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Protohistoric Ancestral Apache Dismal River groups (A.D. 1600–1750) participated in large exchange networks linking them to other peoples on the Plains and U.S. Southwest. Ceramic vessels made from micaceous materials appear at many Dismal River sites, and micaceous pottery recovered from the Central High Plains is typically seen as evidence for interaction with northern Rio Grande pueblos. However, few mineral or chemical characterization analyses have been conducted on these ceramics, and the term "micaceous" has been applied to a broad range of vessel types regardless of the form, size, or amount of mica in their pastes. Our recent analyses, including macroscopic evaluation combined with petrography and neutron activation analyses (NAA), indicate that only a small subset of Dismal River sherds are derived from New Mexico clays. The rest were likely manufactured using materials from Colorado and Wyoming. Seasonal mobility patterns may have given Dismal River potters the opportunity to collect mica raw materials as they traveled between the Central Plains and Front Range, and this has implications for the importance of internal Plains social networks during the Protohistoric and Historic periods.

Los grupos protohistóricos del Río Dismal (antiguos Apaches; 1600–1750) participaron de un extenso intercambio que los conectó con otras comunidades de las planicies y del sureste de los Estados Unidos. Las vasijas de cerámica hechas de materiales micáceos aparecen en muchos sitios del Río Dismal. Los primeros investigadores han considerado a las cerámicas de pasta micácea recuperadas en estos sitios de las altas planicies centrales como evidencia de la interacción con los pueblos del norte del Río Grande y asumieron que la mayoría de estas cerámicas encontradas en los sitios del Río Dismal no eran de la región. Sin embargo, se han realizado escasos análisis minerales o caracterizaciones químicas a estas cerámicas y el término micáceo (micaceous) ha sido aplicado a un amplio rango de cerámicas sin importar el tipo, tamaño o cantidad de mica en sus pastas. Nuestros análisis recientes, incluyendo la evaluación macroscópica combinada con petrografía y el análisis por activación neutrónica (NAA), indican que solamente un pequeño grupo de tiestos son derivados de la arcilla de Nuevo México. Las cerámicas restantes fueron probablemente hechas de materiales disponibles en Colorado y Wyoming. Los patrones de movilidad estacional pudieron haberle dado a estos grupos del Río Dismal la oportunidad de recoger mica y material bruto para sus vasijas de cerámica mientras viajaban entre las planicies centrales y la cordillera frontal. La distribución de estas vasijas destaca la importancia de las redes sociales internas en las planicies durante los períodos Protohistórico e Histórico.

Characterized by extensive social fluidity and the construction of complex plural communities, due largely to long-distance interactions (Habicht-Mauche 2000; Scheiber and Finley 2010), the Protohistoric period (A.D. 1450–1700) was a time of rapid change for many Native Americans living on the North American Great Plains. Here we address the possible ties of Dismal River (ancestral Apache) groups in western Kansas to surrounding regions, including northern

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New Mexico, Colorado, and Wyoming through provenance studies of micaceous ceramics. Previous scholars considered the micaceous pottery found at many Dismal River sites in Kansas and Nebraska to be evidence of interaction with northern Rio Grande Pueblos (Baugh and Eddy 1987; Gunnerson 1959; Wedel 1959), but the origins of these ceramics have not been adequately characterized or reported. This leaves open the question of whether these ceramics were made on the plains and consequently whether interregional connections were important to community growth and survival during this period. Additionally, questions remain regarding interregional networks (such as between Dismal River groups in Kansas and those in Colorado) and how they shaped the social and economic conditions of Dismal River groups following the Spanish colonization of the American Southwest.

Part of the problem relates to the lack of agreed upon terminology for what constitutes "micaceous" from the perspective of paste. In the Southwest, "micaceous" is generally defined as pots made with residual clays, crushed rock temper, or those with a micaceous slip (Warren 1981), with the caveat that mica should be a major constituent of the vessel and that it should be intentionally sought for added effect (Habich-Mauche 1988:25–256). The use of higher quantities of mica in vessels allows for light, strong, and durable pots that have excellent thermal properties, making them superior for cooking (Arnold 1993:74; Eiselt 2006). Many northern Rio Grande Pueblo communities made micaceous pottery, as did the Jicarilla Apache and mestizo women in Spanish households (Carillo 1997; Eiselt and Darling 2012).

