Remarks: Considered a trade ware, it is one of the most popular Mogollon intrusives.

Radium Springs Survey (Figs. 23, 24): Chupadero Black-on White was found at nine sites in the survey area, making it the third most popular type documented.

WESTERN MOGOLLON DISTRICT

Alma Plain (A.D. 300-1300)

Published description: (Breternitz 1966; Hawley 1950; Human Systems Research 1973)

Paste: Brown to buff, coarse; may be gray or black; sometimes zoned from dark gray interior to brown exterior, lighter outer color appearing as a veneer not exceeding one-third of vessel wall.

Temper: Coarse, angular, and rounded grains of quartz and heterogeneous material.

Core: Various colors, sometimes appearing as one of three zones.

Surface treatment: Irregular smoothing apparent; lightly polished; no slip, no paint; surface colors range from brown to gray; firing mottling common.

Decoration: None.

Forms: Jars predominate, few bowls.

Distribution: Northern Chihuahua to the Mogollon rim; western New Mexico south of Quemado; east-central and southeastern Arizona.

Radium Springs Survey: Alma Plain is one of the earliest dated Mogollon types and has been considered a possible antecedent of later plain wares such as El Paso Brown. Its greatest density is west of the survey area, nearer the Arizona state line, and it was not expected in any quantity. Some Alma Plain possibly remained unidentified due to its indistinguished appearance but it was from two sites (AR062, 81) within the survey area. The bead vessel from AR095 is a variety of Alma Plain. It is the seventh (next to last) most popular type identified.

San Francisco Red (A.D. 700-1100)

Published description: (Hawley 1950; Human Systems Research 1973)

Paste: Gray, shading to brown at surface; porous.

Temper: White rounded and angular particles; some sand.
Figure 23. Vessel Fragment. a-c, views of Chupadero Black-on-White pitcher fragment. RXO39, isolated find.
Figure 24. Pottery Fragments. a-f, Chupadero Black-on-White, none with rims. a, AR034; b-f, RS029 SW2, from same vessel, isolated find; g-j, AR013, Socorro Black-on-White, same vessel. Note d, rim of vessel.
Core: Undistinguished

Surface treatment: Bowls have smoothed interiors, with red to brown thin slip and are polished; exteriors are slipped and less well smoothed on both bowls and jars; scraping marks or light smudging may be evident

Decoration: Slip only

Forms: Bowls and jars (a possible variant form is shown in Fig. 26,j)

Distribution: San Francisco and Mimbres River drainages and area in between; southeastern Arizona and southwestern New Mexico

Remarks: Thought to be a possible antecedent, or at least related to, Playas Red of the Chihuahuan District.

Radium Springs Survey: San Francisco Red was recorded at three sites (AR001, 3, 81) and probably was present at more; identification would be difficult if the distinctive slip was removed by weathering. It ranks sixth in popularity of recovered types, along with El Paso Painted, Mimbres Black-on-White and Pitoche Rubbed-Ribbed.

Seco Corrugated (ca. A.D. 1100-1300+)

Published description: (Wilson and Warren 1973)

Paste: Temper usually so profuse that paste is undistinguished

Temper: Mainly a rhyolite ash flow tuff, containing quartz grains, feldspar, biotite(?), white tuff matrix, and lithic fragments

Core: Color variable through section, typically grading from surface colors (of reddish-brown to gray or dark gray) to gray or dark gray interior; sometimes homogeneous

Surface treatment: Surface color is oxidized, colors varying from reddish-brown, gray to dark gray; interiors of bowls and jars are typically smudged and burnished (friction polished), but interiors of both forms may be only scraped smooth with no smudging or scraped smooth and smudged; exteriors corrugated by finger indenting, typically over the entire vessel but sometimes only on jar necks; by scraping, the indentations are smoothed so that individual coils and indentations are obscured but not obliterated; light polishing may be evident on peaks also; some sherds show numerous small, irregular plain areas and more rarely plain coils; no paint or patterned indentations; average wall thickness 6 mm

Decoration: None
Forms: Large bowls and jars both common

Distribution: Not well known; the type site (in Sierra County, New Mexico) is near the study area and corrugated sherds similar to Seco Corrugated are common throughout the area.

Radium Springs Survey (Fig. 25): Seco Corrugated was found at five sites (AR009, 13, 24, 62, 81) within the survey design area, ranking with El Paso Polychrome as the fourth most common type documented.

Mimbres Boldface (Mangus Black-on-White) (A.D. 775-1000+)

Published description: (Breternitz 1966; Hawley 1950; Human Systems Research 1973; Runyan and Hedrick 1973)

Paste: Grayish-brown, dull white toward surface; moderately fine; porous

Temper: Quartz sand, other particles of coarse, angular, soft material, and a little magnetite and mica

Core: Light gray to gray black; also yellow gray to soft brick red

Surface treatment: Exteriors smoothed (slightly bumpy), unslipped, gray to dark gray; interiors poorly smoothed, slipped in chalky white paint, then partially polished and painted with black iron oxide; slipping is often irregular

Decoration: Large and careless black painted patterns; narrow parallel lines, wavy hachure lines; wide areas of white between design; decorations up to rim; some life forms suggesting Hohokam influence

Forms: Hemispherical bowls, seed jars, jars, and pitchers

Distribution: The Mimbres Valley; Mimbres River and its tributaries; north boundary is the Pinos Altos Range, east of the Mimbres Mountains, west of the Burro Mountains; peripheral and intrusive occurrence goes much further, to the east through the Tularosa Basin, Lea and Eddy Counties, New Mexico, southeast through the Sacramento Mountains

Remarks: The distinctive designs and temper serve to distinguish this type from other black-on-white wares; in addition, the less durable white slip often erodes away from the black design and can be thumbnail scratched (as opposed to Chupadero Black-on-White).

Radium Springs Survey (Figs. 26, 27): This type was found at four sites (AR001, 60, 71, 81) in the survey design area. It is the fifth
Figure 25. Textured Pottery. a, Pitoche Rubbed-Ribbed, probably a small olla (AR055); b, Seco Corrugated, form appears to be that of a shallow bowl (AR062); c, fragment of curved vessel neck, possibly Alma Neck Banded (AR048); d, punched sherd, type unknown (AR081); e, punched and faintly red painted sherd, possibly a type of Playas Red (AR062); f, unidentified sherd (AR089); g, coiled and scalloped sherd, probably Three Circle Neck Corrugated type (AR092); h, Seco Corrugated bowl fragment (AR009); i, unidentified eroded rim sherd with coarse striations (AR092); j, "tongue" sherd, perhaps a variant of San Francisco Red (AR048).
Figure 26. Mimbres Black-on-White Boldface Sherds. a, rim sherd, fired brown-on-white (AR092); b, rim sherd, fired brown-on-white (AR092); c, sherd showing large segment of painted design (AR092); d, exterior painted sherd (AR071).
most popular type documented. It is often associated with Mimbres Black-on-White sherds, but only one site (AR001), of the seven where one or the other was documented, yielded both together.

Mimbres Classic Black-on-White (ca. A.D. 1000-1300)

Published description: (Breternitz 1966, Hawley 1950; Human Systems Research 1973; Runyan and Hedrick 1973)

Paste: Moderately fine, porous, friable, light to dark gray; oxidized colors range from yellow-gray to soft brick red

Temper: Quartz sand, fine to medium

Core: Same as Mimbres Boldface

Surface treatment: Interior and exterior better smoothed than Mimbres Boldface; interior heavily slipped with white, polished and painted with black iron oxide; white slip may extend over rim lip to exterior

Decoration: Accurate hatching in very fine narrow black lines, opposed to solid figures; animal and human figures on bowl bottoms, often combined

Forms: Bowls

Distribution: Similar to that of Mimbres Boldface recovered almost everywhere in the Jornada Mogollon area and often in quantity as far as El Paso; even occurs east of the Pecos River into the Llano Estacado

Remarks: This is one of the most famous and distinctive types because of the technically precise linear designs and figures and artistic originality. It is derived from Mimbres Boldface.

Radium Springs Survey: Recovered from three sites, it ranks sixth in overall popularity at sites within the survey design area. See Fig. 27.

SOCORRO DISTRICT

Pitoche Rubbed-Ribbed (dates indeterminate, but probably after A.D. 1100)

Published description: (Hawley 1950; Human Systems Research 1973)

Paste: Soft, friable, brown to black, sandy

Temper: Sand, with some crystalline inclusions and white specks

Core: Undistinguished
Figure 27. Mimbres Black-on-White Pottery. a, Classic rim sherd (AR092); b, Classic rim sherd (AR092); c, Boldface rim sherd (AR092); d, Boldface rim sherd (AR092); e, Classic rim sherd (AR092); f, Boldface rim sherd (AR092); g, Classic rim sherd (AR092); h-j, Classic sherds: h, interlocking scroll design (AR092); j, portion of animal head with eye visible (AR092).
Surface treatment: Some vessels completely smoothed but most still retain evidence of soiling on upper vessel body, each coil averaging 4-5 mm or less; coiling had three variations: flat, clapboard, ribbed; occasional indentations but frequently with combined coiling

Decoration: None

Forms: Jars, with short necks and marked flaring or everted rims

Distribution: Indefinite, but focus within Socorro district

Remarks: Fragments are difficult to distinguish from other banded or corrugated wares such as Alma and Seco.

Radium Springs Survey (Fig. 25): Documented at three sites (AR001, 55, 60), ranking sixth in popularity among identifiable types along with Jornada Painted, San Francisco Red, and Mimbres Classic Black-on-White.

Socorro Black-on-White

Published description: (Hawley 1950; Human Systems Research 1973; Runyan and Hedrick 1973)

Paste: Fine; gray to dark bluish-gray, occasionally black

Temper: Fine sand and crushed dark stone

Core: Undistinguished

Surface treatment: Thin white slip, matching the paste; temper often apparent through slip on bowl interiors; decorated surface usually gives impression of matte finish; exterior has a careless slip

Decoration: Black iron paint which may turn a reddish-brown or even glaze; hatched lines broader than space between them; wide lines; checkerboard with or without dots, opposed hatched and solid figures; black bowl rims; good execution

Forms: Bowls and jars

Distribution: Socorro district west of the Rio Grande; Rio Puerco (of the east) and Rio San Jose with limited Rio Grande extensions mark the northern existence; south to around Socorro, New Mexico; west of the Grants, New Mexico, southern lava flow

Remarks: Finish is much tougher than Mimbres types, being similar to Three Rivers Red-on-Terracotta.

Radium Springs Survey (Fig. 24): This type was recorded at one survey design site (AR013), ranking eighth in popularity of documented types along with the two Chihuahuan district types.
CHIHUAHUAN DISTRICT

Playas Red Incised (A.D. 1060-1340)

Published description: (Hawley 1950; Human Systems Research 1973; Runyan and Hedrick 1973)

Paste: Coarse brown, dark gray-black

Temper: Clear quartz and feldspar, sometimes with clear, red, or yellow sand; variable texture

Core: Reddish-brown to reddish-yellow, carbon streak frequent

Surface treatment: Unslipped and floated or slipped, oxidized red or red-orange with low to high luster; polished and unpolished

Decoration: Incised texturing most common, although indenting, punching, corrugating possible

Forms: Bowls, jars, effigies

Distribution: Chihuahuan culture area generally, most frequent in Casas Grandes and Santa Maria drainages; found in lesser amounts in southern New Mexico and Arizona and intrusive throughout the Jornada Mogollon culture area

Remarks: Playas Red may also be plain (i.e., no incisions, etc.). It has been speculated that a relationship may exist between Playas Red and San Francisco Red.

Radium Springs Survey: Playas Red Incised was recovered from one site within the survey design area (AR062). A single sherd, it ranks lowest in popularity among identifiable types, along with Socorro Black-on-White and Ramos Polychrome. Some of the unidentified worn sherds from other sites with red trace remains may be Playas Red fragments. A possible sherd is shown as Fig. 25,e.

Ramos Polychrome (A.D. 1060-1340)

Published description: (Hawley 1950; Human Systems Research 1973; Runyan and Hedrick 1973)

Paste: Fine, compact, buff

Temper: Red, black, pink, and yellow quartz sand and white angular feldspar

Core: Typically white, ranges from light gray through pink to very pale brown; sometimes carbon streak, medium gray core
Surface treatment: Jar exteriors, bowl interiors well smoothed, floated, sometimes polished; jar interiors and bowl exteriors are less well finished.

Decoration: Mellow ivory color background (vessel surface) with red or maroon and dark gray or black paint patterns, typically narrow linework, figures filled in black or red; paneled bands, dots, ticks, generally complex designs.

Forms: Bowls, jars, effigies.

Distribution: The Casas Grandes drainage; intrusive throughout the Jornada Mogollon area, east to the Pecos River into Texas.

Radium Springs Survey: This type is represented at one site (AR003) and as an isolated find (RS027). It ranks lowest in popularity along with Socorro Black-on-White and Playas Red.

TYPES DOCUMENTED OUTSIDE THE SURVEY DESIGN AREA

Three Rivers Red-on-Terracotta (A.D. 1150-1300)

Published description: (Hawley 1950; Human Systems Research 1973; Runyan and Hedrick 1973)

Paste: Medium to hard; uniform terracotta color; consistent material, apparently from the same source.

Temper: Various feldspars with sand or quartz; gypsum with or without sand; temper constitutes 20-30% of vessel.

Core: Uniform terracotta in most cases.

Surface treatment: Polished; floated; no slip; red paint design.

Decoration: Narrow lines, with triangles along them.

Form: Bowls, round-bottomed and shallow with direct rims; some jars.

Distribution: Southern New Mexico to the Arizona state line; Manzano Mountains into Chihuahua, Mexico; in the El Paso area; 30 miles south of Silver City, New Mexico; and as far as the Llano Estacado in Texas.

Remarks: This is a very distinctive type, always having impressive hardness, slick polish, and color.
Radium Springs Survey (Fig. 28): A single sherd was recovered at AR092, outside the survey design area. The type is intrusive from the Three Rivers area in the Tularosa Basin east across the San Andres Mountains. It is commonly found in middle and late phase Mogollon sites and was expected in greater quantity.

San Andres Red-on-Terracotta (A.D. 1100-1300)

Published description: (McCluney 1962)

Paste: More crumbly than Three Rivers Red-on-Terracotta

Temper: More than Three Rivers Red-on-Terracotta

Core: Dark reddish brown to light red; carbon streak

Surface treatment: Highly polished; often painted like Three Rivers Red-on-Terracotta, but paint is thinner

Decoration: Broad line motifs

Form: Bowls, jars, pitchers

Distribution: Abundant in northern Tularosa Basin east of the Rio Grande between the San Andres and Capitan Mountains, 10 miles south of Alamogordo, New Mexico, and north to around Corona, New Mexico

Remarks: This type was once considered a variant of Three Rivers Red-on-Terracotta, but has slight differences in temper, design, and finish.

Radium Springs Survey: Like Three Rivers Red-on-Terracotta, the type was found only at AR092. It is very similar to Three Rivers Red-on-Terracotta. See Fig. 28,b.

Three Circle Neck Corrugated (Alma Neck Indented) (A.D. 700-1300)

Published description: (Hawley 1950; Human Systems Research 1973)

Paste: Similar to Alma Plain

Temper: Sand, similar to Alma Plain

Core: Similar to Alma Plain

Surface treatment: Lower body of vessel is plain like Alma Plain; upper neck corrugated with plain narrow coils, deep and overlapping; sometimes coils are buffed and polished; bottom coil frequently pressed into scallops with instrument; gray-brown in color
Figure 28. Pottery Fragments from AR072 and AR092. a, AR092, rim sherd. Three Rivers Red-on-Terracotta. Two parallel lines circle rim interior and triangles are evident on left area of sherd; b, AR092, rim sherd, San Andres Red-on-Terracotta; c, AR092, San Andres Red-on-Terracotta. Apparently of same vessel as b. Design seems to have been fired to more black than red color; d, AR092, unidentified Black-on-White bowl sherd; e, AR072, unidentified Black-on-Red sherd; f, AR092, Salado (Roosevelt Red) ware. Not readily identifiable on Pinto Polychrome or other variants.
Decoration: None

Forms: Jars and pitchers

Distribution: Same as Alma Plain

Remarks: This type is assumed to have been derived from Alma Plain.

Radium Springs Survey: One small sherd of Three Circle Neck Corrugated (with the distinct scalloped coil below bands) was found at AR092, outside the survey design area.

