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Micaceous Mindsets: Chemical characterization of classic period utility wares at multiple sites along the Rio Grande

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ABSTRACT

Micaceous utility wares are commonly found at Ancestral Pueblo villages in the Rio Grande region, yet they have received relatively little attention compared to contemporary glaze wares. This lack of attention is unfortunate, because utility wares were a common component of daily Pueblo activities and are shown to have been involved in complex exchange schemes. Neutron activation analysis is used to chemically characterize micaceous utility sherds recovered from seven Classic Period (AD 1300–1600) sites located along the Rio Puerco and Rio Grande between the modern towns of Santa Fe and Socorro, New Mexico. The resulting distribution patterns broadly indicate heterogeneous procurement and/or manufacturing practices from site-to-site over the three centuries examined; however, a shared distribution between the Rio Puerco and Central Rio Grande is distinguishable. This relationship is evaluated and interpreted under a communities of practice framework, and bears to question how the manufacture, distribution, and use of micaceous utility wares elsewhere may be explored with this approach.

1. Introduction

Beginning as early as the latter half of the 13th century, Ancestral Pueblo populations from the Four Corners and Western Pueblo regions, as well as local Rio Grande groups, contributed to the social reorganization of the Central and Southern Rio Grande region. Since the social effects resulting in migration were certainly not uniform, and immigrant group sizes ranged from individual households to hundreds of individuals (Nelson and Schachner, 2002), one can assume a heterogeneous social landscape. That landscape consisted of integration and factionalism, of kin and kith ties, and of dissension and harmony. In the broadest sense, the resulting regional similarities are still recognized and manifest across expansive archaeological delineations of the New Mexico Rio Grande region (Fig. 1).

Discussions of community formation along the Rio Grande Valley during the Classic Period (AD 1300–1600) are underlain by the notion that social similarities and differences existed between people on the landscape (Bayman, 1999; Naranjo, 1995) with integrative activities being one characterization of successful settlements during times of immense social change. One factor that helped bring these communities together was the production, exchange, and use of Rio Grande Glaze Ware ((Cordell and Habicht-Mauche, 2012a), an almost 400-year polychrome pottery tradition (AD 1313–1680) characterized by the application of paints that vitrify (Eckert, 2006). This glaze-painted ware has been associated with newly adopted ceremonial practice and participation in extensive exchange networks during its period of production (Cordell and Habicht-Mauche, 2012a; Eckert et al., 2018; Habicht-Mauche et al., 2006).

Contemporaneous with this glaze paint tradition was the production of various utility wares, including micaceous utility wares, a technology that Eiselt and Ford (2007:220) describe as "truly transcultural". Micaceous wares were produced and used nearly ubiquitously throughout the Classic Period by Ancestral Pueblo communities, appearing to transcend ethnic, linguistic, and technological boundaries. Platy mica interlocks with elongated clay particles resulting in a strong vessel wall resistant to forces applied perpendicular to this alignment. The abundance of mica makes vessels resistant to thermal shock, hence their role as effective and durable cooking vessels when compared to other utility wares (West, 1992). While technological aspects may help explain their widespread use, the glittering appearance vessels gain with

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the addition of mica could also have played an aesthetic or ceremonial role among the Ancestral Puebloans (Munson and Hays-Gilpin, 2020).

There is currently no reliable chronological series for micaceous wares in the Rio Grande region. Limited means with which to delineate such a common material on the social landscape merits an investigation of their distribution at a broader scale. Neutron activation analysis (NAA) of micaceous utility sherds identified multiple compositional groups across seven Classic Period sites, which suggests there may have been more than one community producing micaceous wares. Additionally, the distribution of these compositional groups suggest variability in social interactions between the villages under consideration. Interpretation of these data within a communities of practice framework offers multiple behavioral avenues to help explain these patterns.

2. Background

2.1. Cultural setting

The Rio Grande Classic Period experienced demographic upheavals that resulted in the formation of a radically new social landscape (Adams and Duff, 2004; Spielmann, 1998). Throughout the AD 1300s and 1400s, the majority of the Rio Grande region experienced population increase and nucleation into large villages. Two common frameworks for understanding settlement patterns and corresponding social circumstances remain popular. One framework examines settlement clusters and uses intersite analyses to consider cultural continuities and transformations in regional contexts (Adams and Duff, 2004). Another framework examines intrasite social dynamics to consider the specifics of cultural continuity and transformation at the village level (Habicht-Mauche et al., 2006). This work is an attempt to combine these frameworks by

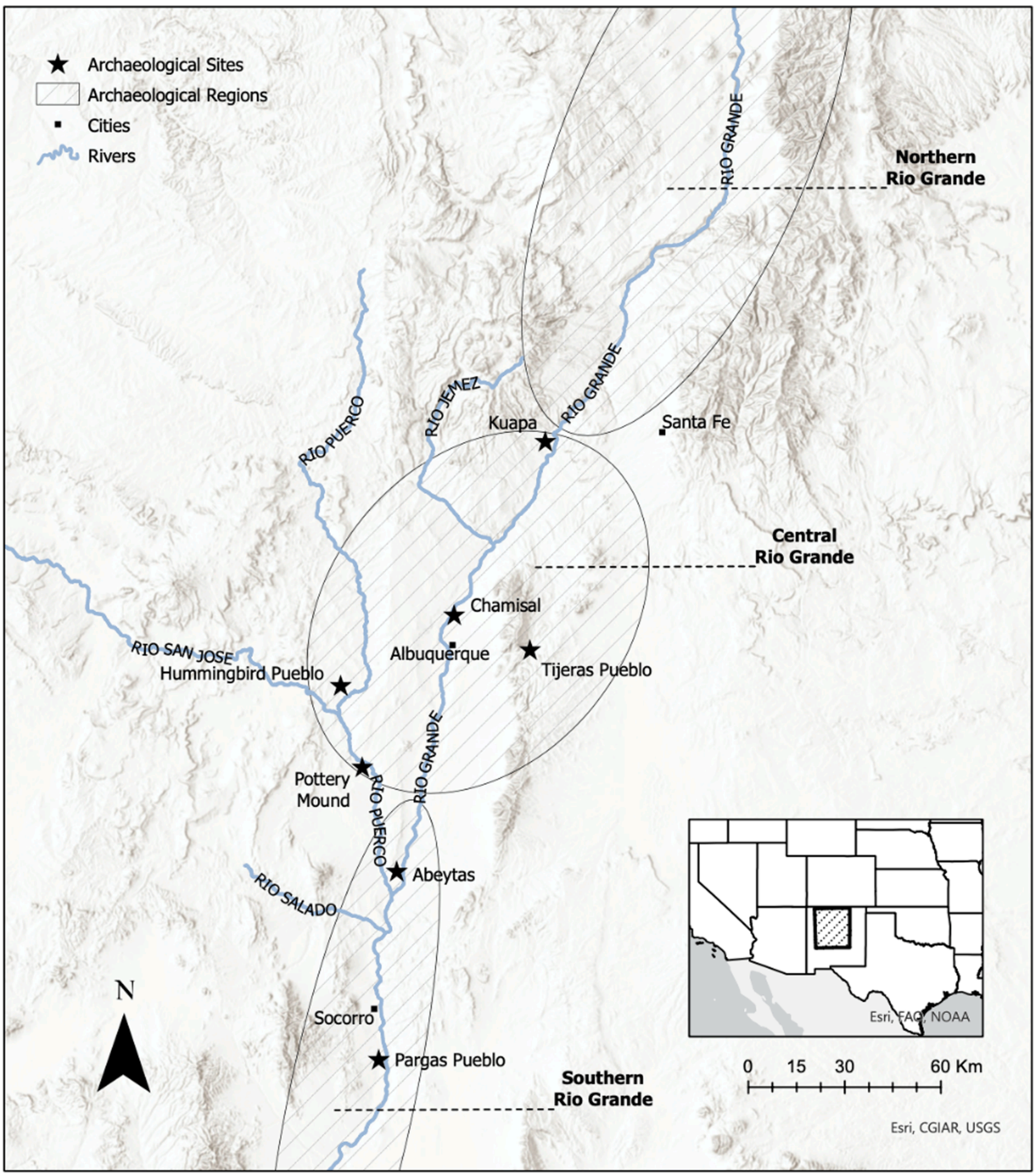

Fig. 1. The study area and studied sites partitioned by the regional geographic nomenclature for archaeological research along the Rio Grande.

utilizing archaeological districts (Adams and Duff, 2004) but considering the circumstances of individual villages within and between them.

