14

Pottery from Funerary Mounds along the Arid Atacama Desert Coast, Chile

Chemistry, Circulation, and Exchange between the Inlands and Coast during the Formative Period

ITACÍ CORREA GIRRULAT, FRANCISCO GALLARDO, MAURICIO URIBE RODRÍGUEZ, ESTER ECHENIQUE, JOSÉ FRANCISCO BLANCO, SAMUEL FLEWETT, MATTHEW T. BOULANGER, AND MICHAEL D. GLASCOCK

INTRODUCTION

The Atacama Desert in the south-central Andean area between southern Peru and the Copiapó River in Chile is considered to be the driest environment on Earth (Weischet 1975). The main hydrographic feature of this landscape is the Loa River, which supports the greatest concentration of plant life in this desert environment. The river is the political boundary between the Tarapacá and Antofagasta Regions, and several riparian oases along its course contain evidence of prehistoric villages from the Formative period (1000 BC–AD 1500) onward. Despite its aridity, the extensive strip of coast possesses a uniform and temperate climate with higher humidity than inland sectors. The coast of the Antofagasta Region is a narrow strip characterized by beaches and rocky shorelines with several sheltered harbors, all flanked by the rugged hills of the coastal range. The mountains create a rain shadow over the Atacama Desert to the east but promote a fog zone that is concentrated on the western (coastal) side. This fog, referred to as *camanchaca*, is the key to the development of fog-zone plant communities (Rundel et al. 1991) characterized by scant vegetation concentrated around a few small, freshwater springs and scantily on hillsides. The scarce cacti in these plant communities provided humans with a source of fuel and raw material for making dwellings and artifacts.

The abundant marine food resources of the Pacific Ocean supported hunters, fishers, and gatherers inhabiting the arid coastal margins of the Atacama Desert throughout the historical sequence from the Early Holocene to the colonial period (Ballester and Gallardo 2011; Llagostera 2005; Núñez and Santoro 2011). Beginning around roughly 2500 BP, these groups started to experience processes generally considered part of the Formative period.[1] Changes associated with this period, such as sedentism, pastoralism, agriculture, and long-distance exchange, are observed in large riverine oases in the Atacama Desert, including Chiu Chiu, Calama, and Quillagua. Formative processes also included the development and implementation of new technologies such as pottery and metallurgy (Agüero et al. 2006; Benavente 1982; Labarca and Gallardo 2012; Pollard 1970; Thomas et al. 1995, 2002; Torres-Rouff et al. 2012a; Westfall and González 2010).

Recent studies have proposed that the Formative period saw the emergence of a new "coastal cultural physiognomy" (Gallardo 2017) characterized principally as a social organization based on family units with limited residential movement but a high mobility for production with multiple logistic forays into different areas (i.e., the ocean, faraway shoreline, and inland desert areas). These families were capable of generating surplus through fishing and mining activities, which would have been sources of wealth and social complexity. This surplus of resources and goods permitted networks of reciprocal exchange and, as a consequence, a political identity that positioned

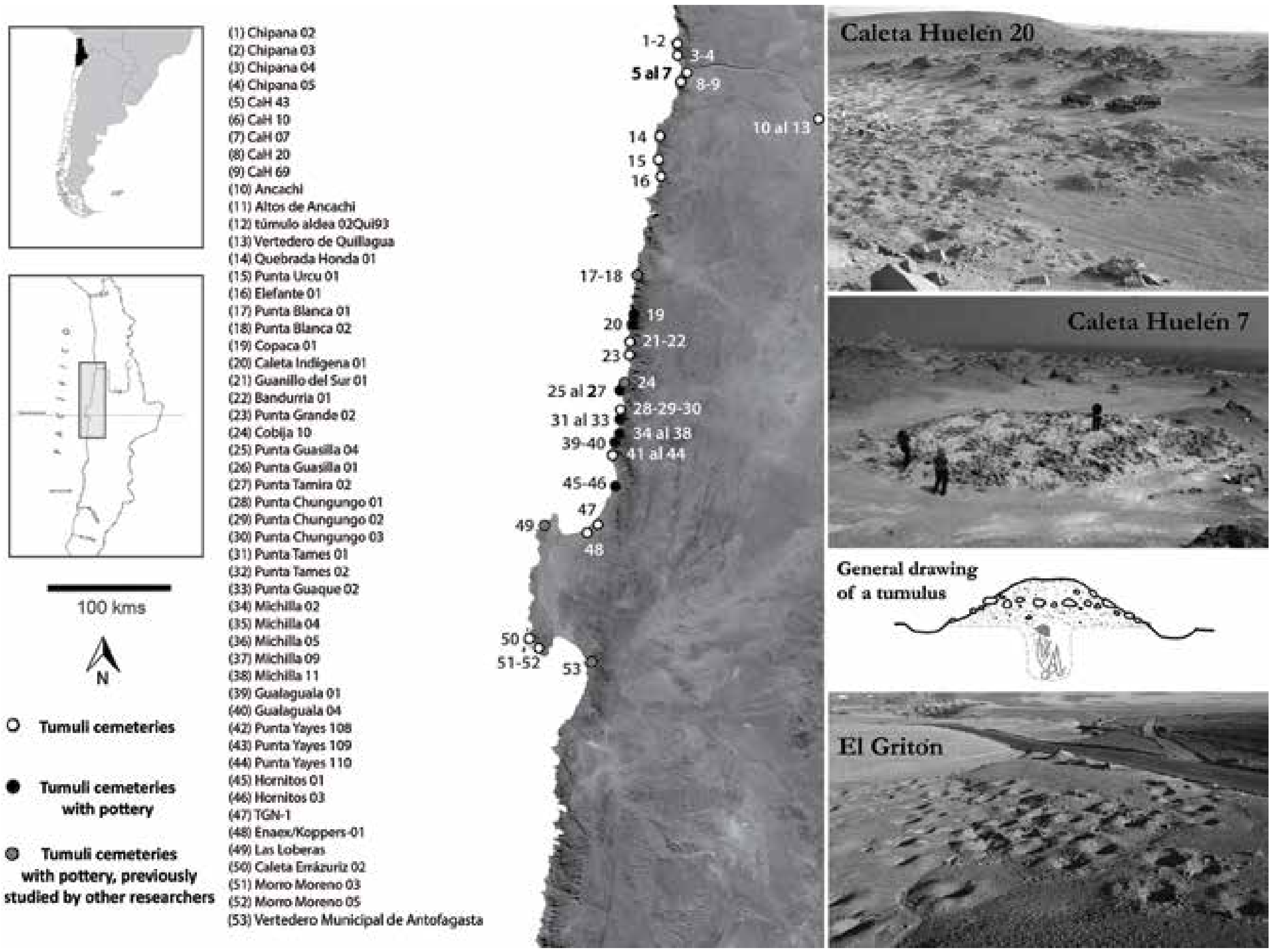

Figure 14.1. Mound cemeteries from Loa River mouth, Tocopilla-Hornitos coastal section, and Mejillones Peninsula. Modified from Gallardo et al. (2016).

coastal groups as distinct from inland populations. The early development (or acquisition) of boats facilitated latitudinal (i.e., north-south) exchange by allowing faster and farther movement with heavier loads.