Alma Neck Banded (A.D. 700-1300) Similar to Alma Neck Indented (Three Circle Neck Corrugated), but lacking the indented or scalloped bottom coil. Two possible sherds were recovered at AR092, outside the survey design area (Fig. 25,c).

St. Johns Polychrome (A.D. 1175-1300)

Published description: (Hawley 1950; Human Systems Research 1973; Runyan and Hedrick 1973)

Paste: Fine, gray to cream, hard; medium texture, slightly crumbly, occasionally friable; strong vessel walls

Temper: Crushed sherd and some sand

Core: Slip and core contrast

Surface treatment: Bowls slipped inside and out with a thick red or orange-red slip, frequently crackled; interior designs in thick black paint, well polished over; sometimes white paint used on interior to outline black designs

Decorations: Interior has longitudinal hatching with interlocking scrolls opposing solid and hatched technique; exterior has simple keys, stepped figures, triangles, and animal forms

Forms: Bowls, rarely dippers or jars

Distribution: Focus is around St. Johns, Arizona, with a 50-mile radius; one of the most widespread Southwestern pottery types

Remarks: Can be expected throughout the Mogollon area.

Radium Springs Survey: One bowl sherd of this type was recovered from AR092, outside the survey design area.
Roosevelt Red (A.D. 1250-1400)

Published description: (Hawley 1950; Human Systems Research 1973)

Paste: Oxidized with core color of gray to black to tan to brick red

Temper: Abundant water-worn fine sand

Surface treatment: Bowl interiors well smoothed, coated all over with a thick, creamy white slip, almost never crazed, slightly gritty, and never polished; bowl exteriors have a thin red slip, well polished with horizontal striations evident; jar exteriors well smoothed, coated with white slip on upper vessel body and thin red slip on lower body, usually gritty, crazed

Decoration: Decorations in black carbon paint over white slip; bowl interiors usually completely covered in overall pattern; less frequently there is a horizontal band design leaving an open hole in the bottom; decoration never goes to the rim, which is usually plain; bowl exteriors usually unpainted; jars often have a broken black line around the shoulder separating the white slip; solid elements are tapering triangles, scrolls with scalloped edges, steps, keys, and small mazes

Forms: Bowls predominate; jars, figurines

Distribution: Area south of Mogollon rim concentrated in Tonto, Roosevelt, and Gila Basins, Verde and San Pedro Valleys, and near Globe and Gafford, Arizona; intrusive in other parts of Arizona, southeastern New Mexico, Chihuahua, and Texas

Remarks: Variant types (Pinto Polychrome, Gila Polychrome, Tonto Polychrome) are defined by differences in decorative elements.

Radium Springs Survey (Fig. 28,f): Only one sherd was recorded, from AR092 outside the survey design area. It was too fragmentary to determine the specific type of Roosevelt Red ware.

Cibola White

Published description: (Mera 1935)

Paste: Very fine, white-gray, compact, not easily friable

Temper: Does not predominate; appears to be dark crushed (basaltic?) stone and quartz; very fine to .07 cm

Core: Slightly darker gray in center grading into gray-white, on one specimen; a uniform light gray on the other
Surface treatment: White surface on both sides; one sherd seems to have a white slip interior, white float exterior, the other sherd just the opposite; all surfaces are fairly smooth, white and chalky, especially the interior of the former sherd; the exterior of latter has the most resistant surface, with a dull gleam from original polishing.

Decoration: White slip only

Forms: Bowls

Radium Springs Survey: The two sherds tentatively assigned to this type were recovered from AR097.

**Unidentifiable Potsherds**

During the course of the survey a number of sherds were collected which at the time were thought to have diagnostic value. Subsequent analysis was unable to assign them to any of the above types of wares. These include six plain brownware sherds which might represent either Alma Plain, Jornada Brown or El Paso Brown, or unpainted portions of the painted varieties of the latter two. Nine sherds with remnants of red paint might represent Jornada Painted, San Francisco Red or Lincoln Black-on-Red, the latter type not documented but expected in the survey area. A group of six textured potsherds might represent either Alma Banded or Seco Corrugated. All these sherds were so badly weathered and fragmented that accurate typing was precluded. It is always possible that they actually represent types or wares not specifically documented by sherds collected from within the study area. It must be remembered that six different types of pottery were recorded outside the sections designated by the survey design.

**Modified Potsherds**

**Worked sherds** refer to specimens which were intentionally altered by rounding their edges. The result is a disc, averaging 4 cm in diameter, usually characterized by a hole drilled through the center of the object. Suggestions as to the function of these artifacts include spindle whorls (those with holes in the center), pottery scraping tools, gaming pieces, or pendants (also necessitating the hole). Four worked sherds were recovered from the survey, two of them outside the sample area:

1. (Jornada Brown, AR068) A disc fragment with smoothed edges, broken at central biconical hole; projected disc diameter approx. 6 cm; sherd 0.6 cm thick (Fig. 22,c)

2. (San Francisco Red, AR068) A roughly rounded sherd approx. 6 cm diameter, with drill holes begun on each side and not well aligned; sherd 0.6 cm thick (Fig. 22,d)

3. (Jornada Brown, interior smudged, AR089) A disc sherd fragment with about 25% of its edge area rounded and smoothed; 0.8 cm thick
4. (Jornada Brown, AR092) A roughly rounded sherd disc, smoothed crudely on edges; 3.5 cm diameter, 0.55 cm thick; no hole

Mended sherds are characterized by the presence of one or more holes drilled through the vessel wall either to stop a crack from widening or to bind across a crack to close it. Three sherds evidenced holes that are thought to be single remnants of a pair that once bound a vessel crack tight, perhaps with sinew or fiber cord. The suggestion that they were holes for a cord handle is not likely from a structural point of view; and the mending proposition is supported by the sherds being broken close to the hole or actually through it. One was recovered outside the survey design area.

1. (El Paso Brown, AR037) A biconical hole, 0.6 cm wide, broken; sherd, 0.68 cm thick (Fig. 22,e)
2. (Jornada Brown, AR062) A nearly straight cylindrical hole, 0.48 wide, broken; sherd, 0.43 cm thick
3. (San Andres Red-on-Terracotta, AR092) A biconical hole approximately 2 cm from rim edge; vertical cracked edge nearby; biconical, but predominately exterior drilled; hole, 0.3 cm wide; sherd, 0.8 cm thick

Unidentifiable Ceramic Artifact or Vessel Appendage

One specimen has two nearly square corners and a curvature which does not reflect a typical vessel shape (Fig. 25,j).

Recovered at AR048, this sherd may be a variety of San Francisco Red. The concave (interior?) side has a worn, polished red slip. Temper appears to be crushed quartz and perhaps gray chert, abundant and protruding through the surface; particle size ranges up to .12 cm. At the break the sherd is .55 cm thick. The convex (outer?) side is unslipped brown but polished and apparently floated. The term "tongue" was applied to this sherd for lack of anything better. It is possible that it is part of a very large ladle or some type of flange or spout from a vessel.
Summary

It was stated in the introduction to this section that the documentation of pottery types and wares provides two kinds of culture-historical data: occupation chronology and directions of interaction between the survey area and adjacent regions.

The two most commonly identified types within the survey design area are El Paso Brown and Jornada Brown; the former was documented at 29 sites (67% of all sites with ceramics) and the latter at 20 sites (46% of all sites with ceramics). As the accepted temporal span for both types is A.D. 900-1350 it can be assumed that the survey area was significantly utilized during this particular period. The next three most popular types recovered (Chupadero Black-on-White at nine sites, El Paso Polychrome and Seco Corrugated at five sites) reflect a slightly later and narrower temporal span than the above two types: from A.D. 1100 to 1400.

The presence/absence nature of ceramic collection procedures precludes any statements at this time as to the relative human populations implied by pottery type variability. Type frequencies as well as their presence at a particular site would have to be determined before interpretations could be made as to population increases reflected by additional types later in time, or population consolidation reflected by these types appearing at much fewer sites later in time.

Likewise, the nature and degree of external relationships relative to the survey area can only be briefly stated at this point. Based on the documented foci of the identified types and wares, only the northern portion of the Jornada district is coincident with the survey design area. This is reflected by the presence of Jornada Brown pottery at almost half the ceramic-bearing sites. Nevertheless, as El Paso Brown occurs at two-thirds of the ceramic sites, perhaps the main thrust of occupation during this period has its origins to the south of the survey area, in the vicinity of El Paso (Fig. 29).

Based on the presence of other pottery types and wares (Fig. 29), the western and northern adjacent areas seem to provide secondary sources of influence and perhaps population; Chupadero Black-on-White and Socorro Black-on-White have a northern focus, and the Mogollon pottery (Alma Varieties, San Francisco Red, Mimbres types) occur most frequently to the west. The eastern area and regions farther south than El Paso are very poorly represented, primarily by single sherds at single sites of such types as the Chihuahuan redwares and terracotta wares from the east.

Despite the postulated documentation of influences or population movements from different adjacent regions, computer analysis of the pottery type distributions within the survey area shows very little spatial clustering. No determinations could be made at the type level; and even at the district
level the associations were weak. Pottery types assigned to the Jornada and Western Mogollon districts did tend to be associated; but it is felt that this reflects their occurrence at more sites than those types from other districts, more than any cultural implications. While the latter can be assumed, the results from this survey cannot document them specifically.

Computer analysis of ceramic densities at the various recorded sites is another aspect of the study which should be investigated further. A weak correlation does exist between larger sites and sites with lower medium ceramic density. It is suspected that this reflects activity specialization limited to certain intrasite areas, whereas the smaller sites with ceramics employed this type of artifact in all portions of the site.

It must be noted in conclusion that a total of 21 types and wares were identified from all sites (96) recorded, although only 14 types and wares were documented at the 88 sites within the survey design area. From a percentage point of view, 30% of the identified pottery types were documented at an additional 8% of the recorded sites. These figures suggest that for ceramics, at least, the survey design area was too small.
Figure 29. *Pottery Intrusives in the Radium Springs Area.* Arrows indicate probable derivation of pottery from the following districts:


2. Western Mogollon district (Mimbres drainage area): Mimbres Boldface and Classic Black-on-White.

3. Salado (Roosevelt Red) wares.


### TABLE 6
RADIUM SPRINGS CERAMIC SITE SURFACE DENSITIES
POTTERY TYPES PRESENT, DISTRICTS OF ORIGIN, AND PERCENTAGES.

<table>
<thead>
<tr>
<th>SITE NO.</th>
<th>CERAMIC DENSITY*</th>
<th>Jornada District</th>
<th>Western Mogollon District</th>
<th>Socorro District</th>
<th>Chihuahua District</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>Black/White</td>
<td>Chupadero</td>
<td>Jornada Brown</td>
</tr>
<tr>
<td>ARO01</td>
<td>☆ High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO03</td>
<td>☆ Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO04</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO09</td>
<td>☆ High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO11</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO13</td>
<td>☆ Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO14</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO15**</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO24</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO28</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO30</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO33</td>
<td>☆ Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO34</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO35</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO36</td>
<td>☆ Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO37</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO39</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO42</td>
<td>☆ Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO44</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO46</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO48</td>
<td>☆ High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO49</td>
<td>☆ Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO50</td>
<td>☆ Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO51</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO52</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO53</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO55</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO57**</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO59</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO60</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO62</td>
<td>☆ High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO63</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO66</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO68</td>
<td>☆ High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO71</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO72</td>
<td>☆ Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO73</td>
<td>☆ Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO75</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO76</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO78</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO80</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO81</td>
<td>☆ Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARO82</td>
<td>☆ High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL SITES FOR EACH TYPE</td>
<td>20 3 29 5 9 2 3 5 4 3 3 1 1 1</td>
<td>20 3 29 5 9 2 3 5 4 3 3 1 1 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% of pottery type for survey design ceramic types:

- **AR001**
- **AR003**
- **AR004**
- **AR009**
- **AR011**
- **AR013**
- **AR014**
- **AR015**
- **AR024**
- **AR028**
- **AR030**
- **AR033**
- **AR034**
- **AR035**
- **AR036**
- **AR037**
- **AR039**
- **AR042**
- **AR044**
- **AR046**
- **AR048**
- **AR049**
- **AR050**
- **AR051**
- **AR052**
- **AR053**
- **AR055**
- **AR057**
- **AR059**
- **AR060**
- **AR062**
- **AR063**
- **AR066**
- **AR068**
- **AR071**
- **AR072**
- **AR073**
- **AR075**
- **AR076**
- **AR078**
- **AR080**
- **AR081**
- **AR082**

% of district types for survey design ceramic types:

- **AR001**
- **AR003**
- **AR004**
- **AR009**
- **AR011**
- **AR013**
- **AR014**
- **AR015**
- **AR024**
- **AR028**
- **AR030**
- **AR033**
- **AR034**
- **AR035**
- **AR036**
- **AR037**
- **AR039**
- **AR042**
- **AR044**
- **AR046**
- **AR048**
- **AR049**
- **AR050**
- **AR051**
- **AR052**
- **AR053**
- **AR055**
- **AR057**
- **AR059**
- **AR060**
- **AR062**
- **AR063**
- **AR066**
- **AR068**
- **AR071**
- **AR072**
- **AR073**
- **AR075**
- **AR076**
- **AR078**
- **AR080**
- **AR081**
- **AR082**

* Ceramic Density is field estimate of all surface pottery: Low = 10-99 sherds; Medium = 100-999 sherds; High = 1000+ sherds.
** At AR015 and AR057 only unclassifiable sherds were recovered.
☆ Presence of rim sherds in ceramic sample.
<table>
<thead>
<tr>
<th>Table 7: Pottery Type Temporal Spans and Archaeological Culture Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.D.</strong></td>
</tr>
<tr>
<td>Lehmer’s Mogollon Phases</td>
</tr>
<tr>
<td>Comparative Anasazi Phases</td>
</tr>
<tr>
<td>Jornada Brown</td>
</tr>
<tr>
<td>Jornada Painted</td>
</tr>
<tr>
<td>El Paso Brown</td>
</tr>
<tr>
<td>El Paso Polychrome</td>
</tr>
<tr>
<td>Chupadero B/W</td>
</tr>
<tr>
<td>Three Rivers R/T</td>
</tr>
<tr>
<td>San Andres R/T</td>
</tr>
<tr>
<td>Alma Plain</td>
</tr>
<tr>
<td>Three Circle Neck Corrugated</td>
</tr>
<tr>
<td>Alma Neck Banded</td>
</tr>
<tr>
<td>San Francisco Red</td>
</tr>
<tr>
<td>Mimbres Bold</td>
</tr>
<tr>
<td>Mimbres Classic</td>
</tr>
<tr>
<td>Socorro B/W</td>
</tr>
<tr>
<td>Pitoche Rubbed-Ribbed</td>
</tr>
<tr>
<td>St. John’s Polychrome</td>
</tr>
<tr>
<td>Salado (Roosevelt Red)</td>
</tr>
<tr>
<td>Playas Red Incised</td>
</tr>
<tr>
<td>Ramos Polychrome</td>
</tr>
</tbody>
</table>
VII. INTERPRETATIONS, PREDICTIVE MODELS AND RECOMMENDATIONS

Joel D. Gunn, James E. Ivey and Thomas R. Hester

Uniform and Informant Models

In the discussion of the Radium Springs research design (Section II), it was noted that one of our major concerns was with the problems of disproportionate sampling. One effort to reduce this bias somewhat was made through the use of site distribution information provided by local people ("local informant's model"). Frequencies that we have since calculated suggest that the local informant's model of site distributions was correct in general outline. In the interest of methodology and explicit treatment of the data, a statistical test of the significance, or goodness-of-fit (Sokal and Rohlf 1969:549), between the observed and expected frequencies was devised.

Before attempting to calculate the goodness-of-fit, it will be recalled from Section II that the sample was disproportioned (Mueller 1974:32) in favor of Zones I and II. In order to remove the effect of this disproportional the number of sites discovered in a zone (Table 8,b) was divided by the area surveyed (Table 8,c) to get the number of sites found per section (Table 8,d). From this value the projected frequency of sites for the zone was calculated (Table 8,f) by multiplying it times the total area in sections of zones (Table 8,e).

The observed projected frequency was then tested against two distribution models. The first is a uniform distribution. The question asked in this exercise is: "Are the sites uniformly distributed over the landscape?" The second test is the "informant model" because the expected site frequency is derived from our local informant's expectations of the number of sections in which sites would occur per zone.

