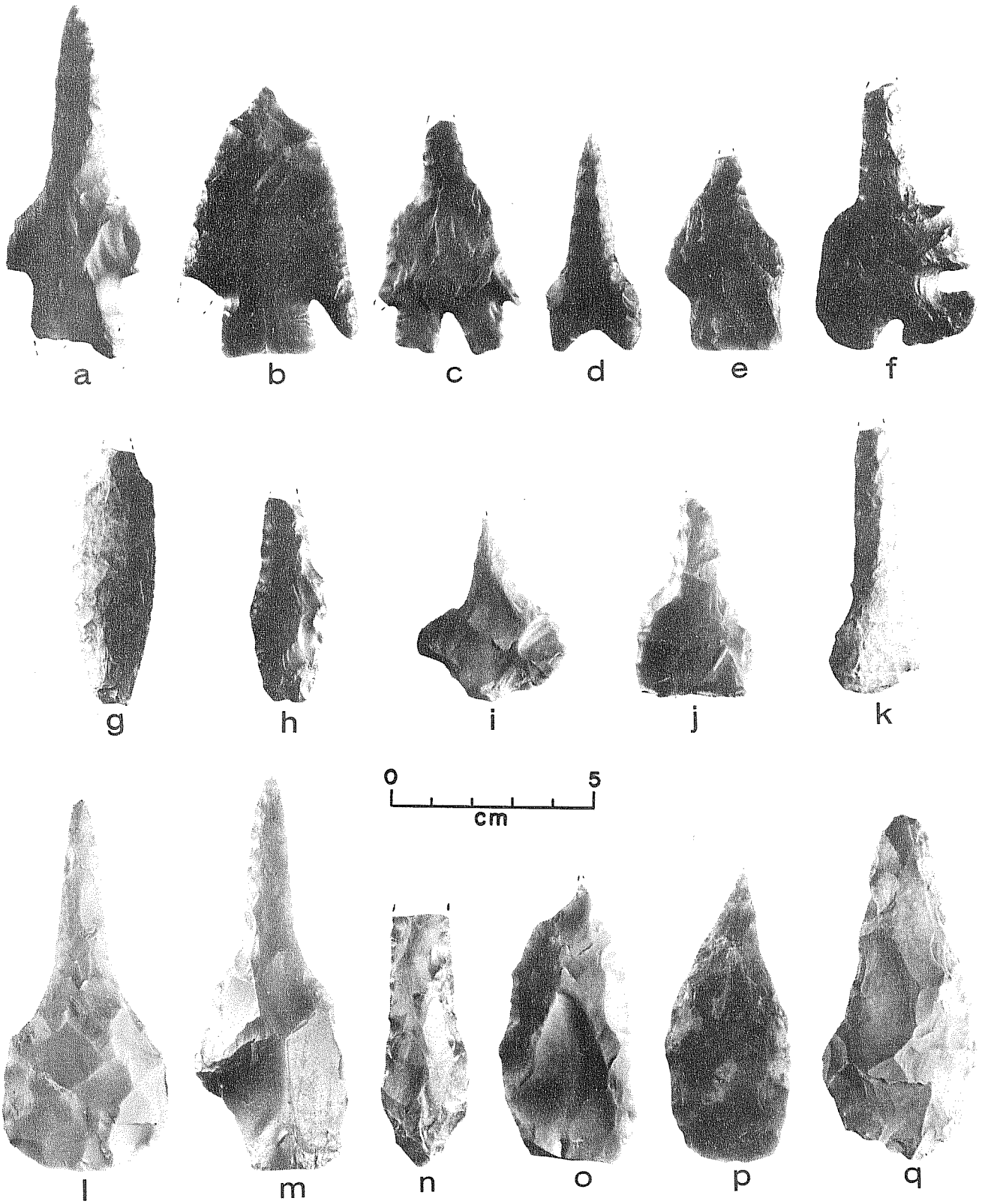


Figure 33. **Perforators.** a-h, P:1; i-m, P:2; n-q, P:3.

point and the tip. Metric data for perforator Forms 1-3 are presented in Table 18.

The perforators were divided into three basal forms and one form containing fragments:

P:1. Form 1 - Identifiable Base
P:2. Form 2 - Flared Base
P:3. Form 3 - Leaf Shaped
P:4. Form 4 - Fragments

P:1. Form 1 - Identifiable Base (12 specimens; Fig. 33,a-h)

Form 1 perforators are made on bases of identifiable dart points; one exception (Fig. 33,f) has a corner-tanged base. The dart point types are as follows: **Pedernales** (six specimens), **Angostura** (two specimens), **Montell** (one specimen), **Castroville** (one specimen), and **Nolan** (one specimen). It appears quite likely that some specimens, particularly the **Angostura** perforators, were picked up and reworked long after being discarded. Six specimens appear heat treated.

P:2. Form 2 - Flared Base (8 specimens; Fig. 33,i-m)

Form 2 perforators have widely flaring bases which constitute less than one-half of the total length. Most of the bases are well rounded but squared bases (Fig. 33,j) and irregular bases (Fig. 33,m) also occur. On several specimens the bases are noticeably thicker and more poorly finished than the bits. Four specimens appear heat treated. Two specimens appear to be made on flakes; one (Fig. 33,i) resembles flake perforators often associated with Late Prehistoric assemblages (Hall, Black, and Graves 1982; Hester 1980:110).

P:3. Form 3 - Leaf Shaped (7 specimens; Fig. 33,n-q)

Form 3 perforators have large leaf-shaped to ovate bases which are typically more than two-thirds the total length (Fig. 33,o). The bit to base transition is very gradual. Four specimens appear heat treated. This form is generally not as finely flaked as Forms 1 or 2.

P:4. Form 4 - Fragments (8 specimens)

Form 4 perforators are distal and medial perforator fragments. The fragmentary condition of the specimens precluded identification, but this category probably includes fragments of all three basal forms.

TABLE 18. PERFORATOR METRIC DATA

Form	Specimen Number	Length (mm) Overall	Length (mm) Bit	Width (mm) Overall	Width (mm) Bit	Thickness (mm) Overall	Thickness (mm) Bit	Weight (g)	Comments
P:1	1	87	45	33	17	9	7	16.0	**Pedernales** (D3:1)
P:1	2	70	39	30	25	10	10	19.6	**Pedernales** (D3:1)
P:1	3	--	--	--	13	--	6	--	**Pedernales** (D3:1)
P:1	4	--	--	36	15	7	6	--	**Pedernales** (D3:1)
P:1	5	54	34	23	13	7	6	6.4	**Pedernales** (D3:1)
P:1	6	68	10	40	5	9	6	19.0	**Pedernales** (D3:1)
P:1	7	--	--	22	13	8	7	--	**Angostura** (D5:1)
P:1	8	--	--	19	13	7	7	--	**Angostura** (D5:1)
P:1	9	58	17	35	13	7	5	11.0	**Montell** (D2:1)
P:1	10	--	--	38	14	10	7	--	corner-tanged (TN15:1)
P:1	11	--	--	3	12	7	5	--	**Nolan** (D3:7)
P:1	12	67	6	42	7	8	4	20.5	**Castroville** (D2:2)
P:2	1	94	45	41	17	18	7	41.0	rounded base
P:2	2	100	59	28	17	10	8	19.5	heat treated
P:2	3	96	40	37	17	15	9	37.5	made on flake
P:2	4	--	--	27	15	9	7	--	heat treated
P:2	5	--	--	35	15	12	12	--	heat fractured
P:2	6	46	21	37	15	6	4	6.6	made on flake
P:2	7	44	26	28	13	8	8	5.9	heat treated
P:2	8	50	22	29	12	7	8	9.8	heat treated
P:3	1	110	47	40	25	15	14	63.4	heavily patinated
P:2	2	70	11	32	7	7	3	9.1	made on flake
P:3	3	72	17	38	19	20	6	44.6	heat treated
P:3	4	73	22	32	14	10	5	21.0	heat treated
P:3	5	--	--	21	15	10	10	--	heat treated
P:3	6	--	--	23	17	12	10	--	heat treated
P:3	7	86	42	37	27	19	15	46.6	heavily patinated

Unifaces (U)

Unifaces are systematically worked flakes which evidence purposeful flaking on only one face. The distinguishing criteria between a uniface and a trimmed or modified flake is that on unifaces the flaking significantly modifies the shape or outline of the flake, while modified flakes exhibit trimming or edge damage with little change in flake shape. Borderline cases are difficult to classify. The majority of the unifaces described below have flaked edges forming an even semicircular to circular outline. In the archaeological literature unifaces are often described as scrapers. Unifaces cannot be presumed to have functioned as scraping tools without wear pattern analysis. The worked edge angles vary considerably but are generally much steeper than those of most bifacial tools.

Unifaces are most frequently classified according to amount and location of edge trimming. Edge angle measurements are often given, but this presents a problem, because on most unifaces the edge angle varies considerably. The degree of edge modification ranges from minor retouch, which may well be use-damage, to extensive trimming.

The unifaces from 41 BX 228 are divided first into complete and fragmentary. Complete unifaces have either a flake platform or have had the platform removed by flaking. Sorting is accomplished by orienting trimming with respect to flake platform. Orientation and morphological terminology for unifacial tools are illustrated in Figure 34. Metric and nonmetric attribute data are presented in Table 19. Two groups of complete unifaces and one group of uniface fragments are described.

Complete Unifaces
- U1. Group 1 - Proximal (Platform) Intact
  - U1:1. Form 1 - Distal Trimming
  - U1:2. Form 2 - Distal and Side Trimming
  - U1:3. Form 3 - Distal and Two Side Trimming
  - U1:4. Form 4 - Miscellaneous
- U2. Group 2 - Platform Modified
  - U2:1. Form 1 - Circumference
  - U2:2. Form 2 - Proximally Trimmed

Incomplete Unifaces
- U3. Group 3 - Unifacial Fragments
  - U3:1. Form 1 - Rounded Fragments
  - U3:2. Form 2 - Pointed Fragments
  - U3:3. Form 3 - Lateral Edge Fragments
  - U3:4. Form 4 - Beaked Fragments
  - U3:5. Form 5 - Unifacial Point Fragments
  - U3:6. Form 6 - Miscellaneous Fragments

