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Tracing the clay source of Nasca polychrome pottery: results from a preliminary raw material survey

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Abstract

This paper describes the results of the first season of a survey in which clays suitable for the production of Nasca polychrome pottery were collected in an effort to (1) determine the geological variability of clay sources in the Nasca region and (2) match clays compositionally to paste groups from previous provenance analyses. Clays were collected, processed, fired, and analyzed using neutron activation. The results demonstrate that clays in the region were compositionally heterogeneous, and that the clay source for the majority of Nasca polychrome pottery sampled thus far can be traced to lower valleys in the region near the ancient ceremonial center Cahuachi. The results have implications for understanding the nature of polychrome pottery production in the Nasca region, and suggest centralized production near the ceremonial center of the majority of painted ceramics consumed in the Southern Nasca Region.

Keywords: Provenance analysis; Clays; Andes; Nasca; Pottery production; Craft specialization

1. Introduction

The prehispanic Andean culture known as Nasca has gained worldwide renown for its artistically and technically spectacular polychrome pottery. The iconography of this pottery has been studied by archaeologists for over a century, but only until relatively recently has an effort been made to understand what role this artifact played in the wider social and economic contexts of Nasca society.

Recently, efforts have considered the contexts of the production, distribution and consumption of Early Nasca polychrome pottery. Nasca polychromes were the primary vehicle for Nasca ideology [7,26,35,42]. They were very finely made yet enjoyed widespread distribution throughout the Nasca region. Despite their wide distribution, based on evidence from previous provenance analyses, it has been argued that the majority were produced in specialized contexts associated with Early Nasca elites [42,46]. Nevertheless, this proposition has remained a hypothesis subject to further testing since clay variability in the region was poorly understood.

In order to redress this deficiency, one of us (Vaughn) is directing the Early Nasca Craft Economy (ENCE) Project to collect clays in the field in an attempt to match raw materials with compositional groups found in previous analyses [45]. The purpose of this paper is to report the results of the first field season of this project. We come to two major conclusions resulting from this fieldwork. First, the results indicate that clays are widely available in the Nasca region and that these clays are compositionally variable. Because of the compositional homogeneity of polychromes sampled thus far, this suggests that ancient potters were selecting specific clays with restricted distributions for polychrome production. Second, we link the group of Early Nasca polychrome pottery to a clay from a prehispanic adobe found in the lower valleys of Nasca within several kilometers of the ceremonial center Cahuachi, as the composition of this adobe matches the composition of most Nasca polychromes. Although preliminary as the survey is not

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complete, we suggest that the source of clays for the bulk of Early Nasca polychrome pottery production was located somewhere in the general vicinity of the ancient ceremonial center. Furthermore, this study lends support to a previous proposition that Cahuachi was a locus of an excess of polychrome pottery production. If this conclusion can be verified through further analyses, it has major implications for how Early Nasca pottery production, distribution, and consumption is understood.

We first introduce the archaeological context of the region with an emphasis on the current state of knowledge regarding the production of Nasca polychromes and summarize several models for Nasca polychrome production. We then focus on the research goals of the raw material survey, a description of the methods of the survey, and the results of the analysis. We conclude by recommending directions for future research.

2. Archaeological context

The Nasca region is located on the south coast of Peru and encompasses the Ica and Rio Grande drainages. Focus here is placed on the Southern Nasca Region which encompasses four river valleys (SNR; Fig. 1). The geographic region was home to Nasca (ca. A.D. 1–750), one of the most well known of the pre-Inca complex societies to arise in the Andes. Nasca is famous for its fine material culture, most notably a ceramic tradition distinguished by a fineware polychrome pottery renowned for its elaborate iconography and technical quality.