The $X^2$ values for each of these models is shown in the totals row of Table 8. The critical value for an $X^2$ test with three degrees of freedom (d.f.=# of Zones-1) at a probability of less than .001 is 16.3. The statistical inference, that both models are significantly different from the observed frequencies, is not to be taken uncritically. The uniform model was tested not because we had any expectation that sites were uniformly distributed over the landscape; the intention was to determine what the relation of the $X^2$ test would be to a clearly unrealistic model and use the results of this test to gauge the effect of alternative models. As Table 8,i shows, the uniform model is very different from the observed distribution when compared to the informant model. Thus, while the informant model can be technically rejected on the basis of an $X^2$ distribution table, it is less so by comparison to the uniform distribution. We conclude that our informant was in large part correct in his assessment of the distribution of sites in the survey area. Further, we believe that the character of the distribution can be explained by extensive depositions in Zone III which are deeply buried sites in the foothills of the Caballo Mountains. The reason for these depositions is determined by presently unknown factors of precipitation and hydrology. It seems likely to us that precipitation falls on the higher elevations on the mountains but not on the valley floor to the east. Consequently, detritus
### TABLE 8

DISTRIBUTIONAL ANALYSIS OF SITES FOUND DURING RADIRUR SPRINGS SURVEY

<table>
<thead>
<tr>
<th>Zone</th>
<th># of Sites Found</th>
<th># of Sections Surveyed</th>
<th># of Sites per Section</th>
<th>Area of Zone</th>
<th>Projected Observed Frequency of Sites</th>
<th>Uniform Model (# of Surveyed Area)</th>
<th>Uniform Model # of Observed Sites</th>
<th>Informant Model # of Sections With Sites</th>
<th>Informant Model # of Area With Sites</th>
<th>Informant Model # of Expected Distribution</th>
<th>Informant Model Expected Frequencies</th>
<th>Informant Model (O-E)^2/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2</td>
<td>3</td>
<td>.5</td>
<td>71</td>
<td>36</td>
<td>11.1</td>
<td>183</td>
<td>118.1</td>
<td>10</td>
<td>14.0</td>
<td>13.2</td>
<td>217</td>
</tr>
<tr>
<td>II</td>
<td>74</td>
<td>19</td>
<td>4.1</td>
<td>332</td>
<td>1361</td>
<td>51.8</td>
<td>853</td>
<td>302.5</td>
<td>220</td>
<td>66.3</td>
<td>62.7</td>
<td>1032</td>
</tr>
<tr>
<td>III</td>
<td>3</td>
<td>9</td>
<td>.3</td>
<td>190</td>
<td>57</td>
<td>29.6</td>
<td>487</td>
<td>379.7</td>
<td>5</td>
<td>2.6</td>
<td>2.5</td>
<td>41</td>
</tr>
<tr>
<td>IV</td>
<td>8</td>
<td>2</td>
<td>4.0</td>
<td>48</td>
<td>192</td>
<td>7.5</td>
<td>123</td>
<td>38.7</td>
<td>11</td>
<td>22.9</td>
<td>21.6</td>
<td>356</td>
</tr>
<tr>
<td>Totals</td>
<td>87*</td>
<td>33</td>
<td>641</td>
<td>1646</td>
<td>100.0</td>
<td>1646</td>
<td>1646</td>
<td>100.0</td>
<td>1646</td>
<td>100.0</td>
<td>100.0</td>
<td>1646</td>
</tr>
</tbody>
</table>

\[ V = 0.41 \]
\[ V = 0.26 \]

*87 of the 96 total sites recorded were used for the analysis reported in the table.
is transported to the valley floor but because of the rain shadow no further transport is provided to carry the material down the valley and out of the region.

**Optimal Utilization Model**

Having determined that the sites found in the course of the survey were non-uniform in distribution, we next examined their distribution when broken down into size categories.

Sites were divided into four groups according to size (large or small) and presence or absence of ceramics. The dividing line between small and large sites was set at 10,000 m² on the basis of inspection of a site area frequencies histogram; 10,000 m² is the point where the "curve" becomes flat.

It was assumed that non-ceramic sites generally predated those containing ceramics, although this probably is not always true. The distributions of these types were then compared to that predicted by the "optimal utilization" model.

What we have termed the "optimal utilization model" is, in principle, a central place theory scheme of site distribution. Sites are presumed to be divided between large base camps and small exploitation camps. As in central place theory, the exploitation camps are arranged about the base camp in a hexagonal pattern. In contrast to central place theory, however, we do not assume the adjacent hexagons to be packed. The base camps are seasonal loci at which uniformly distributed subsistence items are concentrated for transport to permanent winter camps in the foothills of the San Andres Mountains.

As long as foodstuffs are available within a nominal walking distance of the base camp, gathering concentrates around its perimeter. As the immediate area is more extensively exploited, however, substations are established to exploit the more distant areas. For reasons made explicit in central place theory these substations are arranged in a hexagonal pattern, notably optimal spacing with minimized travel distance to any point in the sector. We do not assume that the substations are the nodes of the adjacent hexagon. Since the gatherers exploit a radius around each temporary camp, such an arrangement would only result in walking to a point half of whose radius of exploitation was already harvested. It is the hexagons of exploitation radii, then, that are packed rather than the hexagons formed by the pattern of base and exploitation camps.

As a consequence, each hexagonal pattern will be separated from nearby hexagons by at least double the nominal walking and gathering distance. In practice the hexagons would probably be dispersed in an unpacked system to avoid overlapping radii.

Because of the disjointed nature of the nodes, or camps, the ratio of base camps to exploitation camps should be 1:6. This ratio can be used in goodness-of-fit evaluation of site relations were the uniform and informant distributions to test the validity of the idea. One of the elements of the idealized central place theory model is that the sites be on an unbounded plain over which resources were uniformly distributed. While the Jornada del Muerto is not
## Table 9

**Optimal Utilization Model**

<table>
<thead>
<tr>
<th>Zone</th>
<th>η of Sites</th>
<th>% of Sites (a/84)</th>
<th>Expected % Frequency (b/a/84)</th>
<th>Expected Frequency (c/84b)</th>
<th>Site Frequency, O (d)</th>
<th>X² = Σ (O-E)²/E</th>
<th>Non-Ceramic (O-E)²/E</th>
<th>Ceramic (O-E)²/E</th>
<th>X² = Σ (O-E)²/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2</td>
<td>.024</td>
<td>.003</td>
<td>.021</td>
<td>0.2 2.8</td>
<td>.2 .2</td>
<td>No Sites</td>
<td>0.0</td>
<td>0.3 2.0</td>
</tr>
<tr>
<td></td>
<td>74</td>
<td>.881</td>
<td>.126</td>
<td>.755</td>
<td>18.6 56.1</td>
<td>5.2 .8</td>
<td>6 30.9</td>
<td>.2 .0</td>
<td>12 26.0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.024</td>
<td>.003</td>
<td>.021</td>
<td>1.0 1.8</td>
<td>1.6 .4</td>
<td>No Sites</td>
<td>1.0</td>
<td>1.3 1.7</td>
</tr>
<tr>
<td>IV</td>
<td>6</td>
<td>.071</td>
<td>.010</td>
<td>.061</td>
<td>1.8 5.0</td>
<td>.1 .4</td>
<td>1.7 4.3</td>
<td>.1 .0</td>
<td>0 .1 .9</td>
</tr>
<tr>
<td>TOTALS</td>
<td>84*</td>
<td>1.00</td>
<td>.142</td>
<td>.858</td>
<td>20.0 64.0</td>
<td>X² = 8.5</td>
<td>d.f. = 7</td>
<td>c.u. = 24.3</td>
<td>α = .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>v = .12</td>
</tr>
</tbody>
</table>

*Site not in survey area and of questionable size eliminated*
without topographic variation there was almost surely never a more ideal place to test the model's effectiveness as a conceptual device.

The 1:6 ratio of large to small sites converts to percentages of 14.3%:8.7%.

In Table 9, a-d the expected values are calculated and e-h show how the observed distribution is found. The $X^2$ value at the bottom of columns g-h indicates that the fit between the optimal utilization model and the data is relatively good.

The $X^2$ values for the non-ceramic sites (columns i-l) and ceramic sites (columns m-p) show that there is a remarkable amount of heterogeneity within the overall data structure.

It is apparent that non-ceramic sites fit the "optimal utilization" pattern very well. Zones I and III have no non-ceramic sites; this is probably related to the erosion/deposition characteristics of these areas, as discussed above. If most of the non-ceramic sites are Archaic, they have been exposed to the elements for a considerable time, and the frequencies of those in the areas of highest environmental stress would naturally have been somewhat attenuated.

It is equally apparent that the ceramic sites do not fit the model as well. The ratio for these sites seems to be on the order of two small to each large. Explanations come to mind for this: (1) the cultural patterns associated with ceramics produce a different ratio of small to large sites, implying a different mechanism of land utilization--possibly associated with agriculture; or (2) the dividing point between small and large sites is different for ceramic sites. The second possibility prompted an examination of the area distribution curve for ceramic sites alone and for non-ceramic sites alone. This examination indicates that the division point should probably remain at 10,000 m$^2$ for ceramic sites and should probably be raised to about 12,000 m$^2$ for non-ceramic sites. Such a change would have little effect on the $X^2$ scores for non-ceramic sites.

It is concluded that the apparent difference in large to small site ratios between non-ceramic and ceramic sites represents a real difference, and that this difference stems from a different utilization pattern.

It should be noted that in the case of ceramic sites, Zones I and IV have insufficient numbers of sites for a meaningful $X^2$ test. Again, a mechanism causing an alteration of site frequencies in these zones may be the explanation, but the fact that some sites of this type were found indicates that perhaps a cultural influence is at work.

A third alternative that must be considered is that the ceramic and lithic sites are a part of the same settlement pattern but of different functional importances. The higher $X^2$ would then be a product of analyzing a part-system rather than any meaningful relationship. As can be seen in Table 9, the lithic and the lithic and ceramic analyses are virtually the same in significance.
TABLE 10
SITE DENSITY, RADIUM SPRINGS AREA

a. Mean Density, Sites Per km²

<table>
<thead>
<tr>
<th>Site Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0</td>
<td>0</td>
<td>0.193</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>0.644</td>
<td>0.558</td>
<td>0.129</td>
<td>0.257</td>
</tr>
<tr>
<td>III</td>
<td>0</td>
<td>0.043</td>
<td>0</td>
<td>0.043</td>
</tr>
<tr>
<td>IV</td>
<td>0.772</td>
<td>0.193</td>
<td>0.193</td>
<td>0</td>
</tr>
</tbody>
</table>

b. Mean Density with ± 34% Confidence Interval (1 Standard Error)

<table>
<thead>
<tr>
<th>Site Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0</td>
<td>0</td>
<td>0.193 ± 0.184</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>0.644 ± 1.151</td>
<td>0.559 ± 1.381</td>
<td>0.129 ± 0.151</td>
<td>0.257 ± 0.380</td>
</tr>
<tr>
<td>III</td>
<td>0</td>
<td>0.043 ± 0.065</td>
<td>0</td>
<td>0.043 ± 0.065</td>
</tr>
<tr>
<td>IV</td>
<td>0.772 ± 1.243</td>
<td>0.193 ± 0.220</td>
<td>0.193 ± 0.220</td>
<td>0</td>
</tr>
</tbody>
</table>

c. 68% Confidence Interval, Sites Per km²

<table>
<thead>
<tr>
<th>Site Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>No Estimate</td>
<td>N.E.</td>
<td>0.009 - 0.377</td>
<td>N.E.</td>
</tr>
<tr>
<td>II</td>
<td>0 - 1.795</td>
<td>0 - 1.939</td>
<td>0 - 0.280</td>
<td>0 - 0.637</td>
</tr>
<tr>
<td>III</td>
<td>N.E.</td>
<td>0 - 0.108</td>
<td>N.E.</td>
<td>0 - 0.108</td>
</tr>
<tr>
<td>IV</td>
<td>0 - 2.015</td>
<td>0 - 0.413</td>
<td>0 - 0.413</td>
<td>N.E.</td>
</tr>
</tbody>
</table>

d. Area to be Surveyed for a 50% Probability of Finding One Site, km²

<table>
<thead>
<tr>
<th>Site Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>N.E.</td>
<td>N.E.</td>
<td>N.E.</td>
<td>N.E.</td>
</tr>
<tr>
<td>II</td>
<td>1.55</td>
<td>1.79</td>
<td>7.75</td>
<td>3.89</td>
</tr>
<tr>
<td>III</td>
<td>N.E.</td>
<td>23.25</td>
<td>N.E.</td>
<td>23.25</td>
</tr>
<tr>
<td>IV</td>
<td>1.30</td>
<td>5.18</td>
<td>5.18</td>
<td>N.E.</td>
</tr>
</tbody>
</table>
At this time, however, it is beyond our ability to determine the contemporaneity of lithic and ceramic sites. So we are by default dependent on our original assumption that the two types of sites are temporally disassociated.

Because of the grossly differing sample sizes in the various tests the $X^2$ coefficients cannot be compared directly. Cramer's $V$, calculated as

$$V = \left( \frac{X^2}{N - \frac{d.f.}{d.f.}} \right)^{1/2}$$

where $N =$ Number at sites and $d.f. =$ degrees of freedom, removes the effect of different sample and vector sizes between the various tests. The tests are ranked on $V$ in Table II.

<table>
<thead>
<tr>
<th>TABLE II. Cramer V for Various Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal Utilization - Lithic Sites</td>
</tr>
<tr>
<td>Optimal Utilization - Lithic and Ceramic Sites</td>
</tr>
<tr>
<td>Optimal Utilization - Ceramic</td>
</tr>
<tr>
<td>Informant's Distribution</td>
</tr>
<tr>
<td>Uniform Distribution</td>
</tr>
</tbody>
</table>

If this ranking is assumed to be a measure of the relative power of the various concepts the optimal utilization distribution is clearly in the lead. Any subsequent research in the Radium Springs survey area should include as a part of its design the survey of a large enough block of land in Zone II to use standard central place pattern fitting techniques to test for the presence of the proposed model.

**Site Density**

In addition to examining the models discussed above, we also carried out a study of site density for each major type of site within each of the four environmental zones. Densities of site distribution and their range at the 68% level of confidence are presented in Table 10. These are calculated using the approach of A. E. Rogge (see Fuller, Rogge and Gregonis 1976).

Rogge's method for estimating the number of sites per unit area based on a stratified sampling is as follows:

$$r_c = \frac{\sum_{h=1}^{L} \frac{N_h}{n_h} \sum_{i=1}^{n_h} x_{hi}}{\sum_{h=1}^{L} \frac{N_h}{n_h} \sum_{i=1}^{n_h} y_{hi}}$$
where \( r_c \) = combined ratio estimate of number of sites per unit area

\[ \text{L} = \text{number of strata (zones)} \]

\[ N_h = \text{number of sample units in stratum h} \]

\[ n_h = \text{number of sample units surveyed in stratum h} \]

\[ \frac{N_h}{n_h} = \text{reciprocal of the sampling fraction} \]

\[ x_{hi} = \text{number of sites in sample unit i in stratum h} \]

\[ y_{hi} = \text{number of units of area in sample unit i in stratum h} \]

Because of the conditions of our survey, this equation was more complicated than necessary:

\[ \sum_{1}^{n_h} y_{hi} = \text{total area surveyed} \]

\[ \sum_{1}^{n_h} x_{hi} = \text{total number of sites found of each type} \]

\[ \sum_{0}^{L} \frac{N_h}{n_h} = \text{total reciprocal of sampling fraction, or ratio of total area of each zone to area surveyed in each zone.} \]

Since in each case we are interested primarily in the density for each zone rather than for the entire survey area, the summations across the zones may be omitted. The reciprocal of the sampling fraction cancels, leaving:

\[ r_c = \frac{\sum_{1}^{i} x_i}{\sum_{1}^{i} y_i} \]

where \( i = \text{number of sample units} \).

This equation says that the combined ratio estimate of site density in each zone is equal to the ratio of the total number of sites in each zone to the total area surveyed in each zone. Sample units are all the same size, one square mile or 2.592 km². Therefore:
where \( X \) = total number of sites in zone

\[ Y = \text{total area surveyed in zone} \]

For the sake of clarity, Rogge's alphanumerics were changed to mnemonic letters:

\[ r_c = D: \text{ site density of each site type in each zone} \]

\[ X = t: \text{ number of sites of each type in zone} \]

\[ Y = a: \text{ area surveyed in zone} \]

This makes Rogge's simplified equation:

\[ D = \frac{t}{a} \]

which is a clear and straightforward relationship. This computation must be carried out for each type of site in each zone.

