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AMS RADIOCARBON DATES FROM PREHISPANIC FORTIFICATIONS IN THE HUAURA VALLEY, CENTRAL COAST OF PERÚ

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ABSTRACT. In this paper, we report 11 AMS radiocarbon dates from 8 Prehispanic fortifications located in the Huaura Valley, central coast of Perú. Small fragments of organic material embedded in preserved mud mortar in architecture, and samples from construction layers exposed by looter's holes were used to date architectural features without undertaking extensive excavations. These dates contribute toward refining the chronology of fort building in the valley, and provide a test for assumptions about temporal change and architectural style. The results indicate that fortifications date to at least 3 periods. These data provide a starting point for exploring the occurrence of warfare through time on a regional scale.

INTRODUCTION

Articulating the extent and timing of conflict and war that occurred in the past with existing cultural historical frameworks, environmental records, and other variables requires the development of precise chronologies of warfare. A particularly useful indicator of ancient warfare is the construction and use of fortified sites, which signal clear preparations for defense (Topic and Topic 1987; Arkush and Stanish 2005; Schaepe 2006; Keeley et al. 2007; Parkinson and Duffy 2007; Allen 2008; Martindale and Supernant 2009; Brown Vega et al. 2011). Organic material embedded in walls of these ancient forts can be radiocarbon dated to establish the age of construction. Understanding not only the spatial patterning, but also the temporal patterning, of fortifications across a regional landscape is key to examining the variables that contribute to warfare and its intensity (Kennett et al. 2006; Field 2008; Field and Lape 2010; Arkush 2011).

As part of a long-term regional project directed by the lead author (*Proyecto Awqa Pacha*) to study warfare, fieldwork was carried out in the Huaura Valley of the central coast of Perú (Figure 1) to document and date fortified hilltop sites. More than 30 fortifications were identified (Brown Vega et al. 2011). Fieldwork focused on rapid documentation of surface characteristics at each fortification. Excavations were not undertaken. Pottery styles, certain lithic forms, other special artifacts, and architecture styles provided provisional data on when a site was built or in use. Each site was tentatively assigned to time periods within the Central Andean relative chronology based on surface artifact assemblages and architectural styles (Table 1). These data provided a coarse chronological view of the timing of conflict. The focus of this paper is the ^{14}C dating of architectural features to test tentative temporal assignments, and provide more precise information about the age of the initial and subsequent phases of fort construction.

Prior research at the Fortress of Acaray in the Huaura Valley provided a baseline for determining temporally diagnostic architectural styles. Two principal architectural styles (Figure 2) were identified at Acaray: a more formal style using large quarried stone blocks stabilized by mortar and smaller chinking stones is attributed to the Early Horizon (EH, ~900–200 BC), and the other, characterized by uncut stone or mixed materials backfilled with layered fill, appears in the Late Intermediate Period (LIP)/Late Horizon (LH) (~AD 1000–1532) (Brown Vega 2009). In this paper, estimates derived from the relative dating of archaeological materials are noted as BC/AD, while ^{14}C dates are distinguished as ^{14}C yr BP or cal BC/AD.

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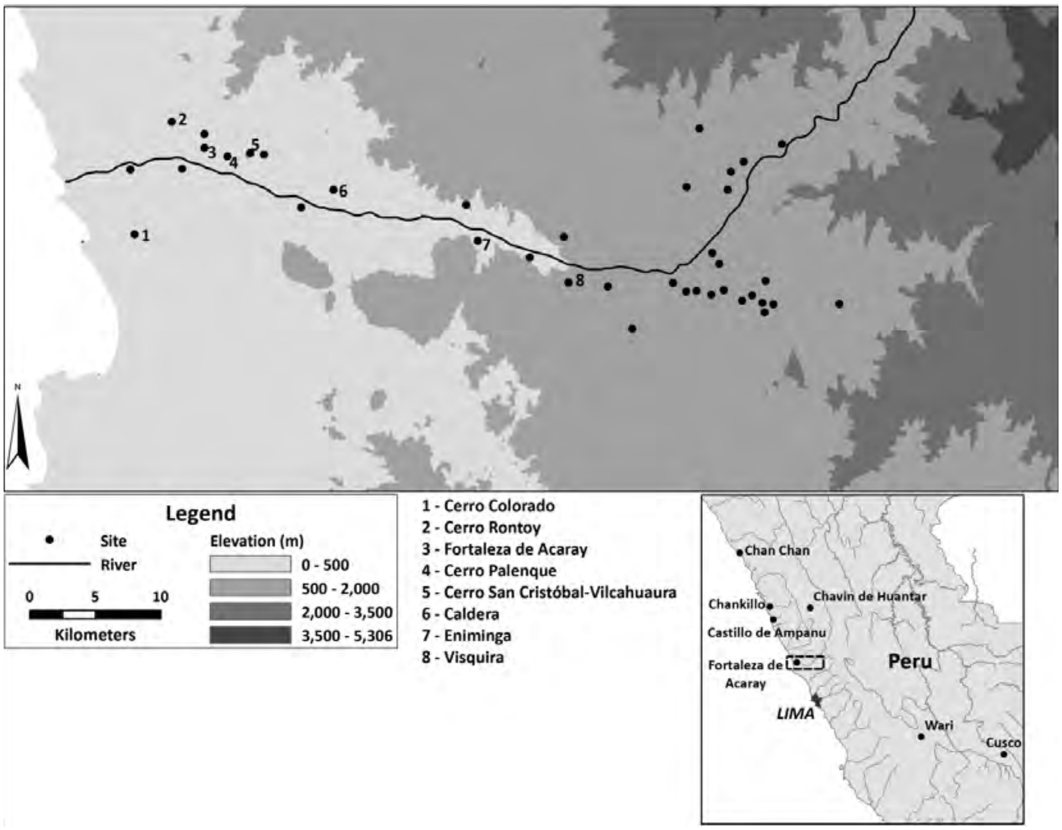

Figure 1 Map of the Huaura Valley with locations of documented fortifications. Inset shows other sites discussed in the text.

