HOHOKAM TO AKIMEL O’ODHAM: OBSIDIAN ACQUISITION AT THE HISTORIC PERIOD SACATE SITE (GR-909), GILA RIVER INDIAN COMMUNITY, ARIZONA

Chris R. Loendorf, Craig M. Fertelmes, and Barnaby V. Lewis

Obsidian provenance studies within the Phoenix Basin of south-central Arizona have become increasingly comprehensive during the last four decades. As a result, broad regional and temporal trends have been defined regarding Preclassic (ca. A.D. 650–1150) and Classic period (ca. A.D. 1150–1450) socioeconomic interactions in the Hohokam core area. However, Historic period patterns are still poorly understood, and these data are essential for understanding the relationship between the prehistoric Hohokam and historical Akimel O’odham. The association between the Akimel O’odham and Hohokam has been debated since Euro-Americans first visited the area in the late 1600s, yet this issue is still not fully resolved. This article presents analyses of historical obsidian from the Sacate site that suggest that long-term trends in cultural patterns within the Phoenix Basin continued unbroken into the Historic period. These continuities provide another line of evidence that the Akimel O’odham are the direct cultural descendants of the Hohokam.

Los estudios sobre las fuentes de origen de la obsidiana dentro de la Cuenca de Phoenix en la región sud-central de Arizona han llegado a ser cada vez más completos durante las últimas cuatro décadas. Como resultado, amplios patrones espaciotemporales han sido definidos con respecto a los periodos Pre-Clásico (ca. d.C. 650–1150) y Clásico (ca. d.C. 1150–1450) destacando las interacciones socioeconómicas en el núcleo de la cultura Hohokam. Sin embargo, las interacciones durante el periodo Histórico todavía no son claras, y estos datos son esenciales para comprender la relación entre los Hohokam prehistóricos y los Akimel O’odham históricos. La asociación entre los O’odham y los Hohokam ha sido debatida desde que los primeros Euroamericanos visitaron la región al final de los 1600; no obstante, este tema todavía no está resuelto completamente. Este trabajo resume los resultados del análisis de obsidiana histórica del sitio Sacate, lo que sugiere que a largo plazo los patrones culturales dentro de la Cuenca de Phoenix continuaron intactos durante el periodo Histórico. Esta continuidad es fuerte evidencia de que los Akimel O’odham son los descendientes de los Hohokam.

The study examines Akimel O’odham (i.e., Pima) socioeconomic interactions through analyses of Protohistoric (ca. A.D. 1500–1693) and Historic period (A.D. 1694–1962) obsidian acquisition patterns at the Sacate site (GR-909) in south-central Arizona. Until recently, comparatively few archaeological data were available from the Akimel O’odham settlement area along the Middle Gila River portion of the Hohokam core area in the Phoenix Basin (Figure 1). However, as part of the Pima-Maricopa Irrigation Project, the Gila River Indian Community (GRIC) created a Cultural Resource Management Program that has conducted a full-coverage archaeological survey of nearly 57,000 ha within the community (Darling 2011; Darling et al. 2004; Loendorf 2012; Loendorf and Rice 2004; Ravesloot 2007; Waters and Ravesloot 2000, 2001; Wells 2006; Wells et al. 2004; Woodson 2010). These investigations included recording efforts at Sacate, an extensive historical village located on the south side of the Middle Gila near the center of the GRIC. Prehistoric remains are uncommon at Sacate, and therefore it is possible to study indigenously

Chris R. Loendorf ■ Cultural Resources Management Program, Gila River Indian Community, Sacaton, AZ 85147
(chris.loendorf@gric.nsn.us)
Craig M. Fertelmes ■ Cultural Resources Management Program, Gila River Indian Community, Sacaton, AZ 85147
(craig.fertelmes@gric.nsn.us)
Barnaby V. Lewis ■ Tribal Historic Preservation Office, Gila River Indian Community, Sacaton, AZ 85147
(barnaby.lewis@gric.nsn.us)
produced historic artifacts in a setting that largely lacks intermixing of earlier materials.

Despite repeated attempts to obtain firearms, the historical Akimel O’Odham possessed few guns. Instead, bows and arrows were commonly used until the end of the nineteenth century (Bancroft 1886:520; Grossman 1873:416; Mason 1894; Russell 1908:111). In contrast to many eastern and Plains groups, Native Americans along the Middle Gila rarely employed metal arrowpoints, and they continued to make projectile tips from stone, including obsidian, until roughly A.D. 1880 (Bancroft 1886; Ferg and Tessman 1997:259–261; Grossman 1873). Written descriptions of Akimel O’Odham settlement locations, technological traditions, socioeconomic interactions, and subsistence
practices began in the late 1600s and continued over the course of the Historic period (DeJong 2009, 2011; Ezell 1961; Fewkes 1912; Hackenberg 1974; Russell 1908; Seyfert 2011; Wells 2006; Wilson, forthcoming). Thus, the situation along the Middle Gila offers an important opportunity to compare spatial and temporal patterning among obsidian artifacts with historically documented socioeconomic interactions, projectile technology, and other cultural practices (Loendorf 2012).

For multiple reasons, obsidian has properties that are ideally suited for studying exchange and interaction in southern Arizona (Ballenger and Hall 2011; Bayman 1995; Fertelmes et al. 2012; Loendorf 2010, 2012; Marshall 2002; Mitchell and Foster 2011; Mitchell and Shackley 1995; Peterson et al. 1997; Rice et al. 1998; Shackley 1988, 1990, 1995, 2005). First, raw materials necessary for manufacturing retouched tools are uncommon in the Phoenix Basin, and obsidian is a desirable stone for producing arrowpoints. Second, because obsidian does not occur naturally within the Phoenix Basin, all of the material at archaeological sites must have been culturally transported from elsewhere. Third, obsidian sources are generally abundant and localized deposits. Fourth, obsidian has geochemical properties that allow source locations to be objectively identified with a high degree of precision. It is therefore possible to examine the nature of exchange interactions between the core area and surrounding populations, as well as relationships among communities within the Phoenix Basin.