Rogge's method of estimating the level of confidence of these densities, modified and transliterated for our purposes, begins with the calculation of the standard error of the number of sites of each type in each zone:

\[ S.E. = \sqrt{\frac{1}{n} \sum_{1}^{n} \frac{(t-m)^2}{n-1}} \]

where S.E. = standard error (standard deviation)

\[ D = \text{density of sites of each type per km in each zone} \]

\[ n = \text{number of sections in each zone} \]

\[ t = \text{number of sites of each type in each section} \]

\[ m = \text{mean number of sites of each type per section for all sections surveyed in zone} \]

This says that the standard error of the number of sites of each type in each zone is equal to the square root of the product of the density of sites per \( \text{km}^2 \) and the variance in the number of sites of each type per \( \text{km}^2 \) surveyed in each zone.

The density arrived at by these equations represents a mean density. The standard error gives us a method of estimating the probability that the actual number of sites found in a given zone by a survey of previously unexamined sections would be reasonably close to the mean density stated here. The usual
statement of this density and a probability estimate for it is as presented in Table 10,b; the probability is stated in terms of an interval, giving a range of densities and a probability that the actual number found will be within this range, quite similar to the method used in expressing radiocarbon dates. An interval of one standard error is equivalent to a probability interval of 34%—that is, the expression (mean density ± S.E.) states that there is a 68% chance that the actual density of sites found in a survey of a new area in a given zone would fall between the values of (mean density - S.E.) and (mean density + S.E.). Intervals appropriate to other probabilities are determined by multiplying the standard error by the proper amount, as determined by consulting the "Areas of a Standard Normal Distribution" tables to be found in most statistics texts.

Discussion of Density Results

The highest site densities are found among small non-ceramic sites in Zones II and IV, followed by large non-ceramic sites in Zone II. The greatest range of error is also found in these three sites and zone combinations. It will be noted that in all cases but the small ceramic sites in Zone I, the error is larger than the mean density. This simply means that there is considerable variation in the number of sites in any given section or square kilometer, which reduces the accuracy of any predictive statistics.

Table 10,d indicates the area to be surveyed to find one site if the mean density were an accurate statement of the density of a uniformly distributed number of sites. In actuality there is a 50% probability that a site will be found within this area. This is because the area given is equal to the inverse of the site density (in Zone II, type 1, for example, a density of 0.644 sites per km² is the equivalent of \( \frac{1}{0.644} \), or 1.55, km² per site), which is the mean of an assumed normal distribution. This means that as a survey is carried out, the first few square feet examined have minuscule probability of containing a site. This probability increases as the amount of area surveyed increases, and reaches 50% when the mean area has been surveyed. This table is presented as an illustration of the uses of these numbers as estimates of the probable number of sites to be found in any survey area.

In general, it should be kept in mind that the densities presented here are based on a 5% survey of a huge area. Rogge's work indicates that the situation is not necessarily so vague as it seems; his theoretical work implies that it is reasonably likely that the actual density of sites throughout the zones is quite close to the mean density figures presented in Table 10,a, and that the areas to be surveyed in Table 10,d would probably have a much higher chance than 34% of containing a site. Further refinements of estimates can and should be made by examining Tables 8-10 and noting other topographic characteristics shared by sites. Obviously some areas within a zone would have a far better chance than others of containing sites. Further refinement of the zone-wide density estimates and confidence intervals would require additional random sampling.
### TABLE 12

Rotated Principal Components Matrix for Environmental and Cultural Relationships in the Radium Springs Survey Area

| ENVIRONMENT                        | VECTORS | | | | | h² |
|------------------------------------|---------|---|---|---|---|---|---|
| East                               | I       | II | III| IV| V  | VI |     |
| Elevation (North)                  | .8      | .8 | .8 | | | | |
| Physiographic Transect Loc.        | -.7     | .8 | .8 | | | | |
| Physiographic Orientation          | .4      | -.6| -.7| | | | |
| Vegetation (Mesq-Other)            | -.7     | .5 | .5 | .5 | | | |
| Soil (Sand-Other)                  | -.4     | .5 | .5 | .8 | | | |
| Water Source                       |         |   |   |   |   |   |     |

<table>
<thead>
<tr>
<th>CULTURE</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Late (Archaic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.8</td>
<td>.7</td>
</tr>
<tr>
<td>Site Orient. (East of North)</td>
<td>.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.7</td>
</tr>
<tr>
<td>Site Length (Width)</td>
<td>.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.8</td>
</tr>
<tr>
<td>Ceramics</td>
<td>.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.7</td>
</tr>
<tr>
<td>Chipped Stone</td>
<td>.6</td>
<td></td>
<td>.4</td>
<td></td>
<td></td>
<td></td>
<td>.7</td>
</tr>
<tr>
<td>Ground Stone</td>
<td></td>
<td></td>
<td>.8</td>
<td></td>
<td></td>
<td></td>
<td>.8</td>
</tr>
<tr>
<td>Hearths</td>
<td>.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.9</td>
</tr>
</tbody>
</table>

**Active Variance (61%)**

<table>
<thead>
<tr>
<th></th>
<th>15%</th>
<th>12%</th>
<th>10%</th>
<th>9%</th>
<th>9%</th>
<th>6%</th>
<th>.72 = Total Variance Accounted For</th>
</tr>
</thead>
</table>

...
Environmental and Cultural Relationships

The major presumption which informed the collecting of data for the Radium Springs analysis is that some proportion of the behavior which human beings exhibit, and which is recorded in the archaeological record, is governed by factors of the environment. With this thought in mind we attempted to metrically describe the environment of each site in terms of not only its Cartesian location but also its characteristics as a source of water, shelter and subsistence. In the following discussion we will attempt to delineate the probable environmental preferences of the people who inhabited the Jornada del Muerto. In the first analysis the problem will be dealt with at a rather general level by analyzing the data from the site survey forms. Because of unforeseen logistical problems, we found it difficult to get site survey forms from the field to our computer facility on a regular basis. However, it should be kept in mind that, assuming the solution to particular logistical problems, this analysis could have run simultaneously with the survey (on a day-to-day basis if need be). In the second analysis we attempt to incorporate the results of the laboratory analysis into the study.

Table 12 is a varimax rotated principal axis matrix (Nie et al. 1975:479) which has been partitioned into environmental and cultural variables. Each column in the matrix represents a statistically independent trend in the data. If it is acceptable to assume that cultural traits will be correlated with the environmental phenomena to which they are causally related, then cultural and environmental traits which are causally related will appear on the same columns or vectors of the matrix. Two vectors in the matrix are related to the environmental indicators we have defined, causal Vectors I and VI. Between them, these two constitute 21% of the active variance in the system as defined by the 14 analyzed variables. Purely cultural components, Vectors II and III account for 22% while the interaction of environmental influences in Vectors IV and V accounts for 18% of the system's behavior.

The first vector shows that the location of sites on the physiographic transect (and the distance to water) is inversely correlated with site orientation, amount of ceramics and lithics (Fig. 30). Larger amounts of ceramics and lithics located closer to sources of water are a reasonable relationship in any circumstance. Why sites should be oriented more toward the north on the upland, and to the south closer to water courses, is not immediately apparent.

Vector VI shows that chipped stone tends to be located in areas where mesquite is sparse and other types of vegetation are prominent. Mesquite is thought to be a recent intruder in the area so the relationship is not direct. The aboriginal populations did not use chipped stone on or around whatever vegetation complex the mesquite has replaced.

Vectors IV and V are special cases because they both represent a great deal of natural variation which seems to be influencing the way sites are located relative to physiographic features. Vector IV shows that sites farther east tend to be located to the side of physiographic features and they tend to be on sand. Sites to the west are on other soil types and tend to be on the tops of features. Vector V shows that sites which are farther north
and higher in elevation are farther from water resources on the tops of topographic features. Conversely, those to the south and lower in elevation are closer to water and located to the side of features.

The two purely cultural vectors show that larger sites have more lithics and more hearths. This leads to no surprises but it is interesting that the number of hearths should be so totally related to size of the site. If there were functional variability between sites, the number of hearths relative to site size could vary significantly.

The remaining cultural trend, Vector III, is the Archaic-Late cultural continuum. The only time-related changes in the valley involve a gradual increase in ceramics and ground stone.

Any enviro-cultural system described numerically as we have done here is going to be composed of those environmental and cultural variables which are specified and measured and those which are unspecified and as yet unknown. If we take some things for granted, we can say that 61% of the variance between environment and culture, in the narrow sense they are defined in this study, are accounted for by the foregoing analysis and 39% of the variance in culture are as yet of unknown sources. Fig. 31 illustrates cultural and environmental interaction in a causal diagram.

Fig. 31 is defined without feedback and as such is probably more simple than the real interaction. Interpretation of the causal forces in a matrix like Table 12 is purely a matter of theory, and so we are obligated to consider alternative interpretations. One possibility is to further partition the variance into feedback loops. Let us assume that "culture" per se is an unknown causal agent in the system, the effects of which we can read from the structure of archaeological materials collected in the survey. In the case where a vector contains loadings in both the environmental and cultural sections of the matrix, we are observing a demonstrated causal relationship between environmental stimulus and cultural response as in Vectors I and IV.

This is illustrated in Fig. 32 by the E to C relationship of 21%. What of the other vectors which show no activity across the environmental and cultural subsystem boundaries? The purely environmental Vectors IV and V are not purely environmental in the sense that culture is not involved. The physiographic-environmental context of a site is selected by cultural criteria. These variables, then, reflect the effect of unseen cultural influences on the preselection of site locations. In a sense they are the products of the effect of culture on environment. This is shown in Fig. 32 as an 18% C to E relationship.

Vectors with only cultural variables show the effect of culture on cultural distributions of materials at 22%. Unknown relationships of unknown causal directions are illustrated as before at 39% but the ambiguity of the causal relationships is shown by arrows in both directions.

While this discussion is methodologically incomplete, it does serve to outline a synopsis of prehistoric enviro-cultural relationships in the Radium Springs survey area and provide rough estimates of the magnitude of those interactions. Future research in the area should consider these relationships as hypotheses around which research designs could be constructed.
Figure 30. Physiographic Transect and Related Variables.
Figure 31. Recursive Interaction Between Environment and Culture and Factors As Yet Unknown.

Figure 32. Non-recursive Interaction.
The larger principal components analysis was calculated in 59 variables. These included all of the variables in the site survey analysis except ceramics and lithics and all of the ceramic and lithic types which had variance. All variables were converted to binary states. This was done to avoid the problem of correlation coefficient attenuation which happens when binary variables (presence or absence of ceramic types, etc.) and continuous variables, with large numbers of states (such as elevation in meters), are correlated (Doreian 1972). The effect of attenuation (lowering) is to produce spurious independence in the correlation matrix.

The results of this analysis must be considered very tenuous relative to lithics since there was only a marginal attempt to sample the large quantities of lithics in the survey area as per contract specifications. The ceramics, on the other hand, are accurately represented. All results are offered as numerically inferred hypotheses to be tested by fieldwork and are in no sense meant to be taken as conclusions.

Using a scree-test (Rummel 1970:364), it was determined that there were 14 substantially important components in the data. These were rotated to varimax criteria.

These 14 components represent 67% of the variance in the original data matrix.

<table>
<thead>
<tr>
<th>VECTOR</th>
<th>LOADING</th>
<th>COMMUNALITY</th>
<th>COMMENT*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Mimbres Boldface</td>
<td>.89</td>
<td>.89</td>
<td>B T_w</td>
</tr>
<tr>
<td>Mimbres Classic</td>
<td>.44</td>
<td>.79</td>
<td>B T_w</td>
</tr>
<tr>
<td>Pitoche Rubbed-Ribbed</td>
<td>.56</td>
<td>.70</td>
<td>U T_w</td>
</tr>
<tr>
<td>Unidentified Painted Ware</td>
<td>.55</td>
<td>.77</td>
<td></td>
</tr>
<tr>
<td>Unidentified Corded/Banded/Incised Ware</td>
<td>.76</td>
<td>.89</td>
<td></td>
</tr>
<tr>
<td>II. Ornaments</td>
<td>.76</td>
<td>.70</td>
<td></td>
</tr>
<tr>
<td>Alma Plain</td>
<td>.73</td>
<td>.82</td>
<td>U T_w</td>
</tr>
<tr>
<td>Seco Corrugated</td>
<td>.39</td>
<td>.58</td>
<td>U T_w</td>
</tr>
<tr>
<td>Playas Red Incised</td>
<td>.92</td>
<td>.92</td>
<td>U T_w</td>
</tr>
<tr>
<td>Concave Scraper</td>
<td>.39</td>
<td>.67</td>
<td></td>
</tr>
<tr>
<td>Core Trimmer</td>
<td>.58</td>
<td>.83</td>
<td></td>
</tr>
</tbody>
</table>

*(B = Burial Ware; U = Utility; T = Trade; Subscripts n, e, s, w = direction of trade importation).*
### TABLE 13 (continued)

<table>
<thead>
<tr>
<th>III.</th>
<th>Late</th>
<th>.87</th>
<th>.84</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Archaic</td>
<td>.86</td>
<td>.81</td>
</tr>
<tr>
<td></td>
<td>Hearth (Limestone)</td>
<td>.42</td>
<td>.63</td>
</tr>
<tr>
<td></td>
<td>Jornada Brown</td>
<td>.51</td>
<td>.65</td>
</tr>
<tr>
<td></td>
<td>El Paso Brown</td>
<td>.78</td>
<td>.79</td>
</tr>
<tr>
<td></td>
<td>Site Type (Large Sites?)</td>
<td>.66</td>
<td>.85</td>
</tr>
</tbody>
</table>

| IV. | Hearth (Basalt) | .84 | .75 |
|     | Hearth (90% Basalt) | .68 | .53 |
|     | Hearth (Basalt/Limestone/Sandstone) | .76 | .70 |
|     | Unidentified Plainware | .42 | .72 |

| V. | North | .43 | .75 |
|    | Unidentified Plain | .53 | .72 |
|    | Pulping Plane | .60 | .54 |
|    | End Scraper | .56 | .57 |
|    | Concave Scraper | .43 | .67 |

### TABLE 14

Rotated Principal Components Results for Post-Laboratory Analysis

<table>
<thead>
<tr>
<th>NAME</th>
<th>LOADING</th>
<th>COMMUNALITY</th>
<th>COMMENT*</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seco Corrugated</td>
<td>.46</td>
<td>.58</td>
<td>U</td>
</tr>
<tr>
<td>Preforms</td>
<td>.55</td>
<td>.68</td>
<td></td>
</tr>
<tr>
<td>Finished Bifaces</td>
<td>.72</td>
<td>.74</td>
<td></td>
</tr>
<tr>
<td>VII.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worked Potsherds</td>
<td>.64</td>
<td>.72</td>
<td></td>
</tr>
<tr>
<td>End-Side Scraper</td>
<td>.56</td>
<td>.56</td>
<td></td>
</tr>
<tr>
<td>Plano-Convex-Oval</td>
<td>.62</td>
<td>.53</td>
<td></td>
</tr>
<tr>
<td>Quarry Blanks</td>
<td>.56</td>
<td>.53</td>
<td></td>
</tr>
<tr>
<td>Preforms</td>
<td>.42</td>
<td>.68</td>
<td></td>
</tr>
<tr>
<td>Drills &amp; Perforators</td>
<td>.41</td>
<td>.64</td>
<td></td>
</tr>
<tr>
<td>Cores</td>
<td>.44</td>
<td>.73</td>
<td></td>
</tr>
<tr>
<td>Core Trimmer</td>
<td>.63</td>
<td>.83</td>
<td></td>
</tr>
<tr>
<td>VIII.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>.64</td>
<td>.65</td>
<td></td>
</tr>
<tr>
<td>Soil (Sand-Other?)</td>
<td>-.81</td>
<td>.69</td>
<td></td>
</tr>
<tr>
<td>Ground Stone</td>
<td>.50</td>
<td>.52</td>
<td></td>
</tr>
<tr>
<td>End Scraper</td>
<td>-.46</td>
<td>.57</td>
<td></td>
</tr>
</tbody>
</table>

*(B = Burial Ware; U = Utility; T = Trade; Subscripts n, e, s, w = direction of trade importation).
Based on Tables 13 and 14 (above), we can make a number of observations. Vector III suggests that larger sites are more frequent later in time and that later and larger sites have Jornada Brownware and El Paso Brownware consistently associated with them. Both are utilitarian types of pottery which might be expected to be the staple indicators of change through time. In addition, limestone hearths were present where these trends appeared. From these associations we infer a tendency for the increased use of utilitarian brownwares through time, perhaps at the expense of perishable containers and perhaps a more sedentary character to prehistoric lifeways. For as yet undetermined reasons limestone was more frequently used in later times. There is no indication of directional preferences in the use of limestone which would probably result from a shift in regional locations of sites. It is therefore possible that limestone was preferred to basalt and carried over distances to use-points, thus randomizing the pattern.