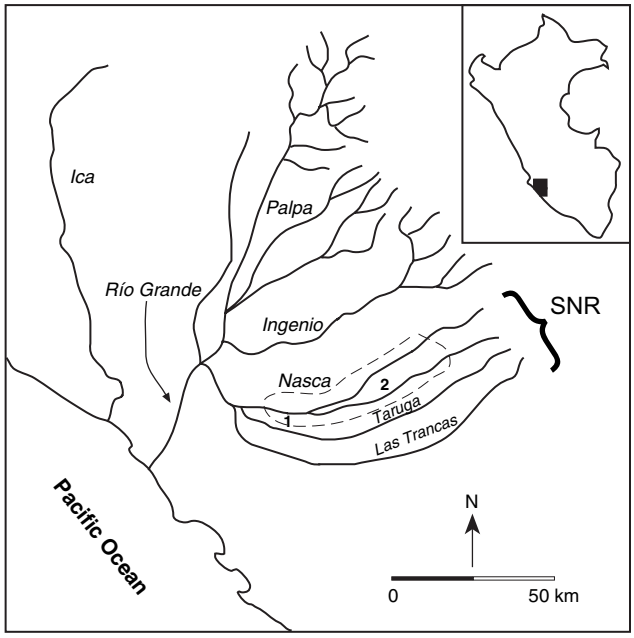

Fig. 1. Map of the Southern Nasca Region (SNR; based on [30]). The dotted line outlines the approximate boundaries of the clay survey. Prehispanic sites mentioned in the text: 1 = Cahuachi; 2 = Marcaya.

Geologically, the SNR is composed primarily of the Ica-Nasca Depression, and the Andean foothills. The Ica-Nasca Depression is a tectonic depression consisting of Quaternary sedimentary rock formations that are riverine and riverine alluvial [14,22]. This formation is located from approximately 400–450 m in elevation in the western portion of the SNR. Above 450 m in elevation are the Andean foothills which are composed primarily of the Jurassic Guanero Formation, and the Cretaceous formations Portachuelo, Copará, and Yura. Each of these is composed of clastic sedimentary rock, and has Cretaceous plutonic intrusions of granodiorites and gabbrodiorites from the Coastal Batholith [14].

ONERN [22] classifies the region as Pre-Montane Desert Formation, and the climate is hot and arid with very little measurable rainfall recorded each year. The rivers are the limiting factor in the region as they are classified as "influent streams" [22], only flowing for a few weeks in a year as a result of runoff from rains in the highlands during the wet season. In particularly dry seasons, they do not flow at all [30]. Despite the unfavorable local conditions, Nasca culture developed and flourished.

Chronologically, Nasca is divided into phases 2–7 and these phases are grouped into the Early (phases 2–4), Middle (phase 5), and Late (phases 6–7) Nasca cultures [29,30,42]. Each culture corresponds to major regional changes in Nasca society evident through changes in settlement patterns and ceramic iconography. The focus of this study is the Early Nasca culture (Table 1).

During Early Nasca, the majority of people lived in small, rural villages located in the upper valleys of the region [30], while Cahuachi, a ceremonial center, was the focus of regional pilgrimages [34]. The small villages appear to have been autonomous in terms of their subsistence economy, the basis of which was a mixed agro-pastoral economy focusing primarily on maize [12] augmented with beans, peanuts, and other agricultural products, the occasional exploitation of marine resources, and limited camelid herding [40,41]. The entire region, however, was incorporated into a wider social realm with an economy involving the production,

Table 1
Abbreviated Peruvian and Nasca chronology

Horizons and intermediate periods	Culture	Nasca phases	Approximate dates
Middle horizon	Loro, Wari		A.D. 750–1000
Early intermediate period	Late Nasca	6, 7	A.D. 550–750
	Middle Nasca	5	A.D. 450–550
	Early Nasca	2–4	A.D. 1–450
Early horizon	Proto Nasca	1	100 B.C.–A.D. 1
	Paracas		800–100 B.C.

circulation, and consumption of polychrome ceramics [42], and through group ceremonies conducted at Cahuachi [34].

The technical quality and artistry of polychrome pottery has given the prehispanic culture worldwide recognition. Since the early 20th century when the pottery was first documented as a distinct art style, Nasca polychromes gained renown for their quality of manufacture. They have thin vessel walls, up to 15 distinct mineral based slip colors [25], a wide range of recurring vessel shapes, and complex iconography featuring natural and supernatural motifs. Due to many studies of museum specimens, this body of iconography is well known. Carmichael [7] has argued that the entire corpus of iconography is directly tied to themes of water and fertility, and it is generally argued that polychromes were the principal vehicle for Nasca ideology [7,35,42].

3. Models of Nasca pottery production

Recent studies regarding Nasca ceramic production and distribution have tended to favor one of two models focusing on the context in which these ancient artifacts were produced, circulated and consumed. Carmichael [7] favors a household production model in which communities or lineages were responsible for the production of their own pottery. He envisions a model in which a pottery community was responsible for the production and circulation of polychrome pottery within a defined territory in dispersed settlements on a part-time basis.

