Forming Techniques of Ychsma Cephalomorphic Bottles and Cara-Golletes from Pachacamac, Peru

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Ychsma was a hierarchical society centered on the Lurín and Rímac valleys of Peru's central coast during the Late Intermediate Period (1000 – 1470 CE). During the Late Horizon (1470 – 1532 CE), it was the subject of intense investment and transformation by the Inka, most notably in the administrative and pilgrimage center of Pachacamac. Using x-radiography to evaluate forming methods and techniques, we compare two similar Ychsma forms of pottery: cephalomorphic bottles, dating to earlier Ychsma periods, and cara-golletes, dating to later Inka periods. We find that these forms, though similar in shape and appearance, were formed using very different methods.

Ychsma fue una sociedad jerárquica centrada en los valles Lurín y Rímac en la costa central del Perú durante el Período Intermedio Tardío (1000 – 1470 dC). Durante el Horizonte Tardío (1470 – 1532 dC), lo fue el sujeto de investidura y transformación intensa por la Inka, lo más destacado en el centro administrativo y peregrinación de Pachacamac. Usando x-radiografía para la evaluación de métodos y téchnicas del formación, compramos dos formas similares de alfarería Ychsma: botellas cefalomórficas (mas tempranos) y cara-golletes (de los períodos Inkas). Encontramos que estas formas, aunque similares en figuras y apariencia, fue formado con métodos muy diferentes.

Keywords:
Ychsma; Pachacamac; pottery; cara-gollete; cephalomorphic bottle; forming techniques

Palabras claves:
Ychsma; Pachacamac; alfarería; cara-gollete; botella cefalomorfas; técnicas de formación

This study uses x-radiography to study the forming methods for cephalomorphic bottles from the Temple of Pachacamac and cara-golletes from the second precinct of Pachacamac, Peru. Cephalomorphic bottles are present in funerary contexts in the Lurín and Rímac valleys and at Pachacamac during Early and Middle Ychsma periods from the end of the Middle Horizon through the Late Intermediate Period. Cara-golletes (meaning "face-necked jars"), a morphometrically similar form, begin to appear during the Late Ychsma periods concurrent with Inka presence at Pachacamac.

Forming methods are investigated to address several questions. First, how is the production for cephalomorphic bottles organized? There are different models for Pachacamac's purpose and structure both internally and within Ychsma territory more broadly. The Temple of Pachacamac was the home of an oracular deity and a pilgrimage destination. Were the vessels used there produced by one community of potters, or by multiple communities? Were they made by disparate groups, brought there as offerings for pilgrimages, or were these vessels part of the restricted, exclusive ceremonies that occurred there and their production was similarly restricted or controlled?

Second, we investigate forming methods of both cephalomorphic bottles and cara-golletes to determine if there is any relationship or connection between these two forms. Temporally distinct but morphologically similar, Ychsma cara-golletes are often cited as an indicator of Inka presence on the central coast due to the

morphometric similarities to the Inka form *urpu*, also called an aríbalo, including a flaring neck, conical bottom, and lateral vertical handles on the body. Are these vessels made by the same community that previously had produced the cephalomorphic bottles? If so, was the same forming technology employed to make both forms, or did methods adapt and shift, either over time or with the influence of Inka pottery?

PACHACAMAC

Pachacamac occupies around 500 hectares where the Lurín River meets the Pacific Ocean on the Peruvian central coast (Figure 1). When the Spanish arrived, it was a major Inka center for pilgrimage and administration. Cobo (1990 [1653]:85) describes the Sun Temple there as the second-most important in *Tawantinsuyu*, after the *Qorikancha* in Cuzco. The Temple of Pachacamac, or the Painted Temple, was the home of a *wak'a*, an oracular non-human being that in Inka times was consulted by adherents from across *Tawantinsuyu*, including the *Sapa Inka*. Curatola (2008:51) describes the *wak'a* at Pachacamac as an "Incaicized" (*incaicizada*) oracle-god, that pre-dated the Inka and was incorporated into the state pantheon. After Inka conquest of the central coast around 1460 – 1470 CE (Marsteller et al. 2017), they constructed and modified a

number of buildings and spaces, undertaking likely the most monumental example of the Inka adapting architecture and planning to an existing layout (Hyslop 1990:260).

Exactly what was present at Pachacamac prior to its incorporation into the Inka pantheon and empire remains a subject of debate (for a detailed discussion, see López-Hurtado 2011:25–30). The Lurín and Rímac river valleys were the home of the Ychsma, a hierarchical society that rose to prominence during the Late Intermediate Period (c. 1000 – 1470 CE) following a significant El Niño event (Espinoza 2015; Winsborough et al. 2012). Settlements in the Lurín Valley during the Late Intermediate Period and Late Horizon are numerous and frequent, possessing monumental architecture and clear divisions between commoner and elite residential areas (Marcone 2010; Marcone and López-Hurtado 2015). Objects from these settlements share a common decorative art style, including pottery (Vallejo 2004, 2009).

At Pachacamac, the period preceding Inka occupation is characterized by a structure known as a "pyramid with ramp," a raised orthogonal platform with a series of rooms atop, with a gently sloping ramp leading down to an enclosed courtyard. There are a total of 15 such structures at Pachacamac (Eeckhout 2003; Paredes and Franco 1987). Investigations into the chronology of these structures (Michczyński et al. 2003, 2007) places their use beginning in the 1200s CE, with continued use and renovation through Inka occupation. Interpretation of these

structures has varied, including as “inns” for traveling pilgrims or “embassies” for political or religious elites from other settlements, or palatial structures for Ychsma elites (Eeckhout 2000). At the center of this debate is the structure of Ychsma society during the Late Intermediate Period: some have argued it was a “religious federation” centered at Pachacamac, with little control exercised over the local population (Bueno 1982; Cornejo 2000). Alternatively, Ychsma has been posited as a polity centered at Pachacamac which controlled the surrounding area through secondary centers (Eeckhout 2000, 2003). While other ceremonial structures, like the Temple of the Monkey in the Second Precinct, were in use during the Late Intermediate Period (Eeckhout 2013), the use and activity in Pachacamac’s ceremonial core, including the Temple of Pachacamac, remains unclear. Some of these structures and spaces have origins in the Middle Horizon, and were heavily altered by the Inka (Makowski 2008). The Temple of Pachacamac was in use during the Late Horizon (Rostworowski 1992:103). A carved wooden statue thought to be the physical representation of the Pachacamac *wak’a* was recently radiocarbon dated to 1289 ± 25 BP; cal. 760 – 876 CE, placing its origin in the Middle Horizon (Sepúlveda et al. 2020).

YCHSMA POTTERY

Vallejo (2004) created a chronological sequence for Ychsma pottery, dividing it into three phases: Early, Middle, and Late (Temprano, Medio, Tardío), each with subphases (A and B). Early Ychsma A corresponds roughly with Middle Horizon 4, the end of the Middle Horizon, and the Late Ychsma Phases correspond to subjugation of the region by the Inka (Vallejo 2004). Ychsma pottery first appears at Pachacamac towards the end of the Middle Horizon, the earliest date being 967 ± 37 BP; cal. 990 – 1170 CE (Eeckhout 2018:559). This pottery borrows loosely from earlier Middle Horizon decorative motifs, though often simplified or only partially (Menzel 1964; Vallejo 2004). Eeckhout (2018:555) describes this early pottery as poor and domestic, with "a crude finish and frequent traces of fire clouding or other defects of careless manufacture," stating also that "…Ychsma skills were best expressed in weaving, wood carving, and monumental building, not in pottery." Forming methods used were primarily coiling or modeling (Vallejo 2004:598). Forming with molds is present in later periods of Ychsma pottery, concurrent with Inka presence.