Obsidian source provenance studies are also an important component of prehistoric archaeological research throughout the Southwest and other parts of North America, including the Pacific Northwest, California, the Great Basin, and Mesoamerica. Although archaeologists have devoted considerable effort to analyzing precontact assemblages, obsidian from Historic period contexts has rarely been considered (but see Millhauser et al. 2011; Silliman 2005). This lack of research does not result from an absence of obsidian at historical indigenous sites but, instead, occurs because archaeologists who study postcontact sites generally have not considered the research potential of these remains (Silliman 2005:75). The following analyses explore the broader implications of these artifacts, and this investigation illustrates how obsidian data can be used to improve our understanding of associations among prehistoric and historical indigenes.

The relationship between the late prehistoric inhabitants of the Middle Gila (i.e., Classic Hohokam) and the Akimel O’Oddham has been debated since Spanish missionaries first visited the Phoenix Basin in the late 1600s (Fewkes 1912:33; Russell 1908). Despite centuries of speculation and argument, the association between the precontact and postcontact populations remains unresolved (Ezell 1983:149–150; Gilpin and Phillips 1998:28–43; Seyfert 2011; Wells 2006). Data from the Protohistoric and Early Historic periods (A.D. 1694–1820) are critical for assessing the Hohokam collapse as well as the continuum of populations. However, Akimel O’Oddham archaeological remains from this time are largely restricted to the GRIC, where until recently little research has occurred (Wells 2006:1–2).

Relationships among the Hohokam and contemporary groups are of considerable importance to the Akimel O’Oddham, and this issue has modern sociopolitical ramifications in a region where highly contested water rights are based on prior usage (DeJong 2011:17–21). While the Akimel O’Oddham continue to maintain detailed oral traditions regarding their past, these social memories have been extensively ignored or misunderstood. Not only does this matter affect these peoples’ perceptions of their past, it also impacts their lives in other ways. These include issues of cultural patrimony and repatriation cases where Akimel O’Oddham perspectives are still sometimes undervalued or dismissed.

**Ethnohistorical and Ethnographic Background**

The following section presents descriptions of projectile design and hunting practices, which are employed to infer functional aspects of historical projectiles. These observations suggest that historical flaked-stone arrowpoints were largely if not exclusively produced for use in warfare. Next, intergroup conflicts that substantially impacted Akimel O’Oddham socioeconomic interactions are described. Finally, historical descriptions of exchange relationships are used to generate expectations for obsidian acquisition patterns at Sacate.
**Akimel O’Odham Projectile Design**

Contrary to a common assumption, a stone projectile tip is not necessary to “balance” the shaft. Instead, prehistoric and historical projectiles commonly had organic tips such as bone, antler, or wood (Mason 1894). In a cross-cultural study of over 100 societies, Ellis (1997) found that different types of projectile tips were employed for separate purposes. Stone points were almost invariably associated with hunting large game animals (> 40 kg) and/or warfare, while organic tips were far more commonly employed in small-game (< 40 kg) hunting.

By the 1800s, the Akimel O’Odham rarely hunted large animals (Ezell 1961; Rea 1998; Russell 1908). Prehistoric sites below 800 m elevation in southern Arizona generally have low incidences of large faunal remains, while habitation sites above this elevation commonly have evidence for greater reliance on ungulates (Szuter 1991). The nearest extensive areas above 800 m are roughly 30 km away from the Middle Gila in the mountains to the north and east, but these locations were occupied by the Nnéé (i.e., Apache) and Gōōn (i.e., Yavapai) during the Historic period (see Figure 1).

The Akimel O’Odham instead primarily hunted locally available small game, and the arrows they used for this purpose lacked stone tips. Arrows designed for use in warfare, however, had flaked-stone points attached (Bancroft 1886:520; Grossman 1873:416; Mason 1894; Russell 1908). For example, Bancroft said that the Akimel O’Odham “wing their war arrows with three feathers and point them with flint, while for hunting purposes they have only two feathers and wooden points” (1886:520).

**Conflict**

While the nature and intensity of warfare varied over time and space, conflict was endemic among Southwestern Historic populations (Basso 2004; Burns 2012; Ezell 1961; Jacoby 2008; Kroeber and Fontana 1986; Rice 2001; Russell 1908; Shaw 1994:10–14; Spier 1933; Webb 1959:22–25). The Nnéé and Gōōn regularly raided Akimel O’Odham villages along the Middle Gila. Although individual attacks were generally minor, conflict with these groups caused the aggregation of Akimel O’Odham populations, which resulted in the abandonment of extensive former habitation areas (Ezell 1961; Hackenberg 1974). These conflicts effectively circumscribed Akimel O’Odham socioeconomic interactions, because intervening Nnéé and Gōōn populations restricted trade with other groups, including Pueblo populations to the north and east (Russell 1908; see Figure 1).

**Socioeconomic Interactions**

By the nineteenth century the Pee Posh (i.e., Maricopa) and Tohono O’Odham (i.e., Papago) were the primary indigenous exchange partners for the Akimel O’Odham (Russell 1908:93). Prior to roughly A.D. 1830, Pee Posh from the Gila Bend area came at harvest time to exchange goods with the Akimel O’Odham (Russell 1908:93). After the Pee Posh moved from farther west along the Gila to the area immediately adjacent to the Akimel O’Odham villages, the Tohono O’Odham were their primary nonlocal exchange partners. Although the Tohono O’Odham lived in more arid desert environments to the south, in addition to salt they also brought food and a wide variety of other items for exchange (Russell 1908:93; Webb 1959:65).

The Akimel O’Odham also sold items to or bartered with Mexican populations to the south, and by the 1850s they traded or sold large amounts of goods with settlers and others who traveled through the area (DeJong 2009, 2011). The Akimel O’Odham also “sent well-armed bands through the Apache cordon to trade at the Spanish and Mexican settlements of Sonora” (Russell 1908:94). In addition, an annual fair was held along the Middle Gila that was “attended by ‘multitudes’ of people from the towns and presidios of Tucson, Tubac, Santa Cruz, and the San Ignacio River” (Ezell 1961:30).

For much of the Historic period, the items the Akimel O’Odham produced for trade consisted largely of “baskets and woven goods—belts, hair bands, and above all else cotton blankets” (Ezell 1961:29). By the 1850s they also grew large surpluses of commodities that they sold or bartered to the U.S. military, and previously they were able to provide food to other communities in times of need (DeJong 2009; Ezell 1961). These socioeconomic interactions were not exclusively based on kinship ties or simple reciprocal relationships, and Russell listed the late 1800s exchange rates as follows:
A gourd was equivalent to a basket; a metate, a small shell necklace, or the combination of a basket and a blanket and a strand of blue glass beads was equivalent to a horse; a string of blue glass beads 4 yards long was equivalent to a bag of paint; and a basket full of beans or corn to a cooking pot [1908:92].