Table 1 Central Andean relative chronology.

Period	Date ranges
Preceramic Period	3000–1800 BC
Initial Period	1800–900 BC
Early Horizon	900–200 BC
Early Intermediate Period	200 BC–AD 600
Middle Horizon	AD 600–1000
Late Intermediate Period	AD 1000–1476
Late Horizon	AD 1476–1532

The Early Horizon (EH) has long been recognized as the earliest period of fort construction along the central and north coasts of Perú, possibly related to the expansion or collapse of an ideology associated with the prominent site of Chavín de Huántar (Wilson 1983, 1987, 1988; Proulx 1985; Daggett 1987; Ghezzi 2006, 2007; Ghezzi and Ruggles 2007; Brown Vega 2010). Yet, there are claims that EH fortifications were built slightly later in the Early Intermediate Period (EIP, ~200 BC–AD 600) (Chamussy 2009). In the EH, people at Acaray built the early configuration of the hilltop fort with large stone architecture. They quarried sizable blocks of square stone, which they fit together in a neatly ordered pattern to build walls with vertical façades. These larger building stones were held together with mud mortar and smaller stones. One previously published AMS ^{14}C date (Table 2) from organic material embedded in mortar on such a wall at Acaray yielded a date of 390–200 cal BC (2300 ± 30 BP; Brown Vega 2008), consistent with construction at the end of the EH.

Figure 2 Two dated wall styles from the Fortress of Acaray, showing part of the outer façade and the construction fill exposed by wall collapse: EH style (left) with rock and mortar, and LIP style (right) with plant layers visible. Scale on left is 50 cm. Photos by Brown Vega.

Table 2 Summary of prior ^{14}C dates from the Fortress of Acaray in the Huaura Valley. The last 3 dates come from samples taken directly from defensive walls, and were used as a baseline for assigning architecture to the EH or LIP. Dates (from Brown Vega 2009: Table 1) were calibrated with CALIB 5.0 (Stuiver et al. 2005), using the SHCal04 Southern Hemisphere calibration curve (McCormac et al. 2004).

Lab nr	Conventional ^{14}C age BP	2σ calibrated age	Period	Architectural style
ISGS-5983	2640 ± 90	902–479 BC (94%) 470–414 BC (6%)	EH	Large quarried stone masonry terrace
ISGS-5975	2390 ± 70	751–686 BC (8%) 667–638 BC (3%) 617–615 BC (0.1%) 594–203 BC (89%)	EH	Not applicable (burning event associated with terrace)
NOSAMS-60935	2300 ± 30	393–341 BC (30%) 327–204 BC (70%)	EH	Large quarried stone masonry with mortar
ISGS-5974	790 ± 70	AD 1159–1329 (84%) AD 1336–1391 (16%)	LIP	Smaller stone façade with layered fill
ISGS-5965	480 ± 70	AD 1396–1628	LIP/LH	Smaller stone façade with layered fill

Across much of the Central Andes, the LIP is considered to be a time of intensive conflict, and construction of fortifications was widespread (Parsons and Hastings 1988; Arkush 2006, 2011; Covey 2008; Brown Vega 2010). During this time, the Chimú and Inca empires expanded out of their heartlands (centered around the sites of Chan Chan and Cusco, respectively). The architecture at Acaray during this time was more expedient compared with the preceding EH construction episodes. This more expedient style may have continued into the LH. These later walls have sloped façades (battered). People reused previously quarried stone from the EH, and constructed walls in a more haphazard fashion. They also stacked much smaller stones or even old groundstone tools to build walls. Construction fill of these post-EH style walls consisted of alternating layers of plant material and small rock mixed with trash. Two conventional ^{14}C dates from Acaray from the plant layers in these walls were given in Brown Vega (2009): cal AD 1160–1390 (790 ± 70 ^{14}C yr BP; LIP), and cal AD 1400–1630 (480 ± 70 ^{14}C yr BP; LIP/LH). Based on these data, similar style walls were used to assign newly documented fortifications to 1 of these 2 broad time periods.

One additional type of stone architecture was observed at fortified sites in the Huaura Valley during survey. This architecture style is characterized by thinner walls with a vertical façade composed of smaller stones and assembled in a more careful fashion when compared to the LIP. Artifacts on the surface of these fortifications suggest they were constructed and used during the Middle Horizon (MH, ~AD 600–1000). The MH is poorly understood in the Huaura Valley. During this time, the first empires may have formed in the Central Andes, including the Wari Empire that developed and expanded out of the modern-day Ayacucho region, to the south of the Huaura Valley. The Wari Empire had a strong influence on populations elsewhere in the Andes. Militarism and violence were important for Wari's expansion, particularly close to its core (Tung 2007). It is not clear what impact the Wari Empire had in the Huaura Valley or neighboring regions (see Menzel 1977; Shady Solís and Ruiz Estrada 1979).

