OBSIDIAN PROCUREMENT AMONG THE JUMANOS PUEBLOS, NEW MEXICO, A. D. 1300–1670S

WILLIAM M. GRAVES

ABSTRACT

In this article, I present (1) the results of x-ray fluorescence (XRF) sourcing analyses and (2) the relative frequencies of archaeological obsidian artifacts from three Late Prehispanic and Early Colonial period (A. D. 1300 to 1670s) Jumanos pueblos in central New Mexico: Gran Quivira, Pueblo Blanco, and Pueblo Colorado. The XRF data suggest that the villages were relatively independent from one another in terms of the nonlocal social and economic relationships through which obsidian was acquired. At the same time, the analysis of the relative frequencies of obsidian suggests that at first the residents of Gran Quivira, and then those of Pueblo Blanco, had greater access to obsidian than the inhabitants of the other two villages. Taken together, the results of these two analyses suggest that seemingly opposing relations of autonomy and differentiation may have characterized the long-distance social and economic activities of the residents of these pueblos and their relationships to each other.

RESUMEN

En este artículo, presento (1) los resultados del análisis por radiografía de fuentes de fluorescencia (XRF) y (2) las frecuencias relativas de artefactos de obsidiana de tres pueblos de los Jumanos de los períodos Prehispánico Tardío y Colonial Temprano (D. C. 1300 a 1670) ubicados en la parte central de Nuevo México. Los datos de XRF sugieren que los pueblos fueran relativamente independientes el uno de los otros en términos de las relaciones sociales y económicas no locales por las cuales la obsidiana fue adquirida. A la vez, el análisis de las frecuencias relativas de la obsidiana sugiere que al principio los habitantes de Gran Quivira, y luego los de Pueblo Blanco tuvieran mayor acceso a la obsidiana que los habitantes de los otros dos pueblos. Los resultados de los datos tomados juntos sugieren que relaciones de autonomía y diferenciación, pudieran haber caracterizado las actividades sociales y económicas de los habitantes de estos pueblos y las relaciones entre ellos.

KIVA: The Journal of Southwestern Archaeology and History, Vol. 71, No. 1, (Fall 2005), pp. 7–35.

Over the past several decades, chemical characterization studies of obsidian have become an important analytical tool for examining both local and long-distance exchange and procurement strategies of peoples who lived in the Prehispanic Southwest (Baugh and Nelson 1987; Bayman 1995; Church 2000; Findlow and Bolognese 1980; Hughes 1988a; Mitchell and Shackley 1995; Peterson, Mitchell, and Shackley 1997; Shackley 1988, 1992, 1995; Stevenson and Klimkiewicz 1990; Stevenson and McCurry 1990). In particular,

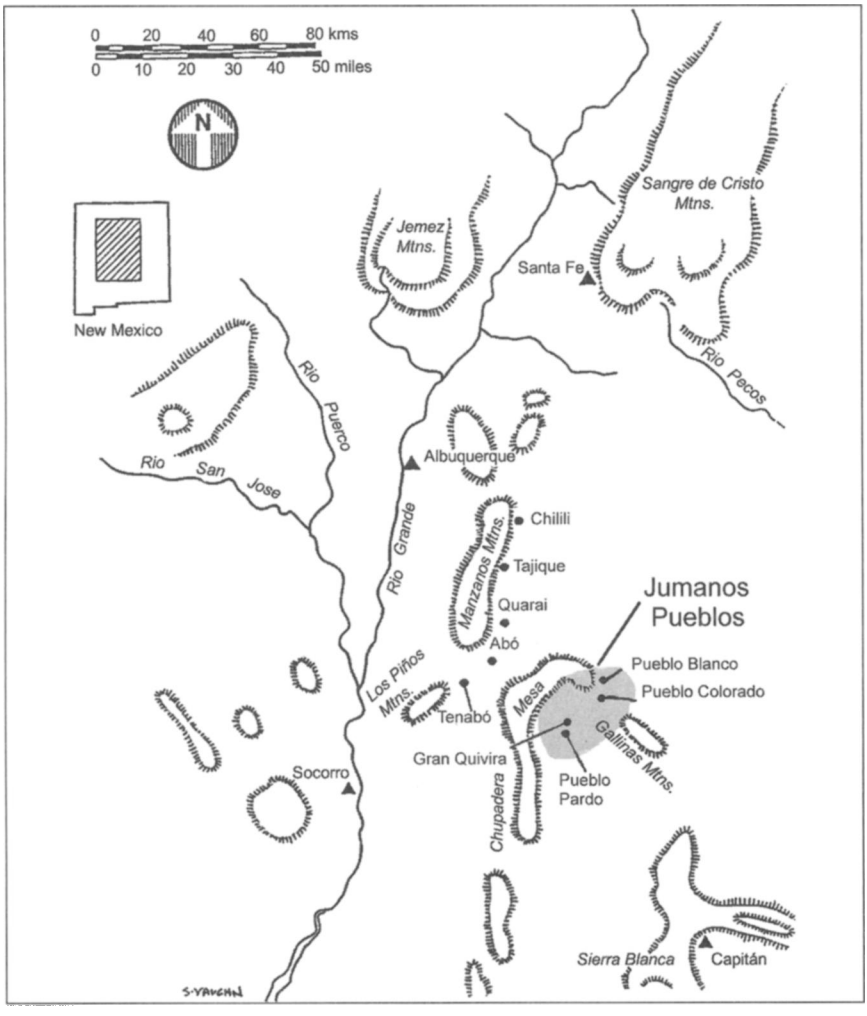

FIGURE 1. The Jumanos pueblos and other Late Prehispanic and Historic period pueblos (modern and prehispanic pueblos shown with circles; modern cities shown with triangles).

obsidian can provide data concerning the regional social and economic relationships in which the inhabitants of different pueblo villages engaged and their potential involvement in local and long-distance exchange and the procurement of goods. In this paper, I present the results of two x-ray fluorescence sourcing analyses of archaeological obsidian artifacts recovered from three Pueblo IV and Early Colonial period (A. D. 1300 to the late 1600s) villages in central New Mexico, Gran Quivira, Pueblo Blanco, and Pueblo Colorado (Figure 1). These three villages belong to a cluster of sites known as the Jumanos pueblos (Hayes 1982; Hayes et al. 1981). The XRF data are used to reconstruct the structure of obsidian acquisition and procurement among these pueblos. I also examine the relative frequencies of obsidian artifacts recovered from midden deposits at the three sites in order to examine the relative access to this raw material that residents of these villages may have enjoyed.

The results of the analyses of relative frequencies and the XRF sourcing studies show that the Jumanos pueblos may have had differential access to obsidian. During the 1300s, although relatively little obsidian appears to have been utilized at these pueblos, residents of Gran Quivira were apparently able to acquire somewhat more than the other two villages. By the mid-1400s and well into the seventeenth century, the inhabitants of Pueblo Blanco seem to have obtained greater quantities of obsidian than the inhabitants of the other two villages.

Interestingly, the XRF data show that, although there may have been differences in the relative access to obsidian among the different Jumanos pueblos, each of the three pueblos was generally independent of each other in terms of the long-distance social and economic relationships they established and maintained. This independence in long-distance relations suggests a level of autonomy among the Jumanos pueblos in the acquisition of obsidian and mirrors a pattern of inter-village autonomy in political and economic practices among the Jumanos pueblos that has been suggested by several previous analyses (Graves 2002, 2004; Graves and Spielmann 2000).

CULTURAL HISTORICAL BACKGROUND

THE JUMANOS PUEBLOS

The Jumanos pueblos are a cluster of large, Pueblo IV (A. D. 1300–1598) and Early Colonial period (1598–late 1600s) village sites located in the Salinas district of central New Mexico (Figure 1). The cluster consists of four sites: Gran Quivira, Pueblo Pardo, Pueblo Blanco, and Pueblo Colorado. Occupations at three of the sites, Gran Quivira, Pueblo Pardo, and Pueblo Blanco, began around A. D. 1300 and lasted until the 1670s (Hayes, Young, and Warren 1981). Pueblo Colorado was founded around 1300 and was abandoned sometime in the 1500s (Spielmann 1998a). Although no firm population figures are available for the

villages, it has been estimated that between 500 and 1500 people occupied each site at any one time (Graves 2002).

The Jumanos pueblos form a coherent settlement cluster and a number of lines of evidence suggest that the four villages shared a distinct group identity that differentiated them socially from other Pueblo groups in the Rio Grande (Graves 2004). In terms of material culture, the Jumanos pueblos exhibit differences in the stylistic traditions of decorated ceramics that may mirror significant differences in social identity. The Jumanos pueblos were the only pueblos south of the Jemez and Santa Fe areas to retain a significant black-on-white painted ceramic tradition after the adoption of red- and yellow-slipped Glaze wares that occurred throughout the central and southern Rio Grande in the early 1300s (Hayes, Young, and Warren 1981:68). In addition, cremation burials and inhumations have been found at the two Jumanos sites, Gran Quivira and Pueblo Pardo, where the only excavations likely to encounter burials have been conducted (Hayes, Young, and Warren 1981; Toulouse and Stephenson 1960). Cremations have not been found at other Late Prehispanic pueblo sites in the region (Graves and Spielmann 2003; Spielmann 1991a, 1992, 1998a).

Other evidence also suggests the existence of a shared Jumanos identity. The four villages shared a common language, Tompiro (Hayes, Young, and Warren 1981:63). Furthermore, early ethnohistoric documents by Spanish colonists and missionaries consistently differentiate the inhabitants of the Jumanos villages from others living in the Salinas district (e. g., Hammond and Rey 1953:393; Hayes, Young, and Warren 1981:4–8). Thus, taken together, these archaeological, linguistic, and ethnohistoric lines of evidence suggest a coherent cultural identity that was shared among the inhabitants of the Jumanos villages. Although the exact nature of this shared identity is not known, it seems safe to assume that the Jumanos pueblos did indeed share cultural and social traditions that distinguished them from other, contemporaneous Pueblo groups in the Rio Grande.