The organization of daily domestic life among coastal inhabitants during the Formative period has received little attention from archaeology when compared with inland populations. However, this new cultural physiognomy may be observed through one of the most widely recognized elements of the period: the emergence of a common mortuary tradition along several hundred kilometers of the coast (Gallardo et al. 2017). This funerary pattern is characterized by extensive tumuli cemeteries (Castro et al. 2012; Moragas 1982; Núñez 1971a, 1974; Spahni 1967). Some of these cemeteries contain upward of 200 earthen mounds that are, in some cases, approximately 10 m in diameter and nearly 1 m tall (Figure 14.1; Ballester and Clarot 2014; Gallardo et al. 2017). Funerary offerings from these tombs include objects indicating a focus on hunting and gathering of marine resources (e.g., harpoons, knives, fishing hooks and weights, containers, nets, fiber mats, and dried fish). Along with these locally manufactured materials, some offerings evidence an intensification of exchange with social groups from inland environments. Objects made of smelted copper, beads, camelid yarn, threads, and textiles are among many of the burial offerings with known provenance from inland oasis and ravine villages (Gallardo 2017). Pottery, a novel artifact not found at earlier coastal sites, has also been recovered from these tombs.

The spatial distribution of these funerary sites shows that they are concentrated in several areas, beginning with the mouth of the Loa River in the north; between Tocopilla and Hornitos; at the Mejillones Peninsula; and on the coast of Taltal in the south. A recent research project (FONDECYT 1110202) resulted in the recording of several

TABLE 14.1. CALIBRATED RADIOCARBON DATES CONSIDERED IN THIS WORK

TUMULI SITES	CALIBRATED DATES (2σ)
Hornitos 1 (Hor-1)	2012–2161 cal BP (p = 0.86)
Michilla 2 (Mich-2)	1701–1836 cal BP (p = 0.99)
	1583–1727 cal BP (p = 0.99)
Punta Guala Guala 1 (Guala-1)	1588–1747 cal BP (p = 0.98)
	1739–1900 cal BP (p = 0.99)
Punta Guala Guala 4 (Guala-4)	1610–1752 cal BP (p = 0.83)
	1374–1527 cal BP (p = 0.99)
Caleta Huelén 10 (Ch-10)	1827–2180 cal BP (p = 0.95)
Caleta Huelén 10A (Ch-10A)	1359–1520 cal BP (p = 0.99)
	2044–2499 cal BP (p = 0.95)
Caleta Huelén 20 (Ch-20)	980–1978 cal BP (p = 0.99)
Caleta Huelén 7 (Ch-7)	1277–1356 cal BP (p = 0.99)
	1897–2346 cal BP (p = 0.99)

Note: Calibrated using SHCal13 curve (Hogg et al. 2013) with Calib 7.02 software (Stuiver and Reimer 1993).

mound cemeteries on the coastal plain between the Loa River and the northern end of the Mejillones Peninsula, with dates that extend from around 2600 to 800 BP (Ballester and Clarot 2014; Ballester et al. 2014; Gallardo et al. 2017). These studies involved excavations and/or surface collection of 31 previously looted cemeteries, 21 of them containing pottery as offerings (Figure 14.1; Table 14.1).

POTTERY FROM COASTAL MOUNDS

The first descriptions of pottery associated with earthen mound graves in the Antofagasta Region come from Augusto Capdeville (1928; see also Mostny 1964). The contexts of these finds (the sites of Cementerio de la Ollita Gris, Cementerio de los Túmulos de Tierra, and Caleta el Gritón) are in the vicinity of Taltal, a locality south of the study area. The pottery recovered there is characterized as gray, black, and in some cases, red-polished vases. Of particular note is the recovery of black or dark grayish jars with modeled anthropomorphic designs on their neck (i.e., Caleta Oliva and Caleta de Las Guaneras). Today, this pottery is recognized as belonging to the Black Polished San Pedro de Atacama tradition.

Tumuli cemeteries at the mouth of the Loa River were first studied by Jean-Christian Spahni (1967), who excavated 113 tombs. Spahni's work resulted in the recovery of only 8 vessels and 36 pottery fragments, which, judging from his drawings (Plates VIII 3 and IX 6), could be Tarapacá tradition pottery (Loa Café Alisado and Quillagua Tarapacá Café Amarillento types). These sites were later worked by Lautaro Núñez (1969, 1971a, 1971b, 1976a), who defined an early monochrome ceramic component that he called "Complejo Loa-Túmulos" (Loa-Tumuli complex). In his reports, he mentions the presence of polished vessels, bottles, and bell-shaped forms in red, black, or gray colors, with semi-flat bases and finely engraved rims (Caleta Huelén 7), bottle-like vessels with striated surfaces and gourd-like ceramics (Caleta Huelén 10), coarse monochrome pots (Caleta Huelén 20), and smoothed monochrome vessels with semi-spherical bases (Caleta Huelén 43). For Núñez, these ceramic traits, along with other funerary elements, were interpreted as indications of colonization by inland populations during the first centuries AD. Today, based on results from isotopic dietary studies (Pestle 2017; Pestle et al. 2015), we know that the people buried there were in fact marine hunter-gatherers and that the ceramic traits noted by Núñez are the results of these people interacting with agrarian shepherds from the inland oases (Correa 2016). Some of the ceramic traits described by Núñez were correctly associated with inland Tarapacá ceramic traditions, specifically to the pottery of sites that conform to what he called the "Caserones district" at the Tarapacá ravine.

Other references to pottery from coastal tumuli may be found in the work of Moragas (1982) for the Cobija 10 cemetery, located at the Tocopilla-Hornitos section of the coast. In this case, Moragas interpreted the presence of ceramic fragments not as offerings but as having been used to form the tumuli themselves. These ceramics were predominantly smoothed, with brown, gray, or black colors, and in some cases with a light polish, striations, or spatula-treated surfaces. Some of the ceramic pastes show sand (quartz) tempering components. Moragas inferred that the pottery sherds came from large vessels with globular bodies, rounded bases, and everted rims. Such vessels were suggested to have been used as cooking pots. Moragas related this pottery with varieties known from the Alto Ramírez phase in Arica (ca. 450 km north in a straight line), as well as to ceramic remains reported from Caleta Huelén 43 by Núñez (1971a).

In summary, from these early reports on tumuli pottery, it can only be stated that the descriptions are quite vague, not standardized, and difficult to associate with other known ceramic traditions from the broader region. The first systematic studies on the subject were done by Uribe and Ayala (2004) with the collection of materials from three sites at the mouth of the Loa River (Caleta Huelén 7, Caleta Huelén 10, and Caleta Huelén 20). One goal of their study was the comparison of Formative pottery from the Quillagua oasis with pottery from other important locations in the broader northern Chile macroregion. Describing pottery from Formative tumuli cemeteries, Uribe and Ayala identify some of the types of the three major ceramic traditions previously known for northern Chile: Loa Rojo Alisado (LRA [Loa Red Smoothed]) from the Atacama tradition (Caleta Huelén 7); Alto Ramírez (ARA) from the Arica tradition (Caleta Huelén 7 and 10); Quillagua Tarapacá Café Amarillento (QTC [Quillagua Tarapacá Yellowish Brown]) from the Tarapacá tradition (Caleta Huelén 7, 10, and 20); and Loa Café Alisado (LCA [Loa Brown Smoothed]), also from Tarapacá tradition (Caleta Huelén 10). The pottery types that they identified led them to point out, although only tangentially, that the Caleta Huelén district had links with inland Tarapacá as well with the San Pedro de Atacama area, and that it constitutes the southern extreme of the distribution for ceramic industries from the Azapa Valley and the Arica coast.

Rescue excavations of two minor tumuli tombs at Las Loberas and Vertedero de Antofagasta (Mejillones Peninsula) resulted in the discovery of pottery from unmistakably Formative contexts (Cruz and Llagostera 2011; Mavrakis 2003). At Las Loberas, a mound contained a "flower vase" (small bottle) of QTC type from the Tarapacá tradition and a San Pedro Negro Pulido (SNP) bowl. San Pedro Negro Pulido pottery was also recovered from Vertedero de Antofagasta, including highly diagnostic bottles with anthropomorphic modeled decoration on their necks. An LCA-like vessel and a remarkable figurative ceramic vessel of unknown origin were also recovered from the site (Ballester and Clarot 2014:70).

