Routledge
Taylor & Francis Group

Ethnoarchaeology
Journal of Archaeological, Ethnographic and Experimental Studies

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/yeth20

South of the Empire: Inka-Style Pottery Production in Relation to Local Pottery Traditions in the Upper-Middle Basin of the Aconcagua Valley (Central Chile)

Andrea Martínez-Carrasco, Patrick Quinn, Bill Sillar, Silvia Amicone, Baptiste Solard & Daniel Pavlovic

To cite this article: Andrea Martínez-Carrasco, Patrick Quinn, Bill Sillar, Silvia Amicone, Baptiste Solard & Daniel Pavlovic (30 Dec 2024): South of the Empire: Inka-Style Pottery Production in Relation to Local Pottery Traditions in the Upper-Middle Basin of the Aconcagua Valley (Central Chile), Ethnoarchaeology, DOI: 10.1080/19442890.2024.2443346

To link to this article: https://doi.org/10.1080/19442890.2024.2443346

Published online: 30 Dec 2024.

ETHNOARCHAEOLOGY
https://doi.org/10.1080/19442890.2024.2443346

South of the Empire: Inka-Style Pottery Production in Relation to Local Pottery Traditions in the Upper-Middle Basin of the Aconcagua Valley (Central Chile)

Andrea Martínez-Carrasco[a], Patrick Quinn[a], Bill Sillar[a], Silvia Amicone[b], Baptiste Solard[b] and Daniel Pavlovic[c]

[a]Institute of Archaeology, University College London, London, UK; [b]Competence Center Archaeometry Baden-Wuerttemberg, Universität Tübingen, Tübingen, Germany; [c]CIEM Aconcagua Researcher, San Felipe, Chile

ABSTRACT

This study aims to identify the nature and degree of state control over the production of Inka-style pottery used in political commensalism in the upper-middle basin of Aconcagua Valley during the Late Period (1400–1536 CE). Sherds from Inka-style flared-rim jar (maka) and shallow plate forms are compared to local styles from the Late Intermediate Period (1000–1400 CE), Diaguita, and new non-Inka Late Period ceramic manifestations. The potsherds are characterized technologically through macrotrace analysis, thin-section petrography, and geochemical and mineralogical analyses (pXRF, μ-XRD^2). This demonstrates continuities in ceramic production, such as the use of common local raw materials and vessel construction by coiling, both before and during the Inka rule. It also reveals innovations, including new finishing techniques, changes in firing atmosphere control, and pigment recipes. The significance of these findings is discussed in terms of the influence of the Inka, possible foreign specialists (Diaguitas), and local agencies on ceramic production.

Resumen

Este estudio busca identificar la naturaleza y grado de control estatal sobre la producción de cerámica de estilo Inka, usado en actividades de comensalismo político, en la cuenca media-alta del valle del Aconcagua durante el Período Tardío (1400–1536 CE). Fragmentos de jarros de boca acampanada (*makas*) y platos bajos de estilo Inka son comparados con estilos locales del Período Intermedio Tardío (1000–1400 CE), Diaguita y cerámica tardía no Inka siendo caracterizados tecnológicamente a través de macro-trazas, petrografía de sección delgada, análisis geoquímicos y mineralógicos (FRXp, μ-DRX^2). Se demuestra continuidades en producción cerámica, con uso de materias primas locales y modelado por rodetes antes y durante el dominio Inka. También revela innovaciones, incluyendo nuevas técnicas de acabado,

KEYWORDS
Ceramic production; Aconcagua Valley; Inka control; geochemical analysis; thin-section petrography; macrotraces; pigments; *chaîne opératoire*

CONTACT Andrea Martínez-Carrasco andrea.carrasco.19@ucl.ac.uk Institute of Archaeology, University College London, 31-34 Gordon Square, London WC1H 0PY, UK

cambios en control de atmósfera de cocción, y recetas de pigmentos negros. Las significancias de estos hallazgos se discuten en términos de influencia Inka, posibles especialistas foráneos (Diaguitas), y agencias locales en producción cerámica.

Introduction

Around 1400 CE, the Aconcagua River valley, located between the Andes Mountains and the Pacific coast of South America (Central Chile) (Figure 1), was incorporated into the southernmost region of the Inka Empire, or Tawantinsuyu, the last pre-Hispanic pan-Andean political horizon before the arrival of the Spaniards (1532–1536 CE). Tawantinsuyu incorporated communities with distinct forms of social organization over a remarkably diverse landscape, and the Inka employed different annexation strategies to manage this diversity and reorganize local spaces incorporating new state meanings. As a part of this process, a range of material culture was created with Inka-style forms and decorations for political use in the Inka State and more local contexts (Malpass and Alconini 2010; Sillar 2009; Williams 2008, 2022).

Local leaders played a crucial role in the political organization of the Empire, facilitating or blocking the implementation and interaction between the state and their communities (Hayashida, Troncoso, and Salazar 2022, 3). These negotiations, vital to the Empire's functioning, were supported by the establishment of commensal practices by the Tawantinsuyu. Alongside ritualized performance in designated spaces, these practices fostered relations of reciprocity and labor taxation, generating ties of alliance, cooperation, and political domination. Central to these festivities was the provision of food and drink (Bray 2009; Morris and Thompson 1985). Pottery used as containers

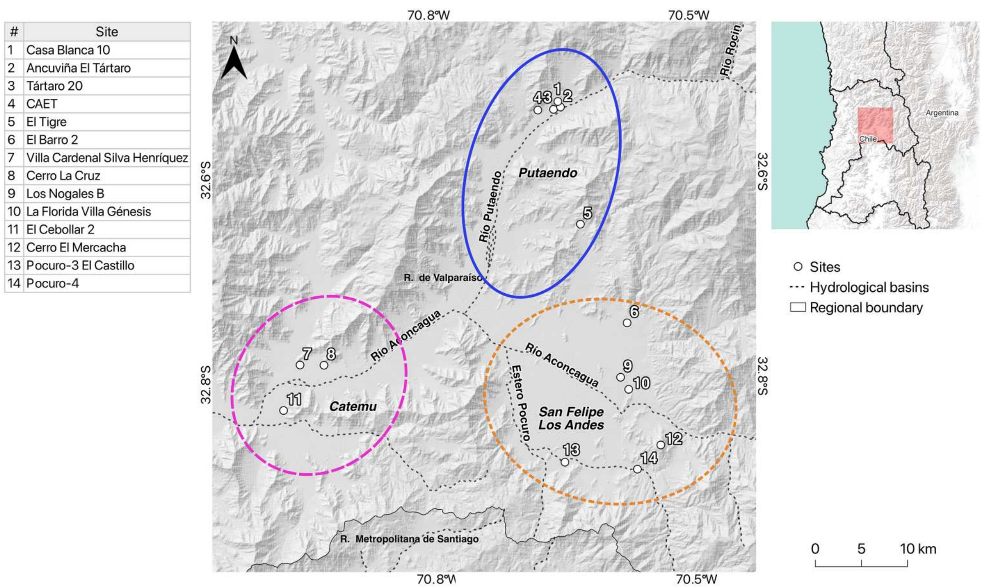


Figure 1. Map of archaeological site locations. Prepared by Cristian González.

for preparing and presenting food and drink for consumption and ritual offerings in these political and religious festivities is one of the most archaeologically diagnostic elements for recognizing the presence or influence of the Tawantinsuyu in the provinces (Morris and Thompson 1985).

In the Aconcagua Valley, during the Inka period, local communities continued to make and use of similar ceramic forms and styles, as identified in the previous period (Figure 2). However, new ceramic forms and decorative styles started to appear, accompanied by widespread Diaguita decorative motifs associated with pottery traditions from the semi-arid zone to the north. This article explores, for the first time in this region from a pottery technology perspective with archaeometric techniques, the extent and nature of Inka state control or influence in this region over the production of Inka-style pottery, as well as the possible agency of the local

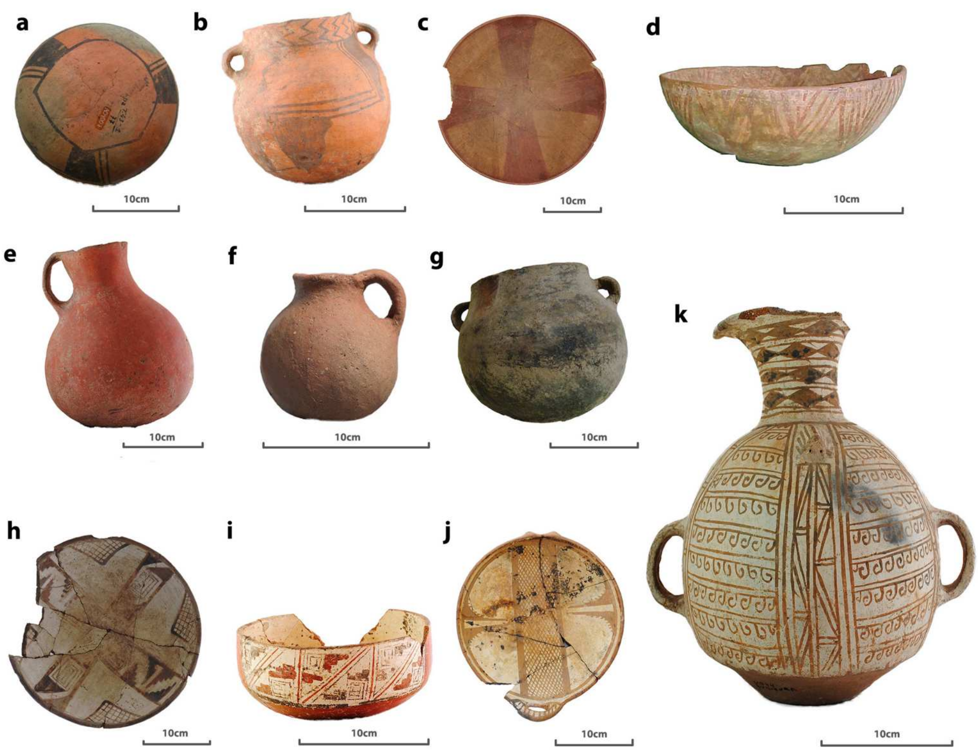


Figure 2. Examples of archaeological vessels from the study region: Aconcagua Salmon bowl (a) and pot (b); Aconcagua Red Slip bowl (c); Local Putaendo bowl (d); Coated jar (e); Undecorated jar (f) and pot (g); Local Inka Phase bowl (h); Diaguita style bowl (i); Inka Style shallow plate (j); and makas (k). Site and Repository Information: Chicauma (a), Departamento Antropología Universidad de Chile, Inv. N°A04007, (surdoc.cl); Quilpué (b), Museo de Historia Natural de Valparaíso, Chile, MHNV-1044, registro surdoc 4-254 (photo credit: R. Mondaca, 2016); Estación Quinta Normal (c), Museo Regional de Rancagua (photo credit: Fondecyt 1140803); Quilicura 1 (e, k), Nos (i) and La Reina (j), Colección Museo Nacional de Historia Natural (©MNHN); Los Libertadores (f) and Estadio de Quillota (g y h), Museo Histórico Arqueológico de Quillota, Inv. N° 8191 (LP/Cult. Aconcagua/07.02.2018), 1058 (LP/ Cult. Aconcagua/ 02.11.2009), 1120 (LP/Cult. Aconcagua/Nov. 2009), respectively; Ancuviña El Tártaro (d), Pavlovic (2006, 184).

communities and the role that "foreign" Diaguita may have played in this mediation. To this end, pottery assemblages from before and during the Inka occupation of the Aconcagua Valley are analyzed from a technological perspective to determine the possible origins of materials (local and non-local), pastes, and pigment recipes and to reconstruct the manufacturing process. Inka-style sherds are compared to local vessels from the Late Intermediate Period (1000–1400 CE) and those that appeared during the Late Period (1400–1536 CE), such as Diaguita and new non-Inka ceramic manifestations, to detect and compare continuities and changes within the Upper-Middle Aconcagua Valley.

By identifying patterns in the ceramic production process (*chaîne opératoire*), drawing upon ethnoarchaeological research, the results allow for a discussion on how the Inka might have controlled (or not) different stages of pottery production and how this could be used as a strategy for integrating local communities, given their strong links with political commensalism activities. In a broader context, this work contributes to a critical reflection on what is stylistically understood as "imperial", in this case, "Inka" versus "local" from a technological point of view, enabling the assessment of possible scenarios of social interaction involved in pottery production within an asymmetrical relationship of negotiation.

Archaeological Background

The upper-middle Aconcagua Valley is composed of two different drainage basins, Putaendo, and San Felipe-Los Andes, that flow westwards from the eastern Andes toward the Pacific Ocean and join around the Catemu area to form the central valley of the Aconcagua River (Figure 1). This area's bedrock geology consists mainly of volcanic igneous units and volcaniclastic formations dated between the Lower Cretaceous and Miocene, and some plutonic units. Two material culture traditions have been defined for the Late Intermediate Period (LIP onward). One is the Aconcagua Culture, whose materiality and settlements are recognized in the Aconcagua, Maipo-Mapocho, and Cachapoal Valleys of Central Chile (Falabella et al. 2016). The second is the Putaendo Cultural Tradition, located in the sub-valley of the river with the same name, northeast of the Aconcagua Valley (Falabella et al. 2016; Pavlovic 2006; Pavlovic et al. 2008). The Aconcagua tradition is recognized for continuities in its material culture from the earlier LIP, between 1000 and 1400 CE, throughout the Late Period (LP, 1400–1536 CE) until European contact. These communities were segmental groups with little material evidence of social inequality and a social organization structured around kinship relationships (Cornejo, Falabella, and Sanhueza 2003). Their craft production, including pottery, might have been organized at the level of domestic units (Falabella, Cornejo, and Sanhueza 2003; Pavlovic et al. 2019).

During the LIP in Putaendo, communities were recognized for sharing a pottery tradition that differed from those contemporary to the San Felipe-Los Andes area and the rest of Central Chile. The archaeological evidence from the Putaendo area LIP also suggests the existence of segmental social groups that did not manifest significant social inequality. These communities would have been related to populations located in the northernmost part of Central Chile (Petorca and La Ligua, current municipalities) and to Diaguita communities in the semi-arid Choapa River area, based on similarities observed in their pottery and rock art traditions, which have not been studied in depth so far, though are distinguishable from the rest of Central Chile (Pavlovic 2006; Pavlovic et al. 2014). Both local traditions had no significant changes in their domestic spaces during the Inka Rule period (LP). Studies in the neighboring southern region, Maipo-Mapocho, see a reduction in the Aconcagua pottery incorporated into funerary contexts during the LP. In contrast, new local styles (Local Inka Phase), Inka-Style pottery, and Diaguita motifs increased (Dávila et al. 2018). Thus, although no significant changes are observed in pottery in domestic sectors, transformations in the ceramic repertoire are observed mainly in extra-daily activities linked to ceremonial (funerary) and festive spheres (congregational activities) (Fuenzalida 2021), where the new late styles of vessels, with Inka and Diaguita influence, were used alongside local pottery styles that continue from the earlier period.