Relative dating of fortified architecture provides a working temporal framework for the development of defensive features, but should be considered a set of assumptions and hypotheses to be tested by independent chronological methods. Because of the reliance on pottery styles to determine the age of many archaeological sites in the Andes, including fortifications, discrepancies in temporal assignments are difficult to sort out without absolute dates. Aside from the Fortress of Acaray that yielded EH and LIP/LH dates, no other fortifications have been directly dated in the Huaura Valley, and very few have been directly dated in neighboring valleys (Brown Vega 2010). Absolute dates from secure contexts are needed to test and refine hypotheses based on the known cultural sequence of conflict.

Although no excavations were undertaken during the Huaura Valley fort survey, samples for direct dating were collected from architecture and exposed features at suitable sites. A few studies demonstrate the utility of AMS ^{14}C dating as a reconnaissance and survey tool (Erlandson and Moss 1999; Braje et al. 2005; Kennett et al. 2012). Because *Proyecto Awqa Pacha* is a long-term research program aimed at the rapid documentation of surface remains, and because so few of these forts have been absolutely dated, systematic sampling of organic material from architecture was integrated into the survey. AMS ^{14}C dates will help refine research questions at multiple scales, and provide a basis for designing more focused and intensive research in the future. Methods have been successfully employed to date organic inclusions from mortar and plaster in architecture (Mathews 2001; Rech et al. 2003; Rech 2004; Wyrwa et al. 2009; Al-Bashaireh and Hodgins 2011). In the case of the Huaura Valley samples, architectural mortars are not derived from limestones. They are composed of fine sediments with few inclusions that include small fragments of straw and other macrobotanical materials, carbon or shell fragments, and fine gravels. Samples that come directly from wall façades or construction fill provide a way to check temporal assignments that are based on stylistic characteristics. Moreover, absolute dates help to further refine temporal ranges of fort building in comparison to the broad temporal categories identified by the relative chronology (see Table 1).

SAMPLE SELECTION METHODS

Two methods were used for collecting samples for AMS ^{14}C dating. The first method involved the extraction of organic material completely embedded in preserved mud mortar in architecture. Sections of intact mud mortar situated between quarried stone of defensive walls were identified and sampled. The exposed surface was scraped back using a clean trowel. Tweezers were then used to scrape mud mortar into a sieve, allowing for organic material to be separated. Each sample was placed in a clean foil packet. When possible, organic pieces were placed directly from the wall mortar into the aluminum foil packet using tweezers.

When no preserved architecture or mud mortar was identified, samples were secured from construction fill that had been exposed by looting. In these cases, the stratigraphy revealed by the looter hole was carefully examined. Using a clean trowel, the profile was cut back several inches to remove disturbed material. Organic material exposed in these cleaned profiles was then removed using tweezers and deposited directly into a foil packet. These contexts yielded abundant macrobotanical remains.

Preference was given to sampling individual plant fibers (straw, annual grasses, or small plant fragments). Charcoal samples were acquired only in the absence of suitable uncharred plant materials. In total, 26 different contexts at 15 sites were sampled. A selection of 11 samples was analyzed during this initial phase of work. These samples were prioritized because they were deemed to be large enough to yield sufficient material for dating, and because, with 1 exception, they were grasses or small twigs. The 1 exception was a piece of charcoal that was paired with a sample of plant fibers from the same context.

LABORATORY METHODS

Sample pretreatment and combustion were carried out at The Pennsylvania State University (PSU). After removing visible sediment, samples were soaked in Nanopure® water at 70 °C for 20 min, and then subjected to dilute acid/base/acid (ABA) pretreatment in repeated baths in 0.1N HCl and 0.2N NaOH at 70 °C for 20 min on a heater block. The initial acid wash dissolved exogenous carbonate, and repeated base washes extracted organic contaminants such as humic acids. The final acid wash removed any secondary carbonates formed during the base treatment, and then the samples were rinsed in Nanopure water at 70 °C to remove chlorides. We note that standard concentrations for both reagents are typically 1N, but because most of the samples were uncarbonized, more dilute acid and base solutions were used to conserve as much of the material as possible. The combination of arid conditions in the project area and deposition within dry mud mortar left these plant materials relatively free of humic acids, so the dilute base was adequate to remove exogenous organics after only a few rounds. To give a sense of the sample sizes required for AMS ^{14}C dating and provide a guideline for archaeologists working in the region, we report the initial sample weight, treated sample weight, and the % yield in Table 3. Samples of roughly 1.8 mg pretreated material were packed using single pieces where possible. Noting that pretreatment yields average between 25% and 35% of the initial mass, uncarbonized samples ranging between 5 and 8 mg would be expected to provide adequate final C without incurring higher error values associated with small samples.