While the Akimel O’Odham used Euro-American glass beads for exchange, they expressed strong preferences for particular types of ornaments, especially those made from marine shell and stone. For example, Bartlett observed that some Akimel O’Odham had long strings of sea-shells or parts of shells, which are highly prized. I tried to buy some of them; but the only man at all disposed to sell asked me five dollars [equivalent to roughly $130 today] or a pair of blankets for a few strings, a price so extravagant that I declined to make the purchase [1854:231].

Many who came to trade had already made up their minds only to do so for some particular article, and in those cases it was not of the least avail to offer anything else. . . . Jewelry had no value to them, fancy beads were worthless, stone beads however they traded for eagerly, but we had none [1906:150].

In aggregate, these observations suggest that the Akimel O’Odham chose to adopt Euro-American goods that fit within previously existing socio-economic interaction patterns along the Middle Gila. Furthermore, until the Akimel O’Odham became more fully incorporated into the American economic system in the 1900s, Euro-Americans and the Akimel O’Odham also valued goods differently, such that items considered valuable by the former had little worth to the latter and vice versa.

**Sacate Site Description**

Sacate (GR-909) is a roughly 3-km-long and .8-km-wide habitation where 204 features, including *ki-kuh* (traditional Akimel O’Odham round houses), other areas with structural remains, extensive midden deposits, and three cemeteries were identified (Figure 2). Obsidian artifacts analyzed in this study were derived from systematic surface collections undertaken by GRIC Cultural Resource Management Program field crews between March and August 2000. All identified diagnostic remains, including any obsidian or projectile points, were collected. A total of 184 quantitative units, which
consisted of 3.14-m² areas where all artifacts were recovered, were also collected (Wells et al. 2004). Darling (2011) describes a process whereby Akimel O’Odham villages drift over time, and analyses of nonindigenous artifacts and projectile point data from Sacate support this model (Darling et al. 2004; Loendorf 2012:83–89; Spier 1933:22). Temporal shifts among segments of the site appear to have resulted from historical and environmental events such as immigration, movement of the Gila River channel, flooding, the construction of transportation routes, and other Euro-American interactions (Darling 2011). Although the precise dating of site segments is uncertain, there is considerable evidence that occupation of Sacate spans the Protohistoric to Modern periods, and substantial differences in the artifact collections and feature types in site segments suggest relative differences in the age of habitation.

Indigenous ceramic data suggest that Sacate largely postdates the prehistoric period, as all precontact types combined make up only 1 percent of the collection (Table 1). Similarly, projectile points from the site are also predominately historic types (Table 2). Based on an analysis of early historical records, Wilson (forthcoming) concludes that Sacate was documented by the Jesuit missionary Father Kino, who was the first Euro-American to visit the Phoenix Basin (see also Ezell 1961). This village was labeled “Soación” on Kino’s 1695–1696 map of the area. Wilson argues that the synonymy of this name suggests that it corresponds with a village called Sudac-sson or Su-taquisón (Where the water comes up) that was recorded by Franciscan missionaries in the eighteenth century. As can be seen in Figure 1, the recorded positions for this village all roughly correspond with the location of Sacate. It is improbable that this area was settled immediately before Kino’s visits, suggesting that Sacate was occupied at least prior to the mid-1600s.

The relative ages of occupation in different site segments can in part be inferred from variation in feature types and nonlocal artifacts. The oldest nonindigenous remains were recovered from the central segment and consist of one-piece metal buttons that were manufactured from 1750 to 1812. Other nonlocal artifacts suggest that this segment was occupied through at least the late 1800s. In contrast to the central segment, ki-kuh are less com-

### Table 1. Absolute Frequencies of Pottery Sherds Recovered from Sacate by Time Period, Type, and Segment of Site.

<table>
<thead>
<tr>
<th>Period</th>
<th>Ceramic Type</th>
<th>Central</th>
<th>Expansion</th>
<th>Western</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historic</td>
<td>Red on Buff</td>
<td>3659</td>
<td>2965</td>
<td>2724</td>
<td>9348</td>
</tr>
<tr>
<td>Historic</td>
<td>Red on Brown</td>
<td>1588</td>
<td>1403</td>
<td>1197</td>
<td>4188</td>
</tr>
<tr>
<td>Historic</td>
<td>Plain</td>
<td>1534</td>
<td>1556</td>
<td>746</td>
<td>3836</td>
</tr>
<tr>
<td>Historic</td>
<td>Red</td>
<td>1165</td>
<td>769</td>
<td>394</td>
<td>2328</td>
</tr>
<tr>
<td>Historic</td>
<td>Black on Red</td>
<td>176</td>
<td>129</td>
<td>132</td>
<td>437</td>
</tr>
<tr>
<td>Historic</td>
<td>Papago Green Glaze</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Historic</td>
<td>Indet. Yellow Ware</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>8124</td>
<td>6825</td>
<td>5196</td>
<td>20145</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Plain/Smudged</td>
<td>42</td>
<td>-</td>
<td>4</td>
<td>46</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Sacaton Red on Buff</td>
<td>8</td>
<td>30</td>
<td>4</td>
<td>42</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Snaketown Red on Buff</td>
<td>1</td>
<td>25</td>
<td>3</td>
<td>29</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Gila Butte Red on Buff</td>
<td>5</td>
<td>9</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Casa Grande Red on Buff</td>
<td>8</td>
<td>8</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Santa Cruz Red on Buff</td>
<td>1</td>
<td>13</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Gila Polychrome</td>
<td>6</td>
<td>2</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Tanque Verde Red on Brown</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Prehistoric</td>
<td>Red/Smudged</td>
<td>3</td>
<td>-</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Cibola White Ware</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Tonto Polychrome</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Indet. Corrugated Plain</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>Mogollon Brown</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>76</td>
<td>88</td>
<td>40</td>
<td>204</td>
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<tr>
<td>TOTAL</td>
<td></td>
<td>8200</td>
<td>6913</td>
<td>5236</td>
<td>20349</td>
</tr>
</tbody>
</table>
mon in the expansion segment. A change to other structural types occurred in the 1800s, but kikuk were used until at least the 1930s (Sayles 1938:61). The comparatively low incidence of kikuk in the expansion segment suggests that it was first inhabited more recently than the central segment. Nonindigenous artifacts from the expansion segment include military buttons and black glass, including one example with an “improved” pontil scar, suggesting that this segment was used prior to the 1880s. Nonindigenous artifacts from the western segment differ substantially from those collected in the rest of the site, and the incidence of glass and nonindigenous ceramics as well as metal items is higher, suggesting that this area has the most recent occupation (Randolph et al. 2002). Sacate has not been abandoned, and scattered houses as well as modern housing subdivisions occur in the area. Furthermore, the Akimel O’Odham continue to use the cemetery in the western site segment.