The settlement and material histories of the villages examined here are complex results of the cohesion between local populations and immigrants carrying out their lifeways in traditional, hybridized, and novel forms. Researchers have identified evidence of Mogollon and Western Pueblo migrants in the Rio Puerco, Rio Abajo and Central Rio Grande regions in various proposed magnitudes (Eckert, 2008; Eckert and Cordell, 2004; Eckert and Snow, 2015; Marshall and Walt, 1984). Other work has shown that inhabitants from the Rio Puerco and the Middle Rio Grande regions were more closely related biologically than Rio Puerco populations were to Western Pueblo or Mogollon groups (O'Donnell et al., 2020). The arrival of migrants and relationships formed thereafter had the potential to leave a resounding impact on the social landscape for centuries to follow, leading to major transformations in notions of community, ritual practice, and the nature of leadership and power in Ancestral Puebloan society (Habicht-Mauche and Eckert, 2021). The production, use, and exchange of micaceous wares – probably for, by, and between households – were directly affected by these changes.

2.2. Geological setting

The Rio Grande Valley is the result of geologic rifting that caused extension in some areas and tectonic uplift in others (Kelley and Chamberlin, 2012; Reiter and Chamberlin, 2011). Northern portions of the Rio Grande Valley more closely resemble the textbook definition of a single rift valley, while southern portions are mostly indistinguishable from the Basin and Range Province; however, these basins are vital for clay deposition because they consist of exposed formations that are susceptible to erosion (Keller and Baldridge, 1999). Both widespread and localized clay deposits have formed and many of these deposits have been identified as clay sources used by ancient and historic Puebloan potters (Habicht-Mauche, 1993; Nelson and Habicht-Mauche, 2006; Shepard, 1936,1942,1956; Warren, 1970,1976,1980). All of the archaeological districts examined herein contain clays appropriate for pottery production, although not all districts had clays appropriate for the production of micaceous ware. While much of the study area shares a similar clay depositional history, local geological variation often results in distinct enough differences to infer production provenance through mineralogical or chemical compositional studies.

Mica is a laminated mineral that can form under a variety of circumstances (Nesse, 2000); 'mica' is a blanket term encompassing many platy minerals, including muscovite, biotite, and chlorite. It can be found in a variety of geological settings, but most notably in the Rio Grande region in formations containing schist and gneiss (Jahns, 1946; Williams and Cole, 2007). Accessibility to mica-bearing deposits at the surface depends mostly on local geomorphology. Within the Rio Grande rift environment, the circumstances were right for uplift to expose old and/or form new mica-bearing deposits. Erosion of these deposits is best known in the Northern Rio Grande where mica-bearing clays have formed from the eroding middle Precambrian Vadito group (see Eiselt and Darling, 2012:Fig. 1).

Mica-bearing rocks are also present in the Sandia, Manzanita, and Manzano Mountains that span the Middle and northern portion of the Southern Rio Grande areas (see Lucas et al., 2014 for detailed geological descriptions of local formations). Presumably, residual micaceous clay deposits could form in these areas under the proper circumstances, but this is currently not well mapped. What is known is that mica-bearing rock sequences are present and were utilized. In the Sandia Mountains, mica and hornblende-bearing pegmatites are in Tijeras Canyon, while metamorphic rocks and bands of micaceous schists are found towards the northern and southern ends of the range (Jahns, 1946; Williams and Cole, 2007).

3. Communities of practice and Classic Period Rio Grande pottery

Inhabitants of Classic Period settlements, at multiple different scales, had a shared set of ways to make pottery that may be distinguishable from others. These often-informal collectives of individuals, who shared similar social and technological frameworks for manufacture, have been referred to as communities of practice (Lave and Wenger, 1991; Stark, 2006). Communities of practice have been extensively studied in the Rio Grande region through analysis of Pueblo glaze wares, primarily Rio Grande Glaze Ware (Cordell and Habicht-Mauche, 2012b; Habicht-Mauche et al., 2006). Beginning in the late thirteenth century, Ancestral Pueblo potters experimented with copper and lead-based paint recipes that vitrified upon firing at a high enough temperature, resulting in a shiny glaze paint (Cordell et al., 2006). Glaze technology is fairly complex so knowledge of how to produce these paints most likely had to be taught directly from one potter to another (Crown, 2014; Herhahn et al., 2006).

The study of Pueblo glaze wares has shown that a community of practice is not simply a reflection of shared material culture in the Ancestral Pueblo world. Some communities of practice can be identified across different sites and even regions, while multiple communities of practice have been identified within a single site (Cordell and Habicht-Mauche, 2012b; Habicht-Mauche et al., 2006). For example, at Hummingbird Pueblo (LA 578), a 14th Century village that produced glaze-painted pottery, Eckert (2008) argued that potters (including immigrants) from multiple communities of practice produced similar looking vessels to signal a shared village-wide identity. Alternatively, potters from the same community of practice may produce different looking vessels for different social contexts, as has been argued for two Zuni Glaze Ware types (Eckert, 2012).

Although communities of practice have most commonly been studied through decorated wares, they are also reflected through the manufacturing traits on utility wares. For example, while all pottery made in the Rio Grande region during the Classic Period was produced using the coil and scrape tradition, potters had myriad decisions to make during the selection and preparation of clay which could be reflected in utility wares (Shepard, 1956). Etienne Wenger (2011) notes that a community of practice requires 1) a shared interest, commitment, and identity that distinguishes members from nonmembers (domain), 2) pursuing that interest, commitment, and identity to the point of cooperation and collaboration as a means to learn, assist, and share (community), and 3) actively developing a toolkit comprised of tangible and intangible resources and information that are vital to the goals and interests of the group (practice). Here we use Wenger's model as an interpretive framework to begin to understand the production and distribution of micaceous wares in the Rio Grande region.

3.1. Micaceous wares

As already discussed, mica can refer to a suite of different but related minerals and is available in a variety of geological settings. For the purposes of this study, we define a micaceous ware as unpainted and unslipped pottery containing enough mica in its paste to be visible to the naked eye, no matter its geological source (rock, sand, clay), form (mineral grains or in rock fragments), or behavioral origin (intentionally added temper vs. nonplastics native to the clay). This definition is a result of the sampling process by which sherds were selected. While further distinctions through petrography or other analyses would potentially be useful, such techniques were beyond the scope of this study.

Micaceous wares were produced throughout the Southwestern United States and are found among various cultural traditions spanning time and space. Although these wares are often referred to as "mica-tempered", this description is an oversimplification that hides different technical processes. The two most obvious technical differences between different micaceous wares recovered in the Rio Grande region is how the mica ended up in the paste: either 1) from use of a residual micaceous clay, which is clay formed from the erosion of a mica-bearing parent rock and has retained the mineral, or 2) the intentional addition of a mica temper (or mica-bearing rock) to a non-micaceous clay (Eiselt and Ford, 2007). Shepard (1956:162) has cautioned that it may be difficult to discern whether a specific ceramic sample is derived from a residual micaceous clay or tempered with a mica-bearing resource.