Vector VIII is an environmentally-related tendency. It properly shows that soils to the east are sandy and other soil types are found to the west.
Related to this physiographic fact is the presence of ground stone to the east and sandy region while end scrapers appear more frequently to the west with clays. This vector could lead one to very cautiously hypothesize plant processing in the sand hills with ground stone and hide processing in the west, perhaps during climatically wetter times.

Vector XIII contains the north coordinate and negatively related to it the physiographic transect and vegetation. Toward the south, then, sites are more often on the uplands between water courses and the vegetation is more frequently non-mesquite varieties. Associated with the south also are combination basalt-limestone hearths.

Vector IV shows that various hearth types typically occur together in the same sites. It also demonstrates that these hearth types are typically associated with unidentified sherds of plainware pottery.

Vector V shows a tendency for "pulping planes," end scrapers and concave scrapers to be more frequently present toward the north of the survey area. Unidentified plainware sherds also appear in a systematic fashion in the north.

Vector I contains both of the Mimbres varieties of pottery which are typically found as burial goods and Pitoche Rubbed-Ribbed is a utilitarian ware. The other two categories are unidentifiable scrap pottery.

Lithics

Vector VII is a complex of lithics, particularly bifaces and quarry materials. The sites with such a combination of tools are clearly workshops. There are no indications of direction or other environmental relationships. This could be taken to mean that sites containing the Vector VII lithic complex are uniformly spread over the survey area. If further study shows them to be potential base camps, this vector supports the central place or maximum utilization model tested in the predictive models portion of this section.

The association of preforms and finished bifaces in Vector VI suggests sites at which bifacial thinning was important. Why Seco Corrugated, a utility ware, should be associated with bifacing is obscure but it does suggest that the execution of such duties within the valley was a late rather than early trait. While Vector VI is conceptually close to the lithic complex in Vector VII, the fact that the two are statistically independent may suggest an earlier date for the purely lithic Vector VII as inferred from the association of ceramics with Vector VI.

Ornamentation

Vector II is composed of utilitarian wares and two lithic types. While we offer no interpretation of the functional aspect of the vector it is interesting to note the presence of ornaments with the cluster. Perhaps the possibility of using the tools and containers for manufacture and storage of ornaments should be considered for testing in future research.
Questions

Several vectors are difficult to interpret and could easily be the products of sampling error, spurious correlations, and any number of other problems that make this analysis very tenuous. Vector IX is composed of El Paso Polychrome, a tradeware from the south, hammerstones and cores. Vectors X, XI, XII, and XVI are composed of similarly obscure combinations of lithics and ceramics which may someday be meaningful, but for which we have no plausible interpretation now. They are the very lowest vectors as far as accounting for variance is concerned. They could be simply error variance with no real meaning; although this is as a matter of judgement somewhat unlikely in this case, since the number of substantively important vectors was conservatively estimated.

In summary, the analysis shows that there are directional and environmental tendencies in the data which can be justifiably investigated by archaeological research. Among the hypotheses to be considered is the possibility of differential land use between sandy and clay (other) soil zones, and vegetation zones. The valley appears to have been occupied on a more sedentary basis later in time (i.e., the prehistoric period during the Jornada Branch times before Apache occupation). The types of hearths and the use of varying emphases in chipped stone technology also appear to be potentially rich topics for future research. In addition, vectors which cannot be immediately interpreted may prove to be useful sources of hypotheses as our understanding of the Radium Springs Survey area matures and the vectors are reconsidered in the light of that maturity.

Recommendations

Our recommendations, on a site-by-site basis, are listed in Table 3. Most sites fall into Categories 1 and 2 (see key to Table 3). Category 1 sites are those that, in all probability, have been essentially destroyed by erosion. They are scattered remnants, with little remaining archaeological potential. In Category 2 we have placed sites which cannot be fully evaluated at this time. Some of these sites may be significant, but due to the lack of field time or to minimal erosion they could not be adequately assessed. If any of the Category 2 sites are found to be within areas slated for modification, they should be field-checked again prior to being disturbed.

Sites in Categories 3 and 4 are important ones. All should be nominated to the National Register of Historic Places. The three sites in Category 3 (AR001, AR089, AR092) are presently being damaged, primarily through the vandalism of relic collectors. The sites are on federally-controlled lands, and we urge that steps be taken to insure their protection. The five sites in Category 4 (AR062, AR068, AR093, AR094, AR096) are of outstanding importance, and we recommend their immediate nomination to the National Register. Even though some of these were found outside the selected survey sections, we have documented their existence and they should be protected.

We believe that this survey has adequately reported the major kinds of sites within the Radium Springs study area. In addition, we have provided detailed descriptive and illustrative information on these sites and the materials
recovered from them. We have indicated our estimate of site density, in terms of site type occurrence within specific and environmental zones. However, these data constitute only a limited and very preliminary assessment of the archaeological resources in the vicinity of Radium Springs. Before any modification of government land occurs in this section, we strongly recommend that intensive archaeological surveys be made of those areas that would be affected.
VIII. APPENDICES
The coding format for the Radium Springs survey was designed: (1) to collect the maximum amount of information on site character and context which could reasonably be asked of individual personnel without unduly interrupting a largely team-oriented effort, and to meet the specifications of the BLM contract; and (2) to facilitate rapid coding, checking for completeness and key punching. The form used in the survey is reproduced on the following page.

The first section records the location at the site and its designations. The second section is a field estimate of the antiquity of the site [Paleo-Indian, Archaic, and Late (ceramics, villages, arrow points, etc.)]. Site context is determined by answering the eight questions in section three of the form. Topography is the location of a site relative to a physiographic transect which is subdivided at various points between the bottoms of water courses and the tops of upland eminences. Landform within one mile is intended to record any nearby physiographic features which would attract occupation such as natural windbreaks, elevated areas, etc. Site orientation is likewise noted to record relationships to features which would provide a natural attraction to inhabitants such as orientation toward or away from direct sunlight, prevailing winds, etc. Vegetation, soils, distance to the nearest water, wildlife, soil and lithic outcrops might also reflect the availability of attractive resources.

The site dimensions are recorded as maximum length and width and the direction east of north in degrees of the long axis of the site.

Density of various aboriginal and modern features is designed to collect information on the appearance of prehistoric remains and the disruption of those materials by modern collecting, economic, and erosional activity.

The column of recording space down the right side of the form is largely work space which allows the field investigators to expand the coding format based on mutual understanding in the field. Some items which were agreed on by the end of the first week of the survey are entered in this work space since a large reproduction run of the forms was made at that time.

Each underscore on the page represents a computer card key punch column. Any information that is to be entered into the computer must be coded one digit per underscore on, and only on, the underscored spaces. The underscores are aligned so the survey personnel can readily locate the spot where information is to be entered, so the field supervisor can check for completion at a glance, and so key punchers can readily and accurately transcribe the record to cards.

With regard to completeness, a form is complete only when all underscores are filled in. If data are missing a zero is entered. If there is a blank it means that the question was not dealt with.
Zero = Missing Data. If there are any blanks when you walk away from a site, you did something wrong!

Location
---
- Zone
- Survey Unit
- Site No.
- --- East Coordinate
- --- North Coordinate
- --- Elevation

Components (Field Estimates: to be refined in Lab)
- Paleo-Indian (1=Pres, 2=Abs)
- Archaic (1=Pres, 2=Abs)
- Late (1=Pres, 2=Abs)
- Individual Find (See Lithic Type List)

Site Location

- Topographic feature at site
  (1=Water Course, 2=Valley Bottom, 3=Valley Slope, 4=Upland Margin, 5=Upland, 6=Upland Feature)
- Land form within 1 mile (see list)
- Orientation (1=Upon, 2=N. of feature, 3=E. of feature, 4=S. of feature, 5=W. of feature)
- Vegetation on site (see vegetation list)
- Water Source (1=On Site, 2=<100 m, 3=<1 km, 4=>1 km)
- Wildlife in area (see wildlife list)
- Lithic outcrops (see outcrop list)
- Soil type (see soil list)

Site Dimensions
---
- Long orientation (degrees East of North)
- Meters long
- --- Meters wide

Density (Site-Wide)
- Ceramic (1=1-10, 2=10-100, 3=>100)
- Lithic (1=1-10, 2=10-100, 3=>100)
- Ground stone (count, 9=>9)
- Ornaments (1=1-10, 2=10-100, 3=>100)
- # of hearths
- Collecting of site (1=pristine, 2=potholed, 3=destroyed by human activity)
- Economic Activity (1=disturbed, 2=partially dist., 3=wholly dist.)
- Erosion (1=undisturbed, 2=partially eroded, 3=wholly eroded

Ceramic Types:
1. Jornada Brown
2. Jornada Painted
3. El Paso Brown
4. El Paso Polychrome
5. Chupadero Black/White
6. Three Rivers Red/Terracotta
7. San Andres Red/Terracotta
8. Lincoln Red/Black
9. Alma Plain
10. Three Circle Neck Corrugated
11. Alma Neck Banded
12. San Francisco Red
13. Seco Corrugated
14. Mogollon Red/Brown
15. Three Circle Red/White
16. Mimbres Boldface
17. Mimbres Classic
18. Pitoche Rubbed-Ribbed
19. Socorro Black/White
20. St. Johns Polychrome
21. Salado (Roosevelt Red)
22. Playas Red Incised
23. Ramos Polychrome
24. Rio Grande Glaze
25. Cibola Whiteware
26. Unidentified Plain ware
27. Unidentified Paint ware
28. Unidentified Textured ware
29. "Worked" Potsherds
30. "Mendinghole" Potsherds
31. (Not Used)
32. Hearth-Basalt
33. Hearth-90% Basalt
34. Hearth-Bas-LS (50-50)
35. Hearth-LS
36. Hearth-LS-SS
37. Hearth-SS
38. Hearth-Bas-LS-SS
39.
40.
41.
42. Biface-Arrow
43. Biface
44. Biface-Site Notched
45. Biface-Corner Notched
46. Scraper-end
47. Scraper-side
48. Uniface
49. Perforators
50. Choppers
Potentially the coded information could be analyzed simultaneously with the progress of the survey. (See section on numerical analysis for further discussion.) Logistics problems in the case of this survey precluded effective simultaneous analysis. When the crew returned to The University of Texas at San Antonio the cards were key punched and various analyses performed. Besides providing the basis for linear analysis of intersite relationships, the computer coding provided readily available tabulations of site characteristics which were used during the writeup phase.

After the lithics and ceramics were analyzed in the laboratory, a second card was added to the existing key punch information for each site based on these endeavors.

While some of the categories did not provide useful information because of the special circumstances of the survey area, especially economic activity and erosion (widespread deflation), the form should be left unchanged in future surveys in the area in the interest of universal applicability.

Suggested Improvements for the Survey Form

The data that are given to the computer are derived in several ways. As far as we are concerned, the two most important data derivations are (1) "field acquired" and (2) "laboratory acquired."

1) Field Acquired Data: These can be defined as those pieces of information which can best (or only) be acquired in the field, on site.

2) Laboratory Acquired Data: This information is worked up in the laboratory as a result of artifact analysis, map study, or documentary research.

It is inefficient to include both types of information on the same form, since in effect the laboratory information is peculiar to the project and probably would require a unique format designed to match its needs and goals. The field survey form, on the other hand, should be of such a design as to permit its use almost anywhere in the world.

We believe the present form is quite good in the sense of universal applicability. It can be adjusted to any area by the setting up (after a brief preliminary inspection of the project area) of appropriate type lists for items 1, 11, 12, 14, and 16-18.

We recommend changes to the form used for the Radium Springs survey as follows:

1) Place numbers along the left margin indicating the sequential number of each blank of each item.

2) Place an item number immediately to the left of the item-defining phrase.
3) It is essential that the appropriate lists be worked up carefully beforehand and crew members be familiarized with the intent of each description on the lists, and how to interpret actual field situations in terms of these lists. Vegetation, wildlife, lithic outcrops, and soil types are areas of great potential difficulty, and the information intended to be acquired by each item should be made very clear in the minds of all persons involved in the project.

Basically, we are looking at the field form as a framework into which we can plug modules of code-lists, the values of which change from region to region, but all of which are at the same level of resolution so that one region can be compared to another.
APPENDIX II

THE HIGH LONESOME BEAD CACHE

Thomas C. Kelly

Introduction

The site designated "The High Lonesome Bead Cache" (AR095) was an accidental discovery on a non-programmed BLM-controlled section. The site was found by crew chief Erwin Roemer while he was looking for a USGS section marker to aid in locating one of the programmed survey sections.

Site Environs

The section was identified as Section 13, Range 1E, Township 15S and is in Zone 1 of our survey area, the western foothills of the San Andres Mountains. Runoff is southwest from the San Andres Mountains at a slope of 125 feet per mile to the site location at an elevation of 5,250 feet. The site is situated on the north bank of a shallow arroyo that originates a quarter-mile to the northeast and disappears in flatter land as an alluvial fan approximately one mile to the southwest. According to a local rancher, the site has been just recently uncovered by erosion within this drainage.

The soil in the site area is a very fine red-yellow sand 28 to 30 cm deep overlying a gray caliche subsoil of undetermined depth. The vegetation is characteristic of the uplands in this area of the San Andres with creosote, mesquite, and grama grass all sparsely represented. Native fauna observed in the area included deer, coyote, jackrabbit, cottontail rabbit, raccoon, ringtail, rock squirrel, quail, and rattlesnake.

Investigation at the Site

While searching for the above-mentioned section marker, Roemer spotted several white beads and a turquoise pendant and called them to the attention of the field supervisor. The crews were organized to locate and flag the beads and it soon became apparent that the site was of substantial size. An arbitrary reference was established by driving a steel reinforcing rod into the ground southwest of the flagged beads and a metric grid was laid from this point for 10 meters north and east. The beads were picked up and bagged by one meter-squares and their distribution was plotted. A total of 72 beads and the turquoise pendant were collected. The only other artifacts found were three Alma Punched potsherds.

Controlled shovel tests indicated that beads continued to some depth, and a small-scale excavation was planned. The time limitations of the Radium Springs survey were such that further investigations of the site were accomplished by crew members voluntarily in their spare time.
A total of 17 one-meter squares were excavated. All units were assigned an alphabetical designation for easy reference, but all measurements were recorded in terms of meters north and east of the datum point. Squares C, D, E, G, H, I, L were excavated in arbitrary 10-cm levels by trowel into the basal caliche at 30 cm, and all soil was passed through 1/8 inch-mesh screen. Results were evaluated and because of time limitations, the remaining 10 squares were excavated by 10-cm levels to a depth of 20 cm. No appreciable recovery of cultural material was made below 15 cm except in squares H and I where a cache pot, beads, and limestone cobbles were found to a depth of 28 cm.

The soil was homogeneous from the surface to the gray caliche sub-soil where a sharp disconformity was noted. The fine sand is moved about by wind and water from year to year. Consequently, both surface and sub-surface distribution of artifacts fall within a rough oval oriented northeast to southwest and centered in the unit where the cache vessel was found. Numbers of artifacts diminish inversely to the distance from unit H. Maps are on file at the Center for Archaeological Research showing horizontal and vertical distribution of the artifacts.

Ceramics

The Cache Pot

The bottom fragment (8 cm vertically and 16 cm horizontally) of a black smudge-ware pot of Mimbres affinity (Alma Punched) was exposed at 18-cm depth in unit H at N5.45, E5.85. It was completely filled with large shell and smaller calcite beads (Fig. 33,a). Many of the beads were standing on edge and wedged in their original stringing order. The bowl was undermined, boxed, and taken to the laboratory of the Center for Archaeological Research (in San Antonio) for excavation and recording. Three additional sherds from unit H and one from unit I were later fitted to the pot. Fourteen plain sherds and five punched sherds of the pot were found randomly scattered throughout the site. No rim sherds were found.