Makowski and colleagues (2008, 2015) investigated the distribution and production of decorative styles and pastes along with the composition of locally available clays during the later periods of the Ychsma area. They found evidence for the same pastes being used to produce multiple decorative styles of pottery and that there at least three clay sources exploited to produce pottery in the region, each being used for a suite of decorate styles (2015:149). For each

compositional group identified, a specific form and decorative style was more prevalent, though neither were found exclusively in any group. The authors hypothesize that each of these chemical groups represents workshops that, under Inka control of the valley, adapted to produce imperial styles and forms to varying degrees. Local traditions continue to be produced alongside novel forms related with Inka expansion, as an expression and affirmation of stylistic identity (Makowski et al. 2015:145).

Cephalomorphic bottles are present in Ychsma pottery from its earliest phases. They have been found in funerary contexts (Eeckhout 2010; Uhle 1991). These generally are made with globular bodies with flat bottoms, straight necks, and modeled faces which can be undecorated, painted, or punctated and incised. Occasionally bodies are decorated with painted geometric or zoomorphic motifs (Figure 2a,b; Eeckhout 2010, Figures 7, 9; Kaulicke 1997, Figures 53G, 55C, 63; Shimada et al. 2010, Figure 16; Uhle 1991 [1903], Plate 7, Figure 1). From the Middle Horizon to Late Intermediate Period, the elements of these vessels become less precise, with less intricate painted decorations and more abstract faces.

Ychsma cara-golletes are similar to cephalomorphic bottles in several ways: a face, either modeled, painted, incised, or some combination of these, is fashioned onto the neck of an ovoid body. Despite similarities, these vessels are a distinct class, first appearing during Middle Ychsma B and persisting through Late Ychsma (Vallejo 2004). Cara-golletes are also generally found in a broader

range of contexts (including residential and ceremonial contexts) than cephalomorphic bottles, which are generally restricted to burials. Cara-golletes are considered to be some of the most notable Late Ychsma forms (Feltham and Eeckhout 2004), and while some forms persist between Middle and Late Ychsma periods with variable painting (e.g., Feltham and Eeckhout 2004:657), cephalomorphic bottles do not appear in the Late Periods, and there is no evidence of cara-golletes in any period earlier than Middle Ychsma B. Cara-golletes produced during the Late Horizon sometimes exhibit characteristics shared by Inka *urpus*, including flaring rims and pointed bottoms, during these later phases (Vallejo 2004:634). In addition to the face, they are characterized by an elongated, flaring neck, vertical handles on the side of the body, painted or modeled hands on the body and occasionally a modeled animal, usually a bird, being held by these hands, and a bottom that is typically—but not always—conical (Figure 2c,d; Feltham and Eeckhout 2004, Figure 14; Shimada et al. 2010, Figure 15; Uhle 1991 [1903], Plate 13 Figure 6; Vallejo Berríos 2004, Figures 11b, 15, 16a, 17). Cara-golletes, and other Ychsma forms, appear as burnished blackware during the late periods (Figure 2e,f; Franco 1998).

The practice of making face-necked vessels was not exclusively an Ychsma practice; restricted vessels decorated with human faces on the necks have been found in many time periods and regions throughout the Andes. Burnished blackware *urpus* with modeled faces on the necks, and occasionally arms on the

body, are common during the Inka periods on the north coast (Costin 2016:326). At Pachacamac, the presence of polished blackware cara-golletes indicates that the potters who made these vessels were Ychsma potters with access to different forms of technology either through innovation or instruction, or that these vessels were made by potters using different technology, perhaps relocated *mitmaq* potters from the north coast of Peru, where polished blackwares were regularly made. During later periods at Pachacamac, there is an overall increase in the diversity of ceramic styles, including regional Inka styles such as Chimú-Inka and Chancay-Inka, which has been hypothesized as corresponding to an increasingly progressive degree of control by the Inka (Eeckhout and López-Hurtado 2018).

FORMING TECHNIQUES

Craft producers learn techniques for production in a community of practice, which is a group of people that participate in an activity system and share and transmit knowledge about that activity (Lave and Wenger 1991:98). Multiple communities of practice may exist in one settlement, and can overlap, contradict, and be contained within a broader community of identity (Eckert 2012). Technical attributes related to craft production reflect choices made during the production process based on shared norms (Sillar and Tite 2000). Knowledge gained through

participating in a community of practice is experiential and inseparable from the sphere of social action and activity (Arnold 2018). Together, the choices made by artisans are known as "chaînes opératoires," or production sequences (Gosselain 2000). Not all elements in a chaîne opératoire carry the same social or symbolic weight (Gosselain 2000:190), and thus while some decisions may be symbolically crucial, others may be changed with little or no consequence and differ from person to person (DeBoer 1990).

Forming is an important yet understudied part of the chaîne opératoire. Whole vessels are infrequently recovered by archaeologists, and inference of forming techniques can be difficult from fragments. Nonetheless, even fragments can provide information about forming techniques and sequence for vessels at multiple scales of analysis (Boileau 2005). Forming techniques are mechanical gestures that can only be learned through observing and copying a skilled potter (Roux 2019). Though there are many ways to form a pot, the techniques used to do so are performed by the potter at the level of practical consciousness, and thus are resistant to change (Giddens 1984). Because forming techniques must be learned through cultural transmission, because they are conservative, and because there are many ways to successfully form a pot, investigating forming techniques is useful to address questions across social or political boundaries. Variability in forming techniques for archaeological pottery and other steps of the chaîne

opératoire, combined with stylistic and morphometric analyses, can uncover boundaries and relationships in past societies (Roux 2019).

Rye (1981:62) divides forming techniques into "primary," that transform a lump of clay into a form close to the finished product, and "secondary," where the vessel's shape is defined and finalized. Both stages however can be closely combined and may not be easily discernable (Thér 2020). Primary techniques include: coiling, where clay is rolled into long ropes which can be stacked as rings, segments, or in a spiral to form the body of a vessel (Rice 2015:136; Rye 1981:67); slab-building, where clay is patted into a flat plane, and one or more of these segments are joined on the edges to make the desired shape (Rice 2015:136; Rye 1981:71); pinching or drawing, where a lump of clay is pinched or pulled in an upward motion without adding any more clay, thinning the walls and increasing the height of a vessel until the desired shape is achieved (Rice 2015:137; Rye 1981:70); molding, where clay is pressed into or over one or a series of aplastic form(s) made in the desired shape (often out of fired clay), and then the different parts joined together (Rice 2015:138; Rye 1981:81); and wheel-throwing, which was not present in the pre-Columbian Americas, where a wet ball of clay is rotated on a wheel and a potter applies pressure with their hands to shape the clay in to the desired form (Rice 2015:141; Rye 1981:74). Secondary techniques include smoothing or scraping, where a tool is used to remove material from a vessel's surface or create a more even surface (Rice 2015:147; Rye

1981:86); beating, using a tool or tools on one or both side of a vessel wall to thin the wall or apply a pattern to its surface (Rice 2015:147; Rye 1981:84); cutting, carving, or trimming, removing parts of the vessel body with a tool (Rye 1981:90); and joining, adding appliqués (which themselves may be made using different techniques) to the surface of a finished vessel (Rye 1981:92). All these techniques, primary and secondary, can leave distinct signatures and may be identified or reconstructed through attributes of partial or whole vessels, including: surface features; cracks, fractures, or patterns of breakage of sherds; and the size and orientation of inclusions or voids (Rye 1981). For the purposes of this paper, a "technique" refers to an individual part of the forming process, while a "method" is the combination of techniques together used to form a vessel.

