** | | **48** | **2** | **6.3** |
| Lacertilia | Lizard | 1 | 1 | < 0.1 |
| Serpentes | Snakes | 1 | 1 | < 0.1 |
| Reptilia unidentified (cf. Lacertilia) | Cf. lizard | 123 | 1 | 0.5 |
| **Total Reptilia** | | **125** | **3** | **0.5** |
| Tetrapoda unidentified | Unidentified tetrapods | 50 | 0 | 1.6 |
| *Sciaena deliciosa* | Lorna | 3 | 2 | 0.4 |
| Osteichthyes unidentified | Unidentified bony fishes | 25 | 1 | 0.8 |
| **Total Osteichthyes** | | **28** | **3** | **1.2** |
| Vertebrata unidentified (lg) | | n/c | | 43.2 |
| **Total Vertebrata** | | **374** | **11** | **57.4** |
| *Concholepas concholepas* | False abalone | 3 | 3 | 63.0 |
| *Fissurella* sp. | Limpet | 1 | 1 | 11.1 |
| Gastropoda unidentified | Unidentified gastropod | 5 | | 1.6 |
| **Total Gastropoda** | | **9** | **4** | **75.7** |
| *Choromytilus chorus* | Choro mussel | 19 | 2 | 44.2 |
| Mytilidae | Mussel | 1 | | 0.2 |
| Bivalvia unidentified | Unidentified bivalves | 22 | | 62.4 |
| **Total Bivalvia** | | **42** | **2** | **106.6** |
| Mollusca unidentified | Unidentified mollusks | 204 | | 111.7 |
| *Balanus* sp. | Barnacles | 15 | | 0.2 |
| Invertebrata unidentified | | n/c | | 0.4 |
| **Total Invertebrata** | | **270** | **6** | **294.6** |
| **Sample Total** | | **644** | **17** | **352.0** |