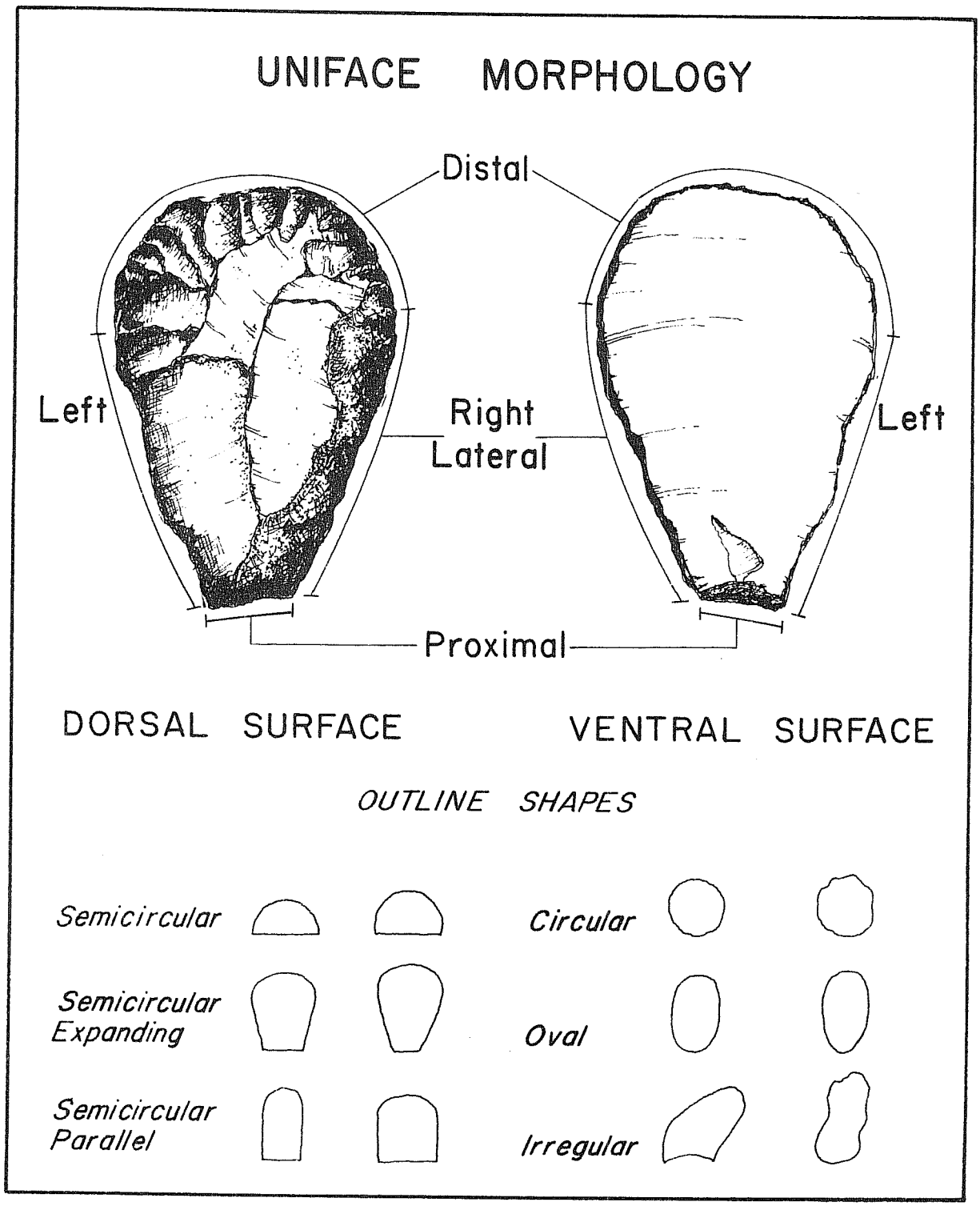


Figure 34. **Uniface Morphology.**

TABLE 19. UNIFACE ATTRIBUTE DATA

Group: Form	Specimen Number	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Bit Angle Range (°)	Outline Shape*	Platform Type**	Dorsal Surface***
U1:1	1	81	52	21	83.3	60-85	SE	SF	D+B
U1:1	2	73	52	20	75.8	65-80	SE	SF	D+B
U1:1	3	70	47	17	58.5	60-70	SE	SF	C<+B
U1:1	4	56	52	17	44.2	60-65	S	SF	C>
U1:1	5	56	55	14	49.2	55-70	S	CP	D
U1:1	6	45	52	13	21.4	45-55	S	SF	D
U1:1	7	52	44	9	22.2	65-70	C	SF	C>
U1:1	8	54	60	13	48.1	65-80	C	CP	C>
U1:2	1	89	80	36	299.5	65-75	SP	CP	C>
U1:2	2	91	81	36	315.8	55-70	C	CP	C>
U1:2	3	59	54	21	65.6	55-70	C	SF	C>
U1:2	4	80	60	13	70.5	55-75	SP	SF	C<
U1:2	5	55	60	35	104.4	60-65	C	CP	C>
U1:2	6	92	72	24	180.8	55-75	SP	CP	C<
U1:2	7	66	42	18	49.5	60-70	SP	CP	C<+B
U1:2	8	70	49	14	69.9	55-85	SE	CP	C<
U1:2	9	54	44	4	25.7	80-85	SE	SF	D
U1:2	10	66	52	19	78.5	60-75	SE	MF	C>+B
U1:2	11	80	36	12	41.4	55-65	SP	CP	C>+B
U1:2	12	55	52	23	64.4	60-75	S	MF	D
U1:2	13	68	53	22	83.6	60-75	SE	SF	C>
U1:2	14	103	70	27	217.9	65-75	SP	SF	C<
U1:2	15	92	58	16	95.0	70-85	SP	CP	C>
U1:2	16	92	65	21	120.0	65-75	SE	CP	C>
U1:3	1	71	42	16	46.6	55-75	SP	CP	C<+B
U1:3	2	65	57	18	66.4	65-75	C	MF	D
U1:3	3	79	55	18	77.2	65-80	SE	MF	D
U1:3	4	92	60	25	140.3	65-80	SE	MF	C>
U1:3	5	90	64	26	161.3	80-85	SE	MF	C<
U1:3	6	59	50	11	36.0	65-80	SE	CP	D
U1:3	7	52	36	9	16.0	65-95	SE	MF	D
U1:4	1	51	63	11	34.0	55-80	I	SF	D
U1:4	2	88	66	14	71.2	60-80	SE	SF	C<
U1:4	3	74	39	12	37.5	40-80	I	SF	D
U2:1	1	84	58	21	101.5	55-70	I	-	C<
U2:1	2	62	45	13	45.4	40-90	O	-	D
U2:1	3	76	74	27	162.0	45-70	C	-	C>
U2:1	4	60	36	19	34.4	55-75	O	-	C>
U2:1	5	65	43	18	42.3	45-70	O	-	C<
U2:1	6	51	46	10	32.9	65-80	SP	-	D
U2:1	7	79	69	15	118.6	55-90	C	-	D
U2:1	8	54	48	9	30.2	45-70	C	-	D
U2:1	9	44	39	12	24.2	50-70	C		C<
U2:1	10	73	53	22	66.4	40-50	SP	-	C<
U2:1	11	60	50	14	34.5	40-60	O	-	C>
U2:1	12	89	61	14	68.4	40-50	O	-	C>
U2:1	13	57	53	15	52.5	70-80	C	-	C<
U2:1	14	75	62	16	68.7	45-65	O	-	C>

Table 19. (continued)

Group: Form	Specimen Number	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Bit Angle Range (°)	Outline Shape*	Platform Type**	Dorsal Surface***
U2:2	1	100	57	32	201.5	50-75	SP	-	C>
U2:2	2	83	56	17	79.5	45-55	O	-	C>
U2:2	3	63	43	15	45.9	50-70	SP	-	C<
U2:2	4	67	45	13	41.6	60-75	O	-	C>
U2:2	5	41	27	9	9.2	65-85	O	-	D
U3:1	1	-	(59)	(8)	-	30-40	-	-	D
U3:1	2	-	-	(12)	-	30-45	-	-	C
U3:1	3	-	(56)	(16)	-	35-45	-	-	C
U3:1	4	-	(44)	(16)	-	40-55	-	-	C
U3:1	5	-	-	(8)	-	60-65	-	-	D
U3:1	6	-	(40)	(11)	-	30-40	-	-	D
U3:1	7	-	(44)	(8)	-	25-40	-	-	D
U3:1	8	-	(32)	(6)	-	30-55	-	-	D
U3:1	9	-	(43)	(7)	-	50-70	-	-	D
U3:1	10	-	(50)	(14)	-	40-60	-	-	D
U3:1	11	-	(53)	(17)	-	35-70	-	-	C
U3:1	12	-	(48)	(13)	-	50-75	-	-	D
U3:1	13	-	-	(8)	-	60-70	-	-	D
U3:1	14	-	(7.3)	(2.1)	-	75-85	-	-	D
U3:1	15	-	(2.4)	(0.6)	-	60-65	-	-	D
U3:1	16	-	(4.2)	(0.9)	-	60-70	-	-	D
U3:2	1	-	-	(8)	-	50-60	-	-	D
U3:2	2	-	-	(12)	-	55-70	-	-	D
U3:2	3	-	-	(9)	-	60-75	-	-	D
U3:2	4	-	-	(13)	-	35-55	-	-	D
U3:2	5	-	(22)	(7)	-	40-70	-	-	C
U3:3	1	(53)	(9)	(7)	-	45-60	-	-	D
U3:3	2	(65)	(12)	(7)	-	25-50	-	-	D
U3:4	1	-	(40)	(12)	-	50-65	-	-	C
U3:4	2	-	(41)	(15)	-	50-75	-	-	D
U3:4	3	-	(47)	(9)	-	60-70	-	-	D
U3:5	1	(4.3)	(2.5)	(6)	-	<30	-	-	D
U3:5	2	-	(22)	(3)	-	<30	-	-	D
U3:5	3	-	(16)	(2)	-	<30	-	-	D
U3:6	1	-	(70)	(22)	-	70-90	-	-	C
U3:6	2	-	(64)	(16)	-	55-70	-	-	D
U3:6	3	-	(64)	(14)	-	60-80	-	-	C
U3:6	4	-	(34)	(11)	-	60-75	-	-	D

Note: Numbers in parentheses indicate specimen is incomplete.

*Outline Shape: C = circular, S = semicircular, O = oval, SE = semicircular expanding, SP = semicircular parallel, I = irregular

**Platform Type: CP = cortex platform, SF = single faceted, MF = multifaceted

***Dorsal Surface: D = decorticate, C< = cortex less than 25%, C> = cortex greater than 25%, +B = blade, C = has cortex

Complete Unifaces

U1. Group 1 - Proximal (Platform) Intact (34 specimens)

Group 1 represents the largest group of unifaces. Further sorting could be accomplished by utilizing a number of criteria: (1) metric dimensions (thickness or weight); (2) platform type (cortex platform, single faceted, multifaceted); (3) flake type (decorticate, cortex <25%, cortex >25%); (4) trimming location (distal only, distal and one side, distal and two sides, sides only); and (5) outline.

In reviewing existing literature from the area, trimming location is the criterion most often used. The following forms are based on this criterion. Metric data (Table 19) includes all of the above criteria, so other researchers can resort for comparative purposes.

U1:1. Form 1 - Distal Trimming (8 specimens; Fig. 35,a,b)

Usually referred to as "end scrapers," Form 1 unifaces have purposeful trimming confined to the distal portion of the flake only. On all specimens the distal trimming forms an even semicircle. Outlines are semicircular expanding elongate, semicircular, and circular. Edge damage, possibly resulting from use, is frequently present along lateral edges. The semicircular expanding elongate specimens closely resemble artifacts found in the Gibson Lithic Cache (Tunnell 1978). Utilizing Tunnell's (**ibid.**:13) criteria, these specimens may have been made on blades.

U1:2. Form 2 - Distal and Side Trimming (16 specimens; Fig. 35,c-e)

Form 2 unifaces have trimming on the distal end (as Form 1) and along one lateral edge. Outlines are semicircular expanding, semicircular, circular, and semicircular parallel.

U1:3. Form 3 - Distal and Two Side Trimming (7 specimens; Fig. 35,f,g)

Form 3 unifaces have continuous trimming on all edges except the proximal end. Outlines are semicircular expanding, semicircular parallel, semicircular, and circular.

U1:4. Form 4 - Miscellaneous (3 specimens)

Form 4 unifaces have atypical morphologies and intact platforms. One specimen has a rounded trimmed edge on the left lateral and a carefully worked beaked protrusion on the right lateral. The beaked projection is similar to U3:4 specimens. The remaining two Form 4 specimens have lateral trimming (both sides) but lack distal trimming.

