Chronology, mound-building and environment at Huaca Prieta, coastal Peru, from 13 700 to 4000 years ago

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The article by Dillehay et al. *in* Antiquity *86 summarised recent research at the mound of Huaca Prieta on the north coast of Peru where a first human presence was documented between ~13 700 and 13 300 cal BP, a combined maritime and incipient crop economy developed between ~9000 and 4000 cal BP and mound building began ~7500 cal BP. The findings contribute to knowledge of the origins of ancient monuments across the globe and to understanding the rise of early social complexity on the coast of Peru. The campaign also included exploratory work on the remnant Pleistocene terrace which has Huaca Prieta at its tip (Figure S1). The supplementary material provided here gives essential data on the floodplain, the stratification of the mound, structural features in the mound, the subsistence economy and domestic sites beyond the mound.*

Keywords: Peru, Holocene, ritual mound, horticulture

SOL 1. Floodplain deposits

The specific floodplain deposits of interest here comprise 1–8m of sand, mud and carbonate sediments that were deposited within various river, floodplain and coastal settings over the past 8000 years. The base of the Holocene sequence is readily identified by a sandy gravel and cobble surface that represents alluvial fan deposition during the late Pleistocene. The earliest Holocene sediments deposited over the lowstand gravels are silty, fine to medium sands typically found 6–8m below the modern surface. These sands are non-fossiliferous and lack any mud drapes or associated overbank muds, suggesting that they are channel and bar deposits of a largely clear-water, bedload-dominated stream channel, one presumably fed by meltwater from snow and glaciers in the Andean highlands. Such a fluvial system is probably not unlike the modern Chicama River during normal discharge regimes (i.e. a non-El Niño year). These fluvial sands are sharply overlain by a complex sequence of well-bedded lagoon deposits that extend <1km inland of the modern shoreline, reflecting the backwater influence of rising sea level. These Early Holocene lagoon sediments are 1–3m thick and characterised by thick, alternating layers (5–20cm) of algal carbonates (primarily *Charophyta*) and micro-fossiliferous blue muds (primarily *Ostracoda*). The ecology of both types of deposits is species depauperate (<6 total species) with intermittent wood, detrital organic layers and seagrass seeds (*Ruppia maritima*). Based on sediment lithology and ecological communities, these units reflect a predominantly oligotrophic and oligohaline lagoon, perhaps groundwater fed, with fringing wetland vegetation, a weak to intermittent connection to the sea and limited fluvial sediment input. Found at depths of 3–6m below the modern surface, three radiocarbon dates near the base of the lagoonal sequence bound its lower age to ~7500 cal BP (~6939–7483 cal BP, see Table 1), with one shallower date (6404–6538 cal BP) showing that this open-water lagoon persisted for at least 1000 years. These lagoon deposits correspond with the deepest pre-mound and early mound building layers at Huaca Prieta, located on the lower inland side of the terrace and dated to ~9000–7600 cal BP (Table 1). Preliminary data indicate that the lowstand gravels are overlain by dark to silty sands that roughly correspond to the ~9000–8000 cal BP phase of initial site occupation and probably represent an environment similar to the shallow, outwash wetland channels carved into the gravels and filled with vegetated sands and muds

located 2–20km to the north of the site today. These data confirm that early settlement and mound building at Huaca Prieta was coincident with the long-term development of an expansive wetland-fringed, estuarine lagoon.

After ~6500 cal BP, the carbonate and muddy lagoon sediments become increasingly rare in the stratigraphic record and are permanently replaced in the upper 3m by 10cm-thick, yellowish-brown silt layers. The silt deposits are massively bedded and characteristic of the modern floodplain, thus reflecting a major environmental transition from open-water lagoon to emergent riverine floodplain. This conversion began by at least 5000 cal BP and appears to have been largely complete by ~4500 cal BP as indicated by a complete lack of carbonate or fossiliferous mud layers after this time. Sediments between the lagoon deposits and floodplain silts contain regular organic-rich horizons that represent ephemeral wetlands that existed during the transition. The driving mechanism for this environmental change requires an increased flux of riverine sediment to the coast, which infilled the lagoon and developed an expansive subaerial floodplain, which provided additional cultivable land.