The situation in Colorado and on the Plains is less clear. Archaeologists working in Colorado have suggested that Dismal River and earlier ceramics were made using local Front Range micaceous materials (Brunswig 1995; Ellwood 2002; Gilmore and Larmore 2012), while others have assumed that they came from northern New Mexico (Baugh and Eddy 1987; Gunnerson 1959; Wedel 1959). Recent petrographic analyses (Trabert 2015) found variations in the type, amount, and size of mica particles in the Dismal River pastes that do not match published descriptions of micaceous wares manufactured in New Mexico (see Dick et al. 1999; Eiselt 2006; Gunnerson 1959), suggesting that at least some highly micaceous Dismal River vessels were produced outside of the northern Rio Grande. The micaceous label applied on the Plains and in the Southwest, therefore, masks significant variation in the ceramics from Dismal River sites.

Given this variation, we hypothesize a more complex origin for ceramics with micaceous pastes recovered from Dismal River sites. If Dismal River groups acquired micaceous ceramics or raw materials from outside of New Mexico, then characterization of ceramic pastes provides valuable insights on interregional social networks and exchange during the Protohistoric and Historic periods. Neutron activation analysis (NAA) and petrographic examination of ceramic and raw material thin sections indicate that only a small collection of micaceous ceramics from Dismal River sites originated in northern New Mexico, while others were probably made using materials from Colorado or Wyoming.

Background

Dismal River

Dismal River is an archaeological complex (A.D. 1600–1750) on the Plains of eastern Colorado, southeastern Wyoming, western Kansas, and western Nebraska (Gunnerson 1959; Schreiber 2006) (Figure 1). It may represent Athapaskan-speaking populations that migrated to the Central Plains sometime after A.D. 1000 (Brunswig 1995; Gilmore and Larmore 2012; Gunnerson 1959). A mixed subsistence strategy, dominated by bison hunting and supplemented with horticulture is evident at most sites on the Plains (Gunnerson 1959; Wedel 1959). Some Dismal River peoples lived in more sedentary communities centered on horticulture in the eastern Plains (Kansas and Nebraska) while others lived in parts of Colorado and Wyoming, hunting large game as evidenced by ephemeral camp and kill sites. Some Plains Apache groups were known to follow a bi-seasonal mobility pattern, living on the Plains for warmer seasons and traveling south to the foothills of the Sangre de Cristo and Rocky Mountains as winter approached (Eiselt 2012:110; Schroeder 1974: 48). Dismal River ceramics are distinct from those of neighboring groups in form, surface treat-