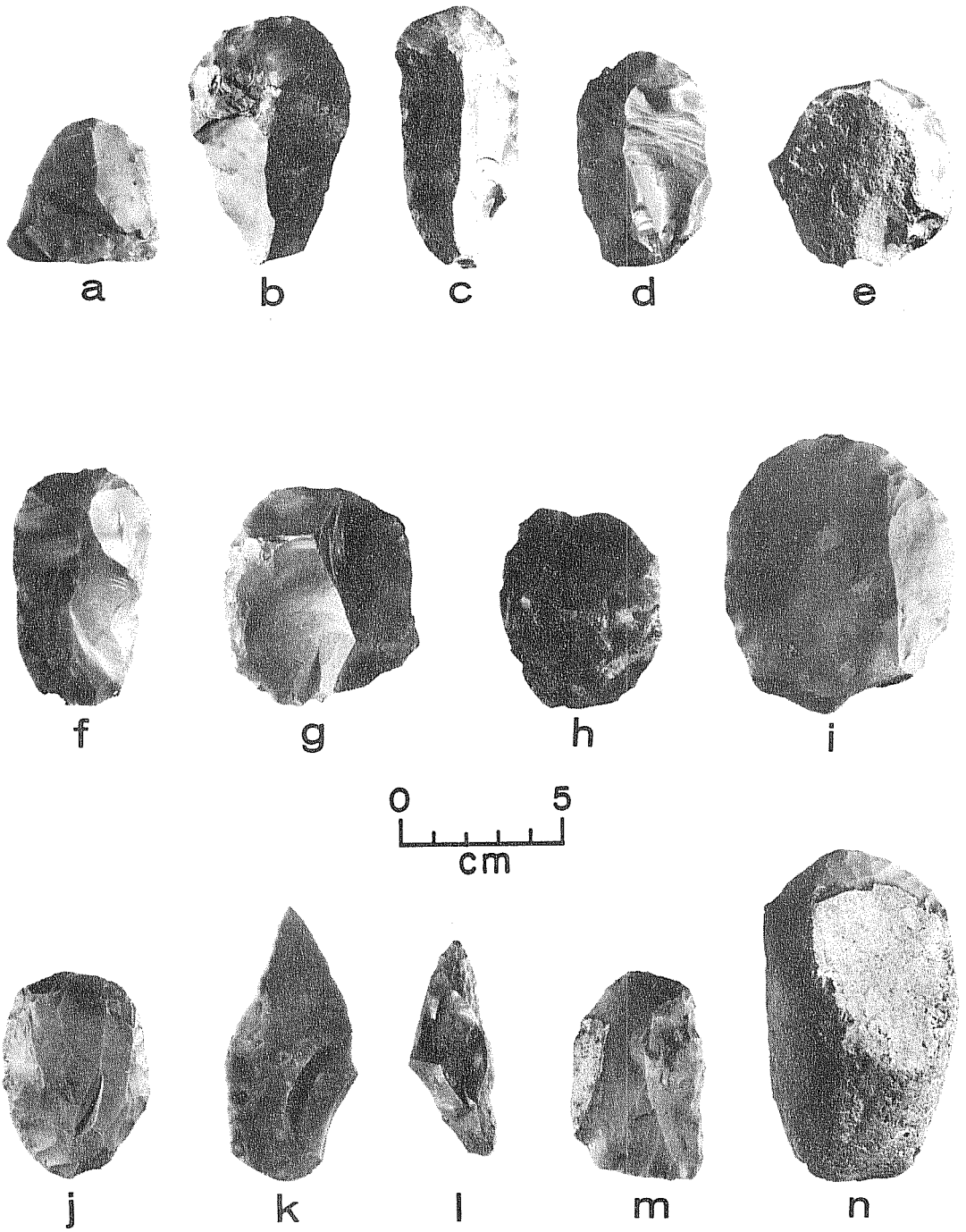


Figure 35. **Unifaces.** a,b, U1:1; c-e, U1:2; f,g, U1:3; h-j, U2:1; k,l, U3:2; m,n, U2:2. Lot numbers: a, F-2; b, 464; c, 457; d, D-2; e, 480; f, 107; g, B-2; h, 363; i, 394; j, 395; k, 39; l, 363; m, 395; n, 391.

U2. Group 2 - Platform Modified (19 specimens)

Group 2 unifaces are complete and have had the proximal end (platform) trimmed or removed.

U2:1. Form 1 - Circumference (14 specimens; Fig. 35,h-i)

Group 2, Form 1 unifaces are trimmed unifacially on all edges. On three specimens unifacial trimming occurs on both faces. Several specimens have small areas with bifacially trimmed edges, but the overall appearance is unifacial. Outlines are circular, oval, ovate, and irregular.

U2:2. Form 2 - Proximally Trimmed (5 specimens; Fig. 35,m,n)

Group 2, Form 2 unifaces have proximal trimming which has removed the platform. Outlines are oval and ovate. One specimen (Fig. 35,n) is a primary flake with a rounded, trimmed proximal end. One specimen is ovate with a pointed, trimmed proximal end. One specimen (Fig. 35,m) has proximal, left lateral, and dorsal trimming.

Incomplete Unifaces

U3. Group 3 - Unifacial Fragments (33 specimens)

Group 3 contains various fragments of unifacial tools. Most of the fragments appear to represent distal and lateral uniface portions, making determination of shape, platform types, and metric dimensions impossible.

U3:1. Form 1 - Rounded Fragments (16 specimens)

Group 3, Form 1 includes rounded fragments which appear to be trimmed sections of various Group 1 and Group 2 unifaces. Many appear to be distal ends terminated with hinge fractures, suggesting they may have been broken in use, perhaps while hafted.

U3:2. Form 2 - Pointed Fragments (5 specimens; Fig. 35,k,l)

Group 3, Form 2 contains specimens that appear to be fragments of unifacial tools not represented in complete groups. All specimens have two straight to slightly convex trimmed edges which converge to form a narrow angle (34°-47°) or point. All specimens are made on flakes. Function is unknown; however, the distinctive morphology of these specimens suggests a use other than that of the rounded working edges characteristic of most Group 1 and Group 2 unifaces.

U3:3. Form 3 - Lateral Edge Fragments (2 specimens)

Two specimens were found in Area M which appear to be narrow, lateral uniface fragments. These appear to be blades or burin spalls (Tixier 1974:5), possibly struck from the distal end of a unifacial artifact. They appear somewhat similar to core trimming flakes or core rejuvenation flakes except that the trimmed edge is regular and well trimmed. These fragments appear to be related to a specialized edge rejuvenation or burin technique, the exact mechanics of which are not understood.

U3:4. Form 4 - Beaked Fragments (3 specimens)

Group 3, Form 4 specimens have trimming on all intact edges similar to Group 2, Form 1 unifaces. The trimming has resulted in an irregular, almost denticulated edge with sharp projections or beaks. The function of these tools is unknown but obviously differs from most Group 1 and 2 unifaces.

U3:5. Form 5 - Unifacial Point Fragments (3 specimens)

Group 3, Form 5 specimens appear to be unifacially flaked to form projectile points, probably arrow points. On each specimen the dorsal flake surface has been flaked extensively, while the ventral surface has only minute lateral retouch. One specimen has a partially formed notch in one corner.

U3:6. Form 6 - Miscellaneous Fragments (4 specimens)

Form 6 specimens are unifacial tool fragments with irregular outline shapes that do not conform to previously described forms.

NONCHIPPED MODIFIED STONE

This section contains descriptions of lithic artifacts which were modified by techniques other than chipping. These methods include battering, pecking, grinding, smoothing, polishing, incising, and abrading. The nonchipped modified stone artifacts are made from a variety of materials: chert, limestone, dolomite, hematite, graphite schist, an unknown igneous material, and ferruginous sandstone. These artifacts are described under functionally and/or morphologically descriptive headings.

Battered Stone

Hammerstones (23 specimens; not illustrated)

Hammerstones are artifacts that have readily visible macroscopic wear patterns which strongly suggest a specific function. A typical hammerstone has areas or patches along the edges, protrusions, or pointed ends which appear battered and crushed. Hammerstones appear to have functioned

primarily as percussors for flintknapping. Other functions requiring a heavy hand-held object may have also been performed.

A variety of materials, including chert, quartzite, limestone, calcite, and sandstone, was utilized as hammerstones. They vary in size from large pebbles (40 g) to large cobbles (898 g). From the variation in material types of differing hardness and size, it is apparent that some hammerstones served as hard hammer percussors, probably used as primary lithic reduction tools, while others were used as soft hammer percussors, probably utilized as final edge trimming tools. Hammerstones are generally rounded; however, the shapes vary from oblong to spherical to egg shaped to discoidal to irregular.

Hammerstone wear is very destructive. It is likely that a number of fragmented hammerstones were present but not recognized. On softer materials such as limestone, battering crushes and smoothes rough edges and blends into nonutilized areas of the tool. A weathered limestone hammerstone is often very difficult to distinguish from a stream-rolled cobble. It appears highly probable that a much larger number of limestone cobbles were utilized as hammerstones than were recognized under field conditions. The hammerstones were divided into two forms based on whether the battering wear was definitely discernible or not. Table 20 presents the metric data for the hammerstones.

Form 1 - Definite Battering (12 specimens)

Form 1 includes most of the hard materials such as chert and quartzite. Battering and crushing are generally extensive, confined to narrow portions of the tool, and very obvious.

Form 2 - Probable Battering (11 specimens)

Form 2 includes most of the limestone hammerstones. Battering occurs either lightly and is, thus, difficult to distinguish or very heavily over much of the surface, thus, obscuring possible working edges of the tool. It is interesting and probably significant to note that only one limestone hammerstone is fire fractured. This is a marked contrast with the vast majority of all limestone cobble fragments present in the site deposits.

Boulders (3 specimens; not illustrated)

Three relatively large boulders were recovered from the Panther Springs Creek site in comparatively early contexts. Two of the boulders were made from limestone and one from chert. The chert boulder measures 42 x 22 x 21 cm and weighs 21.15 kg. It is irregularly shaped, and the exterior surface exhibits many obvious inclusions, voids, and fracture planes, thus, rendering the boulder useless for flintknapping. The boulder has been modified by apparent battering (in addition to natural abrasion) along the uppermost surface (as found **in situ**) and by the removal of several flakes or chunks at one end of the boulder. The two limestone boulders measure 32 x 29 x 18.5 cm and

TABLE 20. HAMMERSTONE METRIC AND ATTRIBUTE DATA

Form 1

Minimum diameter distribution:	<5 cm (N=2); 5-7.5 cm (N=5); 7.5-10 cm (N=5).
Material:	chert (N=5); limestone (N=2); quartzite (N=2); sandstone (N=1); and calcite (N=2).
Shape:	spherical (N=1); discoidal (N=3); oblong (N=2); egg shaped (N=5); and irregular (N=1).
Metric:	weight (N=12); high (898); low (51); total weight (5331 g); standard deviation (228.7); mean (410.1); variance (48,290.7).

Form 2

Minimum diameter distribution:	<5 cm (N=4); 5-7.5 cm (N=4); 7.5-10 cm (N=3).
Material:	chert (N=1); limestone (N=8); unknown ferruginous material (N=2).
Shape:	spherical (N=1); oblong (N=5); egg shaped (N=2); irregular (N=3).
Metric:	weight (N=11); high (611); low (40); total weight (2256 g); standard deviation (213.8); mean (250.7); variance (40,648.2).

31.5 x 29 x 16 cm and weigh 19.8 and 17.55 kg, respectively. The former is stained or discolored gray to reddish by heat on the upper and lateral surfaces (as found **in situ**), while remaining a natural tan color on the bottom (specimen visible in lower right of Fig. 8,f). No evidence of battering was observed. The latter is a rounded boulder with a natural tan orange coloration. Possible battering was observed on the upper surface (as found **in situ**).

The function of these boulders is unclear. Based on their size and provenience, it is obvious that they were purposefully carried onto the site (from the stream bed) to serve some specific function. These boulders were originally called "anvil" stones. However, little evidence supports this function. Possible battering was observed on the upper surfaces of two of the boulders. No increase in chert or bone was observed around the boulder as would be expected from an anvil location. It is possible that they were used as anvils for some type of vegetal processing (nuts?). The burned

boulder may have served as a cooking platform, although the heat appears to have been applied from the sides and top.