Sacate Projectile Point Analysis

Almost 100 arrowpoints were recovered from GR-909 (see Table 2). All of these artifacts are small isosceles triangular forms that lack notches or serration (Figure 3). Historic point types that have been defined within southern Arizona are largely triangular forms that lack notches, but there is significant variation in blade shape, degree of basal concavity, and particularly serration (Justice 2002; Loendorf 2012; Loendorf and Rice 2004; Seymom 2011; Vint 2005; Wells 2006:17). Although 7 percent of the arrowpoints from Sacate were classified as Classic period types, similar unnotched and unserrated points were produced during the Classic and Historic periods, and these artifacts are possibly misclassified historical remains (Loendorf and Rice 2004:60; Ravesloot and Whittlesey 1987:96). While the similar morphological characteristics of Classic and Historic points complicate the separation of these types, this consistency in design (especially the absence of serration) is also evidence for continuity in technological practices from prehistory to history (Loendorf 2012:101–106). Detailed description of the typological classification system, metric and attribute data, and images of all points from Sacate are available in Loendorf and Rice 2004.

The incidence of obsidian artifacts varies across Sacate, and the highest concentration occurs in the western segment, which was most recently inhabited (Table 3). These observations suggest that increased obsidian use occurred over time, which is reflected in the material type proportions for points by site segment (Table 4). This apparent diachronic trend is supported by the fact that arrowpoint densities are relatively consistent across the site, which suggests that patterning in these data did not result from sampling bias, formation, or postdepositional processes.

This trend toward greater reliance on obsidian for point production appears to be part of a longer-term process that began well before the Historic period. Along the Middle Gila, Archaic points were only occasionally made from obsidian (< 2 percent), but use of this material became common by the Classic period (Loendorf and Rice 2004:4–8). Similar tendencies for an increase in obsidian use over time have been documented within Hohokam collections.

### Table 2. Absolute Frequencies of Arrowpoints Recovered from Sacate by Time Period, Style, and Segment of Site.

<table>
<thead>
<tr>
<th>Period</th>
<th>Arrow Point Type</th>
<th>Central</th>
<th>Expansion</th>
<th>Western</th>
<th>TOTAL</th>
</tr>
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<tbody>
<tr>
<td>Historic</td>
<td>Straight Base Triangular</td>
<td>14</td>
<td>9</td>
<td>5</td>
<td>28</td>
</tr>
<tr>
<td>Historic</td>
<td>U-shaped Base Triangular</td>
<td>13</td>
<td>12</td>
<td>13</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>27</td>
<td>21</td>
<td>18</td>
<td>66</td>
</tr>
<tr>
<td>Classic</td>
<td>Bulbous Base</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Classic</td>
<td>Concave Base Triangular</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Classic</td>
<td>Long Triangular</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Classic</td>
<td>Thin Triangular</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>5</td>
<td>-</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>Indeterminate</td>
<td>7</td>
<td>12</td>
<td>4</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td>39</td>
<td>33</td>
<td>24</td>
<td>96</td>
</tr>
</tbody>
</table>
from elsewhere in southern Arizona (Ballenger and Hall 2011:146–148; Bayman and Shackley 1999; Fertelmes et al. 2012; Marshall 2002; Peterson et al. 1997). This continuation of diachronic prehistoric patterns is also evidence for cultural continuity between the Hohokam and Akimel O’Odham.

**Obsidian Source Analysis Methods**

A total of 131 obsidian artifacts from Sacate were subjected to energy-dispersive X-ray fluorescence (EDXRF) analysis. EDXRF analyses of 13 samples were completed by the Archaeological XRF Laboratory, University of California, Berkeley, using a Spectrace/ThermoNoran QuanX spectrometer (Shackley and Daehnke 2004). The remaining 118 artifacts were analyzed by the GRIC Material Sciences Laboratory (MSL) using a Bruker Tracer III-V portable spectrometer.1

In order to compare Berkeley and Tracer III-V compositional results, GRIC-MSL reanalyzed 105 obsidian artifacts that were previously character-

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Table 3. Absolute Frequencies and Densities (n/ha) for Total Obsidian and Arrowpoints from Sacate by Segment of Site.

<table>
<thead>
<tr>
<th>Site Segment</th>
<th>Obsidian Count</th>
<th>Arrow Point Count</th>
<th>Hectares</th>
<th>Obsidian Density</th>
<th>Arrow Point Density</th>
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</thead>
<tbody>
<tr>
<td>Central</td>
<td>51</td>
<td>39</td>
<td>53</td>
<td>0.97</td>
<td>0.74</td>
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<tr>
<td>Expansion</td>
<td>54</td>
<td>28</td>
<td>50</td>
<td>1.07</td>
<td>0.56</td>
</tr>
<tr>
<td>Western</td>
<td>105</td>
<td>29</td>
<td>48</td>
<td>2.17</td>
<td>0.60</td>
</tr>
<tr>
<td>TOTAL</td>
<td>210</td>
<td>96</td>
<td>151</td>
<td>1.39</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Table 4. Absolute and Relative Frequencies of Arrowpoints from Sacate by Raw Material and Segment of Site.