Forming Techniques in the Central Andes

Regional differences in forming techniques in the Andes have been observed through archaeological and ethnographic investigations into pottery production. The ceramist Luis Tokuda (2011) examined a collection of *urpus* from Pachacamac to investigate their forming techniques. He observed that necks were generally thicker than bodies, and thus made separately through a process of hollowing out a ball of clay, raising the walls of the cylinder, and adding coils until the desired height was achieved, where it was then smoothed and the rim

was formed with a cloth. Because the joins between necks and bodies was smoothed, he concluded that this step was done before the vessel was closed and that the interior of the body was smoothed to an even thickness with a gourd, stone, or sherd. He also noted that for these *urpus*, the base was made with spiraled coils and was the last part of the vessel to be added, leaving an "ombligo" or navel of clay where it was exteriorly sealed. Inka pottery is found at many locations around Pachacamac, but evidence for ceramic production is limited to contexts associated with the Late Intermediate Period, and has been found at Pyramids with Ramps numbers 1 and 3 (Ángeles 2011; Eeckhout 2018), and tools found included polishing stones and smoothing cloths.

On the central coast, burials of women from the Early Intermediate Period (200 BCE to 200 CE) at Tablada de Lurín, about 8 km north of Pachacamac, contained within them potter's plates, pieces of worked clay, and polishing stones (Cárdenas 1994). Evidence of Inka pottery production has also been found nearby at Armatambo (Pareja et al. 2023), where petrographic analysis did not indicate any change to raw material selection or preparation after Inka presence in the valley.

On the south coast of Peru, Nazca bowls examined by Carmichael (1998, 2020) were started in either a potter's plate or a shallow negative or concave mold for the base and then built upon using a combination of drawing or coiling. One attribute of this forming method is a thinning or pinching in the profile of the vessel between the join of the base and body (Carmichael 2020:16). A few vessels

exhibit signs of paddle-and-anvil construction as well (Carmichael 1986). Investigations into production workshops for Wari pottery that were active during the Middle Horizon have revealed a similar set of tools and techniques across multiple sites, including Cerro Baúl (Nash 2019), Conchopata (Isbell and Cook 2002), and Maymi (Anders et al. 1998). While molds were present for figurines or appliqués, including human and animal faces, mold-making was not the primary forming method. Tools present at these workshops include potter's plates, paddles, anvils, and scrapers or smoothers made from sherds. Closed forms with rounded bottoms and mold-made faces on the necks are common in Wari pottery (Groleau 2009). Fine Wari pottery was made in controlled contexts by elite specialists (Nash 2019), and while forming technology is shared between sites it is unclear if this is the result of state-wide standardization.

As the cara-golletes may have been influenced by the production of Inka *urpus*, it is worthwhile to examine studies into the forming of these vessels. Inka pottery was made by a multitude of potters conscripted into service for the empire through the *mit'a* system of labor taxation (Murra 1982). The Inka also relocated groups of potters around the empire to work fulltime for the state as *mitmaqkuna* (Bongers et al. 2020; Hayashida 1998; Lorandi and Cremonte 1991). It is therefore not surprising that there is no clear standard method for making these vessels, and forming methods vary geographically, typically reflecting the traditional techniques used by the potters to make their preceding and

contemporaneous local styles. In the Inka pottery workshop in Cheqoq in the Cuzco basin, vessels were made exclusively by coiling, and no molds were found (Quave 2012, 2017). Other tools used in forming pottery at Cheqoq, were a potter's plate used for starting bases, a custom-made ring for forming rims or necks, and scrapers made from repurposed sherds (Quave 2012). Examining pottery from Ollantaytambo and five sites in the Cusichaca valley, 90 km north of Cuzco, Lunt (1988) found that *urpus* were made in six coiled and smoothed sections that were then joined, and that the joins correspond to changes in angle. She also found that necks were joined to the body on the inside of the shoulder segment. In the Mantaro valley near Hatun Xauxa of the central highlands of Peru, *urpus* were made by coiling, though they were well-made and further forming techniques are difficult to decipher (Hagstrum 1989:195). In *Qollasuyu* (the southern quarter of the Inka empire), a study of ceramics from nine locations in northern Chile found that *urpus* were constructed in three separate segments that were then joined (Viñales et al. 2020). On the north coast, press molds for making *urpus* have been found (Costin 2016; Donnan 1997; Hayashida 1999) that are typically negative or concave and longitudinally hemispheric. Within the north coast, there is no standard number of molds to make an *urpu*. Molds have been found for making various *urpu* parts in multiple combinations at different production centers (e.g., neck, neck and shoulder, body, body and base, body and handles, etc.). At La Viña and Tambo Real in the Leche valley, molds were

compositionally similar to the pottery made with them (Hayashida 1995:226). Molding was not the only technique used at Tambo Real and La Viña, and larger vessels were built and occasionally decorated using a paddle-and-anvil technique. Vessels were not built through coiling, but coils were added to vessels to construct rims or other features (Hayashida 1995).

Though contemporary pottery production using traditional techniques has ceased in many areas of the Andes (Litto 1976) including the area around Pachacamac, there are still communities where these traditions continue and have been the focus of ethnographic work. None of the potters involved in these studies produced cephalomorphic bottles or cara-golletes; nonetheless, an examination of the forming techniques they employ is still useful. In much of the Andes, contemporary potters use potter's plates combined with coiling to construct vessels and secondarily smooth them to an even thickness (Druc 2005; Hagstrum 1989; Mohr Chávez 1984, 1992; Ramón 2008, 2013; Sillar 2000; Tschopik 1950). Though it is commonly used in most places, the potter's plate is not the only technology used: paddle and anvil forming technology is used in some communities in the far north coast of Peru (Bankes 1985; Camino 1982; Ramón 2008; Sosa 1984), and imitations of archaeological forms are mold-made for sale to tourists (Litto 1976). Sillar and Ramón (2016:664) note broad regional technical traditions of potter's plates being used in the south and central Andes, and mold-making and paddle-and-anvil being used in more northern areas,

complemented by more specific community-level specializations. Ramón (2013) examined the distribution of technical styles simultaneously with networks of clay and temper source use and distribution in the Conchucos region of Ancash. Different techniques were employed for forming, including mold-making, paddle-and-anvil, and coiling, in various combinations. He found three technical styles in use across the region, each corresponding with a distinct set of tools and unique vocabularies.

CERAMIC SAMPLE

The vessels analyzed by x-radiography were excavated from Pachacamac by Max Uhle from May 13 to December 10, 1896 with the support of the University of Pennsylvania Museum of Archaeology and Anthropology (Uhle 1991 [1903]). Uhle made surface collections and excavated several cemeteries, including one at the base of the Temple of Pachacamac that he called “Gravefield I,” one between the Mamacona “convent” and the Pilgrims’ Plaza called “Gravefield III,” and one within the first terrace on the southeast face of the Sun Temple that is sometimes called “The Cemetery of Sacrificed Women” (Tiballi 2010). Uhle also excavated and collected surface ceramics from a context he called “Town” or “Northwest of Town” which is today known as the Second Precinct. From both cemeteries, he

uncovered mummy bundles comprised of human remains, metal objects, textiles, pottery, wood and feather objects, and some foodstuffs. Uhle's work was undertaken before the development of modern excavation techniques and best practices for accessioning and cataloging items, and the provenience within these cemeteries and association of artifacts within the mummy bundles has been lost.