The distinction between residual micaceous clays and clays intentionally tempered with mica is an important component of long-standing potting traditions along the Rio Grande. In pre-contact periods, two broad techniques to create micaceous pottery have been identified: the use of a coarse residual micaceous clay, and the addition of mica to a non-micaceous clay. By the Contact Period, and possibly shortly before, Northern Rio Grande potters began using fine residual micaceous clays that did not require the addition of any temper (Eiselt and Darling, 2012). This echoed down the Rio Grande and made its way to other Rio Grande Pueblos starting as early as CE 1500 (Gilmore and Larmore, 2012:65). This shift to fine grained micaceous clays is contextually specific to material, demographic, and social circumstances originating along the Northern Rio Grande that may or may not have been facilitated during the Historic Period by Athapaskans from the High Plains (see Gilmore and Larmore, 2012 for discussion). Ethnographic accounts in the 19th century Northern Rio Grande document that these residual

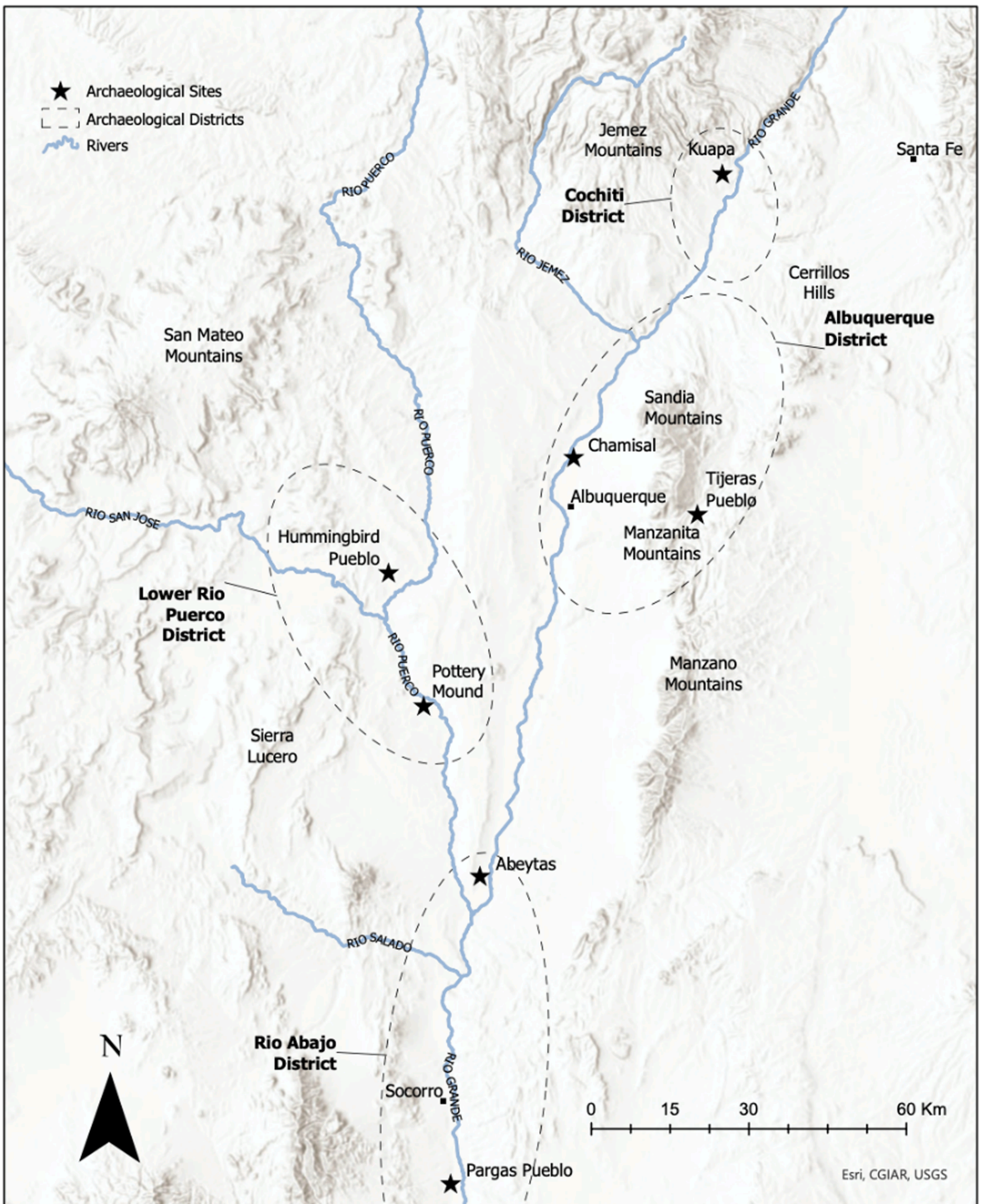

Fig. 2. Extent of the study area with relevant districts. The extent of districts roughly corresponds to the extent of clusters, wherein more sites also reside.

micaceous wares moved rather frequently between Vecino, Pueblo, and Jicarilla-Apache communities (Eiselt and Darling, 2012). Prior to these historic developments, there is little reason to suspect that all three types of micaceous clays (course residual, fine residual, and intentionally tempered) were not used by potters throughout the Middle and Southern Rio Grande regions.

A critical step in examining micaceous wares archaeologically was affirming that the paste could be sourced to locations on the landscape. This confirmation came when Eiselt and Ford (2007) matched sherds to micaceous clays from 10 mining districts in the Northern Rio Grande using NAA. This study showed that micaceous artifacts (n = 510) could be matched with a parent clay formation on a rather consistent basis. About 68 % of archaeological specimens were assigned to actual source areas, while an additional 22 % were assigned to archaeological districts (Eiselt and Ford, 2006). Residual micaceous clays are unique in that they are more chemically related to their geological source because they require less processing than non-micaceous clays with added mica temper (which may be related to two or more geological sources). This is an important distinction because NAA alone is not capable of matching these intentionally tempered clays to the many geological environments that mica can originate. Instead, NAA functions better to identify paste recipes, which are temporally and spatially significant to their cultural, rather than geological, contexts.

To summarize, we know or suspect the following about micaceous utility wares. First, micaceous wares along the Rio Grande have a long-established history. Second, deposits of micaceous clays and mica-bearing rock formations were accessible to Ancestral Pueblo potters from up and down mountain ranges bordering the Rio Grande Rift Valley. Third, micaceous clays and tempering materials may be sourced to the landscape using chemical and petrographic methods. Fourth, the potential for multiple production locations across the landscape reflects the possibility of multiple communities of practice participating in the production of micaceous wares. Fifth, and finally, these materials and finished vessels were exchanged between communities and households in ways that could indicate broader social and economic connections.

4. The archaeological context

For the purposes of this study, a district constitutes a geographic area, while a cluster contains archaeologically related sites that are close together and separated from other clusters (Eckert and Cordell, 2004). Seven Classic Period sites were selected for this study (Fig. 2) that allowed us to examine the distribution of micaceous wares in and between four archaeological districts. Date ranges for the sites were determined through a combination of absolute dating techniques at some sites and presence of specific Rio Grande Glaze Ware types at all sites. Although there is some debate as to how chronologically sensitive rim forms are, the designations Glaze A-F refer to differences in bowl rim forms that are commonly used to seriate Rio Grande Glaze Ware pottery (Eckert, 2006). For this project, we were specifically interested in site contexts that had Glaze A, B, and C. While all the sites are relatively contemporaneous and residents of these sites shared the Rio Grande Glaze Ware tradition, the site locations represent a range of natural and cultural environments.

One site, Kuapa (LA 3444) is located just southeast of the Jemez Mountains in the Cochiti District. This village consists of an estimated 400+ rooms, nine kivas, at least three plazas, and was occupied from AD 1200–1400 (Eckert and Cordell, 2004).

Two sites, Chamisal (LA 22765) and Tijeras Pueblo (LA 581), are in the Central Rio Grande district. Chamisal conservatively consists of 40–50 rooms and radiocarbon dates put occupation between AD 1335–1562 (Alexander Kurota, personal communication March 2022). Tijeras Pueblo is in the highlands to the east. Tijeras dates between about AD 1275–1400 (Wendorf and Reed, 1955). The pueblo probably has a total of 200 + rooms with 10–12 smaller roomblocks centered on a 125-room core roomblock, both a rectangular and circular kiva, and one plaza.