<table>
<thead>
<tr>
<th>Site Segment</th>
<th>Basalt</th>
<th>Obsidian</th>
<th>Chert</th>
<th>Chalcedony</th>
<th>Rhyolite</th>
<th>Glass</th>
<th>Quartzite</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>64%</td>
<td>10%</td>
<td>13%</td>
<td>5%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>39</td>
</tr>
<tr>
<td>Expansion</td>
<td>57%</td>
<td>21%</td>
<td>11%</td>
<td>7%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>28</td>
</tr>
<tr>
<td>Western</td>
<td>17%</td>
<td>38%</td>
<td>38%</td>
<td>0%</td>
<td>3%</td>
<td>3%</td>
<td>0%</td>
<td>29</td>
</tr>
<tr>
<td>TOTAL</td>
<td>46</td>
<td>21</td>
<td>19</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>96</td>
</tr>
</tbody>
</table>

---

Figure 3. Arrowpoints from Sacate (GR-909): rightmost top two are man-made glass; rightmost bottom three are obsidian.
ized by the Archaeological XRF Laboratory as part of several prior investigations (Loendorf and Fer
telmes 2012). GRIC-MSL independently determined source locations for these artifacts, which co
cided with prior results in 104 of the 105 cases. Although differences exist in the elemental con
centrations calculated by GRIC-MSL and Berkeley, they are not sufficient to affect the accuracy of
source assignments (Figure 4). These data demonstrate that the precision of the Tracer III-V is suf
Nonetheless, additional interlaboratory, interinstrument, and intermethod comparisons are nec
essary to fully assess the accuracy of concentration results produced by the Bruker calibration software
(but see Speakman and Shackley 2013:1438).

**Sacate EDXRF Results**

Table 5 lists obsidian source proportions for the 131 artifacts that were subjected to EDXRF analysis.
Figure 5 shows locations for the obsidian quarries that occur in the sample, as well as other known
deposits. The straight-line distance of sources alone is a poor predictor of obsidian use (Figure 6; Pear
son’s $r = -.42$; $p = .23$), suggesting that other fac
tors also conditioned procurement patterns at Sacate. Obsidian from 10 locations was identified
in the sample, but 92 percent of the material was derived from just four sources. Sauceda obsidian,
which is located to the south, is the most common type and accounts for nearly 65 percent of the col
lection. Vulture obsidian is the next most common type, and the incidence of this material is higher
than has been previously documented along the Middle Gila (Loendorf 2012:107–114). Los Vidrios, which is located to the south of Sauceda, is the third most common stone and is also more
frequent than previously found in GRIC prehistoric contexts (Loendorf 2012). Los Vidrios, which is located to the south of Sauceda, is the third most common stone and is also more
frequent than previously found in GRIC prehistoric contexts (Loendorf 2012). Sand Tanks, also to the
south, is the fourth most common obsidian, and de
spite its close proximity to the Hohokam core area,
this material rarely occurs in previously docu
mented prehistoric assemblages, including those
from the GRIC (Loendorf 2012:107; Shackley and
Tucker 2001).

**Akimel O’Odham Socioeconomic Interactions**

Sacate data suggest that a general trend toward
greater utilization of materials located to the
south of the Middle Gila occurred over the course
of the Historic period, and 93 percent of the col
lection from the western site segment is from souther
sources (Sauceda, Sand Tanks, Los Vidrios, and
Los Sitios; Figure 7). Materials from the north and
east of Sacate, including the nearby Superior obsidian, are rare or absent. Sources to the west, including the Tank Mountains and Vulture, decline in the western segment, which has the most recent remains. This possible decrease in materials from the west in the latter part of the Historic period matches the observation that the Pee Posh, who formerly lived in this direction, had immigrated to the Middle Gila by this time. The patterning in these data is thus consistent with the ethnohistorically and ethnographically documented socioeconom-
ic interactions described above, which suggest that the Akimel O’odham primarily obtained obsidian through exchange. Other observations suggest that these interactions largely involved raw materials rather than completed arrowpoints.

For instance, the patterning in Sacate obsidian debris and completed points suggests that raw materials were generally acquired rather than finished products (Table 6). If projectile points commonly were deposited as completed objects, then material type frequencies for points should differ from

Table 5. Absolute and Relative Frequencies of Obsidian Sources Identified from Sacate by Segment of Site.

<table>
<thead>
<tr>
<th>Source</th>
<th>Direction</th>
<th>Central Segment</th>
<th>Expansion Segment</th>
<th>Western Segment</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Mountain</td>
<td>N</td>
<td>5%</td>
<td>4%</td>
<td>0%</td>
<td>4</td>
</tr>
<tr>
<td>Superior</td>
<td>E</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>1</td>
</tr>
<tr>
<td>Gwynn Canyon?</td>
<td>E</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>1</td>
</tr>
<tr>
<td>Antelope Wells</td>
<td>E</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>1</td>
</tr>
<tr>
<td>Los Sitios del Aqua</td>
<td>S</td>
<td>0%</td>
<td>2%</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>Los Vidrios</td>
<td>S</td>
<td>10%</td>
<td>4%</td>
<td>11%</td>
<td>10</td>
</tr>
<tr>
<td>Sauceda</td>
<td>S</td>
<td>67%</td>
<td>52%</td>
<td>82%</td>
<td>85</td>
</tr>
<tr>
<td>Sand Tanks</td>
<td>S</td>
<td>8%</td>
<td>11%</td>
<td>0%</td>
<td>9</td>
</tr>
<tr>
<td>Tank Mountains</td>
<td>W</td>
<td>0%</td>
<td>4%</td>
<td>3%</td>
<td>3</td>
</tr>
<tr>
<td>Vulture</td>
<td>W</td>
<td>10%</td>
<td>19%</td>
<td>5%</td>
<td>16</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>41</td>
<td>50</td>
<td>40</td>
<td>131</td>
</tr>
</tbody>
</table>

Figure 5. Obsidian locations in the Southwest and archaeological sites with comparative data. Source areas are shaded based on their overall proportion in the Sacate collection.
those for manufacturing debris, and waste from point production should not be present (Bayman 1995:50). However, the most common types (Sauceda and Vulture) do not differ significantly (Fisher’s Exact Test $p = .5$), and obsidian in various stages of reduction was recovered, including unmodified nodules, cores, shatter, primary flakes, secondary flakes, and tertiary flakes.