A total of 27 whole vessels were analyzed in this study (Table 1). Fifteen of these vessels are Ychsma cephalomorphic bottles, and fourteen are from the Temple of Pachacamac (e.g., Figure 2a) while one is from Uhle's excavations at Gravefield III (Figure 2b). These vessels range in size from 9.7 to 23.0 cm in height, and 13.5 to 31.5 cm in diameter. The remaining 12 vessels are cara-golletes from the Second Precinct. Five of these are polychrome, with either Inka or Ychsma designs (Figure 2c,d), and six are burnished blackware (Figure 2e,f). The final sample is a canteen with a modeled and painted face in Inka style on the neck (Figure 2g).

X-RADIOGRAPHY

There has been limited but effective use of x-radiography to study the formation and function of Andean pottery (Carmichael 1986, 1998, 2020; De La Fuente 2015; Digby 1948; Heck and Feldmüller 1990; Lima et al. 2011; Stone-Miller

2006; Wauters 2008). X-radiography is non-invasive and useful to archaeologists for evaluating techniques for forming and construction of pottery that may not be visible on the object's surface (Berg 2008; Berg and Ambers 2016; Carr and Komorowski 1995; Rye 1981). The internal structure, created by the deformation of the clay paste under hand and tool pressure, can be observed on x-rays. Microstructural criteria for the identification of forming techniques rely on porosity and inclusion visualization in terms of shape, alignment and orientation, and take into consideration variation in wall thickness, density and superimposition. Because x-radiography captures complex 3D volumes on a plane, the interpretation of microstructural details for complete objects where walls are superimposed is challenging. Extensive surface treatments such as burnishing and polishing obliterate surface features diagnostic of different construction method but do not impact the internal structure (Berg 2008:1185).

Recent applications of Computed Tomography (CT) scanning to archaeological objects have produced clear and detailed data related to forming methods (e.g., Bouzakis et al. 2011; Sanger et al. 2013; Sanger 2016; Wauters 2016). In contrast to x-radiography, CT scanning allows for the construction of a 3-dimensional reconstruction using multiple x-ray scans, permitting different cross sections of the object to be examined. While this method has produced clear data and results for the study of archaeological ceramics, it also remains limited in its application, due primarily to factors of accessibility and cost. Recently, more

affordable benchtop versions of this technology have been developed, however these often have limits to the size of objects that can be analyzed, precluding many whole vessels. In the absence of access to CT technology, x-radiography remains a useful method of analysis for understanding forming methods and techniques.

X-radiography was conducted at the University of Pennsylvania Museum of Archaeology and Anthropology's Center for the Analysis of Archaeological Materials using an industrial GE Eresco 65 MF4 Tube and 16" x16" GE-DXR 250V digital capture plate. Source-to-plate distance was 183 cm and x-rays were captured with built-in aluminum filter. The software was GE Rhythm RT and post-processing was conducted with Rhythm Review. The proprietary GE FLASH post-processing filter was used during the interpretation of the images to enhance details by optimizing contrast and brightness. Results are presented as negative radiographic images, in which radiopaque features appear light and radio-lucent ones appear dark. Porosity and thinner areas on radiographic images appear black to dark gray while dense areas are white to light gray. Each vessel was x-rayed twice, first positioned vertically on the digital plate for a 'top-down' view, and then positioned horizontally for a side view.

RESULTS

Multiple techniques for vessel construction were present in this sample (Table 2). Different techniques were used to create cephalomorphic bottles and cara-golletes.

Cephalomorphic Bottles

Cephalomorphic bottles evaluated in this research were all made with a similar forming method (Figure 3). Most vessels show a uniform thickness for the base and lower third to half of the bodies, except for the transition from the base to the body which is sometimes thinner and has a well-defined interior angle. Bases range from rounded to flat, flat-bottomed bases are generally thinner than ones that are rounded. In some cases, vertical cracks are present which are only visible on the interior from the base to top of the lower body. The lower body is generally thicker than the upper portions of the body and neck. Some vessels exhibit a thin layer of clay applied to the exterior of the lower body. It is possible that lower bodies were made using a potter's plate, based on the thinness in the corners and the discussion of this feature by Carmichael (1986, 2020). Vertical cracks present in the lower bodies of some of the cephalomorphic bottles may indicate shrinkage during drying of a slab, or joins where multiple slabs were joined. It is also

possible that slabs were shaped or pressed into a negative mold to form this portion of the body.

Next, the upper body was formed by adding coils on top of the lower body. These coils are evident in the x-rays through horizontal bands of uneven thickness and horizontal seams (voids) where coils are joined. The number of coils varies with the size of the vessel, but in this sample ranges from one to four. Diagonal impressions are sometimes present between the lower body and the first coil where these two pieces were joined. For most of the cephalomorphic bottles, the transition from the lower and upper body also marks a change in the angle of the vessel wall, where the lower body flares outward from the base and the coiled upper body angles inward toward the neck.

The necks of vessels were made separately, as flattened coils, slabs, or strips that are joined into a ring, exhibiting generally even thicknesses. In some cephalomorphic bottles, a coil join near the rim is visible, indicating that some necks (or rims) were formed with one or several coils. Some may have been drawn upwards to achieve greater height. Necks were attached to the top of the coiled section of the body. Extra clay, or luting, was added to this joint on the vessel interior. Because of restricted access at this point in the vessel's construction, the luting was not smoothed to an even thickness, and finger impressions are visible. It is also possible that this upper section was made

separately from the lower body and base, and the neck was attached before the two sections were joined. Some of the necks that exhibit finger impressions are narrow, and access to the interior of the vessel at this point would have been limited. Faces attached to the necks were either mold-made or modeled and incised. Faces may have been added at once or in several modeled pieces. Drag marks around features on the faces show that they at least some of them were incised. Simpler mold made faces may have been applied to the neck and then details added later through incision, but it is difficult to determine the sequence of these steps.

While there is some variation within this sample of cephalomorphic bottles, for example the number of coils added or the size and proportion of the bottom piece, all vessels still follow this forming method. Some vessels, especially smaller or miniature vessels, do not exhibit all of these features clearly, but there are clear indications that at least some steps of this process were used in each vessel examined. Within this forming method, there are variations in wall thickness, overall shape of the body, roundness of the base, height and width of the neck, and technique used to form the faces. The sample represents the work of multiple potters at different points in time, varying techniques slightly for personal preference or based on variations in the desired vessel, yet still employing the same shared forming method.

Cara-Golletes

It is more difficult to discern the forming techniques used to create cara-golletes. Many of these are extremely well-made, with thin, even walls, and interiors which were scraped to an even thickness, which obliterated many traces of forming techniques (Figure 4a). This scraping is slightly at a diagonal. Some slight unevenness in the body walls in some of the cara-golletes (Figure 4b) which does not follow linear or circular patterns could potentially be a sign of the paddle-and-anvil technique, though the scraping to an even thickness makes this difficult to ascertain with certainty. Blackware cara-golletes (Figure 5) are not mold-made, as the blackware pottery examined by Wauters (2008, 2016) was. They instead show signs of being made through coils, with a few showing scraping on the interior to smooth the walls to an even thickness. Cara-golletes with pointed bottoms all generally have an uneven thickness through the base, occasionally demonstrating the "ombligo" feature noted by Tokuda (2011) on *urpus* from Pachacamac (Figure 6). This was likely the last part of the vessel body formed, and access to the interior to thin or smooth the walls would have been limited at this point in these vessels' construction. Necks and faces are attached directly onto the walls of the body, without the luting and finger impressions that are present in the cephalomorphic bottles.