Ground and Pecked Stone (Stephen L. Black and Betty Markey)

Ground and pecked stone are lithic artifacts that have one or more surfaces modified by pecking or grinding. Grinding is the process of crushing, pulverizing, or powdering various organic or mineral substances by rubbing between two relatively hard surfaces. In this report, the term grinding is synonymous with milling. The process of grinding or milling produces smoothed and shaped use-facets on lithic surfaces through repeated friction. Pecking is the process of roughening a surface or shaping an edge of a lithic artifact by repeated blows with some type of pointed object (perhaps a small hammerstone or a core). Pecking results in a pitted, roughly textured surface. Some artifacts may have been shaped by battering (see hammerstone descriptions) rather than pecking, but this distinction is largely irrelevant. The majority of the artifacts, which have been modified by grinding or pecking, are made from materials softer than chert, including limestone, dolomite, and sandstone.

Ground and pecked stone artifacts have been referred to in regional literature by a variety of names, including manos, mullers, handstones, grinding slabs, grinding basins, milling slabs, milling basins, and metates. Such artifacts have received little descriptive detail in Texas, particularly in south and central Texas. The presence of ground and pecked stone artifacts is usually interpreted as evidence of plant processing (cf. Jelks 1962:94; Hester 1971:121; Prewitt 1981). The various plant materials processed are generally assumed to have included seeds, nuts, kernels, fruits, and other foodstuffs. It is also likely that some ground and pecked artifacts were used to process minerals such as hematite for paint pigments.

The ground and pecked stone artifacts from the Panther Springs Creek site are described in four forms: manos (GP:1), grinding boulders (GP:2), grinding slabs (GP:3), and miscellaneous ground and pecked stone (GP:4). Metric and nonmetric attribute data are presented in Tables 21-23 as well as in the text. Most of the attributes are self-explanatory; however, a few need additional explanation. The cross section attribute refers to the latitudinal shape through the major use-facets. The shapes actually present on the artifacts are not as symmetrical as the term may suggest. For example, if a given surface is irregular but clearly dished out, it is referred to as concave rather than irregular. The shaping attribute refers to the outline shape. Most ground and pecked artifacts with modified shapes have been either pecked or battered--usually to round the edge and make it more symmetrical.

GP:1. Form 1 - Manos (11 specimens; Fig. 36)

Manos are hand-held grinding implements which are thought to have been used in conjunction with grinding boulders (GP:2) or grinding slabs (GP:3) at 41 BX 228. Manos are also referred to as mullers or handstones. Most manos

TABLE 21. GROUND AND PECKED STONE ATTRIBUTE DATA

Artifact Category	Specimen Number	Lot	Metric Attributes: Length (cm)	Width (cm)	Thickness (cm)	Weight (g)	Material Type[1]	Outline Shape[2]	Cross Section Shape[3]	Number of Faceted Surfaces	Surface Modification[4]	Shaping[5]	Comments
Manos GP:1	1	465	11.0	8.5	4.9	639.5	1	1	1	1	2	2	-
	2	344	--	--	3.1	--	1	3	1	2	2	2	-
	3	396	--	--	5.6	--	1	3	1	2	1	1	-
	4	395	13.5	10.3	5.4	1185.6	2	1	2	2	1	1	-
	5	392	8.9	7.7	3.9	513.5	2	1	1	2	1	2	-
	6	396	--	--	3.4	--	1	3	2	2	1	3	-
	7	396	--	--	--	--	1	3	2	2	1	3	-
	8	464	--	8.2	4.1	--	2	3	2	?	3	1	burned
	9	359	--	12.5	4.3	--	1	3	2	1	1	1	burned
	10	141	--	--	4.2	--	1	3	2	2	1	1	-
	11	176	--	--	2.0	--	2	4	3	1	1	4	-
Grinding Boulders GP:2	1	468	45.0	27.5	11.5	13950	1	2	4	3	2	1	-
	2	469	45.0	36.0	12.0	22500	2	2	4	1	2	1	-
	3	392	28.0	--	9.0	--	1	2	5	2	2	1	-
	4	64	35.0	25.0	9.0	12100	1	2	4	1	2	1	-
	5	43	26.0	15.0	5.1	900	1	2	4	1	1	1	-
Grinding Slabs GP:3	1	390	--	--	4.0	--	1	4	6	1+?	1	1	Faceted Surface Types: Concave: ; Flat: 1+?; Other:
	2	262	--	(22.0)	2.8	--	1	4	6	1	1	4	
	3	393	--	--	(3.5)	--	3	4	5	2	2	4	Concave: 2
	4	241	--	--	(3.9)	--	1	4	6	1	2	4	Concave: 1
	5	368	--	--	(4.2)	--	1	4	4	1	1	4	Concave: 1
	6	129	--	--	1.0	--	3	4	6	2	2	4	Flat: 2
	7	397	--	--	3.6	--	3	4	9	2	2	4	Concave: 2
	8	397	11.3	(7.2)	2.0	(205.5)	1	4	7	1+?	1	4	Concave: 1; Other: ?
	9	464	--	--	2.2	--	3	4	4	2	2	4	Concave: 1; Flat: 1
	10	359	(15.8)	(14.0)	(7.0)	(1592.2)	1	2	8	1	1	4	Other: 1
	11	159	--	--	4.5	--	1	4	1	1	1	4	Flat: 1
	12	212	--	--	3.5	--	1	4	6	1	2	4	Flat: 1
	13	211	--	--	3.8	--	1	4	1	1	1	4	Flat: 1

[1]Material Type: 1=limestone, 2=dolomite, 3=ferruginous sandstone
[2]Outline Shape: 1=oval, 2=irregular, 3=rounded fragment, 4=undetermined
[3]Cross Section Shape: 1=plano-convex, 2=biconvex, 3=convex/irregular, 4=plano-concave, 5=biconcave, 6=plano/plano, 7=convex/concave, 8=irregular, 9=undetermined
[4]Surface Modification: 1=smoothed, 2=pecked and smoothed, 3=none?
[5]Shaping: 1=unmodified (except surface), 2=modified, 3=possibly modified, 4=undetermined

Note: Measurements in parentheses indicate specimen is incomplete.

TABLE 22. GRINDING BOULDERS, GP:2, DESCRIPTIVE DATA

Specimen Number	Description
1	Two faces have use-facets; one has a pecked and smoothed oval depression which measures 14.5 x 17.0 x 1.7 cm (length x width x depth). The opposite face has apparent smoothing over most of the surface and a small smoothed circular depression 4 cm in diameter and 0.7 cm deep.
2	One face has a use-facet which is a pecked and smoothed circular depression measuring 14.5 cm in diameter and 1.4 cm deep.
3	Both faces have circular pecked and smoothed depressions that measure approximately 8 and 12 cm in diameter and 1.5 and 2.0 cm deep, respectively. A number of small (less than 1.5 cm in diameter) spherical hematite inclusions are exposed on the surface of this fine-grained limestone artifact. The exposed inclusions appear to have been pried out, perhaps for use as a pigment.
4	One face has a single depression that measures 14 x 12 x 1.8 cm. The depression appears to be a natural concavity which has been only slightly modified by pecking and smoothing.
5	This multifaceted specimen is made of fossiliferous limestone and has many natural concavities. Three irregular concave facets are present on one face. These are difficult to measure due to their irregularity; however, one is much larger than the other two (they measure roughly 9 cm, 5 cm, and 3 cm in diameter). Two irregular grooves are present on the same surface. All of these features appear to be smoothed modifications of existing surface irregularities. This atypical artifact probably served several functions.

TABLE 23. GRINDING SLABS, GP:3, DESCRIPTIVE DATA

Specimen Number	Description
5	This specimen has a distinctly concave surface on one face. At the approximate center or low point of the concavity are two tiny holes that appear to have been drilled. Both holes have a maximum diameter of 0.3 cm and depths of 0.2 cm and 0.4 cm. The artifact appears slightly burned (carbon stained).
7	This specimen has two concave facets on opposite faces. One facet is gradual (slightly concave), and the other is markedly concave.
8	This artifact is a small tabular limestone slab that has a slightly concave smoothed surface on one face and a convex surface on the opposite face which may have been lightly smoothed.
9	This specimen has a slightly concave, smoothed surface on one face and a flat pecked surface on the opposite face.
10	This specimen has been burned and fire fractured. One surface is very irregular; the opposite surface is slightly undulating and appears to have been smoothed.

appear to have been modified by pecking into oval or circular shapes. Faceted surfaces are either convex or flat, usually with evidence only of smoothing. Only three specimens are complete; all are oval. Jackson (1938:35-36) mentions seven mano shapes for central Texas; unfortunately his descriptions are incomplete, making comparisons with the 41 BX 228 specimens difficult.

GP:2. Form 2 - Grinding Boulders (5 specimens; not illustrated)

Grinding boulders are large calcium carbonate (limestone or dolomite) cobbles or small boulders which have two roughly parallel faces with naturally rounded edges. Circular depressions (concavities) occur on one or both faces. Most depressions appear to have been formed by pecking or grinding; a few appear to have been natural concavities which were used with little or no modification. Most depressions are 10-15 cm in diameter and 1.5-2.0 cm deep. The grinding boulders from 41 BX 228 are relatively heavy artifacts (up to 22.5 kg) which were obviously transported only short distances. It is suggested that they were used in a fixed horizontal position in conjunction with a mano (GP:1) to grind various substances (primarily vegetal foodstuffs). Individual descriptive data are provided in Table 22.

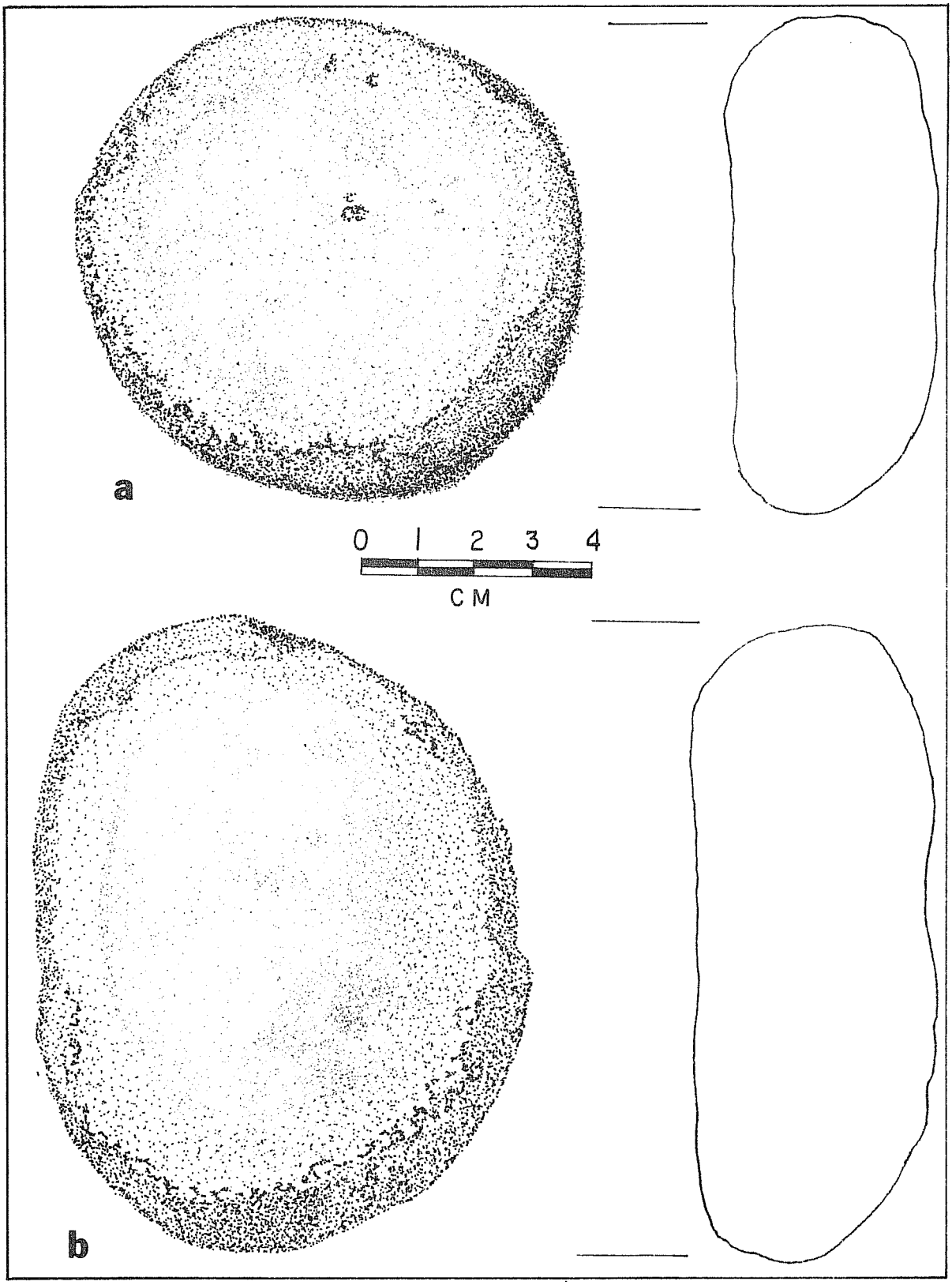


Figure 36. **Manos.** a, Specimen 5; b, Specimen 1.