Finally, although isolated, another case shows a well-documented ceramic of the period at the Punta Blanca cemetery, south of Tocopilla. At this site, the tumuli yielded whole vessels, mainly of Tarapacá tradition (QTC type), and some vessels of the San Pedro tradition (San Pedro Rojo Bruñido) (Ballester and Clarot 2014).

The tumuli pottery in this study was previously analyzed by Correa (2016) following the typologies developed by Varela (1992, 2002), Uribe and colleagues (Uribe 2004, 2009; Uribe and Ayala 2004; Uribe et al. 2007), and Tarragó (1989) for the northern Chile macroregion. These analyses were based on morphological, decorative, and technological traits and were compared with petrographic analyses (Correa 2016). All these studies indicate that the pottery was not produced by coastal populations. Rather, it likely had an inland origin and was obtained by coastal populations through exchange. Correa (2016) and Carrasco et al. (2017) examined residues adhering to some of the pottery recovered from mortuary contexts. They determined that prior to their deposition as funerary offerings, these vessels were used as cooking ware by littoral inhabitants. That is to say, ceramic vessels were not obtained solely for funerary practices, revealing how little we actually know about the domestic contexts of these coastal groups. It is highly probable that the ceramic vessels were an active part of the daily lives of coastal people during the Formative period.

In northern Chile, the main ceramic typologies (Uribe 2004, 2009; Uribe and Vidal Montero 2015) posit the existence of three major Formative traditions that start to develop around 900 BC. Although these traditions have distinct centers of origin, they also interlaced with each other across space and through time. As noted above, these traditions consist of the Arica tradition, well defined in the Azapa and Camarones Valleys as well as on the Arica coast; the Tarapacá tradition, present in the inland valleys and on the coast, as well as at Quillagua oasis and along the Loa River; and the Atacama tradition, described from sites at the oasis of San Pedro de Atacama and from sites at several oases along the Loa River.

During our previously mentioned survey of coastal Formative mounds (FONDECYT 1110702), we recovered pottery from looted funerary units, where the materials were usually fragmented due to this illegal activity. The pottery belongs mainly to two of these major traditions, exhibiting representative types of phases within the Formative for each one (Table 14.2). A lesser part of the collection (9.26%) was either not identified or corresponds to ceramic types from later periods.

The earliest pottery we observed at the mound cemeteries corresponds to the Loa Café Alisado type (LCA). This is an industry of the Tarapacá ceramic tradition, representative of the Early Formative period of that region, with dates between about 700 BC and AD 600 (Uribe and Vidal Montero 2012, 2015).[2] It shows a broad geographical distribution covering the pampas, the Tarapacá ravines, the Tarapacá coast, the Quillagua oasis of the Loa River, and the upper Loa in the highlands (Mostny 1970; Pollard 1970; Sinclaire et al. 1998; Uribe 2004). LCA vessels have been generally described as exhibiting smoothed walls, ovoid bodies, hyperboloid necks, convex-pointed

TABLE 14.2. CHRONO-CULTURAL ASSESSMENT AND GENERAL FREQUENCIES OF COASTAL TUMULI POTTERY

PERIOD	POTTERY TYPES	SHERDS (*N*)	SHERDS (%)
Middle Formative from Tarapacá	Loa Café Alisado type	1,005	23.20
Middle and Late Formative from San Pedro	San Pedro types	362	8.36
Late Formative from Tarapacá	Quillagua-Tarapacá types	2,563	59.18
Late Intermediate Period onward (various traditions)	Later types	106	2.45
Undetermined	Undetermined	295	6.81
Total Sample	4,331	100.00	

Note: Late period types were not registered within grave association but at surface re-collection at the sites.

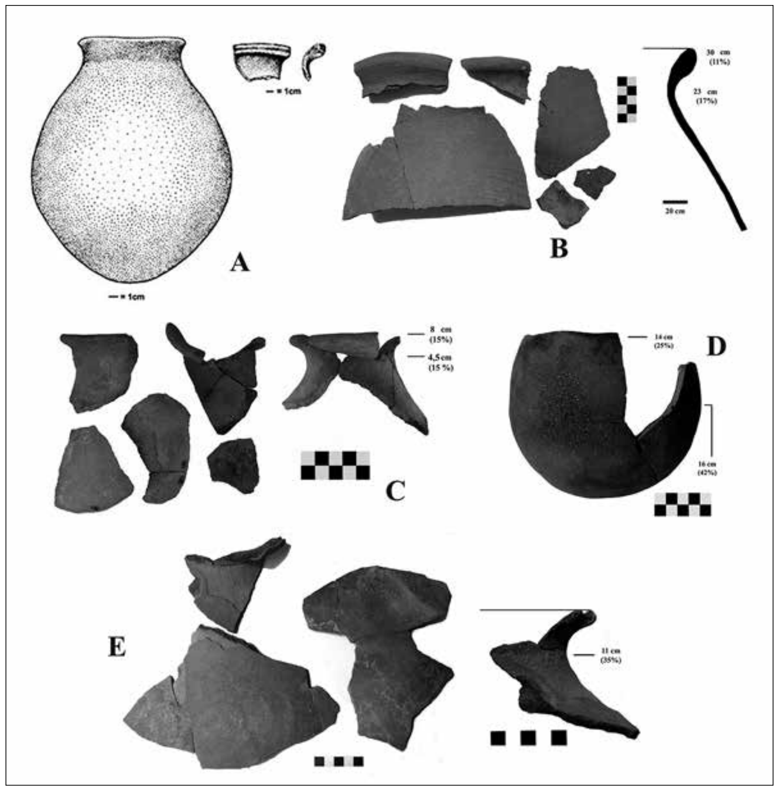

Figure 14.2. Loa Café Alisado examples: (A) Whole LCA vessel; (B) Hornitos 1 site, mound 84, inside grave; (C) Punta Gualaguala 4 site, F6 Unit; (D) Punta Tamira 2, mound 1; (E) Punta Gualaguala 1, C3 Unit. Image (A) used with permission from Uribe and Ayala (2004).

bases, and lips that show a diagnostic thickening usually referred to as *borde en coma* (comma rim). These thickened lips are probably an element that replaced the function of handles (Uribe and Vidal Montero 2012) (Figure 14.2). The LCA paste is very homogeneous, and it is characterized by dense rounded and angular white mineral inclusions of varied size (Uribe and Ayala 2004; Uribe and Vidal Montero 2012). This pottery is present in almost every mound cemetery where ceramic offerings were documented, but its frequency is considerably lower at sites near the mouth of the Loa River, such as Caleta Huelén 7, 10, and 20 (Correa 2016).