**Table 4.5.** Fauna identified from Profile 3C, Unit 5.

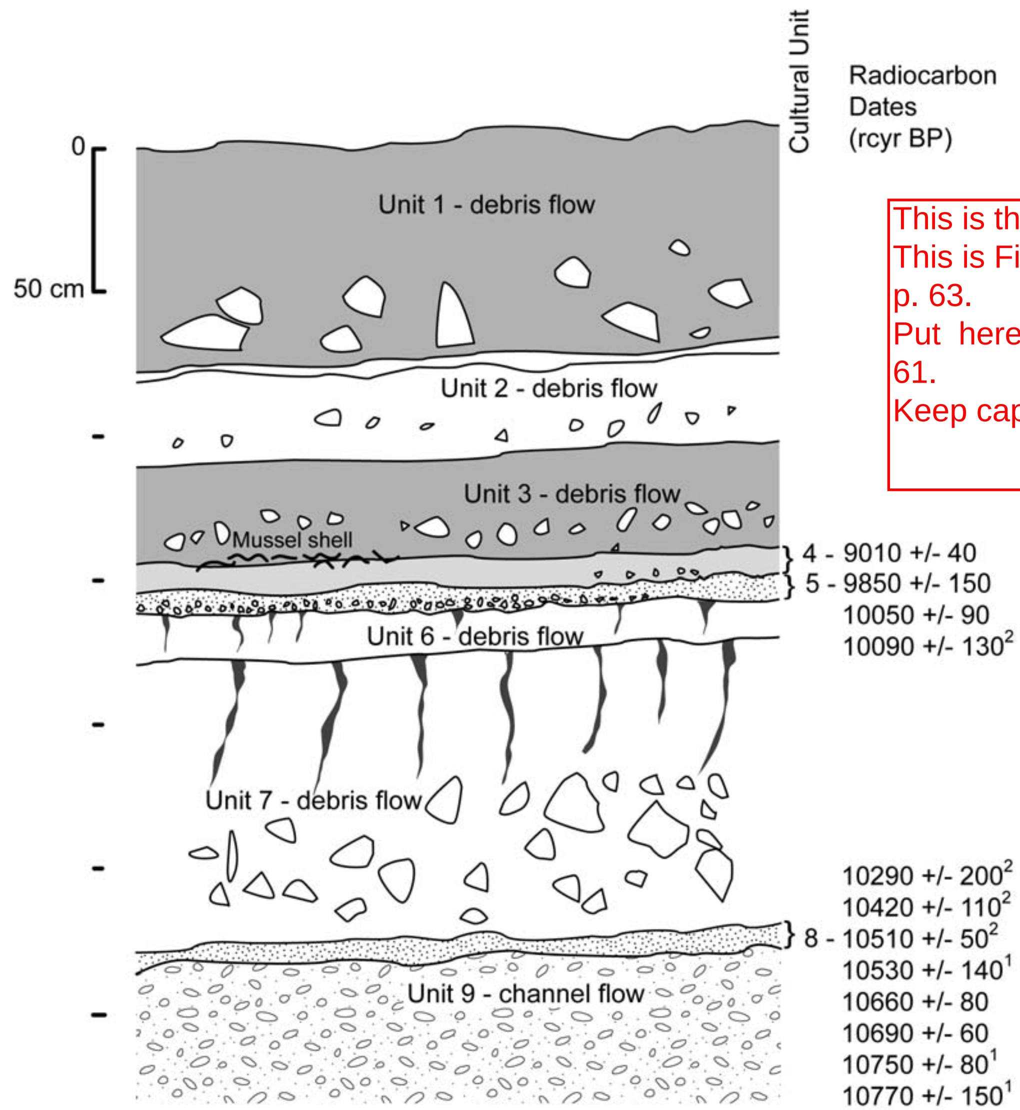
| Scientific Name | Common Name | NISP | MNI |
|---|---|---|---|
| Rodentia | Rodent | 15 | 2 |
| Mammal unidentified | Unidentified mammal | 25 | 1 |
| **Total Mammalia** | | **40** | **3** |
| *Phalacrocorax bougainvillii* | Guanay cormorant | 3 | 1 |
| Aves unidentified | Unidentified birds | n/c | |
| **Total Aves** | | **3** | **1** |
| Clupeidae | Shad, herring, sardines | 4 | 2 |
| Engraulidae/Clupeidae | Anchovy/shad, herring, sardine | 1 | 0 |
| *Sciaena deliciosa* | Lorna | 1 | 1 |
| Cf. Sciaenidae | Cf. drum | 1 | 1 |
| Osteichthyes unidentified | Unidentified bony fish | 44 | 2 |
| **Total Osteichthyes** | | **51** | **6** |
| **Total Vertebrata** | | **94** | **10** |
| *Concholepas concholepas* | False abalone | 18 | 17 |
| **Total Gastropoda** | | **18** | **17** |
| *Balanus* sp. | Barnacles | 2 | 0 |
| *Choromytilus chorus* | Choro mussel | 2 | 2 |
| **Total Bivalvia** | | **2** | **2** |
| Chiton *sensu latu* | Chiton | 4 | 2 |
| Mollusca unidentified | Unidentified mollusks | 11 | — |
| **Total Invertebrates** | | **37** | **21** |
| **Sample Total** | | **131** | **31** |

number of nonutilized basalt flakes (n = 2). The only tool present is the coastal block scraper from Feature 1 (Figure 4.6). Chalcedony debitage is also common in Unit 5 deposits (n = 243).

The only nonlithic artifact recovered in the 2001 season is a small, unfired clay ball approximately 2.5 cm in diameter found in Block 3, Unit 8B between Features 2 and 4, but not within either hearth. Spherical in shape, it is made of reddish sandy silt, probably the same material as Unit 8C. It is not notched or otherwise modified for use as a bola stone. And since it is unfired, it could not have been a net weight; therefore its function is not known.

## DISCUSSION

The 2001 field season entailed excavation of 100 $m^2$ of site deposits and the collection of volumetric samples along a previously unstudied profile. These investigations significantly expanded our understanding of site use and formation processes. They also confirmed previous interpretations of site economy and behavior focused on the acquisition of local foodstuffs and raw materials. Our investigations did not unearth any new types of features, nor did we recover material from other geographic regions or elevations. The material kit for this time period is exclusively utilitarian stone tools with the exception of one bone artifact (recovered




This is the wrong image.
This is Fig. 4.5, goes on p. 63.
Put here fig. now on p. 61.
Keep caption here as is.