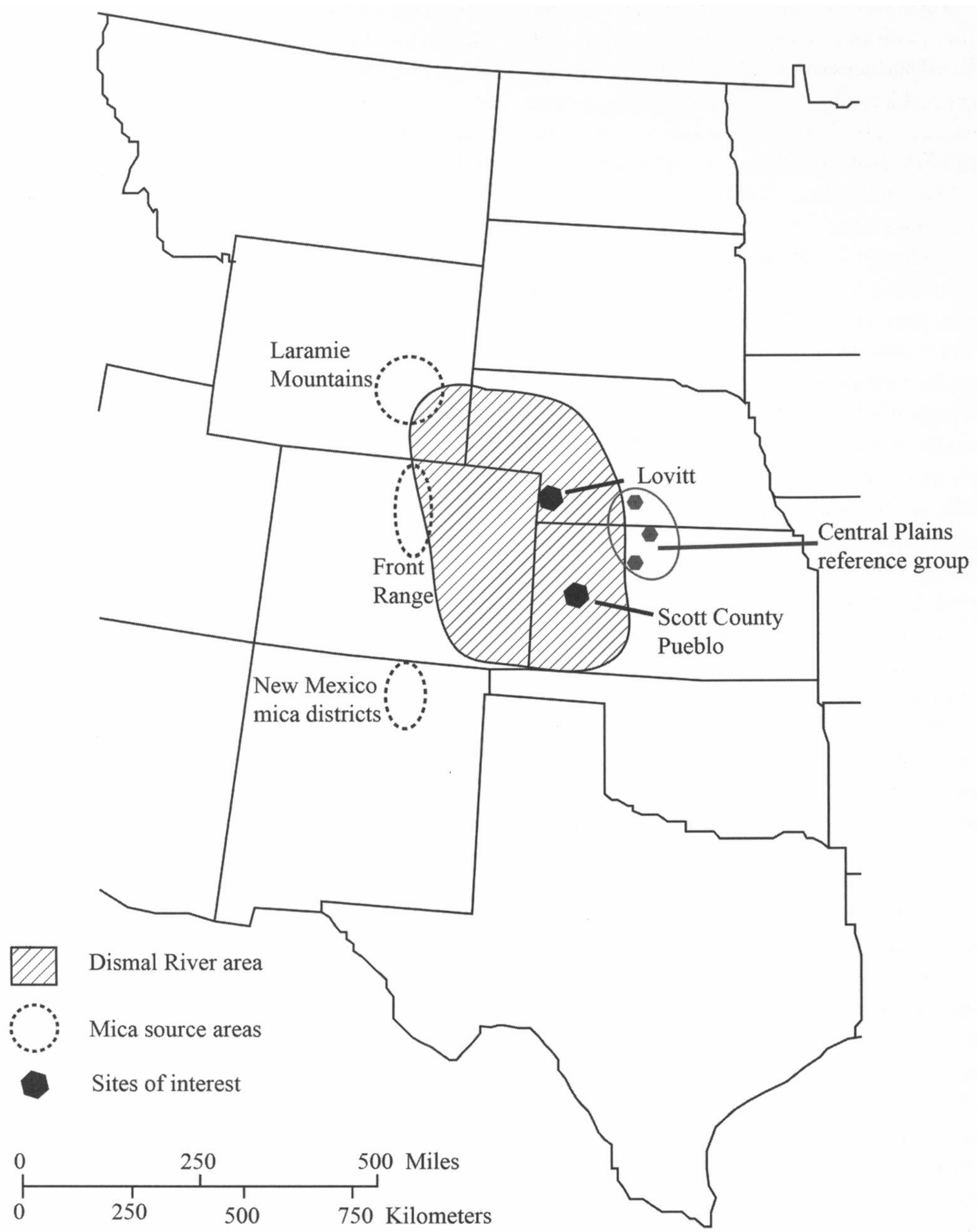

Figure 1. Location of Dismal River culture area, possible mica source areas, and sites of interest.

ment, temper, and decoration and are considered the most diagnostic cultural marker for this group (Brunswig 1995; Scheiber 2006; Wedel 1959).

One of the largest and most significant Dismal River sites, the Lovitt Site (25CH1) in the sandhills of western Nebraska (A.D. 1674–1706) (Hill and Metcalf 1942), includes the excavated remains of at least three houses, numerous middens, and roasting pits. Dismal River Gray Ware ceramics are abundant and are described as thin, smooth or simple stamped, and dark in color, with fine sand temper. Micaceous ceramics are present in minor frequencies and include vessels manufactured with paddle and anvil construction, tempered with very fine or powdered mica and fine arkosic sands, and dark gray to black in color, with very smooth, but unpolished surfaces (Metcalf 1949; Trabert 2015).

A second key site is the Scott County Pueblo ruin (14SC1), also known as El Cuartelejo (A.D. 1630–1680). This site includes the remains of a multi-component, seven-room masonry structure with external activity areas that have yielded evidence for Dismal River and Puebloan occupation (Beck and Trabert 2014). Dismal River Gray Ware ceramics, most of which are very similar in paste and form to those recovered from the Lovitt Site, dominate the excavated ceramic assemblage (Beck and Trabert 2014; Wedel 1959). Present in much smaller frequencies are nonlocal painted ceramics, including Tewa Polychrome and Rio Grande Glaze Ware, locally made copies of Tewa Red Ware, and micaceous ceramics.

Wedel (1959) noted that micaceous sherds are more common in Kansas area Dismal River sites, and he suggested that the micaceous ceramics at these and other Dismal River sites originated at Taos or Picuris Pueblos (Wedel 1959). Gunnerson (1959) and Baugh and Eddy (1987) shared Wedel's views and hypothesized that micaceous ceramics were acquired by Dismal River people through trade with the Jicarilla Apache or other Northern Rio Grande groups.

Ceramics containing mica are not found at all Dismal River sites (they are noted in only 14 of 43 assemblages recently studied by Trabert) and are most common at 14SC1, where they make up five percent of the sherd assemblage (Beck and Trabert 2014; Trabert 2014, 2015). They constitute less than one percent of the ceramics at Nebraska, Colorado, and Wyoming sites. While some of these specimens ($n = 15$) do contain large quantities of lamellar mica, similar to expectations for Northern Rio Grande micaceous ceramics, most display lower frequencies of finely divided mica that is unevenly distributed in the paste (Figure 2; see Supplemental Figure 1 for color version). The ceramics with lower frequencies of mica also include large quantities of quartz and feldspar sands (Trabert 2014, 2015).