During the LP, incorporating the Aconcagua Valley into the Tawantinsuyu generated a differential and discontinuous panorama (Sánchez 2004), with different degrees of participation and social interaction (González 2000). Inka sites were placed in visible landmarks, such as prominent hills, besides new ceremonial spaces, including funerary structures at locations not previously occupied by local populations (Pavlovic et al. 2022). However, the presence of a high-altitude sanctuary on the highest peak of the valley and the American continent, Mount Aconcagua (Schobinger 1999), with human offerings, denotes this valley's symbolic importance for the Empire. As seen in the rest of the Tawantinsuyu, the Inka's political strategy in this region was based on political commensalism and congregation activities, where pottery containers for food and drink played an essential role in these ceremonies, linked to the construction of funerary and congregation sites (Pavlovic et al. 2019). Unlike some other places in Tawantinsuyu, in Central Chile, there are no recognized workshops or specialized locations for pottery production (Dávila et al. 2018), so the study of this process requires us to analyze the evidence of the pottery materials, techniques, and forms.

Another important group was the Diaguita, or their representation in the visual language of LP vessels, in the middle-upper Aconcagua basin. The Diaguita ceramic tradition developed in the semi-arid north, between the Elqui and Choapa rivers, to the north of the study region, contemporaneously with the Aconcagua communities during the LIP and LP (González 2013). The Diaguita developed a pottery style with distinctive iconography and shapes; the subsequent occurrence of this Diaguita-style pottery in the Aconcagua area during the LP has led to the proposal that the Inka supported the relocation of these external specialists to help control the area on their behalf (Cornejo and Saavedra 2018; Sánchez et al. 2004; Silva 1985; Stehberg and Sotomayor 2012). However, this suggestion that there was a Diaguita *mitmaqkuna*, a resettled population system under the Inka Empire, has not been fully assessed through a detailed ceramic analysis.

Late Pottery in Aconcagua Valley

The present study uses typological categories already defined for the late ceramics of Central Chile as a starting point. Inka-style pottery is understood as all ceramics with forms like those originating in Cuzco, following Calderari and Williams' nomenclature

(1991) and including the provincial and mixed categories. Two of the most recognizable forms that are known to have played an essential role in Inka feasting and ritual in Central Chile (Dávila et al. 2018) are studied in detail. The first form is long-neck and flared-rim jars, commonly called *makas* or *urpus* and sometimes referred to as *aryballos* (Figure 2 k) in Cuzco. These had a pointed bottom, although in Central Chile, the bottom shows a marked convex-concave shape. They are particularly associated with the production of an alcoholic beverage called *chicha* (Hayashida 2009). The second Inka form is a shallow plate (Figure 2 j) associated with the serving of food and making of offerings. The Diaguita pottery forms (Figure 2 i) correspond mainly to bowls of composite contours (corner point in base-body) with a characteristic abstract and symmetrical decorative style (González 2013).

In turn, the pre-existing local pottery tradition primarily consists of bowls of continuous profiles, restricted vessels of inflected profiles, one-handled jars, and cooking pots with two handles and a small neck. Sub-types are distinguished by the kind of surface treatment and decorations (or their absence). Aconcagua's Undecorated pottery (Figure 2 f-g) includes pieces finished by smoothing without decoration. There are two sub-types with red slips. Coated (Figure 2 e) vessels have no painted decorations except for the red slip, while Aconcagua Red Slip bowls (Figure 2 c) have a design of a diametrical cross and a band parallel on the rim. One of the most important sub-types for this study is Aconcagua Salmon pottery (Figure 2 a-b), which is characterized by its orange paste without or with decoration, such as black and/or red on the surface or white slip (Massone 1978). All these sub-types had been used extensively, with some distributional difference, in the Central Chile region during the LIP and remained during the Inka LP. Only the Putaendo area presented a contemporary LIP ceramic tradition that differed from the rest, characterized by bowls with red-on-white decoration (Pavlovic 2006) and corresponds to Local Putaendo (Figure 2d). Finally, the Local Inka Phase pottery appears during the LP and presents changes in decorative and formal designs (Figure 2 h), showing unprecedented decoration, with the usual application of Diaguita and Inka iconography and/or forms (Dávila et al. 2018).

Chaîne Opératoire, Technological Traditions, and Sponsored Production

The fundamental basis of this study is the technological approach through the *chaîne opératoire* concept, which refers to "a series of operations which transforms a substance from a raw material into a manufactured product" (Cresswell 2010[1976], 26), whether it is an object or a tool (Roux 2019). These operational chains are deeply intertwined with the social and cultural systems they are a part of (Cresswell 2010 [1976]; Leroi-Gourhan 1973), as their operations respond to "technological choices" (Sillar and Tite 2000) influenced by the functionality of the object and the ideological, economic, and social environment of its producers and consumers.

In the specific case of pottery, distinct stages in the *chaîne opératoire* can be considered: extraction and preparation of the raw material into a paste, fashioning, finishing, surface treatment, decoration, drying, and firing (Gosselain 1992, 564–577; Roux 2016, 104; Rye 1981, 62). For Roux (2019), technical practice is always the fruit of a social group's way of doing things, and this is illustrated in various Andean ethnoarchaeological studies such as those by Arnold (1993), Lara, Ramón, and Bray (2023), and Sillar (2000). This inherited knowledge develops at the individual level from learning and the collective level from the transmission of knowledge, since learning facilitates the transmission and permanence of technological tradition within a social group (Roux 2019).

At the individual level, learners build motor and cognitive skills to make artifacts according to the models they learn from their teachers and others (Bowser and Patton 2008; Gosselain 1992; Ramón 2013; Roux 2019). Less visible techniques in the manufacturing process tend to be more rigid and unchanging, gradually becoming ingrained in the potter's unconscious psychomotor schema. However, more visible elements, such as decoration and form, are usually more adaptable to situational changes within potter groups (Gosselain 1992). In this line, it should be noted that although decoration may be an expression of the demand for objects (Roux 2019), a decorative technique also responds to similar social factors as other stages of the *chaîne opératoire* and may follow its own sequences in different decorative designs (i.e. pigment recipes) (Saball 2019). On the other hand, at the collective scale, tutors are usually selected from within the same social group as the learners. The transmission of ways to do things conforms to the social norms, as the ceramic styles visibly display the learning in the same social group. These limits are constrained by the nature of the community, temporality, and transmission networks (Roux 2019).

Ceramic manufacturing responds to the needs of the society that produced it. Production is determined, in part, by demand (consumption), and distribution is defined according to those needs within the socio-economic context (Costin 1991). Therefore, production, distribution, and consumption are interdependent phenomena embedded in a cultural context encompassing specific social organizations, territories, landscapes, resources, and defined technological knowledge. Andean archaeology has drawn strongly from historical and ethnographic studies to consider the organization of pottery production and ceramic technology. However, as Sillar and Ramón (2016) highlight, it is essential to consider how pottery production has varied across the Andean region. This article draws upon ethnoarchaeological insights into how production techniques are embedded within ceramic learning traditions (e.g. Druc 1996; Gosselain 1992; Hosler 1996; Lara, Ramón, and Bray 2023; Ramón and Bell 2013). This allows us to compare the introduction of new pottery forms and decoration (Inka-style *makas* and shallow plates) concerning changes in the technological processes used to make these pots to consider what this tells us about how the organization of production may have changed during the period of Inka rule.

In this context, the importance of understanding the form of relationship and obligation between provincial potters and the Inka state makes sense (see discussion of state-sponsored production, Hayashida 1995). On the one hand, the producer may have an absolute responsibility toward their sponsor, or this responsibility may respond to only one of their daily or seasonal productive obligations. Furthermore, the sponsor might control all stages of the *chaîne opératoire* or only some stages. Through the recognition of patterns in the different stages of the ceramic manufacturing sequence, this study seeks to understand how the production of Inka-style ceramics was organized, during which stage(s) the state had the most significant influence, and how this process could have been used as part of the political strategies of integration of local communities by the Tawantinsuyu, to facilitate the commensalism that the Inka used for political engagement.

Materials and Methods

A sample of 226 potsherds was selected from over 20,000 fragments recovered by previous excavation at 14 archaeological sites in the upper middle Aconcagua Valley. This sample was chosen using the previously identified ceramic types, periods, sub-valleys, and context criteria to assess similarities, continuities, differences, and changes (Table 1). Besides the Inka-style forms of *makas* and shallow plates, it also included a sample of local contemporary and pre-Inka styles (Aconcagua Salmon, Aconcagua Red Slip, Local Putaendo, Coated, Undecorated, Local Inka Phase) and Diaguita-style vessels, through decorated and undecorated fragments of diagnostic shapes, such as rims, necks, union, bases, handles, and bodies. The selected material is mainly from the period of Inka presence (LP), and a smaller sample of pottery is dated to the previous period and corresponds to the local pottery tradition (LIP). Three areas within the Upper-Middle Aconcagua Valley are distinguished: Putaendo, San Felipe-Los Andes, and Catemu (Figure 1). Each sub-valley is defined by distinct tributaries of the Aconcagua River, except for the Catemu area. The last criterion, related to archaeological context, focuses on LP Inka sites, corresponding to those settlements with stone architecture on hills and funerary contexts. The former appears

Table 1. Characteristics of the ceramic sample according to typology, period, area, and context.

	Local Tradition					Foreign Influence			
Period/Area/Context Type	A. Red Slip	A. Salmon	Loc. Put	Coated	Undec.	Inka	Diaguita	Loc. Ink.Ph	**Total**
LIP	**6**	**4**	**1**	**9**	**29**				**49**
Putaendo	**2**	**1**	**1**	**7**	**12**				**23**
Domestic		1	1	5	2				9
Funerary-Domestic	2				6				8
Funerary				2	4				6
San Felipe-Los Andes	**4**	**2**			**2**				**8**
Funerary	4	2			2				8
Catemu		**1**		**2**	**15**				**18**
Domestic		1		1	3				5
Funerary				1	12				13
LIP-LP	**2**	**1**			**8**	**1**			**12**
San Felipe-Los Andes	**2**	**1**			**8**	**1**			**12**
Funerary-Domestic	2	1			8	1			12
LP	**10**	**23**	**3**	**20**	**34**	**48**	**6**	**21**	**165**
Putaendo	**1**		**3**	**7**	**14**	**16**	**1**	**7**	**49**
Tambo					4	2		4	10
Congregation-Adm	1		3	5	6	4	1	1	21
Domestic				2	4	10		2	18
San Felipe-Los Andes	**7**	**5**		**1**	**13**	**14**	**2**	**4**	**46**
Congregation-Adm				1	1	14	2	3	21
Funerary-Domestic	7	5			12			1	25
Catemu	**2**	**18**		**12**	**7**	**18**	**3**	**10**	**70**
Congregation-Adm	2	8		6	7	18	3	8	52
Funerary-Domestic		10		6				2	18
Total	**18**	**28**	**4**	**29**	**71**	**49**	**6**	**21**	**226**

multifunctional (ceremonial-administrative) and is distinguished from other sites with well-defined functions and formats, such as the *tambos* (a state-organized roadside lodge). As for the funerary contexts, there is a proliferation of a range of burial sites, which breaks with the previous LIP rites associated with mounds. Material from local domestic contexts of both periods and LIP funerary contexts will also be considered. All sherds come from consumption contexts rather than production sites, which have not been identified in the study area.

Observation and Characterization of Macrotraces

From the total sample, 106 fragments were examined macroscopically for traces of manufacture based on the premise that each gesture within the technical operations of the *chaîne opératoire* leaves evidence that can be observed with the naked eye or a binocular microscope (Livingstone Smith 2007, 24; Roux 1994, 2019; Rye 1981), although subsequent actions may also obscure the traces of some activities. Adopting the macroscale analysis indicators of Roux (2019), specifically macroscopic features and meso-structures, this analysis focused only on the stages of fashioning (roughing out and preforming), finishing, surface treatment, decoration, and firing atmosphere. Most of these stages are recognizable by relief (e.g. profiles and topography), fracture type (defined by orientation and profiles), and surface features (such as color, shine, granularity, microtopography, striation, and variation in coating thickness). In turn, the firing atmosphere was defined by the colors since an oxidizing firing regime generates iron (III) oxides, tending toward reddish tones. In contrast, a reducing atmosphere creates iron (II) oxides with darker colors (Roux 2019, 101–110). Although the sample size is too small to establish technical traditions, these preliminary results shed light on differences and similarities between the local pottery tradition and that recognized during the Late Period, linked to the production of Inka-style pottery, raising questions for future research.

Thin-Section Petrography

Petrographic thin-section analysis was performed on 92 sherds from the total assemblage to characterize and classify them in terms of their mineralogical, petrographic, and microstructural composition. It was used to infer the geological characteristics of their raw materials and reconstruct aspects of ceramic technology, such as paste preparation, forming, firing, and finishing.

The petrographic analysis includes 72 samples selected in a previous project (Pavlovic, Troncoso, and Sánchez 2013), plus 20 additional fragments representatively selected according to sites, macrofabrics, ceramic types, and forms. All thin sections were prepared in the Wolfson Labs at the UCL Institute of Archaeology following a modification of the standard technique for rocks and sediments (Quinn 2022, 22–36). The 92 petrographic thin sections (30 μm) were examined under a Leica DM EP polarizing microscope at magnifications of 40 to 400x. Samples were classified visually into fabrics based on the nature of their inclusions (identification, shape, size, roundness/angularity, abundance, spacing orientation, sorting grains, and size distribution), clay matrix (presence or not of calcite, color variation, and homogeneity/ heterogeneity, raw material mixture, firing atmosphere, and mineral deposition after firing) and voids (abundance, shape and size) (Quinn 2022, 89–135). Based on the assumption that the mineralogy and petrography of an artifact are related to the geology of the area in which the raw materials were obtained (Bishop, Rands, and Holley 1982; Hunt 2012), the fabrics were compared to geological maps of the region to identify possible raw material sources and suggest whether the ceramics could have been made locally to their site of excavation or imported (Quinn 2022, 167–171), considering ethnographic studies of clay collection and processing in the Andes (Roddick and Klarich 2012; Sillar 2000). Direct geological field sampling of clay and other potential raw materials has been untaken, but at the time of writing these samples have not been analyzed.

Portable X-ray Fluorescence Spectroscopy

All 226 sherd samples were analyzed via portable X-ray fluorescence spectrometry (pXRF) to characterize their geochemical composition and detect compositional patterning linked to raw materials, paste recipes, and provenance. Analysis was carried out with an Olympus Vanta M-Series pXRF analyzer in the factory 3-Beam Geochem Mode which measures the concentrations of 40 elements (Mg, Al, Si, P, S, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Y, Zr, Nb, Mo, Ag, Cd, Sn, Sb, Ba, La, Ce, Pr, Nd, W, Hg, Pb, Bi, Th, U, LE). All three beams were used for 60 seconds of live time, resulting in a total analysis time of three minutes. The samples were first abraded to remove decorative layers or contamination (Holmqvist 2016, 366; Webb 2018, 243) before two or three separate readings were taken of different flat 10 mm diameter surfaces of each fragment, depending on the size of the sherd. These were then averaged to obtain a single value for each element for each sample (Holmqvist 2016, 369). A ceramic recalibration was developed by analyzing a set of 14 powdered certified reference materials of rock, ore, sediment, soil, and ceramic with the same machine set up and comparing the certified and measured samples via linear regression (Quinn 2022, 343–345). A good correlation (>0.8 R^2) was observed for 24 measured elements that were both certified in standards and recorded by the pXRF, though some outliers were removed for certain elements. The linear regression equation ($Y=aX+b$) was then used for recalibration. Their efficiency was tested on a second set of eight powdered certified reference materials. This revealed that the recalibration yields a marked improvement in the percentage accuracy for most elements compared to the factory 3-Beam Geochem Mode. Using the “University College London (UCL) Olympus Vanta pXRF Machine 4 Ceramics Recalibration”, a total of 13 elements can be measured with an accuracy of less than 20 percent error (Al, Si, K, Ca, Ti, Mn, Fe, Zn, Rb, Sr, Y, Zr, Pb). The multivariate dataset of 13 elements and 226 samples was explored via descriptive statistics and principal component analysis (PCA) via the RStudio package. The data were first centered log-ratio transformed to adjust for differences in scale between the major and trace elements. Bivariate scatterplots were also studied to recognize covariance relationships between pairs of chemical elements, which may respond to the presence or substitution of certain minerals (Quinn 2022, 353).