**Figure 4.6.** Examples of chalcedony lithic artifacts recovered during the 2001 field season.

in the 1998 field season) and the unusual clay ball from the most recent investigations.

Although these studies have defined the site economy, several aspects of behavior associated with the use of coastal resources during the Terminal Pleistocene remain unknown for this locale. The nature of both coastal residence and population movement for the people associated with Quebrada Tacahuay is not known. I argue that linear migration along the coast rather than population movement to the interior makes better economic and adaptive sense, owing to the unavailability of water in many areas of the interior, particularly in the lower part of the Osmore drainage, and because of biological constraints on human adaptation to high-elevation settings (Aldenderfer 1998; deFrance in press). The degree of coastal specialization at Tacahuay does not suggest random or opportunistic use of coastal habitats. The economic and subsistence specialization support a model of coastal residence; however, without empirical data on coastal structures or residences, it is impossible to define the territorial pattern of land use. No post molds or evidence for structures were identified even with the large spatial area that was exposed during the 2001 season. Within the Tacahuay study region there are no exotic materials that indicate either population movement to other elevations or interactions with populations in other regions that resulted in the acquisition of raw materials.

If populations did not reside at Tacahuay, more permanent residence may have been at sites such as at the Ring Site (20 km north of Tacahuay; see Figure 4.1), or perhaps elsewhere along the coast, where deep refuse accumulated (deFrance in press). The Ring Site is a strong candidate since it has deposits dated to over 10,500 rcry BP and it has a long sequence of use through the Archaic period (Sandweiss et al. 1989). If movement to the interior was undertaken for subsistence reasons, I propose that it would not have been beyond the coastal cordillera or to elevations in excess of 1000 masl. A migration pattern that did not necessitate physiological adaptation to changes in elevation would have been biologically advantageous (deFrance in press).

Ten thousand years ago, the resources of the south-central Peruvian coast were bountiful. The coastal resources in the vicinity of Tacahuay are not subject to seasonal fluctuations in availability; therefore, there was no need to migrate to other areas in search of subsistence resources. In some areas of the south-central Andes, researchers have identified patterns of coastal-inland migration that included inland settlements with coastal refuse, as well as hunter-gatherers exploiting both the coast and low-elevation lomas (fog-dependent plant oases that form along low-elevation coastal hillslopes) (Núñez 1983, 1999; Llagostera 1989; Santoro 1993; Núñez et al. 1994). If water was a limited resource in coastal settings during the Late Pleistocene, people may also have devised storage methods that left no archaeological remains. With an active ENSO regime at the end of the Pleistocene, flexibility in subsistence strategies would have been advantageous; however, we have no evidence within the lower Osmore for a seasonal pattern of migration or for logistical stations that involved the exploitation of inland food resources such as terrestrial mammals.

Among the issues that remain to be addressed with investigations of other early coastal sites are the social contexts of settlement and foraging behavior. House floors, living areas, and nonfood domestic refuse could be used to address issues related to the social and gender organization of households. Trade and contact with people in other geographic areas (inland or other coastal areas) could be used to infer population movements and the social mechanisms for these interactions (i.e., to reduce risk, identify mates, obtain raw materials). In regard to environmental conditions, it is also evident that El Niño perturbations caused flooding during the period of initial human settlement along the Andean coast (Keefer et al. 1998, 2003); however, little is known of human reaction and adaptation to the changing environment at the end of the Ice Age.

The bioarchaeology of the earliest inhabitants is also an unstudied topic. Human remains from early sites have the potential to provide genetic and morphological data on the founding Andean populations, the chemical signatures of diet as well as information on ideological beliefs regarding the dead. Mortuary data would be particularly relevant to questions of both human origins and ideology. The social life, mortuary beliefs, and worldview of later complex coastal dwellers that possessed organized political structure have their origins with the first inhabitants of the Andean coast. Understanding the Late Pleistocene populations with archaeological data provides a foundation for interpreting coastal cultures through time. Goals of future research on early Andean littoral sites should address territoriality, residence patterns, and geographic variability in Late Pleistocene adaptations.