Micaceous Ceramic Production in Northern New Mexico

Archaeological research indicates that the northern Rio Grande micaceous tradition originated in the Tewa Basin at around A.D. 1300 (Warren 1981). Pre-contact Tewa culinary ceramics are made from coarse residual micaceous clays or clays with lesser amounts of naturally occurring mica or crushed micaceous schist temper. Later post-contact ceramics are distinguished based on surface finish and the exclusive use of residual (primary) micaceous clays rather than crushed mica rock. These highly micaceous clays contain abundant amounts of distinctive platy clumps of mica that result in flaky or laminated pastes and large flakes of mica visible on vessel surfaces (Eiselt 2006: 427; Habicht-Mauch 1988:339, 405) (Figure 2). The historic residual paste tradition is thought to have begun around A.D. 1550 to 1650 through the joint efforts of Picuris, Jicarilla, and Taos potters (Eiselt 2006).

Micaceous clay with superabundant levels of mica (ca. 80 percent by volume) needed little cleaning once collected and could be shaped into thin, light vessels that likely appealed to more mobile Apache groups (Gunnerson 1969; Woosley and Olinger 1990). Vessels made from micaceous clays, such as Ocate or Cimarron Micaceous, typically have large quantities of evenly divided lamellar mica throughout the pastes, and these characteristics differentiate them from vessels tempered with mica-rich granitic materials that also contain higher frequencies of fine to coarse sands (Figure 2) (Eiselt and Ford 2007; Habicht-Mauche 1988).

The Nature and Sources of Micaceous Materials

Mica is a 2:1 layer silicate mineral that is abundant in many types of rocks including shales, slates, phyllites, schists, gneisses, and granites (Fanning and Keramidas 1989). In North America, mica deposits are located in the western states (California, Arizona, New Mexico, Colorado, South Dakota, Idaho, Montana, and Wyoming). Mica may be found in granite and granite gneiss, a type of Precambrian rock found along the Front Range of Colorado or in micaceous clay weathered from mica schist in the Northern Rio Grande region of New Mexico and along the Front Range in central Colorado where mica is present in the bedrock geology (Beckman 1982; Lovering and Goddard 1950) (see Supplemental Text 1 for full discussion).