Silverman [34] envisions people from around the south coast of Peru producing their own pottery, in a household production model similar to Carmichael's proposed model. Silverman adds exchange to this model by suggesting that people brought their locally made pottery to the ceremonial center of Cahuachi where they participated in ritual pilgrimages, exchanged that pottery and then returned to their residential villages, presumably with pottery from around the Nasca region made by various potters. This scenario is part of the wider belief that Cahuachi was an empty ceremonial center, filled with people only at certain times of the year when pilgrims flocked to the site from throughout the south coast of Peru.

Most recently, a third model of Nasca pottery production has been proposed by the first author [42] who has suggested that polychrome pottery was an artifact produced in the contexts of specialization. By specialization, we mean that they were made by producers who manufactured more goods than they consumed. This contrasts with Carmichael's model which suggests that producers made pottery for lineage or household needs. In particular, the quality of manufacture, and the apparent restricted locus of production yet widespread distribution of polychromes, is seen as an evidence for specialized production, though this specialization need not have been full-time. Theoretically, the locus of this specialization could be in the form of household or community specialization typical of ethnographic examples in the Andes [3]. Currently, however, there is no evidence for community or household specialization in Nasca as no firing loci, or other evidence of production has been found in the many surveys of the region [7,46]. In contrast, one possible locus of ceramic production that has been proposed is the ceremonial center Cahuachi [42,46]. Although firing loci have not been identified at the site, other evidence for the production of pottery including artifacts relating to their manufacture and decoration have been found [23,33,34].

4. Testing the models

To test these models and to learn more about residential villages in Nasca, excavations were undertaken at the small Early Nasca village Marcaya. Work there provides evidence for a relatively self-sufficient community that was engaged in mixed agropastoralism, lithic production, and textile production [40–42,44]. While the community did not produce pottery, a high percentage of polychrome finewares was used there [40,42]. In fact, excavations demonstrate that polychrome pottery was available to a wide range of people and consumed by individuals and households of both high and low status. Polychromes made up 56% of the vessel assemblage, compared to about 70% of the assemblage at Cahuachi [34]. While polychrome bowls and vases were used for daily consumption by all households at Marcaya, higher status households had exclusive access to several important vessel shapes including headjars and cup bowls. Thus, while all people used polychrome pottery, certain vessel types carried greater significance as they were only associated with high status households.

While intriguing, the results from Marcaya did not resolve the question of where the polychromes were made. Without direct evidence for pottery production at Marcaya, the composition of ceramic pastes was studied to determine if there was any variability in the paste types present at the site. A neutron activation analysis of a sample of both the polychrome and plain pottery from Marcaya ($n = 100$) revealed that the painted pottery ($n = 60$, including two panpipe samples) had a unique chemical signature with most polychromes ($n = 54$, 90%) forming a single compositional group referred to as "INAA Group 1", while plain pottery had various signatures [46]. In this analysis, it was proposed that these groups were linked to raw material resource zones that had yet to be identified, and more importantly suggested that the production of polychrome pottery was undertaken in restricted contexts.

This earlier conclusion of specialized pottery production has been supported by two parallel compositional studies. First, a supplementary neutron activation analysis of a sample of additional polychrome sherds ($n = 159$, for a total of 259 sherds sampled in both studies) taken from 14 additional domestic sites from the four valleys of the SNR shows remarkable homogeneity in the polychrome pottery, despite the fact that production loci have yet to be found at these sites [43]. Combined with the earlier study, a total of 139 of the 166 total polychrome sherds (84%) that have been sampled fall into INAA Group 1 (the remaining sample of sherds in the study include utilitarian pottery and samples from other time periods, primarily the Late Intermediate Period). The other 16% fall into a small compositional group ($n = 5$) comprising polychromes and plainware, while the remainder ($n = 22$) are unassigned. Second, a compositional study of polychrome paints demonstrates that the black paint used to decorate Early Nasca pottery consisted of a very uniform recipe despite the fact that several sources appear to have been available to ancient potters [47].

Numerous cautionary notes warn against extrapolating production contexts from compositional analyses alone [2,28]. Two major factors that influence paste variability include (1) the local geology which affects the natural variability in ceramic raw materials [2] and (2) "paste preparation variables" including the mixing of raw materials (especially clay and temper) to form the ceramic paste [2]. Ethnographically, additional factors include "procurement variables" such as a potter's perception of available raw materials, religious concerns associating, for example, certain raw materials associated with sacred mountains, and the potters' settlement pattern affecting their access to particular raw materials [2].