SOL 2. Mound stratigraphy

The stratigraphy of the mound is complex. Certain individual strata within the mound represent discrete cultural use components and others collectively constitute single components. Others cease toward one end or both horizontal ends of the mound in such a fashion that the underlying layers unite to clasp them and hold them within a uniform mass. Others join up laterally, like fingers extending from the palm of the hand, signalling contemporaneous strata (Figures 5–7). Thus, there is little current evidence to suggest that a single use or construction layer ever completely and evenly developed across the site, although such surfaces surely once existed. Furthermore, all stratigraphic components must have been subjected to different rates of deposition, as a result of short- or long-term use episodes, construction phases and, very infrequently, the deposition of thin water-borne and wind-borne deposits in the basal levels. It was thus necessary to clearly distinguish between these types of strata and those that represent physical boundaries between components. A case in point is a succession of strata that represent

intermittent use episodes with time gaps between episodes. In such cases, the sediments at the point of juncture between any two components may be a floor, a fill layer or an architectural wall or room. To isolate discrete use episodes and component assemblages involved differentiating between fill and primary-deposition units, the latter best defined by floors and their *in situ* features and artefact offerings located on floors. Another important element in the stratigraphic analysis was the common practice of burying the dead in fills under floors in the mound. Graves served as reliable stratigraphic markers. Knowing the site was comprised of discrete depositional units, we devised an excavation strategy to examine and date as many horizontal and vertical components as possible by conducting deep trenching and horizontal stripping to examine strata, floors and features. We also carried out extensive off-mound trenching and block excavation to detect associated domestic areas (Figure S2). Given these stratigraphic characteristics, the excavation of the site involved a variety of techniques ranging from wall clearing, floor and use-surface stripping, trenching, block excavation or some other tactic designed to expose vertical profiles of a wide variety of cultural deposits both on and off the mound.

SOL 3. Observations on the architectural phases

Remnants of the pre-mound occupation and the subsequent early mound layers of Phases II and III were eventually deeply buried beneath later mound constructions, thus making it very difficult to expose them during excavation. Bird's (Bird *et al*. 1985: 35–43, 51–8) excavations were located on the ramp on the east side of the mound (HP-3), on its western edge (HP-2), and on top of it (HP-3), areas all dating to Phases IV and V. His excavations never reached the deeper, more interior layers of the mound, which are located ~3–4m directly below and behind the foundation stones of the Phase III retention wall. Thus, Bird's excavations in HP-3, the long north to south-trending trench on the eastern flank of the mound, exposed stratigraphy primarily associated with the ramp during Phases IV and V, which accounts for all of his radiocarbon dates between ~4500 cal BP and younger. His work in this area also exposed a stone-faced retention wall built during Phases III and IV, which was later covered by construction of the ramp during Phase V. Bird (Bird *et al*. 1985: 40–1) reports that he terminated excavation in HP-3

when he reached a culturally sterile conglomerate rock layer, but what he exposed was an artefact-free fill composed of rock and clean sediments, which corresponds to our stratum 35 in this unit (Figure 5). Our excavation below stratum 35 recovered nearly 3m more of cultural deposits.

Bird (Bird *et al*. 1985: 43–6) thought that the Phase III circular sunken pit on the south side of the mound was a looter's hole. However, our excavations have revealed that it is a sunken plaza defined by a series of stone-faced, stepped platforms and small rooms with stone walls constructed across a deep, roughly circular, concave-pit measuring ~25m in diameter. Shell, coca, bird feathers and other offerings, dating from at least ~4000 cal BP, were recovered from floors of the rooms and platforms of the plaza. The north end of the plaza ascends through a sinuous pathway to connect to burial chambers located on top of the mound that date to Phases III, IV and V.