## CONCLUSIONS

Archaeologists conducted three seasons of research at Quebrada Tacahuay. Small-scale investigations were completed in both 1997 and 1998. The 2001 field season was the most comprehensive, entailing the excavation of four 5 × 5-m blocks and the collection of volumetric samples from one profile. The goal of these large spatial excavations was to identify features and artifact types not previously identified that would expand our understanding of coastal behavior beyond subsistence and animal processing. These block excavations were successful in exposing three discrete pockets of cultural deposits in Units 2, 4, and 5 that are not uniform across the site. The Unit 5 deposits held the greatest variety of cultural refuse, including a small hearth, subsistence remains, and lithic tools, while the other two, more recent deposits yielded exclusively marine shell and charcoal. The Unit 5 subsistence remains are more varied than the older Unit 8 deposits; however, the economic focus continues to be maritime resources, with greater use of both finfish and shellfish. Volumetric samples of Unit 5 deposits from one profile produced well-preserved subsistence remains and some lithic tools, as well as abundant wood charcoal.

Of the four blocks, the Unit 8 deposits in Block 3 were the best preserved. Researchers excavated abundant marine bird refuse, lithic tools, and five hearths. The stratigraphic superposition of some features and the burial of others by aeolian sands indicate that the site was reused over some period of time rather than in a single-use episode. The temporal depth of site use for the earliest occupation is not known; however, the calibrated range of radiocarbon dates suggests the site was used intermittently over several centuries. The subsistence remains and stone artifacts support previous interpretations that the site was an extractive locale where marine birds and some other marine resources were processed, prepared, and consumed. The deposits contain no terrestrial fauna that is considered edible and no cultural material from other geographic locations. Although no new examples of features were uncovered, the excavations were successful in providing new data on site formation processes, particularly for sediments that immediately predate human use of the area. Within the Unit 8 deposits there are water-lain deposits, volcanic tephra, and sterile sands that accumulated prior to human occupation.

Future research should be directed at identifying the nature of coastal settlement, residence, and migration in southern Peru. At a broader level, research is also needed on the range of geographic variation in subsistence adaptations at the end of the Pleistocene and during the early Holocene. Research at Quebrada Tacahuay demonstrates that understanding dynamic landscapes and their role in both the burial and the preservation of cultural deposits helps elucidate some of the earliest maritime foundations.

### *Acknowledgments*

Research was supported by FERCO, a Canaries Island Foundation created to honor Thor Heyerdahl's life and research, and by National Geographic Society grant no. 6963-01. I thank the following individuals who assisted with the 2001 field season: Adán Umire Alvarez, Ana Miranda, Erin Kennedy, Anna Wright, and our field crew. David Steadman identified some of the avian skeletal elements. Susan Duser assisted with the production of Figure 4.5. David Keefer read and commented on a draft version of the chapter. I owe special thanks to Michael Moseley for persuading me to join the field research at Tacahuay in 1997 and for his support throughout this project.

## NOTES

1. Exclusive of the tens of meters of geological strata present in the main quebrada channel, more than 10 m of deeply stratified deposits (Units 1–22) were exposed at Tacahuay in road cut and water main profiles parallel to the channel; however, only the upper series contains evidence of human occupation (see Keefer et al. 2003).

2. In 1997 we studied volumetric samples (0.3–2 liters) from 22 linear areas (0.50–2 m long) along four profiles (Keefer et al. 1998). In 1998, volumetric samples (0.5–5 liters) were taken from forty-six linear areas along six profiles, and we completed the excavation of eight 1 × 1-m squares and one 2 × 1.5-m context (deFrance et al. 2001).

3. The decision not to use heavy machinery was not based on inexperience with this method. I had previously worked extensively with backhoe excavation in the removal of both urban overburden on eighteenth- and nineteenth-century sites in New Orleans and prehistoric sites in central Louisiana that were covered with alluvium; therefore, I was experienced with the technique. In addition to the desire to see the contacts between strata, hand excavation by a crew of laborers using picks and shovels was far more economical owing to the distance of the site from the nearest city, Ilo.

4. In an effort to discern if Unit 8 cultural material that derived from more deeply buried deposits was older, I submitted bird bone elements identified to taxon from four of the features for radiocarbon dating. Unfortunately, there was no collagen remaining in the skeletal elements, and they could not be radiocarbon dated.