The most abundant types at the mounds are those belonging to the Late Formative Tarapacá tradition: Quillagua Tarapacá Café Amarillento (QTC), Quillagua Rojo Pulido (QRP), and Quillagua Negro Pulido (QNP). Here, we refer to all of these varieties under the generic term Quillagua-Tarapacá (QT), as they represent a specific industry of the Late Formative phase within the Tarapacá pottery tradition (Uribe and Vidal Montero 2015). QT pottery is mainly distributed along the ravines and coast of the Tarapacá Region, the oases of Pica and Quillagua, and the lower Loa Valley. Dates associated with QT pottery span between 200 BC and AD 1150 (Uribe and Vidal

Montero 2015). QT vessels tend to have been expediently made, and they exhibit a diversity in paste characteristics (i.e., color and inclusion heterogeneity). Additional factors contributing to the diversity of ceramic pastes in QT vessels are the mixing of different mineral tempers with organic materials and/or ground pottery (grog). Normally, QT sherds exhibit smoothed surfaces, sometimes with no treatment or even unfired. A wide variety of vessel forms have been documented for QT wares; among these are small cups and bowls, pots, and "flower vases" (Figure 14.3). The miniature appearance and negative impressions of basketry on vessel bases tend to be characteristic of QT types (Agüero et al. 2006; Uribe 2004, 2009; Uribe and Ayala 2004; Uribe and Vidal Montero 2012, 2015; Uribe et al. 2007). The QT industry is not recorded at all mound sites that possess ceramic offerings. For instance, in the Tocopilla-Hornitos section, QT pottery is present only at Michilla 2 and 5, Punta Chungungo 2, Punta Guala Guala 1 and 4, Punta Tames 1, and Hornitos 1. Sherds of the QT types are, however, abundant at sites along the mouth of the Loa River (e.g., Caleta Huelén 7, 10A, and 20; see Correa 2016).

The least represented pottery at the coastal tumuli offerings is of the Atacama tradition (8.36%), comprising Middle and Late Formative San Pedro types: Rojo Pulido (SRP), or Toconao type (ca. 300 BC–AD 100), and Negro Pulido (SNP), or Séquitor type (ca. AD 100–400) (Berenguer et al. 1986; Tarragó 1989). The latter exhibits characteristic and easily recognizable technological, morphological, and decorative traits such as thin walls, compact pastes, and carefully polished or burnished surface treatments of gray or black color achieved by smoking and/or slip. Also, they have a finite repertoire of restricted and unrestricted forms that are very standardized (see Tarragó 1989; Uribe 2006). The former, SRP, consists generally of regular-sized bottles and big bottles. Vase-like forms are also known. All of these vessels are very well polished or burnished (Figure 14.4). Both SRP and SNP constitute a standardized industry that was produced at San Pedro de Atacama. SNP was widely distributed as an exchange good, and it is found in large numbers at sites along the upper Loa River, in the middle Loa oases, at the Tarapacá ravine, and quite distant locations such as northwestern Argentina, the Copiapó River, and the Taltal coast (Capdeville 1928; Gallardo et al. 2016; González and Westfall 2005; Niemeyer and Cervellino 1985; Núñez 1982; Sinclaire et al. 1998; Tarragó 1996).

It should be noted that the chronological differences between both ceramic styles—Toconao and Séquitor—have been questioned on the basis of recent studies

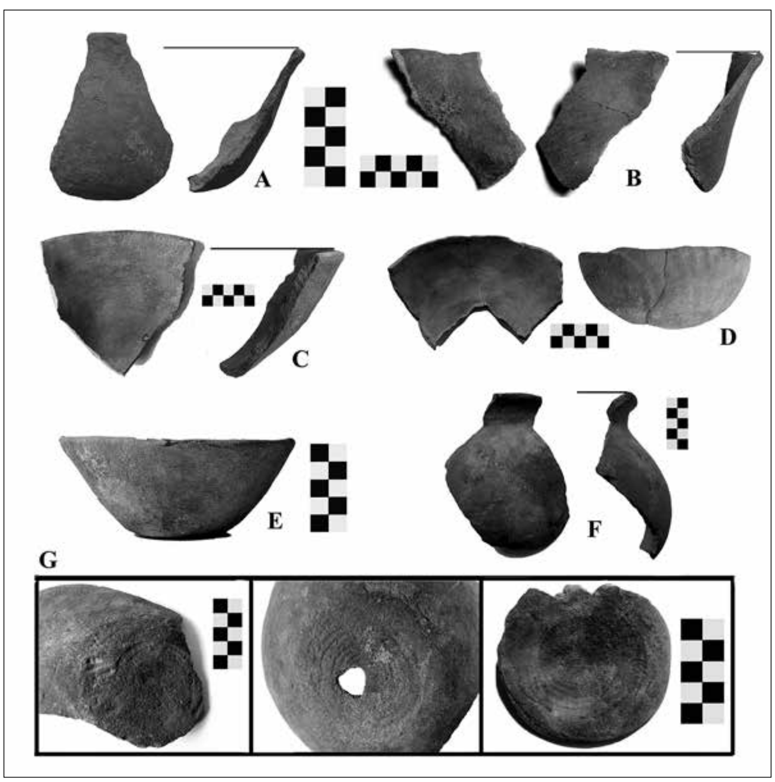

Figure 14.3. Quillagua-Tarapacá examples: (A) Caleta Huelén 10A, QTC type; (B) Caleta Huelén 10A, QRP type; (C) Caleta Huelén 7, QTC type; (D and E) Caleta Huelén 10A, QTC type; (F) Caleta Huelén 10A, QTC type; (G) Basket printings in QT pottery bases, from left to right, Caleta Huelén 7 (QTC type), Caleta Huelén 10A (QRP type), and Caleta Huelén 7 (QNP type). Photo by Itaci Correa.

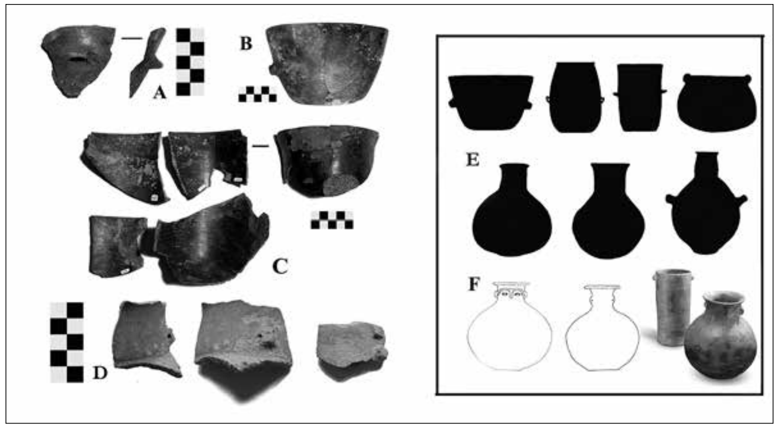

Figure 14.4. San Pedro Negro Pulido and San Pedro Rojo Pulido examples: (A, B, and C) Three partially reconstructed Séquitor type (subtype III) from Caleta Huelén 7; (D) Toconao fragments from Caleta Huelén 10A; (E and F) Séquitor and Toconao morphological sketches, modified from Tarragó (1989) and Uribe (2013). Photo by Itaci Correa.

where new radiocarbon dates show that both were in use during the first seven centuries AD (Hubbe et al. 2011; Torres-Rouff and Hubbe 2013; Stovel 2013). Contemporaneity of production and use of these types is consistent with the association of both varieties of Atacama tradition wares along with Late Formative Tarapacá types documented at Caleta Huelén 7, 10A, and 20. This "Atacameño" pottery has scant representation in the mound cemeteries of the Tocopilla-Hornitos coastal section, appearing only at Michilla 2 and Punta Guala Guala 4, sites that also present QT pottery. Its distribution seems to be strongly related to the sites at the mouth of the Loa River.

INSTRUMENTAL NEUTRON ACTIVATION ANALYSES

The objective of using instrumental neutron activation analysis (INAA) is to evaluate the provenance of the clays used in the production of ceramic vessels recovered from Formative coastal tumuli. By identifying the source(s) of these ceramic raw materials, we hope to examine the principal axes or directions of regional ceramic exchange. As demonstrated by other studies in this volume and as discussed by Glascock in chapter 1, the primary advantage of INAA is in the identification of distinct homogeneous groups with similar elemental compositions. These groups often represent statistically significant chemical or mineralogical variation resulting from differences in paste preparation or raw material procurement (Arnold et al. 1991; Glascock 1992; Neff 2000). The geographic distribution of such groups can allow archaeologists to reconstruct zones of production and exchange on a general level (Stoner and Glascock 2012).