Micro X-Ray Diffraction

A representative sample of 14 decorated sherds was selected and measured via micro-X ray diffraction coupled with a two-dimensional detector (μ-XRD²) to identify the main crystalline phases in the three decorative colors (red, white, and black). Analysis was performed at the Competence Center Archaeometry Baden-Wuerttemberg, University of Tübingen, using a Bruker D8 Discover Θ/Θ GADDS micro-diffractometer equipped with a Co-X-ray tube running at 30 kV/30 mA, a HOPG-primary monochromator, a 500 μm monocapillary optic, and a VÅNTEC-500 2-dimensional detector. The usual measurement setup involves a fixed incident beam angle of 10° and two positions for the detector (15 and 40°) with a 4-minute measurement time by position for a final diffractogram covering approximately a 60° 2θ angle range. Mineral phase identification was performed using the Powder Diffraction File (PDF) database from the International Centre for Diffraction Data (ICDD; Newtown Square, PA, USA). At least one measurement per color was taken and compared with surface and clay matrix measures to confirm that the signal corresponds to the pigment layer. Only the analysis of the black pigment, the most significant within the set, is presented here.

Results

This section presents the findings from analysis of the ceramic samples summarized in Table 1 using the four techniques described above: macrotrace analysis, thin-section petrography, pXRF, and micro X-ray diffraction.

Macrotraces

The visual analysis of manufacturing traces from a subsample of 106 fragments of the total set yielded possible shared patterns in each step of the *chaîne opératoire*. It is proposed that 61 (57.5%) samples were manufactured by coiling, mainly from the identification of irregularities and over-thickness in inner surfaces and horizontal fissures (Roux 2019, 160–166) (Figure 3 a, b, c, d). Identifying U-shaped and rounded breaks and coarse particles in the meso-structures (sherd sections) associated with an S-shaped orientation allows the proposed coiling technique by pinching in 31 samples. In comparison, 12 samples exhibited coarse particles in their meso-structure with vertical subparallel orientation according to the coiling technique by drawing (Roux 2019, 55, 163–166). The remaining 45 (42.5%) sherds showed no visible traces corresponding to this stage.

For the preforming stage, scraping grooves with irregular edges were recognized in 24 fragments (Figure 3 d) with a fluidified bottom, indicating that scraping would have been made on a wet paste. While some scarce evidence of deep striation with a compact bottom suggests shaving of a leather-hard clay mass for five fragments, three of which also exhibit evidence of percussion. Sherds from restricted vessels (N=11) present an outer microtopography with inserted grains, interior walls with protruding grains, and an irregular micro-topography, perhaps suggesting thinning with a paddle and anvil technique. In contrast, those from unrestricted vessels (N=6), such as bowls and plates, have outer percussion blows with a compact microtopography and inserted

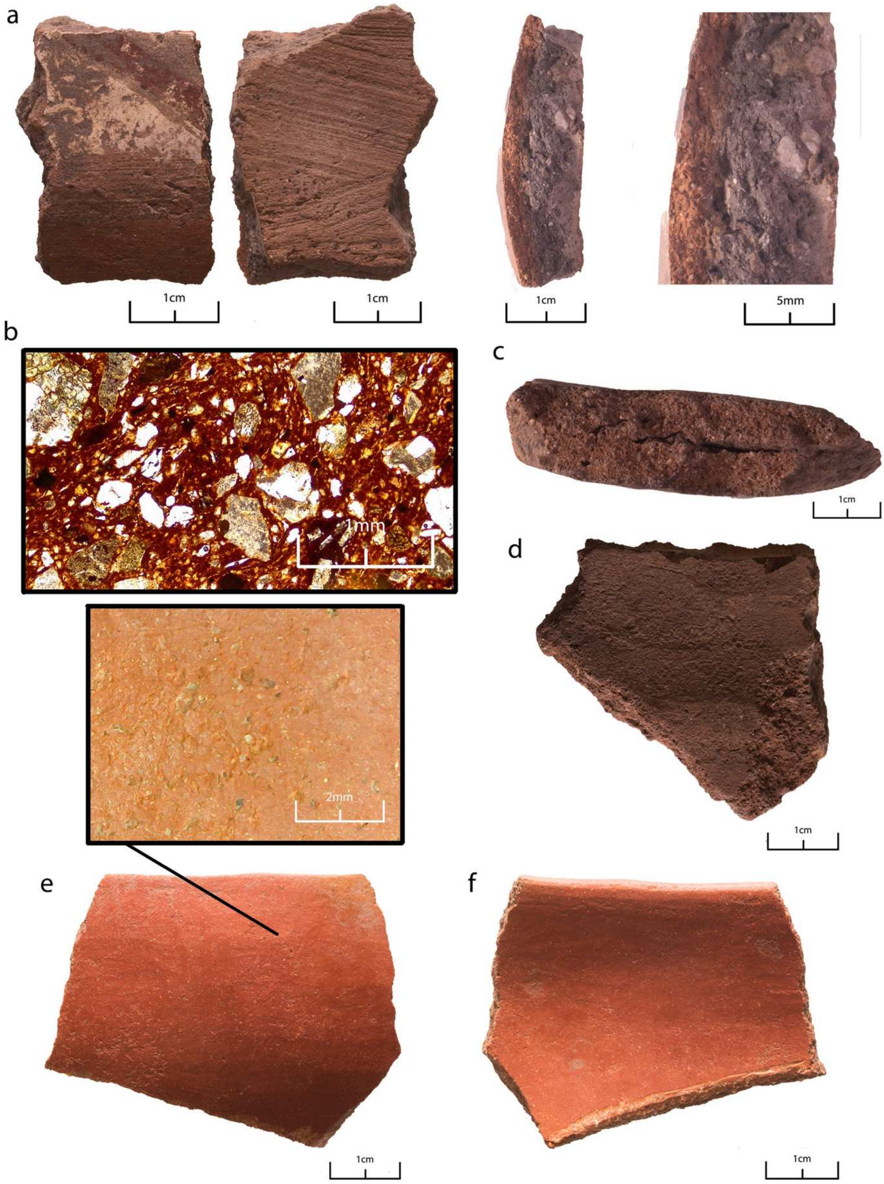


Figure 3. Examples of technological traces on pottery analyzed in the study. (a) Inka maka fragment, inflection point, from different perspectives. Deep striation with ribbed edges is associated with a brushed fluidified microtopography with partially covered protruding grains. Fracture of the sections with an S-shape orientation is linked to an assemblage by coiling. (b) Undecorated restricted vessel of a thin body wall (5 mm), microstructure of vertical thin section in PPL. Oblique and concentric alignment of inclusions and voids. (c) Undecorated restricted vessel, horizontal fissure in the base indicating the placement of a coil, possibly linked to the junction between the base and body. (d) Undecorated restricted vessel, horizontal striation with over-thickness related to scraping grooves and a fluidified microtopography with protruding grains. (e) and (f) Aconcagua Red Slip bowl rim with outer flat area depression, exhibits inserted grains, compact microtopography, and some micro-pull-out. Inner depression is unclear so it could be related to hammering or use of beater/paddler.

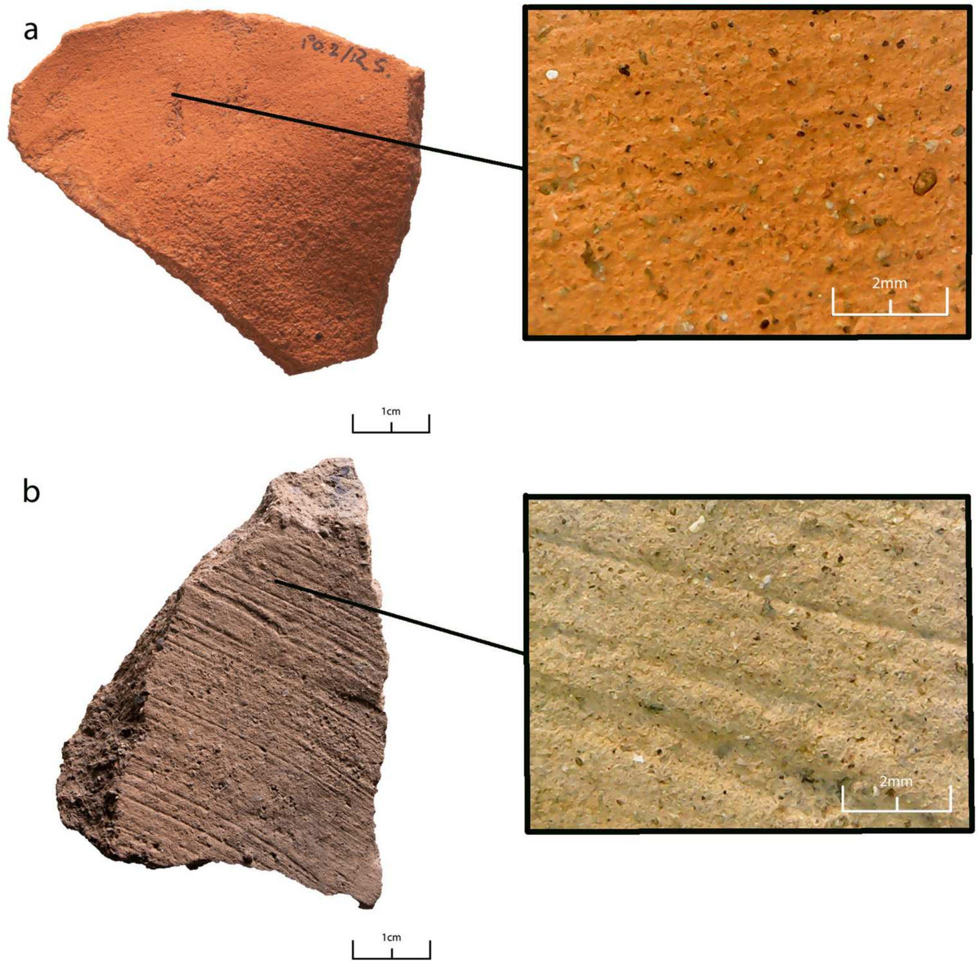


Figure 4. Additional examples of technological traces on pottery analyzed in the study. (a) Aconcagua Salmon jar neck. Smoothing on wet clay with fingers without additional supply of water and protruding grains. (b) Inka *maka* body. Deep one-directional set of striations, ribbed edges associated with brushed fluidified microtopography, and partially covered protruding grains.

grains with a very regular inner surface, possibly linked to hammering (Figure 3 e-f) (Roux 2019, 174–178).

Regarding finishing techniques, for 35 (33%) samples, it was difficult to recognize the associated traces, partly due to overlay by paint and other types of decoration. Most of the rest of the sherds show traces of smoothing (N=57). In 33 of these, a smooth microtopography with protruding grains and reticulated and ribbed striation was detected, related to the rubbing of fingers on a wet paste (Figure 4 a). Within the smoothed samples are 13 fragments finished using a hard tool producing ribbed striations and a fluidified microtopography, most of which are in a horizontal direction. The remaining fragments exhibit leather-hard paste smoothing (N=11), recognized by compact striation bottoms with a hard/soft tool. Apart from smoothing, 14 fragments show a set of deep striations with the same direction and compact bottom, referred to here as brushing (Figure 4 b), even though their striations are deeper than those defined by Roux (2019).

Surface treatment appears to have used friction techniques (N=31), such as softening (N=23) or burnishing (8), but also coating (N=16) or both (N=27), with only 32 samples showing no traces at this stage. The softened sherds exhibited inserted grains and compact microtopography with a fine and erratic striation layout. At the same time, those burnished display a compact microtopography, with burnished strips, sometimes with facet and scalloped striation. Within the 43 sherds that showed coating, 27 were red slips, 11 were white slips, and five had both. Just 15 samples were decorated over a coated surface, while four fragments presented decoration without coating. Regarding firing, 52 sherds show a complete oxidation atmosphere, followed by 41 samples with incomplete oxidation. At the same time, 13 appear to have been fired in a reducing atmosphere with a final oxidizing phase, as they have red margins and a dark core (Figure 3 a).

The use of coiling is generalized in most ceramic types. Scraping was a common technique for preforming, except for Aconcagua Red Slip, Coated, and some Inka-style shallow plate sherds, which only exhibit percussion techniques. Inka-style *makas* and Undecorated Jar/Pot show traces of both preforming techniques and shaving. In the finishing stage, most sherds display traces of smoothing, except for the Inka-style *makas* and the Local Inka phase, which exhibit brushing on all the inner sides and some outer sides (Figure 3 a, and Figure 4 b). Only the Aconcagua Salmon, Diaguita, Inka-style, and Local Putaendo ceramics are decorated. Regarding firing, the macroscopic observations suggest that one of the most characteristic features was the tendency of the *makas* to have a reduced core and oxidizing margins (Table 2).

Thin-Section Petrography

The 91 thin sections were classified into nine separate petrographic fabrics. These include three fabrics with multiple samples and six single sample fabrics or “loners” (Quinn 2022, 95). The Intermediate Volcanic Rock Fabric (IVR) is the most common, comprising 62 percent of the analyzed samples (N=56), and is characterized by poorly sorted, subangular to subrounded volcanic rock fragments, including abundant andesite and less common basalt, as well as isolated mineral inclusions, in a brown to light brown colored, non-calcareous clay matrix (Figure 5 e-f). Twenty-five samples (27.5%) could be classified within the Intermediate Plutonic and Volcanic Rocks Fabric (IPVR), which is characterized by a moderately bimodal grain size distribution of a range of poorly sorted and angular plutonic igneous rocks, with diorite being the most dominant, followed by significant andesite, and other volcanic rocks, as well as biotite, pyroxene, and hornblende inclusions, all in a brown-colored, and non-calcareous clay matrix (Figure 5 c-d). Finally, four sherds correspond to the Plagioclase-Rich Fine Fabric (PRF), which is characterized by a predominance of poorly sorted and subangular plagioclase feldspar inclusions, a high frequency of subrounded volcanic rocks and some ferrous inclusions in a reddish brown colored and non-calcareous clay matrix (Figure 5 a-b). Concentric alignments of inclusions, picking out “relic coils” (Quinn 2022, 101), were recognized in samples of all fabrics (Figure 3 b). Inka-style sherds occur in both the IPVR Fabric and the IVR Fabric, whereas the Aconcagua Salmon samples account for the PRF Fabric.