Field research over the past two decades has provided controlled, excavated data from three of the four Jumanos villages, Gran Quivira, Pueblo Blanco and Pueblo Colorado (Graves and Spielmann 2003; Spielmann 1991a, 1992, 1998a). Although data are not available from Pueblo Pardo, the information gathered from these excavations provide an adequate data base with which to characterize the social, political, and economic relations that may have existed among the settlements of the Jumanos cluster throughout their occupations. Excavations at the three sites have yielded a wealth of materials from stratified trash midden deposits. On the basis of Glaze ware bowl rim sherd seriations, deposits excavated at all three sites have been assigned to one of three chronological periods: Early (1300 to the mid–1400s), Intermediate (mid–1400 to the mid– to late–1500s), or Late (mid– to late–1500s to the 1670s). Early, Intermediate, and Late period deposits were encountered at Gran Quivira and Pueblo Blanco (Graves and Spielmann 2003; Spielmann 1991a, 1992). Because Pueblo

Colorado was abandoned sometime in the 1500s, no Late period materials were recovered from that site (Spielmann 1998a).

THE RIO GRANDE REGIONAL ECONOMY

The Pueblo IV period (1300–1598), which encompassed most of the occupation span of the Jumanos pueblos, was a time of great change in the social, political, economic, and ritual organization of Prehispanic Pueblo society (e.g., Adams 1991; Adams and Duff 2004; Crown 1994; Potter 1997; Spielmann 1998b). Throughout the Rio Grande, these changes were particularly significant as the region witnessed widespread population increases (due to immigration and indigenous population growth), the establishment of large pueblo settlements, the formation of settlement clusters, the spread of new religious and ritual practices, and the development of a complex regional economy involving the specialized production of goods and widespread long-distance exchange. Then, social and cultural developments in the Rio Grande region, and throughout the American Southwest, were irrevocably altered in 1598, with the establishment of the Spanish colony of New Mexico by Juan de Oñate. This marked the beginning of the Early Colonial period of the historic era, and this period of European domination brought great changes to many aspects of Pueblo life.

During the early part of the Pueblo IV period, a complex economic system developed throughout the Rio Grande (Shepard 1942; Snow 1981; Spielmann 1989, 1991b; Warren 1969, 1979). This highly complex economy involved the specialized production and long-distance exchange of a variety of utilitarian and non-utilitarian goods from both within and beyond the region that persisted well into the A. D. 1600s. Both the complexity and the scale of this production and exchange system are unparalleled in Puebloan history, and it appears to have played a major role in fostering changes in social and political relations throughout the region (Graves and Spielmann 2000; Shepard 1942; Snow 1981). Although some of the production and distribution of goods seen during the Pueblo IV period may be due to the distribution of natural resources or favorable environments, it has been suggested that much of the complex economic activity evident in the Late Prehispanic Rio Grande was driven by the region-wide need for, and the procurement of, religious ritual paraphernalia (Snow 1981:355).

As a key component of this larger regional economy, individual pueblos and different clusters of pueblos specialized in the production of certain material items for apparent region-wide distribution. For example, ethnohistoric accounts (Bolton 1908; Hammond and Rey 1953; Mecham 1926; Snow 1981) and a GIS analysis conducted by Hill (1998) demonstrate that the Piro and southern Tiwa pueblos specialized in the production of cotton for regional consumption. However, the most well-documented example of specialized production and distribution of goods in the Rio Grande regional economy is Glaze ware ceramics.

Glaze ware ceramic vessels were produced and used in the central and southern Rio Grande from around 1300 to the late 1600s. During this period, Glaze ware was the dominant form of decorated pottery in this portion of the Rio Grande. Many petrographic sourcing analyses (e.g., Shepard 1942; Warren 1979, 1981) and chemical characterization studies (e.g., Habicht-Mauche et al. 2000) have documented the existence of specialized production and long-distance exchange of Glaze ware vessels throughout the region. Throughout the long history of Glaze ware use, numerous production centers arose in several districts of the Rio Grande. Importantly, potters at two pueblos in particular, Tonque Pueblo and San Marcos Pueblo, became major region-wide producers of yellow-slipped Glaze ware ceramics (Capone 1995; Shepard 1942; Warren 1969). Products from these two pueblos are found in high frequencies and sites throughout the Rio Grande region.

The relative involvement of a community in long-distance economic activities, either through the acquisition or the production of high-demand or socially valuable items has been implicated as a factor contributing to developments in intervillage social relations and political organization within local areas of the Rio Grande (e.g., Graves 2004; Graves and Spielmann 2000; Spielmann 1994; Wilcox 1981, 1991). More specifically, the relative engagement of communities in the acquisition of these kinds of goods from long distances has been suggested to be a prestige-enhancing activity and one on which the potential establishment of unequal political and economic relations among communities within a local area may have been based (e.g., Graves and Spielmann 2000; Habicht-Mauche 2000).

Among the Jumanos pueblos, the acquisition of two classes of goods derived through long-distance exchange, Glaze ware ceramic vessels and bison meat and other products, have been suggested as activities upon which prestige and power in local-area social relations may have been built (Graves and Spielmann 2000; Potter 1995). Glaze ware petrographic sourcing studies suggest that although the residents at Pueblo Colorado had greater access to the socially valuable Glaze ware vessels produced at Tonque and San Marcos Pueblos during much of the Prehispanic period, no one pueblo in the Jumanos cluster was able to dominate and control the acquisition of these high-demand products. In contrast, analysis of the relative frequencies of bison remains recovered from deposits at the three Jumanos villages suggest that the inhabitants of one pueblo, Gran Quivira, enjoyed much greater access to bison meat and other products (such as bison masks and, perhaps, hides), which were derived through the establishment of long-distance exchange relationships with Plains hunting groups. These intersite patterns of differential access to these classes of goods, and the apparent lack of centralization in the procurement of and access to such products at any one particular pueblo within the cluster, suggest that both relations of autonomy and differentiation or dependency characterized the political-

economic interactions among the Jumanos villages. Thus, understanding the acquisition of certain non-local goods has important implications for reconstructing not only economic behaviors and relations within the Late Prehispanic and Early Colonial period Rio Grande, but also the social and political relations that may have characterized interaction among different communities of people in local areas.

OBSIDIAN

In addition to items such as cotton, decorated ceramics, and bison, the procurement and trade of obsidian has also been suggested as a component of the long-distance production and exchange systems of the Rio Grande economy (e.g., Snow 1981). Obsidian, which is found in relatively small quantities at virtually every Late Prehispanic site in the region, derives mainly from a handful of volcanic flows in the Jemez Mountains in the northern Rio Grande and Mt. Taylor in west-central New Mexico (see Figure 2). A number of sites and site clusters are located adjacent to these sources and it is possible that at least some of the obsidian found at sites throughout the region was acquired through long-distance exchange with these pueblos. As I discuss below, obsidian also occurs in pebble form ("Apache tears") in gravel deposits of the Rio Grande itself and as gravels deposited by the Ancestral Rio Grande in basins adjacent to the modern stream course. If some or all of the obsidian found at Late Prehispanic sites came from these gravel deposits, then such materials may tell us something, either directly or indirectly, about social and economic relations with pueblo communities located along and adjacent to the Rio Grande floodplain.

Our understanding of the nature of obsidian procurement in the Rio Grande area and the potential exchange in this material, and its role in both region-wide and local socioeconomic relations has been limited (but see Camilli 1988; Church 2000; Snow 1981). The Jumanos cluster, however, with extensive excavated collections from three of the four pueblos, provides an exceptional opportunity to begin to examine the nature of obsidian procurement within a local area and how it might relate to broader political-economic relations among villages.

OBSIDIAN FREQUENCIES
DATA AND METHODOLOGY

By examining the relative frequencies of obsidian in the deposits at Gran Quivira, Pueblo Blanco, and Pueblo Colorado, I can determine which village, if any, had greater access to obsidian in general. Theses data can then suggest which village, if any, was more successful in establishing and maintaining the apparently diverse social and economic relations through which obsidian may have flowed. In this analysis, I have included all obsidian artifacts, including cores and formal