One final sample (Figure 7), a canteen from the second precinct with a modeled and painted face and handles on the upper body, is made with a different forming method than any others analyzed in this study. While the back of the vessel's interior is smooth, the front shows an unevenness and indentations that may relate to the adding of sequential coils. At the center of the front of the vessel is the "ombligo" feature. This vessel was likely made primarily on its side from its back to its front, with the neck and face added after the primary body was formed.

DISCUSSION

While x-radiography has provided insight into the forming methods used to create these vessels, there is still some uncertainty regarding the techniques used by potters. For several of these vessels, potters used techniques that obliterated traces of forming as part of their process. This study utilized a small sample size, and the variation in context, provenience, and decorative style of these vessels may also be critical in understanding the organization of their production. There are nonetheless points of note that stand out.

The cephalomorphic bottles examined through x-radiography are made using a similar sequence of forming techniques. The base is made either using a

potter's plate and a slab is added onto the base flaring outward, or the lower bodies are made together in a negative mold with coils or slabs added, and then a sequence of one to four coils of varying sizes are added, restricting the body back inwards, and coils are joined. Necks are placed on top of the coils and luting—extra clay to secure the join—is added, without any smoothing, likely due to restricted access to the interior of the vessel at this point in the construction. Faces are mold-made, or modeled and incised. While some variation exists within the sample, all the cephalomorphic bottles examined in this study share a common technology of forming. Whether the activities at Pachacamac drew adherents on a local, regional, or multi-regional level, the forming techniques for creating cephalomorphic bottles supports the creation of these vessels by a single or several closely related communities of practice working in a geographically restricted area.

Cara-golletes, whether they are polychrome or blackware, canonically Ychsma or more Inka, are not made using the forming method used to produce cephalomorphic bottles. Instead, these show signs of being made through coiling. It could be that the potters who produced these vessels have a completely different technological tradition than those that produced the cephalomorphic bottles. Shimada and colleagues (2010:123), in a study utilizing Neutron Activation Analysis on pottery from the Pilgrim's Plaza, noted a cara-gollete with a compositional signature different from the rest of their sample which may have

had foreign production. There is also compositional evidence for the local production of Inka pottery at Pachacamac and potential evidence that, during later periods, multiple communities of practice were working there (Davenport 2020). Despite the similarities in shape, size, and decoration, cara-golletes and cephalomorphic bottles may also have been emically distinct and different forms for different purposes that required different forming methods.

CONCLUSIONS

These pots were made by different potters at different times and for potentially different purposes. The comparison between their forming method should therefore be approached cautiously with these things in mind. While these forms are similar in size and morphology, they also have key differences that may have affected the choices the potter made in creating the pot out of clay.

The cephalomorphic bottles all share a common forming method. One single community of practice is supplying these vessels for the Temple of Pachacamac's funerary rituals. While the ritual organization of Pachacamac during the yearly Ychsma periods is a subject of debate, the vessels involved in the funerary rituals at the Temple of Pachacamac itself during this period were all created with one shared forming method. This method is consistent with the one

vessel examined from Gravefield III, though comparison with other Ychsma contexts within and beyond Pachacamac would be a productive future step.

While the cara-golletes all exhibit signs of being made through coiling, compared to the cephalomorphic bottles, they do not share features of a single community of practice. Some show signs of high technical skill, with very thin and even walls and few traces of the forming process remaining on the finished vessels, while others are less refined. As these cara-golletes borrow from the distinctive Inka *urpu* form yet remain Ychsma in their painted decoration, this inconsistency may be the result of these vessels being produced outside of Inka networks of power or control, made as "hybrids" by local potters invoking their identities and negotiating the colonial systems they found themselves within (Costin 2016). On a broader level, they share forming methods with *urpus* from the capital region, and the influence of Inka pottery on these cara-golletes is more than just an imitation of form but a replication of techniques that do not produce highly visible attributes on a finished product, generally a sign of communication and knowledge transmission between potters (Eckert et al. 2015; Hegmon et al. 2000; Lechtman 1977). The second precinct context is loosely controlled, and it is not known whether these objects are from domestic, funerary, or disturbed surface contexts. Again, a comparison with other cara-golletes from other Ychsma contexts within and beyond Pachacamac would help to contextualize this small sample.

There is a technical discontinuity between cephalomorphic bottles and cara-golletes from Pachacamac. Whether this discontinuity exists due to outside stressors like Inka influence, shifts and changes in technology and practice over time in Ychsma pottery, or if these vessels, their uses, or even their potters were distinct and unrelated is not possible to determine without further research. Technologically, however, Ychsma cara-golletes share more in common with Inka *urpus* than earlier Ychsma forms.

Acknowledgements. Funding for x-radiography was provided by the Wenner-Gren Foundation (Grant No. 9810) and a Moore Research Grant from the University of New Mexico's Department of Anthropology. Work at MURR was supported by NSF Grant No. 2208558. At the Penn Museum, we thank Clark Erickson, William Wierzbowski, and the Scientific Testing Committee. James A. Davenport was also supported by a Ph.D. Fellowship from the University of New Mexico's Latin American and Iberian Institute, a Dissertation Fellowship from the University of New Mexico's Department of Anthropology, and a Summer Fellowship from the Dumbarton Oaks Research Library and Collection. Thank you to Frances Hayashida, Sarah Thomson, and Jillian M. Jordan for providing helpful feedback on this manuscript.