Sample CO_2 was produced by combustion at 900 °C for 3 hr in evacuated sealed quartz tubes using a CuO oxygen source and Ag wire to remove chloride compounds. Primary (OX-1) and secondary standards were selected to match the sample type and expected age, and Queets Wood was used as the background. The CO_2 generated at PSU was sent to the UC Irvine Keck Carbon Cycle AMS Facility (KCCAMS) and reduced to graphite at 550 °C using a modified hydrogen reduction method onto a Fe catalyst (Santos et al. 2004, 2007), with reaction water drawn off with $Mg(ClO_4)_2$. All ^{14}C ages were $\delta^{13}C$-corrected for mass dependent fractionation with measured $^{13}C/^{12}C$ values (Stuiver and Polach 1977). Because fractionation during sample graphitization or AMS measurement can cause these values to differ from the $\delta^{13}C$ of the original material, these values are not reported by KCCAMS. Conventional ages were calibrated with OxCal v 4.1 (Bronk Ramsey 2009) using the SHCal04 Southern Hemisphere atmospheric curve (McCormac et al. 2004). In Table 3, calibrated ages are reported as 2σ ranges. Some discontinuous ranges are glossed in the text for clarity.

Table 3 Summary of AMS results and weights for each sample.

Lab nr (UCIAMS-	Sample ID	Site	Description	Initial sample wt (mg)	Treated sample wt (mg)	% yield	Conv. ^{14}C age (BP)	2σ calibrated age
107498	ACA1	Fortress at Acaray	Unidentified plant fibers from preserved mud mortar on the exterior façade of uppermost defensive wall of Sector B (Muralla B3) (Brown Vega 2008).	8.06	2.26	28.0%	2150 ± 15	186–46 BC
107499	FID47	Caldera	Unidentified twig bark from preserved mud mortar on the exterior façade of the uppermost defensive wall.	23.60	9.06	38.4%	2105 ± 15	164–130 BC (9.3%) 120 BC–AD 6 (85.2%) AD 12–18 (1.0%)
107500	FID2A	Cerro Colorado	Unidentified plants fibers and small twigs from preserved mud mortar of wall base of summit platform retaining wall. Paired sample with UCIAMS-107501.	10.13	2.96	29.2%	535 ± 20	AD 1409–1446
107501	FID2B	Cerro Colorado	Unidentified burnt twig (charcoal) from preserved mud mortar of wall base of summit platform retaining wall. Paired sample with UCIAMS-107500.	6.32	4.11	65.0%	460 ± 15	AD 1440–1485
107502	PAL1	Cerro Palenque	Unidentified plant fibers from mud mortar exposed by looter's hole on the interior façade of summit platform retaining wall.	7.73	4.56	59.0%	155 ± 15	AD 1684–1730 (24.6%) AD 1802–1819 (7.5%) AD 1826–1894 (40.1%) AD 1909–1953 (23.2%)
107503	FID26	Cerro Rontoy	Unidentified small twig pieces from preserved mud mortar on the exterior façade of the second defensive wall.	17.01	5.66	33.3%	2180 ± 15	344–324 BC (3.8%) 205–54 BC (91.6%)
107504	RNT1	Cerro Rontoy	Unidentified twig from preserved mud mortar on the exterior façade of the lower defensive wall.	2.28	0.62	27.2%	2160 ± 15	195–52 BC
107505	FID25	Cerro Rontoy	Partially burnt unidentified twig from underneath an inner course of the lower defensive wall, just above bedrock.	56.28	13.39	23.8%	2475 ± 20	746–688 BC (14.5%) 665–647 BC (3.4%) 587–581 BC (0.5%) 553–401 BC (77.1%)
107506	FID12	Cerro San Cristóbal, Vilcahuaura side	Cane from layer of construction fill of a terrace located outside the lowest defensive wall. Layer was exposed by a looter's hole in terrace.	36.09	14.83	41.1%	2145 ± 15	179–44 BC
107507	FID45	Eniminga I	Unidentified twig from a layer of construction fill of the summit platform. Layer was exposed by a looter's pit. Exposure showed 5 layers of plant remains with gravel layers in between. Sample came for bottommost plant layer.	40.11	11.52	28.7%	2220 ± 15	359–277 BC (45.9%) 260–242 BC (2.1%) 236–152 BC (44.1%) 136–114 BC (3.3%)
107508	FID41	Visquira	Unidentified plant fibers from preserved mud mortar on the exterior façade of a stone wall built on 1 summit of the site.	3.25	0.47	14.5%	1315 ± 25	AD 671–825 (92.1%) AD 840–862 (3.3%)

RESULTS AND DISCUSSION

Table 3 summarizes the results and includes brief descriptions of the materials sampled as well as their context.

Early Horizon (EH) and Early Intermediate Period (EIP) Dates

Based on surface features, 33 fortifications in the Huaura Valley were tentatively assigned to the EH. Seven of the 11 samples analyzed from the Huaura Valley are relevant for understanding warfare during the EH (Figure 3). The lead author hypothesized that 6 of these samples should correspond to the EH based on architectural style observed at other relatively dated EH forts. The 7 dates range between the 9th century BC and 1st century AD. Date ranges for only 2 of the samples correspond with the EH temporal period. The ranges for the other 5 samples primarily fall in the early EIP. These results help refine when during the EH some defensible settlements were constructed. More importantly, however, the other dates suggest that the initial building of walled fortifications occurred during the transition from the EH to the EIP.