Mimbres Boldface Black-on-White

Seven sherds of Mimbres Boldface Black-on-White were recovered randomly distributed throughout the site (Fig. 33,b).

Lithics

A single unaltered flake of fine gray chert was found in unit H at 15-cm depth. In addition, a cluster of fist-sized, limestone cobbles surrounded the bead-filled pot in unit H and continued into unit I. There were approximately 30 of these irregular cobbles and none were altered by fire or man. However, they were certainly gathered and placed about the pot by man probably as a cairn to mark the pot location. The single flake found near the cache pot is shown in Fig. 33,a.
Figure 33. Ceramics and Flake Artifacts Recovered from AR095.  

a, plainware sherds and chert flake (lower left); sherds appear to be Alma Plain type and belong to the intact vessel base, including the punched fragment (bottom); b, Mimbres Boldface Black-on-White bowl sherds associated with AR095.
Figure 34. Calcite and Shell Beads from AR095. a, Calcite beads, 5-15 mm diameter. Marine pelecypod beads 16-28 mm; b, Calcite and one shell bead magnified 15X. Shell bead exhibiting calcification and the typical accretion rings of marine shells; c, upper row--double perforated bead pendants, lower row--typical large shell beads all made around umbo cavity of marine pelecypod.
Beads and Pendants

A total of 393 beads and pendants were excavated from the 10 one-meter squares, and 405 more from the pot under laboratory conditions. With the 73 surface specimens, this brought the total to 871. The three groups were analyzed separately but no distinction could be made between them. They are all from the same population and must have come from the cache pot. The three groups are combined for the following analysis.

Laboratory Description and Analysis

Procedure

Measurements and nomenclature closely follow those of DiPeso (1974, Vol. 6:385-389), and the bead data were entered on IBM punch cards for computer analysis. The irregular pendants are described in Table 15 (and Fig. 46). Beads are summarized in Table 16. Photomicrography was employed in studying and recording materials and manufacturing techniques.

Calcite Beads

The numerically predominant bead form (736 or 88% of the 837 total) is a well-made, symmetrical disc-shaped bead, white to cream in color and well polished. The beads were manufactured with precision, uniformity and skill. They are conically, biconically, and cylindrically perforated (53%, 37%, and 10% respectively) with perforations varying from 1 to 3 mm. Diameter varies from 5 to 15 mm, thickness from 2 to 7 mm, and weight from .1 to 2.8 gm. A summary of bead measurements is given in Table 16. The usual test to distinguish between shell and stone beads (using diluted hydrochloric acid) produces the same reaction as shell, which is soluble and fizzes away. However, under 20x magnification, the structure of a broken bead is made up of hexagonal crystals. Dr. Richard McGehee (Associate Professor of Geology at UTSA) identified the material as calcite, which is also soluble in hydrochloric acid. Views of these beads are illustrated in Figs. 34 and 41.

Shell Beads

The shell beads (101 or 12%) are completely different from the calcite beads. They are larger (11 to 33 mm in diameter, 6 to 15 mm in thickness), weigh from 6 to 17.6 gm, have perforation diameters of 2 to 4 mm, and are buff colored, usually with streaks of pink. They are concavo-convex in section and irregularly wedge-shaped in thickness, as well as out of round. The larger ones have a deep natural concavity in the concave face which Dr. Harold Murray (malacologist at Trinity University, Department of Life Sciences) has identified as the umbo cavity of a marine pelecypod of undetermined species. The hinge line was visible on several specimens despite grinding. The convex or exterior side of the shell is heavily pockmarked by marine worm and sponge holes. The smaller shell beads are often made from broken fragments of shell and vary from nearly round to triangular. Compared to the calcite beads, these look like home-made "do it yourself" specimens (Figs. 34 and 35).
Figure 35. *Large Marine Pelecypod Beads from AR095.* a, reverse. Note marine worm and sponge holes; b, obverse. Bead is made using umbo cavity to reduce perforation depth.
Double-Perforated Bead Pendants

Four of the large pelecypod beads have a peripheral perforation in addition to the central perforation (Fig. 34,c). They range from 21 to 24 mm in diameter, 7 to 10 mm in thickness, 5 to 8.4 gm in weight, and the perforations vary from 2 to 4 mm in diameter. DiPeso (1974, Vol. 6:453) describes specimens identical in appearance but made of freshwater mussel shell. These also could serve as strand spacers to separate adjacent strands of beads.

Grooved Pendant

This unusual pendant has three grooves in one edge and four in the other (Fig. 36,a). It is 30 mm long, 6 mm wide, 3 mm thick, weighs 2.0 gm, and has a biconical perforation 2 mm in diameter. It is made of the straight lip of unidentified marine pelecypod.

Dentate Pendants

Three dentate pendants were ground out of unidentified marine pelecypod lips (Fig. 36,a). These look more like teeth than those specimens described by DiPeso (1974, Vol. 6:437-459) from the Casas Grandes Medio period. Two of the High Lonesome specimens have shallow grooves in the left side. Typical measurements are 22 mm long, 5 mm wide, 4 mm thick, weigh 1 gm, and have a 2-mm biconically-drilled perforation.

Spacer Beads

Four irregular beads are believed to have served as spacers between groups of beads (Fig. 37,a). The two center specimens are carefully made and highly polished and the two outer ones appear rather carelessly made on broken pelecypod shell fragments and poorly finished. They are streaked with pink and their shape and color would make effective breaks in a string of calcite beads. A typical measurement is 9 mm long, 4 mm wide, weighs .3 gm, and the biconical perforation is 2 mm in diameter.

Dentalium Tubular Beads

Two large tubular beads have been identified by Dr. Harold Murray as being made from sections of marine tusk shell (class Scaphapoda, family Dentalium). These were either carelessly cut or broken as one end of each is jagged while the other end has been smoothed (Fig. 36). One is 43 mm long, 7 mm in outer diameter, 5 mm in inner diameter, and weighs 61 gm. The other is 24 mm long, 9 mm in outside diameter, 6 mm in interior diameter, and weighs 3.7 gm. The exterior has been slightly polished and in cross section is quite round both interior and exterior. DiPeso (1974, Vol. 6:411) illustrates three species of Dentalium from Casas Grandes, but only Dentalium semipolitum has both circular interior and exterior sections. Keen (1958:238) lists the range of Dentalium semipolitum from lower California to Nicaragua.
Figure 36. Shell Pendants and Tubular Beads from AR095. a, left to right, grooved pendant, two grooved dentate pendants, plain dentate pendant. All of unidentified buff colored marine shell; b, Dentalium tubular beads. Shell is Dentalium semipolitum.
Turquoise Beads

There are four turquoise beads in the collection. One is a regular disc bead made exactly like the calcite beads. It is 11 mm in diameter, 5 mm thick, has a 1-mm diameter biconically-drilled perforation, and weighs 1.0 gm. The turquoise is light green with buff matrix and is highly polished. The other three beads are smaller and of irregular shape. The impression is that small bits of turquoise were perforated and polished with the objective of wasting as little of the turquoise as possible.

The second specimen is roughly heart-shaped, 9 mm long, 5 mm wide, 3 mm thick, weighs .3 gm, and the diameter of the biconically-drilled perforation is 1 mm. The highly polished turquoise is light blue-green with light brown matrix.

The third specimen is nearly round but with an off-center perforation. It is 9 mm in diameter, 2 mm thick, weighs .3 gm, and the conically-drilled perforation is 2 mm in diameter. The turquoise is light green with brown matrix, and is not polished.

The fourth specimen is slightly out of round, 10 mm in diameter, 4 mm thick, weighs .7 gm, and the biconically-drilled perforation is 2 mm in diameter. It is polished blue-green turquoise with brown matrix.

Turquoise Bead Pendants

There are three turquoise bead pendants (Fig. 29). They are roughly oval in shape, but again the impression is that minimum removal of material was one of the guidelines in manufacture. Lengths vary from 12 to 14 mm, thickness from 2 to 3 mm; each weighs .4 gm; two are biconically, and one conically, perforated; and the perforation diameter is 1 mm on each.

Iridescent Shell Pendants

Three iridescent shell pendants are made of freshwater mussel shell Unionidae (according to Dr. Harold Murray). One (Fig. 37) had separated along deposition rings but was successfully restored. They were made from the straight lip portion of the shell by breaking or sawing, grinding, and polishing.

The rectangular specimen with rounded corners (Fig. 37) is 17 mm long, 11 mm wide, 2 mm thick, weighs .6 gm, and the conical perforation is 2 mm in diameter. One specimen is nearly round (Fig. 37); it is 15 mm long, 14 mm wide, 1 mm thick, weighs .5 gm, and the conically-drilled perforation is 2 mm in diameter. The restored specimen (Fig. 37) is 31 mm long, 18 mm wide, 2 mm thick, weighs .8 gm, and the biconical perforation diameter is 1 mm.

Mussel shell was not observed by the Radium Springs survey crew. However, Mr. Daniel C. B. Rathbun (District Manager, Bureau of Land Management, Las Cruces District) writes (1977, personal communication): "Mussel shells of indeterminate age have been found near playas, or dry lake beds. Mussels
Figure 37. Shell Ornaments from AR095. a, shell pendants, spacers and strand connector (lower left); b, pendants freshwater mussel and marine pelecypod.
Figure 38. Bead Cache from AR095. a, cache vessel as exposed by excavation. Left end of scale points north; b, partially excavated cache. Strand connector in upper left. Note intrusive creosote root movement of beads.
may have existed in the Rio Grande at one time. There are no species of freshwater mussel which live in the area today.

Strand Connector

This incised shell item (Figs. 37, 43) is 16 mm in diameter, 5 mm thick, weighs 1.8 gm and has a half-moon perforation 2 mm x 3 mm measured on the obverse. There is a deep lens-shaped cut 11 mm long and 4 mm wide in the front or incised face. This cut tapers to the perforation in the rear face.

While experimenting with stringing sequences, it was noted that this specimen did not fit anywhere if strung as a bead. As a bead, the 20 incised grooves, supposedly ornamental, would not show. Microscopic examination showed traces of wear polish in two grooves at each end of the lens-shaped cut.

The small strand divider (Fig. 46, #23) and probably the four double-perforated bead pendants previously noted indicate multiple strands of beads. This artifact would serve perfectly as the common connector of two strings of beads and the four polished grooves would serve the utilitarian purpose of guides to the four string ends. It would act as a fulcrum to tighten the strings, and the knots would fit neatly in the deep groove. The incised grooves would then serve an ornamental function as they would be exposed on the wearer's neck. Possible use of the artifact as a strand connector is illustrated in Fig. 43,b.

Little mention is made of connectors or clasps in the literature. McGregor (1965:184) mentions loop and toggle bead fasteners.

Strand Divider

A single oval-shaped, bi-perforated specimen of dense shell is tentatively placed in this category. It is 12 mm long, 7 mm wide, 4 mm thick and weighs .6 gm. The central perforation is 3 mm and the peripheral perforation is 4 mm in diameter. Both are biconically-drilled. It would fit into DiPeso's classification of strand dividers (DiPeso 1974, Vol. 6:466) but the perforations are only 4 mm apart center to center. The smallest High Lone-some beads are 5 mm in diameter, and in experimental stringing this specimen would not serve as a divider because of inadequate distance between the perforations. It was more probably used as a clasp, or to suspend a short pendant, such as our turquoise pendants, clear of the bead string.

Button-shaped Beads

Five unusual transversely-pierced "button"-shaped beads (Fig. 46, #25-29) were not identified elsewhere in our literature search. They are made by perforating the flanged portion of a hinge segment of pink marine pelecypod shell parallel to the outside of the shell. The outer face is smoothed and polished and the flange is ground down at right angles to the perforation, leaving an artifact resembling an old-fashioned collar button. The perforation parallel to the face of the button puts a crimp or bend into the string when strung along with regular beads. They fit and work perfectly when used to string
the tubular beads (which have no perforations) as pendants. A string is tied to the button bead, passed up the tube of the tubular bead and secured to the peripheral perforation on one of the double-perforated bead pendants.

The "buttons" range from 11 to 12 mm in diameter, 5 to 6 mm in thickness, .5 to .8 gm in weight, and 1 to 2 mm in perforation diameter. Two are biconically-perforated, two are cylindrically-perforated, and one is biconically-perforated.

Laboratory Excavation of the Cache Vessel

Objective

It was hoped that careful excavation of the cache vessel remnant might yield cultural or aesthetic information if the original stringing order could be determined.

Procedure

The beads were excavated at the Center for Archaeological Research laboratory with an ear syringe and tweezers, with careful photography of each layer of beads. Groups of beads with closely aligned perforations were sequentially numbered and strung as found. The large concavo-convex beads were strung with their concave face to the convex face of the next bead. They must also have been tightly strung when folded into the pot. Consequently, they tend to stay together through the centuries much better than the smaller, flat-surfaced, polished calcite beads. Too, the long (estimated at 2.3 m) necklace (or necklaces) strung with beads varying from 5 to 33 mm in diameter could not be inserted into the pot without many turns and folds, producing voids. When the string disintegrated, the smaller beads dropped into the voids until the pot was broken and filled with sand. Creosote roots must have further caused some dislocation (note Figs. 38,39,40; roots growing through bead perforations). Despite these obstacles, the excavation effort was largely successful.

Findings

Series of 7,7,5,4, and 3 of the larger beads were recovered intact (Fig. 41). These were graded within each series. They were in fact still in the exact order, and something about their manufacture was learned by numbering the beads in as straight a line as possible. These beads are individually so irregular that they will not fit when experimentally restrung except when the numbers are exactly lined up. When manufactured, these beads were tightly strung while quite rough, and smoothed by pulling over abrasive surfaces such as grooved stone bead grinders or shaft straighteners, as described by Haury (1931) and DiPeso (1974, Vol. 7:239).

One long series of the calcite beads (12) was found with a turquoise bead at one end and an off-center irregular pink shell bead at the other. The calcite beads graded from 9 to 11 mm in diameter. Series of 5,4,4,4 were the longest
Figure 39. Partially Excavated Bead Cache. a, approaching third level. Note turquoise pendant (center) and dentate shell pendant (upper right); b, lower level of cache vessel. Turquoise pendant and shell pendant (upper right). Large calcite beads as originally strung (lower left).
Figure 40. Cache Vessel Under Laboratory Excavation. a, turquoise and shell pendants and several stringing sequences; b, largest of shell beads. Turquoise pendant right of center.
Figure 41. *Shell and Calcite Beads.* a-b, AR095, concavo-convex beads in original stringing sequence
remaining series and beads did not vary more than 2 mm in diameter within each series. None of the pendants or bead spacers were found aligned with each other. While the evidence is rather scanty, the string or strings of beads must have been composed of a series of graded calcite beads broken at intervals by turquoise beads, turquoise pendants, pink shell beads, and shell pendants. Two of the large shell bead series had an aligned calcite bead at one end, both slightly smaller than the adjacent shell bead. A biconical string of beads is indicated, starting with small calcite beads grading up to large, then the smaller shell beads grading to largest and back down to the smallest calcite bead. Fig. 42,b is an experimental reconstruction of a necklace based on these and, later, computer observations. A spacer bead, or pendant, is inserted every twelfth bead and this uses up all available spacers and pendants. Fig. 42,a is a small, two-strand reconstructed necklace that uses up all remaining beads. Its two strands are connected by the incised shell connector bead Fig. 43,b. The button beads are out of place, and some of the pendants need to be located elsewhere. Time was not available to come up with the final configuration of the necklaces but the stringing order or portions of the necklaces is felt to be accurate.

Cultural Associations and Comments on the Cache

Previous Bead Caches

Ceremonial or religious caching of beads has been previously recorded throughout the Southwest. Stevenson (1904:116) and White (1962:179,216) are examples, and, more recently, DiPeso (1974, Vol. 7:238) reports a jar full of beads buried in the bottom of a reservoir at Casas Grandes.

Several bead caches have been reported in the Jornada Branch of the Mogollon area. Phelps (1967:22) reports two sites on the McGregor Range not related to camp sites. He also reports undocumented caches in the Hueco Mountains and near Villa Ahumada, Chihuahua, Mexico, with caches containing up to 15,000 beads, and postulates that they were hidden by traders along trade routes for use as needed. During the 1975 Texas Archaeological Survey of the McGregor Range, two more bead caches were found (these are presently being analyzed for publication). Hill (1971:91) reports a site in the Sabina Mountain area of El Paso County, Texas. Two miniature ollas attributed to the Mesilla Phase were found associated with shell, bone, and "fossilized worm casing" beads. Klinger and Lekson (1973:66-68) report a cache near Cliff, New Mexico, of 325 beads and pendants in an olla of the Middle Mimbres period. Olivella beads predominated but there were turquoise beads and pendants. Bradfield (1929:121-123) at Cameron Creek Village reports five Mangus Phase and one later Mimbres bead caches and observed that bead caches may be a trait of the Mimbres Mangus Phase.