GP:3. Form 3 - Grinding Slabs (13 specimens; not illustrated)

The grinding slabs from 41 BX 228 are tabular artifacts with flat or concave use-facets. Two-thirds of the grinding slabs are made of limestone, and one-third are made of fine-grained ferruginous sandstone. These specimens are fragments of grinding slabs which are much lighter and, thus, more easily transported than the grinding boulders (GP:2). The fact that all are fragmentary might suggest that they were transported and used until broken, in contrast to the grinding boulders which probably never left the site. This suggestion is supported by the fact that four specimens are made of ferruginous sandstone which is not available in the immediate site area.

The larger grinding slabs (3 to 7 cm thick) were probably used in conjunction with manos (GP:1) to grind various vegetal materials. The smaller slabs, which could be more accurately described as palettes, may have been used to prepare small quantities of mineral pigment (hematite) or perhaps plants for medicinal purposes. Five specimens are individually described in Table 23.

GP:4. Form 4 - Miscellaneous Ground and Pecked Stone (9 specimens; not illustrated)

Ground and pecked stone Form 4 contains a variety of small fragments of atypical modified stone. Most specimens have evidence of pecking or smoothing. Several artifacts in this category have wear patterns that suggest functions other than grinding. Due to the variation in appearance, these artifacts are briefly described individually in Table 24.

Incised and Abraded Stone (IA) (Stephen L. Black and Betty Markey)

IA:1. Form 1 - Limestone Cobbles with Parallel Incised Lines (5 specimens)

Form 1 specimens are fist-sized oval limestone cobbles that have from four to seven parallel incised lines (narrow grooves). The incised lines range from 2.3 to 5.4 cm in length, 1.5 to 2.5 cm in width, 1.0 to 1.5 mm in depth, and are centered 2 to 3 mm apart. Most of the lines are slightly deeper and wider near the center of the line. They appear to have been created by a sharp pointed tool, probably a chert flake. The lines are parallel to the long axis of each cobble. The cobbles are plano-convex to subtriangular in cross section. The incised lines always occur on the convex side or on one edge of the subtriangular cobble on the high point or ridge. Directly opposite the incised lines the cobble surface is flat. This suggests that these artifacts were used either by placing the cobble on a flat surface with the lines facing up or were hand-held with the flat cobble face in the palm and the incised lines facing outward or downward. All specimens are heat fractured and/or discolored (reddened) by heat. All specimens were found in apparent association with the burned rock middens at 41 BX 228. Attribute data are summarized in Table 25. Figure 37 illustrates three of the most complete Form 1 specimens.

TABLE 24. MISCELLANEOUS GROUND AND PECKED STONE, GP:4, DESCRIPTIVE DATA

Specimen Number	Description
1	This artifact is a very small, yellow (limonite stained) calcium carbonate fragment with a pecked depression on one face. It measures 4.0 x 2.4 x 0.6 cm and weighs 7 g. The function is unknown, but perhaps it served as a small palette for preparing mineral pigment.
2	This specimen is a small fragment of a very thin ferruginous sandstone slab (thickness 0.7 cm). Both faces appear smoothed.
3	This artifact appears to be a limestone bead fragment. The projected outline is circular, with an approximate diameter of 2.6 cm. A small hole has been biconically drilled near the center of the bead. The cross section is plano-convex. The thickness is 1.0 cm.
4	This small specimen may be a limestone fossil fragment. It has a tapered point which has evidence of smoothing on the tip and along the edge. This artifact may have functioned as an awl. It measures 3.0 x 1.2 x 0.5 cm and weighs 2.1 g (incomplete).
5	This small limestone rock is smoothed on both faces and along one edge. It measures 7.5 x 5.6 x 1.0 cm and weighs 45.6 g.
6	This specimen is a small tabular limestone cobble with apparent chipping along one edge and possible smoothing on one face. It measures 9.7 x 9.2 x 1.8 cm and weighs 283.6 g.
7	This artifact is a pointed limestone fragment with a teardrop cross section. The thin edge is worn smooth. The fracture at the thick end of the artifact may be original (before use). It measures 6.9 x 4.6 x 2.2 cm and weighs 13.9 g.
8	This specimen is a tabular limestone fragment with smoothing on one face and several edges. One face may also be pecked. It is fire reddened and measures 6.8 x 5.2 x 1.5 cm.
9	This small chert or limestone cobble has a natural concavity which is extremely smooth, perhaps due to use-wear. The concavity measures 3.8 x 3.3 x 0.7 cm. The cobble measures 8.8 x 7.4 x 3.5 cm and weighs 338.4 g.

TABLE 25. ATTRIBUTE DATA INCISED AND ABRADED STONE

Artifact Type	Specimen Number	Provenience	Metric Attributes				Cross Section Shape*	Modifications and Comments
			Length (mm)	Width (mm)	Thickness (mm)	Weight (g)		
IA:1	1	E1016 N1019 L.4	--	5.4	4.2	--	2	Heat fractured and reddened. Four roughly parallel incised lines are present along with a fifth shorter line which veers off at an angle. Line length ranges from 2.3-5.0 cm.
IA:1	2	Surface	9.7	5.9	4.1	284	1	Reddened and severely weathered. Seven very faint parallel lines present 2-3 cm in length.
IA:1	3	E1018 N1018 L.1	--	6.8	4.7	--	1	Heat fractured. Five well-formed, evenly spaced lines present, all are over 4.4 cm in length. Maximum line depth 1.5 mm.
IA:1	4	E1016 N1018 L.3	--	4.1	--	--	-	Heat-fractured and discolored dark gray. Five well-formed and evenly spaced lines are present, overall 2.7 cm in length. Maximum line depth 1.5 mm.
IA:1	5	BT 6	--	8.0	4.9	--	3	Heat fractured. Four well formed and evenly spaced lines are present which range from 4.1-4.6 cm in length. Maximum line depth 1 mm.
IA:2	1	E998 N1009	5.9	3.9	3.5	112	3	Small stream-rolled chert cobble with a groove or abraded line on one face which measures 3.9 cm in length, 2.5 mm in width, and has a maximum depth of 1.5 mm.

*Cross section shape: 1=plano-convex, 2=subtriangular, 3=irregular.

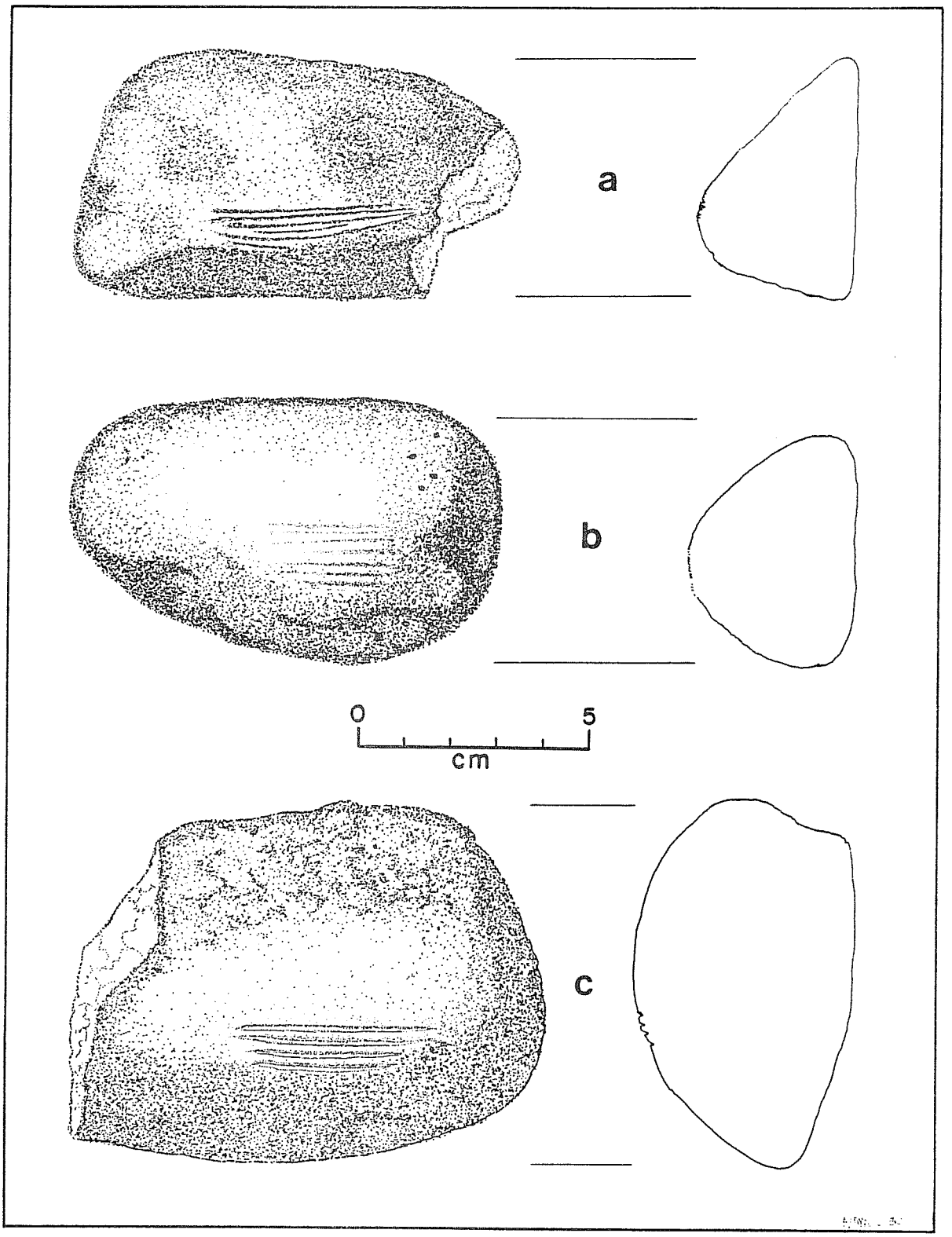


Figure 37. **Limestone Cobbles with Parallel Incised Lines.** a, Specimen 1; b, Specimen 2; c, Specimen 5.