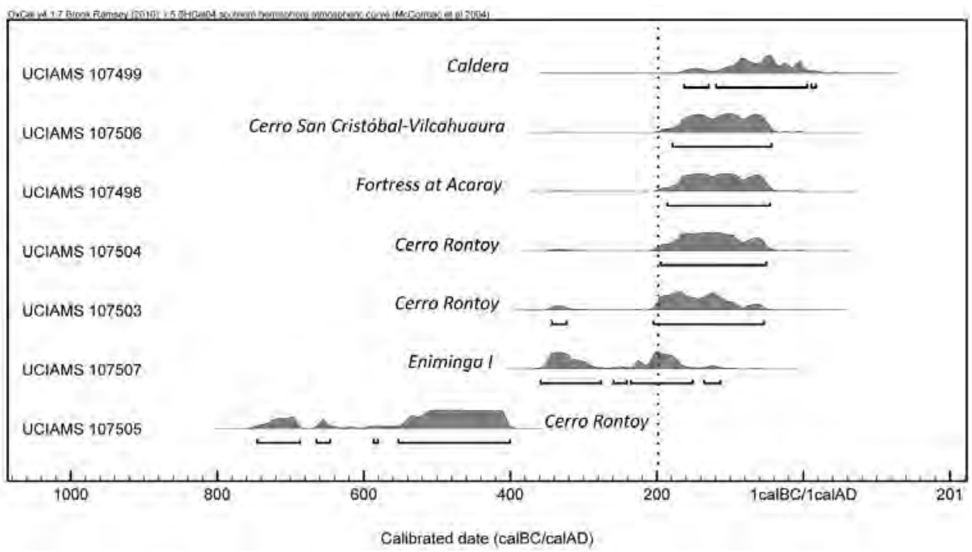

Figure 3 Two-sigma calibrated EH and EIP dates. The dotted line represents the boundary according to the relative chronology between the EH and EIP.

The oldest date is from a lower defensive wall at Cerro Rontoy built during the EH (746–401 cal BC; UCIAMS-107505). This sample was taken from beneath an inner course of wall built of a variety of materials, including large cobbles and smaller rock. This construction style suggested the wall was built in the Late Intermediate Period/Late Horizon (LIP/LH). The date does not confirm this assessment. There are 2 possible explanations for this: 1) the construction materials of the inner course (versus the façade) of the defensive wall may not be temporally diagnostic; or 2) an older twig preserved in this arid environment (see Kennett et al. 2002) was incorporated into the architecture. Further study of the construction and associated rubble of this wall might resolve this issue. This date also falls within a plateau in the calibration curve (Hallstatt plateau) at ~750–400 BC (~2450 BP, see Guilderson et al. 2005; Malainey 2011), and it is difficult to date sites from this interval with great precision. The other 6 dates fall outside of this problematic portion of the curve.

A hilltop platform at the site of Eniminga I dates to 359–114 cal BC (UCIAMS-107507). This date places construction at the tail end of the EH and extending into the early EIP. Two dates from the upper second and third defensive walls at Cerro Rontoy indicate they were effectively contemporary, and that these walls were most likely constructed during the early part of the EIP (344–54 cal BC, UCIAMS-107503; and 195–52 cal BC, UCIAMS-107504). A sample from a defensive wall in Sector B of the Fortress at Acaray yielded a date firmly in the early EIP (186–46 cal BC; UCIAMS-107498). The sample from Caldera dates the upper defensive wall to the EIP as well (164 cal BC–cal AD 18; UCIAMS-107499). The sample from Cerro San Cristóbal (Vilcahuaura side) is not from a defensive wall, but from a domestic terrace located within one of the defensive walls (179–44 cal BC; UCIAMS-107506). These 6 dates are consistent with prior ^{14}C dates for other EH fortresses that were constructed at the end of the EH and into the early EIP in the Casma and Culebras valleys (Ghezzi and Ruggles 2007; Giersz and Prządka 2009). In these 3 valleys (Casma, Culebras, and Huaura), this early period of fort construction begins very late in the EH or at the boundary of the EH and the EIP.

The oldest date from Cerro Rontoy, if accepted, and the date from Eniminga suggest that in the Huaura Valley some construction of architecture on hilltops began earlier in the EH. Two prior published samples from hillside domestic terraces at the Fortress at Acaray also date to the earlier part of the EH, lending support to his hypothesis: 751–203 cal BC (2390 ± 70 ^{14}C yr BP; ISGS 5975) and 902–414 cal BC (2640 ± 90 ^{14}C yr BP; ISGS 5983) (Brown Vega 2009). Yet, at the other newly dated sites discussed here there is evidence that people did not build concentric defensive walls until the very end of the EH, and more likely the early part of the EIP. All but 1 of these sites (Eniminga I) have archaeological assemblages suggesting reuse of these locations in later time periods. Thus, the dates reflect 1 temporal component of a longer occupation history.

Middle Horizon (MH) and Later Dates

A recent study indicated that the MH in the Huaura Valley was not characterized by a defensive settlement pattern (Nelson et al. 2010). Twelve fortifications in the Huaura Valley were tentatively assigned to the MH based primarily on surface ceramic assemblages (Brown Vega et al. 2011). The result from a single sample from the site of Visquira (UCIAMS-107508) is the first direct date to confirm the construction of defensive architecture during the MH. This new date calls into question prior characterizations of the settlement pattern for this period (see Nelson et al. 2010). The sample indicates that reconstruction on the summit of Visquira, a reoccupied fort with abundant EH materials, took place cal AD 671–862, during the first half of the MH (Figure 4). While 1 sample cannot definitively indicate that this wall style dates to the MH, it is a point of departure for further work.