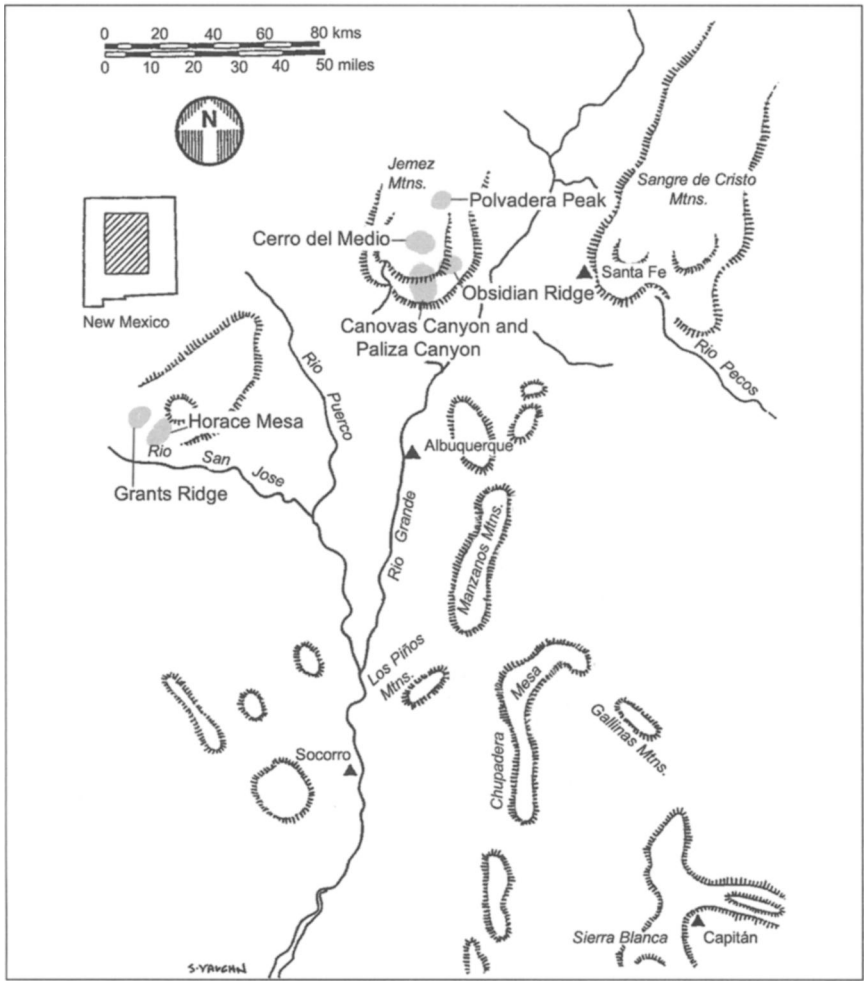

FIGURE 2. Approximate locations of primary obsidian sources identified by XRF analyses (from Baugh and Nelson 1987; Shackley 1998a).

and informal tools, that were recovered from excavated trash midden contexts at each of the three sites that could be dated to one of the three occupational periods, the Early, Intermediate, or Late periods, as described above. Table 1 presents the frequencies and total weights for the obsidian assemblages recovered from midden contexts by time period at the three sites. As discussed above, no Late period deposits were encountered at Pueblo Colorado.

Midden excavation units at all three sites from which the obsidian assemblages were recovered consisted of varying numbers of contiguous 1 m × 1 m

TABLE 1. Frequencies, weights (in grams), and average weights (in grams) of obsidian artifacts recovered from datable excavated trash midden contexts at Gran Quivira, Pueblo Blanco, and Pueblo Colorado.

	Early Period frequency/total wt. average wt.	Intermediate Period frequency/total wt. average wt.	Late Period frequemcy/total wt. average wt.
Gran Quivira	190/158.1 .83	346/272.18 .79	1088/762.88 .70
Pueblo Blanco	72/40.20 .56	583/322.39 .55	1331/964.50 .72
Pueblo Colorado	90/78.72 .87	191/146.95 .77	—

TABLE 2. Percentages and counts of all obsidian by artifact type from datable excavated midden contexts at Gran Quivira, Pueblo Blanco, and Pueblo Colorado. (Other Tools include retouched flakes, resharpened flakes, unifaces, bifaces, scrapers and drills; Unknown and Miscellaneous Artifacts include gizzard stones and unknown artifacts).

n	Flakes	Shatter	Projectile Points	Other Tools	Unknown and Miscellaneous Artifacts	Cores
Gran Quivira 1624	87.2%	3.9%	3.5%	5.0%	0.1%	0.2%
Pueblo Blanco 1986	86.2%	5.3%	4.4%	4.3%	0.2%	0.9%
Pueblo Colorado 281	79.0%	9.6%	0.0%	7.1%	2.1%	0.0%

squares aligned on a grid system centered on a main site datum. In general, unit placement at all three sites were guided by surface indications that suggested the potential of underlying midden deposits. As a result, the spatial extent of midden deposits dating to each time period varies among the sites as well as the number of different excavation units at each site in which deposits dating to any one particular time period occur. See Graves and Spielmann (2003) and Spielmann (1991a, 1992, 1998a) for more detailed discussions of excavation unit placement and coverage at Gran Quivira, Pueblo Blanco, and Pueblo Colorado.

The overall percentages of different artifact types in the obsidian assemblages from the three sites (Table 2) suggest that any differences that are found in

TABLE 3. Obsidian from Gran Quivira, Pueblo Blanco, and Pueblo Colorado standardized by different methods.

		Standardizations		
Period Site	Obsidian Counts/m^3	g of Obsidian/m^3	Counts of Obsidian/100 Locally Available Flaked Stone	g of Obsidian/ kg of Locally Available Flaked Stone
Early				
Gran Quivira	31	25.9	10	34
Pueblo Blanco	16	8.6	4	11
Pueblo Colorado	8	6.9	2	13
Intermediate				
Gran Quivira	25	19.4	20	70
Pueblo Blanco	88	48.7	24	72
Pueblo Colorado	13	10.1	5	26
Late				
Gran Quivira	38	26.5	22	90
Pueblo Blanco	61	44.0	33	128

the relative frequencies of obsidian among the sites or any differences in the XRF sourcing of obsidian are not due to differences in the modes of reduction, the use, or the discard of obsidian among the three villages. The relative frequencies of different artifact types are similar among the three sites. When added together, the percentages of the two debitage types, flakes and shatter, are virtually identical; varying from 91.5 percent at Pueblo Blanco to 88.6 percent at Pueblo Colorado. There are some slight differences in the percentages of projectile points and other tools present in the three site assemblages. It is difficult to interpret the significance of these slight differences, and they may be due to sample size differences among the three assemblages or to the fact that no Late period deposits were recovered from Pueblo Colorado. Regardless, the overall similarities in the three obsidian assemblages suggest that there were minimal differences in how obsidian was reduced and used at the three villages. In addition, it appears that there are also minimal differences in how obsidian was discarded at all three sites.

To determine the relative frequency of obsidian at each site, I standardized the counts and weights of obsidian from the three sites by soil volume (m^3) and by locally available flaked stone artifacts (Table 3). For this analysis, I have excluded all formal tools (projectile points and drills) and limestone artifacts from the local flaked stone. There are some interpretive problems that exist with the standardizations of artifact frequencies by volume of excavated soil and by flaked stone for the Jumanos pueblo artifact assemblages (see Graves 2002 for a more detailed discussion). Regardless of the problems that may exist with any

one standardization method, cases in which intersite comparisons using both soil volume and locally available flaked stone artifacts coincide should provide a relatively strong measure of differences, or the lack of differences, among the three pueblos (Graves 2002).

DISCUSSION

Table 3 presents the amounts and relative frequencies of obsidian recovered from Gran Quivira, Pueblo Blanco, and Pueblo Colorado for each chronological period. All four standardizations suggest that during the Early period, the residents of Gran Quivira seem to have acquired somewhat more obsidian than the inhabitants of either Pueblo Blanco or Pueblo Colorado. In the Intermediate period, the density of obsidian at all three sites increased substantially. The standardizations of obsidian by soil volume suggest that inhabitants of Pueblo Blanco had better access to obsidian than those of Gran Quivira. The standardizations by local flaked stone, however, suggest that the two pueblos enjoyed similar access to obsidian. Regardless, it is clear from the data that both Gran Quivira and Pueblo Blanco have greater relative frequencies of obsidian than Pueblo Colorado. During the Late period, all four standardizations of obsidian show that Pueblo Blanco had more discarded obsidian artifacts than Gran Quivira. It appears that the inhabitants of Pueblo Blanco had somewhat better access to obsidian during the Late period of occupation than the residents of Gran Quivira.

Although there is no reason to suggest that obsidian was considered a socially valuable item in the Late Prehispanic and Early Colonial period Rio Grande area, the acquisition of obsidian can still inform us about long-distance social and economic relationships and interactions among the Jumanos pueblos. The fact that Pueblo Blanco has a greater relative frequency of obsidian in its Intermediate and Late period deposits than does Pueblo Colorado and Gran Quivira suggests that the residents of this pueblo were somewhat more involved in long-distance relations and interactions through which obsidian flowed.

X-RAY FLUORESCENCE ANALYSES

To examine inter-site patterns of obsidian procurement, I examine data from two x-ray fluorescence compositional analyses of obsidian artifacts recovered from Gran Quivira, Pueblo Colorado, and Pueblo Blanco. Both XRF studies were conducted by Richard Hughes (Hughes 1988b, 2001a, 2001b). The first analysis in 1988 focused on 89 obsidian artifacts from Gran Quivira (Hughes 1988b). The second dealt with 160 obsidian artifacts from Pueblo Blanco and Pueblo Colorado (Hughes 2001a, 2001b). The compositional data of obsidian artifacts from all three sites is presented in Graves (2002). Only data from artifacts recov-

ered from datable contexts from the three sites are considered here (Gran Quivira, n = 86; Pueblo Blanco, n = 100; Pueblo Colorado, n = 60).

In general, energy-dispersive XRF works by acquiring X-ray energy spectra for each sample and then elemental concentrations (in ppm by weight) are calculated from these spectra. Based on its correspondence with known obsidian geochemical groups characterized by a few key diagnostic trace element concentrations, an artifact can often be assigned to a specific obsidian geochemical group. Each group represents materials from a *primary* source location (i. e. , a volcanic flow or geographic area). Primary source locations have been assigned to these geochemical groups based on the findings of published chemical characterization studies of geologic sources throughout New Mexico (e.g., Baugh and Nelson 1987; Glascock, Kunselman, and Wolfman 1999; MacDonald, Smith, and Thomas 1992; Shackley 1995, 1998a). The primary source locations/geochemical groups for obsidians recovered from the Jumanos pueblos include five from the Jemez Mountains (Canovas Canyon, Cerro del Medio, Obsidian Ridge, Paliza Canyon, and Polvadera Peak) and two from the Mt. Taylor volcanic field (Grants Ridge and Horace Mesa). General locations for these primary sources are shown in Figure 2.