5. The GISP2 (Greenland) ice core contains sulfate concentrations indicating considerable volcanism from approximately 12 to 12.5 k (calibrated age range; Zielinski et al. 1996) that corresponds to the calibrated time range of Quebrada Tacahuay. However, the tephra present at Tacahuay is not correlated with a specific event.

6. We obtained one anomalous C14 date on a presumably contaminated uncarbonized root fragment from Block 1, Unit 8C (the thin reddish gray water-lain silt deposits below the Unit 8 cultural material). Following the excavation of Unit 8 and the exposure of the thin silt lens, some small uncarbonized root fragments embedded in the silt were collected for AMS dating. The sample produced a date of 3170 ± 40 rcyr BP. Uncarbonized roots from Units 2 and 3 produced dates that were consistent with the stratigraphic sequence (Keefer et al. 1998); therefore, this anomalous sample was probably contaminated.

## REFERENCES


Aldenderfer, Mark S.

1998 *Montane Foragers: Asana and the South-Central Andean Archaic*. University of Iowa Press, Iowa City.

Bard, Edouard, Bruno Hamelin, Maurice Arnold, Lucien Montaggioni, Guy Cabioch, Gérard Faure, and Francis Rougerie

1996 Deglacial Sea-Level Record from Tahiti Corals and the Timing of Global Meltwater Discharge. *Nature* 382:241.

Clement, Christopher O., and Michael E. Moseley

1991 The Spring-Fed Irrigation System of Carrizal, Peru: A Case Study of the Hypothesis of Agrarian Collapse. *Journal of Field Archaeology* 18(4):425–444.

Craig, Alan K.

1992 Archaeological Occurrences of Andean Land Snails. *Andean Past* 3:127–136.

deFrance, Susan D.

2002 Late Paleoindian use of Coastal Resources at Quebrada. Tacahuay: 2001 Field Season. Paper presented at the 21st Annual Meeting of the Northeastern Conference on Andean Archaeology and Ethnohistory, Pittsburgh, Pennsylvania.

2005 Late Pleistocene Marine Birds from Southern Peru: Distinguishing Human Capture from El Niño-Induced Windfall. *Journal of Archaeological Science* 32:1131–1146.

In press Human Use of the Andean Littoral during the Late Pleistocene: Implications for Social and Economic Behavior. In *Flowing Through Time: Exploring Archaeology Through Humans and Their Aquatic Environment*, edited by Larry Steinbrenner. Proceedings of the 36th Annual Chac-Mool Conference, Calgary, Canada.

deFrance, Susan D., and David K. Keefer

2005 Burial and Site Integrity at Quebrada Tacahuay: A Late Pleistocene Forager Landscape from Coastal Southern Peru. *Journal of Field Archaeology* 30(4):385–399.

deFrance, Susan D., David K. Keefer, James B. Richardson III, and Adán Umire A.

2001 Late Paleo-Indian Coastal Foragers: Specialized Extractive Behavior at Quebrada Tacahuay, Peru. *Latin American Antiquity* 12:413–426.

deFrance, Susan D., Michael E. Moseley, and David K. Keefer

1998 An Early Maritime Adaptation on the Southern Coast of Peru: Preliminary Results from Quebrada Tacahuay. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle, WA.

deFrance, Susan D., and Adán Umire A.

2004 Quebrada Tacahuay: una ocupación marítima del Pleistoceno Tardío en el sur del Perú. *Chungará: Revista de Antropología Chilena* 36(2):257–278.

deFrance, Susan D., Adán Umire A., James B. Richardson, David K. Keefer, and Dennis R. Satterlee

1999 Quebrada Tacahuay, an Early Andean Maritime Occupation: Results from the 1998 Season. Paper presented at the 64th Annual Meeting of the Society for American Archaeology, Chicago, IL.

Keefer, David K., Susan D. deFrance, Michael E. Moseley, James B. Richardson III, Dennis R. Satterlee, and A. Day-Lewis

1998 Early Maritime Economy and El Niño Events at Quebrada Tacahuay. *Science* 281:1833–1835.

Keefer, David K., Michael E. Moseley, and Susan D. deFrance

2003 A 38000-Year Record of Floods and Debris Flows in the Ilo region of Southern Peru and Its Relation to El Niño Events and Great Earthquakes. *Paleogeography, Palaeoclimatology, Palaeoecology* 194:41–77.