Two more sites, Hummingbird Pueblo (LA 578) and Pottery Mound (LA 416), are situated along the Lower Rio Puerco in the Lower Rio Puerco district. Hummingbird Pueblo consists of around 200 rooms, at least one rectangular kiva, three enclosed plazas, and was occupied between AD 1300–1450 (Adams and Duff, 2004). The terminal date may be earlier or as late as AD 1500, since abandonment of this area is still unclear (Eckert, 2008). Downriver is Pottery Mound, which includes about 400 rooms, 16 kivas, and at least three plazas. The primary occupation appears to have been between AD 1300–1500; however, recent work suggests that there may have been a later reoccupation at the site (Phillips et al., 2021).

Two sites, Abeytas Pueblo (LA 780) and Pargas Pueblo (LA 31746), are located in the Rio Abajo district on the Rio Grande floodplain. Abeytas Pueblo is just north of the Rio Puerco and Rio Grande confluence. Marshall and Walt (1984) initially noted that cultural debris from this site extended over 250 square meters but believed the site to have been destroyed; more recently, Eckert and Snow (2015) revisited the site and estimated 400–500 rooms with two plazas. Near Socorro, Pargas Pueblo appears to be highly disturbed to the point of having no clearly defined architectural characteristics (Marshall and Walt, 1984).

5. Methods

A total of 166 micaceous utility sherds were analyzed by NAA at the Archaeometry Laboratory at the University of Missouri Research Reactor Center (MURR). Sherds from Pargas, Chamisal, and Kuapa were provided by the Maxwell Museum of Anthropology at the University of New Mexico. Sherds from Pottery Mound, Hummingbird, and Abeytas were provided by Eckert. A micaceous utility ware dataset from Tijeras Pueblo (Habicht-Mauche and Eckert, 2021) was included at the data analysis stage because of that community's export of micaceous wares and micaceous schist temper (Habicht-Mauche and Jones Burgess, 2016), which brings the assemblage total to 201 specimens. The procedures for sample preparation and analysis are described in Glascock (1992). A total of 33 elements were measured and standards include SRM-1633a Fly-ash, SRM-688 Basalt Rock from NIST, SRM-278 Obsidian Rock, and Ohio Red Clay. Copper (Cu) and magnesium (Mg) were removed from the Tijeras Pueblo dataset to make it compatible with the data analyzed at MURR. Nickel (Ni) was also removed from the MURR dataset because of frequent concentrations below detection limits.

Following the detection and subsequent conversion of gamma ray spectra into elemental concentrations, the data were log transformed and visualized on elemental scatter plots. Groups were then identified based on the visual assessment of multiple element combinations and some refined using group membership probabilities based on Mahalanobis distance (MD) calculations. Aluminum, potassium, calcium, manganese, zinc, antimony, strontium, and barium were excluded from the MD calculations because they did not aid in discriminating larger compositional groups. Nickel was also excluded for low detection purposes.

This study consists of two levels of categorization: 1) *compositional groups* and 2) *distribution patterns*. Compositional groups are defined by elemental values irrespective of archaeological distributions. Visual assessment of bivariate elemental plots was the primary tool to initially distinguish compositional groups. Visual indicators were then cross-checked with verification at a statistical level with MD, which measures the probability that any given point belongs to a group.

For an MD calculation to be viable, the compositional group must have at least two more members (sherds) than the number of variables used to define the group. Since aluminum, potassium, calcium, manganese, zinc, antimony, strontium, and barium were excluded from the MD calculations because they did not aid in discriminating larger compositional groups, and because nickel was removed altogether because of low concentrations, the variable requirement for MD drops from 33 to 24 and the group size requirement to 26. However, this is a minimum because group separation is increasingly optimal as the difference between the member size and variables measured increases. The group size limitation has restricted our ability to use MD to further assess compositional groups that have fewer than 26 members.

Distribution patterns are defined by similarities and differences in the compositional groups when tracked within and between archaeological sites. Distribution patterns are dependent on behaviors involving manufacture and exchange but are *not* geographic delineations from which raw materials were procured. Here, distribution patterns are defined by the highest frequency of one or more shared compositional groups; however, all artifacts at a single site *do not* contribute to the categorization and elucidation of a single distribution pattern.

Santa Fe Group clays (e.g., Galusha and Blick, 1971) present a caveat for our data and subsequent interpretations because they are so common in the basin-fill of the Rio Grande region and have the potential for unpredictable chemical homogeneity at depth and across space. Differentiating these clays ideally would rely on petrofacies, a combination of lithic and mineralogical characteristics that may or may not crosscut geological formations (e.g., Miksa and Heidke, 2001), however no such research has been done. Even in the case when the chemistry of two sherds could be proven to be independent, ethnoarchaeological evidence in the Southwest United States shows that potters are very particular about the clays they select (Costin, 2000:380) and processes involved in clay preparation are a major factor in compositional variation (Neff et al., 1988). Therefore, compositional similarities in paste recipes can reflect an amalgamation of procedures in the crafting process and for the purposes of this research are assumed to do so.

6. Results

Eleven compositional groups were defined (Figs. 3 and 4). Group 1 through Group 10 are novel to this analysis, whereas the Tijeras group varies only slightly from the dataset reported in Habicht-Mauche and Eckert (2021). Group 10 (n = 53) and Tijeras (n = 34) were refined through MD calculations for reasons explained above. Although Group 1 (n = 27) technically meets the numerical requirement for MD, the calculation was excluded for this group because the size is so close to the minimum.

Eight outliers were identified and are not further included in the regional analysis. Compositional groups either include micaceous sherds recovered from multiple sites or are limited to a particular site, and these define the distribution patterns which include Areas A, B, C, D, E, and F. These areas are summarized by archaeological sites and count of members within certain compositional groups (Table 1).

Many distribution patterns are local to individual sites and others are not (Fig. 5). Area A includes Compositional Group 1 and is unique to Pargas Pueblo. Area B includes sherds from Compositional Groups 2, 7, and 8. Groups 2 and 8 are unique to Abeytas Pueblo while Group 7 also includes sherds from Abeytas Pueblo, Chamisal Pueblo, and Hummingbird Pueblo. Area C is unique to Tijeras Pueblo, with 32 of the 34 sherds from Tijeras Pueblo confidently assigned to this group, while the other two are from the Rio Puerco sites. Area D is defined by the high frequency of Group 10 and is shared between Hummingbird Pueblo, Chamisal Pueblo, and Pottery Mound. Area E includes Kuapa, where all compositional groups are unique apart from three sherds assigned to Group 10 (Hummingbird Pueblo, Pottery Mound, and Chamisal Pueblo) and one assigned to Group 6 (Chamisal).

Our approach to statistical group formation is conservative, trading for a higher number of uncharacterized samples in order to establish greater confidence in our compositional groups. Therefore, the eight outliers (excluded from tables and figures) and 40 unassigned sherds can result from a mix of analytical or behavioral factors. They may represent specimens distinct from defined compositional groups, marginal members of groups removed during statistical refinement, or exceptionally different samples. Some unassigned wares could also underly the fact that all sites have some degree of micaceous clay/ware procurement or trade that, unless additional data prove otherwise, are emblematic of nuances within small-scale household ceramic production and exchange. These might also reflect inconsistencies in production that may or may not be a factor of temporal trends, learning, or clay mixing.