The differentiation between the Grants Ridge and Horace Mesa groups within the Mt. Taylor volcanic field source is a fairly recent development (Shackley 1998a), and such a distinction was not made in the earlier XRF analysis of artifacts from Gran Quivira (Hughes 1988b), but was made in the more recent analysis (Hughes 2001a, 2001b). All Mt. Taylor artifacts from the first study (Hughes 1988b) were identified as coming from the Grants Ridge source only. Therefore, I have collapsed all artifacts assigned to Horace Mesa and Grants Ridge from the more recent study of Pueblo Blanco and Pueblo Colorado (Hughes 2001a, 2001b) into one category named Grants Ridge to make the results of the two studies comparable. This has relatively little impact, if any, on the analysis because only five samples from Pueblo Blanco and Pueblo Colorado were attributed to these two Mt. Taylor sources (Horace Mesa, n = 3; and Grants Ridge, n = 2; see Graves 2002). In addition, these two sources are located close to each other (see Figure 2), and the distinction between them, although important geochemically, likely had little social significance in terms of patterns of exchange and interaction.

It is important to note here that there is variation in the geographic names assigned to particular primary source locations/geochemical groups and some disagreement among obsidian analysts as to which name more correctly identifies the exact source location for each geochemical group (Baugh and Nelson 1987; LeTourneau et al. 1999; LeTourneau and Steffen 2002; Steven Shackley, personal communication, 2005). Despite these disagreements, I have decided to use the names of geochemical source groups provided by Hughes (1998b, 2001a,

2001b) in this article. More specifically, of the seven geochemical source groups identified by Hughes (see above), at least three are referred to by other names in the literature and by other obsidian analysts. Obsidian Ridge, used here, includes both the Cerro Toledo Dome and the Rabbit Mountain Ash Flow of the Valles Caldera in the Jemez Mountain region (Steven Shackley, personal communication, 2005). Obsidian Ridge is also referred to as Cerro Toledo Rhyolite. Cerro del Medio, also used here, is also referred to as the Valle Grande Member (LeTourneau et al. 1999; LeTourneau and Steffen 2002). And, finally, Polvadera Peak is also referred to as El Rechuelos, which more properly characterizes the exact flow or primary source from which this obsidian comes (Steven Shackley, personal communication, 2005).

SAMPLING

For the XRF analysis of artifacts from Pueblo Blanco and Pueblo Colorado, I employed a stratified (by chronological period) random sampling strategy to pick the samples. For each site, 30 samples were chosen, regardless of artifact type (i. e. , flake, shatter, or tool) from Early period and Intermediate period contexts. In addition, 40 samples were chosen at random from Late period contexts at Pueblo Blanco.

The samples from the earlier XRF analysis for Gran Quivira consist of flakes and projectile points only. These were also chosen by a stratified (by chronological period) random sampling strategy (Katherine Spielmann, personal communication, 2002). Only those artifacts that can be assigned to one of the three occupation periods are examined here. The XRF sample size for each site and chronological period are listed in Table 4.

As stated above, each site sample consists of a number of different artifact types including debitage, formal, and informal tools. Obsidian debitage was classified as flakes or shatter. Tools consist of bifaces, scrapers, and projectile points. A small number of obsidian cores, all from Pueblo Blanco, are also included. XRF sample sizes for each of these artifact types are listed in Table 5.

TABLE 4. Number of samples from datable contexts at each site analyzed by XRF.

	Early Period	Intermediate Period	Late Period	Site Totals
Gran Quivira	29	23	34	**86**
Pueblo Blanco	30	30	40	**100**
Pueblo Colorado	30	30	—	**60**
Period Totals	**89**	**83**	**74**	**246**

TABLE 5. Obsidian artifact types included in the XRF analysis, percent totals in parentheses.

	Flakes	Shatter	Projectile Points	Bifaces	Scrapers	Cores	Unknown	Site Totals
Gran Quivira	66	0	20	0	0	0	0	**86**
Pueblo Blanco	64	7	14	10	2	3	0	**100**
Pueblo Colorado	37	11	8	3	0	0	1	**60**
Artifact Totals	**167**	**18**	**42**	**13**	**2**	**3**	**1**	**246**
	(67.9%)	(7.3%)	(17.1%)	(5.3%)	(.8%)	(1.2%)	(.4%)	

THE ISSUE OF PRIMARY AND SECONDARY OBSIDIAN SOURCES

XRF analysis, as with other obsidian sourcing techniques, identifies the *primary* geological sources of artifacts recovered from archaeological contexts. In New Mexico, these primary sources consist mainly of various flows in the Jemez Mountains and the Mt. Taylor volcanic field (Figure 2). Obsidian is also distributed in *secondary* deposits throughout the central and southern Rio Grande region (Camilli 1988; Church 2000; Shackley 1992, 1998b; Stevenson and McCurry 1990; Stevenson and Klimkiewicz 1990). As Shackley (1992, 1998b) cautions, this fact has important implications for interpreting the results of obsidian sourcing studies of archaeological sites in central and southern New Mexico.

Obsidian is found both in geologically recent secondary gravels deposited throughout the Rio Grande valley and in gravels deposited by the Ancestral Rio Grande in a number of adjacent basins, such as the Española, Albuquerque, and San Marcial (Church 2000:650). These gravels are of Cenozoic age and are referred to collectively as the Santa Fe group (Stevenson and McCurry 1990:154–155). Santa Fe group gravels are located throughout the Rio Grande Trough and parallel basins (Stevenson and McCurry 1990:Figure 3). Of the seven primary sources identified in obsidian recovered from the Jumanos pueblos, only one, Cerro del Medio, has not been found in Santa Fe gravel deposits. Cerro del Medio obsidian has been found on surveys in alluvial deposits *within* the Valles Grande Caldera, but not outside of the Jemez Mountain area in secondary gravel deposits associated with the Rio Grande (LeTourneau et al. 1999; LeTourneau and Steffen 2002).

The widespread distribution and availability of obsidian gravels in these secondary deposits calls into the question the assumption often made in sourcing studies that the artifacts of interest were acquired directly, either by trade or direct procurement, from the primary sources identified in the analysis (Church 2000; Shackley 1992, 1998b; Stevenson and McCurry 1990). In a recent study, Church (2000) has used XRF to source samples of obsidian gravels recovered

from survey collections of a number of Ancestral Rio Grande gravel deposits in the Las Cruces/El Paso area. The results of Church's analysis demonstrate (1) that secondary gravel deposits contain obsidian materials from multiple primary sources and (2) that different secondary deposits have substantially different *proportions* of primary sources present (Church 2000:658–660; see also Shackley 1992, 1998b and Stevenson and McCurry 1990).

Although some obsidian recovered from the Jumanos pueblos may have been procured from the primary flows that XRF analyses identify, it appears that many originated from secondary Santa Fe group gravel deposits. Obsidian found in Rio Grande gravel deposits is often called "Apache tears," and it has been assumed by flaked stone analysts that obsidian at the Jumanos pueblos comes from such gravels (Cameron 1991:92; Spielmann 1998a:102–103). The small average weights of obsidian artifacts from Gran Quivira, Pueblo Blanco, and Pueblo Colorado (see Table 1) correspond with the small size of pieces recovered from secondary gravel deposits in the Las Cruces/El Paso area, where 82 percent were less than 3 cm in length (Church 2000:653, from Mauldin, Graves, and Bentley 1998; see also Camilli 1988 and Stevenson and McCurry 1990:157). Obsidian found at primary sources in the Jemez Mountains and Mt. Taylor occurs as larger pieces, generally fist-sized or greater (Baugh and Nelson 1987; LeTourneau and Steffen 2002; Richard Hughes, personal communication, 2002). Although not conclusive, the small size of obsidian debitage and tools throughout the occupational sequence at each of the Jumanos sites (see Table 1) suggests that gravel-sized pieces of obsidian were acquired and reduced.

An examination of the obsidian cores (n = 17) recovered from Pueblo Blanco also suggests that obsidian was acquired from secondary gravel deposits. The obsidian cores with cortex present (n = 4) are all fragments of smoothed, gravel-size pieces that appear water-worn. Obsidian cores (n = 13; Cameron 1991:102) from the Gran Quivira assemblage were not available for examination, and no obsidian cores were recovered from Pueblo Colorado (Spielmann 1998a:105). Spielmann (1998a:103), however, notes that "many of the [relatively] larger pieces of obsidian from Pueblo Colorado appear to be from 'Apache tear'-sized obsidian pebbles. " Additional data concerning core types, cortex type, and core reduction patterns that could provide information about the relative location of procurement are not available.

In sum, the small sizes of artifacts and the small number of gravel-like cores from Pueblo Blanco seem to suggest that a large proportion of the obsidian assemblages at the three sites is comprised of material procured from secondary gravel deposits. A possible exception to this may be materials sourced to the Cerro del Medio geochemical group (see above). We cannot tell exactly what proportions of the obsidian recovered, if any, originated from primary or secondary deposits, however. Thus, in the following discussion of the XRF

analysis, the reader should keep in mind that the obsidian at the three sites could have originated from any number of locations throughout the Rio Grande region.

EXCHANGE OR DIRECT PROCUREMENT?