Llagostera, Agustín

1989 Caza y pesca marítima. In *Culturas de Chile, prehistoria desde sus orígenes hasta los albores de la Conquista*, edited by Jorge Hidalgo, Virgilio Schiappacasse, Hans Niemeyer, Carlos Aldunate del S., and Iván Solimano R., pp. 57–79. Editorial Andrés Bello, Santiago, Chile.

1992 Early Occupations and the Emergence of Fishermen on the Pacific Coast of South America. *Andean Past* 3:87–109.

McInnis, Heather E.

1999 Subsistence and Maritime Adaptations at Quebrada Jaguay, Camana, Peru: A Faunal Analysis. Master's thesis, Institute for Quaternary Studies, University of Maine, Orono.

Núñez, Lautaro

1983 PaleoIndian and Archaic Cultural Periods in the Arid and Semiarid Regions of Northern Chile. In *Advances in World Archaeology*, vol. 2, edited by Fred Wendorf and Angela Close, pp. 161–203. Academic Press, New York.

1999 Archaic Adaptation on the South-Central Andean Coast. In *Pacific Latin America in Prehistory: The Evolution of Archaic and Formative Cultures*, edited by T. Michael Blake, pp. 199–212. Washington State University Press, Pullman.

Núñez, Lautaro, Juan Varela, Rodolfo Casamiquela, and Carolina Villagrán
1994 Reconstrucción multidiciplinaria de la ocupación de Quereo, centro de Chile. *Latin American Antiquity* 5(2):99–118.

Richardson, James B. III
1998 Looking in the Right Places: Pre-5000 B.P. Maritime Adaptations in Peru and the Changing Environment. *Revista de Arqueología Americana* 15:33–56.

Sandweiss, Daniel H., Heather McInnis, Richard L. Burger, Asunción Cano, Bernardino Ojeda, Rolando Paredes, María del Carmen Sandweiss, and Michael D. Glascock
1998 Quebrada Jaguay: Early South American Maritime Adaptations. *Science* 281:1830–1832.

Sandweiss, Daniel H., James B. Richardson III, Elizabeth J. Reitz, J. T. Hsu, and Robert A. Feldman
1989 Ring Site. In *Ecology, Settlement, and History in the Osmore Drainage, Peru*, edited by Don Rice, Charles Stanish, and Phillip R. Scarr, pp. 35–84. BAR International Series 545 (i). British Archaeological Reports, Oxford.

Santoro, Calogero
1993 Complementariedad ecológica en las sociedades arcaicas del área centro sur andina. In *Acha-2 y Los orígenes del poblamiento humano en Arica*, edited by Iván Muñoz, Bernardo Arriaza, and Arthur Aufderheide, pp. 133–150. Ediciones Universidad de Tarapacá, Santiago, Chile.

Satterlee, Dennis R.
1993 *Impact of a Fourteenth Century El Niño Flood on an Indigenous Population near Ilo*. Unpublished doctoral dissertation, Department of Anthropology, University of Florida, Gainesville.

Stuiver, Minze, Paula J. Reimer, Edouard Bard, J. Warren Beck, G. S. Burr, Konrad A. Hughen, Bernd Kromer, Gerry McCormac, Johannes Van Der Plicht, and Marco Spurk
1998 INTCAL98 Radiocarbon Age Calibration 24,000-0 cal BP. *Radiocarbon* 40:1041–1083.

Tudhope, Alexander W., Colin P. Chilcott, Malcolm T. McCulloch, Edward R. Cook, John Chappell, Robert M. Ellam, David W. Lea, Janice M. Lough, and Graham B. Shimmield
2001 Variability in the El Niño-Southern Oscillation Through a Glacial-Interglacial Cycle. *Science* 291:1511–1517.

Zielinski, Gregory A., Paul A. Mayewski, L. David Meeker, S. Whitlow, and Mark S. Twickler
1996 An 110,000-Year Record of Explosive Volcanism from the GISP2 (Greenland) Ice Core. *Quaternary Research* 45:109–118.