Ceramic fragments from eight mound cemeteries on the coast were compared with samples from domestic and funerary contexts from a variety of settings along the Loa River and the Tarapacá Region (Figure 14.5). Some of these sites were previously studied and served as the basis to define the specific Formative technological tradition for Tarapacá (Table 14.3; Uribe and Vidal Montero 2015). The mound cemeteries that were sampled are located at the mouth of the Loa River (Caleta Huelén 7, 10, 10A, and 20) and in the Tocopilla-Hornitos coastal section of the Antofagasta Region (Michilla 2, Gualaguala 1, Gualaguala 2, and Hornitos 1).

Because the San Pedro pottery tradition has a well-known production center, restricted to the San Pedro de Atacama ayllus, we will comment only on the analyses relevant to the other two Formative industries of the Tarapacá tradition that are present in the mounds: LCA and QT.

The application of INAA—and indeed nearly all chemical and mineralogical assays—to the study of pottery provenance relies on the idea that clay from a certain place or geographical region will have some characteristic composition of major, minor, and trace elements. Present-day sources of local clay may give information on the chemical composition of the geological region (Wagner et al. 1998), but clay's ubiquity makes it difficult to sample every source potentially used by prehistoric potters. More to the point, clay sources that are identified by the archaeologist may not have been those that were used by ancient potters, and there are no guarantees that the exact geological localities from which clay and/or temper were prehistorically obtained are still available today. Changes in land use and of the landscape (e.g., mining, urbanization, terraforming,

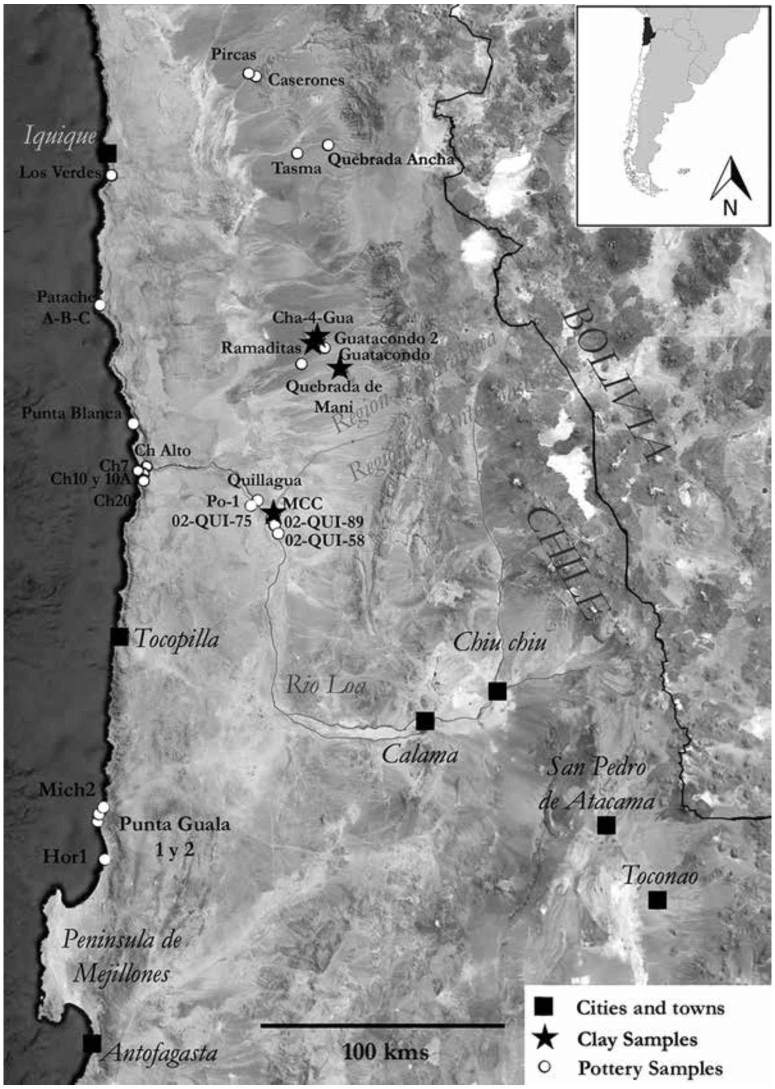

Figure 14.5. General map showing where pottery and clay samples were obtained. Map by Itaci Correa.

or highway construction) can make prehistorically used clay resources inaccessible (Boulanger and Glascock 2015).

Despite these possible hindrances to the identification of ceramic raw materials, we note that the Atacama Desert is a landscape with a very low rate of natural modification. Indeed, there are geological studies that suggest it is one of the oldest landscapes in the world, with the extremely low erosional rate of 0.0005mm/year (Clarke 2006; Dunai et al. 2005). For this reason, we decided to include in our analyses some samples of clay from naturally occurring deposits located adjacent to archaeological sites (Table 14.4) so as to reinforce geographical comparisons for the samples in this study.

The use of INAA to study ceramic provenance in northern Chile is at an early developmental stage, and consequently, there has yet been no systematic mapping or sampling of clay sources. Generally, pottery that was locally made can be identified as such by comparison with unfired clay samples found in the same excavation context. In such cases, it is essential to first characterize the properties of locally made pottery (Wagner et al. 1998). Yet, in the case of coastal tumuli cemeteries, there is little reason to believe that the pottery was locally produced, and current archaeological evidence points to pottery being a distinctly foreign (i.e., nonlocal) element (Correa 2016). Here, we include samples from several inland localities (Antofagasta and Tarapacá) in order to establish a chemical reference for the geological environment from which some of the coastal pottery may have come. Of the six clay samples included in our study, three come from the excavations at the Montículo Ceremonial Cemetery (MCC) Formative site at the Quillagua oasis. These three

TABLE 14.3. AREA, SITES, AND NUMBER OF SAMPLES

AREA	SITES	*N*	PROJECT
Tocopilla-Hornitos Coast	Hornitos 1 (Hor-1)	1	FONDECYT 1110702
	Michilla 2 (Mich-2)	2	
	Punta Guala Guala 1 (Guala-1)	2	
	Punta Guala Guala 4 (Guala-4)	2	
Loa River Mouth	Caleta Huelén 10 (Ch-10)	1	
	Caleta Huelén 10A (Ch-10A)	3	
	Caleta Huelén 20 (Ch-20)	3	
	Caleta Huelén 7 (Ch-7)	3	
	Caleta Huelén Alto (Ch-Alto)	3	FONDECYT 1080458 (Uribe y Vidal 2015)
Quillagua Oasis	Ancachi cemetery (02-QUI-75)	2	
	East terrace of high cemetery (02-QUI-58)	2	
	La Poroma 1 (Po-1)	6	
	Los Túmulos (02-QUI-89)	1	
	Montículo Ceremonial Cemetery (MCC)	1	
	Quillagua 89 (02-QUI-89)	2	
Tarapacá Coast	Los Verdes	1	
	Patache A-B-C	1	
	Punta Blanca	1	
Tarapacá Ravines	Caserones	4	
	Guatacondo (Gua)	2	
	Pircas	10	
	Ancha	1	
	Ramaditas	1	
	Tasma	4	
Total Sample Sherds		59	

Note: Coastal mound cemeteries sites are shaded.