Taking these caveats into consideration, we still find that the current data support the proposition of specialized pottery production for the majority of polychromes. For example, the compositional groups found in the analysis did not appear to be related to differential paste preparation. Ethnographically, potters can choose different locally available clays for their physical and thermal properties, such as preferring a particular clay over another because it makes for better cooking vessels [2]. This does not appear to be the case for the Nasca compositional groups. Indeed, the principal polychrome group (INAA Group 1) included a few samples of undecorated *olla* (cooking pot) fragments suggesting that the clay used to manufacture polychromes was also adequate for the production of utilitarian wares [46].

Furthermore, the addition of non-plastic temper did not affect the composition of the groups. Most Nasca polychromes used little, if any temper in their manufacture [7,25,40]. Plainwares are generally sand tempered [25,40], however, the compositional analysis demonstrated that the temper had little effect on the bulk INAA [46], primarily because the temper is low in rare earth elements.

Yet, there is still one missing piece in the puzzle: the region's geological variability. Compositional analysis alone is a robust method of determining where groups of pottery were made only if ancient ceramic workshops are known [4,13]. Because no pottery workshops are known in Nasca, compositional analyses remain inadequate to assess ancient ceramic production. While we do have evidence that some production took place at Cahuachi, the scale of that production remains to be demonstrated. In the absence of evidence for workshops, and without a sample of the raw materials available to ancient potters, the explanatory potential of compositional analyses is limited. Indeed, without knowing the distribution of raw materials in the region, aligning the compositional groups found in previous analyses with clays located on the ground is not possible [4,20,21,24,27,38], thus to move forward with investigations, it is imperative to determine the distribution of clays in the region.

As part of the larger ENCE project directed by Vaughn, in an effort to determine the availability of clays in the region, an initial clay survey of the SNR was undertaken. The ENCE project's goals are to evaluate the production, circulation, and distribution of Nasca polychrome ceramics. Its goals are being met by undertaking a clay survey of the region, and by evaluating the circulation and consumption of Nasca polychromes through test excavations at contemporaneous domestic sites located throughout the SNR. The remainder of this paper focuses on describing one part of this project, the raw material survey, as well as the preliminary results of the analysis resulting from the survey.

5. Raw material survey

According to modern potters, clays that are adequate for the manufacture of pottery are widely available in the SNR. These include what Carmichael refers to as both "industrial" clays for the production of utilitarian wares and "fine" clays for the production of polychromes [7]. However, neither the composition of these clays nor their geological variability is known.

To begin work on designating resource zones in the region, a clay reconnaissance was conducted in the Tierras Blancas and Aja Valleys in the summer of 2002 [45]. The objective was to take systematic samples from river valleys and to augment these with judgmental samples based on advice by modern potters. The sampling methodology then, was a combination of "culturally biased" and "systematic" sampling [21]. Indeed, approaches to raw material sampling generally follow

a continuum from culturally biased to systematic [21]. Culturally biased approaches rely on information from modern potters and other individuals who use modern clays. In areas such as Nasca where modern potters employ techniques used by their ancient counterparts the advantage of culturally biased approaches is that modern artisans have intimate knowledge of clays and other resources in the region [27,32,36]. Unless deposits are extremely limited in a region, however, those exploited by modern potters may not be identical to the ones used by ancient potters. Furthermore, it is just as important to evaluate which sources were not exploited if they exist, and if so, why [21].

To avoid biases that are inherent in cultural approaches, systematic sampling of raw materials is often employed. The primary disadvantage of a systematic approach, however, is that if modern potters are using the same clay deposits as ancient potters, then the exact locations of these sources may not actually be sampled in a systematic program [21]. Because of these advantages and disadvantages, both approaches were employed in the raw material survey, with systematic samples being augmented with judgmental samples based on the advice of modern Nasca potters.

Originally, samples were to be taken every 2 km along the river valleys. Valley bottoms and margins in the SNR, however, are composed of materials that are geologically similar—mostly valley alluvium that gets mixed every year with annual flooding. In contrast, small quebradas feeding into the valleys cut through parent rock of distinct geological formations, indicating that primary and residual clays found in these quebradas may have been chemically distinct. Therefore, samples were taken occasionally along the valley margins, but quebradas were also surveyed, as were clay deposits associated with previously documented archaeological sites.