Table 2. Inferred production sequence by ceramic typology. Parenthesis indicate techniques that correspond to less frequent traces.

Type	Form	Roughing-out	Preforming	Finishing	Surface treatment	Decoration	Firing
Aconcagua Red Slip (N=11)	**Bowl**	–	Hammering	Smoothed by soft tool	Red slip coating and Burnishing	Without	Complete oxidizing (incomplete)
Aconcagua Salmon (N=6)	**Bowl**	Coiling by pinching	(Scraping)	Smoothed by finger	Without (softening)	Black paint over smoothed (softened) surface	Complete oxidizing
	Jar/Pot	Coiling by pinching	(Scraping)	Smoothed by finger	Without	Without (Black paint over smoothed surface)	Complete oxidizing
Coated (N=8)	**Bowl**	(Coiling by pinching)	Hammering	Smoothed	Red slip coating and Burnishing	Without	Complete oxidizing
	Jar	-	(Beating/ Paddling)	Smoothed by rigid tool	Red slip coating and Burnishing	Without	Complete oxidizing
Other local patterns (N=1)	**Bowl**	-	-	Smoothed by soft tool or finger	White slip coating and Burnishing	Red paint over white slip	Complete oxidizing
Undecorated (N=50)	**Jar/Pot**	Coiling by pinching	Scraping (beating/ paddling)	Smoothed by finger (hard tool)	Without (Softening and Burnishing)	Without	Oxidizing and incomplete oxidizing
Diaguita Style (N=2)	**bowl**	Coiling by pinching	Scraping	-	White slip coating.	Black and red paint over white slip (thin lines)	Incomplete oxidizing
Inka Style(N=22)	***maka***	Coiling by pinching and spreading	Scraping (beating/ paddling)	Brushing	Red and/or White slip coating (+ burnishing).	Red and/or black paint over coating (without).	Reducing atmosphere with Oxidizing final phase (incomplete oxidizing)
	Plates	Coiling by pinching and spreading	hammering and scraping	-	Red Slip and other with Red and White Slip coating (+burnishing)	Black and red paint over white slip (without)	Reducing atmosphere with Oxidizing final phase (incomplete oxidizing)
Local Inka Phase (N=6)	**Jar/Pot**	Coiling	-	Brushing	Without (softening)	-	Incomplete oxidizing

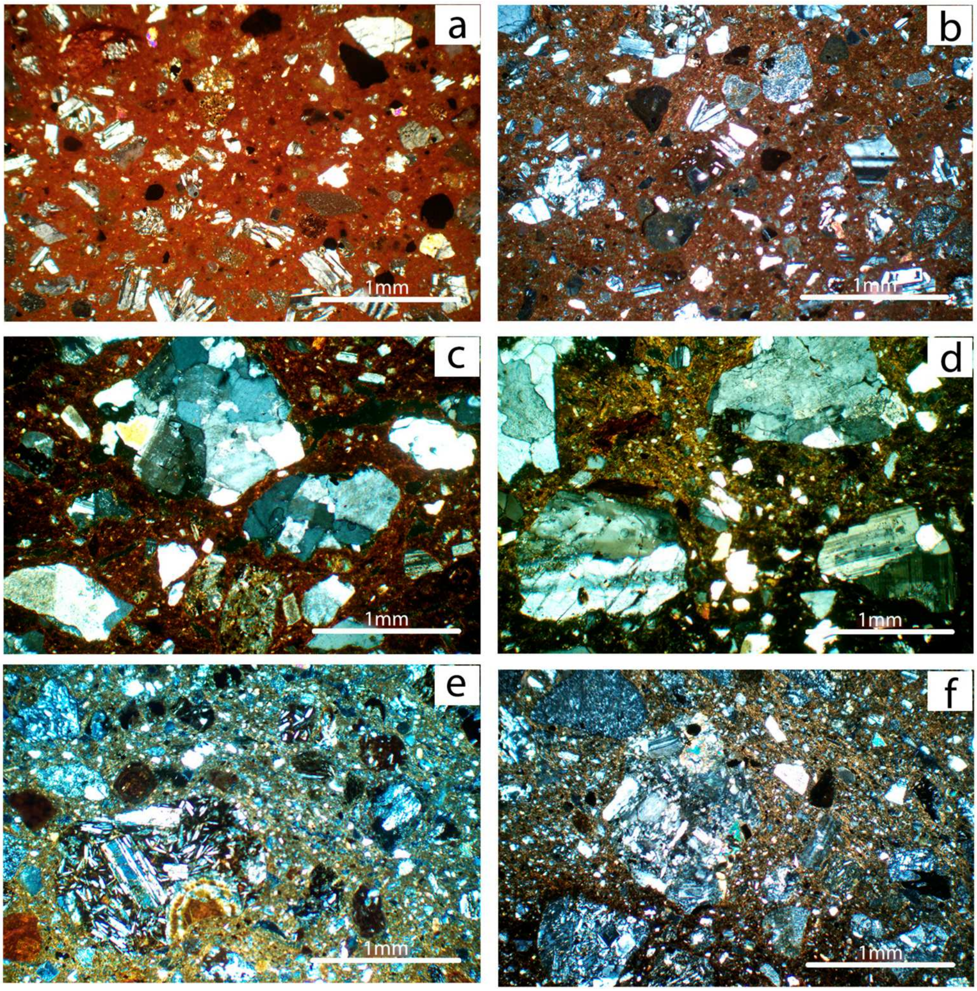


Figure 5. Representation of each Fabric in cross-polarized light. (a) and (b) Plagioclase-Rich Fine Fabric (samples 43 and 100). (c) and (d) Intermediate Plutonic and Volcanic Rock Fabric (samples 51 and 123). (e) and (f) Intermediate Volcanic Rock Fabric (samples 126 and 121).

Portable X-Ray Fluorescence Spectroscopy

Multivariate statistical analysis of the geochemical data collected on 226 sherds reveal two geochemical groups and several outliers, which correspond well to the independent petrographic thin-section fabric classification of 91 selected sherds and are informative when compared to ceramic type, period, and geographic area. In a plot of the scores of principal components 1 and 2, which explained a total of 57.5 percent of the total variance in the dataset, which is close to the 60 percent recommended threshold (Baxter 2003; Shennan 1997), the first group is more dispersed and presents a higher Rb and K concentration than the outliers and the other group (Figure 6, bottom). It mainly comprises Aconcagua Salmon sherds and includes two Undecorated, one Coated (*Engobado*), and two Local Inka Phase sherds (Figure 6, top). The four samples classified within PFR Fabric fit inside this group (Figure 7, top) and are

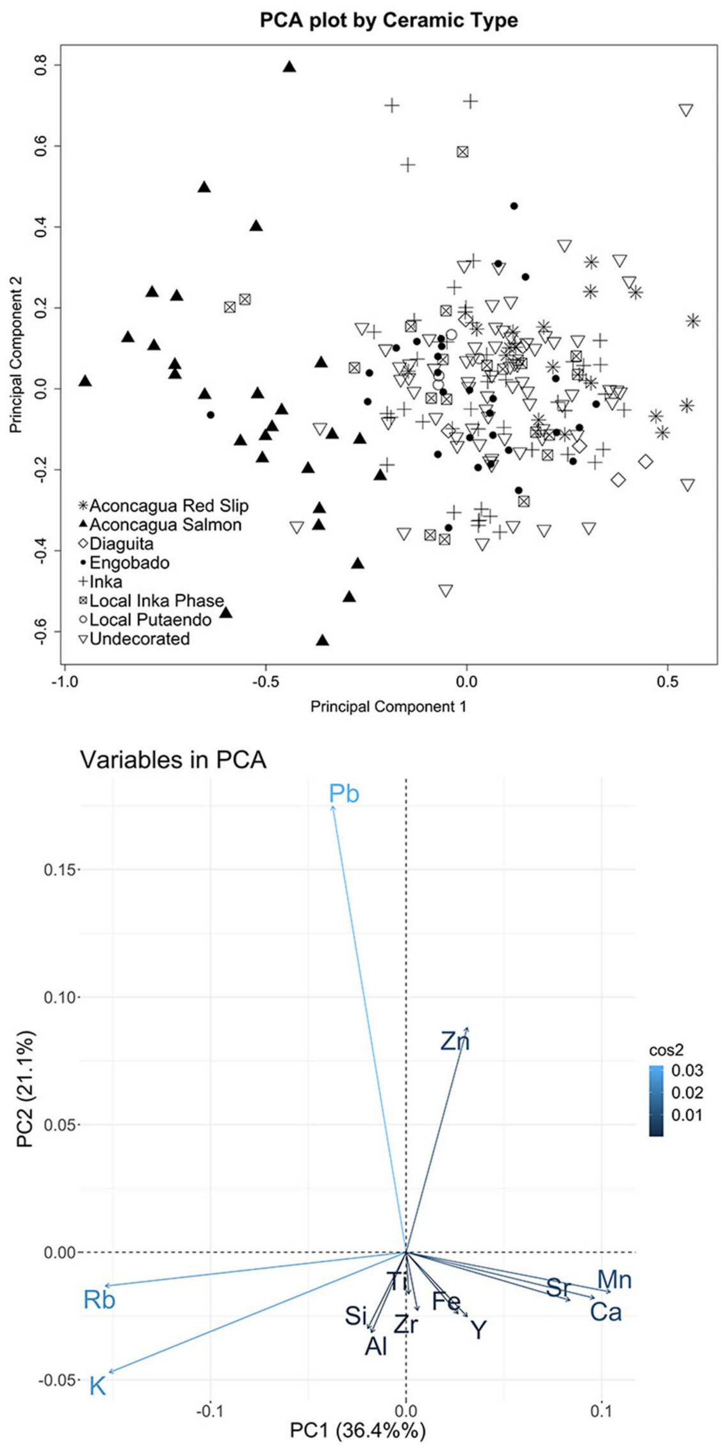


Figure 6. Results of principal component analysis, ceramic types. Top: Scatterplot of PC1 and PC2 labeled by ceramic types showing a differentiated cluster for Aconcagua Salmon samples. Bottom: Loading plot of PCA run on center log-ratio transformed data of 13 elements recorded in 226 ceramics sherds, showing elements influencing each component.

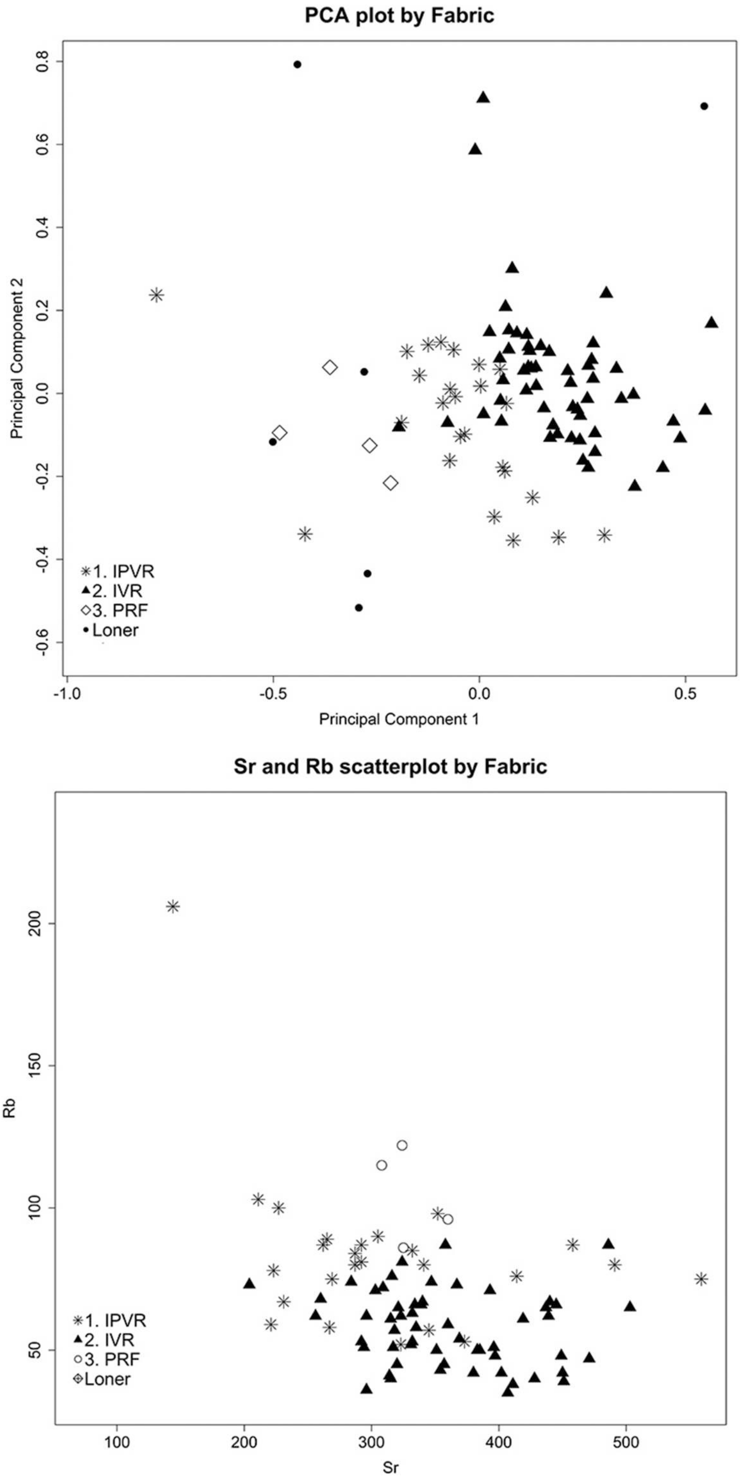


Figure 7. Results of principal component analysis, fabrics and loners. Top: Scatterplot of PC1 and PC2 labeled by fabrics and loners. Bottom: Scatterplot of pairs of elements Sr and Rb, labeled by fabrics and loners.