TABLE 14.4. PROVENANCE OF CLAY SAMPLES FOR INAA

AREA	SECTOR OR SITE	*N*
Quillagua Oasis	Montículo Ceremonial Cemetery (in stratigraphic position)	3
Tarapacá Ravines	Sector between Challacollo 4 and Guatacondo (surface collect)	1
	Guatacondo (surface collect)	1
	Maní (surface collect)	1
Total Clay Samples		6

samples represent clay scraps that appear to have been discarded during pottery production. The other three samples were collected from surface clay deposits from the Maní (Q. Maní) and Guatacondo (A-Gua-02 and A-Cha-4-Gua) ravines, from the area surrounding the Guatacondo archaeological village (G-1; Mostny 1970). In total, our sample comprises 65 archaeological ceramic artifacts and clay specimens from 28 localities.

RESULTS

Statistical analyses were carried out on the entire 65-sample collection for the combined ceramic and clay data set described above. Principal component analysis revealed that six elements are responsible for the majority of chemical variation in the data set. For this analysis, we employed the natural logarithm covariance matrix of measured element concentrations. Principal component #1 (PC#1) is strongly weighted on Cs, As, Th, Sr, and Ca. PC#2 is weighted on As and Sb. A plot of these results shows that the two ceramic industries, LCA and QT, tend to form separate groups (Figure 14.6), suggesting that differences in bulk chemistry complement typological and petrographic differences. Similar results were obtained from a hierarchical cluster analysis of the elemental data (Figure 14.7), showing different paste compositions associated with the QT and LCA groups that again supports the presence of the two pottery industries or technological styles, as posited by Uribe and Vidal Montero (2015).

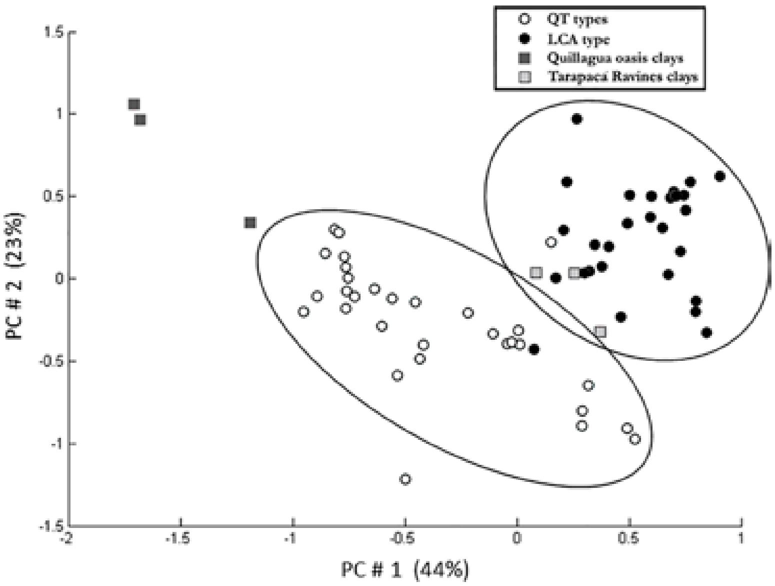

Figure 14.6. PCA plot of overall sample. Natural logarithm covariance matrix of the measured element concentration was employed.

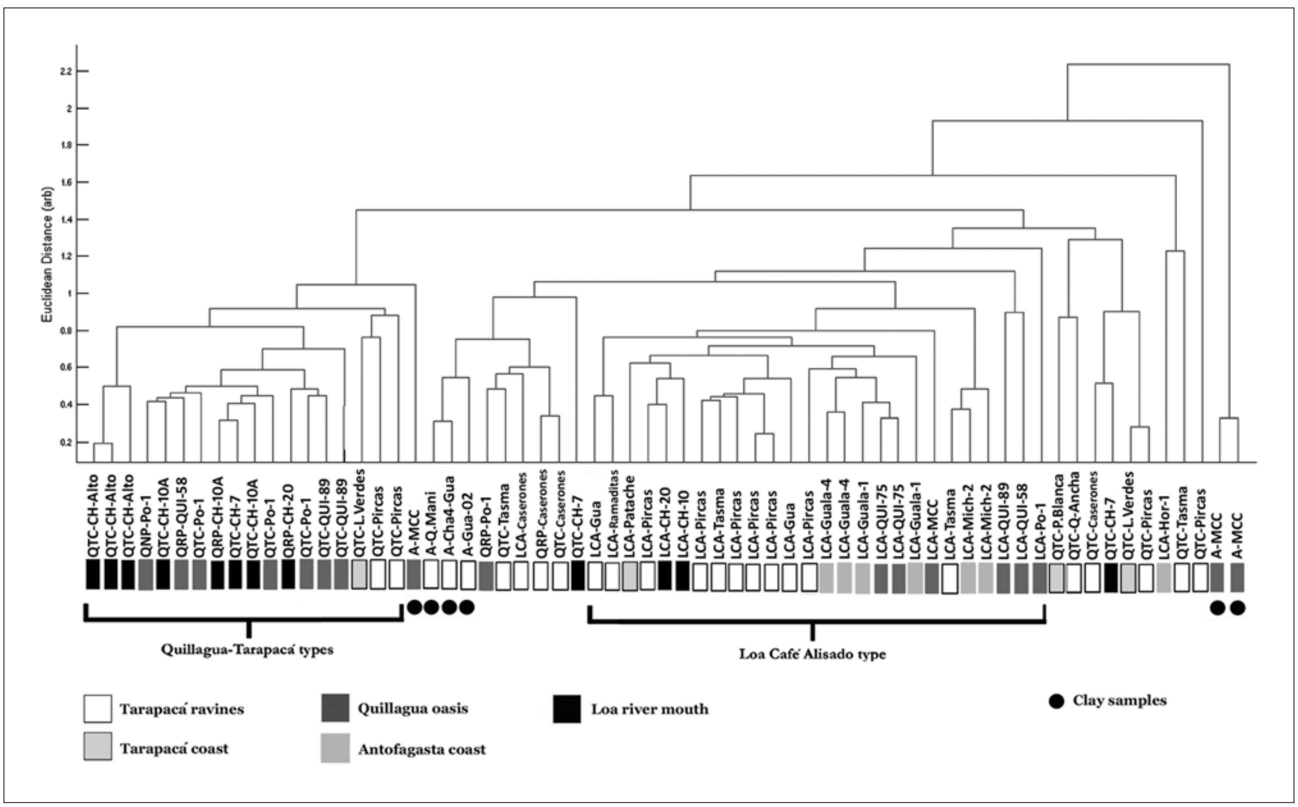

Figure 14.7. Hierarchical cluster analysis of quantitative elemental data.

Clays from Tarapacá ravines (Guatacondo and Maní) group closely together within geochemical expectations as being from nearby locations and are positioned between both groups but closer to LCA. MCC site clay specimens showed high concentrations of As, Sb, and Cs, being farther from the overall fragment samples. However, they are relatively closer to the group of fragments of the QT family rather than LCA. The high levels of As, Sb, and Cs possibly reflect the geochemistry of the water and sediment load of the Loa River. Several studies have documented that the chloride water from the El Tatio geothermal field is enriched with As, Sb, and Cs.

These waters feed the Loa River at the headwaters of Río Salado, one of the Loa's main tributaries. Systematic sampling of sediment along the course of the Loa shows an increase of these elements from the upper to the middle courses of the river, likely reflecting increased input from merging streams and rivers draining out of volcanic quaternary fields such as the El Tatio (Boulanger and Glascock 2015; Romero et al. 2003).