High Lonesome Ceramics

The Alma Punched cache vessel and the seven Mimbres Boldface Black-on-White sherds (all apparently from one pot) indicate Mimbres association for the cache. A time frame of A.D. 775-1000 would probably be appropriate for the site (see Ceramics Section).
The Mimbres Boldface vessel could have been intrusive, another cache pot, or the cover over the Alma Punched vessel. The absolute lack of other artifacts plus the uniform distribution of the sherds of both vessels would tend to eliminate the intrusive theory. The fact that only one rim sherd from either pot (the Boldface vessel) was recovered indicates that the site was partially uncovered in the past, the vessels broken, upper portions and presumably some beads swept clear of the immediate area and the remnants reburied, only to be partially exposed again recently. If the Mimbres Bold vessel was the cover for the cache, then it would have been even more exposed than the cache pot and fewer sherds would remain (seven Mimbres Bold vs. 19 Alma Punched). The cache pot, with an estimated one-fourth of the vessel remaining when discovered, could easily have contained all 871 recovered beads in its original configuration, as the remnant held 405. A careful search for sherds and beads made for .25 mile up and down the arroyo failed to reveal a single bead or sherd outside the immediate site environs.

Beads and Pendants

The High Lonesome beads do not fit into any of the published caches. Even Casas Grandes, commercial bead manufacturing center that it was, has nothing like the large marine pelecypod beads. Nor does the site have calcite beads although 10,000 gm of mined calcite was reported (DiPeso 1974, Vol. 7:466). The largest concavo-convex shell bead reported at Casas Grandes was 7 mm in diameter, and the largest shell disc bead was 19 mm in diameter (DiPeso 1974, Vol. 6:430), as compared to the 16 to 33 mm range of the High Lonesome shell beads. The only calcite reference found, and that is questionable, was from the distant Winona Site where McGregor (1965:198) describes two distinctive forms of beads of fine, hard, white, crystalline rock (calcite?), highly polished and carbonized.

The High Lonesome beads were probably manufactured in the local Jornada area. Identical calcite beads were found in the Radium Springs survey area at AR084 30 miles away, at AR062 four miles west, and at the large Mimbres village (AR092) 15 miles south. This village (one square mile in size) has been known to collectors for many years as the "Bruton Bead Site." Despite massive bulldozer "archaeology" at the site, it should be explored as the possible manufacturing locus of the calcite beads.

The source of pure calcite (white marble) is unknown, but Mr. Daniel C. Rathbun (personal communication, 1977) states that "there is a deposit of anchoritic marble in Radium Springs. Material from this deposit comes in many colors, including white. Some of it may appear to have a crystalline structure under microscope. There is also a deposit of travertine near Hatch. The travertine is white to buff in color. Some of it is marbleized." Hatch is 25 miles west-southwest of the "Bruton Bead Site" (AR092).

Dr. Harold Murray, who examined the shell artifacts, concluded that with the exception of some freshwater mussels the shell species came mainly from the Pacific. All of the very large, deeply concavo-convex beads (of unidentified pink/orange
Figure 42. Experimental Reconstruction of High Lonesome Beads.  
a, beads strung with spacers or pendants every 12th bead;  
b, graduated strands. Note strand connector. Total length of all strands 3.24 meters.
Figure 43. Strand Connector from AR095. a, magnified view of strand connector; four grooves show wear polish; b, strand connector securing two strands of calcite beads.
marine pelecypod shell) were made by cutting and grinding around the umbo cavity. Their rough exterior was heavily pock-marked by the action of marine worms and sponges. The hinge lines and teeth were recognized on several specimens.

Casas Grandes must always be considered whenever the distribution of Pacific marine shells is discussed because it was apparently one of the major distribution centers, as well as a manufacturing center for the entire Southwest (DiPeso 1974, Vol. 6:401).

The High Lonesome bead assemblage is the combination of mass-produced, precision-made calcite beads and the very provincial-looking, crudely-made shell beads that aesthetically are highly individualistic, as are the pendants. I believe the materials are not a trader's cache, but some individual's valued personal belongings. The cache was almost certainly marked with a rock cairn. The most likely function of a rock cairn was to permit a person to find the site again, either to recover his treasure, or for purposes of ceremony or ritual.

Statistical Analysis of the High Lonesome Beads

The 837 cache beads were measured and data punched on IBM cards. Diameter, thickness (maximum), perforation diameter (minimum), and weight were measured to the closest millimeter or gram. Perforation type (conical, biconical, and cylindrical) and material type were recorded. Several computer programs were explored to see if the raw data could be transformed into aesthetic, technological, or economic information about the bead makers or owners. Some interesting observations resulted that may be of value to future research. The card runs are available to interested researchers at the Center for Archaeological Research.

SPSS Sub-Program Frequencies (Nie et al. 1975:200). This program produced 11 standard statistical measurements and the histograms (Figs. 44,45) which are numbered in accordance with the corresponding paragraphs below. For economy of space, some of the histograms have been attenuated where the data are no longer significant.

1. Diameter (Fig. 44, left). The frequency of beads from 5 to 33 mm in diameter shows that 80% of the beads fall between 5 and 10 mm with a mean of 9.8 mm. By contrast, Haury's (1931:82) Casa Grande bead makers made tiny beads (2 mm mean diameter with very little variation). Casas Grandes bead makers had a mean diameter of 5 mm for 17,000 stone disc beads (DiPeso 1974, Vol. 7:246).

Observation. A trait of the High Lonesome bead makers was a preference for larger and less uniform-sized beads than those of other Southwestern people.

2. Thickness (Fig. 44, right). Thickness varies from 2 to 15 mm with 90% falling between 3 and 6 mm. Since strand length is a function of numbers of beads times thickness, something of economics and technology might be learned from examining this function closely. Based on maximum thickness the computer gave a predicted length of 3.783 meters for the total length of the High Lonesome
bead string. It actually measured 3.24 meters because of the nestling of the concavo-convex shell beads into each other, and because some of them were wedge-shaped in thickness. If economics (labor and material) entered into the aboriginal scheme of things, there should have been an optimum bead thickness. Using modern drills and sanders on San Antonio River mussel shell, we found in the laboratory that it took over three times as long to make a bead 30 mm in diameter and 10 mm thick as it did a bead 8 mm in diameter and 4 mm thick (36 minutes vs. 11 minutes). For the two and one-half times gain in thickness we also took 32 times as much material to manufacture the larger bead.

\[
\text{Volume} = \pi r^2 t; \text{for 30 mm bead: } v = 15 \times 15 \times 10 \times 3.1416 \text{ or } 7068 \text{ cu. mm}; \text{for 8 mm bead: } v = 4 \times 4 \times 4 \times 3.1416 \text{ or } 218 \text{ cu. mm}; \text{ } 7068 \div 218 = 32.4.
\]

Assuming that the aboriginal manufacturing time would be at least proportional and that labor and material were valuable, the large and varied sizes of beads represent aesthetic tastes for which the High Lonesome bead owners were willing to pay the price.

An unexpected insight on the technology and reason for manufacture of the shell beads about the umbo cavity of marine pelecypods resulted from this exercise. It is difficult and time-consuming to drill through thick shell even with an electric drill. With slight grinding of the outside of the shell over the umbo cavity, the aboriginal workman had a shell thickness of only about two mm to perforate. He also had a pre-center-punched surface to drill provided by the numerous marine worm or sponge holes on the shell exterior.

3. Perforation Diameter (Fig. 45). Ninety-eight percent of the beads had perforation diameters from 2 to 3 mm. Only two beads had perforations of 1 mm diameter, compared with Haury's (1931:85) minimum perforation of .51 and maximum or 1 mm. Both technological and aesthetic differences exist between the two areas.

Assuming that the two 1-mm perforated beads were strung with the rest of the beads, a string of 1 mm or less in diameter was used to string the High Lonesome beads.

4. Weight (Fig. 45). Weight is a function of diameter and thickness, so the histogram is quite similar to the diameter and thickness histograms. The mean weight is 1.038 gm and the total (1.038 x 837) is 868.8 gm. Our 1-mm diameter string has to support 2.6 gm per cm in length (868.8 \div 324, the total length of the strung beads).

5. Material (histogram not shown). Eighty-eight percent (736) of the beads were of white to cream colored calcite while 12% (101) were pink-tinged marine shell. The calcite beads appear to be mass or commercially produced. The fact that no other type of stone beads was used would indicate a plentiful supply of calcite, probably in the regional area. Radium Springs and Hatch have been previously mentioned as possible sources. The shell has been identified as marine and probably Pacific in origin.

The individuality and uniqueness of these beads are possibly traits of a previously unidentified group of people of the Jornada area. The finding
of three other sites in the Radium Springs survey area with identical calcite beads strengthens this possibility.

6. Perforation by Type (Fig. 45). Beads were perforated conically (53%), biconically (37%), and cylindrically (10%). DiPeso (1974, Vol. 6:413) reasons that one man made all the beads in nine caches in one room at Casas Grandes because all were biconically-drilled. If we stretch that assumption, the High Lonesome beads were made by at least three different persons. The calcite vs. shell beads also have different makers implied (mass producers vs. individual manufacture). A correlation test was made by Dr. Joel Gunn to see if the type of perforation was dependent on any of the other variables (SPSS sub-program Multiple Regressions). It seemed logical that the technical problems of perforating thick beads would require biconical drilling. However, no correlations were found.

Conclusions

There is no evidence that the High Lonesome Cache is either a trader's or a ceremonial cache. Our hypothesis is that the cache was buried and marked with a cairn, and that the owner intended to return. Beads of varying sizes were strung progressively from smallest to largest to smallest (biconically) in contrast to cylindrically strung beads of comparatively constant size reported over most of the Southwest (DiPeso at Casas Grandes 1974, Vols. 6 and 7; Haury at Casa Grande 1931:82; McGregor at Winona Ridge 1965:196).

The apparent unique occurrence of these beads in the Jornada area should be thoroughly investigated in the course of future research.
Figure 44. Bead Frequency by Diameter and Thickness.
Figure 45. Bead Frequency by Weight, Perforation Diameter, and Type of Perforation.
Figure 46. Shell and Stone Pendants from AR095. 1-32, reference Table 16 for descriptive data.
<table>
<thead>
<tr>
<th>No.</th>
<th>Diameter Length (mm)</th>
<th>Width (mm)</th>
<th>Thickness (mm)</th>
<th>Perforation Diameter (mm)</th>
<th>Weight (gm)</th>
<th>Material</th>
<th>Perforation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>12</td>
<td>2</td>
<td>2</td>
<td>.6</td>
<td>Iridescent</td>
<td>Fresh Water Pelecypod</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>14</td>
<td>1</td>
<td>2</td>
<td>.5</td>
<td>Iridescent</td>
<td>Shell</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>.1</td>
<td>Iridescent</td>
<td>Shell</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>-</td>
<td>5</td>
<td>1</td>
<td>1.0</td>
<td>Turquoise</td>
<td>Biconical</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>.7</td>
<td>Turquoise</td>
<td>Biconical</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>.3</td>
<td>Turquoise</td>
<td>Biconical</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>.3</td>
<td>Turquoise</td>
<td>Conical</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td>.4</td>
<td>Turquoise</td>
<td>Biconical</td>
</tr>
<tr>
<td>9</td>
<td>13</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>.4</td>
<td>Turquoise</td>
<td>Conical</td>
</tr>
<tr>
<td>10</td>
<td>14</td>
<td>11</td>
<td>2</td>
<td>1</td>
<td>.4</td>
<td>Turquoise</td>
<td>Conical</td>
</tr>
<tr>
<td>11</td>
<td>19</td>
<td>14</td>
<td>4</td>
<td>2</td>
<td>1.5</td>
<td>Striated</td>
<td>Orange-Yellow Alabaster</td>
</tr>
<tr>
<td>12</td>
<td>16</td>
<td>14</td>
<td>5</td>
<td>2x3</td>
<td>1.8</td>
<td>White Shell</td>
<td>Cut</td>
</tr>
<tr>
<td>13</td>
<td>21</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td>.6</td>
<td>Marine Shell</td>
<td>Conical</td>
</tr>
<tr>
<td>14</td>
<td>22</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>1.0</td>
<td>Marine Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>8</td>
<td>6</td>
<td>1</td>
<td>2.0</td>
<td>Marine Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>16</td>
<td>9</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>.3</td>
<td>Marine Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>17</td>
<td>21</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>.7</td>
<td>Marine Shell</td>
<td>Conical</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>8</td>
<td>5</td>
<td>2</td>
<td>.9</td>
<td>Marine Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>19</td>
<td>17</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td>1.0</td>
<td>Marine Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>20</td>
<td>14</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td>.7</td>
<td>Pink Marine Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>21</td>
<td>17</td>
<td>16</td>
<td>4</td>
<td>2</td>
<td>1.7</td>
<td>Pink Marine Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>No.</td>
<td>Diameter or Length (mm)</td>
<td>Width (mm)</td>
<td>Thickness (mm)</td>
<td>Diameter of Perforation (mm)</td>
<td>Weight (gm)</td>
<td>Material</td>
<td>Perforation Type</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------</td>
<td>------------</td>
<td>----------------</td>
<td>-----------------------------</td>
<td>-------------</td>
<td>-----------------</td>
<td>------------------</td>
</tr>
<tr>
<td>22</td>
<td>18</td>
<td>-</td>
<td>6</td>
<td>2</td>
<td>2.3</td>
<td>Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>23</td>
<td>12</td>
<td>8</td>
<td>4</td>
<td>2-3</td>
<td>.6</td>
<td>Pink Marine Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>24</td>
<td>11</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>.3</td>
<td>Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>25</td>
<td>11</td>
<td>10</td>
<td>6</td>
<td>1</td>
<td>.8</td>
<td>Pink Marine Shell</td>
<td>Cylindrical</td>
</tr>
<tr>
<td>26</td>
<td>12</td>
<td>8</td>
<td>5</td>
<td>2</td>
<td>.7</td>
<td>Pink Marine Shell</td>
<td>Cylindrical</td>
</tr>
<tr>
<td>27</td>
<td>11</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>.7</td>
<td>Buff Marine Shell</td>
<td>Conical</td>
</tr>
<tr>
<td>28</td>
<td>12</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>.5</td>
<td>Pink Marine Shell</td>
<td>Conical</td>
</tr>
<tr>
<td>29</td>
<td>12</td>
<td>10</td>
<td>6</td>
<td>2</td>
<td>1.1</td>
<td>Pink Marine Shell</td>
<td>Biconical</td>
</tr>
<tr>
<td>30</td>
<td>31</td>
<td>18</td>
<td>2</td>
<td>1</td>
<td>.8</td>
<td>Iridescent Fresh Water Mussel</td>
<td>Biconical</td>
</tr>
<tr>
<td>31</td>
<td>43</td>
<td>7</td>
<td>-</td>
<td>5</td>
<td>61.3</td>
<td>Dentalium semipolitum</td>
<td>Natural Tube</td>
</tr>
<tr>
<td>32</td>
<td>24</td>
<td>9</td>
<td>-</td>
<td>6</td>
<td>37.1</td>
<td>Dentalium semipolitum</td>
<td>Natural Tube</td>
</tr>
</tbody>
</table>
### TABLE 16
DATA FOR BEAD COLLECTION, AR095