Exactly how the obsidian recovered from the Jumanos sites was procured is not known. Obsidian may have been obtained (1) through exchange with pueblos situated nearby sources (either primary or secondary sources) or (2) by residents of the Jumanos pueblos traveling directly to the sources and procuring the obsidian themselves. Such direct procurement is often embedded in other economic activities, such as hunting, gathering, or collecting other raw materials (Binford 1979). It seems unlikely, although not impossible, that the residents of the Jumanos pueblo would have traveled as far as the Jemez Mountain area and the Mt. Taylor area to hunt, gather, and collect (see Figure 1). If obsidian was procured from secondary gravel sources, however, then those sources would have been somewhat closer. The nearest potential gravel deposits of the Santa Fe group are along the eastern side of the Rio Grande in the Albuquerque and San Marcial Basins (Church 2000:650; Stevenson and McCurry 1990:Figure 3). The Albuquerque and San Marcial Basins are located along the Rio Grande from just north of Albuquerque to between Socorro and Truth or Consequences. Residents of the Jumanos pueblos would have needed to travel a minimum of 40 km to reach potential gravel deposits (see Figure 1).

On the other hand, the general direction and location of the Jemez Mountain primary sources, including Cerro del Medio (which may have only been available *at* the primary source location), are similar to those of Tonque and San Marcos Pueblos, the two major producers of Glaze ware ceramics during the 1400s and 1500s (see Figure 1). Because the Jumanos pueblos relied fairly heavily on these pueblos for their decorated pottery (Graves 2002, 2004; Graves and Spielmann 2000), it seems plausible that at least some of the obsidian acquisition among the residents of the Jumanos pueblos may have been a result of direct procurement from primary sources, perhaps in conjunction with trips to the Tonque and San Marcos areas.

EARLY PERIOD

The results of the XRF sourcing analysis for the Early period samples from Gran Quivira, Pueblo Blanco and Pueblo Colorado are presented in Table 6 and graphically in Figure 3. The probability of obtaining a χ^2 value by chance as large as the one calculated for the frequencies in Table 6 is .036. The distributions of sources among the three site samples appear to be significantly different.

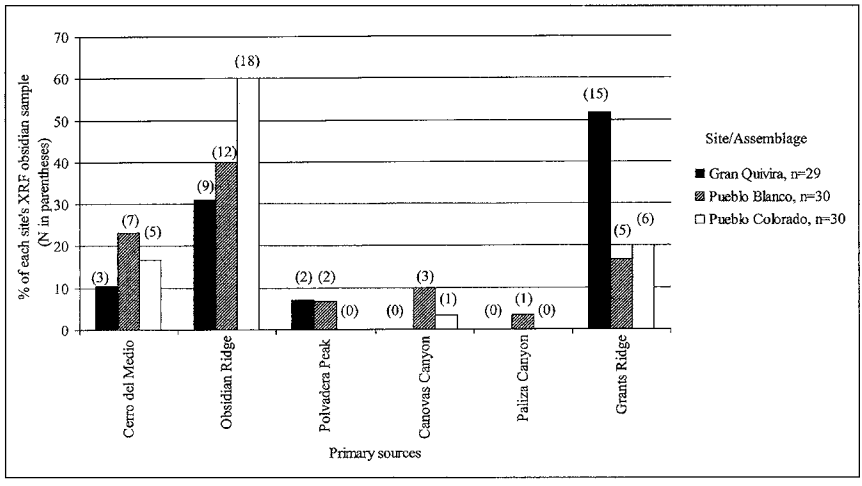

FIGURE 3. Early period XRF obsidian samples from Gran Quivira, Pueblo Blanco, and Pueblo Colorado. $\chi^2 = 19.39$; p = .036; df = 10.

TABLE 6. Early period obsidian XRF analysis, calculated as percentages of site samples (row percentages and observed/chi-squared expected frequencies shown).

	n	Cerro del Medio	Obsidian Ridge	Polvadera Peak	Canovas Canyon	Paliza Canyon	Grants Ridge
Gran Quivira	29	10.3%	31.0%	6.9%	0.0%	0.0%	51.7%
		3/4.9	9/12.7	2/1.3	0/1.3	0/0.3	15/8.5
Pueblo Blanco	30	23.3%	40.0%	6.7%	10.0%	3.3%	16.7%
		7/5.1	12/13.1	2/1.3	3/1.3	1/0.3	5/8.8
Pueblo Colorado	30	16.7%	60.0%	0.0%	3.3%	0.0%	20.0%
		5/5.1	18/13.1	0/1.3	1/1.3	0/0.3	6/8.8

Chi-squared = 19.39, p = 0.036, df = 10

The Gran Quivira sample is dominated by obsidian from the Mt. Taylor primary source of Grants Ridge and the Jemez primary source of Obsidian Ridge. Pueblo Blanco is dominated by the two Jemez primary sources, Cerro del Medio and Obsidian Ridge. Pueblo Colorado is more similar to the Pueblo Blanco sample, with all but one artifact derived from the primary sources of Obsidian Ridge, Cerro del Medio, and Grants Ridge.

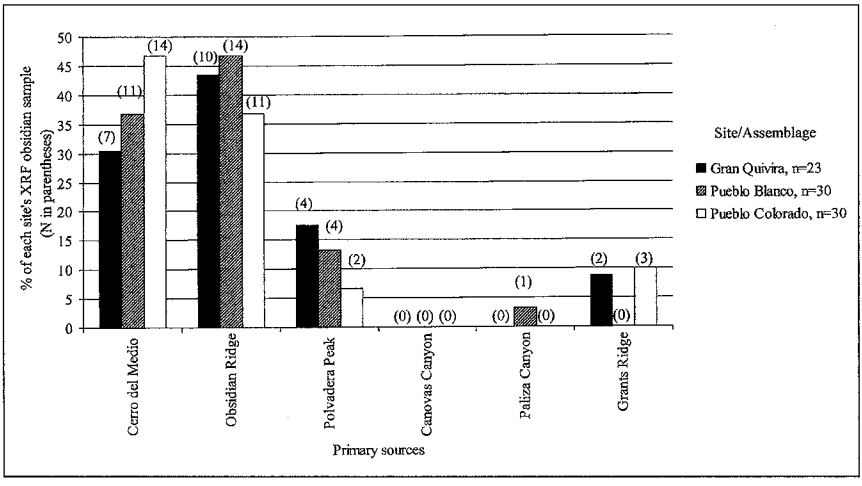

FIGURE 4. Intermediate period XRF obsidian samples from Gran Quivira, Pueblo Blanco, and Pueblo Colorado. $\chi^2 = 7.24$; p = .511; df = 8.

TABLE 7. Intermediate period obsidian XRF analysis, calculated as percentages of site samples (row percentages and observed/chi-squared expected frequencies shown).

	n	Cerro del Medio	Obsidian Ridge	Polvadera Peak	Paliza Canyon	Grants Ridge
Gran Quivira	23	30.4%	43.5%	17.4%	0.0%	8.7%
		7/8.9	10/9.7	4/2.8	0/0.3	2/1.4
Pueblo Blanco	30	36.7%	46.7%	13.3%	3.3%	0.0%
		11/11.6	14/12.7	3/4.6	1/0/4	0/1.8
Pueblo Colorado	30	46.7%	36.7%	6.7%	0.0%	10.0%
		14/11.6	11/12.7	2/3.6	0/0.4	3/1.8

Chi-squared = 7.24, p = 0.511, df = 8

INTERMEDIATE PERIOD

The results of the XRF sourcing analysis for the Intermediate period samples from Gran Quivira, Pueblo Blanco and Pueblo Colorado are presented in Table 7 and Figure 4. Differences in the distribution of artifacts from the sources among the three site samples are not statistically significant ($\chi^2 = 7.24$; p = .511; df = 8) (Table 7). Overall, there is a substantial decrease in the amount of Grants Ridge obsidian at all three sites, especially Gran Quivira, from the Early to the

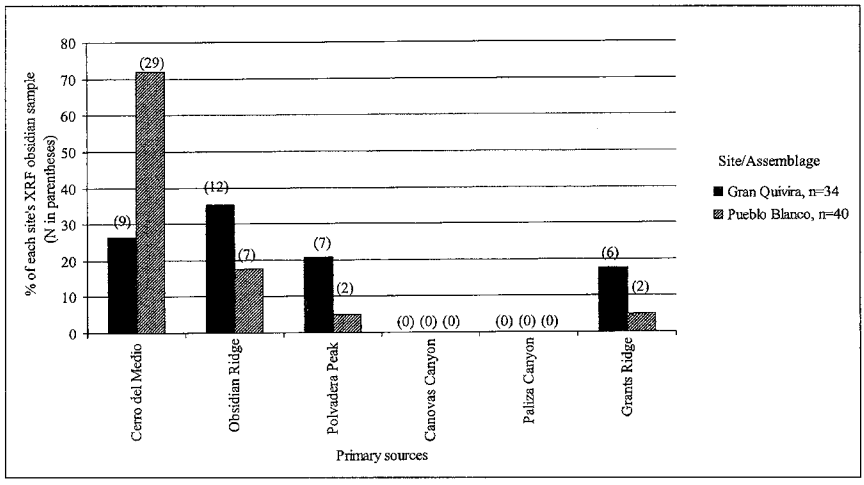

FIGURE 5. Late period XRF obsidian samples from Gran Quivira and Pueblo Blanco. $\chi^2 = 16.24$; p = .001; df = 3.

TABLE 8. Late period obsidian XRF analysis, calculated as percentages of site samples (row percentages and observed/chi-squared expected frequencies shown).

	n	Cerro del Medio	Obsidian Ridge	Polvadera Peak	Grants Ridge
Gran Quivira	34	26.5%	35.3%	20.6%	17.6%
		9/17.5	12/8.7	7/4.1	6/3.7
Pueblo Blanco	40	72.5%	17.5%	5.0%	5.0%
		29/20.5	7/10.3	2/4.9	2/4.3

Chi-squared = 16.24, p = 0.001, df = 3

Intermediate period (see Figure 3). Once dominated by Grants Ridge obsidian, the Intermediate period sample from Gran Quivira contains only nine percent of this material.