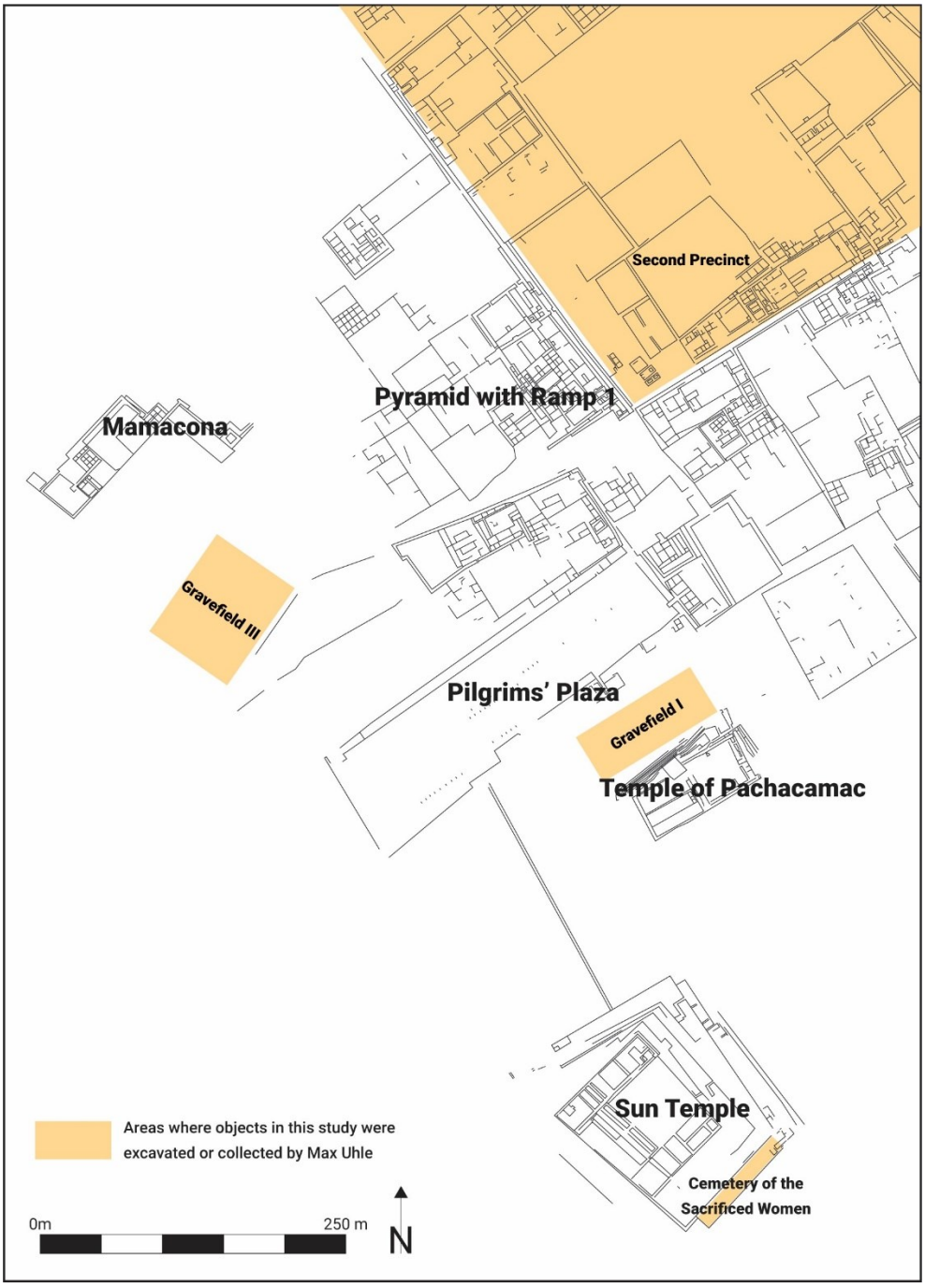

Figure 1. Map of Pachacamac, with contexts highlighted.

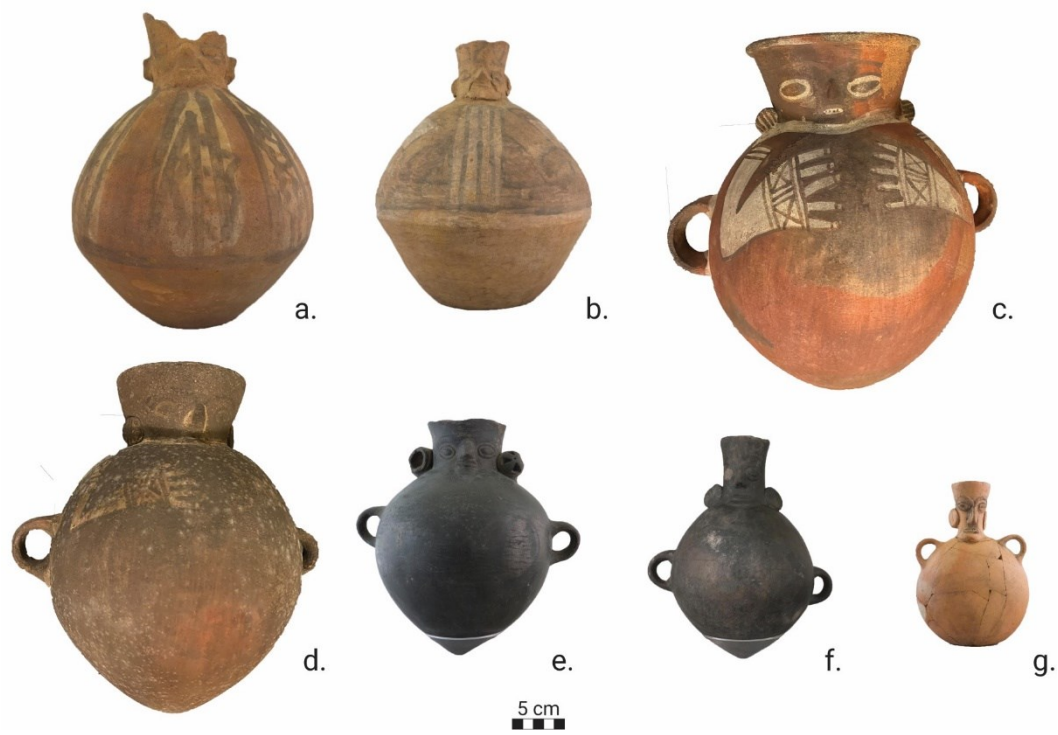

Figure 2. Examples of cephalomorphic bottles and cara-golletes included in this study. Penn Museum catalog numbers a: 27121, b: 27099, c: 31738, d: 31739, e: 31770, f: 31772, g: 31812.

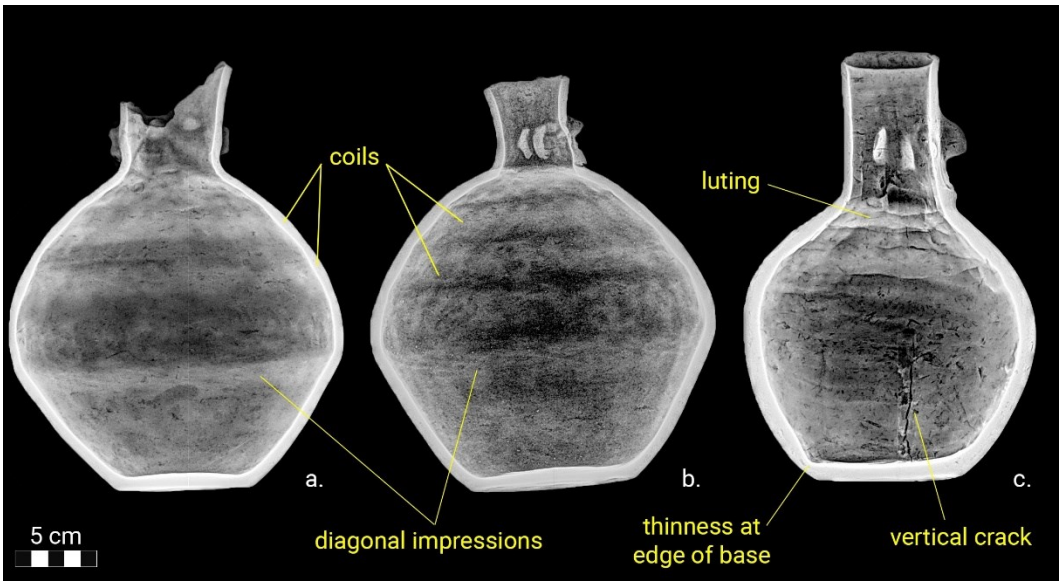

Figure 3. X-radiographs of cephalomorphic vessels, with features related to forming highlighted. All negative x-radiographs presented in this paper were captured at 90 kV, 2 mA, for 6 s and post-processed with GE FLASH filter and Adobe Photoshop Unsharp Mask Filter. Penn Museum catalog numbers a: 27121, b: 27099; c: 27153.