Teams of 2 or 3 surveyed each day for three weeks. On survey, crew members identified clay deposits by looking at road and river cuts and for areas of poor vegetation growth which often correlate with underlying clay beds [37]. When possible, knowledge of local artisans and itinerant miners was used to find clay deposits as well, including several clay sources in the higher elevations in the upper valleys of the region. On occasion, prehispanic adobes encountered on sites were also sampled as these were thought to be representative of local clays.

Total coverage of the clay survey included the region depicted in Fig. 1. Most samples were found in quebradas and in the upper valleys. Suitable materials were rarely found in the principal river valleys. Samples were collected, however, in the middle valley near the modern town of Nasca, as well as near Cahuachi (Fig. 2).

When found, 21 samples of clay deposits were collected. A total of 51 samples of sediment were taken in the field. Once brought back to the lab, the samples were processed by screening through a fine mesh to remove large anomalies and grain sizes, and if necessary, ground using a mortar and pestle to make the clay more workable. After preliminary processing, water was added to the sample to test its plasticity and overall workability. Each sample was then formed into a clay disc roughly 3 cm in diameter (less if there was less sample material to work with), and about 0.5–1 cm in thickness.

After following these procedures, only 29 of the 51 total samples collected in the field were found to be adequate to work into discs. The others were highly silty or sandy, and were not suitably plastic when prepared. The 29 remaining samples formed the basis of the subsequent compositional analysis. After processing, the 29 clay discs were submitted to a local potter's workshop, and they were fired in his pottery kiln at a temperature of 800 °C. After firing they were submitted for neutron activation analysis at the University of Missouri Research Reactor (MURR).

6. Results

The raw clays obtained during the sampling program described above were analyzed using standard MURR procedures for instrumental neutron activation analysis (INAA) of pottery and ceramic raw materials [10,18]. In brief, two irradiations, three gamma-ray counts, and a standard-comparator approach to calibration were used to obtain concentration data for 33 elements.

The general question addressed in this study is: how does the range of variation in our sample of raw clays from the Nasca region compare to the variation in materials exploited by Nasca potters? More specifically, we hope to identify certain raw clays that fall within the range of variation of INAA Group 1, the group that contains the vast majority of Nasca polychrome ceramics from a total of 15 domestic sites analyzed thus far. This would constitute evidence for the location of the source zone exploited by Nasca polychrome potters.

The results of the analysis indicate that there is considerable variability in the clay samples. Comparing the coefficient of variation (CV) of the clay samples to the compositional groups found previously demonstrates that the clays collected were compositionally variable (Table 2). The CV for a variety of rare earth elements is high for clays while the CV for each of the four pottery groups found in the original compositional analyses is relatively low. The same pattern is seen in essentially all the 33 elements used in the analysis. This suggests that while clays in the region are highly variable, the specific clays chosen to make ceramics by Early Nasca potters were not. Thus, while there were a number of clays that Nasca potters could have chosen, they were very selective in the clays used for manufacturing polychrome pottery.

Comparison of the raw clays to INAA Group 1 involved calculation of individual-specimen Mahalanobis