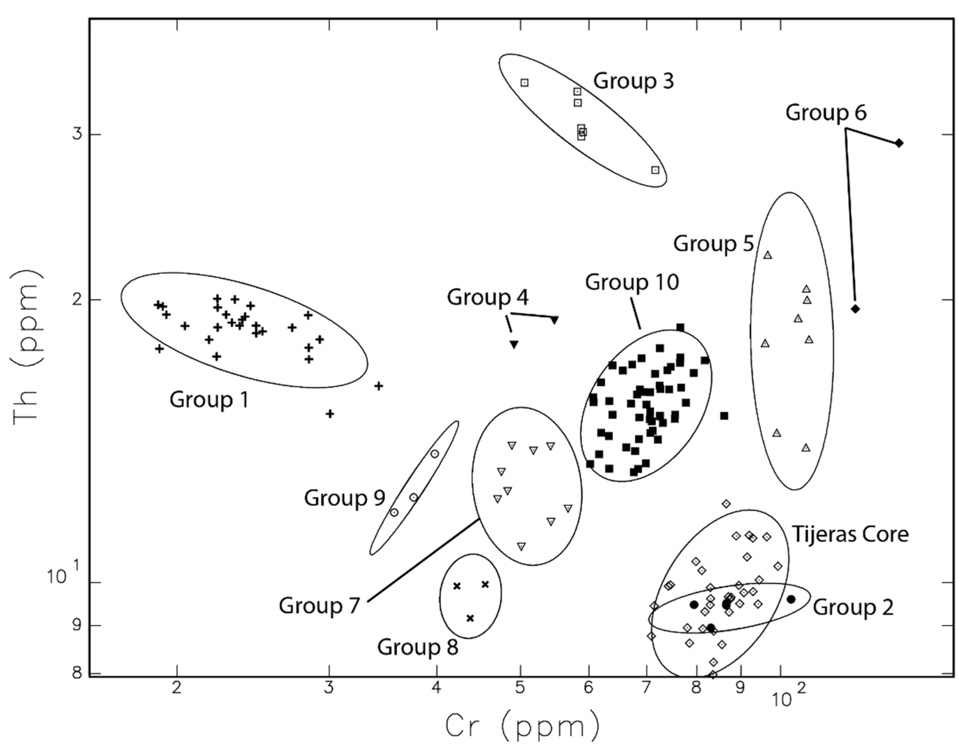

Fig. 3. Identified compositional groups in the study area (log-transformed).

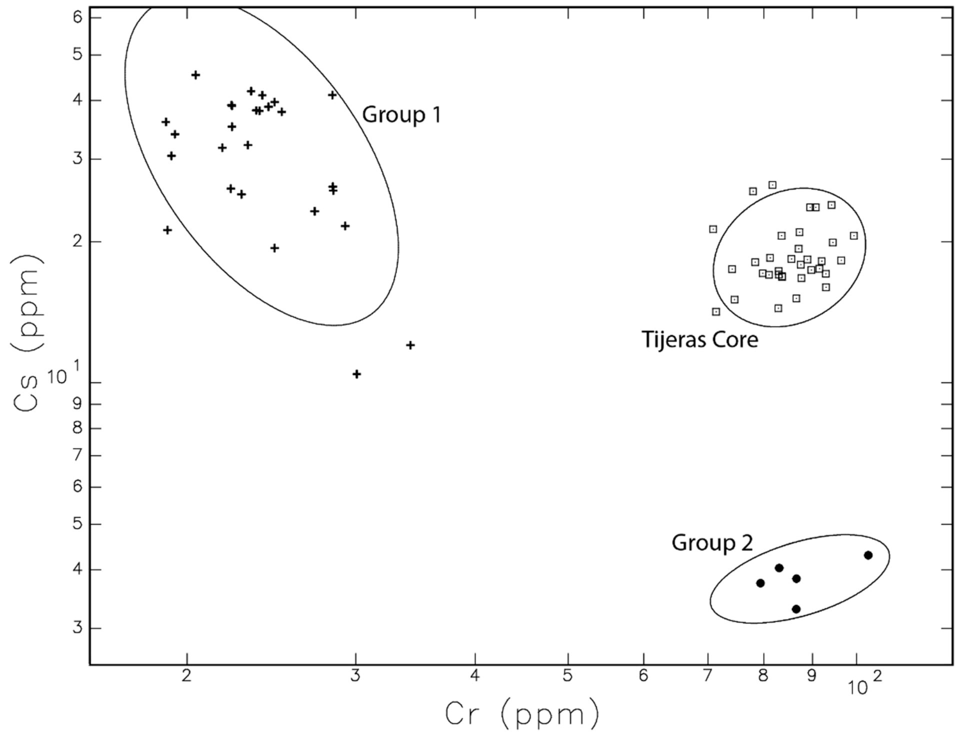

Fig. 4. Scatter plot showing separation between Group 2 and the Tijeras Core (log-transformed).

Table 1
Count of compositional groups across different sites.

	Compositional Group												
Distribution Pattern	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tijeras**	**Unas.**	**Total**
Area A													
Pargas Pueblo	27											3	30
Area B													
Abeytas Pueblo		5					4	3				4	16
Area C													
Tijeras Pueblo											32	3	35
Area D													
Chamisal Pueblo						1	3			24		2	30
Hummingbird Pueblo			1				2			17	1	6	27
Pottery Mound Pueblo			6							9	1	12	28
Area E													
Kuapa Pueblo				2	8	1			3	3		10	27
Total	27	5	7	2	8	2	9	3	3	53	34	40	193

7. Discussion

Interpreting our data within the framework of communities of practice allows us to consider relationships at both the regional and site level. To be clear, at this time we are assuming that, based on compositional and distributional patterns, we have evidence for one community of practice centered on the Rio Puerco and Albuquerque area. Further compositional data (on both ceramic sherds and micaceous clays) as well as petrographic analysis will help to refute or substantiate this assumption, but this is beyond the scope of the current paper. Given that our samples were taken from all glaze ware producing sites that have non-micaceous utility wares as well, there are other communities of practice producing these other wares that require further exploration to understand how they intersected with the production of micaceous wares.

As discussed earlier, Wenger (2011) outlined three aspects that all communities of practice share: domain, community, and practice. The distribution of micaceous wares in our study area showcases these three aspects in different ways. From our data, we draw the conclusion that a micaceous ware community of practice was probably operating between the Lower Rio Puerco and Albuquerque districts. We were unable to define other communities of practice, but we consider this limit as a factor of sample size and data availability rather than a true behavioral assessment of micaceous ware manufacture, transport, and use across the study area. Our discussion focuses on the community of practice we have defined and then concludes with a consideration of other potential communities of practice and future research directions.

7.1. Rio Puerco and Albuquerque community of practice

As defined by Wenger (2011), a domain is the ability to distinguish members from nonmembers because of their interests and commitment to an idea or thing. Rio Grande micaceous ware potters may be analyzed as such a domain, requiring that those individuals retain a certain set of skills, access to materials, and behavioral goals with which to execute the ideals defined by both them and the group. We argue that the Rio Puerco and Albuquerque community of practice was part of a greater domain that spanned much of the region. Since domains are beyond