LATE PERIOD

The results of the XRF sourcing analysis for the Late period samples from Gran Quivira and Pueblo Blanco are presented in Table 8 and Figure 5. Pueblo Colorado was abandoned by the Late period of occupation. It appears that the distributions of sources at each site are different ($\chi^2 = 16.24$; p = .001; df = 3) (Table

8). This difference appears to lie primarily in the amount of Cerro del Medio obsidian present in each sample.

DISCUSSION

The primary sources represented within each site sample change significantly over time (see Figures 6, 7, and 8). Chi-squared tests calculated for each site (Figures 6, 7, and 8) suggest that these temporal changes were nonrandom. The Gran Quivira sample exhibits a significant drop in the amount of material from Grants Ridge from the Early period to the Intermediate and Late period and increases in the amount of obsidian from different Jemez sources over time (Figure 6). Both the Pueblo Blanco and Pueblo Colorado samples exhibit a marked increase in the *amount* of obsidian from the Cerro del Medio source and substantial decreases in the *percentage* of items from Obsidian Ridge and Grants Ridge (Figures 7 and 8). In sum, during each period of occupation, with the exception of the Intermediate period (see Figure 4), the compositions of the three villages' obsidian assemblages are different. In addition, the composition of each site's obsidian assemblages changed substantially though time.

Unfortunately, the scale of the data does not allow me to examine internal variation within each pueblo. The village level patterns I present here are the result of the actions of hundreds of households each over relatively long time periods. Undoubtedly, different individuals and different households within each village had different exchange or procurement relationships and the site level data I examine here mask such potential variation. The differences in the XRF data among the three sites, however, suggest that as a group, each village's

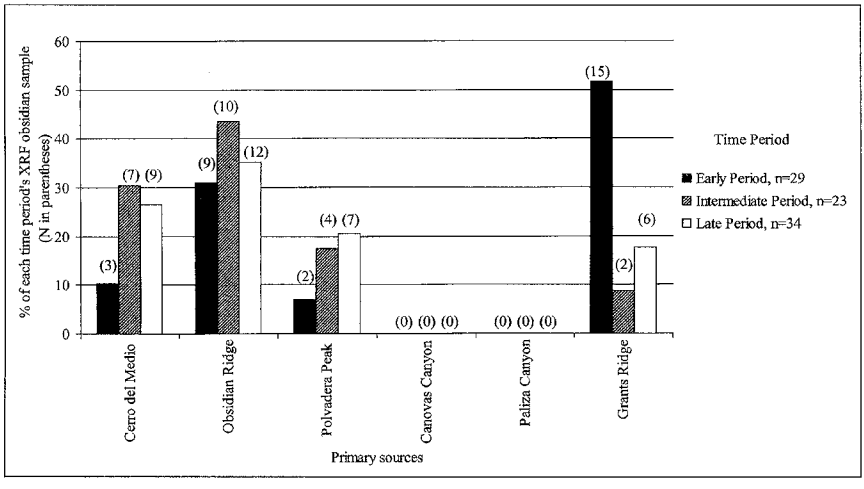

FIGURE 6. XRF obsidian samples from Gran Quivira. $\chi^2 = 16.06$; $p = .013$; $df = 6$.

obsidian exchange or procurement differed fairly significantly from other Jumanos pueblos. Whether such variation was driven by the actions of a few households within each village or reflects the activities of many households is unknown.

As discussed above, it is not possible to determine with certainty what proportions of obsidian recovered from the Jumanos pueblos were procured direct-

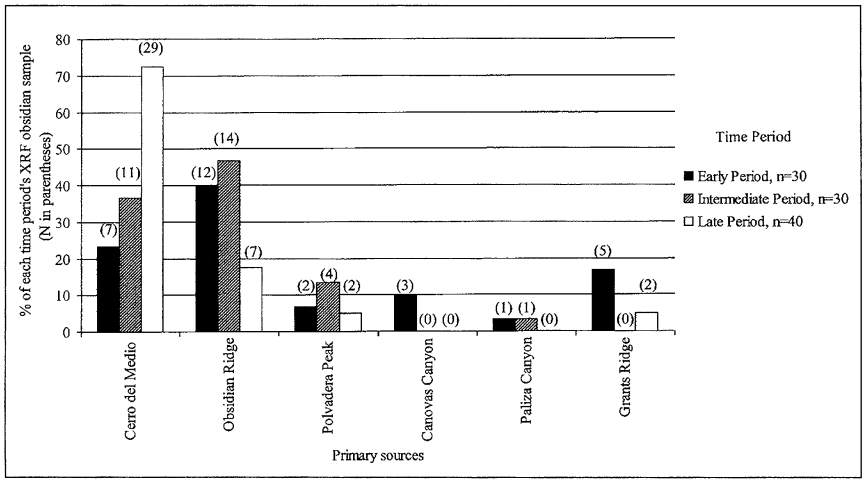

FIGURE 7. XRF obsidian samples from Pueblo Blanco. $\chi^2 = 31.10$; $p = .001$; $df = 10$.

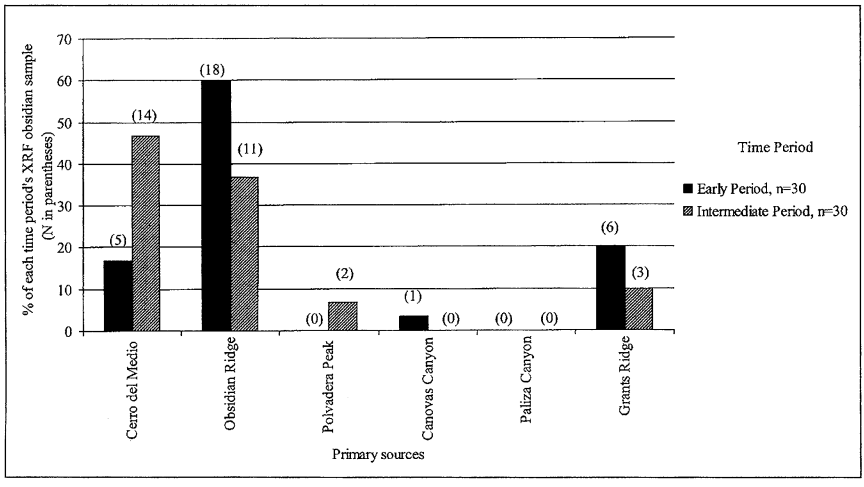

FIGURE 8. XRF obsidian samples from Pueblo Colorado. $\chi^2 = 9.95$; $p = .041$; $df = 4$.

ly from primary sources or from various secondary gravel deposits. To acquire this obsidian, the Jumanos pueblos would have relied either on exchange with pueblos located near sources, traveled to primary or secondary deposits to directly procure these materials, or a combination of the two. Unfortunately, it is not possible to distinguish among these possibilities.

The sources present in the secondary deposits from the Las Cruces/El Paso area sampled by Church (2000) are different than the sources present in the obsidian samples from the Jumanos pueblos. Specifically, Cerro del Medio materials are present in all of the Jumanos samples, often in high frequencies. This material is not present in the deposits sampled by Church (2000:663); nor is it present in samples from the same area analyzed by Stevenson and McCurry (1990:164). The samples from Las Cruces/El Paso secondary deposits also contain a small amount of materials from another primary source, No Agua (Church 2000:663), located in the Taos Plateau Volcanic Field, which is not present in any of the Jumanos pueblos' samples. This difference suggests two possibilities. First, Cerro del Medio materials may *not* have eroded into secondary gravel deposits in high frequencies and the presence of these materials in the Jumanos pueblos samples may represent direct procurement from the primary source or exchange with nearby pueblos. Given that Cerro del Medio materials have not been found outside of their primary source locale in the Jemez Mountains area, this is perhaps the more likely possibility. Baugh and Nelson (1987:317–318), however, report that the Cerro del Medio volcanic dome, the primary source of Cerro del Medio obsidian, is the youngest of the obsidian-bearing formations in the Jemez Mountains area. Because of the differences in depositional ages among the various primary obsidian sources in the Jemez Mountains and the Mt. Taylor volcanic field, as well as differences in the depositional ages of different Santa Fe gravel deposits (Stevenson and McCurry 1990:154–155), the proportions of primary sources represented in different Santa Fe gravel sedimentary deposits may vary across the landscape. Thus, it is also possible that the secondary gravel deposits sampled by Church (2000) in the Las Cruces/El Paso area simply predate the deposition of the gravel deposits from which the Jumanos obsidian may have been procured.

Although the exact locations of the secondary gravel deposits from which the inhabitants of the different Jumanos pueblo may have acquired obsidian are unknown, we can determine the broad area where they may have been located from the primary sources represented in each site sample. Given the appearance of Grants Ridge materials from the Mt. Taylor volcanic field, it is likely that a substantial proportion of the obsidian materials at these Jumanos pueblos would have been acquired from gravel deposits from (1) the Rio San Jose and Rio Puerco drainages, (2) south of the juncture of the Rio Puerco and the Rio Grande (the most likely point of entry for eroding Mt. Taylor materials into the Rio Grande Valley), or (3) from even more southerly deposits (see Figures 1 and 2). Some

obsidian materials from the Jemez Mountains would weather out and be transported down the Jemez River and its tributaries to the Rio Grande. It is likely, however, that more Jemez Mountain materials would erode into the Rio Grande River valley around the Cochiti area, roughly west of modern Santa Fe (Figure 2). Thus, secondary sources of the obsidian found at the Jumanos pueblos could be located from as far north as Cochiti to El Paso and even father south.