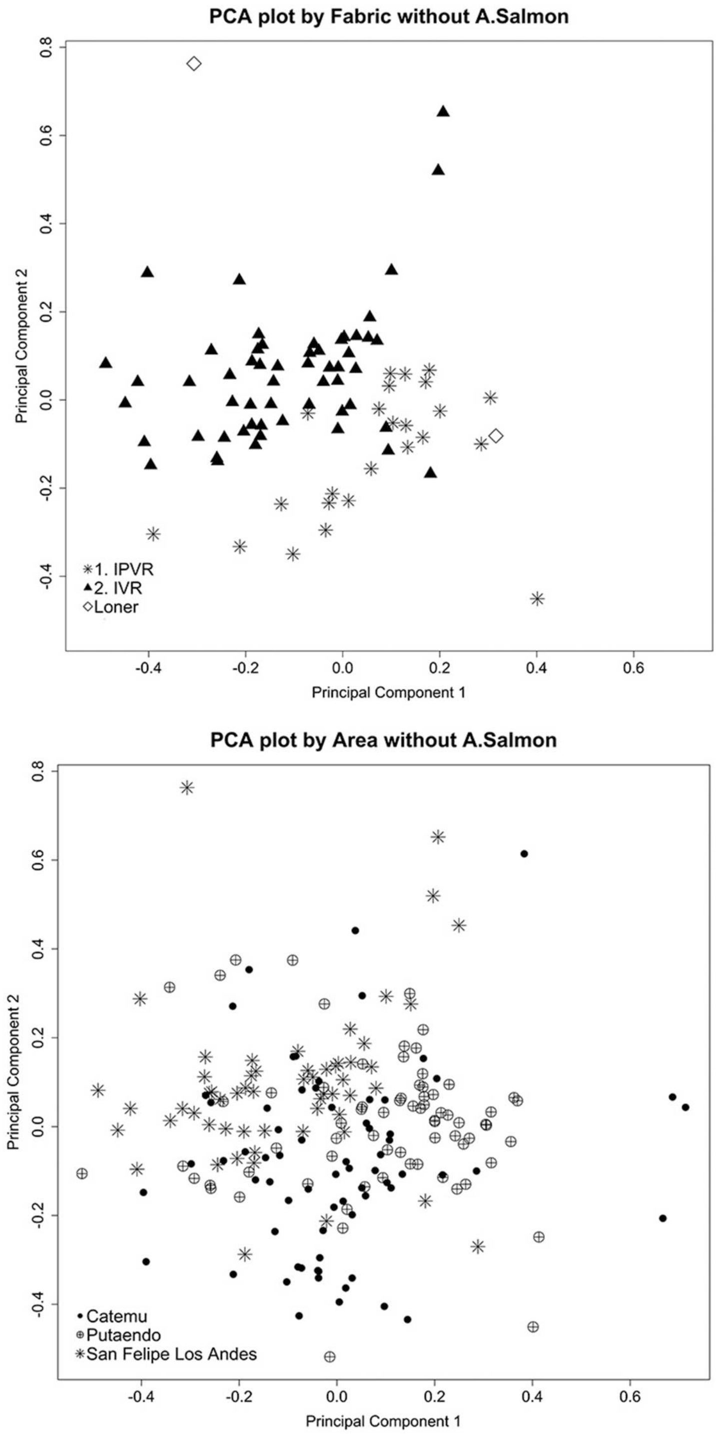


Figure 8. Results of principal component analysis, without Aconcagua Salmon sherds. Top: Scatterplot of PC1 and PC2 without Aconcagua Salmon sherds (Plagioclase-Rich Fine Fabric and most loners), 53 percent of the total variance, labeled by fabrics and loners. Bottom: Scatterplot of PC1 and PC2 without Aconcagua Salmon sherds labeled by sub-valley.

positioned in the center of the plot, with lower amounts of K and Rb compared to the rest of the fragments in this group and similar values of Sr to fragments made with other fabrics (Figure 6, bottom). This last element has been associated with Ca alterations in plagioclase (Degryse and Braekmans 2014, 194). Also noteworthy within this group are most sherds petrographically characterized as loners, which coincidentally are from the Late Period, evidencing petrographic variability within this chemical group and possibly suggesting pottery from a wider range of suppliers circulating in this period.

The second group is characterized by a relatively high concentration of the elements Mn, Sr, and Y, including all the remaining ceramic types (Figure 6, top) and the IPVR and IVR fabrics (Figure 7, top), which tend to group differentially. A second plot of principal components 1 and 2, which explained 53 percent of the total variance of the dataset without Aconcagua Salmon, revealed more evident grouping patterns for the latter two fabrics (Figure 8, top). Labelling the same plot by area exhibited a relative tendency for sherds from San Felipe-Los Andes to be grouped in the upper part of the plot. At the same time, Putaendo and Catemu show an overlapping distribution (Figure 8, bottom).

Micro X-Ray Diffraction

The mineral analyses of the black decoration via μ-XRD² revealed two distinct types of black pigments, which seem to match specific ceramic types (Table 3). In all Aconcagua Salmon sherds, iron (II) oxides, such as magnetite (Mag) and maghemite (Mgh), were identified as black pigments (Figure 9, top-left). These two iron oxides have similar crystallographic structures, resulting in overlapping diffraction patterns, which cannot be distinguished with the resolution of the μ-XRD² settings. Therefore, either magnetite, maghemite, or a combination of both could be the main contributor

Table 3. Summary of the main minerals identified by μ-XRD² according to form, provenience, period, sub-valley, and type.

TYPE	SUB VALLEY	PERIOD	CODE	SITE	FORM	MAIN MINERAL	FORMULA
Aconcagua Salmon	Putaendo	LIP	43	Casablanca 10	Jar/Pot	**Maghemite/ Magnetite**	**γ-Fe_2O_3/Fe_3O_4**
	Catemu	LIP	172	El Cebollar 2	Jar/Pot	**Maghemite/ Magnetite**	**γ-Fe_2O_3/Fe_3O_4**
			175	El Cebollar 2	Bowl	**Maghemite/ Magnetite**	**γ-Fe_2O_3/Fe_3O_4**
		LP	CAT010	Cerro La Cruz	Jar/Pot	**Maghemite/ Magnetite**	**γ-Fe_2O_3/Fe_3O_4**
Inka	Putaendo	LP	22	Tártaro 20	*Maka*	**Tenorite**	**Cu O**
			70	CAET	Plate	**Tenorite**	**Cu O**
	Catemu	LP	CAT014	Cerro La Cruz	*Maka*	**Tenorite**	**Cu O**
			CAT020	Cerro La Cruz	*Maka*	**Tenorite**	**Cu O**
	San Felipe-Los Andes	LP	143	Po3-El Castillo	Plate	**Tenorite**	**Cu O**
			136	Po3-El Castillo	*Maka*	**Tenorite**	**Cu O**
			144	Po3-El Castillo	Plate	**Tenorite**	**Cu O**
Diaguita	Putaendo	LP	46	CAET	Bowl	**Tenorite**	**Cu O**
	Catemu	LP	CAT003	Cerro La Cruz	Bowl	**Tenorite**	**Cu O**
Local Inka Phase	Catemu	LP	CAT025	Cerro La Cruz	Jar/Pot	**Non-Identified**	**Non-Identified**

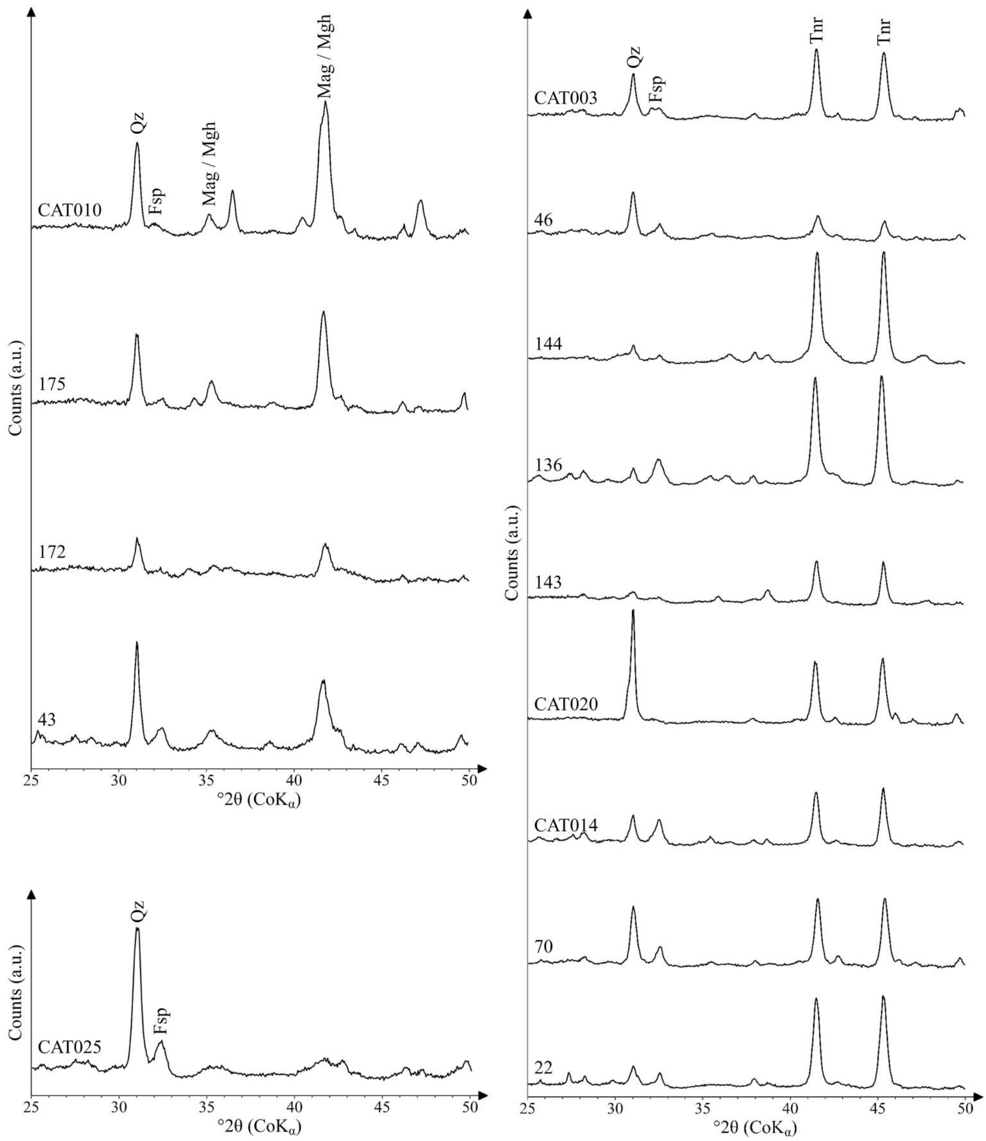


Figure 9. Results of the µ-XRD² analysis. Top-left: Aconcagua Salmon. Right: Inka Style (22, 70, CAT014, CAT020, 143, 136, and 144) and Diaguita Style (46 and CAT003). Bottom-left: Local Inka Phase (CAT025). (Mineral abbreviations after Warr 2021).

to black coloration. In contrast, all the Inka- and Diaguita-styles decorated fragments contain tenorite (Tnr), a copper (II) oxide (Figure 9, right). The diffractogram of the black-brown paint of the Local Inka Phase sherd exhibited no clear diffraction peaks, suggesting a low amount of pigment due to the preservation factor or a different recipe (Figure 9, bottom-left). It should also be pointed out that the main reflections of quartz (Qz) and feldspar (Fsp) were detected in most measurements. These most probably come from the penetration of part of the X-ray signal under the black decoration and are reflections from the mineral phases present on the surface of the ceramic body.

Discussion

The following section discusses the implications of the findings above in terms of ceramic technologies and the nature and extent of state control over Inka-style ceramic production in the upper-middle Aconcagua Valley during the LP. It is organized into four sections. The first three use the results to reconstruct the different pottery production steps, and the final section considers the organization of ceramic production and the nature and extent of state control.

Raw Materials, Provenance, and Production Location

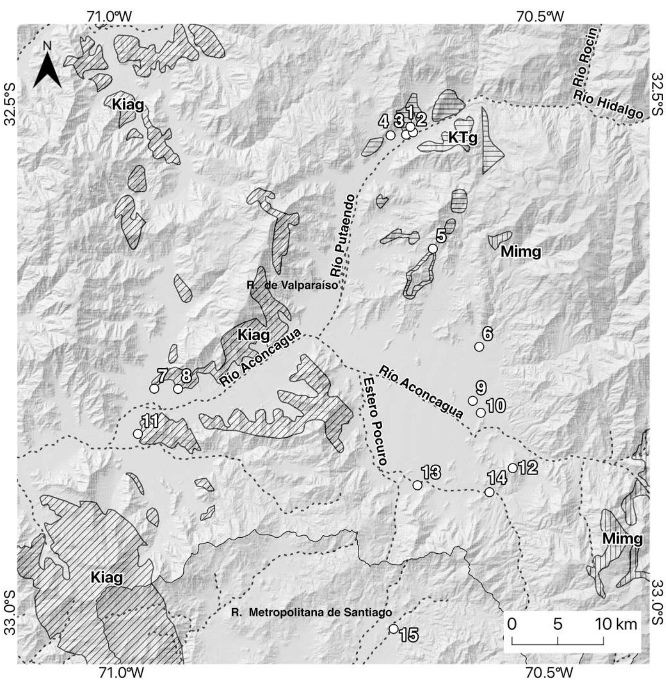
The pXRF and petrographic results provide data from the first stages of the manufacturing process that can be related to material selection and the possible supply provenances. The geochemical patterning suggests the existence of two compositional groups that correspond well to the thin-section petrographic fabrics, the ceramic types, and the valley from which the ceramics were excavated. One of the compositional groups corresponds exclusively to the Aconcagua Salmon sherds, a pottery tradition assumed to be local in the area. These samples are petrographically differentiated, with an exclusive fabric (PRF), as well as several loners. The Aconcagua Salmon sherds have higher Rb than the other samples in the study and a lower K/Rb ratio, which is associated with a more felsic igneous rock composition containing micas and feldspars (Degryse and Braekmans 2014, 194). It should be noted that these chemical elements are common among alkali feldspar, which may be unexpected given the plagioclase of Fabric PRF, based on sodium and calcium. However, the samples within this fabric included more strontium than the rest of this chemical group, which has been documented in calcium alterations in plagioclase (Degryse and Braekmans 2014, 194). The compositional heterogeneity within the analyzed Aconcagua Salmon samples is also documented for other areas of Central Chile (Falabella and Andonie 2011).

While the orange tone of the paste is thought to have had significant social value, it may have been possible to achieve this with iron-rich raw materials available in Central Chile (Falabella, Sanhueza, and Neme 2001). So far, it is not feasible to identify a sole source or supply area for manufacturing this type of vessel in upper-middle Aconcagua Valley. The compositional variability observed suggests that this pottery could have been manufactured from more than one clay source, both within the studied valleys and outside this area. It is essential to note the late chronological assignment (LP) of all the Aconcagua Salmon sherds with unique compositional characteristics (chemical outliers and/or petrographic loners). This could be linked to the intraregional distribution of this type of pottery, specifically at Inka sites such as CAET, located in the Putaendo area, where this type of pottery was not recorded in the earlier period (LIP).

The second geochemical group includes the remaining ware types, including Inka-style ceramics and samples of two fabrics (IPVR and IVR) that plot separately within the group (Figure 7, top, and Figure 8, top). This separation reflects the sub-valley from which the samples were excavated, with IPVR occurring more frequently among samples from Catemu and Putaendo, and IVR Fabric is found in sherds from San Felipe-Los Andes. Sherds of IPVR appear to be related to two geological formations

(Figure 10). The Fredes Unit, located at the headwaters of the Putaendo sub-valley, originated during the Upper Cretaceous and Paleogene and is characterized by plutonic rocks such as granodiorite, diorite, and granite porphyry. The Lower-Upper Cretaceous Illapel Plutonic Complex is located between two mountain ranges in the Catemu area and comprises diorite, monzodiorite, monzogranite, and granodiorite. The recurrence of Intermediate Plutonic and Volcanic Rock (IPVR) Fabric in samples from the sites of Putaendo and Catemu may be related to a local scale of raw material provision.