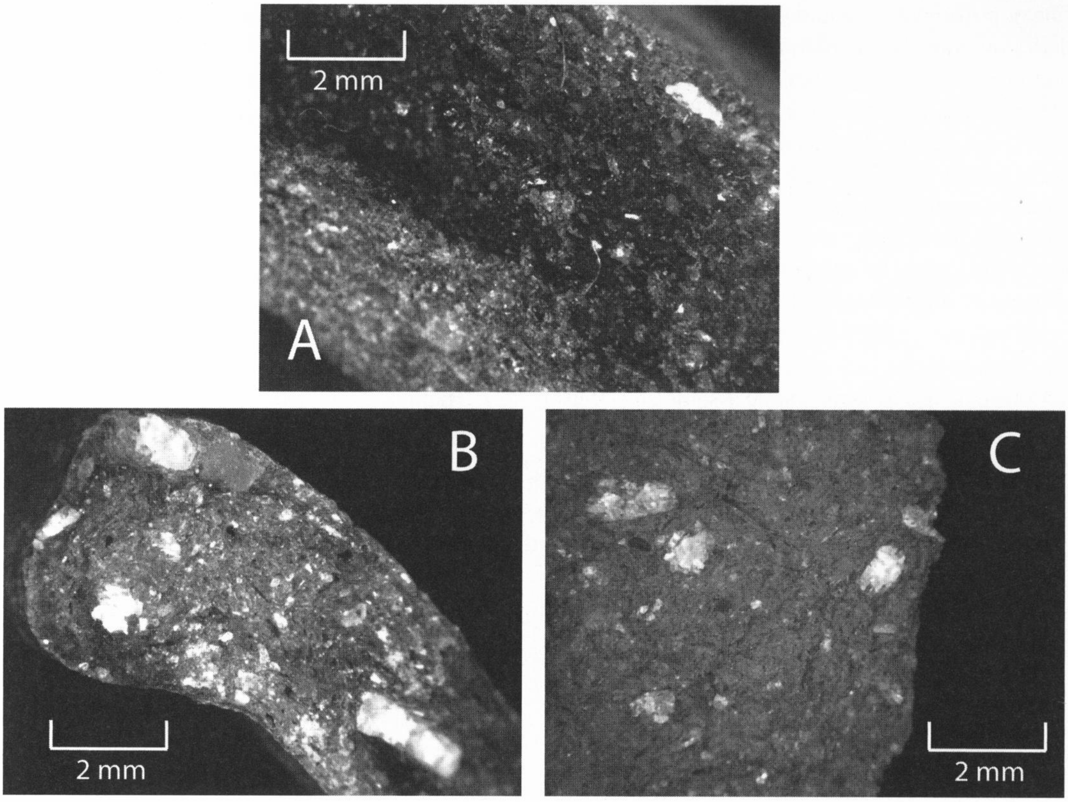

Figure 2. Micaceous and granite-tempered pastes: (a) Dismal River granite tempered (25CH1, catalog number 808_5); (b) Jicarilla Apache Cimarron Micaceous (LA90855, catalog number S6); (c) Petaca Red Mine residual clay sample.

Sample

Macroscopically, the micaceous ceramics recovered from Dismal River sites are distinct from typical Dismal River Gray Ware ceramics, yet they vary a great deal in the amount of mica present in their pastes. The significance of this variation is unknown because the label "micaceous" is applied loosely to ceramics with variable amounts of mica. Here, we examine whether this variation is the result of multiple geological sources for raw materials through the application of NAA and petrography. The NAA sample includes 49 micaceous and 32 Dismal River Gray Ware sherds from the Lovitt site and Scott County Pueblo ruin (Table 1). The petrography sample includes 10 micaceous and 57 Dismal River Gray Ware sherds (Table 1). Only five sherds (all micaceous) were large enough to be subjected to both NAA and petrographic analyses.

We also include several samples of raw materials: two sediment specimens from the Ogallala formation exposure at Lake Scott, Scott County, Kansas, and six clay specimens derived from the Scott County Pueblo site and from a cut bank of Ladder Creek, located 2 km from the site (see Supplemental Text 2 for discussion of analytical procedures).

Results

This combined characterization of micaceous and non-micaceous ceramics and samples of possible raw materials collected from Scott County allowed us to better describe local Central Plains ceramics and to define non-local compositional groups. The results of the chemical characterization of the Dismal River Gray Ware sample indicates that these ceramics compare favorably with Central Plains reference materials (Cobry 1999, Cobry and Roper 2002, Roper et al. 2007, Speakman 2010, and Speakman and Glascock 2004) (Figure 3). This affinity confirms that the Dismal River Gray Ware ceramics that we assumed were locally manufac-

Table 1. Number of Samples for NAA and Petrography.

Method	Site	Sample type: Micaceous	DRG*	Clay	Ogallala sands	Totals
NAA	25CH1	12	20	-	-	32
	14SC1	37	12	-	-	49
	Scott County, Ks	-	-	6	-	6
Petrography	25CH1	-	34	-	-	34
	14SC1	10	23	-	-	33
	Lake Scott, Ks	-	-	6	2	8

*Dismal River Gray Ware

tured were likely made elsewhere on the Central Plains (see Supplemental Text 3).

Chemical Characterization of the Micaceous Sample

A thorough review of published literature and the MURR database indicates that no previous research has attempted to chemically characterize micaceous ceramics recovered from Central and High Plains sites. However, Eiselt (2006, 2012) and Eiselt and Ford (2007) have characterized micaceous clay sources from the Vadito Formation in the San Juan and Sangre de Cristos Mountains of northern New Mexico. This dataset provides the best available comparative material for the micaceous ceramic compositional groups presented here.

The sherds with micaceous pastes from the Scott County Pueblo site separated into two distinct groups, Group 1 (*n* = 13 and Group 5 (*n* = 15), while the micaceous ceramics from the Lovitt site are classified as unassigned. These sherds consistently fall outside of the 90-percent confidence ellipses for northern Rio Grande clays and do not form cohesive clusters. Macroscopically, the micaceous ceramics within compositional groups and those that are unassigned are remarkably similar. They display smooth surfaces, thin walls (2.5–4.5mm), and varying amounts of mica in the paste. Some samples, such as #375-2, included large amounts of mica, while #2817-52 display small finely divided flecks that are infrequently observed on the surfaces and in cross sec-