Furthermore, obsidian points are small portions of complex systems (including the arrow, bow, and archer) that must be tuned to effectively function (Cotterell and Kamminga 1992; Loendorf 2012). Therefore, it is unlikely that completed projectile points or arrows were regularly exchanged, and instead it is more probable that raw materials necessary for point manufacture were traded. Points must be the correct size for projectile shafts, which in turn need to be the proper draw length and stiffness for a given bow and archer. Moreover, arrows of different masses will have different points of impact when fired from the same bow, and without some form of standardization in the manufacturing process, projectiles will be inaccurate (Mason 1894:660). Consequently, customized arrows of consistent sizes were carefully produced to match the body size of individuals, and arrows or points are not freely interchangeable among bows or archers (Burns 1916; Rea 2007a; Russell 1908:96).

Figure 6. Scatterplot of obsidian proportions and source distances from Sacate (GR-909).

Figure 7. Obsidian frequencies by direction of source and segment of Sacate (GR-909).
Previous researchers have suggested that prehistoric populations commonly exchanged finished projectile points (Bayman 1995; Bayman and Shackley 1999; Shackley 2005). Investigators have also argued that the presence of completed points made of materials that do not occur in manufacturing debris is evidence for trade (Bayman 1995; Peterson et al. 1997). Another possibility that could account for these points is that they were deposited as the result of conflict. Although this potential formation process is not generally considered by prehistorians, numerous attacks by nonlocal groups were documented in the Akimel O’Odham calendar stick records (Russell 1908). As an example, a Pee Posh village located approximately 3 km west of Sacate was attacked, looted, and burned by the Quechan on August 31, 1857 (Kroeber and Fontana 1986). Hypothetically, this event should have resulted in the deposition of completed arrowpoints. However, neither of these mechanisms appears to have been a primary source for points from GR-909. The observations presented in this section do not rule out the possibility that points were deposited through warfare or trade and instead only suggest that the majority of the analyzed collection was deposited as a result of various activities undertaken by Sacate residents.

Prehistoric Hohokam Socioeconomic Interaction Patterns

In order to further compare both spatial and temporal variation in obsidian use at Sacate, Table 7 presents source proportions for collections from the Hohokam region of southern Arizona. As a geographical reference point, the sites and obsidian sources are organized based on distance from Sacate.

At prehistoric sites in southern Arizona, the direction of the source has a greater effect on raw material utilization, and obsidian proportions are weakly correlated with source distances (Bayman 1995:49; Bayman and Shackley 1999; Loendorf 2012:107–115; Mitchell and Shackley 1995:299; Rice et al. 1998). By the Late Classic (ca. A.D. 1320–1450), obsidian frequencies differ significantly between some adjacent areas, such as the Middle Gila and Lower Salt rivers, suggesting that different Hohokam communities maintained separate trade contacts during this time (Loendorf 2010; Simon and Gosser 2001). This variation suggests that Late Classic populations were not closely economically integrated across the Hohokam region of southern Arizona (Simon and Gosser 2001). The patterning in obsidian acquisition, instead, suggests that the strongest socioeconomic ties among Classic period communities were between sites on the same rivers, and exchanging food for items such as obsidian provided a mechanism for redistributing water-dependent resources (Loendorf 2012:113).

As can be seen in Table 7, temporal patterns are also apparent in the obsidian from prehistoric sites. These data suggest that diachronic trends identified at Sacate began before the advent of the Historic period (Figure 8). For example, the ten-
Table 7. Relative Frequencies of Obsidian Artifacts at Southern Arizona Archaeological Sites by Source.

<table>
<thead>
<tr>
<th>Source</th>
<th>Collection</th>
<th>Period</th>
<th>Sacate Sand</th>
<th>Saucedo Superior</th>
<th>Vulture Mts</th>
<th>Los Vidrios Burro Creek</th>
<th>Tank Mts</th>
<th>Government Mountain Sitegreaves</th>
<th>RS Hill/ Sigreaves</th>
<th>Cow Canyon</th>
<th>Partridge Creek</th>
<th>Mule/ Antelope</th>
<th>Other</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>48</td>
<td>87</td>
<td>92</td>
<td>120</td>
<td>198</td>
<td>200</td>
<td>221</td>
<td>260</td>
<td>267</td>
<td>239</td>
<td>284</td>
<td></td>
</tr>
<tr>
<td>Sacate</td>
<td>Historic</td>
<td>N/A</td>
<td>7%</td>
<td>1%</td>
<td>65%</td>
<td>12%</td>
<td>8%</td>
<td>0%</td>
<td>2%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>*Snaketown</td>
<td>Preclassic</td>
<td>8</td>
<td>1%</td>
<td>60%</td>
<td>22%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>*ELXP</td>
<td>Classic</td>
<td>11</td>
<td>5%</td>
<td>8%</td>
<td>63%</td>
<td>5%</td>
<td>7%</td>
<td>1%</td>
<td>0%</td>
<td>3%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>*GR-522 Locus D</td>
<td>Preclassic</td>
<td>19</td>
<td>0%</td>
<td>20%</td>
<td>61%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>*GR-522 Locus A</td>
<td>Classic</td>
<td>22</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Pueblo Grande</td>
<td>Classic</td>
<td>35</td>
<td>0%</td>
<td>10%</td>
<td>30%</td>
<td>27%</td>
<td>4%</td>
<td>0%</td>
<td>1%</td>
<td>22%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>Rowley</td>
<td>Classic</td>
<td>35</td>
<td>0%</td>
<td>23%</td>
<td>30%</td>
<td>47%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Los Colinas</td>
<td>Preclassic</td>
<td>38</td>
<td>0%</td>
<td>2%</td>
<td>3%</td>
<td>27%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>42%</td>
<td>20%</td>
<td>0%</td>
<td>7%</td>
<td>1%</td>
</tr>
<tr>
<td>Los Colinas</td>
<td>Classic</td>
<td>38</td>
<td>0%</td>
<td>3%</td>
<td>48%</td>
<td>17%</td>
<td>22%</td>
<td>0%</td>
<td>0%</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>Crismon</td>
<td>Classic</td>
<td>41</td>
<td>0%</td>
<td>18%</td>
<td>57%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>23%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>Casa Grande</td>
<td>Classic</td>
<td>44</td>
<td>0%</td>
<td>7%</td>
<td>46%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>29%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>Grewe</td>
<td>Preclassic</td>
<td>47</td>
<td>0%</td>
<td>95%</td>
<td>1%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
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<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>Gatlin</td>
<td>Preclassic</td>
<td>66</td>
<td>0%</td>
<td>0%</td>
<td>85%</td>
<td>4%</td>
<td>1%</td>
<td>3%</td>
<td>0%</td>
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<td>0%</td>
<td>0%</td>
<td>7%</td>
</tr>
<tr>
<td>Brady Wash</td>
<td>Classic</td>
<td>84</td>
<td>0%</td>
<td>3%</td>
<td>79%</td>
<td>7%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>Palo Verde</td>
<td>Preclassic</td>
<td>87</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>55%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>31%</td>
<td>11%</td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Tonto Arm</td>
<td>Classic</td>
<td>95</td>
<td>0%</td>
<td>48%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>22%</td>
<td>0%</td>
<td>0%</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>Salt Arm</td>
<td>Classic</td>
<td>107</td>
<td>0%</td>
<td>40%</td>
<td>12%</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>23%</td>
<td>7%</td>
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<td>13%</td>
</tr>
<tr>
<td>UIR</td>
<td>Classic</td>
<td>144</td>
<td>1%</td>
<td>0%</td>
<td>13%</td>
<td>0%</td>
<td>14%</td>
<td>0%</td>
<td>2%</td>
<td>36%</td>
<td>0%</td>
<td>1%</td>
<td>0%</td>
<td>31%</td>
</tr>
</tbody>
</table>