Similarly incised stones have been discussed by Kelley (1948) and by Hill, House, and Hester (1972). Kelley (1948) describes these artifacts as "problematical incised stones." Many functions have been postulated for these artifacts, including tally stones, abrading stones, bark beaters, pottery stamps, pigment stamps, or arrow shaft straighteners. Kelley (**ibid.**:83) states that there is no evidence to support any of these suggestions. Kelley (1948:83) and Hill, House, and Hester (1972) note the general similarity to the shaft straighteners of the American Southwest and Mexico. Kroeber (1925) discusses shaft straighteners from California. The shaft straighteners from these areas vary tremendously in shape and form. A common attribute is one or more grooves and usually several incised lines.

The specimens from 41 BX 228 all lack the groove usually associated with shaft straighteners. The distribution of similar artifacts with parallel incised lines was plotted (Fig. 38) based on the following published descriptions: Kelley 1948; Schuetz 1966; Collins 1969; Hill, House, and Hester 1972; Warren 1975; and Beasley 1980. The literature search was primarily restricted to south, central, and western Texas, as are the reported occurrences. From the number of occurrences along the Rio Grande, it is suggested that the distribution continues into northeastern Mexico.

The five specimens from 41 BX 228 were examined with a variable-power binocular microscope for possible traces of wear. Due to the soft nature of the limestone, all specimens showed considerable postdepositional damage from weathering, excavation tool retouch, and to a lesser extent from laboratory processing. Nonetheless, some limited observations could be made. The narrow incised lines show little evidence of use. All visible wear occurs on the raised ridges between the lines. These ridges appear rounded, smoothed, and in some cases, polished. Little evidence of striations (except recent damage) was noted. The absence of striations, lack of wear within the lines, and general rounded and somewhat polished nature of the ridges suggest that these artifacts were used to process some type of soft material, perhaps wood, bark, or leather.

The similarity of the working surface formed by the parallel incised lines to that of Mesoamerican "bark beaters" was suggested to the authors by K. M. Brown. The morphology of the cobble, combined with the wear pattern, leads the authors to hypothesize that these artifacts were used as a "texture anvil." The cobble was placed upright (parallel lines upward) in a fixed position, and a soft pliable material (leather or bark?) was "texturized" by applying pressure with a paddle (wooden?). This hypothesized function, while far from proven, appears more probable to the authors than that of a shaft straightener. Future researchers should recognize the fragile nature of these artifacts and handle and process them extremely carefully. Abrasion created by standard laboratory processing (i.e., scrubbing with a toothbrush) could be avoided by soaking and ultrasonic cleaning. Field recognition could be enhanced as Suhm (1960:87) suggests by field washing of limestone rocks, especially in burned rock midden sites.

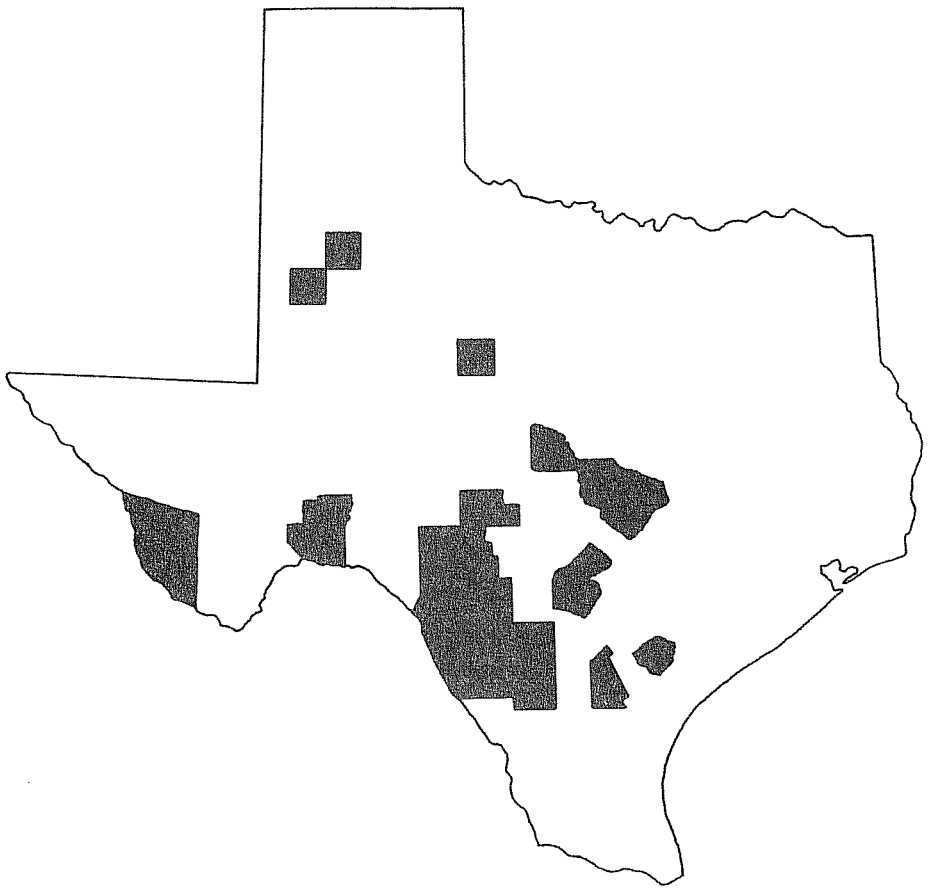


Figure 38. **Distribution by County of Cobbles Bearing Parallel Incised Lines.**

IA:2. Form 2 - Abraded Cobble (1 specimen; not illustrated)

One small chert cobble, which contains a single abraded groove on one face, was recovered. This specimen clearly differs from Form 1 artifacts. The single groove is more irregular and was formed on considerably harder material (chert). This artifact probably represents an abrader used for platform preparation (edge dulling) during biface manufacture. Shafer (1979) discusses the use of quartzite cobbles for edge abraders. Attribute data are presented in Table 25.

Polished Stone (1 specimen)

This unusual artifact is a unique specimen at 41 BX 228. It is made of a nonlocal lithic material that appears to be composed of metamorphosed igneous minerals. The material has a dark green matrix, with areas tinted yellow brown, or pink, and numerous small black spots. The stone measures 10 x 7.2 x 3.6 cm and weighs 403.7 g (Fig. 39).

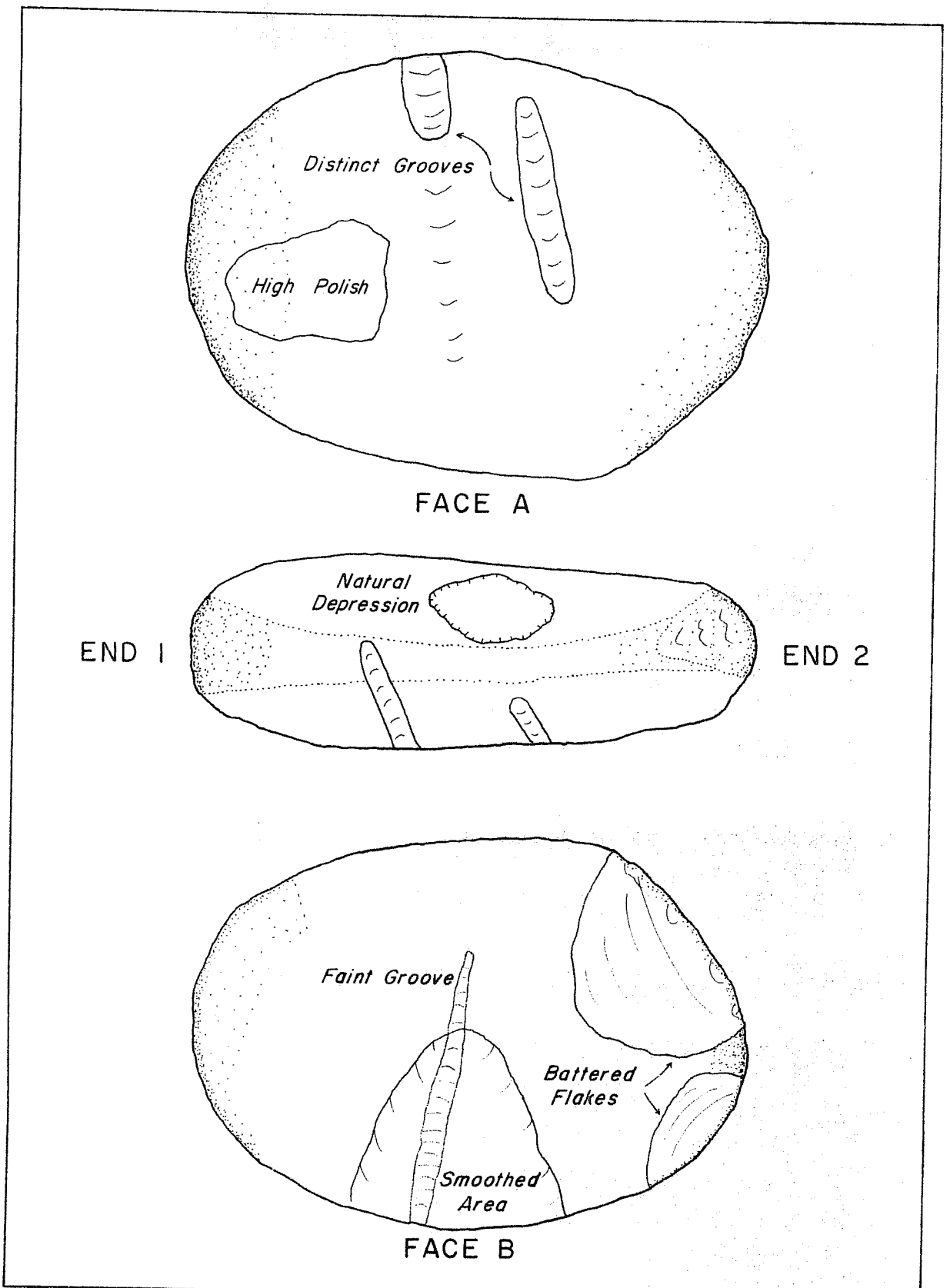


Figure 39. **Unusual Polished Stone Artifact.** Shown at actual size.

Wear Patterns

A lengthy examination of this artifact revealed the following wear patterns: high polish, light polish, scratches, battering, pecking, and grooves. The extent and diversity of these wear patterns suggest that this tool was modified both by shaping and use-wear and that the tool was probably used for a variety of functions. Wear patterns are discussed individually.

High polish occurs on both faces in small isolated patches. These occur on high points on the smoothed, unbattered surface between the grooves and the ends of the tool. A large, roughly circular patch of high polish occurs on Face A. This patch measures approximately 3 x 2 cm and extends into the pecked area of the artifact. This wear pattern probably resulted from repeated contact with a soft material (use-wear).

Light polish occurs all over both faces of the artifact except where pecked, battered, or polished areas exist. This polish is fairly even except in several of the grooves, where the polish is somewhere between "high" and "light." This wear pattern may have resulted from overall smoothing of the artifact during initial shaping.

Small paralled scratches occur principally in the distinct groove on Face A. These scratches are perpendicular to the groove and seem to extend from the center of the groove outward a few millimeters. Additional parallel scratches were occasionally observed near the ends of the tool on high polish patches. These scratches were perpendicular to the tool end.

Both ends of the tool were heavily battered. All high points were crushed and rounded by repeated blows--as if it were used as a hammer or axe. Some battering extends onto the artifact faces.

Pecking was difficult to distinguish from battering. On Face A, End 1, isolated peck marks occur as opposed to the massive crushed areas associated with battering. Pecking may have been used to initially shape the tool ends. Later wear such as battering may have removed most traces of this shaping.

Several grooves appear on both faces as slight smoothed indentations. These grooves have slightly higher polish than the immediate surrounding face. The prominent groove on Face A has definite scratches perpendicular to the axis of the groove.