Orientation of defensive features and viewshed analysis at the Fortress at Acaray suggest a threat from the north during the LIP, possibly from the expanding Chimú Empire (Brown Vega 2008, 2009). Twenty fortifications in the Huaura Valley were tentatively assigned to the LIP (Brown Vega et al. 2011). Pottery, architectural layout, and the style of the summit platform wall at Cerro Colorado suggested initial construction of the site during the EH, although the presence of LIP pottery on the site indicated the site was multicomponent. The 2 samples taken from mortar within the summit platform wall indicate construction took place in the 15th century at the end of the LIP (cal AD 1409–1446, UCIAMS-107500; and cal AD 1440–1485, UCIAMS-107501; see Figure 3). There is only some overlap in the 2 dates. The slightly younger date is from charcoal. In this instance, old wood does not appear to be a confounding factor. These dates confirm prior assertions that the fort at Cerro Colorado has a Late Intermediate Period (LIP) component (Ruiz Estrada 1999). The dates are consistent with temporal assignments based on pottery styles found on the surface of the site. However, the late LIP dates from Cerro Colorado are much later than LIP dates for the Fortress of Acaray, suggesting either a lengthy period of fort construction in the LIP or multiple pulses of fort construction during this period. In addition, due to uncertainty regarding the incorporation of the Huaura Valley into the Inca Empire and recent issues raised about the chronology for Inca state expansion (Ogburn 2012), we cannot rule out the possibility that Cerro Colorado may date to Inca times.

The sample from the fort at Cerro Palenque came from a hypothesized EH-style wall. However, the date (cal AD 1684–1953, UCIAMS-107502) indicates that the organic matter from the wall mortar is historic, but sometime before AD 1950 (pre-bomb age). It is not clear why this would be the case. No colonial or Republican period materials (post-AD 1532) were identified on the surface of the site, and there is no indication that the site was used during these later time periods. Unlike other fortifications encountered in the Huaura Valley that show clear signs of more recent historic use for ceremonies, Cerro Palenque shows no such signs.

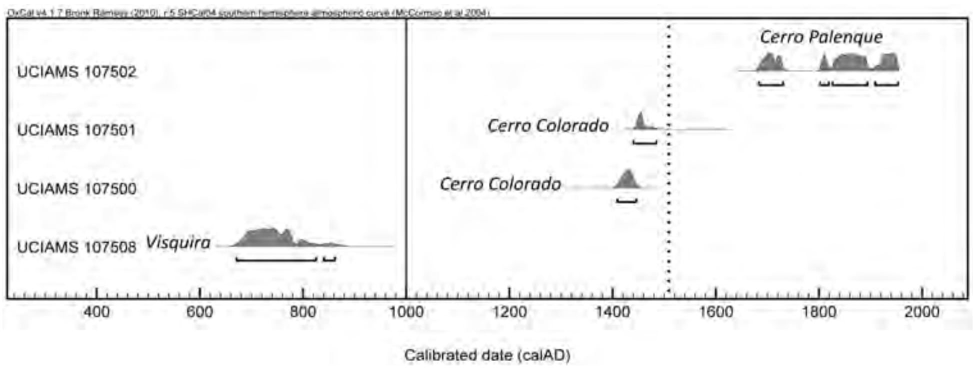

Figure 4 Two-sigma calibrated Middle Horizon (MH), Late Intermediate Period (LIP), and later date. The solid black line represents the beginning of the LIP according to the relative chronology. The dotted line represents AD 1532, the year that marks the beginning of the Late Horizon (LH) according to the relative chronology.

CONCLUSION

Samples of organic matter recovered from mud mortar and exposed stratigraphy were used to ^{14}C date architectural features at 8 fortifications in the Huaura Valley. The method of extracting organic material embedded in mortar or exposed construction fill is shown to be an effective way to directly date architecture at fortifications without undertaking extensive excavations. This work provides the basis for additional AMS ^{14}C work on architecture in this region. The data set points to multiple periods of conflict in this valley.

Based on current data, some hilltop sites with defensive characteristics are built during the early and middle EH in the Huaura Valley. However, the building of perimeter defensive walls at hilltop sites dates to the early stages of the EIP, possibly beginning at the very end of the EH. Another phase of fort construction is also tentatively proposed for the MH. However, more MH fortifications need to be absolutely dated to see if the others date to the same part of the MH (early) or later. The late LIP is also a period of interest, since it comes right before the Inca Empire became firmly established across much of the coast of Perú. While localized LIP conflict may have characterized the earlier part of this period, late LIP forts in the Huaura Valley may be related to the expansion of either the Chimú or Inca empires into the area. The possibility that both empires may have had an overlapping presence in the Huaura Valley must be considered.

These new dates not only refine the chronology of fort building in the Huaura Valley, but bear on our understanding of conflict for the last 2000+ yr at a regional scale. The construction and use of fortifications relates to widespread sociopolitical and cultural changes. Although numerous fortifications have been identified in the Andean region, they have been dated primarily on the basis of pottery styles, allowing for no more than coarse correlations to the horizons and intermediate periods of the Central Andean relative framework. These results contribute to a growing body of absolute dates that specify when fortifications were built. They also raise issues about the utility of the EH/EIP and LIP/LH divisions of the relative chronology. Anticipated future funding will permit samples collected from elsewhere in the Huaura and Fortaleza valleys to be analyzed. Continued field research employing the same dating methods holds great promise for rapidly securing samples from standing architecture. However, future sampling strategies will need to incorporate minimal subsurface testing if intact contexts with organic material are to be found, especially at up-valley sites where preservation of wall mortar is less likely. These data, nevertheless, are the first step toward assembling a ^{14}C database with which to examine regional patterns of Prehispanic warfare and cultural change along the central coast of Perú.