Middle Gila Data

*Average Preclassic 13 1% 56% 18% 4% 0% 0% 0% 0% 7% 1% 1% 0% 0% 9% 338
*Averages Classic 16 3% 14% 62% 3% 5% 1% 0% 4% 2% 0% 0% 1% 7% 271
*Combined Average Both 15 2% 35% 40% 3% 2% 0% 0% 5% 2% 0% 0% 1% 8% 609

*Nearby sites included in the middle Gila average.
(Data from Fertelmes et al. 2012; Loendorf 2012; Loendorf and Fertelmes 2011; Marshall 2002; Mitchell and Foster 2011; Mitchell and Shackley 1995; Peterson et al. 1997; Rice et al. 1998; Shackley et al. 2011.)
dency for greater reliance on southern Arizona sources started during the Classic period throughout the Hohokam core area (Fertelmes et al. 2012; Marshall 2002:132–133; Shackley 2005). At the same time, use of sources located to the north and east of the Phoenix Basin declined. Superior obsidian, for example, was the most common material (60 percent) identified at the Preclassic Snaketown site within the GRIC, but this stone rarely occurs in Classic contexts along the Middle Gila, when Sauceda obsidian is consistently more abundant (Bayman and Shackley 1999; Loendorf 2012; Shackley 2005). Shackley (2005) argues that access to Superior was restricted by the Salado. However, a similar pattern occurs in the Tonto Basin, which is considered to be the heartland of the Salado, where use of Superior obsidian also declined during the Classic period (Rice et al. 1998). Rice et al. (1998) suggest two explanations for this pattern. First, the source was depleted. Second, a village appropriated exclusive use of the material. The first suggestion is improbable because substantial obsidian deposits remain at the source today. While the second is possible, the site that cut off access has not been identified. Another possibility is that hunter-gatherers, such as the Nnē who occupied the source area during the Historic period, moved into the area and restricted access (Loendorf 2010).

Finally, these data also suggest that the Akimel O’Odham did not generally acquire points by collecting them at prehistoric sites, as some researchers have suggested (e.g., Russell 1908). If the Akimel O’Odham obtained a substantial proportion of their points from nearby sites, then obsidian frequencies at Sacate should reflect the underlying proportions at prehistoric sites where the artifacts were collected. However, the frequencies for prehistoric obsidian data differ substantially from those for the Sacate sample (see Table 7 and Figure 8). In particular, the near-complete absence of Superior obsidian and high incidence of Sauceda obsidian are unlikely to have occurred if points were commonly obtained from prehistoric sites (Fisher’s Exact Test $p < .01$).

**Hohokam–Akimel O’Odham Continuum Discussion**

Until recently, most outside observers who considered the relationship between the Hohokam and the Akimel O’Odham focused on differences between historical ki-kuh and Classic period adobe structures. Based on this evidence, they concluded
that the Historic populations were recent migrants to the Phoenix Basin (Ezell 1961; Fewkes 1912; Russell 1908; Seymour 2011). However, Emory is an exception; he wrote:

My own impression, and it is stated so in my journal, is that the many ruins we saw on the Gila might well be attributed to Indians of the races we saw in New Mexico, and on the Gila itself. I mean by the last, the Pimos [Akimel O’Odham], who might easily have lost the art of building adobe and mud houses. In all respects, except their dwellings, they appeared to be of the same race as the builders of the numberless houses now level with the ground of the Gila River [Emory et al. 1848:133].

At the time this conclusion was almost universally rejected, and it was not until the 1960s that the possibility of a Hohokam and Akimel O’Odham continuum gained more widespread acceptance. Ezell (1963), for example, examined material cultural traits and found both similarities and differences between prehistoric and Historic remains. Based on this review, Ezell (1963:62) provisionally concluded that the Akimel O’Odham were related to the Hohokam. By the 1990s, broader agreement was reached among Southwestern archaeologists that the Akimel O’Odham are cultural descendants of the Hohokam (Gilpin and Phillips 1998:117). Despite this general consensus, some researchers continue to argue that the Akimel O’Odham are recent migrants to the Phoenix Basin (e.g., Rea 2007b), and ambiguity regarding the nature of their relationship remains. For example, Hegmon et al. (2008) suggest that although some people remained in the Phoenix Basin after the Classic period, the association between prehistoric and Historic groups is difficult to trace using archaeological evidence. Most recently, based on a comprehensive data review, Seymour concludes that historical populations “either replaced the Hohokam, absorbed them, or represent a modified form of them” (2011:296).

However, this analysis has identified continuities between prehistoric and historical material culture that suggest that the Akimel O’Odham are the direct cultural descendants of the Hohokam. Furthermore, many additional lines of evidence also exist. First, the Akimel O’Odham practiced a dispersed rancheria settlement pattern that is similar to Preclassic Hohokam strategies (Fish 1989:21; Seymour 2011:198–209). Second, the Akimel O’Odham made red-on-buff pottery, which has close similarities in manufacturing technique (i.e., paddle and anvil), clay, and design with prehistoric ceramics (Ezell 1963). Third, in contrast to other surrounding groups, the Akimel O’Odham were dependent on large-scale irrigation agriculture, and their canal system shares close correspondences with Hohokam agricultural strategies (Ravesloot et al. 2009; Webb 1959:121–126; Woodson 2010:45). Fourth, most Akimel O’Odham believe that they are Hohokam descendants (Shaw 1994; Webb 1959:53). Fifth, Classic period sites play a prominent role in Akimel O’Odham traditions, and the close similarities between the archaeological record and these stories are unlikely to have occurred by coincidence (Loendorf 2012; Teague 1993).