Functional Interpretation

The polished stone appears to have been a hafted tool--possibly a handaxe or a maul. The grooves on either face appear to have facilitated hafting. The hafting occurred near the center of the tool--possibly a split wooden haft with sinew or leather bindings. The tool was either mounted or the haft bindings were wrapped at a slight angle (i.e., not perpendicular to the long axis). The artifact was definitely used to administer repeated blows with both ends of the tool. The polish occurring on both faces may represent use-

polish or may be related to tool manufacture. The unusual material originates at least as far away as the Llano Uplift area.

Mineral Pigments (MP)

A number of small modified rock fragments which appear to be mineral pigments were recovered from 41 BX 228. These are described under two material types: hematite (red ochre) and graphite schist.

MP1. Form 1 - Hematite (3 specimens; not illustrated)

A number of hematite fragments (red ochre) were found at 41 BX 228; most are hard, spherical hematite objects that exhibit minimal modification and probably served as "curiosity" objects or in some other nonapparent function. Soft red ochre or hematite occurs as occasional small crumbly fragments and as smoothed and scratched artifacts. The three specimens are discussed individually.

Specimen 1 measures 4.3 x 3.7 x 1.3 cm and weighs 37.7 g. This artifact appears to be a tabular piece of banded iron oxide (primarily hematite). Layers of differing hardness (i.e., varying composition) are visible on the edges. The upper surface is dark maroon and has hundreds of tiny incised lines or scratches. The opposite face appears to be a layer of hard hematite which has oxidized to a yellow rust color. All edges are smoothed and rounded, either through natural weathering or use. Certain sections of the edges appear polished--perhaps through frequent handling. While many of the tiny scratches are oriented in clusters of parallel lines, others are oriented at odd angles, giving the entire face a random appearance of many different episodes of use. The morphology of individual "scratch clusters" suggests that a small sharp object such as a flint flake was used to make the incised lines.

Specimen 2 measures 2.8 x 2.5 x 1.3 cm and weighs 11.7 g. This specimen is an angular fragment of dark maroon hematite. The upper surface exhibits several clusters of roughly parallel scratches, some of which form shallow grooves. One corner of the artifact protrudes and has been highly polished, rounded, and faceted by repeated wear. The lower surface appears unmodified. The longest edge adjacent to the polished corner has numerous incised lines or scratches which run the length of the edge and are roughly parallel although overlapping. All other edges appear slightly rounded and somewhat polished by repeated handling.

Specimen 3 measures 2.7 x 1.9 x 0.9 cm and weighs 3.2 g. This artifact is maroon to orange red in color and is much softer than Specimens 1 and 2. Modification includes smoothed use-facets, incised lines, and a groove on one face. One edge has been broken. It is incised by many lines that run face to face (perpendicular to the edge).

Functional Interpretation

Form 1 specimens appear to be red ochre (hematite) pigment stones. Based on the extensive wear patterns, it is suggested that these pigment stones were used for many episodes of pigment removal. The mineral pigment was removed through direct rubbing (polishing facets) or by incising narrow lines which produced small amounts of powdered pigment. The derived pigment was probably used for a variety of purposes, including personal ornamentation, decoration of pottery (Hall, Black, and Graves 1982), and pictographs. Red ochre occurs as a burial inclusion in the region (Hall 1981).

MP2. Form 2 - Graphite Schist (4 specimens; not illustrated)

Four small fragments of graphite schist were recovered from widely scattered proveniences at 41 BX 228. These lead gray mineral specimens have a shiny metallic luster on unoxidized (fresh) surfaces. Three of the specimens are irregularly shaped, weigh from 0.8 to 3.4 g, and exhibit possible modification (smoothing) on one surface. The final specimen is definitely modified and deserves detailed description.

Specimen 1 measures 2.4 x 1.0 x 0.7 cm and weighs 2.6 g. This artifact is roughly cylindrical in appearance; all surfaces are faceted, resembling a small used piece of chalk. The two ends are rounded or blunted by multiple wear facets. From the differences in wear facet morphology (some are flat, others rounded), one can infer that this artifact was rubbed repeatedly against several different types of surfaces.

Functional Interpretations

The function of the Form 2 graphite schist artifacts is unknown. They exhibit smoothing facets but no incising or obvious pigment removal indications such as the hematite specimens (Form 1). Hall (1981) discusses a graphite schist abrader from the Ernest Witte site which he suggests was used to smooth or shape bone artifacts. Hall (1981:179) points out that the abrasive qualities of graphite schist "seem ideally suited for finishing and polishing." Both the abrader and granulated graphite biotite schist fragments from the Ernest Witte site were grave inclusions associated with Burial Group 2, which Hall attributes to the Late Archaic. As stated previously, the nearest source of graphite schist is the Llano Uplift area. Hence, these artifacts are nonlocal in origin.

CERAMICS (A. Joachim McGraw)

South-central Texas ceramics have been broadly described, due in large part to the relatively recent formal investigations of the Late Prehistoric cultural phenomenon. Hester (1968) and Hester and Hill (1971) presented the first descriptive classification of southern Texas ceramics based on a review of available information. Since then, prehistoric ceramic studies have been limited to a series of descriptive analyses (cf. Story 1968; Hester and

Parker 1970; Hester 1972c; Fawcett 1972; Lynn, Fox, and O'Malley 1977; Hall, Black, and Graves 1982), but little has been done to define areal, spatial, and temporal relationships.

High resolution physical and chemical analyses have yet to be initiated, although some attempts have been made in this direction by the CAR-UTSA during such projects as at 41 BX 300, during which thin section petrographic analysis, DTA (Differential Thermal Analysis), and statistical attribute analysis were attempted. The current Nueces River project of the CAR has also collected a comparatively large ceramic collection of over 2500 sherds from 25 sites in the Choke Canyon area, partially analyzed by Black (in Hall, Black, and Graves 1982).

In summary, regional ceramic studies have made limited contributions due to (1) small sample sizes, (2) lack of high resolution chemical and physical science analyses, and (3) lack of broadly conceived research designs focusing on ceramic technology of the region.

DESCRIPTION OF THE COLLECTION

The ceramic analysis at 41 BX 228 was designed with three specific goals in mind: (1) to accurately describe all ceramic materials within the limitations of the study; (2) to consistently define common characteristics and identify preliminary morphological groups; and (3) to elucidate general intrasite and intersite comparisons, if possible. The project-oriented goals are also considered within the scope of a much broader design that may eventually better define south-central and southern Texas prehistoric ceramics and the Late Prehistoric cultural period.

Ceramic materials at 41 BX 228 were generally concentrated in the northern site area (i.e., north of BT 4). Most concentrated distributions occurred in or near Area A with ca. 87.9% of the collected sherds coming from this locality. Other, smaller concentrations were identified near E1004 N987 and near Area J (Fig. 40). The general provenience of the sherds is presented in Table 26. A total of 227 prehistoric sherds was collected from the site. Their distributions are discussed below.

Ceramic materials were usually washed and labeled, although several larger fragments from Area A were tabulated, separated, and stored for potential future thermoluminescence dating.

Following initial processing, the large number of sherds from Area A were placed by lot number on a large sheet of drawing paper in which the levels and units for the area were superimposed. Distributions of materials were noted. Broad clusters were observed, and three preliminary distributional groups were defined. An additional 10 groups were eventually added from other ceramic site localities. These generally correspond to 13 ceramic loci within the site. It should be noted that these groups were based on horizontal relationships, not morphological similarities. These 13 groups were later resorted into six morphological categories based on a selected criteria of similarities and/or attributes.

This page has been redacted because it contains restricted information.

Prehistoric ceramics were distributed throughout the upper cultural deposits in specific localities in the northern part of the site. The major concentration of ceramics occurred in an area ca. 5-6 m in diameter and near Feature 1, an accumulation of heat-fractured limestone and cultural debris (see discussions of Feature 1 in text). A total of 198 sherds was collected from within Area A. These materials were later regrouped into categories based on eight physical attributes or specific distributions. Twenty-nine additional small sherds were from other parts of the site, although this latter group included surface-collected and shovel test materials with limited provenience data.

Sherd sizes throughout the site ranged from less than 1 cm to over 4 cm in diameter. The size of sherds was considered a rough estimator of localized disturbances; the smaller the sherd (of similar thickness and morphological characteristics to other larger sherds), the more disturbance (destructive activity) was assumed to have taken place. Ceramic sherds from 41 BX 228 were briefly grouped into arbitrary groups based on size (in diameter): (1) <1 cm; (2) 1-2 cm; (3) 2.1-3 cm; (4) 3.1-4 cm; and (5) >4 cm. This was viewed as an indicator of relative feature/site disturbance since original deposition. Area A indicates that, while almost 80% of the sherds were less than 3.1 cm in diameter, several specific localities (E1016 N1019, 100.13-100.00; E1016 N1020, 100.00; and E1017 N1020, 100.16-100.00) contained relatively large ceramic fragments, presumably indicating only moderate or infrequent disturbance. The overall horizontal distribution of ceramic materials across the site also suggests that sherds were generally clustered and only occasionally scattered across sections of the site.

Following sherd size tabulations, ceramic sherds were regrouped by general location into 13 provenience groups. These groups represent all locations of collected ceramics at the site and were later used as a cross-reference against morphological classes (Table 26).

After provenience group separations were completed, similar sherds were reseparated into groups based on rim, body, and basal sherds, if identifiable. Consistent morphological considerations were applied to these groups and included a sherd thickness range (minimum-maximum, measured with metric vernier calipers); an interior-exterior surface color range, as defined by a Munsell Color (1975) chart comparison (dry); decoration (or nondecoration) of interior-exterior surfaces; burnished or nonburnished surfaces; and smoothed or nonsmoothed (rough) surfaces. The latter observation was a qualitative judgment based on the tactile sense of the observer. Burnishing (polishing), as used here, is defined as the finishing of a surface by using polishing tools such as a waterworn pebble or a gourd rind. Luster, determined by the technique and degree of burnishing, is defined as low (slight) or moderate. While luster is presumably related to burnishing, this qualitative statement is only a tentative estimate and may also be interrelated to the characteristics of the individual clay and/or with shrinkage.

The extent of carbonized material in the core, paste, temper, and grain size, was briefly described with the aid of a B&L stereoscopic microscope (7.5-30X). Paste texture follows the standardized description of Wentworth

TABLE 26. INTRASITE SPATIAL DISTRIBUTION OF CERAMIC MORPHOLOGICAL GROUPS

Group Number	Sherd Count	Provenience
1	124	Area A
2	74	Area A; concentrated in E1016 N1020
3	12	E1020 N1024; BT 11; E1016 N1020; E996 N1008; E1015 N1018 (shovel test)
4	10	E1010 N1029; E1004 N989 (shovel test) surface
5	6	E995 N994; BT 4
6	1	E1004 N989 (shovel test)

(Shepard 1976:118). Width of core streak and type of temper are included as general interior morphological characteristics. Grain size of paste is defined by standard AGI criteria for roundness (Powers 1953:117-119) and includes descriptions of angularity, opaqueness, and density of materials (Terry and Chilingar 1955:229-234). Ceramic characteristics are discussed as group morphological characteristics.

PHYSICAL CHARACTERISTICS OF MORPHOLOGICAL CERAMIC GROUPS

Six groups of ceramics were defined from the earlier 13 provenience groups. These morphological groups were classified on the basis of physical and identifiable manufacturing similarities.

Group 1

Provenience: Area A: surface (ca. 100.10) to 100.00, concentrated in E1019 N1020, E1017 N1019, E1018 N1020, E1015 N1015, and E1005 N1015. Also scattered on surface in vicinity of these units.

Associations: Associated with Feature 1 (Area A). Spatially related to provenience Groups 2 and 3 (morphological Groups 2 and 3). See Area A in Excavation Area Descriptions and Interpretations section.