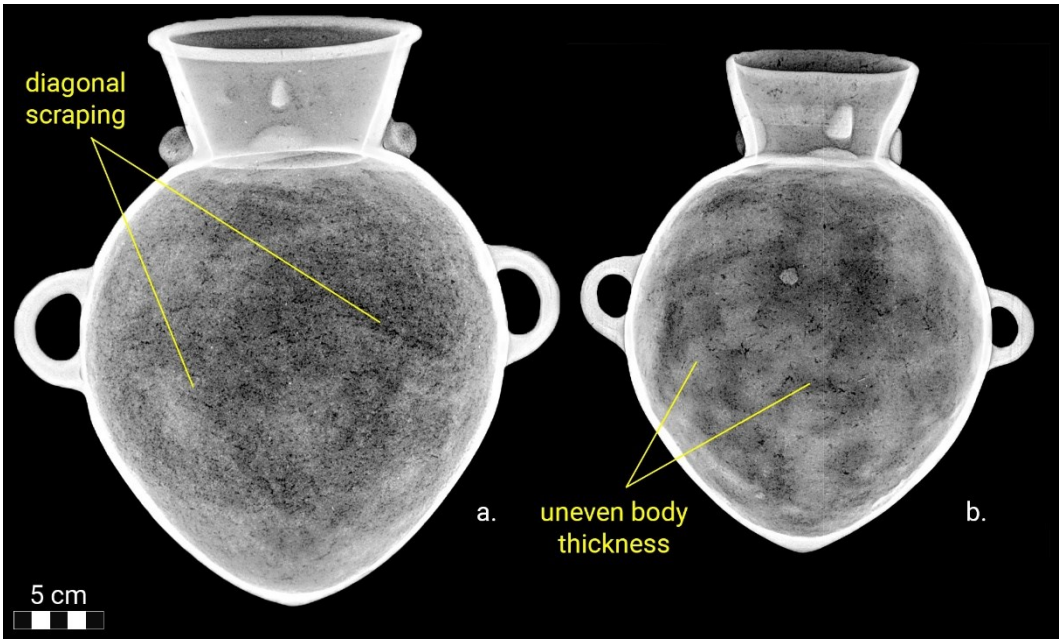

Figure 4. X-radiographs of polychrome cara-golletes, with features related to forming highlighted. Bands present on neck and handles of (b) are artifacts of the mount used to hold the vessel in position while capturing the radiograph and are not features of the vessel itself. Penn Museum catalog numbers a: 31738, b: 31739.

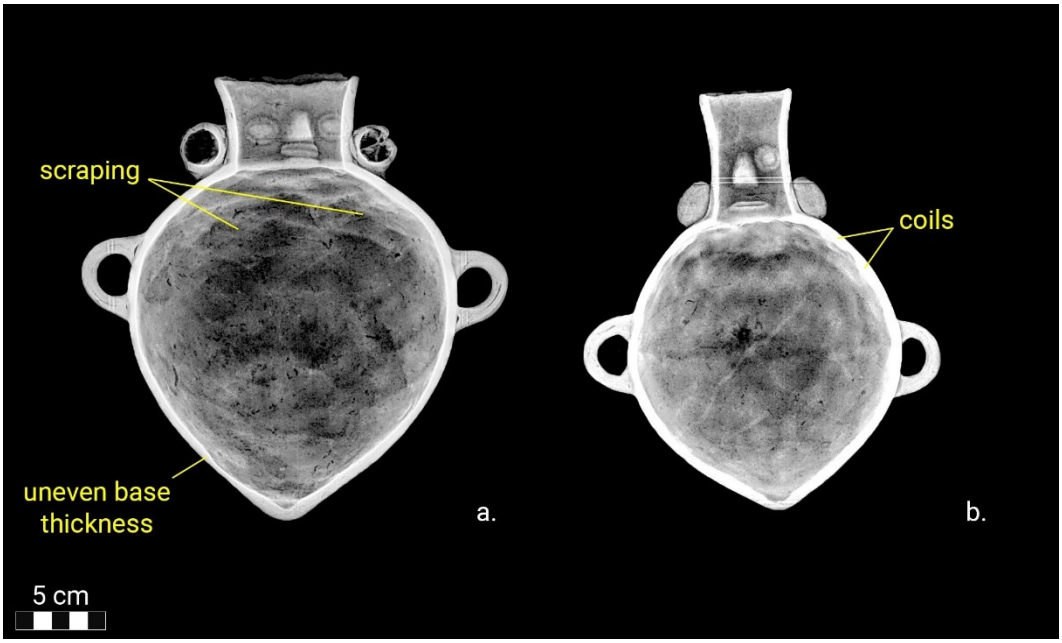

Figure 5. X-radiographs of blackware cara-golletes, with features related to forming highlighted. Parallel lines present in handles of (a) and neck of (b) are artifacts of the mount used to hold the vessels in position while capturing the radiographs and are not features of the vessels themselves. Penn Museum catalog numbers a: 31770; b: 31772.

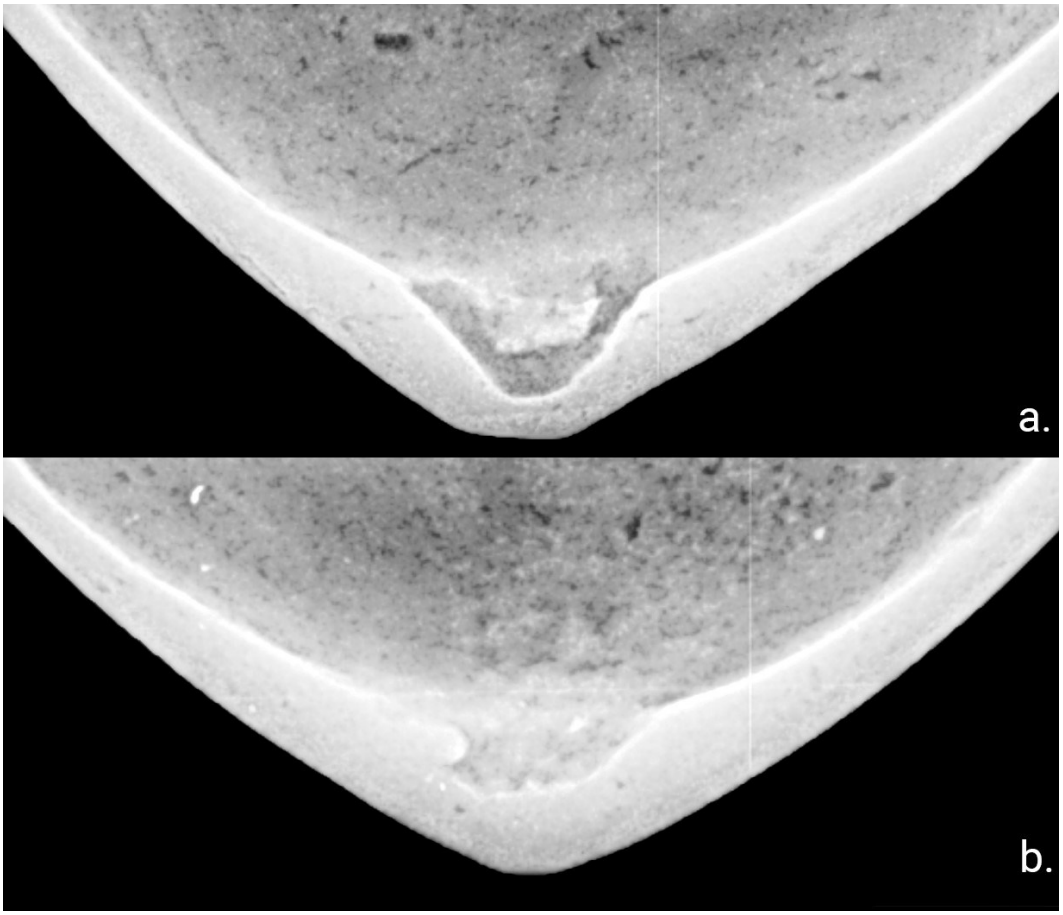

Figure 6. X-radiographs showing examples of the “ombligo” feature on the interior of bases for cara-golletes. Penn Museum catalog numbers a: 31769; b: 31771.