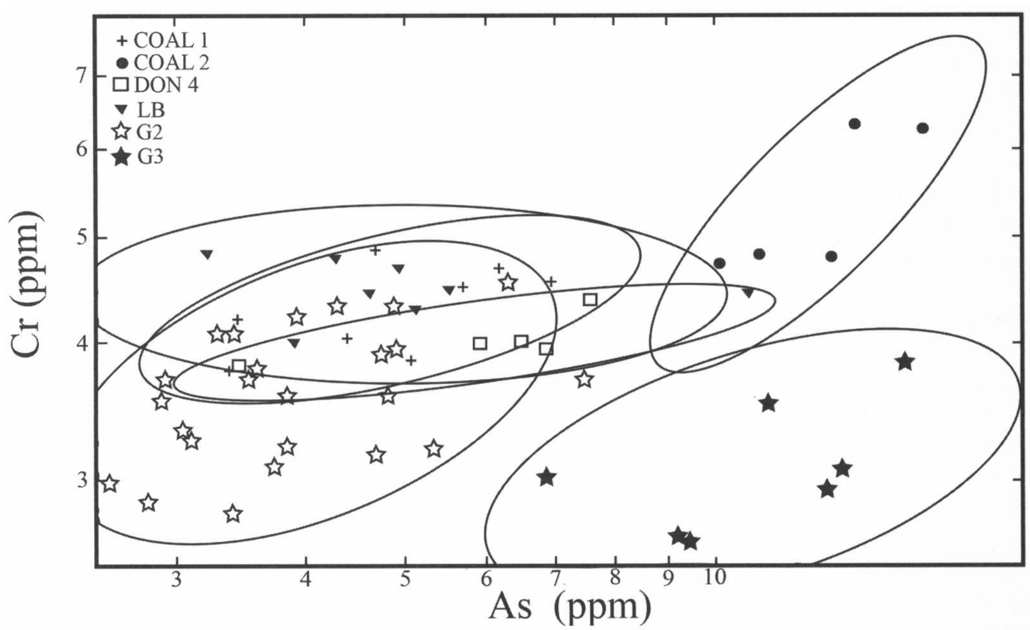

Figure 3. Sand tempered groups (G2 and G3) plotted against best Great Plains reference groups.

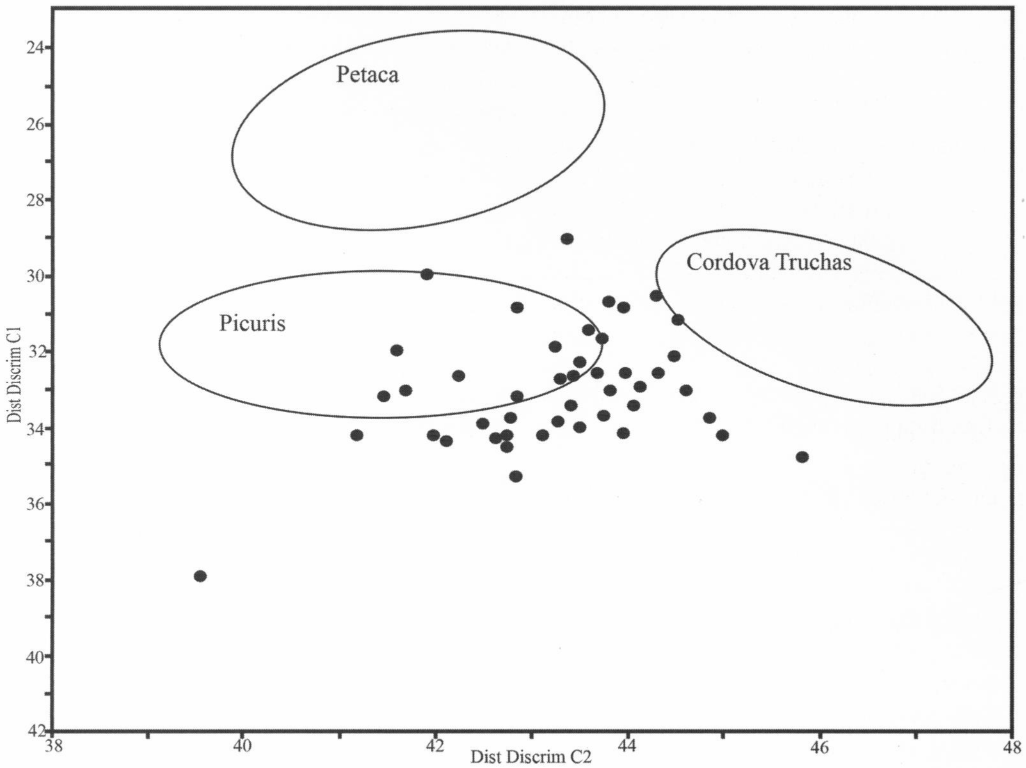

Figure 4. Bivariate plot of discriminant functions 1 and 2 for clays grouped by source district (Picuris, Petaca, and Cordova Truchas) with all Dismal River micaceous sherds projected.

tion. Given this variation, it appears that macroscopic observations alone cannot be used to identify the origin of these ceramics. This further underscores the importance of petrography and chemical characterization.