After each use and building episode, the mound was completely capped by a hardened artificial cement layer composed of saltwater, sediment, ash, crushed shells and other organic debris. These layers not only sealed the prior floors and fills but also prevented erosion of the site. Scattered among the floors and rooms are artefacts, extensive burned areas and deposits of ash and charcoal, articulated and disarticulated human remains, and ritual offerings. No hearths, post-holes, storage pits, food containers and other indicators of domestic occupation were recovered from the mound. While Bird (Bird *et al*. 1985: 43–8) thought that the small, low-ceiling stone rooms (~1m high and 2–3m in diameter) on top of the mound were habitation structures, our excavations indicate they are burial chambers (cf. Rick 1990) containing articulated human skeletons and dated to Phases III–V. Human burials were recovered from all mound-building phases, suggesting the structure was closely associated with mortuary rituals. However, the most prevalent activity associated with the mound is thousands of individual burning episodes within and across all strata in the site, suggesting it was built by limited groups of people during numerous ritual and construction episodes over a period of ~3500 years. Also notable is the absence of domestic debris throughout the mound. Off-mound domestic areas appear ~7000 cal BP just north of the mound (Units 16 & 24), near Paredones and at domestic sites located several kilometres north in the coastal wetlands (Figure S1).

SOL 4. Subsistence economy

We recovered over 200 000 floral and faunal remains representing more than 360 individual species (Vasquez & Tham 2010), 65 of which correspond with Bird's findings in the 1940s (Bird *et al*. 1985: 229–44). A detailed quantitative report on the specific taxa far exceeds the space limits here, thus a brief listing of the major species is provided. Marine species dominate throughout all time periods, with fish and shellfish being the most abundant and diverse remains. There are 34 shellfish species: *Chiton, Fissurella, Collisella, Tegula, Polinices, Concholepas, Oliva, Cancellaria, Helisoma, Protothaca, Semele*; 5 crustacean species: *Cancer, Platyxanthus*; 2 echinoderm species: *Tetrapygus, Caenocentrotus*; 19 fish species: *Galeorhinus, Mustelus, Squatina, Rhinobatos, Myliobatis, Galeichthys, Engraulins, Ethmidium, Sardinops, Mugil, Trachurus, Sciaena, Anisotremus, Sarda*; 11 bird species: *Spheniscus, Diomedea, Charadrius, Larus, Egretta, Pelecanus thagus, Phalacrocorax, Sula, Zenaida, Podylimbus, Anas,* and 8 mammalian species: *Cavia, Canis, Lycalopex, Otaria, Balanidae, Delphinus, Odocoileus, Lama*. The frequency of these species changes throughout time, which probably reflects changes in the local environment.

Bird also recovered squash, chili pepper, lima bean, jack bean, gourd, cotton and other cultivars (Bird 1948; Bird *et al*. 1985: 229–40). Results of our macro-botanical study of floated feature fills and floor sediments, as well as starch grain, phytolith and pollen analyses, have added several additional species, including Preceramic maize (*Zea mays*), coca (*Erythroxylum coca*), peanut (*Arachis hypogaea*), chirimoya or guanábana (*Annona* sp.), pacae (*Inga feuillei*), sweet potato (*Ipomoea batatas*), yuca (*Manihot esculenta*), avocado (*Persea* sp.), quinoa (*Chenopodium* sp.), bean (*Phaseolus vulgaris* & *Phaseolus lunatus*), various tubers (*Solanum* sp.) and other crops. Not yet determined for some species is whether the morphological features are associated with domesticated forms. All of these crops are exotic to the littoral zone of the site.

Our combined ecological and dietary evidence indicates that the initial economy of Phase I (~9000–7500 cal years ago) depended primarily on fish, shellfish, birds, seaweeds and sea lions. Squash (*Cucurbita* sp.), lima bean, and avocado were minor food elements.

Between ~7000–6000 cal BP, chili pepper (*Capsicum* sp.) and gourds (*Lagenaria siceraria*) were added. Around 6800 cal BP (Table 1), when the deltaic floodplain began to form, there is evidence for cotton production. Corn and the other crops were incorporated in Phases II to V, after ~6500 cal BP. Although increases in plant species show a continuous greater reliance on cultigens, marine species dominated the diet throughout all phases.