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REFERENCES

Al-Bashaireh K, Hodgins GWL. 2011. AMS ^{14}C dating of organic inclusions of plaster and mortar from different structures at Petra-Jordan. *Journal of Archaeological Science* 38(3):485–91.

Allen MW. 2008. Hillforts and the cycling of Maori chiefdoms: Do good fences make good neighbors? In: Railey JA, Reycraft RM, editors. *Global Perspectives on Collapse of Complex Systems*. Albuquerque: Maxwell Museum of Anthropology. p 65–81.

Arkush EN, Stanish C. 2005. Interpreting conflict in the ancient Andes. *Current Anthropology* 46(1):3–28.

Arkush EN. 2006. Collapse, conflict, conquest: the transformation of warfare in the Late Prehispanic Andean Highlands. In: Arkush EN, Allen MW, editors. *The Archaeology of Warfare: Prehistories of Raiding and Conquest*. Gainesville: University Press of Florida. p 286–335.

Arkush EN. 2011. *Hillforts of the Ancient Andes: Colla Warfare, Society, and Landscape*. Gainesville: University Press of Florida.

Braje TJ, Erlandson JM, Rick TC. 2005. Reassessing human settlement on the south coast of San Miguel Island, California: the use of ^{14}C dating as a reconnaissance tool. *Radiocarbon* 47(1):11–9.

Bronk Ramsey C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51(1):337–60.

Brown Vega M. 2008. War and social life in Prehispanic Perú: ritual, defense, and communities at the fortress of Acaray, Huaura Valley [PhD dissertation]. Urbana-Champaign: University of Illinois at Urbana-Champaign.

Brown Vega M. 2009. Conflict in the Early Horizon and Late Intermediate Period: new dates from the fortress of Acaray, Huaura Valley, Perú. *Current Anthropology* 50(2):255–66.

Brown Vega M. 2010. Regional patterns of fortification and single forts: evaluating the articulation of regional sociopolitical dynamics with localized phenomena. In: Cutright R, Hurtado Lopez E, Martin A, editors. *Comparative Perspectives on the Archaeology of Coastal South America*. Pittsburgh: Center for Comparative Archaeology, University of Pittsburgh; Quito: Fondo Editorial, Pontificia Universidad Católica del Perú; Lima: Ministerio de Cultura del Ecuador. p 169–89.

Brown Vega M, Craig N, Asencios Lindo G. 2011.

Ground truthing of remotely identified fortifications on the central coast of Perú. *Journal of Archaeological Science* 38(7):1680–9.

Chamussy V. 2009. *Les débuts de la guerre institutionnalisée dans l'Aire Andine Centrale: versla formation de l'État, du Formatif à la Période Intermédiaire Ancienne*. BAR International Series 2017. Oxford: Archaeopress.

Covey RA. 2008. Multiregional perspectives on the archaeology of the Andes during the Late Intermediate period (c. A.D. 1000–1400). *Journal of Archaeological Research* 16(3):287–338.

Daggett R. 1987. Towards the development of the state on the north central coast of Peru. In: Haas J, Pozorski S, Pozorski T, editors. *The Origins and Development of the Andean State*. New York: Cambridge University Press. p 70–82.

Erlandson JM, Moss ML. 1999. The systematic use of radiocarbon dating in archaeological surveys in coastal and other erosional environments. *American Antiquity* 64(3):431–43.

Field JS. 2008. Explaining fortifications in Indo-Pacific prehistory. *Archaeology in Oceania* 43:1–10.

Field JS, Lape PV. 2010. Paleoclimates and the emergence of fortifications in the tropical Pacific Islands. *Journal of Anthropological Archaeology* 29(1):113–24.

Ghezzi I. 2006. Religious warfare at Chankillo. In: Isbell W, Silverman H, editors. *Andean Archaeology III: North and South*. New York: Springer. p 67–84.

Ghezzi I. 2007. La naturaleza de la guerra prehispánica temprana: la perspectiva desde Chankillo. *Revista Andina* 44:199–226.

Ghezzi I, Ruggles C. 2007. Chankillo: a 2300-year-old solar observatory in coastal Peru. *Science* 315(5816): 1239–43.

Giersz M, Prządka P. 2009. Cronología cultural y patrones de asentamiento prehispánico en el Valle del Río Culebras, costa norcentral del Perú. *ARKEOS: Revista Electrónica de Arqueología PUCP* 4(11):1–40.

Guilderson TP, Reimer PJ, Brown TA. 2005. The boon and bane of radiocarbon dating. *Science* 307(5708): 362–4.

Keeley LH, Fontana M, Quick R. 2007. Baffles and bastions: the universal features of fortifications. *Journal of Archaeological Research* 15(1):55–95.

Kennett DJ, Ingram BL, Southon JR, Wise K. 2002. Differences in ^{14}C age between stratigraphically associated charcoal and marine shell from the Archaic period site of Kilometer 4, southern Peru: old wood or old water? *Radiocarbon* 44(1):53–8.

Kennett DJ, Anderson A, Prebble M, Conte E, Southon J. 2006. Prehistoric human impacts on Rapa, French Polynesia. *Antiquity* 80(308):340–54.