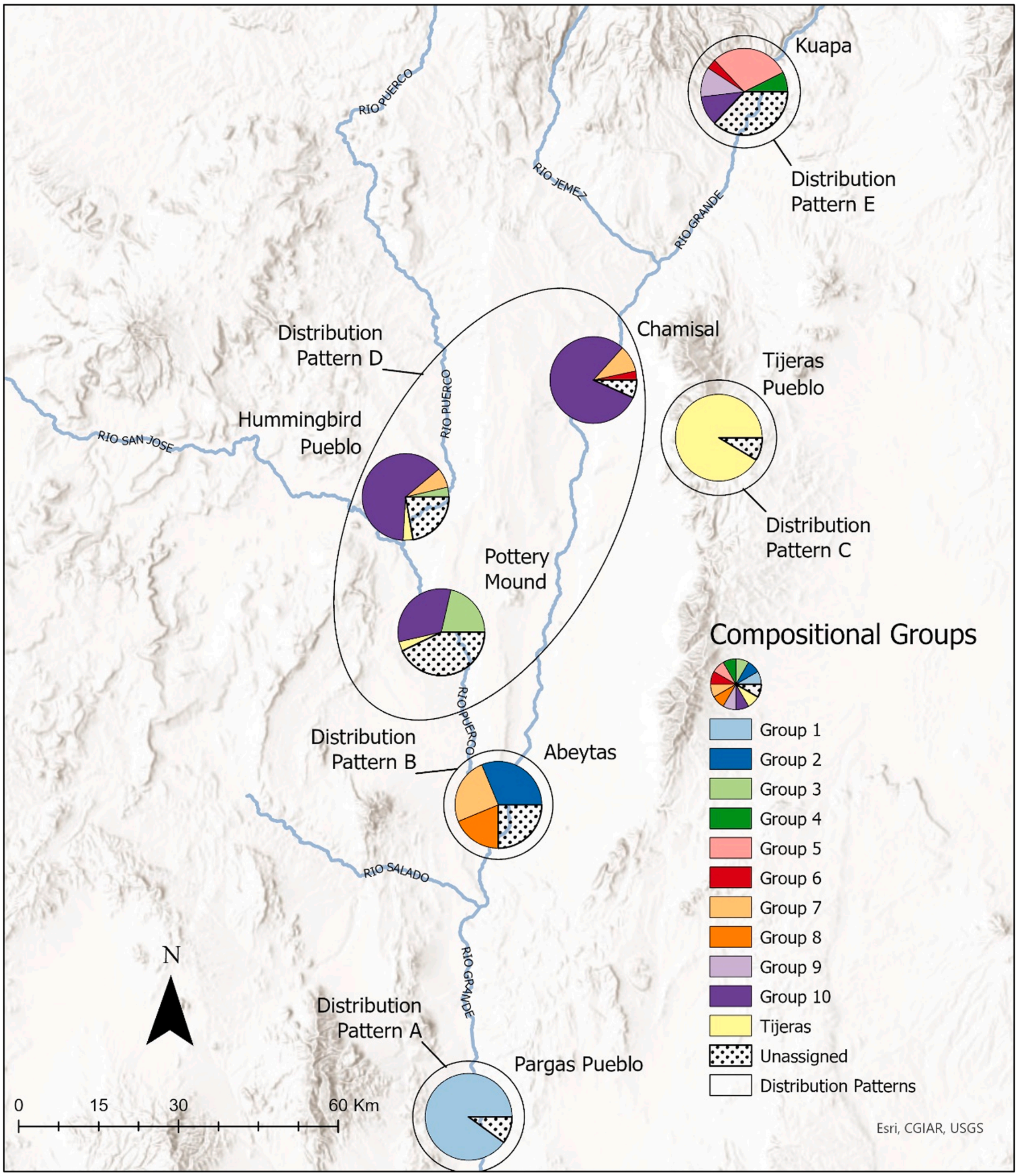

Fig. 5. Frequencies of compositional groups per site with proposed distribution patterns captured in the study area.

spatial connections and are relatively intangible, our data serve little to further define a micaceous ware domain apart from broader characteristics and patterns. We can infer that people who engaged in a community of practice inherently shared a domain, but this does not define the domain because "You could belong to the same network and never know it" (Wenger, 2011:1). Instead, what can be generally stated is that Classic Period social reorganization augmented the previous micaceous ware domain; populations were incentivized to change because of new participants, reformulated regional and local ties, and altered goals. However, other novel introductions (e.g., technology or intent of use) may alter the domain and the basic foundational principles of community of practice that follow.

Wenger (2011:2) asserts that in a community, "…members engage in joint activities and discussions, help each other, and share information". Here is where our data hold more explanatory power for micaceous ware communities. Distribution Pattern D (see Fig. 5) is an indicator that micaceous wares were moving between the Rio Puerco and Albuquerque regions. The movement of these wares can be explored as either a function of population movement (e.g. migration, marriage, opportunity, etc), exchange (e.g. markets, feasts, gifts, etc), or both.

Albuquerque and Rio Puerco populations have a long history of interaction that was especially active dating back to around AD 900–1200 (Larson, 2013). Whether a product of direct migration (see Habicht-Mauche and Eckert, 2021) or from social ties nurtured over generations, these relationships would inevitably have produced familial connections (see O'Donnell et al., 2020 for gene flow example) across space that may have resulted in the direct transportation of micaceous wares. Therefore, knowing the role of micaceous wares in the household, it is likely that their exchange from one person to another would occur during the inception of new households, as gifts to family members or friends, and various other possibilities centered around the success of the home (see Eckert et al., 2018 for comparable example of household exchange). Modes of direct contact may have also included Katsina ceremonies, where micaceous wares could have also been used in ceremonial and feasting events. Ritually and socially significant goods may move great distances, and the act of feasting often demands more cooking vessels to reach preparation demands (Spielmann, 2022). But direct evidence of this is currently isolated to Tijeras in the study sample via the presence of an abnormally high frequency of large feasting bowls (Habicht-Mauche and Jones Burgess, 2016). Purely economic reasons for exchange of micaceous wares are doubtless to exist distinctly or alongside these circumstances and others, but we do not consider this the primary means for exchange within this community of practice based upon the understood nature of Pueblo village interaction.

Practice is the subconscious or conscious development of, as Wenger (2011:2) puts it, "[a] shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems". Micaceous ware practice was an action that stemmed from shared interests and goals (domain) being actively discussed (community). Micaceous utility ware technology was generally stable over time, so aside from discrete changes or household preferences in production that may be mostly undetectable at the level of the artifact, we suspect the "shared repertoire" was primarily cognitive and nostalgic as they relate to how the micaceous ware was utilized and what its life history entailed; this operated at the level of, in maintenance of, and because of the dynamics of the household.

Micaceous wares are well known for being effective cooking vessels and have fed the deliberation that their use and exchange in the archaeological record may indicate familial connections between households (Duff, 2002; Larson, 2013). Their longevity has also garnered a reputation for being family heirlooms and more than just a tool for the house. For example, regarding historic diasporic contexts in New Mexico, Cowell and Jenks (2021:458) describe, in the face of "a new social and economic paradigm", that micaceous wares became "…something irreplaceable, precious, and laden with cultural significance and memories of home". The connections with micaceous wares may have also been experienced particularly by and between women. During immense social change brought on by Euro-American material culture at 19th and 20th century Los Ojitos along the Pecos River, Cowell (2019:5) states: "…micaceous pots referenced the past…[and] embodied memories of past cooking experiences, familial relationships between women, and trade relations with potters, perhaps across ethnic and cultural boundaries". It may also be that these historic cases translate well to the social contexts of the Classic Period: another era of unprecedented social change.

To summarize, we contend that a community of practice operated between Classic Period potters along the Lower Rio Puerco and near Albuquerque. The communities formed by these collectives of individuals, especially women, probably sustained this effort through various potential behaviors embedded in the broad systems of migration and exchange. Households could have turned to their micaceous cookware to reaffirm old ties and formulate new relationships by a multitude of selective actions, including utilizing their renowned cooking properties, holding on to them while on the move, gifting them to friends and family, employing them in exchange and bartering activities, and displaying them during feasts. Known for their role in the household within and across generations, it can be speculated that these connections, and the distribution we now observe, are in part the result of familial or amical relationships and the basis for the continued technological, social, and perhaps spiritual development of the micaceous practice.

7.2. Other communities of practice?

While many of the other compositional groups we identified may represent similar relationships to that described above for the Rio Puerco and Albuquerque districts, communities of practice most fundamentally require sharing. If proof for sharing cannot be presented, then a community of practice should not be defined. Therefore, we do not currently have sufficient quantity of data to elaborate on smaller compositional groups limited to a site or present at a low frequency between sites, nor do we have the proper resolution to ascertain whether some groups reflect communities of practice operating within a single site. Nonetheless, we can share some ideas and speculations. Kuapa and Abeytas Pueblo are alike in that they both have micaceous ware compositions unique to those sites, but with some similarities shared with Pottery Mound, Hummingbird Pueblo, and Chamisal. Although Kuapa's compositional variability may be a factor of the area's variable geology (see Goff, 2009) we still hypothesize micaceous communities of practice were directed south in the Santo Domingo Basin, east in the Galisteo Basin, and more locally to populations in its immediate vicinity because of material and ethnohistorical ties (see Curewitz, 2008; Habicht-Mauche et al., 2000; Mathien, 2004). Abeytas Pueblo residents may have shared micaceous ware communities with populations to the south in the Rio Abajo, or populations in the north that correspond with glaze ware ties (see Eckert and Snow, 2015). Meanwhile, Pargas Pueblo, which is compositionally distinct from every other node in the study area, likely shared micaceous ware communities with other sites in the Rio Abajo such as the Tigua province to the south (Marshall, 1986:34).