The Intermediate Volcanic (IVR) Fabric sherds, most abundant in San Felipe-Los Andes, may also have been manufactured locally. The rocks of this sub-valley are mainly andesite and pyroclastic volcanic, and less quantities of basalt, rhyolite, and dacite. However, detailed field sampling and analyses are still required to identify possible specific deposits that could have been used within this area. Nevertheless, sherds belonging to the IVR Fabric within Putaendo and Catemu and fragments of the IPVR Fabric in San Felipe-Los Andes could indicate the movement of ceramics between the two sub-valleys in pre-Inka times. An important finding is that there appears to be no change in the ceramic paste in Inka times. Inka-style pottery, used for ceremonial purposes, was manufactured using local raw materials and processing recipes similar to those used for utilitarian pottery by populations in the upper-middle Aconcagua Valley. The use of local raw materials to manufacture state vessels has also been recognized in other parts of Tawantinsuyu (e.g. Williams et al. 2016). These local sources suggest that representatives of the Inka state engaged local potters to produce the Inka-style pottery vessels.



#	Site
1	Casa Blanca 10
2	Ancuviña El Tártaro
3	Tártaro 20
4	CAET
5	El Tigre
6	El Barro 2
7	Villa Cardenal Silva Henríquez
8	Cerro La Cruz
9	Los Nogales B
10	La Florida Villa Génesis
11	El Cebollar 2
12	Cerro El Mercacha
13	Pocuro-3 El Castillo
14	Pocuro-4
15	Cerro Tahuitaca 6

Figure 10. Map of plutonic units, river, and archaeological sites in the Upper-Middle Aconcagua Valley. Prepared by Cristian González from data of SERNAGEOMIN 2004.

In sum, there is a continuity of use of the same local clay body raw materials between the two periods for manufacturing local vessels and those of the Inka- and Diaguita-styles, except for Aconcagua Salmon. The concordance of the minerals identified at the petrographic level, the chemical groups, and the geological maps allow us to propose a local supply of clays, and possibly tempering agents, at the sub-valley level for the manufacture of both local utilitarian vessels and Inka- and Diaguita-style vessels. The sourcing strategy for the local Aconcagua Salmon vessels is less clear. Although this pottery type has different components, it is a technical recipe of regional knowledge, given the similar visual characteristics of the orange-colored paste and its chemical group. In any case, the selection of raw material that might be crucial in distinguishing the local tradition from the foreign one is the choice of different minerals to produce black paint, which also opens questions regarding sourcing strategies (local, non-local), given its characteristics (storage, small quantity) allows a greater range of movement for its collection, and therefore, distribution or exchange (Saball 2019; Varela 2002).

Pottery Decoration

In terms of pottery decoration, the selection of raw materials differs significantly between ceramic types. Magnetite and maghemite indicate the use of iron-based paint to decorate the local Aconcagua Salmon sherds. These results contrast with other studies from Central Chile, which recorded more variability in the black decoration of the Aconcagua Salmon sherds analyzed. For example, XRF analysis on black pigment from a sherd from the coast (El Tabo) yielded manganese oxide with a possible addition of iron oxide (Dinator and Morales 1990). Other research in the Maipo Valley identified five recipes of Aconcagua Salmon black pigment from LA-ICP-MS and Raman spectroscopy analyses: three of them involved iron oxides (hematite or magnetite) with chalcocite (Cu_2S), one was composed of chalcopyrite and galena, and the last one used manganese (jacobsite) and iron oxides (goethite and hematite) (Saball 2019). The recurrence of iron-based black pigments could mean that in the upper-middle Aconcagua Valley, only one of these recipes was being used. This proposal undoubtedly needs to be tested further by comparison with other compositional analyses.

The Inka-style, Diaguita, and Local Inka Phase decorated sherds are painted with black pigments made of copper, specifically tenorite (copper (II) oxide). Other documented cases exist where the ingredient used to make black paint changed between periods, such as on the Central Coast of Peru, where iron gave way to manganese-based pigments (Davenport 2019). However, the use of copper in black paint on Inka-style pottery has not been reported so far, even though it is a widely available mineral in this region. There is mention of Cu-based black pigment on earlier Paracas vessels (800–1000 CE) in the central-south coast of Peru, among other compositional recipes for the same color rich in iron and arsenic (Dulanto, Gonzáles, and Guadalupe 2019). It should be noted as well that tenorite (Campos V. and Aguayo 2015; De La Fuente et al. 2021; Osorio et al. 2014; Perrier and Bracchita 2016), as well as copper ore (Dinator and Morales 1990), have been previously identified in the black pigments of Diaguita ceramics. This and the present study suggest that the local potters were given access to new materials and techniques to decorate the new Inka forms they produced.

Technology, Chaîne Opératoire, and Tradition

The results of this study can be used to reconstruct several aspects of the technological traditions of the pottery studied. For the first steps of fashioning, roughing out via coiling can be recognized for the manufacture of most vessels, based on macrotraces and thin-section petrography. This finding is consistent with previous research conducted at the CAET site in Putaendo (Albán 2016) and Cerro La Cruz and VCSH in Catemu (Martínez-Carrasco 2020), where extensive use of coiling was identified. Indeed, coiling is the dominant forming technique recorded ethnographically in the Andean highlands (e.g. Sillar 2000) with the use of molds and paddle and anvil more prevalent on the coast and in northern Peru (e.g. Ramón 2013). Of the preforming techniques, scraping is common on restricted vessels, with the possible exception of Coated jars. While open vessels, shallow plates included, usually show traces of percussion, possibly by hammering.

Regarding finishing techniques, the Inka-style *makas* have deep striations from inner brushing, which also appeared in some undecorated fragments of local pottery from this period with use-wear soot, presumably from cooking. This type of finish is absent in pre-Inka times both in Central Chile and the semi-arid north, where the Diaguita originated, and only appears in contexts linked to Tawantinsuyu (Pavlovic et al. 2003; Troncoso et al. 2004). Again, this suggests local potters adopted new techniques to facilitate Inka-style vessel production, whether by imitation or through direct teaching.

Regarding the surface treatments and decoration, *makas* show a red and white slip, with later burnishing. The use of red slip is generalized from the LIP in Central Chile, and characteristics of the red slip are usually indistinguishable between LIP and LP vessels. White slip, in turn, is scarcely present on LIP Aconcagua Salmon pottery, with some recurrence in Local Putaendo vessels (Pavlovic 2006). Its frequency increases, especially with the appearance of Inka-style ceramics, Inka Phase Local, and Diaguita. What technical decisions, such as material selection, recipe, application, firing, are behind this white slip during the LP remain to be further explored. As for the firing stage, the thin sections of the *makas* exhibit a particular type of firing atmosphere, with a recurrence of a reduced center and oxidized margins. This characteristic has been documented in other parts of the Inka Empire, such as the Cuzco area (Lunt 1988) and the Leche Valley, northern Peru (Hayashida 2019; Hayashida et al. 2003). The reduced core and oxidized margins suggest a certain degree of technical knowledge transmission concerning this firing stage in the *makas*, which could be related to a type of state control or technological transfer, in relation to this stage of the *chaîne opératoire*.

Special attention should be given to the use of black decoration. Mineralogical analysis clearly demonstrates the presence of both iron black (magnetite/maghemite) and tenorite. Iron black usually nucleates by firing iron-rich slip in reducing conditions (Solard et al. 2023). However, most of the Aconcagua Salmon samples seem to be fired in oxidizing conditions, which could be related to other technical choices not visible in the final artifact or the presence of manganese, which still needs to be assessed. Iron-rich slip on an oxidized surface is also observed in the contemporary period in north-western Argentina (Acevedo et al. 2015), where it is proposed that the firing process involved a first reducing phase followed by an oxidizing phase to obtain the black pigment and reddish paste.

Even though the use of tenorite as a black pigment in Diaguita-style ceramics already has been documented, there are still no published studies of the firing procedures required to achieve a black tone. Even though copper oxide is naturally available in the regional environment, it is essential to note that most copper minerals, such as malachite, azurite, atacamite, antlerite, cuprite, and chalcocite, can transform to tenorite when fired in an oxidizing atmosphere (Gutscher et al. 1989; Perrier and Bracchita 2016). Future experimental work could shed light on this.

In summary, the initial stages of manufacturing *makas* and shallow plates, like local vessels, primarily involve coiling. However, notable differences emerge in their surface treatment, decoration, and firing atmospheres, particularly in the Inka-style forms, where a brushing finish is exclusive to *makas*. While the potters shared technical decisions regarding raw material selection and the early stages of crafting for both local and Inka-style vessels, distinctions become apparent in the later manufacturing processes. These preliminary results highlight a spectrum of technical choices within the local tradition, many of which were prevalent in the studied area. Specific techniques introduced in the later stages of the *chaîne opératoire* for Inka-style production suggest a pattern in technical innovation, even as these vessels may have been produced in various locations throughout the upper-middle Aconcagua Valley.

Organization of Production and State Control

Following Costin (1991), it is inferred that the organization of production of Inka-style ceramics likely was directly related to the users' needs and the distribution of these vessels. In Central Chile, one of the main political strategies of the Tawantinsuyu was organizing social congregation activities under political commensalism and redistribution logics, typical of the Andean world, possibly linked to the Inka ritual calendar (Cornejo and Saavedra 2018; Pavlovic et al. 2019; Stehberg and Sotomayor 2012). The *makas*, used as chicha containers, and the shallow plates, linked to food consumption and rituals, would have been crucial in such events. The analyzed material corresponds to fragments of vessels recovered from the congregation and administrative sites located on prominent hills or burial sites involving festive rites (Pavlovic et al. 2019). Although the sample is small, this study suggests that Inka-style vessels were made using the same raw materials as local pottery, available at the sub-valley level, where the *makas* would have been made in the initial production steps by coiling, similar to local traditional vessels. The main distinctions in Inka-style pottery production were the brushed finish, pigments choice, firing atmosphere, and the Inka shapes and decoration designs. From here, inferences can be drawn regarding production organization and possible strategies for transferring technical knowledge, whose origin is clearly linked to a state sphere that exceeds the local tradition but converges with its logic.

It has been suggested that, before the Inka arrival, local populations manufactured their pots within domestic settings, sharing knowledge in producing Aconcagua Salmon pottery (Saball 2019). This ceramic type had a characteristic visual language due to the orange color of its paste, in addition to decoration with a specific catalog of colors and designs. The local populations already had mechanisms for transmitting technical knowledge at the regional level to obtain the desired colors and pigments for certain selected vessels within their ceramic repertoire, which they could obtain from accessible resources in their immediate environment. This is what the Inka encountered when they incorporated the area into their Empire, and they likely utilized these existing integration networks to obtain the vessels required for commensalism activities essential to their political strategy.

This situation is also consistent with other areas of Central Chile, where it is proposed that the collection of raw materials and pottery making took place at the domestic and co-residential level before the Inka (Falabella and Andonie 2011; Saball 2019). The Inka may have requested the production of their vessels under this same production regime, which would have been carried out by local potters together with other local vessels production in a seasonal part-time manner, possibly as some form of local labor tax and organized to support state-sponsored activities and political commensalism events. As Hayashida (1999) has suggested for northern Peru, in Chimú sites, the Inka would not have needed to retrain local potters substantially. Instead, they would have reorientated the local production system to produce Inka pottery shapes and decorations to supply Inka commensurate sites, probably delegating the administration of this work to local leaders.

The latter raises two critical questions. If the production of *makas* and shallow plates continued to be carried out in domestic units alongside other local vessels, it might be expected to find more evidence of such manufacture and use of this Inka-style pottery in domestic Aconcagua sites. Only one possible firing loci has been found at the Tártaro 20 site, exceptionally with Inka-style sherds evidence, burnt clay, and ceramic tools spatially associated with the CAET Inka site in the Putaendo area, where Diaguita sherds are absent (Albán 2015, 82). These findings suggest that, at least in the studied area, the Inka would have requested the production of such vessels only for a specific portion of potters from the local communities.

The second question delves into the manufacturing aspects that deviate from the local tradition and relate to the final stages of the sequence. The use of new pigments, decorative styles, and the control of firing atmospheres (as well as the new pottery forms) is intricately linked to the final appearance of pottery (Noll, Holm, and Born 1975). Perhaps it is not surprising that the state had a greater interest in controlling or intervening to achieve the style and quality required since both shapes and decorations played a significant role within Inka ritual commensalism (Bray 2018). This suggests that local potters were brought together for the production of these vessels and taught new techniques of finishing, decorating, and firing them, with a master potter in charge of transmitting this knowledge who may have been a Diaguita or another Inka representative.

The transfer of this new know-how is a central element in understanding these changes in manufacturing and possible degrees of Inka control. Although the expansion of interaction networks during the LP, and thus of objects and ideas, could partly explain changes in the Late pottery, it is essential to highlight that while designs and some formal features can be imitated by the potters, technical operations, such as developing a new pigment recipe or controlling the firing atmosphere, require knowledge transfer (learning) through the visual observation of the technical operation (Gosselain 1992; Roux 2019).

Conclusions

In conclusion, this study has shed light on the nature and extent of state control over Inka-style ceramic production in the upper-middle Aconcagua Valley during the Late

Period. By reconstructing the *chaîne opératoire*, significant patterns have been uncovered that reveal a complex relationship between local traditions and Inka influences. While local potters retained certain traditional practices, such as using the same raw material sources and roughing-out by coiling, Inka likely exerted control over specific production stages, including finishing, decoration and firing, to align with their political strategies, particularly in the context of commensalism.

The results also suggest the existence of foreign pottery specialists under Inka rule who taught local potters these new technical steps to produce Inka-style vessels to be used in specific state activities. Although the Diaguita have been proposed as *mitmaqkunas* on several occasions (Cornejo and Saavedra 2018; Sánchez et al. 2004; Silva 1985; Stehberg and Sotomayor 2012), more data would be needed to confirm this. The current lack of published studies on the technological characterization of Diaguita pottery complicates our understanding of whether these innovations were unique to Diaguita potters or represent shared technical knowledge across Central Chile and the semi-arid north during the Inka period. A key finding is the use of black pigment recipe based on tenorite.

A critical question remains regarding who transferred this new knowledge to local potters. As part of the seasonal state labor obligations of local communities, it is possible that local potters gathered or were required to attend Inka sites on prominent hills and then collectively made the required state vessels, with guidance from a master potter only for the latter stages, possibly including a collective firing. Thus, it is possible that local potters made these vessels, which became "Inka" toward the end of the sequence, transforming a local product into an imperial one as the *chaîne opératoire* continued. If this were the case, the very production of state vessels could have been an intrinsic part of integration strategies through labor taxation and collaborative work. Undoubtedly, this is something that will be further investigated. What is clear, however, is that local potters were essential to Inka statecraft, producing vessels for state-sponsored commensalism that mediated power dynamics. Through their craft, they actively shaped negotiations between the Inka and local leaders, demonstrating the agency of artisans within imperial sociopolitical structures.