If obsidian was procured by the Jumanos pueblos through exchange with pueblos in or near the Rio Grande Valley, then the variability seen in the XRF data demonstrates that the possible exchange relationships established and maintained to acquire obsidian changed substantially over time. Obsidian trade relationships may also have been quite variable between the Jumanos villages and the variability in primary sources shows that different gravel deposits and, thus, different sets of exchange partners, may have been present at each site. It appears that the residents of each of the three pueblos may have had different sets, or combinations, of exchange partners they relied upon to acquire obsidian.

On the other hand, if obsidian was obtained primarily through direct procurement, then the XRF analysis may tell us something about long-distance social relationships the inhabitants of each pueblo, as a group, may have established. If people were traveling long distances from the Jumanos pueblos and procuring obsidian, then it may be likely that they would have had relatively close social relationships with pueblo groups living near those obsidian gravel sources. Differences in the primary sources present in the sites' obsidian samples may suggest that the inhabitants of each of the three Jumanos pueblos procured obsidian from different secondary gravel sources and, thus, had different sets of long-distance social relationships. In summary, the variability seen in the primary sources represented among the sites' obsidian samples, whether due to exchange or direct procurement or whether acquired from primary or secondary sources, documents a level of autonomy or independence among the three Jumanos villages in terms of their inhabitants' involvement in the long-distance acquisition of obsidian.

CONCLUSIONS

The results of the XRF sourcing analyses and the relative frequency analysis of obsidian recovered from Gran Quivira, Pueblo Blanco, and Pueblo Colorado are consistent with previous findings of both autonomy and some differentiation among villages in terms of their involvement in long-distance exchange or procurement (see Graves 2004; Graves and Spielmann 2000; Potter 1995). In particular, the obsidian data suggest two factors concerning the long-distance procurement or exchange of this material among the Jumanos pueblos. First, as shown in Table 3, there may have been differential access to obsidian among the three sites. During the Early period, Gran Quivira may have had somewhat better

access to obsidian. During the Intermediate period and, especially, the Late period, however, it was the residents of Pueblo Blanco who seem to have acquired more obsidian than the inhabitants of Gran Quivira. If the acquisition of goods derived through long-distance exchange or direct procurement was a way to create power and prestige for the inhabitants of the Jumanos pueblos during the Late Prehispanic era, then at least some individuals or households at Gran Quivira during the Early period and at Pueblo Blanco during the Intermediate and Late periods may have been more heavily involved in this potential prestige-enhancing activity than others.

Second, the XRF data shows that the distributions of primary sources in each site's obsidian samples during the Early and Late periods are significantly different (Table 9). This demonstrates that each pueblo operated independently of the others in terms of establishing and maintaining the long-distance social and economic relationships through which obsidian was obtained. The samples from each pueblo consist of different mixes of primary sources, suggesting (1) that the obsidian at each site was procured at different secondary gravel deposits or (2) that materials from different secondary gravel deposits and primary deposits are represented in varying proportions. Regardless of how obsidian was procured (either directly or through trade) or from where it was procured (primary or secondary sources), this independence suggests a level of autonomy among the three villages in the long-distance social and economic interactions they each had with the rest of the Rio Grande Pueblos. This autonomy in establishing and maintaining long-distance social and economic relations seems to have been characteristic of the Jumanos pueblos throughout their occupations.

In this paper, I have demonstrated the utility of analyzing chemical characterization studies of obsidian and examining the relative frequencies of such artifacts in site assemblages as tools for reconstructing past long-distance social and economic relations. Although obsidian does not appear to have been a socially-valued or prestigious item in the Late Prehispanic and Early Colonial period Rio

TABLE 9. Most frequent primary obsidian sources for each site sample (most frequent source listed first; "=" = no significant differences among the site samples for the Intermediate Period).

	Early Period	Intermediate Period	Late Period
Gran Quivira	Grants Ridge Obsidian Ridge	=	Obsidian Ridge Cerro del Medio
Pueblo Blanco	Obsidian Ridge Cerro del Medio	=	Cerro del Medio Obsidian Ridge
Pueblo Colorado	Obsidian Ridge Grants Ridge	=	—

Grande world, as seems to have been the case for the Hohokam of southeast Arizona (see Bayman 1995, 2001; Peterson, Mitchell, and Shackley 1997), it can provide useful information regarding the character of nonlocal social and economic relationships in which communities were engaged. Among the Jumanos pueblos, an examination of obsidian has shown both a level of autonomy and a level of differentiation among different villages in terms of the acquisition of this material. Such a finding is in line with ceramic and faunal studies of the Jumanos pueblos (e.g., Graves 2004; Potter 1995), which suggest that seemingly opposing relations of both autonomy and differentiation characterized the long-distance economic activities of the residents of these pueblos as well as the sociopolitical relations that existed within the local area.

ACKNOWLEDGMENTS

Funding for excavations at and analyses of materials from Pueblo Blanco were provided through grants to William Graves from the National Science Foundation (SBR-9904932) and the Wenner-Gren Foundation for Anthropological Research (Grant #6578) and by a Ford Foundation Dissertation Fellowship. Funding for excavations at and analyses of materials from Gran Quivira and Pueblo Colorado was provided through grants to Katherine Spielmann (SBR-9423194 and BNS-8418586) and the Wenner-Gren Foundation for Anthropological Research (Grants-in-Aid #5202 and #4655). I would like to thank Dr. Richard Hughes for conducting the XRF analyses of obsidian artifacts from the Jumanos pueblos and Scott Van Keuren, Steven Shackley, and Ana Steffen for providing comments on earlier drafts of this paper.

REFERENCES CITED

Adams, E. Charles
1991 *The Origin and Development of the Pueblo Katsina Cult.* University of Arizona Press, Tucson.

Adams, E. Charles, and Andrew I. Duff (editors)
2004 *The Protohistoric Pueblo World, A. D. 1275–1600.* The University of Arizona Press, Tucson.

Baugh, Timothy G., and Fred W. Nelson, Jr.
1987 New Mexico Obsidian Sources and Exchange in the Southern Plains. *Journal of Field Archaeology* 14(3):313–329.

Bayman, James M.
1995 Rethinking "Redistribution" in the Archaeological Record: Obsidian Exchange at the Marana Platform Mound. *Journal of Anthropological Research* 51(1):37–63.
2001 The Hohokam of Southwest North America. *Journal of World Prehistory* 15(3):257–311.

Binford, Lewis R.
1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35:255–273.

Bolton, Herbert E.
1908 *Spanish Exploration in the Southwest, 1542–1706.* Barnes and Noble, New York.

Cameron, Judi L.
1991 Lithics. In *Subsistence and Exchange at Gran Quivira Pueblo, New Mexico, Part 1*, by K. A. Spielmann, pp. 89–115. Report submitted to the National Park Service, Southwestern Regional Office, Santa Fe.
Camilli, Eileen L.
1988 Lithic Raw Material Selection and Use in the Desert Basins of South-central New Mexico. *Kiva* 53(2):147–163.
Capone, Patricia
1995 *Mission Pueblo Ceramic Analysis: Implications for Protohistoric Interaction Networks and Cultural Dynamics.* Unpublished Ph. D. dissertation. Harvard University, Cambridge. UMI, Ann Arbor.
Crown, Patricia L.
1994 *Ceramics and Ideology: Salado Polychrome Pottery.* University of New Mexico Press, Albuquerque.
Church, Tim
2000 Distribution and Sources of Obsidian in the Rio Grande Gravels of New Mexico. *Geoarchaeology* 15(7):649–678.
Findlow, Frank J. , and Marisa Bolognese
1980 An Initial Examination of Prehistoric Obsidian Exchange in Hidalgo County New Mexico. *The Kiva* 45(3):227–251.
Glascock, Michael D. , Raymond Kunselman, and Daniel Wolfman
1999 Intrasource Chemical Differentiation of Obsidian in the Jemez Mountains and Taos Plateau, New Mexico. *Journal of Archaeological Science* 26:861–868.
Graves, William M.
2002 *Power, Autonomy, and Inequality in Rio Grande Puebloan Society, A. D. 1300–1672.* Ph. D. dissertation, Arizona State University, Tempe. UMI, Ann Arbor.
2004 Social Identity and the Internal Organization of the Jumanos Pueblos Settlement Cluster in the Salinas District, Central New Mexico. In *The Protohistoric Pueblo World, A. D. 1275–1600,* edited by E. C. Adams and A. I. Duff, pp. 43–52. The University of Arizona Press, Tucson.
Graves, William M. , and Katherine A. Spielmann
2000 Leadership, Long-Distance Exchange, and Feasting the Protohistoric Rio Grande. In *Alternative Leadership Strategies in the Prehispanic Southwest,* edited by B. J. Mills, pp. 45–59. The University of Arizona Press, Tucson.
2003 Politics and Economy at Pueblo Blanco (LA 51), New Mexico: Final Report of the 1999 and 2000 Field Seasons. Report submitted to the USDA Forest Service, Cibola National Forest Office, Albuquerque.
Habicht-Mauche, Judith A.
1999 Pottery, Food, Hides, and Women: Labor, Production, and Exchange across the Protohistoric Plains-Pueblo Frontier. In *The Archaeology of Regional Interaction: Religion, Warfare, and Exchange across the American Southwest and Beyond,* edited by M. Hegmon, pp. 209–231. University Press of Colorado, Boulder.
Habicht-Mauche, Judith A. , Stephen T. Glenn, Homer Milford, and A. Russell Flegal
2000 Isotopic Tracing of Prehistoric Rio Grande Glaze-Paint Production and Trade. *Journal of Archaeological Science* 27:709–713.
Hammond, George P. , and Agapito Rey
1953 *Don Juan de Oñate, Colonizer of New Mexico.* Coronado Cuarto–Centennial Publications, Volumes 5 and 6. University of New Mexico Press, Albuquerque.
Hayes, Alden C.
1982 The Jumanos Pueblos. In *Salinas: Archaeology, History, and Prehistory.* Exploration, Annual Bulletin of the School of American Research:11–15.
Hayes, Alden C. , Jon N. Young, and A. Helene Warren
1981 *Excavation of Mound 7, Gran Quivira National Monument, New Mexico.* Publication in Archeology 16. National Park Service, Washington, D. C.
Hill, J. Brett
1998 Agricultural Production and Specialization Among the Eastern Anasazi During the Pueblo IV Period. In *Migration and Reorganization: The Pueblo IV Period in the*

American Southwest, edited by K. A. Spielmann, pp. 209–232. Arizona State University Anthropological Research Papers 51, Arizona State University, Tempe.