SOL 5. Off-mound domestic sites

Our research also located 38 Preceramic domestic sites between the shoreline and backwater wetlands within 100m to 20km of Huaca Prieta (Figure S1). Preliminary results show that although these sites yield artefacts and food remains similar to those at Huaca Prieta, they differ significantly by containing domestic hearths, food preparation areas, middens and residential structures. However, they do not contain the black soot and ash found at Huaca Prieta. Geological dates and diagnostic artefacts place the majority of these sites between ~6000 and 4000 cal BP, which roughly corresponds with Phases III–V at Huaca Prieta and with an apparent population increase along this sector of the coast. The mound at Huaca Prieta was built and maintained probably by people living at these sites, especially Paredones, a large, deeply stratified domestic midden located ~1km to the north. The mound probably served these people for many generations as a communal ossuary and as a continuing focus for public events beyond the household and community levels.

The stretch of the coast north of Huaca Prieta is an area that shared characteristics of material culture dating between at least 6500 and 500 cal BP and evolved as an integrated region. Cursory observation of Preceramic sites (n=38) along this stretch shows that low house mounds consisting of small cobblestone structures, midden refuse and human burials characterize them. In some locations, the mounds form small hamlets or communities comprised of several households and an open plaza-like area. One exception to these sites is Pulpar, a smaller version of Huaca Prieta that is also built on a terrace remnant and has similar tomb construction and cultural debris, but probably dates to our Phases IV and V. These communities are located on both the coastal and inland sides of

the estuarine wetlands, and were probably linked to Huaca Prieta and to late preceramic domestic sites situated farther inland, on the coastal plains and in the foothills of the Andes. The larger coastal sites are about 200m in length and defined by several mounded areas. Smaller sites have one to two house mounds and midden areas. As evidenced by study of the stratigraphy and artefact content in looter holes and natural drainages, many sites were continuously occupied from middle Preceramic to Chimu times (~5500–700 cal BP).

Particularly significant is the discovery of raised agricultural platforms buried ~1.5m below the present-day ground surface in ancient wetlands immediately east of Huaca Prieta and the domestic sites. The fields are radiocarbon dated to ~4800 cal BP, contain phytoliths of beans, squash and chili pepper, and are probably where crops were grown by occupants of Paredones and other nearby domestic sites.

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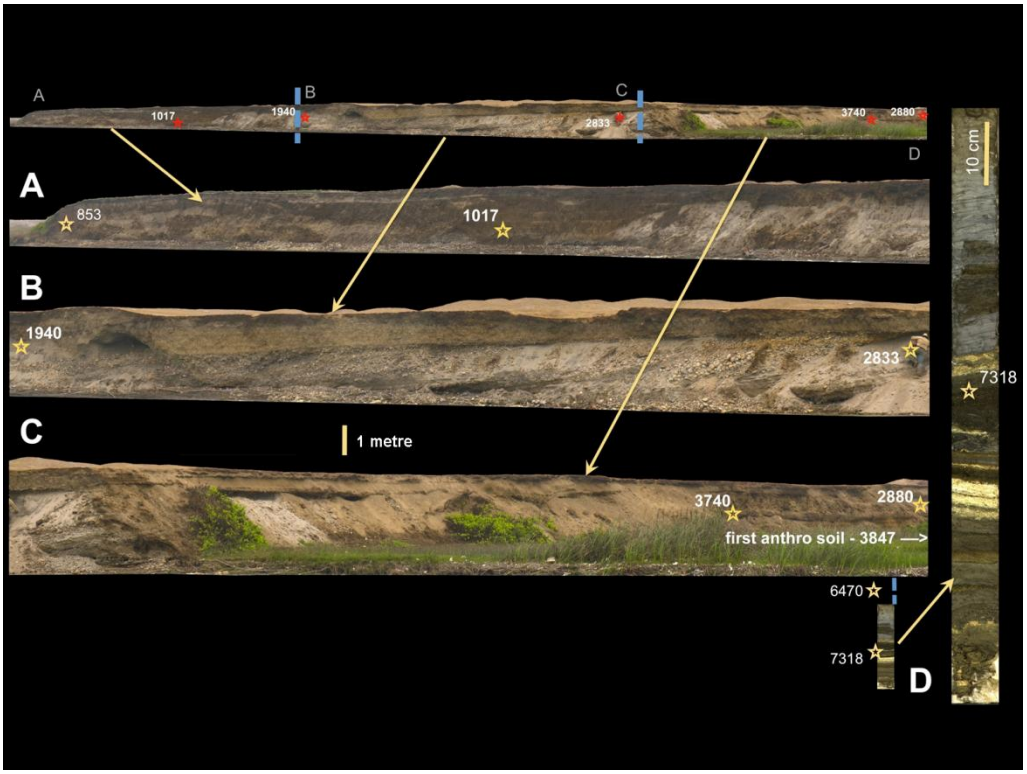