Acknowledgments

These results are part of ongoing doctoral research at the UCL Institute of Archaeology funded by Becas Chile, Doctorado en el Extranjero, call 2020 (ANID, Chile). Special thanks are due to the support of the staff of the Wolfson Laboratories, especially Michael Charlton, Russell Bailey, and the Laboratory of Competence Center Archaeometry Baden-Wuerttemberg, University of Tübingen. The material analyzed comes from FONDECYT projects 1090680, 1040153, 1000172, and 1970531. The preparation of maps by Cristian González is also appreciated. The reviewers' comments are gratefully acknowledged and have reinforced the quality of this work.

Andrea Martínez-Carrasco contributed to the conceptualization, methodology, formal analysis, investigation, and writing of the original draft, as well as reviewing, editing, figures, and project administration. Patrick Quinn supervised the petrographic and elemental analysis and oversaw project development. He also contributed to reviewing and editing the manuscript and providing resources for the research. Bill

Sillar supervised the macrotrace, technical analysis, and development of ethnographic parallels. Additionally, he contributed to the review and editing of the manuscript. Silvia Amicone offered supervision, provided resources, and contributed to reviewing and editing the texts. Baptiste Solard supervised the μXRD^2 analysis and contributed to the writing, reviewing, editing, and figures. Finally, Daniel Pavlovic assisted with sample selection and contributed to the review and editing of the manuscript.

Notes on contributors

Andrea Martínez-Carrasco is a PhD candidate at the University College London (UCL) Institute of Archaeology studying the nature and extent of state control over the production of Inka-style pottery in Central Chile, at the southern edge of the Inka Empire, Tawantinsuyu. She has participated in archaeological research projects in Central Chile since 2006, investigating Inka interaction with local populations. Martínez-Carrasco completed an MSc in Archaeological Science at UCL Institute of Archaeology in 2020 specializing in the Inkanization of pottery production at the locality of Catemu in the Aconcagua Valley. She uses a technological approach applying macroscopic and archaeometric techniques to investigate the pottery production process.

Patrick Quinn is Principal Research Fellow in Ceramic Petrography at UCL Institute of Archaeology. He is a leading expert in scientific ceramic analysis and has written a key textbook on ceramic petrography and geochemistry techniques. Quinn is the president of the Ceramic Petrology Group, coordinates the Archaeomaterials Research Network, and leads a team of PhD and postdoctoral researchers at UCL working on ceramics from many different periods and parts of the world. His own research includes projects in prehistoric Greece, prehistoric Britain, prehistoric East Africa, pre-contact California and Puerto Rico, and Qin Period China. He was one of the first western scholars to analyze petrographically and geochemically the ceramic statues of the Terracotta Army.

Bill Sillar, BSc, MSc, PhD, is Professor of Archaeology and Technology in Society at the UCL Institute of Archaeology. Sillar has undertaken ethnographic research of pottery production, trade, and use in Peru and Bolivia, as well as work on contemporary building construction and household ritual practices. An archaeological project investigated the impact of successive expansionist states (Wari, Inka, and Spanish) in the development of the temple complex and modern village of Raqchi, Department of Cuzco, Peru. More recently he has been studying changes in the organization of pottery production, stone-working, and monumental architecture in the Cuzco region during the emergence of the Inka Empire.

Silvia Amicone is a research scientist in the Archaeometry Research Group of the University of Tübingen and Honorary Research Fellow at the UCL Institute of Archaeology. She completed Arts and Humanities Research Council-funded doctoral research at the UCL Institute of Archaeology, UCL, as a member of the international project "The Rise of Metallurgy in Eurasia". As a pottery analyst specializing in ceramic technology in contexts of intense socio-cultural innovation, she has contributed to several projects in the Balkans and the Mediterranean area, and she is an active member of the UCL Archaeomaterials Research Network. Her primary field of research is archaeomaterials, with an emphasis on ceramics and the multifaceted interactions between resources, technology, and society.

Baptiste Solard is a PhD candidate in the Archaeometry Research Group of the University of Tübingen. He completed his Diplôme d'ingénieur chimiste (BSc and MSc equivalent) in Material Sciences at the National Graduate School of Chemistry of Montpellier, France in 2019. In 2021, he earned his master (MSc) of Archaeological Sciences with specialization in Archaeometry at the Institute for Archeological Sciences, University of Tübingen with a thesis on Atticizing Black Gloss from the fourth century BCE. During his time in Tübingen, he worked as research assistant at the Competence Center Archaeometry Baden-Württemberg on various projects on ancient ceramic technology. His current PhD project aims to explore the production technology, craft organization, and distribution of early Medieval colored glass from Zurich, Switzerland.

Daniel Pavlovic is a PhD candidate at the University of Buenos Aires, Argentina. He is a researcher at CIEM Aconcagua with 28 years of experience in research, commercial archaeology, and the protection, dissemination, and management of archaeological heritage in the public and private sectors. Daniel is a founding member of the Colegio de Arqueólogos de Chile Asociación Gremial and a member of the Sociedad Chilena de Arqueología. He has lectured at the Universidad de Chile and Universidad SEK, supervising several students' dissertations. Daniel has been responsible and part of the research team in several governmental research projects primarily focused on the populations that inhabited Central Chile and the semi-arid north during the last 2500 years. More recently, he has focused on the interaction between local populations and the Inka Empire.

References

Acevedo, Verónica J., Mariel López, Eleonora Freire, Emilia Halac, Griselda Polla, María Reinoso, and Fernando Marte. 2015. "Caracterización Arqueométrica de Pigmentos Color Negro de Material Cerámico de la Quebrada de Humahuaca, Jujuy, Argentina." *Chungará (Arica)* 47 (2): 0–0. https://doi.org/10.4067/S0717-73562015005000026.

Albán, María. 2015. "Funcionalidad de Sitios y su Rol en las Dinámicas de Ocupación Incaica en el Valle de Aconcagua, Chile Central (1450-1536 d.C.): Aportes Desde la Alfarería." Memoria para optar al Título de Arqueólogo, Departamento de Antropología, Facultad de Ciencias Sociales, Universidad de Chile, Santiago.

Albán, María. 2016. "Étude Technologique de l'assemblage Céramique du Site Inca Compleho Arquitectónico El Tártaro, Vallée de l'Aconcagua. Période Tardive (1450 ap. J.C. -1536 ap. J.C.), Centre du Chile." Mémoire de Master. Spécialité Préhistoire. Département des Anthropologies. UFR des Sciences Sociales et Administration, Université Paris Ouest Nanterre-La Défense, Paris.

Arnold, Dean E. 1993. *Ecology and Ceramic Production in an Andean Community*. Cambridge: Cambridge University Press.

Baxter, Michael J. 2003. *Statistics in Archaeology*. New York: Oxford University Press.

Bishop, Ronald, Robert Rands, and George Holley. 1982. "Advances in Archaeological Method and Theory" *Advances in Archaeological Method and Theory* 5:275–330. https://doi.org/10.1016/B978-0-12-003105-4.50012-1.

Bowser, Brenda, and John Q. Patton. 2008. "Learning and Transmission of Pottery Style: Women's Life Histories and Communities of Practice in the Ecuadorian Amazon." In *Cultural Transmission and Material Culture. Breaking Down Boundaries*, edited by Miriam T. Stark, Brenda J. Bowser, and Lee Horne, 105–129. Tucson: University of Arizona Press.

Bray, Tamara. 2009. "The Role of Chicha in Inca State Expansion. A Distributional Study of Inca Aríbalos." In *Drink, Power, and Society in the Andes*, edited by Jennings Justin, and Brenda J. Bowser, 108–132. Gainesville: University Press of Florida.

Bray, Tamara. 2018. "Partnering with Pots: The Work of Objects in the Imperial Inca Project." *Cambridge Archaeological Journal* 28 (2): 243–257. https://doi.org/10.1017/S0959774317000828.

Calderari, Milena, and Verónica Williams. 1991. "Re-Evaluación de los Estilos Cerámicos Incaico en el Noroeste Argentino." *Comechingonia. Revista de Antropología e Historia, El Imperio Inka. Actualización y Perspectivas por Registro Arqueológicos y Etnohistóricos* 9 (N° Especial): 75–95.

Campos V., Marcelo, and Tomás Aguayo. 2015. "Vibrational Spectroscopy for the Study of Chilean Cultural Heritage." *Heritage Science* 3 (1): 18. https://doi.org/10.1186/s40494-015-0047-0.

Cornejo, Luis, Fernanda Falabella, and Lorena Sanhueza. 2003. "Patrón de Asentamiento y Organización Social de los Grupos Aconcagua de La Cuenca Del Maipo." *Revista Chilena de Antropología* 17:77–104.

Cornejo, Luis, and Miguel Saavedra. 2018. "El Centro Político Inka en el Extremo Austral del Tawantinsuyu (Chile Central)." *Boletín del Museo Chileno de Arte Precolombino* 23 (1): 133–158. https://doi.org/10.4067/S0718-68942018005000306.

Costin, Cathy. 1991. “Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production.” *Archaeological Method and Theory* 3:1–56.

Cresswell, Robert. 2010. “Technique et Culture: Les Bases D’un Programme de Travail.” *Techniques and Culture* 54-55: 20–45. https://doi.org/10.4000/tc.4979.

Davenport, James A. 2019. “Inca Craft and Ritual Production: Compositional Analysis of Ceramic Pigments from the Temple of the Sun, Pachacamac.” In *Ceramics of the Indigenous Cultures of South America: Studies of Production and Exchange Through Compositional Analysis*, edited by Michael D Glascock, Hector Neff, and Kevin J. Vaughn, 87–96. Albuquerque: University of New Mexico Press.

Dávila, Cristian, Constanza Cortés, Andrea Martínez, Juan Hermosilla, and Daniel Pavlovic. 2018. “Interacción Social al Sur del Collasuyu. Alfarería Funeraria del Período Tardío (1400-1536 DC) en la Cuenca Maipo-Mapocho.” *Chungará* 50 (4): 577–590. https://doi.org/10.4067/S0717-73562018005002101.

Degryse, Patric, and Dennis Braekmans. 2014. “Elemental and Isotopic Analysis of Ancient Ceramics and Glass.” In *Treatise on Geochemistry*, edited by Heinrich D. Holland, and Karl K. Turekian, 191–207. Oxford: Elsevier. https://doi.org/10.1016/B978-0-08-095975-7.01215-8.

De La Fuente, Guillermo, Fernando Marte, Noemí Mastrangelo, Marina Martínez, Guillermo Rozas, Sergio Vera, Carlos Nazar, and Marcos Tascón. 2021. “Raman and FT-IR Spectroscopy of Prefiring Paintings and Slips in Pre-Hispanic South American Pottery—the Case of Diaguita Inca Pottery: An Initial Glazing-Painting Process? (Tinogasta, Catamarca, Argentina).” *Archaeological and Anthropological Sciences* 13 (1): 10. https://doi.org/10.1007/s12520-020-01260-6.

Dinator, María I., and José R. Morales. 1990. “Characterization of Colour Pigments in Pre-Columbian Chilean Potteries by PIXE Elemental Analysis.” *Journal of Radioanalytical and Nuclear Chemistry Articles* 140 (1): 133–139. https://doi.org/10.1007/BF02037370.

Druc, Isabelle. 1996. “De la Etnografía Hacia la Arqueología: Aportes de Entrevistas con Ceramistas de Ancash (Perú) Para la Caracterización de la Cerámica Prehispánica.” *Bulletin de l’Institut français d’études andines* 25 (1): 17–41. https://doi.org/10.3406/bifea.1996.1222.

Dulanto, Jalh, Patricia Gonzáles, and Enrique Guadalupe. 2019. “Los Pigmentos Utilizados en la Pintura Poscocción de Vasijas de Cerámica Paracas Temprano de Puerto Nuevo y las Redes de Intercambio de la Costa y Sierra Surcentral del Perú durante los Siglos IX-VI a.C.” *Boletín de Arqueología PUCP* 26 (26): 65–83. https://doi.org/10.18800/boletindearqueologiapucp.201901.004.

Falabella, Fernanda, and Oscar Andonie. 2011. “Análisis por Activación Neutrónica Instrumental de Alfarería Aconcagua en el Valle del Río Maipo, Chile.” In *In II Congreso Latinoamericano de Arqueometría*, edited by Luisa Vetter, Rafael Vega-Centeno, Paula Olivera, and Susana Petrick, 215–228. Lima: Fondo Editorial de la Universidad Nacional de Ingeniería.

Falabella, Fernanda, Luis Cornejo, and Lorena Sanhueza. 2003. “Variaciones Locales y Regionales en la Cultura Aconcagua del Valle del Río Maipo.” In *Actas del IV Congreso Chileno de Antropología, Tomo II*, edited by Andrea Aravena, Milka Castro, Rodrigo Sepúlveda, and Mónica Weisner, 1411–1419. Santiago: Colegio de Antropólogos-LOM.

Falabella, Fernanda, Daniel Pavlovic, María Teresa Planella, and Lorena Sanhueza. 2016. “Diversidad y Heterogeneidad Cultural y Social En Chile Central Durante Los Períodos Alfarero Temprano e Intermedio Tardío (ca. 300 a.C. - 1.450 d.C.).” In *Prehistoria Desde sus Primeros Habitantes Hasta los Incas*, edited by Fernanda Falabella, Mauricio Uribe, Lorena Sanhueza, Carlos Aldunate, and Jorge Hidalgo, 365–400. Santiago: Editorial Universitaria.

Falabella, Fernanda, Lorena Sanhueza, and Gustavo Neme. 2001. “Análisis Comparativo de Cerámica Aconcagua Entre Chile y Argentina.” *Relaciones de la Sociedad Argentina de Antropología* XXVI:193–214.

Fuenzalida, Nicole. 2021. “El Estilo Arqueológico Como Huella Colonial: Referentes de la Alfarería Prehistórica Tardía en Chile Central.” *Boletín Del Museo Chileno de Arte Precolombino* 26 (1): 57–72. https://doi.org/10.4067/S0718-68942021000100057.

González, Carlos. 2000. “Comentarios Arqueológicos Sobre la Problemática Inca en Chile Central (Primera Parte).” *Boletín de la Sociedad Chilena de Arqueología* 29:39–50.