Kennett DJ, Culleton BJ, Anderson A, Southon J. 2012. A Bayesian AMS ^{14}C chronology for the colonization and fortification of Rapa. In: Anderson A, Kennett DJ, editors. *Taking the High Ground: The Archaeology of Rapa, a Fortified Island in Remote East Polynesia*. Terra Australis: Australia National University Press.

Malainey ME. 2011. *A Consumer's Guide to Archaeological Science: Analytical Techniques*. New York: Springer.

Martindale A, Supernant K. 2009. Quantifying the defensiveness of defended sites on the northwest coast of North America. *Journal of Anthropological Archaeology* 28(2):191–204.

Mathews JP. 2001. Radiocarbon dating of architectural mortar: a case study in the Maya region, Quintana Roo, Mexico. *Journal of Field Archaeolog*y 28(3–4): 395–400.

McCormac FG, Hogg AG, Blackwell PG, Buck CE, Higham TFG, Reimer PJ. 2004. SHCal04 Southern Hemisphere calibration 0–11.0 cal kyr BP. *Radiocarbon* 46(3):1087–92.

Menzel D. 1977. *The Archaeology of Ancient Peru and the Work of Max Uhle*. Berkeley: R H Lowie Museum of Anthropology, University of California.

Nelson K, Craig N, Perales M. 2010. Piecing together the middle: the Middle Horizon in the Norte Chico. In: Jennings JD, editor. *Beyond Wari Walls*. Albuquerque: University of New Mexico Press. p 171–87.

Ogburn DE. 2012. Reconceiving the chronology of Inca imperial expansion. *Radiocarbon* 54(2):219–37.

Parkinson WA, Duffy PR. 2007. Fortifications and enclosures in European prehistory: a cross-cultural perspective. *Journal of Archaeological Research* 15(2):97–141.

Parsons JR, Hastings CM. 1988. The Late Intermediate Period. In: Keatinge RW, editor. *Peruvian Prehistory: An Overview of Pre-Inca and Inca Society.* Cambridge: Cambridge University Press. p 190–229.

Proulx DA. 1985. *An Analysis of the Early Cultural Sequence in the Nepeña Valley, Peru*. Amherst: Department of Anthropology, University of Massachusetts.

Rech JA. 2004. New uses for old laboratory techniques. *Near Eastern Archaeology* 67(4):212–9.

Rech JA, Fischer AA, Edwards DR, Jull AJT. 2003. Direct dating of plaster and mortar using AMS radiocarbon: a pilot project from Khirbet Qana, Israel. *Antiquity* 77(295):155–64.

Ruiz Estrada A. 1999. *Tesoros arqueológicos de Huacho*. Hoyos I, editor. Huacho: Ediciones Didacta.

Santos GM, Southon JR, Druffel-Rodriguez K, Griffin S, Mazon M. 2004. Magnesium perchlorate as an alternative water trap in AMS graphite sample preparation: a report on sample preparation at the KCCAMS facility at the University of California, Irvine. *Radiocarbo*n 46(1):165–73.

Santos GM, Southon JR, Griffin S, Beaupre SR, Druffel ERM. 2007. Ultra small-mass AMS ^{14}C sample preparation and analyses at KCCAMS/UCI Facility. *Nuclear Instruments and Methods in Physics Research B* 259(1):293–302.

Schaepe DM. 2006. Rock fortifications: archaeological insights into pre-contact warfare and sociopolitical organization among the Stó:lo of the Lower Fraser River Canyon, B.C. *American Antiquity* 71(4):671–705.

Shady Solís R, Ruiz Estrada A. 1979. Evidence for interregional relationships during the Middle Horizon on the north-central coast of Peru. *American Antiquity* 44(4):676–84.

Stuiver M, Polach HA. 1977. Discussion: reporting of ^{14}C data. *Radiocarbon* 19(3):355–63.

Stuiver M, Reimer PJ, Reimer RW. 2005. CALIB 5.0 Radiocarbon Calibration [WWW software and documentation]. URL: http://calib.qub.ac.uk/calib/.

Topic JR, Topic TL. 1987. The archaeological investigation of Andean militarism: some cautionary observations. In: Haas J, Pozorski T, Pozorski S, editors. *The Origins and Development of the Andean State*. Cambridge: Cambridge University Press. p 47–55.

Tung TA. 2007. Trauma and violence in the Wari Empire of the Peruvian Andes: warfare, raids, and ritual fights. *American Journal of Physical Anthropology* 133:941–56.

Wilson DJ. 1983. The origins and development of complex Prehispanic society in the Lower Santa Valley, Peru: implications for theories of state origins. *Journal of Anthropological Archaeology* 2(3):209–76.

Wilson DJ. 1987. Reconstructing patterns of early warfare in the Lower Santa Valley: new data on the role of conflict in the origins of complex north coast society. In: Haas J, Pozorski S, Pozorski T, editors. *Origins and Development of the Andean State*. New York: Cambridge University Press. p 56–69.

Wilson DJ. 1988. *Prehispanic Settlement Patterns in the Lower Santa Valley, Peru: A Regional Perspective on the Origins and Development of Complex North Coast Society*. Washington, DC: Smithsonian Institution Press.

Wyrwa AM, Goslar T, Czernik J. 2009. AMS ^{14}C dating of Romanesque rotunda and stone buildings of a Medieval monastery in Łekno, Poland. *Radiocarbon* 51(2):471–80.