In Figure 14.7, clays from Tarapacá ravines are included in a subgroup mostly represented by QT types but with some similarities to the chemical composition of most LCA sherds. The archaeological clay samples from Quillagua (MCC site) are generally dissimilar to the rest of the sherds and clays, and they exhibit exceedingly high levels of As, Sb, and Cs. It is noteworthy that the LCA sample from this very same site does not group with the clays obtained there.

Other aspects observed were the chemical characteristics of both pottery industries separately. We developed two new principal component analyses, one considering all LCA specimens plus clay samples, and another with all QT specimens plus all clay samples; both resulted in slightly different concentrations in each case. For these two analyses, we used the natural logarithm covariance matrix of measured elements concentration as well. It is clear that for QT pottery, a concentrated set shows high chemical similarity between the Quillagua oasis and the Loa River mouth (Figure 14.8), while the fragments from Tarapacá ravines form a more disperse group to the left of the graph, which may be related to a broader geographical dispersion of these samples. The samples from the Tarapacá coast show proximity to each other, being plotted halfway between the first two groups. The clay samples separate into two groups relatively distant from the cloud of fragments of QT pottery, the Quillagua oasis clays group being the farther one.

When looking at the chemical characteristics of the LCA samples, it is evident that the spatial location of the sites does not generate a very clear pattern in the sample, except for two subgroups (Figure 14.9). One subgroup consists of a set of fragments from Tarapacá ravines, mainly from the Pircas site (six samples), plus one from the Guatacondo site and another from the Tasma site. The other subgroup that shows consistency is composed of specimens from the Tocopilla-Hornitos coast. The latter group is mixed with LCA fragments from Tarapacá ravines and has a chemical proximity to the clay samples collected from the same area (Guatacondo and Maní). Finally, the clay samples from the Quillagua oasis are very distant from the LCA samples.

CONCLUSIONS

The results obtained from INAA of pottery and clay suggest both pottery industries of the Tarapacá tradition (Loa

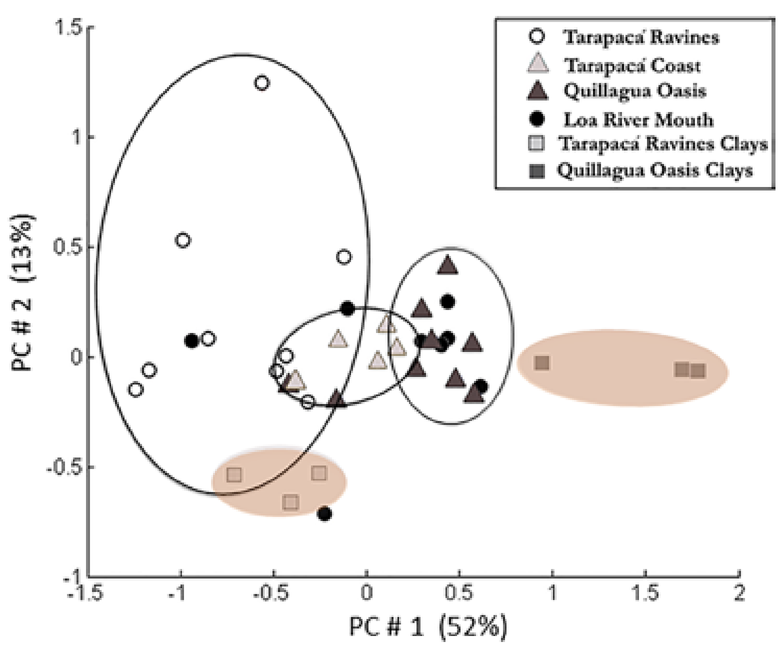

Figure 14.8. PCA considering only QT pottery fragments and clay samples. Natural logarithm covariance matrix of the measured element concentration was employed. Main positively weighed elements at PC#1 are As, Cs and Sb; at PC#2, Lu and Sr are positively weighted and Yb negatively.

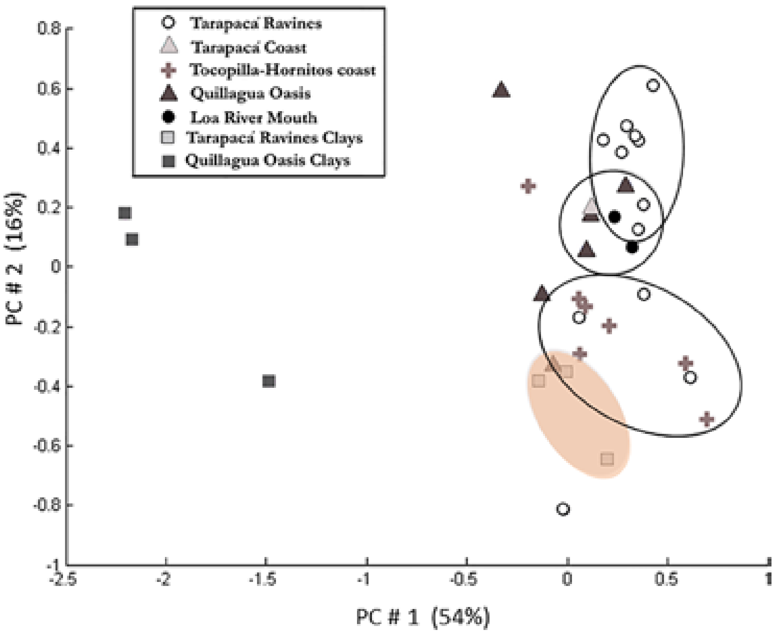

Figure 14.9. PCA considering only LCA fragments and clay samples. Natural logarithm covariance matrix of the measured element concentration was employed. Main negatively weighed elements at PC#1 are As, Cs, Sb; at PC#2, As, Sb, and Th are positively weighted.

Café Alisado from the Early and Middle Formative and Quillagua-Tarapacá from the Late Formative) show different chemical characteristics. This reinforces the previously proposed differences for both traditions by Uribe and Vidal Montero (2015) in the Tarapacá Region, based on a combination of INAA with petrographic and chronological analyses (e.g., thermoluminescence dating).

Clays from Tarapacá ravines collected at surface natural sources fall between the groups but are closer to LCA. This suggests that the LCA pottery of this sample was made inland in the ravines and pampa of the Tarapacá Region.

Previous LCA studies (Uribe and Vidal Montero 2012, 2015) suggested localized sources of raw materials or discrete production centers. Chemical homogeneity also suggests a very specific recipe of manufacture that is diagnostic of a well-defined technological style (Lemonnier 1992). It has been posited that this recipe could have been kept as restricted knowledge to pottery makers who inhabited the villages of the Tarapacá ravines, such as Guatacondo, Ramaditas, and Pircas, which developed the distinctive ceramic technology (Uribe and Vidal Montero 2015). This idea will continue to be explored with future research. Besides this well-defined technological style, the widespread geographic distribution of LCA reinforces the idea of an initial wide-ranging circulation system, as previously suggested by Uribe and Vidal Montero (2015). When observing the chemical landscapes (characteristics) within each ceramic tradition, our results from INAA support these proposals, including as a novelty to the circulation system, a very distant and hard to access area, the Antofagasta coast (the Tocopilla-Hornitos coastal sector), lying more than 200 km distant across the harshest desert on Earth.

Quillagua-Tarapacá pottery seems to be organized by geographic area with more definition than Loa Café Alisado. This could be related to the fact that, unlike LCA, QT pottery did not circulate far from the places where the raw materials were obtained. Petrographic studies have proposed that the greater variability of raw materials in the production of QT pastes indicate the existence of more than one center of production and that the spread of knowledge of pottery production occurred throughout that region during the Late Formative phase (Uribe 2004, 2009; Uribe and Ayala 2004; Uribe and Vidal Montero 2012, 2015). If this system of production is at the family level, it may well be related to marriage alliances, a subject yet to be explored.