Finally, rather than resulting from the migration of outside ethnic groups, the architectural changes that occurred in the Phoenix Basin are consistent with responses to variation in the raw materials available for construction (Loendorf 2012:123–126). Instead of an abrupt disruption in construction techniques, house types that used progressively less wood were built over time from the Preclassic to Classic periods, which suggests that the architectural changes were a response to environmental constraints (Abbott and Foster 2003:26–30; Ezell 1961:49; Sayles 1938:79–80). Preclassic pithouses were built largely of wood and frequently had multiple support posts, whereas Late Classic adobe structures used no wood in the walls and commonly only had one main roof support post (Haury 1976:46–74). A massive down-cutting event occurred at the transition between these two periods around A.D. 1150 (Waters and Ravesloot 2000, 2001). This event impacted riparian habitats along the Gila and Salt rivers, which eliminated many of the trees in the area (Waters and Ravesloot 2001:292). Macrobotanical evidence also suggests that fewer trees were locally available during the Classic period (e.g., Kwiatkowski 2003:57). Waters and Ravesloot (2001:292) have suggested that riparian habitats along the Middle Gila recovered by the Historic period. As a consequence, more trees were available that could have been used for construction and other purposes. Historic ki-kukh are similar to Preclassic pithouses, and they both require substantially more wood for con-
struction than adobe structures (Ezell 1963; Sayles 1938; Seymour 2011:97–138). These similarities led Haury to conclude that the “Pima house, in my opinion, represents the retention of the old Hohokam architectural idiom, a not insignificant argument in the favor of Hohokam–Pima continuity” (1976:72).

Conclusions

Multiple lines of evidence suggest that the Akimel O’Odham primarily obtained obsidian in the form of raw materials acquired through trade with the Tohono O’Odham and Pee Posh. They appear to have largely employed this obsidian to manufacture flaked-stone points, which were used to tip arrows designed for use in warfare. While some other goods may have been more readily traded among different people, the employment of flaked-stone points in warfare is expected to have restricted patterns of exchange for the materials, including obsidian, necessary to manufacture these weapons. Instead, it appears that these items were generally only exchanged among more closely allied peoples.

Data from Sacate suggest that prehistoric temporal trends toward greater reliance on obsidian sources to the south of the Middle Gila culminated during the Historic period, which appears to be the result of changes in socioeconomic interactions and the well-documented conflicts that occurred during this interval. Access to northern and eastern obsidians including the San Francisco volcanics and Superior sources was restricted by intervening Nneé and Góon populations. Meanwhile, alliances between the Tohono O’Odham and the Pee Posh allowed continued access to raw materials to the south and west. The fact that the decline of obsidian from the north and east begins during the Classic period suggests that the Nneé or similar groups moved into southern Arizona at this time. This possibility is supported by recent research on Nneé migration, as well as both Nneé and Akimel O’Odham social memories (Loendorf 2012; Seymour 2011).

Examination of Akimel O’Odham obsidian use at Sacate suggests that long-term cultural trends that began during prehistory continued unabated after the advent of the Historic period in A.D. 1694. These include a general pattern of increasing reliance on obsidian for point manufacture and consistencies in point design between the Classic and Historic periods. More important, trends in the interaction patterns within southern Arizona continue unbroken between the prehistoric and Historic periods. This continuation of socioeconomic relationships and technological traditions provides additional evidence that the Historic Akimel O’Odham are the cultural descendants of the prehistoric Hohokam. This conclusion is supported by multiple lines of evidence including similarities in architecture, subsistence practices, ceramics, and settlement strategies.

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Loendorf, Chris, and Glen E. Rice

Marshall, John T.

Mason, Otis T.

Millhauser, John K., Enrique Rodríguez-Algría, and Michael D. Glasscock

Mitchell, Douglas R., and Michael S. Foster

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1. The primary components of the Tracer III-V are an X-ray tube, an X-ray detector, and a pulse processor. The X-ray tube is equipped with a rhodium target, and it emits a collimated 4.0-mm-diameter beam. The instrument was set to operate at 40 keV and 12 μA using an external power supply. A beam filter composed of 304 μm of aluminum, 25 μm of titanium, and 152 μm of copper was placed between the tube and the sample. This filter provides efficient detection of the “fingerprint” elements (i.e., rubidium, strontium, yttrium, zirconium, and niobium) used in obsidian studies (Shackley 1988, 1995, 2005). The detector is a Peltier-cooled SiPIN diode sensor. This device has a resolution of approximately 170 eV Full Width at Half Maximum for 5.9 keV X-rays (at 1,000 counts per second) in an area of 7.0 mm². The pulse processor partitions X-ray data into 2,048 channels (20 eV/channel), with each channel counting the number of X-ray pulses gathered in that specific energy window during the 180-second analysis time. These multichannel data are stored by the S1PXRF software program. Partitioned pulse data were normalized using the inelastic (or Compton) peak of the rhodium backscatter at 18.2–19.2 keV. Normalized pulse data were converted to parts per million values using a calibration program that incorporates elemental results for 40 reference samples that have a wide range of compositional variation. Concentration values for the reference obsidian were determined by the Archaeometry Laboratory, University of Missouri Research Reactor, using neutron activation analysis, microwave digestion inductively coupled plasma mass spectrometry, and laser ablation inductively coupled plasma mass spectrometry (Glascock and Ferguson 2012). Provenance assignments were assessed through reference to known samples including a K-means cluster analysis of the parts per million values for rubidium, strontium, yttrium, zirconium, and niobium. To examine group fitness, elemental concentrations were compared using two-way scatterplots. Statistical analyses were completed in PASW Statistics 18 (Release 18.0.0). Source nomenclature is adopted from Shackley 1988, 1995, 2005 (see also http://www.swxrflab.net/swobsrscs.htm).