Figure S1. Photomosaic of cutbank exposures (A–C) at the Chicama River mouth (shoreline is 50m left of A), plus a core section from the underlying stratigraphy (D). Each panel (A–C) is contiguous and shown together in the top panel. The stars mark the location of radiocarbon ages, reported in calendar years BP. Overall, the stratigraphy here records a late Holocene prograding cobble-and-sand shoreface sequence (lower B) capped by younger muddy El Niño flood deposits (upper B) that prograde seaward (A). In panel B the cobble shoreface deposits are truncated by a curvilinear surface that extends over 100 landward (panel C) before transitioning into a thin-sand layer reaching another 100m onto the floodplain, representing a tsunami that impacted the coast just before the 1940 cal BP radiocarbon age from the overlying sandy shoreface. The remnant of an earlier tsunami truncation surface is preserved on the right side of panel B, just up and left of the 2833 cal BP radiocarbon age. Another age of an organic-rich swale deposit that is capped by the cobbles dates to 2880 cal BP (panel C), confirming the occurrence of this first, earlier tsunami. The point of maximum shoreline transgression is recorded where shoreface cobbles onlap backdune sediments dated to 3740 cal BP (panel C), roughly the same age as a 3847 cal BP-dated human occupational horizon around 25m away. Underlying the exposed shoreface and floodplain sequence are a series of carbonate-rich coastal lagoon deposits dating from ~6500–7500 cal BP (panel D). These well-bedded sediments include alternating layers of carbonate, organic-rich sediments, and blue mud that each represents changing fluvial sediment inputs and water levels during time of deposition. The carbonates suggest deeper clear water, with the organic deposits indicating shoaling water with emergent vegetation, and the blue muds reflecting river sediment discharge into the lagoon.