Clays from the Montículo Ceremonial Cemetery (Quillagua oasis) were recorded in the stratigraphic deposit as part of refuse heaps. High concentration of As, Sb, and Cs in these clay samples are probably related to the geochemistry of the water and sediment load of the Loa River (Boulanger and Glascock 2015). Their dissimilarity from the general sample could imply that these clays were part of the paste ingredients used to make the vessels, but not the only ones. Other components added to the clay paste could have modified this strong chemical tendency. An alternative explanation is that these specific clays may have been discarded as inappropriate raw material. The fact that one of the three samples shows similarity with QT specimens could support the first interpretation, pointing to the Quillagua oasis as one of the production localities of this kind of pottery.[3]

Based on the exchange of ceramic artifacts and on the chronological assignment of the two ceramic traditions, the INAA results show that coastal populations were involved in two different axes of movement. At an initial stage, the evidence suggests that circulation was established first between Tarapacá ravines and coastal Tocopilla-Hornitos sites, since LCA pottery is found in funerary mounds, has a chemistry closely related to LCA pottery from the Tarapacá ravines, and also shows similarity to the clay collected in that area. Additional support for this idea comes from the fact that early Atacama pottery from inland territories of the Antofagasta Region, known as "Los Morros" type, has not been found, so far, at the mound cemeteries of this strip of coast.[4]

It has been shown in several studies that pathways through the desert form a defined system where both inland (e.g., Núñez 1976b) and coastal groups (e.g., Pimentel et al. 2011) have been detected as early as the Archaic period (Blanco 2013). From the Formative on, the oases groups are associated with llama transport. Thus, their pathways are mostly of multiple tracks: their resting sites usually contain camelid feces, hair, and cordage; they produced agricultural products such as maize and other grains; they have scant lithic artifacts or debitage made of inland rocks (such as obsidian from the Andean range); there is some metallurgy; and of course, they produced pottery (Pimentel 2013). Pathways of coastal agency tend to be single tracks only for pedestrian transport with sites that yield marine shells and bones. Lithics include some derived from sources on the east side of the coastal mountain range. They have small amounts of cordage frequently made of cotton and other plants. And they place a major emphasis on gathered products rather than agriculture, such as algarrobo (*Prosopis* sp.) seeds, wood, and especially cactus thorns and wood (e.g., *Eulychnia iquiquensis*) from the coastal range (cf. Cabello and Estévez 2017; Pimentel and Ugarte 2017; Pimentel et al. 2011; Torres-Rouff et al. 2012b).

Sites from the Middle Formative period of the two populations have been detected on tracks at Pampa Soledad (connecting Quillagua with Maní and Guatacondo), Calate (between the coast at the Loa River mouth and both Maní-Guatacondo and Ancachi-Quillagua areas), Pampa el Toco (between the coast and the Loa south of Quillagua and Calama), and routes of the southern Tocopilla-Hornitos coast (Michilla) to Chacance and Miscanti (Pimentel 2013; Pimentel and Ugarte 2017; Pimentel et. al 2011; Torres-Rouff et al. 2012b).

An alternative exchange route for LCA pottery that is important to consider may have been the maritime route between the coast of Tarapacá and Antofagasta shores, considering the ease of north-south marine navigation, indirectly confirmed for this period and area by Llagostera (1989, 1993).[5] It is worth noting that marine transport of goods presents several advantages over terrestrial ones since heavier loads and larger distances may be achieved. Additionally, for pottery, breakage rates must have been reduced.

During the Late Formative phase, there is a clear circulation axis that connects cemetery mounds from the Loa River mouth with residential and burial sites from the Quillagua oasis. This flow of goods could have been facilitated by the connection offered by the Loa River basin, the only permanent stream of freshwater that goes from the Andean range to the sea through 1,000 km of desert. Quillagua-Tarapacá and San Pedro pottery are considerably more abundant in the Loa River mouth sites than in mounds farther south (Correa 2017). It is possible, then, that people buried there had privileged access to exchange with oases populations during this period. It is noteworthy that at the Loa mouth, the tumuli cemeteries are less numerous but particularly large, showing a population density that was supported by the favorable conditions afforded by the faunal, floral, and hydrological resources of the river, as well as by the control of exchange between regions. Of the samples discussed, these cemeteries show the greatest variability and most abundant offering repertoire, local and foreign (Gallardo 2017).

In general, for both periods, the coastal/interior exchange studies for this part of the Atacama Desert indicate that the inhabitants of the littoral zone amplified their production of dry fish and shellfish into an exchange product to obtain pottery, textiles, agricultural products, metals, and copper mineral beads from the oases and ravine groups (Gallardo 2017). Within the framework of this exchange, pottery appears closely linked to the appearance of agricultural inland products in coastal contexts. Recent studies have demonstrated pottery use as cookware through the recovery and identification of adhered residues of wild local species (*Zephyra elegans*) and domesticated nonlocal probable exchanged species, such as Chenopodiaceae-Amaranthaceae and *Phaseolus* spp. (Carrasco et al. 2017; Correa 2017).

If we consider culinary tradition of the coast based on marine proteins (red meat from marine mammals as well as fish and mollusks), the pottery-plus-crop plants complex is a clear expression of new gastronomical customs derived from the social links generated during the Formative period. Since the earliest moments of the period, the relationships seen through the chemistry of pottery and clays seem to suggest close bonds between coastal groups and the distant inhabitants of the villages of Tarapacá. Later, these bonds would have been monopolized from the coast by the population at the Loa River mouth and from the interior by the people of the Quillagua oasis.

ACKNOWLEDGMENTS

This work is the result of FONDECYT Project 1110702. The INAA data and sample descriptions from this project are available from the MURR Archaeometry Laboratory website: http://archaeometry.missouri.edu/datasets/datasets.html.

NOTES

1. It is noteworthy that the coastal population experienced Formative processes that had several contradictions when compared with the inhabitants of the Loa River oases (Calama, Quillagua, and Chiu Chiu) and Tarapacá ravines (e.g., Guatacondo, Ramaditas, and Caserones villages) (Gallardo et al. 2017). This is obviously related to their different way of life, derived from their marine adaptation, including greater mobility and focus on hunting, fishing, and gathering, in contrast with the sedentary life, agriculture, and pastoralism of the interior inhabitants.

2. For Tarapacá, the Formative period has been divided in two phases, early and late. But for the Antofagasta Region, there are three phases: early, middle, and late. At Antofagasta, there is "Los Morros" type pottery (ca. 3200–2400 BP), corresponding to the first appearance of this technology in Atacama Desert during the Early Formative (Kalazich 2006; Sinclaire et al. 1998; Uribe 2004), being earlier than LCA. So, where this last type appears at Antofagasta, it is considered to be representative of the Middle Formative rather than from the early phase.

3. Yet another explanation could be its selection for medicinal or culinary purposes, as is suggested by ethno-archaeological research (Browman 2004; Browman and Gundersen 1993) and archaeological registry for the Formative period of Arica (Focacci 1990). Even when pottery is always made with clay, clays are used for many other purposes, a line of research yet to be pursued for our region.

4. Regarding the possible pottery circulation from Atacama inner lands and this strip of coast, there is a single case of Los Morros type fragments at a travel camp associated with a path that links the El Toco sector (Inferior Loa) with the Punta Paquica and/or Mal Paso localities. This is one of several "coastal modality" routes, between which there is a majority registry of Tarapacá tradition pottery, whether it be LCA or QT (Pimentel et al. 2011).

5. Although recently it has been noted that the presence of open-sea species at archaic coastal settlements implies much earlier navigation (see Ballester and Gallardo 2011:881; Olguín et al. 2014).