Hughes, Richard E.

1988a Archaeological Significance of Geochemical Contrasts among Southwestern New Mexico Obsidians. *The Texas Journal of Science* 40(3):297–307.

1988b X-ray Fluorescence Analysis of Obsidian Artifacts from Gran Quivira, New Mexico. Letter report submitted to Katherine Spielmann, Arizona State University, August 8, 1988, from Anthropological Studies Center, Cultural Resources Facility, Sonoma State University, Sonoma, CA. Manuscript on file, Department of Anthropology, Arizona State University, Tempe.

2001a X-ray Fluorescence Analysis of Obsidian Artifacts from Pueblo Blanco (LA 51) and Pueblo Colorado (LA 476), Central New Mexico. Geochemical Research Laboratory Letter Report 2000–118, submitted to William Graves, Arizona State University, January 27, 2001. Manuscript on file, Department of Anthropology, Arizona State University, Tempe.

2001b X-ray Fluorescence Analysis of Obsidian Artifacts from Pueblo Blanco (LA 51) and Pueblo Colorado (LA 476), Central New Mexico. Geochemical Research Laboratory Letter Report 2000–118. 1, submitted to William Graves, Arizona State University, February 6, 2001. Manuscript on file, Department of Anthropology, Arizona State University, Tempe.

LeTourneau, Philippe D. , Raymond Kunselman, and Tony Baker

1999 Results of Additional XRF Analysis of New Mexico Folsom Obsidian Artifacts. *Current Research in the Pleistocene* 16:99–101.

LeTourneau, Philippe D. and Anastasia Steffen

2002 Field Investigations at a Likely Source for New Mexico Obsidian Folsom Artifacts. *Current Research in the Pleistocene* 19:57–59.

MacDonald, Ray, Robert L. Smith, and John E. Thomas

1992 Chemistry of the Subalkalic Silicic Obsidians. *U. S. Geological Survey Professional Paper* 1523. Washington, D. C.

Mauldin, R. , T. Graves, and M. Bentley

1998 *Small Sites in the Central Hueco Bolson: A Final Report on Project 90-11.* Conservation Division, Directorate of Environment, U. S. Army Air Defense Artillery Center, Fort Bliss, TX.

Mecham, J. L.

1926 The Second Spanish Expedition to New Mexico: An Account of the Chamuscado-Rodriguez Entrada of 1581–1582. *New Mexico Historical Review* 1(3):265–291.

Mitchell, Douglas R. , and M. Steven Shackley

1995 Classic Period Hohokam Obsidian Studies in Southern Arizona. *Journal of Field Archaeology* 22(3):291–304.

Peterson, Jane, Douglas R. Mitchell, and M. Steven Shackley

1997 The Social and Economic Contexts of Lithic Procurement: Obsidian from Classic-Period Hohokam Sites. *American Antiquity* 62(2):231–259.

Potter, James M.

1995 The Effects of Sedentism on the Processing of Hunted Carcasses in the Southwest: A Comparison of Two PIV Sites in Central New Mexico. *Kiva* 60(3):411–428.

1997 Communal Ritual, Feasting, and Social Differentiation in Late Prehistoric Zuni Communities. Ph. D. dissertation, Arizona State University, Tempe. UMI, Ann Arbor.

Shackley, M. Steven

1987 Sources of Archaeological Obsidian in the Southwest: An Archaeological, Petrological, and Geochemical Study. *American Antiquity* 53(4):752–772.

1992 The Upper Gila River Gravels as an Archaeological Obsidian Source Region: Implications for Models of Exchange and Interaction. *Geoarchaeology* 7(4):315–326.

1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. *American Antiquity* 60:531–551

1998a Geochemical Differentiation and Prehistoric Procurement of Obsidian in the Mt. Taylor Volcanic Field, Northwest New Mexico. *Journal of Archaeological Science* 25:1073–1082.

1998b Intrasource Chemical Variability and Secondary Depositional Processes: Lessons from the American Southwest. In *Archaeological Obsidian Studies: Method and Theory,* edited by M. S. Shackley, pp. 83–102. *Advances in Archaeological and Museum Sciences, Volume 3.* Plenum Press, New York.

Shepard, Anna O.

1942 Rio Grande Glaze Paint Ware. *Contributions to American Anthropology and History 39.* Carnegie Institution, Washington, D. C.

Snow, David H.

1981 Protohistoric Rio Grande Pueblo Economics: A Review of Trends. In *The Protohistoric Period in the North American Southwest, A. D. 1450–1700,* edited by D. R. Wilcox and W. B. Masse, pp. 354–377. Arizona State University Anthropological Research Paper 24. Tempe.

Spielmann, Katherine A.

1989 Colonists, Hunters, and Farmers: Plains-Pueblo Interaction in the Seventeenth Century. In *Columbian Consequences, Volume 1: Archaeological and Historical Perspectives in the Spanish Borderlands West,* edited by D. H. Thomas, pp. 101–114. Smithsonian Institution Press, Washington, D. C.

1991a *Subsistence and Exchange at Gran Quivira Pueblo, New Mexico, Part 1.* Report submitted to the National Park Service, Southwestern Regional Office, Santa Fe.

1991b *Interdependence in the Prehistoric Southwest: An Ecological Analysis of Plains-Pueblo Interaction.* Garland, New York.

1992 *Subsistence and Exchange at Gran Quivira Pueblo, New Mexico, Part 2.* Report submitted to the National Park Service, Southwestern Regional Office, Santa Fe.

1994 Clustered Confederacies: Sociopolitical Organization in the Protohistoric Rio Grande. In *The Ancient Southwestern Community: Models and Methods for the Study of Prehistoric Social Organization,* edited by W. H. Wills and R. D. Leonard, pp. 45–54. University of New Mexico Press, Albuquerque.

1998a *Economy and Society at Pueblo Colorado, New Mexico: Report of the 1989 Excavations.* Report submitted to the USDA Forest Service, Cibola National Forest Office, Albuquerque.

1998b The Pueblo IV Period: History of Research. In *Migration and Reorganization: The Pueblo IV Period in the American Southwest,* edited by K. A. Spielmann, pp. 1–30. Arizona State University Anthropological Research Papers 51. Tempe.

Spielmann, Katherine A., and MaryAnn Emery

1994 Ceramics. In *The Evolution of Craft Specialization in Tribal Societies: Preliminary Report for the 1993 Excavation Season at Quarai Pueblo, New Mexico,* by K. A. Spielmann, pp. 72–79. Report submitted to the National Park Service, Southwestern Regional Office, Santa Fe.

Stevenson, Christopher M. , and Maria Klimkiewicz

1990 X-Ray Fluorescence Analysis of Obsidian Sources in Arizona and New Mexico. *Kiva* 55(3):235–243.

Stevenson, Christopher M. , and Michael O. McCurry

1990 Chemical Characterization and Hydration Rate Development for New Mexico Obsidian Sources. *Geoarchaeology* 5(2):149–170.

Toulouse, Joseph H., and Robert L. Stephenson

1960 *Excavations at Pueblo Pardo.* Papers in Anthropology 2. The Museum of New Mexico, Santa Fe.

Warren, A. Helene

1969 Tonque: One Pueblo's Glaze Pottery Industry Dominated Middle Rio Grande Commerce. *El Palacio* 76:36–42.

1979 The Glaze Paint Wares of the Upper Middle Rio Grande. In *Archaeological Investi-*

gations in Cochiti Reservoir, New Mexico, Volume 4: Adaptive Change in the Northern Rio Grande Valley, edited by J. V. Biella and R. C. Chapman, pp. 187–216. Office of Contract Archaeology, Department of Anthropology, University of New Mexico, Albuquerque.

1981 Appendix I: Description of Pottery Tempering Materials of Gran Quivira. In *Excavations at Mound 7,* by A. C. Hayes, J. N. Young, and A. H. Warren, pp. 179–182. National Park Service Publications in Archaeology 16, Washington, D. C.

Wilcox, David R.

1981 Changing Perspectives on the Protohistoric Pueblos. In *The Protohistoric Period in the North American Southwest, A. D. 1450–1700,* edited by D. R. Wilcox and W. B. Masse, pp. 378–409. Arizona State University Anthropological Research Paper 24, Tempe.

1991 Changing Contexts of Pueblo Adaptations, A. D. 1250–1600. In *Farmers, Hunters, and Colonists: Interaction Between the Southwest and the Southern Plains,* edited by K. A. Spielmann, pp. 128–154. University of Arizona Press, Tucson.

WILLIAM M. GRAVES
Department of Anthropology
University of Iowa
Iowa City, IA 52242-1322
billy-graves@uiowa.edu