The two micaceous groups did not compare favorably with any of the Plains reference groups, making Eiselt's (2006) New Mexico database a logical alternative. Eiselt utilized Canonical Discriminant Analysis (CDA) to define potential geochemical source groups and to assign unknown ceramics to groups. This methodology was continued in our comparisons of the Dismal River micaceous ceramics.[1]

A total of six micaceous sherds from the Scott County Pueblo site and one sherd from the Lovitt site fell within the 90-percent confidence ellipse for the Picuris micaceous clay district (Figure 4, Table 2). These likely represent good source matches to Picuris clays. The remaining 42 micaceous sherds (86 percent of the total sampled assemblage) fell outside of the confidence ellipses for all districts and may represent ceramics made from micaceous sources distributed in Colorado

Table 2. Samples in Agreement with Mica District and Source Area.

ANID	Group	Site	District	Source area
SJT037	1	14SC1	Picuris	Molo nan nana/ Cieneguilla Taos (Border)
SJT043	1	14SC1	Picuris	Cieneguilla Taos
SJT035	5	14SC1	Picuris	Molo nan nana
SJT045	5	14SC1	Picuris	Molo nan nana
SJT047	5	14SC1	Picuris	Molo nan nana
SJT066	Unassigned	25CH1	Picuris	US Hill
SJT028*	Unassigned	14SC1	Picuris	Molo nan nana

*Was also thin sectioned

and Wyoming, although we still lack good comparative geological materials for these assessments.

Mineralogical Classifications

The sand samples collected from a quarry near 14SC1 contained sub-rounded arkosic (quartz and feldspar) grains and trace amounts of welded tuff (ash and pumice), basalt, limestone, and gray-colored caliche. The clays sampled from near Ladder Creek were a medium yellow-brown color, composed of silt- to fine-sized grains, and all contained trace amounts of sub-angular to rounded quartz. Inclusions in these clay samples consisted of untwined alkali feldspar, brown biotitie, arkose, and coarse sized gray-colored caliche. In his analysis of the Dismal River ceramic samples, Hill identified two principal compositional groups, an arkosic sand-tempered group and a biotite granite-tempered group. The arkosic sand group consisted of Dismal River Gray Ware. Although the inclusions are dominated by quartz and feldspar, samples containing basalt, limestone, and tuff are also found in the Ogallala Formation sand samples.

The micaceous ceramics fell into the biotite granite group, which had three subgroups based on texture differences. Some sherds displayed very course biotite granite fragments, while others contained much smaller and more isolated fragments, although only one of the five sherds that Hill examined matched the chemical profile for northern Rio Grande micaceous ceramics.

As noted earlier, the term "micaceous" has been applied to ceramics made with residual micaceous clays and ceramics tempered with biotite-rich granite. We argue here and elsewhere (Eiselt 2006) that the term "micaceous" should be reserved for pottery that was constructed using residual micaceous clays with superabundant levels of mica in the paste. The term "biotite granite-tempered" is more appropriate for ceramics containing accessory mica minerals from biotite granite sources. Although mica is present in the granites found in northern New Mexico, it is also found along the Front Range in Colorado and extend north into the Laramie Mountains in Wyoming. The biotite granite tempered sherds found at Dismal River sites (that do not match the northern Rio Grande mica clay districts defined by Eiselt) therefore may have originated on the High Plains rather than in the Southwest. These sherds also can be distinguished from Apodaca Gray and Rodarte Striated, eighteenth-century types from Picuris Pueblo (Dick et al. 1999) based upon recent petrographic and qualitative analyses (see Supplemental Text 4).