8. Conclusions

The one community of practice we have identified in this study crosscut populations situated in both the Rio Puerco and Albuquerque districts. Here, we described how Etienne Wenger's domain, community, and practice may deconstruct the complex relationships created through the manufacture, movement, and use of micaceous wares. With their technological functionality and ideational potential, the dispersal of compositionally alike wares is likely a factor of familial and amical relationships operating through a variety of behaviors associated with migration and/or exchange. We acknowledge that there are gaps in the communities of practice framework that cannot be answered with our data alone. However, we do not see these as shortcomings of the interpretive framework; rather, we observe this as a need for more data, acquired through methods like bulk chemical composition, petrography, and ethnoarchaeology, that enhances the interplay of micaceous wares and communities of practice to achieve a more detailed picture of household relations, familial and amical dynamics, kinship, trade, and much more.

> If Pueblo ceramics were once a primary mode of production, they were also and still are symbolic forms, containers of cultural value and models of and for reproduction and regeneration. Their potteries, like their stories, their rituals, and their kinship system, connect the reproductive aspect of generation with the cultural basis of thought, transmission, and "in a different voice," clay sings. - Barbara A. Babcock (1988:378-379)

CRediT authorship contribution statement

Blaine K. Burgess: Writing – original draft, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Jeffrey R. Ferguson:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Methodology, Formal analysis, Conceptualization. **Suzanne L. Eckert:** Writing – review & editing, Validation, Supervision, Resources, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data are openly available on the Digital Archaeological Record

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References

Adams, C.E., Duff, A.I. (Eds.), 2004. Settlement Clusters and the Pueblo IV Period 1275-1600, 3–16.
Babcock, B.A., 1988. At home, no womens are storytellers: potteries, stories, and politics in cochiti pueblo. J. Southwest 30 (3), 356–389.
Bayman, J.M., 1999. Craft Economies in the North American Southwest. J. Archaeol. Res. 7 (3), 249–299.
Burgess, B.K., 2022. Micaceous Mindsets: Chemical Characterization of Pueblo IV Utility Wares at Multiple Sites Along the Rio Grande. Department of Anthropology, University of Missouri, Columbia. MA Thesis.
Cordell, L.S., 2006. Rio Grande Glaze Paint Ware in Southwestern Archaeology. In: Habicht-Mauche, J.A., Eckert, S.L., Huntley, D.L. (Eds.), *The Social Life of Pots: Glaze Wares and Cultural Dynamics in the Southwest, AD 1250*–1680. University of Arizona Press, Tucson.
Cordell, L.S., Habicht-Mauche, J.A., 2012a. Practice Theory and Social Dynamics Among Prehispanic and Colonial Communities in the American Southwest. In: Cordell, L.S., Habicht-Mauche, J.A. (Eds.), Potters and Communities of Practice. University of Arizona Press, Tucson, pp. 1–7.
Cordell, L.S., Habicht-Mauche, J.A. (Eds.), 2012b. Potters and Communities of Practice. University of Arizona Press, Tucson.
Costin, C.L., 2000. The use of ethnoarchaeology for the archaeological study of ceramic production. J. Archaeol. Method Theory 7 (4), 377–403.
Cowell, S., 2019. Exploring Gender, Trade, and Heirloom Micaceous Ceramics at Los Ojitos, New Mexico. In: 84th Annual Conference of the Society for American Archaeology. Albuquerque, New Mexico, pp. 10–14.
Cowell, S., Jenks, K., 2021. Beloved things: interpreting curated pottery in diasporic contexts. Int. J. Hist. Archaeol. 25 (2), 448–468.
Crown, P.L., 2014. The archaeology of crafts learning: becoming a potter in the Puebloan southwest. Ann. Rev. Anthropol. 43 (1), 71–88.
Curewitz, Diane C. 2008 Changes in Northern Rio Grande Ceramic Production and Exchange, Late Coalition Through Classic (A.D. 1250-1600). Unpublished Ph.D. Dissertation, Department of Anthropology. Washington State University, Pullman.
Duff, A.I., 2002. Western Pueblo Identities: Regional Interaction, Migration, and Transformation. University of Arizona Press, Tucson, AZ.
Eckert, S.L., 2006. The Production and Distribution of Glaze-Painted Pottery in the Pueblo Southwest. In: Habicht-Mauche, J.A., Eckert, S.L., Huntley, D.L. (Eds.), *The Social Life of Pots: Glaze Wares and Cultural Dynamics in the Southwest, AD 1250*–1680. University of Arizona Press, Tucson.
Eckert, S.L., 2008. Pottery and Practice: The Expression of Identity at Pottery Mound and Hummingbird Pueblo. University of New Mexico, Albuquerque.
Eckert, S.L., 2012. Choosing Clays and Painting Pots in the 14th Century Zuni Region. In: Habicht-Mauche, J., Cordell, L. (Eds.), Technology as Practice: Polychrome Pottery and Social Dynamics among Prehispanic and Colonial Communities in the American Southwest. University of Arizona Press, Tucson, pp. 55–64.
Eckert, S.L., Cordell, L.S., 2004. Community Formation in the Central Rio Grande Valley: The Albuquerque, Cochiti, and Lower Rio Puerco Districts. In: Adams, C.E., Duff, A.I. (Eds.), *The Protohistoric Pueblo World, a.d. 1275*–1600. University of Arizona Press, Tucson, pp. 35–42.
Eckert, S.L., Snow, D.H., 2015. 'The Piro Province' as Viewed from Abeytas Pueblo (LA 780). Papers Archaeol. Soc. New Mexico 41, 69–82.
Eckert, S.L., Schleher, K.L., Snow, D.H., 2018. Following the yellow brick road: yellow slip clays and the production of rio grande glaze ware in North Central New Mexico. J. Archaeol. Sci. Rep. 21, 565–574.
Eiselt, B.S., Darling, J.A., 2012. Vecino economics: gendered economy and micaceous pottery consumption in nineteenth century Northern New Mexico. Am. Antiq. 77 (3), 424–448.
Eiselt, B.S., Ford, R.I., 2006. Analysis of micaceous clay sources in the Northern Rio Grande. Trans.-Am. Nucl. Soc. 95, 475.
Eiselt, B.S., Ford, R.I., 2007. Sangre de Cristo micaceous clays: geochemical indices for source and raw material distribution, past and present. Kiva 73 (2), 219–238.
Galusha, T., Blick, J.C., 1971. Stratigraphy of the Santa Fe Group, New Mexico. Bull. AMNH 144 (1).
Gilmore, K.P., Larmore, S, 2012. Looking for Lovitt in All the Wrong Places: Migration Models and the Athapaskan Diaspora as Viewed from Eastern Colorado. In: Seymour, D.J. (Ed.), From the Land of Ever Winter to the American Southwest: Athapaskan Migrations, Mobility, and Ethnogenesis. The University of Utah Press, pp. 37–77.
Glascock, M.D., 1992. Characterization of Archaeological Ceramics at MURR by Neutron Activation Analysis and Multivariate Statistics. In: Neff, H. (Ed.), Chemical Characterization of Ceramic Pastes in Archaeology. Prehistory Press, Madison, Wisconsin, pp. 11–26.
Goff, S., 2009. Pajarito Plateau Glaze Paint Ware Production: Earlier and More Widespread than Previously Thought. Kiva 74 (4), 371–392.
Habicht-Mauche, J.A., Jones Burgess, H.D., 2016. The life and times of tijeras utility ware. Papers Archaeol. Soc. New Mexico 42.
Habicht-Mauche, J.A., Eckert, S.L., Huntley, D.L. (Eds.), 2006. The Social Life of Pots: Glaze Wares and Cultural Dynamics in the Southwest, AD 1250–1680. University of Arizona Press, Tucson.
Habicht-Mauche, J.A., Eckert, S.L., 2021. Coalescence and the Spread of Glaze-painted Pottery in the Central Rio Grande: The View from Tijeras Pueblo (LA581), New Mexico. Am. Antiquity 86 (4), 752–772.
Habicht-Mauche, J.A., Glenn, S.T., Milford, H., Russell Flegal, A., 2000. Isotopic Tracing of Prehistoric Rio Grande Glaze-paint Production and Trade. J. Archaeol. Sci. 27 (8), 709–713.
Habicht-Mauche, Judith A. 1993. The Pottery from Arroyo Hondo Pueblo, New Mexico: Tribalization and Trade in the Northern Rio Grande. Arroyo Hondo Archaeological Series, vol. 8. Santa Fe: School of American Research.
Herhahn, C.L., 2006. Inferring Social Interactions from Pottery Recipes. In: Habicht-Mauche, J.A., Eckert, S.L., Huntley, D.L. (Eds.), *The Social Life of Pots: Glaze Wares and Cultural Dynamics in the Southwest, AD 1250*–1680. University of Arizona Press, Tucson.
Jahns, Richard H. 1946 Mica deposits of the Petaca district, Rio Arriba County, New Mexico. New Mexico Bureau of Mines and Mineral Resources Bulletin 25. The New Mexico School of Mines, Socorro.
Keller, G.R., Baldridge, S.W., 1999. The Rio Grande Rift: A Geological and Geophysical overview. Rocky Mt Geol 34 (1), 121–130.
Kelley, S., Chamberlin, R.M., 2012. Our Growing Understanding of the Rio Grande Rift. New Mexico Earth Matters Summer 2012, 1–4.
Larson, D.L., 2013. Albuquerque the Frontier? Exploring Migration and Social Identity in the Albuquerque Area During the Late Developmental to Coalition Period Transition. Department of Anthropology. The University of New Mexico, Albuquerque.
Lave, J., Wenger, E., 1991. Situated Learning: Legitimate Peripheral Participation. Cambridge University Press, New York.
Lucas, S.G., Krainer, K., Allen, B.D., Vachard, D., 2014. The Pennsylvanian section at Cedro Peak: A Reference Section in the Manzanita Mountains, Central New Mexico. N. M. Geol. 36, 3–24.
Marshall, M.P., 1986. Archaeological Investigations in a 16th-early 17th century Piro Pueblo in the Village of San Antonio. Office of Contract Archaeology, University of New Mexico Albuquerque, New Mexico.
Marshall, M.P., Walt, H.J., 1984. Rio Abajo: Prehistory and History of a Rio Grande Province. New Mexico Historic Preservation Program, Santa Fe, NM.
Mathien, F.J., 2004. History of Archaeological Investigations on the Pajarito Plateau. In: Kohler, T. (Ed.), Archaeology of Bandelier National Monument: Village Formation on the Pajarito Plateau, New Mexico. University of New Mexico Press, Albuquerque, pp. 69–116.
Miksa, E.J., Heidke, J.M., 2001. It All Comes Out in the Wash: Actualistic Petrofacies Modeling of Temper Provenance, Tonto Basin, Arizona, USA. Geoarchaeology 16 (2), 177–222.
Munson, M.K., Hays-Gilpin, K., 2020. Color in the Ancestral Pueblo Southwest. University of Utah Press, Salt Lake CIty.
Naranjo, T., 1995. Thoughts on Migration by Santa Clara Pueblo. J. Anthropol. Archaeol. 14 (2), 247–250.
Neff, H., Bishop, R.L., Arnold, D.E., 1988. Reconstructing ceramic production from ceramic compositional data: an example from Guatemala. J. Field Archaeol. 15 (3), 339–348.
Nelson, K., Habicht-Mauche, J.A., 2006. Lead, Paint, and Pots: Rio Grande Intercommunity Dynamics from a Glaze Ware Perspective. In: Habicht-Mauche, J.A., Eckert, S.L., Huntley, D.L. (Eds.), The Social Life of Pots: Glaze Wares and Cultural Dynamics in the Southwest, AD 1250–1680. University of Arizona Press, Tucson.
Nelson, M.C., Schachner, G., 2002. Understanding Abandonments in the North American Southwest. J. Archaeol. Res. 10 (2), 167–206.
Nesse, W.D., 2000. Introduction to mineralogy. Oxford University Press, New York.
O'Donnell, L., Meyer, J.V., Ragsdale, C.S., 2020. Trade relationships and gene flow at pottery mound Pueblo, New Mexico. Am. Antiquity 85 (3), 492–515.
Phillips, David A., Jr., Hayward H. Franklin, Suzanne L. Eckert, and Jean H. Ballagh 2021 Revisiting the Hopi Area Connection at Pottery Mound, New Mexico. In: A friend of Kuaua: Papers in Honor of James Conder edited by Emily J. Brown, Matthew J. Barbour, Jeffrey L. Boyer, and Genevieve N. Head, pp. 163-177. Papers of the Archaeological Society of New Mexico Volume 47, Albuquerque.
Reiter, M., Chamberlin, R.M., 2011. Alternative perspectives of crustal and upper mantle phenomena along the Rio Grande Rift. GSA Today 21 (2), 4–9.
Shepard, A.O., 1956. Ceramics for the Archaeologist, Vol. 609. Carnegie Institute of Washington, Washington D.C.
Shepard, Anna O. 1936 The Technology of Pecos Pottery. In The Glaze-Paint, Culinary, and Other Wares, edited by A. V. Kidder and A. O. Shepard, pp. 389–588. The Pottery of Pecos, vol. II. Yale University Press, New Haven.
Shepard, Anna O. 1942 Rio Grande Glaze Paint Ware: A Study Illustrating the Place of Ceramic Technological Analysis in Archaeological Research. Publication No. 528. Carnegie Institution of Washington, Washington, D. C.
Spielmann, K.A., 2022. Feasting, Craft Specialization, and the Ritual Mode of Production in Small-Scale Societies. Am. Anthropol. 104 (1), 195–207.
Spielmann, Katherine A. (editor) 1998 The Pueblo IV Period: History of Research. In Migration and Reorganization: The Pueblo IV Period in the American Southwest edited by Katherine A. Spielmann, pp. 1-30. Arizona State University Anthropological Research Papers No. 51, Tempe.
Stark, M., 2006. Glaze Ware Technology, the Social Lives of Pots, and Communities of Practice the Late Prehistoric Southwest. In: Habicht-Mauche, J.A., Eckert, S.L.,