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>No. of Beads</th>
<th>Range in Thickness (mm)</th>
<th>Average Thickness (mm)</th>
<th>Range in Perforation Diameter (mm)</th>
<th>Average Perforation Diameter (mm)</th>
<th>Range in Weight (gm)</th>
<th>Average Weight (gm)</th>
<th>(1) Material Most Commonly Used</th>
<th>(2) Type of Perforation</th>
<th>Most Common Type</th>
<th>(3) Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3</td>
<td>2-3</td>
<td>2.7</td>
<td>2</td>
<td>2</td>
<td>.1- .3</td>
<td>.2</td>
<td>1</td>
<td>2-3</td>
<td>3</td>
<td>8 beads - #2</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>2-4</td>
<td>2.8</td>
<td>1-2</td>
<td>1.9</td>
<td>.2- .3</td>
<td>.25</td>
<td>1-2</td>
<td>1</td>
<td>1-3</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>124</td>
<td>2-6</td>
<td>3.5</td>
<td>2</td>
<td>2</td>
<td>.2- .6</td>
<td>.35</td>
<td>1-2</td>
<td>1</td>
<td>1-3</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>249</td>
<td>2-6</td>
<td>3.9</td>
<td>2-3</td>
<td>2.1</td>
<td>.3- .7</td>
<td>.47</td>
<td>1-3</td>
<td>1</td>
<td>1-3</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>167</td>
<td>3-7</td>
<td>4.3</td>
<td>2-3</td>
<td>2.1</td>
<td>.4- .9</td>
<td>.56</td>
<td>1-3</td>
<td>1</td>
<td>1-3</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>88</td>
<td>3-8</td>
<td>4.9</td>
<td>2-4</td>
<td>2.6</td>
<td>.4-1.6</td>
<td>.88</td>
<td>1-3</td>
<td>1</td>
<td>1-3</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>42</td>
<td>4-9</td>
<td>5.1</td>
<td>2-3</td>
<td>2.7</td>
<td>.5-1.8</td>
<td>1.09</td>
<td>1</td>
<td>1</td>
<td>1-3</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>22</td>
<td>4-9</td>
<td>5.9</td>
<td>2-3</td>
<td>2.7</td>
<td>.8-2.2</td>
<td>1.47</td>
<td>1-3</td>
<td>1</td>
<td>1-3</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>16</td>
<td>4-7</td>
<td>5.3</td>
<td>2-3</td>
<td>2.8</td>
<td>.9-2.2</td>
<td>1.48</td>
<td>1-3</td>
<td>1</td>
<td>1-3</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>10</td>
<td>5-8</td>
<td>6.1</td>
<td>3</td>
<td>3</td>
<td>1.5-2.7</td>
<td>2.0</td>
<td>1.63</td>
<td>1</td>
<td>1-2</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>8</td>
<td>4-7</td>
<td>5.3</td>
<td>2-3</td>
<td>2.9</td>
<td>1.8-2.9</td>
<td>2.25</td>
<td>1.63</td>
<td>1</td>
<td>1-2</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>8</td>
<td>4-8</td>
<td>5.5</td>
<td>2-3</td>
<td>2.9</td>
<td>1.5-2.8</td>
<td>1.95</td>
<td>2-3</td>
<td>2</td>
<td>1-2</td>
<td>2</td>
</tr>
<tr>
<td>17</td>
<td>4</td>
<td>6-9</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>2.1-3.5</td>
<td>2.93</td>
<td>2-3</td>
<td>2</td>
<td>1-2</td>
<td>1</td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>No. of Beads</td>
<td>Range in Thickness (mm)</td>
<td>Average Thickness (mm)</td>
<td>Range in Perforation Diameter (mm)</td>
<td>Average Perforation Diameter (mm)</td>
<td>Range in Weight to (gm)</td>
<td>Average Weight to (gm)</td>
<td>(1) Material Used</td>
<td>(2) Type of Perforation</td>
<td>(2) Most Common Perforation Type</td>
<td>(3) Remarks</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
<td>-------------------------</td>
<td>------------------------</td>
<td>-----------------------------------</td>
<td>----------------------------------</td>
<td>------------------------</td>
<td>------------------------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>-------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>18</td>
<td>7</td>
<td>4-8</td>
<td>6.6</td>
<td>3</td>
<td>3</td>
<td>1.6-4.6</td>
<td>2.86</td>
<td>1-3</td>
<td>1-2</td>
<td>2</td>
<td>2 beads - #1</td>
</tr>
<tr>
<td>19</td>
<td>7</td>
<td>6-9</td>
<td>7.9</td>
<td>3</td>
<td>3</td>
<td>2.2-6.2</td>
<td>4.17</td>
<td>1-3</td>
<td>1-2</td>
<td>2</td>
<td>1 bead - #1</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>6-9</td>
<td>7</td>
<td>1-3</td>
<td>3</td>
<td>2.3-4.0</td>
<td>3.25</td>
<td>2-3</td>
<td>1-3</td>
<td>2</td>
<td>4 beads - #4</td>
</tr>
<tr>
<td>21</td>
<td>10</td>
<td>6-9</td>
<td>7.1</td>
<td>1-4</td>
<td>3</td>
<td>2.1-5.6</td>
<td>3.7</td>
<td>2-3</td>
<td>1-3</td>
<td>2</td>
<td>1 bead - #1</td>
</tr>
<tr>
<td>22</td>
<td>3</td>
<td>7-11</td>
<td>9</td>
<td>3-4</td>
<td>3.3</td>
<td>3.7-7.3</td>
<td>5.83</td>
<td>2-3</td>
<td>2-4</td>
<td>2</td>
<td>3 beads - #4</td>
</tr>
<tr>
<td>23</td>
<td>7</td>
<td>6-12</td>
<td>8</td>
<td>2-3</td>
<td>2.4</td>
<td>3.9-8.0</td>
<td>5.61</td>
<td>2-3</td>
<td>1-2</td>
<td>2</td>
<td>1 bead - #6</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>7-10</td>
<td>8.5</td>
<td>3</td>
<td>3</td>
<td>5.3-7.8</td>
<td>6.78</td>
<td>2-3</td>
<td>1-2</td>
<td>2</td>
<td>2 beads - #2</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
<td>7-10</td>
<td>8.8</td>
<td>3</td>
<td>3</td>
<td>4.0-8.4</td>
<td>6.38</td>
<td>2-3</td>
<td>1-2</td>
<td>2</td>
<td>1 bead - #2</td>
</tr>
<tr>
<td>26</td>
<td>1</td>
<td>11</td>
<td>11</td>
<td>3</td>
<td>3</td>
<td>8.9</td>
<td>8.9</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1 bead - #4</td>
</tr>
<tr>
<td>27</td>
<td>5</td>
<td>9-12</td>
<td>9.8</td>
<td>3-4</td>
<td>3.4</td>
<td>5.3-9.9</td>
<td>7.76</td>
<td>2-3</td>
<td>1-3</td>
<td>2</td>
<td>5 beads - #4</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>8-9</td>
<td>8.5</td>
<td>4</td>
<td>4</td>
<td>9.1-9.4</td>
<td>9.25</td>
<td>2</td>
<td>1-2</td>
<td>1-2</td>
<td>2 beads - #4</td>
</tr>
<tr>
<td>29</td>
<td>2</td>
<td>9-11</td>
<td>10</td>
<td>4</td>
<td>4</td>
<td>9.2-10.4</td>
<td>9.8</td>
<td>2-3</td>
<td>1-2</td>
<td>1-2</td>
<td>2 beads - #4</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>9</td>
<td>9</td>
<td>4</td>
<td>4</td>
<td>11.3</td>
<td>11.3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1 bead - #4</td>
</tr>
<tr>
<td>31</td>
<td>1</td>
<td>13</td>
<td>13</td>
<td>2</td>
<td>2</td>
<td>13.2</td>
<td>13.2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1 bead - #4</td>
</tr>
<tr>
<td>33</td>
<td>2</td>
<td>12-15</td>
<td>13.5</td>
<td>3</td>
<td>3</td>
<td>15.7-17.6</td>
<td>16.5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2 beads - #4</td>
</tr>
<tr>
<td>Total Beads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>837</td>
</tr>
</tbody>
</table>

KEY:  
(2) Perforation Type: 1. Conical; 2. Biconical; 3. Cylindrical  
(3) Remarks:  
APPENDIX III
TRACE ELEMENT ANALYSIS OF OBSIDIAN ARTIFACTS
FROM THE RADIUM SPRINGS AREA

Thomas R. Hester

In the past 15 years, there has been extensive research in the area of geo­
logic trace analysis of archaeological obsidian. The value of such research
lies in the potential for sound archaeological inferences regarding trade
and other forms of intercultural contact. The application of this research
technique is reflected in dozens of publications, and it has been used with
particular success in the Mesoamerican area (cf. Stross et al. 1976). Simply
stated, nuclear chemistry is employed (neutron activation analysis and x-ray
fluorescence are the two primary techniques utilized) to determine the specific
trace element composition of artifact and geologic source samples. Most
geologic sources (and the artifacts made of obsidian derived from them) have
their own peculiar pattern of trace elements (often described as "finger­
prints" by some researchers), enabling an obsidian artifact to be traced back
to the source.

Several pieces of obsidian were found at archaeological sites within the Radium
Springs project area. Because of previous work I had done with obsidian
sources in New Mexico (Hester and Mitchell 1974) and with the use of available
(but largely unpublished) geologic source data (R. N. Jack, personal communi­
cation), it was felt that non-destructive trace element studies should be
carried out. This would permit us the opportunity to determine the source
of these obsidian artifacts, and to perhaps provide some discussion of trade
relationships or contacts which could be tested through more extensive analysis
in future investigations in the region.

At the time this final report was being written, the results of the trace ele­
ment studies were not available. The research is being directed by Dr. Frank
Asaro of the Lawrence Berkeley Laboratory, University of California, Berkeley.
Because of equipment problems (primarily the installation of the new x-ray
fluorescence facilities) and sample backlog at the Berkeley laboratory, it
will be sometime in August, 1977, before the results are available (Frank

When the results and interpretations are available, these data will be pub­
lished separately and provided to the Bureau of Land Management.
IX. REFERENCES

The bulk of the publications listed here are cited in the text. However, we have included in this compilation a series of additional references which we feel may be of value to archaeologists doing further work in the Radium Springs vicinity. These "resource" items are indicated with an asterisk (*).

Alexander, H. L.


Anonymous


Ares, F. N.


Aten, L. E.


Bailey, V.


Basehart, H. W.


Beck, W. A. and Y. D. Haase

Beckes, M. R. et al.

1977 The Cultural Resource Inventory and Assessment of McGregor Guided Missile Range, Otero County, New Mexico. *Texas Archeological Survey, Research Report 65, Parts 1, 2, and 3.*

Beckett, P. H.


Bennet, M. A.

* 1974 Basic Ceramic Analysis. *Contributions in Anthropology* 6(1). Eastern New Mexico University.

Betancourt, J.


Bilbo, M. J.


Blalock, H. M., Jr.


Bogusch, E. R.


Bradfield, W.

1929 *Cameron Creek Village.* The School of American Research. El Palacio Press, Santa Fe.

Breternitz, D. A.


Brook, V. R.

Brook, V. R. (continued)


Buffington, L. C. and C. H. Herbel


Bussey, S., R. Kelly, and J. Southward

* 1976 LA 4921, Three Rivers, Otero County, New Mexico. Cultural Resources Management Division, New Mexico State University, Report 69.

Butzer, K. W.


Campbell, K. M.


Campbell, R. S. and I. F. Campbell


Collins, M. B.

* 1968 The Andrews Lake Locality: New Archaeological Data from the Southern Llano Estacado, Texas. MA thesis on file at the University of Texas at Austin.
Colton, H. S.


Cosgrove, C. B.

1947 Caves of the Upper Gila and Hueco Areas in New Mexico and Texas. Papers of the Peabody Museum of American Archaeology and Ethnology 24(2).

Cosgrove, H. S. and C. B. Cosgrove


Cremony, J. C.


Davis, J. V.


Davis, J. V. and K. S. Torress


Davis, L.

* 1968 Recent Excavations at Hot Well Site. Transactions of the Third Regional Archaeological Symposium for Southeastern New Mexico and Western Texas:23-32.

1969 Bishop Cap Cave. Transactions of the Fifth Regional Archaeological Symposium for Southeastern New Mexico and Western Texas:35-43.

Dick, H.

1965 Bat Cave. School of American Research Monograph 27.

DiPeso, C. C., J. B. Rinaldo, and G. J. Fenner

Doreian, P.


Fitting, J. E.

* 1971 Burris Ranch Site, Dona Ana County. *Southwestern New Mexico Research Report* I. Department of Anthropology, Case Western Reserve University, Cleveland.

1972 Chipped Stone from the 1967 Mimbres Area Survey. Parts I and II. *Southwestern New Mexico Research Reports* 8. Department of Anthropology, Case Western Reserve University, Cleveland.

Fuller, S. L., A. E. Rogge, and L. M. Gregonis


Gardner, J. L.


Gile, L. H.


Gladwin, H. S.


Gladwin, H. S. and W. Gladwin


Green, J. W.


Hammack, L. C.


Hammersen, M. M.


Harris, D. R.

1966 Recent Plant Invasions in the Arid and Semiarid Southwest of the United States. Annals; Association of America Geographers 56:408-422.

Haury, E. W.


Hawley, F. M.

1950 Field Manual of Prehistoric Southwestern Pottery Types. The University of New Mexico Bulletin 291, University of New Mexico.

Hester, J. J.


Hester, T. R. and R. F. Heizer


Hester, T. R. and J. L. Mitchell

Hill, M.

Houghton, F. E.

Human Systems Research, Inc.


1977 Survey of the Three Rivers Drainage (manuscript in preparation).

Irwin-Williams, C.

Jelinek, A. J.

Judge, W. J.

Katz, P. R.

Keen, A. M.

Kelley, J. H.
Kelly, T. C. and T. R. Hester

1975  Archaeological Investigations at Four Sites in the Dry Comal Watershed, Comal County, South Central Texas. Center for Archaeological Research, The University of Texas at San Antonio, Archaeological Survey Report 15.

Kelly, V. C. and C. Silver


Keyes, C. R.


Klinger, T. C. and S. Lekson


Kottlowski, F. W., R. H. Flower, M. L. Thompson, and R. W. Foster


Krone, M. F.


Laumbach, K. W.

* 1976  An Ex Post Facto Archaeological Reconnaissance of a Mountain Bell Telephone Distribution Line from Hatch, New Mexico to the Las Uvas Farms. Department of Sociology and Anthropology, New Mexico State University, Las Cruces.

Lehmer, D. J.

Levine, F. and C. M. Mobley


Little, E. L. and R. S. Campbell


Lynn, W. M.


Lynn, W. M., B. J. Baskin, and W. R. Hudson, Jr.


Marshall, M. P.


Martin, P. S. and F. Plog


Martin, P. S., J. B. Rinaldo, E. Bluhm, and R. Grange, Jr.


Martin, P. S. and H. E. Wright


McCluney, E. B.

1962 A New Name and Revised Description for a Mogollon Pottery Type from Southern New Mexico. Southwestern Lore 27(4):49-55.

McGregor, J. C.

Mera, H. P.

1935  Ceramic Clues to the Prehistory of North Central New Mexico. Laboratory of Anthropology, Technical Series, Bulletin 8.

* 1943  An Outline of Ceramic Developments in Southern and Southeastern New Mexico. Laboratory of Anthropology, Technical Series, Bulletin 11.

Moorhead, M. L.


Mueller, J. W.


Nesbitt, P. H.


Opler, M. E. and H. Opler


Oppelt, N. T.


Phelps, A.


Quimby, B. and V. R. Brook


Redman, C. L.


Reeves, H. C.


Rinaldo, J. B. and E. A. Bluhm


Rose, M.


Rummel, R. J.


Runyan, J. W. and J. A. Hedrick


Russell, P., Jr.


Sayles, E. B.


Sayles, E. B. and E. Antevs


Schaafsma, C.

Schaafsma, P.

1972 Rock Art in New Mexico. State Planning Office, Santa Fe.

Schroeder, A. H.


Shepard, A. O.


Shumard, G. G.


Skinner, S. A., P. P. Steed, Jr., and S. E. Bearden

1973 Prehistory at Milehigh. Archaeology Research Program, Southern Methodist University, Dallas.

Smiley, T. L. and B. Bannister


Soil Conservation Service


Sokal, R. R. and F. J. Rohlf


Sollberger, J. B. and T. R. Hester


Sommer, A.


Sonnichsen, C. L.

Stevenson, M. C.


Sudar-Murphy, T. and K. Laumbach

Suhm, D. A. and E. B. Jelks

Suhm, D. A., A. D. Krieger, and E. B. Jelks

Trost, M. W.

Ungrade, H. E.

Warren, A. H.

Way, K. L.
Wells, P. V.


Wendorf F. and J. J. Hester (eds.)

1975 Late Pleistocene Environments of the Southern High Plains. Publication of the Fort Burgain Research Center 9.

Whalen, M. E.


White, L. A.


Wilson, J. P. and H. Warren


Wimberly, M. L. and P. L. Eidenbach


Wiseman, R. N.


Wormington, H. M.


York, J. C. and W. A. Dick-Peddie