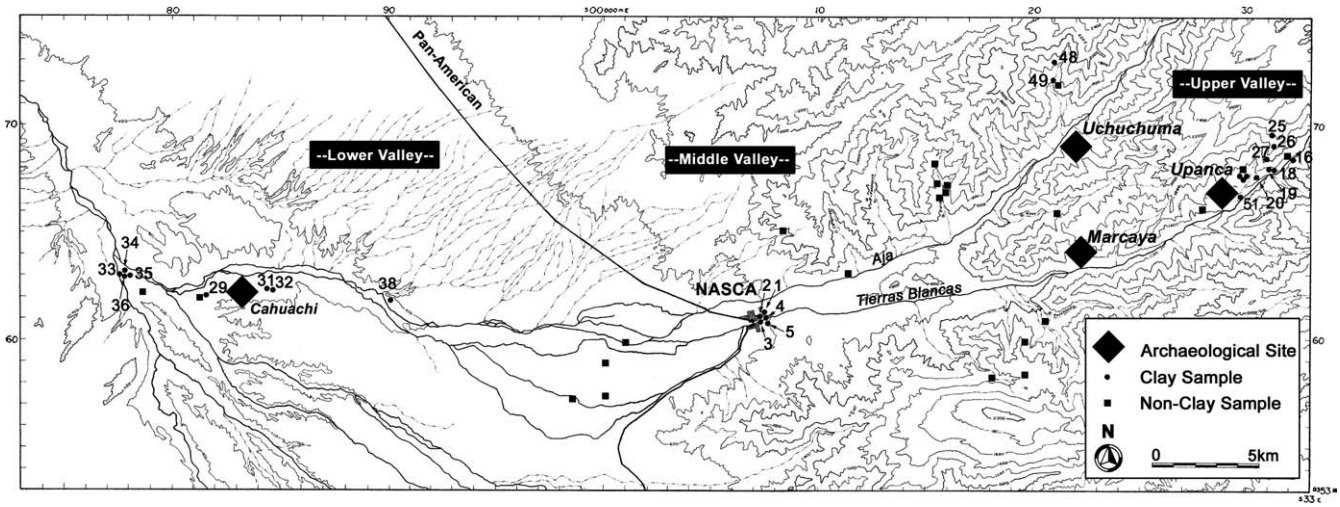

Fig. 2. Area of the clay survey with clay samples (circles) labeled. Surveying was limited mostly to the Aja and Tierras Blancas Valleys and the quebradas feeding into them. (Squares indicate sediments collected that were not clays.)

distances from the group centroid and conversion of the distance data to probabilities of group membership [5,11,19]. Clays showing highest probabilities of group membership (smallest Mahalanobis distances from the group centroid) are potential source clays.

After converting the data to base-10 logarithms, probabilities of membership in INAA Group 1 were calculated in several ways. Using all retained elements (i.e., all elements except nickel, which was below detection in most analyses) none of the raw clays exceeds 1% probability of group membership, although CS029 falls just outside this probability cutoff. Using the first 12 principal components of the complete Nasca data set (>90% of total variance), however, CS029 exceeds 15% probability of membership in the group (Table 3). Similarly, when calcium and aluminum are excluded from the analysis, probabilities calculated from the remaining elements indicate that CS029 exceeds a 5% probability cutoff. Thus, CS029 is actually closer to the centroid of INAA Group 1 than many ceramics actually included in the group (in fact, closer than approximately 17 out of 100 true group members, assuming multivariate normality and calculating probabilities based on the first 12 principal components). These observations build a strong case that CS029, unlike the other raw clays, pertains to the same range of compositional variation as INAA Group 1.

Table 2
Coefficient of variation (CV) for four rare earth elements in compositional analysis

	n	Coefficient of variation (%)			
		La	Ce	Nd	Sm
Clays	**29**	**66.54**	**53.04**	**72.23**	**55.95**
Compositional group 1	174	8.19	10.01	13.32	9.84
Compositional group 2	16	5.92	3.08	11.42	6.04
Compositional group 3	8	10.48	13.41	8.10	8.41
Compositional group 4	14	12.41	13.02	14.48	14.06

Some kind of clay processing and/or diagenetic effect may be partially responsible for the differences between clay and pottery on certain elements (e.g., aluminum and calcium). However, CS029 is clearly the closest approximation of the elemental profile of INAA Group 1.

CS029 was a small fragment of an adobe collected approximately 3 km downstream from Cahuachi at the prehispanic site Estaquería (see Fig. 2). Because permitting limitations required that only geological samples or non-cultural features were collected, we collected an adobe that was incomplete and from the surface (i.e., not from an architectural feature).

7. Discussion

Although preliminary at this stage, the results of the analysis from the first year of the ENCE project empirically demonstrate several things, and we expect to

Table 3
Clay samples ($n = 29$) compared to INAA Group 1 using the first 12 principal components (over 90% of total variance)

ID	MD[a] scores	ID	MD scores	ID	MD scores
CS001	0.004	CS020	0.000	CS034	0.000
CS002	0.520	CS022	0.000	CS035	0.000
CS003	0.000	CS023	0.000	CS036	0.000
CS004	0.000	CS024	0.094	CS037	0.000
CS005	0.013	CS025	0.000	CS038	0.000
CS014	0.000	CS026	0.000	CS039	0.000
CS016	0.000	CS027	0.000	CS048	0.000
CS018	0.000	**CS029**	**16.978**	CS049	0.000
CS019a	0.000	CS031	0.000	CS051	0.000
CS019b	0.000	CS032	0.000		

INAA Group 1 comprised 84% of Nasca polychromes sampled [43]. Missing sample numbers are non-clay sediment not submitted for INAA.