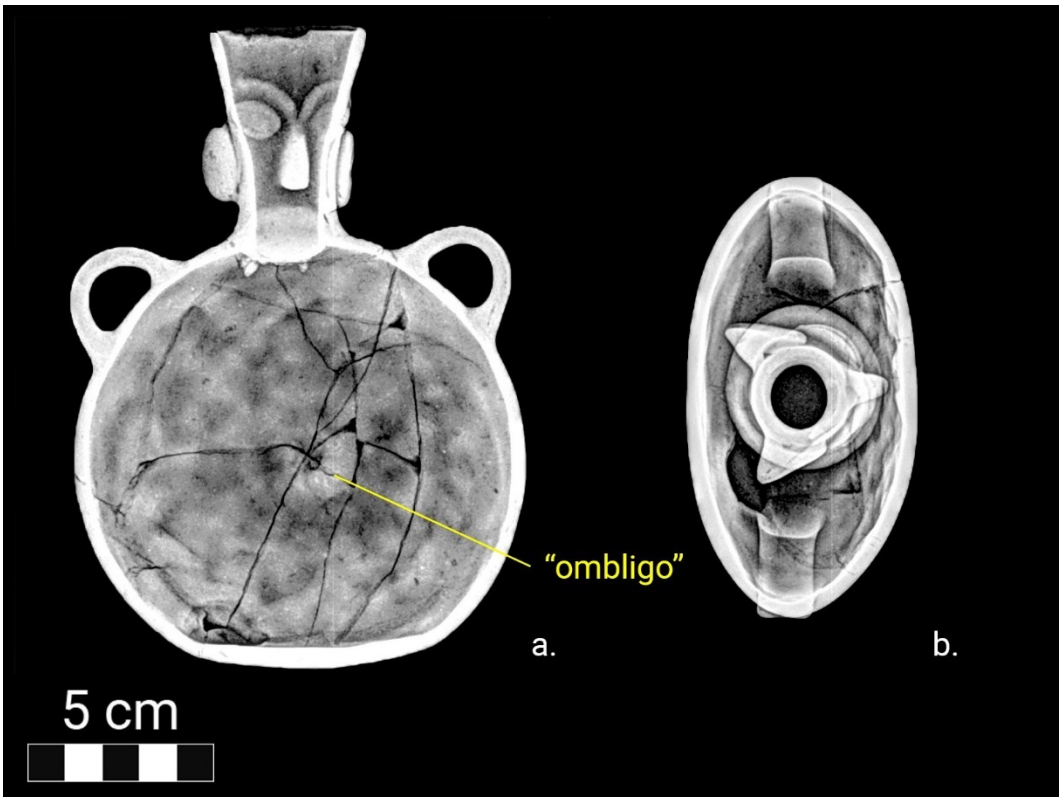

Figure 7. X-radiograph of polychrome canteen, with features related to forming highlighted. Penn Museum catalog number 31812.

Object Number	Description	Provenience
26835	Cephalomorphic Bottle	Temple of Pachacamac
27089	Cephalomorphic Bottle	Temple of Pachacamac
27092	Cephalomorphic Bottle	Temple of Pachacamac
27095	Cephalomorphic Bottle	Temple of Pachacamac
27098	Cephalomorphic Bottle	Temple of Pachacamac
27099	Cephalomorphic Bottle	Gravefield III
27120	Cephalomorphic Bottle	Temple of Pachacamac
27121	Cephalomorphic Bottle	Temple of Pachacamac
27127	Cephalomorphic Bottle	Temple of Pachacamac
27150	Cephalomorphic Bottle	Temple of Pachacamac
27153	Cephalomorphic Bottle	Temple of Pachacamac
27157	Cephalomorphic Bottle	Temple of Pachacamac
27159	Cephalomorphic Bottle	Temple of Pachacamac
27163	Cephalomorphic Bottle	Temple of Pachacamac
27168	Cephalomorphic Bottle	Temple of Pachacamac
31021	Cara-gollete	Sun Temple
31714	Cara-gollete	Second Precinct
31721	Cara-gollete	Second Precinct
31722	Cara-gollete	Second Precinct
31738	Cara-gollete	Second Precinct
31739	Cara-gollete	Second Precinct
31742	Cara-gollete	Second Precinct
31769	Cara-gollete	Second Precinct
31770	Cara-gollete	Second Precinct
31771	Cara-gollete	Second Precinct
31772	Cara-gollete	Second Precinct
31812	Canteen	Second Precinct

Table 1. List of vessels included in this study.

Object No.	*Features present in X-radiographs*									Forming Technique(s)
	Thinness in base corners	Uneven base thickness	"Ombligo" feature	Vertical cracks on interior	Uneven body thickness	Scraping on interior	Luting between body/neck	Parallel voids in handles	Other Features	
26835	Yes				Yes				Additional slab applied to lower exterior	Use of potter's plate? Lower body made with slabs? Coils added on top of lower body
27089				Yes	Yes					Coils added on top of lower body
27092					Yes				Finger impressions on lower interior, radiopaque inclusions	Lower body drawn upwards from base, coils added on top of lower body
27095				Yes	Yes		Yes			Lower body made with slabs? Coils added on top of lower body, luting added to join neck to body
27098	Yes				Yes		Yes			Use of potter's plate? Coil added on top of lower body, luting added to join neck to body
27099	Yes				Yes					Use of potter's plate? Coils added on top of lower body
27120	Yes			Yes	Yes		Yes			Use of potter's plate? Lower body made with slabs? Coils added on

										top of lower body, luting added to join neck to body
27121					Yes		Yes			Coils added on top of lower body, luting added to join neck to body
27127	Yes				Yes		Yes			Use of potter's plate? Coils added on top of lower body, luting added to join neck to body
27150					Yes				Impressions (reed?) in base interior below opening	Coil added on top of lower body
27153	Yes			Yes	Yes		Yes			Use of potter's plate? Lower body made with slabs? Coils added on top of lower body, luting added to join neck to body
27157					Yes		Yes			Coil added on top of lower body, luting added to join neck to body
27159							Yes		Finger impressions on lower interior	Lower body drawn upwards from base, luting added to join neck to body
27163	Yes				Yes		Yes		Radiopaque inclusions	Use of potter's plate? Coils added on top of lower body, luting

										added to join neck to body
27168					Yes		Yes			Coils added on top of lower body, luting added to join neck to body
31021						Yes				Scraping to even thickness; other signs of manufacture obliterated
31714		Yes			Yes			Yes	Off-center interior base point	Coiling used to construct body, base finished as final step, handles rolled
31721		Yes			Yes		Yes			Vessel made through pinching? (miniature)
31722			Yes			Yes				Base finished as final step, scraping to even thickness; other signs of manufacture obliterated
31738		Yes				Yes		Yes	Off-center interior base point	Base finished as final step, handles rolled, scraping to an even thickness; other signs of manufacture obliterated
31739		Yes			Yes			Yes	Off-center interior base point	Base finished as final step, handles rolled, use of paddle and anvil?
31742					Yes					Coiling used to construct body, vessel reconstructed; additional signs of manufacture difficult to interpret

31769			Yes			Yes		Yes		Base finished as final step, handles rolled, scraping to an even thickness; other signs of manufacture obliterated
31770		Yes			Yes	Yes		Yes		Base finished as final step, handles rolled, use of paddle and anvil? Scraping to a somewhat even thickness; other signs of manufacture obliterated
31771			Yes		Yes			Yes		Coiling used to construct body, base finished as final step, handles rolled
31772		Yes	Yes		Yes			Yes		Coiling used to construct body, base finished as final step, handles rolled
31812			Yes					Yes	“ombligo” on front of body	Built from back to front, with front of body finished as final step, handles rolled (canteen)

Table 2. Summary of results of forming techniques used for vessels in this study.

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