Huntley, D.L. (Eds.), The Social Life of Pots: Glaze Wares and Cultural Dynamics in the Southwest, AD 1250–1680. University of Arizona Press, Tucson.

Warren, A.H., 1970. Notes on Manufacture and Trade of Rio Grande Glazes. The Artifact 8 (4), 1–7.

Warren, A.H., 1980. Prehistoric Pottery of Tijeras Canyon. In: Cordell, L.S. (Ed.), Tijeras Canyon, Analysis of the past. Maxwell Museum of Anthropology and University of New Mexico Press, Albuquerque, pp. 149–168.

Warren, A. Helene 1976 The Ceramics and Mineral Resources of LA 70 and the Cochiti Area. In Archaeological Excavations at Pueblo del Encierro, La 70, Cochiti Dam Salvage Project, Cochiti, New Mexico: Final Report 1964–1965 Field Seasons, edited by D. H. Snow, B1–B184. Laboratory of Anthropology Notes, no. 78. Santa Fe: Museum of New Mexico.

Wendorf, F., Reed, E.K., 1955. An Alternative Reconstruction of Northern Rio Grande Prehistory. El Palacio 62, 131–173.

Wenger, E. 2011. Communities of Practice: A Brief Introduction. https://scholarsbank.uoregon.edu/xmlui/handle/1794/11736, accessed January, 2023.

West, Steven M. 1992 Temper, Thermal Shock and Cooking Pots: A Study of Tempering Materials and their Physical Significance in Prehistoric and Traditional Cooking Pottery." PhD Dissertation, The University of Arizona, 1992.

Williams, P.L., Cole, J.C., 2007. Geologic Map of the Albuquerque 30' x 60' Quadrangle. United States Geological Survey, U.S. Department of the Interior, Washing D.C, North-Central New Mexico.