[a] MD = Mahalanobis distances.

test these results in the remaining seasons of the project. First, clays are—as previously suspected—widely available in the Nasca region. Carmichael [6,7] had noted the widespread availability of clays in earlier publications, and this was also indicated by the first author's numerous discussions with local potters. Today, local potters claim that clays are available just outside their door in the town of Nasca and that many clays suitable for pottery production are also available in the upland river valleys.

Second, the study demonstrates that the available clays are far from compositionally homogeneous. In previous analyses of ceramic sherds from domestic sites, it could not be determined with certainty that different compositional groups indicated different resource zones without understanding the geological variability of the region. In fact, this has been mentioned by some as a cautionary note to our previous studies [33,35]. Thus, determining that there is variability in clay resources in the region is significant. Because INAA Group 1 contains the majority (84%) of Early Nasca polychromes analyzed so far, given the heterogeneity of the geological environment, we argue that a strong case for specialized production of the majority of Nasca polychromes can be made. The remaining 16% of the specimens may have been produced in other contexts or they may be statistical outliers (see below).

Third, we suggest that given the evidence presented here, the source of clays used for the majority of polychrome pottery in the Southern Nasca Region can now be traced to the lower valleys of the Nasca region, and the most likely location given the current evidence is somewhere in the vicinity of Cahuachi.

In some rare ethnographic cases, clays are collected at a relatively long distance of up to 30 km [1], however, a procurement radius of a much shorter distance is most common. Based on his extensive ethnoarchaeological study of traditional potters in Mexico, Peru, and Guatemala, Arnold [2] has recently suggested that "distances to most primary ceramic resources in antiquity probably did not exceed 3 to 4 km". Given this relatively small procurement radius, localized resources that match compositional groups in heterogeneous environments are excellent candidates for raw materials used in the past. Other samples from the lower valley near Cahuachi and Estaquería were also taken in the survey (see Fig. 2). These, however, did not match INAA Group 1 in the analysis suggesting that the correct clay bed was not sampled or perhaps the clay used in the past is buried under alluvium and is simply inaccessible today.

Given the utilitarian nature of adobes, the clay used to make them, like the clays for pottery, is rarely transported great distances in pre-industrial societies. Indeed, cross-culturally heavy, utilitarian items are rarely transported far from their point of manufacture [39]. The only conditions in which we are aware that adobes were transported long distances were under the circumstances of elite-controlled labor. For example, Moseley [16] has proposed that the Moche pyramid Huaca del Sol was constructed by different groups who manufactured and then transported adobes to the construction site [17]. He hypothesizes that the "maker's marks" on adobe bricks that comprise the pyramid were a way in which Moche elites could account for commoner labor [15], implying a highly controlled labor force analogous to the well-known mit'a tax system of the Inca Empire. Shimada [31], on the other hand, suggests that the current data do not support the assertion that Moche pyramids were constructed with labor taxes of subjugated populations. While leaving open the possibility that groups could have brought in adobes by transporting them long distances, Shimada [31] suggests that it is more logical, given their cost to transport, that they were manufactured near the site. Of course, this remains an empirical question, and Moseley's hypothesis is easily testable, and the research presented here suggests one way in which this could be tested.

Most studies of Nasca sociopolitical organization suggest that Nasca was not nearly as complex as Moche [30,33]. Therefore, we suggest that the adobes used for construction in sites around Nasca, even at the ceremonial center Cahuachi, were probably made from local materials (i.e., adobes were not manufactured by elite-controlled labor). Silverman [34] has noted that the adobes used for the construction of Cahuachi were made of "tierra barrial", a distinct clayey sediment collected from the river bottom. Today, this sediment is processed into adobe by simply adding water to the extracted dirt in the river bottom itself. This is done without significant mixing, levigation, or the addition of non-plastics. Silverman suggests that adobes used in construction at Cahuachi were probably prepared in the river bottom just as they are in modern times and then transported the short distance to the site.

Given the heterogeneity in the clay samples collected, the match of INAA Group 1 to CS029, and the improbability that the adobe was transported a long distance, we argue that the location from which this sample was taken is near the source of clays used for the polychrome pottery comprising INAA Group 1. The precise dating of the site Estaquería has been in question for some time now, though there is a general consensus that it postdates Cahuachi, and therefore, Early Nasca [34]. While the adobe collected near Estaquería may date to a later period, we find it likely that it was prepared in a similar fashion (i.e., made from a local clay and not transported a long distance), and thus was from a clay source that was located in this vicinity. Of course, this proposition should be tested with further samples from this locality.