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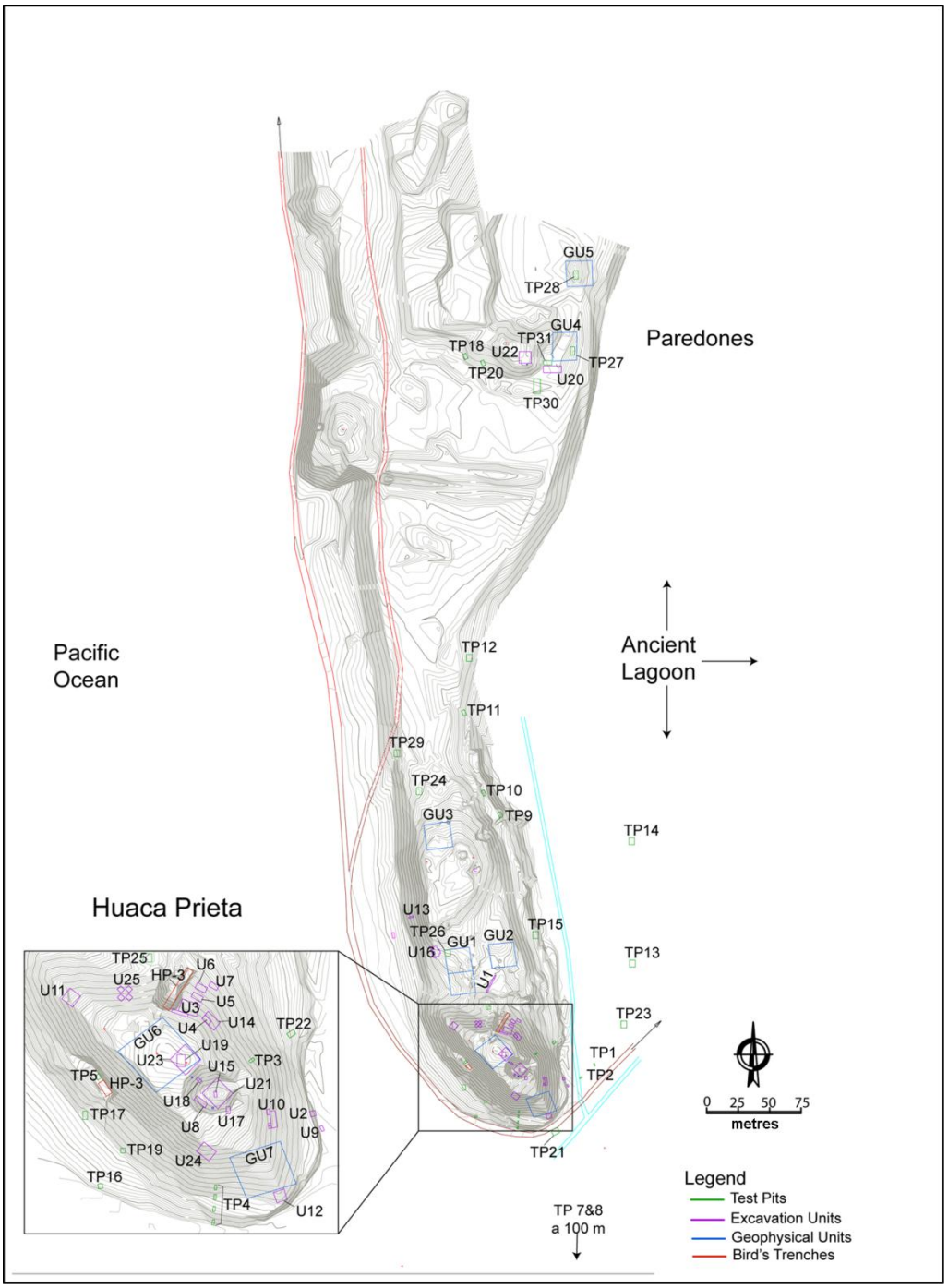

Figure S2. Topographic contour map of Huaca Prieta and Paredones, showing all excavation and geophysical units and the position of the Pacific Ocean and the ancient lagoon to the sites. This stretch of the coast north of Huaca Prieta is an area that shared characteristics of material culture dating between at least 6500 and 500 cal BP and evolved as an integrated region. Cursory observation of Preceramic sites (n=38) along this stretch shows that sites are characterized by low house mounds consisting of small cobblestone structures, midden refuse and human burials. In some locations, the mounds form small

hamlets or communities comprised of several households and an open plaza-like area. One exception to these sites is Pulpar, a smaller version of Huaca Prieta that is also built on a terrace remnant and has similar tomb construction and cultural debris, but probably dates to our Phases IV and V. These communities are located on both the coastal and inland sides of the estuarine wetlands, and were probably linked to Huaca Prieta and to domestic sites situated farther inland on the coast plains and in the foothills of the Andes. The larger coastal sites are about 200 m in length and defined by several mounded areas. Smaller sites have one to two house mounds and midden areas. As evidenced by study of the stratigraphy and artefact content in looter holes and natural drainages, many sites were continuously occupied from middle Preceramic to Chimu times (~5500–700 cal BP).

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