Conclusions

Micaceous vessels made in northern New Mexico were highly prized for their cooking and aesthetic properties and many Northern Rio Grande Pueblo, Jicarilla Apache, and Hispano women made them. Some of these groups were connected to Dismal River people living on the Central High Plains. The closest Dismal River site is approximately 600 km from the micaceous clay sources in northern New Mexico and many other Dismal River communities were much further away from the source of these objects. Although exchange networks are known to have been extensive in Protohistoric North America, it would nonetheless have been difficult for some Dismal River groups to acquire micaceous vessels, yet they appear at sites as far away as western Nebraska and southwestern Wyoming.

The recent macroscopic reanalysis of "micaceous" ceramics recovered from multiple Dismal River sites highlighted the extreme variation between these and Northern Rio Grande micaceous wares (Trabert 2014, 2015). This leads us to hypothesize a complex origin for the Dismal River ceramics that are micaceous. Using a combined chemical and mineralogical approach, we characterized a sample of Dismal River micaceous and Dismal River Gray Ware ceramics to better pinpoint their origin. While confirming that Dismal River Gray Ware ceramics were made locally on the Central Plains, we were unable to match the majority of the micaceous ceramics (86 percent) to any known New Mexico or Central Plains sources.

Our working hypothesis is that some micaceous vessels were acquired by Dismal River people from the northern Rio Grande, while others were derived from groups creating similar vessels from micaceous materials on the western Plains. Although a systematic source survey of micaceous clays along the Front Range in Colorado or in the Laramie Mountains in Wyoming has yet to be completed, mica-rich granites are present in these areas and previous research has shown that local groups did manufacture ceramic vessels from these materials. If Dismal River people did rely on Front Range or Laramie Mountain connections for pottery or raw materials, then we can assume that their social networks extended into these areas as well and that seasonal mobility may have allowed eastern and western Dismal River groups to interact with one another.

Potters living near sources of micaceous materials (including western Dismal River groups) could have capitalized on this desired commodity and manufactured vessels from their own local raw materials in a size, form, and style reminiscent of northern Rio Grande pottery. Vessels made from residual micaceous clays or tempered with mica-rich granites, such as those from New Mexico, take on a very distinct, glittering appearance that is hard to duplicate with sources of raw materials containing lower concentrations of mica. Still, a large range of variation in the type, amount, and size of mica in these Dismal River micaceous vessels does exist, and some of these vessels would have had a stunning glittery appearance, while others would not. The fact that some vessels had less mica in their paste may not have mattered to Dismal River people, since they may have carried the same culinary and symbolic properties as more highly micaceous vessels made in New Mexico.

Our results point to a complex origin for the micaceous ceramics recovered on the Central Plains, and it is very likely that an active internal Plains exchange system allowed Dismal River and other groups access to desired goods. Further characterization of mica sources from Colorado and Wyoming, however, are needed to better pinpoint possible sources of micaceous materials and to understand the importance and extent of the Central-Western Plains exchange systems. Reanalysis of Dismal River lithic assemblages and chert sources also is needed to determine whether other Front Range or Central Plains materials moved in similar exchange systems.

Finally, we stress that terminology does matter and that the term "micaceous" should be reserved for discussions of ceramic vessels constructed from residual micaceous clays. Ceramics constructed with heavy amounts of biotite granites, such as most of the Dismal River mica-rich ceramics, should be described as biotite granite tempered. Arnold (1993) similarly argues that terms such as "micaceous paste" or "natural mica inclusions" better describe ceramics tempered with mica rich materials, as these terms reflect behaviors behind the preparation of raw materials (208). The use of the term "micaceous" by ceramists working in the Great Plains has masked much of the interesting variation observed in these ceramics and potentially obscured evidence of a vibrant and significant internal Plains exchange network.

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Supplemental Materials. Supplemental materials are linked to the online version of the paper, accessible via the SAA member login at www.saa.org/members-login.

Supplemental Figure 1. Color version of Figure 2.

Supplemental Text 1. A discussion of the nature and sources of micaceous materials.

Supplemental Text 2. Description of analytical procedures included in this analysis

Supplemental Text 3. Discussion of the chemical characterization of the Dismal River Gray Ware sample.

Supplemental Text 4. The results of a mineralogical analysis of additional Northern Rio Grande mica tempered wares.

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Note

1. Eiselt's micaceous clay samples were sent to the Phoenix reactor in Michigan for NAA and counts for short irradiation elements were not recorded. We removed a number of elements from our MURR samples leaving the following elements for analysis: As, Ba, Ce, Co, Cr, Cs, Eu, Fe,

Hf, La, Lu, Na, Nd, Rb, Sc, Sm, Ta, Tb, Th, U, Yb, Zn, and Zr.

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