The precise location of this clay source is unknown. Future seasons of the ENCE project will focus on locating the exact source of clay extraction. Nonetheless, after many centuries of geological activity, the original

source could potentially be buried under many meters of alluvium in this environment, and not be accessible today. Wherever the clay source was located, the site of polychrome production must have been near the source, as it has been shown that ceramics are often produced at clay sources themselves [8]. We hypothesize therefore that the locus of production for the majority of Early Nasca polychromes was within a 3–4-km radius (the ethnographic upper limit of clay transport) of where sample #CS029 was found.

Of course, this radius includes the ceremonial center Cahuachi, which fits with our proposed model of centralized polychrome production at the site. One of us has argued that the production of artifacts that served as the primary medium for religious icons would have been a very important source of power for Early Nasca elites [42]. A full 84% (139 of 166) of Nasca sherds sampled from villages around the SNR was compositionally homogeneous and matches sample CS029. That Early Nasca elites at Cahuachi controlled the production of a large sample of polychromes and perhaps distributed these artifacts to people making pilgrimages to the site needs to be considered as a stronger possibility given the results, even if preliminary, of this study.

Additional polychromes ($n = 27$) in the compositional study not part of INAA Group 1 cannot be assigned to a production locus at this time. It is very possible that these represent less centralized production loci of polychromes perhaps in small workshops scattered around the SNR, or perhaps they are imports from other regions (such as the Palpa and Ica valleys) where Nasca polychromes are also widely distributed. Currently, little evidence for smaller workshops have been reported in the fieldwork conducted around the SNR, or in other valleys [7,9], though Silverman reports finding fragments of what may be potter's plates at several sites [33], and the remains of what is interpreted as a potter's house [33] in the Ingenio Valley. Our team did not locate evidence for pottery production during excavations and surface analysis conducted at the two villages Upanca and Uchuchuma located in the upper Tierras Blancas and Aja Valleys, respectively, during the ENCE [45], nor was evidence found in excavations at Marcaya [42]. Nevertheless, it is possible that smaller, household workshops may have existed in the region where utilitarian pottery and perhaps very small quantities of polychrome pottery were produced primarily for household and community use. Lower quality specimens observed in museum collections [7], may be from these household workshops. Future seasons of the ENCE will seek to define clay sources near Early Nasca villages to see if local production can be defined based on compositional analysis.

While more clays from throughout the SNR need to be sampled, and more work is needed to determine the geological variability of the lower valleys as well as to more precisely locate the original clay source, the research conducted in 2002 profoundly changes the landscape of our understanding of Nasca ceramic production. Combined with earlier analyses, we suggest that the data presented here (1) provide more evidence that centralized pottery production in Nasca was responsible for the production of the majority of polychromes; (2) suggest that the household model for Nasca polychrome pottery production cannot explain the production of the majority of polychromes; and (3) locate the source of the proposed centralized polychrome production in the lower valleys somewhere near Cahuachi. Furthermore, we believe that the earlier proposition that Cahuachi was a locus of ceramic production is more plausible given these current data.

Even so, there is still much work left to be done. The ENCE project described here is still underway. Two additional valleys within the SNR, the Taruga and the Las Trancas, have yet to be surveyed. We will continue to collect clays to evaluate the distribution of resource zones in the region. In particular, focus in the remaining seasons will be placed on (1) attempting to further delineate the clay source near Cahuachi and seeking evidence for pottery production in this region and (2) analyzing utilitarian pottery from domestic sites in the SNR and comparing them to locally available clay sources. In the continuing excavations at Early Nasca domestic sites, more unpainted utilitarian pottery will be characterized with INAA to determine their relation with local clays. This will allow us to better understand the differences in production and distribution between utilitarian and painted pottery. Finally, we eventually plan to expand the scope of the compositional analysis by analyzing samples from drainages such as the Ica, Palpa, and the Santa Cruz valleys—all outside the Southern Nasca Region—to determine if the polychrome pottery found in these valleys match the groups in the Southern Nasca Region. Whatever the outcome of the remaining seasons of the ENCE project and future analyses, we have demonstrated the utility of the methods employed here at gaining an understanding of pottery production and organization of this ancient Andean society.

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