González, Paola. 2013. *Arte y Cultura Diaguita Chile: Simetría, Simbolismo e Identidad. Serie Monográfica de la Sociedad Chilena de Arqueología 2*. Santiago: Ucayali Editores.
Gosselain, Olivier. 1992. "Technology and Style: Potters and Pottery Among Bafia of Cameroon." *Man* 27 (3): 559–586. https://doi.org/10.2307/2803929.
Gutscher, Daniel, Bruno Miihlethaler, Armin Portmann, and Armin Reller. 1989. "Conversion of Azurite Into Tenorite." *Studies in Conservation* 34 (3): 117–122. https://doi.org/10.1179/sic.1989.34.3.117.
Hayashida, Frances. 1995. "State Pottery Production in the Inka Provinces." PhD diss., Department of Anthropology, University of Michigan.
Hayashida, Frances. 1999. "Style, Technology, and State Production: Inka Pottery Manufacture in the Leche Valley, Peru." *Latin American Antiquity* 10 (4): 337–352. https://doi.org/10.2307/971961.
Hayashida, Frances. 2009. "Chicha Histories: Pre-Hispanic Brewing in the Andes and the Use of Ethnographic and Historical Analogues." In *Drink, Power, and Society in the Andes*, edited by Justin Jennings, and Brenda J. Bowser, 232–256. Gainsville: University of Florida.
Hayashida, Frances. 2019. "Crafting Beer Jars for the Inca on the North Coast of Peru." In *Ceramics of the Indigenous Cultures of South America: Studies of Production and Exchange Through Compositional Analysis*, edited by Hector Neff, Kevin J. Vaughn, and Michael D. Glascock, 51–54. Albuquerque: University of New Mexico Press.
Hayashida, Frances, Werner Häusler, Josef Riederer, and Ursula Wagner. 2003. "Technology and Organisation of Inka Pottery Production in the Leche Valley. Part II: Study of Fired Vessels." *Hyperfine Interactions* 150 (1): 153–163. https://doi.org/10.1023/B:HYPE.0000007213.22296.62.
Hayashida, Frances, Andrés Troncoso, and Diego Salazar. 2022. *Rethinking the Inka. Communities, Landscape, and Empire in the Southern Andes*. Austin: University of Texas Press. The William and Bettye Nowlin Series in Art, History, and Culture of the Western Hemisphere. https://lccn.loc.gov/2021029506.
Holmqvist, Elisabeth. 2016. "Handheld Portable Energy-Dispersive X-Ray Fluorescence Spectrometry (pXRF)." In *The Oxford Handbook of Archaeological Ceramic Analysis*, edited by Alice Hunt, 362–381. Oxford: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199681532.013.41.
Hosler, Dorothy. 1996. "Technical Choices, Social Categories and Meaning Among the Andean Potters of Las Animas." *Journal of Material Culture* 1 (1): 63–92. https://doi.org/10.1177/135918359600100104.
Hunt, Alice M.W. 2012. "On the Origin of Ceramics: Moving Toward a Common Understanding of 'Provenance." *Archaeological Reviews from Cambridge* 27 (1): 85–97.
Lara, Catherine, Gabriel Ramón, and Tamara L. Bray. 2023. "Inca Mitmaqkuna, Chaînes Opératoires, and Pottery Production in the Northern Andes." *Latin American Antiquity*, First View, 1–18. https://doi.org/10.1017/laq.2023.39.
Leroi-Gourhan, André. 1973. *Evolution et Techniques. Milieu et Techniques*. Paris: Albin Michel.
Livingstone Smith, Alexandre. 2007. *Chaîne Opératoire de la Poterie: Références Ethnographiques, Analyses et Reconstitutions*. Tervuren: Musée Royal de l'Afrique Centrale.
Lunt, Sara. 1988. "The Manufacture of the Inca Aryballus." In *Recent Studies in Pre- Columbian Archaeology*, edited by Nicholas J. Sanders, and Olivier de Montmollin, 489–511. Oxford: BAR Press.
Malpass, Michael, and Sonia Alconini. 2010. *Distant Provinces in the Inka Empire: Toward a Deeper Understanding of Inka Imperialism*. Iowa City: University of Iowa Press.
Martínez-Carrasco, Andrea. 2020. "Inkanisation of Local Pottery Production in the Aconcagua Valley, Chile." Dissertation for the degree of MSc Archaeological Science: Technology and Materials, University College London.
Massone, Mauricio. 1978. "Los Tipos Cerámicos del Complejo Cultural Aconcagua." Tesis para optar al grado de Licenciado en Arqueología y Prehistoria, Santiago: Universidad de Chile.
Morris, Craig, and Donald Thompson. 1985. *Huánuco Pampa: An Inca City and its Hinterland. New Aspects of Antiquity*. London: Thames and Hudson.

Noll, Walter, Reimer Holm, and Liborius Born. 1975. "Painting of Ancient Ceramics." *Angewandte Chemie International Edition in English* 14 (9): 602–613. https://doi.org/10.1002/anie.197506021.

Osorio, Felipe, Guillermo Díaz, Úrsula Martínez, Marcelo Campos-Vallette, Ernesto Clavijo, Alvaro E. Aliaga, M. Fernanda Espinosa, and Daniela Bracchitta. 2014. "Micro-Raman Spectroscopy of Decorated Pottery of the Diaguita Culture From IV Region, Chile (9th - 15th Century AD)" *Journal of the Chilean Chemical Society* 59 (3): 2619–2621. https://doi.org/10.4067/S0717-97072014000300020.

Pavlovic, Daniel. 2006. "La Gente Del Valle de Las Rinconadas. Uso del Espacio y Tradiciones Tecnológicas Durante el Periodo Intermedio Tardío en el Valle del Río Putaendo, Cuenca Superior del Río Aconcagua." Memoria para optar al Título de Arqueólogo, Departamento de Antropología, Facultad de Ciencias Sociales, Universidad de Chile.

Pavlovic, Daniel, Daniel Pascual, Constanza Cortés, Andrea Martínez, María Albán, Cristian Dávila, Esteban Rosende, and Felipe Villela. 2014. "Formas de Ocupación del Espacio en el Valle de Aconcagua Durante los Períodos Intermedio Tardío y Tardío." In *Distribución Espacial en Sociedades no Aldeanas. Del Registro Arqueológico a la Interpretación Social*, edited by Fernanda Falabella, Lorena Sanhueza, Luis Cornejo, and Itací Correa, 117–142. Santiago: Ediciones on-Demand. Serie Monográfica de La Sociedad Chilena de Arqueología 4.

Pavlovic, Daniel, Rodrigo Sánchez, Daniel Pascual, and Andrea Martínez. 2022. "Rituals and Interactional Dynamics: Segmented Societies and Tawantinsuyu in Southern Qullasuyu." In *Rethinking the Inka. Communities, Landscape, and Empire in the Southern Andes*, edited by Frances M. Hayashida, Andrés Troncoso, and Diego Salazar, 165–184. The William and Bettye Nowlin Series in Art, History, and Culture of the Western Hemisphere. Austin: University of Texas Press.

Pavlovic, Daniel, Rodrigo Sánchez, Daniel Pascual, Andrea Martínez, and Constanza Cortés. 2019. "Rituales de la Vida y de la Muerte: Dinámicas de Interacción Entre el Tawantinsuyu y las Poblaciones Locales en la Cuenca del Maipo-Mapocho, Chile Central." *Estudios Atacameños* 63 (1): 43–80. https://doi.org/10.22199/issn.0718-1043-2019-0022.

Pavlovic, Daniel, Andrés Troncoso, Silvia Alfaro, Daniel Pascual, Carolina Belmar, Luciana D. Quiroz, and Cristóbal Iglesias. 2008. "Comprendiendo los Contextos Domésticos del Periodo Intermedio Tardío en el Valle de Putaendo: Investigaciones en el Sitio Casablanca 10." *Clava* 7:51–72.

Pavlovic, Daniel, Andrés Troncoso, and Rodrigo Sánchez. 2013. Informe Cuarto Año y final. Las Poblaciones Locales y el Tawantinsuyo en la Cuenca del Río Aconcagua: Transformaciones Socioculturales e Ideológicas durante el Periodo Tardío. Proyecto Fondecyt 1090680. Santiago, Chile: Comisión Nacional de Investigación Científica y Tecnológica.

Pavlovic, Daniel, Rodrigo Sánchez, Paola González, and Andrés Troncoso. 2003. "Primera Aproximación al Período Alfarero Prehispánico en el Valle Fronterizo de Putaendo, Cuenca Superior del Río Aconcagua, Chile Central." In *Actas Del XIII Congreso Nacional de Arqueología Argentina*. Vol. III, edited by Humberto Lagiglia, 239–255. Córdoba, Argentina: Editorial Brujas.

Perrier, Christine, and Daniela Bracchita. 2016. "Copper Based Pigment Alteration from Diaguita Culture." Poster presented at the American Institution of Conservation (AIC) 44th Annual Meeting and the Classical Association of Canada (CAC) 42th Annual Conference, Montreal.

Quinn, Patrick. 2022. *Thin Section Petrography, Geochemistry and Scanning Electron Microscopy of Ancient Ceramics*. Oxford: Academic Press.

Ramón, Gabriel. 2013. "Las Fuentes del Estilo. Distribución Regional de Canteras y Técnicas Alfareras en Conchucos (Ancash)." *Bulletin de L'Institut Français D'Etudes Andines* 42 (1): 49–90.

Ramón, Gabriel, and Martha Bell. 2013. "Re-Placing Plainware: Production and Distribution of Domestic Pottery, and the Narration of the Pre-Colonial Past in the Peruvian Andes." *Journal of Anthropological Archaeology* 32 (4): 595–613. https://doi.org/10.1016/j.jaa.2013.09.005.

Roddick, Andrew, and Elizabeth Klarich. 2012. "Arcillas and Alfareros: Clay and Temper Mining Practices in the Lake Titicaca Basin." In *Mining and Quarrying in the Ancient Andes:*

Sociopolitical, Economic and Symbolic Dimensions, edited by Nicholas Tripcovich, and Kevin J. Vaughn, 99–122. New York: Springer.

Roux, Valentine. 1994. "La Technique du Tournage: Définition et Reconnaissance par les Macrotraces." In *XVe Rencontres Internationales D'Archéologie et D'Historie D'Antibes. Terre Cuite et Société. La Céramique, Document, Technique, Economique, Culturel*, edited by Association pour la Promotion et la Diffusion des Connaissances Archéologiques, 45-58. Juan-les-Pins: Impr. Louis-Jean.

Roux, Valentine. 2016. "Ceramic Manufacture: The Chaîne Opératoire Approach." In *The Oxford Handbook of Archaeological Ceramic Analysis*, edited by Alice Hunt, 100–113. Oxford: Oxford University Press.

Roux, Valentine. 2019. *Ceramics and Society: A Technological Approach to Archaeological Assemblages*. Nanterre: Springer International Publishing. https://doi.org/10.1007/978-3-030-03973-8.

Rye, Owen. 1981. *Pottery Technology: Principles and Reconstruction*. Washington, DC: Taraxacum.

Saball, Amapola. 2019. Estudio de las Prácticas Asociadas a la Producción del Pigmento Negro de la Cerámica Aconcagua Salmón. Un Acercamiento a la Organización Socioterritorial en Chile Central Durante el Período Intermedio Tardío (1.000-1.450 D.C.). Master's thesis in Archaeology, Facultad de Ciencias Sociales Universidad de Chile, Santiago. https://repositorio.uchile.cl/handle/2250/174974.

Sánchez, Rodrigo. 2004. "El Tawantinsuyu en Aconcagua (Chile Central)." *Chungará (Arica)* 36 (2): 324–336. https://doi.org/10.4067/S0717-73562004000200007.

Sánchez, Rodrigo, Daniel Pavlovic, Paola González, and Andrés Troncoso. 2004. "Curso Superior del Río Aconcagua: Un Área de Interdigitación Cultural. Período Intermedio Tardío y Tardío." *Chungará* 36:753–766. http://doi.org/10.4067/S0717-73562004000400018.

Schobinger, Juan. 1999. "Los Santuarios de Altura Incaicos y el Aconcagua: Aspectos Generales e Interpretativos." *Relaciones de la Sociedad Argentina de Antropología* XXIV:7–27.

Shennan, Stephen. 1997. *Quantifying Archaeology*. Iowa City: University of Iowa Press.

Sillar, Bill. 2000. *Shaping Culture: Making Pots and Constructing Households. An Ethnoarchaeological Study of Pottery Production, Trade and Use in the Andes*. International Series. Oxford: British Archaeological Reports. https://doi.org/10.30861/9781841711515.

Sillar, Bill. 2009. "The Social Agency of Things? Animism and Materiality in the Andes." *Cambridge Archaeological Journal* 19 (3): 367–377. https://doi.org/10.1017/S0959774309000559.

Sillar, Bill, and Gabriel Ramón. 2016. "Using the Present to Interpret the Past: The Role of Ethnographic Studies in Andean Archaeology." *World Archaeology* 48 (5): 656–673. https://doi.org/10.1080/00438243.2016.1211033.

Sillar, Bill, and Mike Tite. 2000. "The Challenge of 'Technological Choices' for Materials Science Approaches in Archaeology." *Archaeometry* 42 (1): 2–20. https://doi.org/10.1111/j.1475-4754.2000.tb00863.x.

Silva, Osvaldo. 1985. "La Expansión Incaica en Chile: Problemas y Reflexiones." In *Actas Del IX Congreso de Arqueología Chilena*, edited by Gabriel Cobo C., 321–340. La Serena, Chile: Museo Arqueológico de La Serena.

Solard, Baptiste, Silvia Amicone, Eleni Aloupi-Sioti, Lars Heinze, Fede Berti, Claudia Lambrugo, and Christoph Berthold. 2023. "Back to Black: A Mineralogical and Chemical Characterisation of Atticising Fourth Century BCE Black Gloss Ware." *Archaeological and Anthropological Science* 15: 135. https://doi.org/10.1007/s12520-023-01822-4.

Stehberg, Rubén, and Gonzalo Sotomayor. 2012. "Mapocho Incaico." *Boletín Museo Nacional de Historia Natural* 61 (1): 85–149. https://doi.org/10.54830/bmnhn.v61.2012.164.

Troncoso, Andrés, Daniel Pavlovic, Cristian Becker, Paola González, and Jorge Rodríguez. 2004. "Césped 3, Asentamiento del Período Diaguita-Incaico sin Cerámica Diaguita Fase III en el Curso Superior del Río Illapel, IV Región, Chile." *Chungará, 36* (Suplemento Especial Tomo 2), 893-906. https://doi.org/10.4067/S0717-73562004000400028.

Varela, Varinia. 2002. "Enseñanzas de Alfareros Toconceños: Tradición y Tecnología en la Cerámica." *Chungará (Arica)* 34 (2): 225–252. https://doi.org/10.4067/S0717-73562002000200006.

Warr, Laurence. 2021. "IMA-CNMNC Approved Mineral Symbols." *Mineralogical Magazine* 85 (3): 291–320. https://doi.org/10.1180/mgm.2021.43.

Webb, Jennifer. 2018. *Lapithos Vrysi Tou Barba, Cyprus: Early and Middle Bronze Age Tombs Excavated by Menelaos Markides*. *Studies in Mediterranean Archaeology* 148. Nicosia, Cyprus: Astrom Editions.

Williams, Verónica. 2008. "Espacios Conquistados y Símbolos Materiales del Imperio Inca en el Noroeste Argentino." In *Lenguajes Visuales de Los Incas*, edited by Paola González, and Tamara Bray, 47–70. Oxford: Archaeopress. BAR International Series 1848.

Williams, Verónica. 2022. "Landscape, Social Memory, and Materiality in the Calchaquí Valley During Inka Domination in the Northwest Argentina." In *Rethinking the Inka. Community, Landscape, and Empire in the Southern Andes*, edited by Frances Hayashida, Andrés Troncoso, and Diego Salazar, 83–106. The William & Bettye Nowlin Series in Art, History, and Culture of the Western Hemisphere. Austin: University of Texas Press.

Williams, Verónica, Calogero Santoro, Roberto Speakman, Michael Glascock, Álvaro Romero, Daniela Valenzuela, Vivien Standen, and Terence D'Altroy. 2016. "Instrumental Neutron Activation Analysis of Inka and Local Pottery from Northern Chile's Atacama Desert." *Journal of Archaeological Science: Reports* 9:481–492. https://doi.org/10.1016/j.jasrep.2016.08.028.