Sherd Sizes (based on diameter indicators): All ranges represented. Over 40% are between 1-2 cm in diameter.

Total Sherd Count: 124.

Morphological Characteristics: Ceramic sherds include rim, body, and basal sherds of at least one jarlike vessel, partially reconstructed (Fig. 41). While another vessel may be represented, the large number of unreconstructed sherds makes further interpretations difficult.

Sherd Thickness Range:	Vessel base: 0.95-1.12 cm. Vessel wall: 0.80-1.00 cm. Rim sherd: 0.51-1.55 cm.
Color Range:	Light to dark. Exterior: 5 YR 6/6 (reddish yellow)-10 YR 4/2 (dark grayish brown).
	Interior: 5 YR 5/8 (yellowish red)-7.5 YR 5/4 (brown).
Exterior Surface:	Undecorated, tactilely smooth, burnished, and fine grained. Some evidence of very faint, smoothed-over brush strokes. Quartz and/or calcite grains observed, with small bone fragments as inclusions. Luster is a slight sheen (low). Minute, compact, and tactilely smooth streaks suggest a firm, smooth polishing tool.
Interior Surface:	Unsmoothed; many silica grains observed, ca. 1.0-1.2 mm in diameter. Bone fragments vary in size from ca. 0.40-2.5 mm. Roughness may indicate vessel was coiled or pinched.
Core:	Dark gray; blackened carbonized materials extend completely across sherd.
Temper:	Bone, finely ground.
Paste:	Silty, fine grained. Paste texture fine (0.25-0.125) to very fine (0.125-0.062). Silica particles are generally subangular (abraded) and opaque. Materials include very angular chert chips, with and without cortex.

Vessel Description: Reconstructed vessel height: 16.0 cm. Reconstructed vessel diameter: ca. 13.0 cm. Estimated height: ca. 18-23 cm. A very slight inflection point (Shepard 1976:226) was noted at ca. 11 cm above the base and along wall; curvature may be the result of asymmetry; thus, the actual vessel dimensions were not easily calculated. Vessel shape suggests a simple, constricted vessel, with the constriction and inflection point appearing very near the (unreconstructed) rim (Fig. 41). The cylindrical, jarlike vessel may be described as ellipsoid with no elaboration of the rim. The variation in rim thickness might indicate a strengthening of a particular side. However, the uneven wall sherds suggest only unintentional variation in molding thickness. Rim sherd curvatures indicate a vessel diameter ca. 9 cm at the orifice. The rim is simple and tapered.

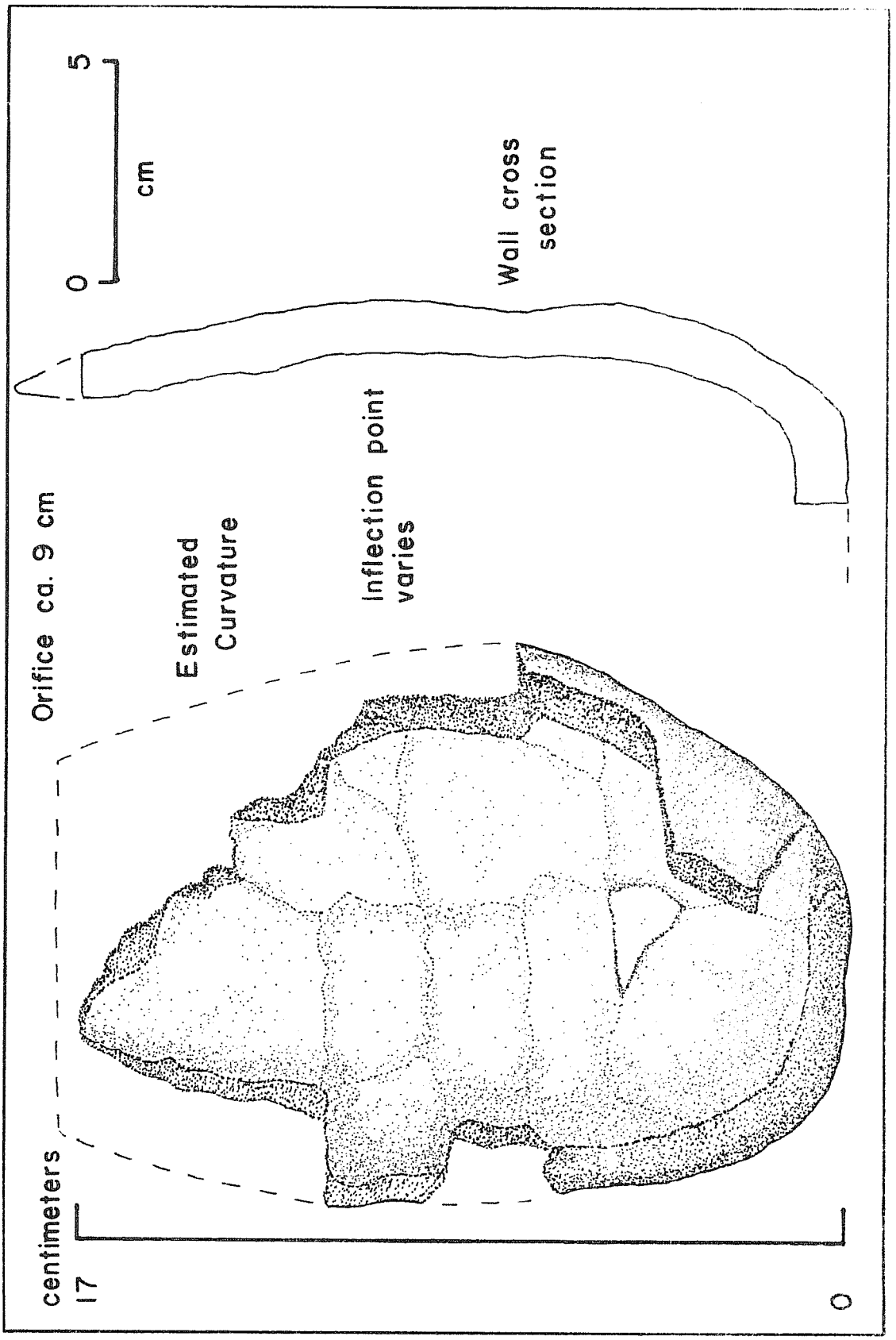


Figure 41. Partially Reconstructed Ceramic Vessel, Group 1.

Group 2

Provenience: As noted in Table 26, the highest concentration of Group 2 ceramic sherds appears in Area A, Level 1 of E1016 N1020. A comparison of Groups 1 and 2 in Area A is shown in Figure 42.

Associations: Broadly associated with morphological Group 1; temporal relations are not clear.

Sherd Sizes: Small; all are less than 2 cm in diameter.

Total Sherd Count: 74.

Morphological Characteristics: All sherds appear to be of the same vessel; no rimsherds were noted. Based on the curvature and thickness of the sherds, the original vessel was small, approximately the size of a small, shallow, modern cup.

Sherd Thickness Range:	0.5-0.45 cm.
Color Range:	Exterior: 5 YR 5/6 (yellowish red)-7.5 YR 5/2 (brown).
	Interior: 7.5 YR 6/4 (light brown)-7.5 YR 3/0 (very dark gray).
Exterior Surface:	Undecorated, tactilely smooth, burnished. Very little evidence of former brush strokes. Luster is low (slight sheen).
Interior Surface:	Tactilely smooth interior surface is also distinctly polished.
Core:	No carbon streak present.
Temper:	Finely ground bone, burned and unburned; often dark gray in color.
Paste:	Silty fine grained. Texture is fine to very fine. Silica particles are clear to translucent, subangular. Larger silica grain composition with paste ranges ca. 1%, bone composition ca. 3%

Comments: Interior and exterior burnishing and lack of core streak suggest a small, plain, shallow container relatively well made and highly fired. Its proximity to Group 1 suggests cultural affinities but manufacturing differences.

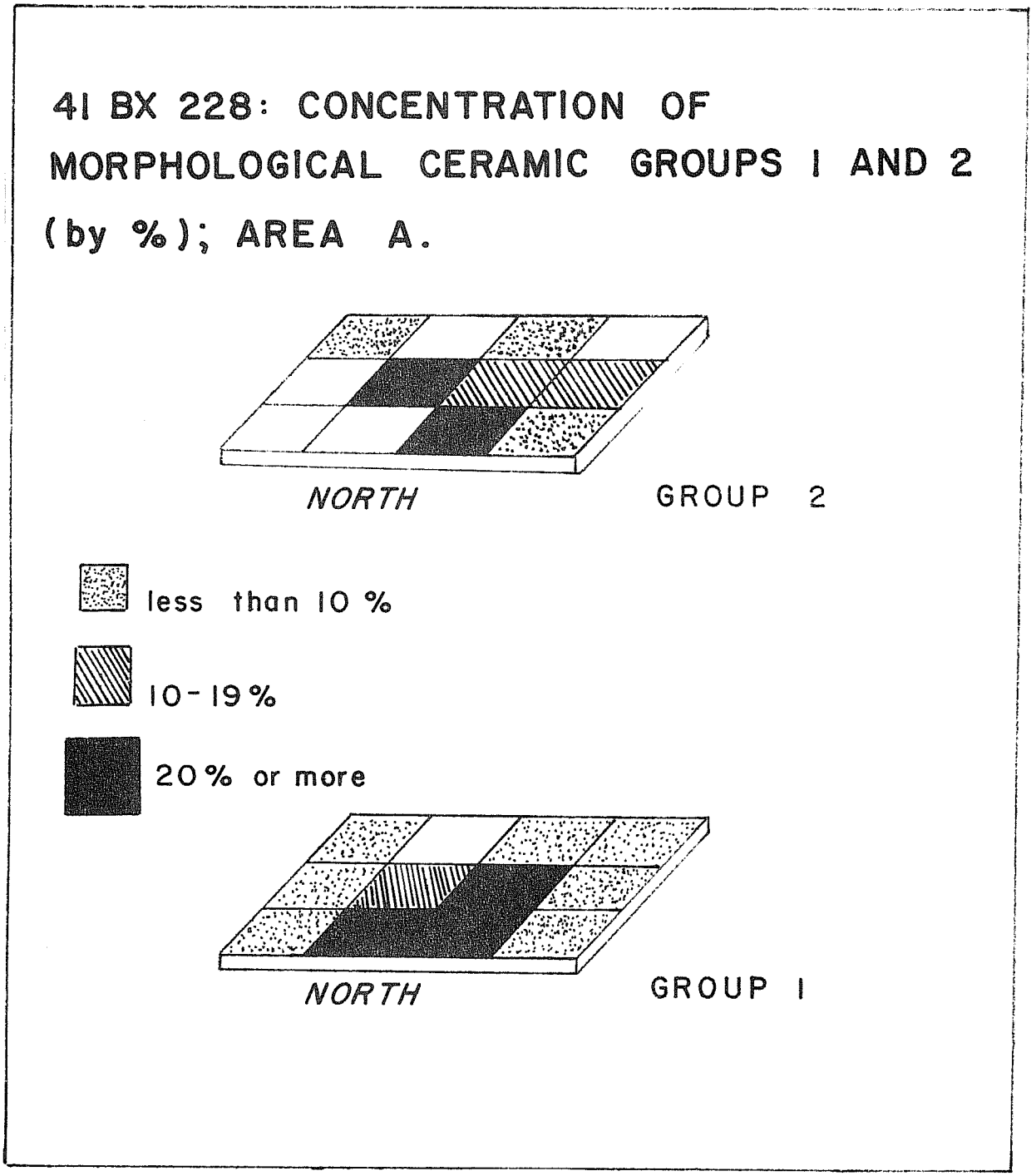


Figure 42. **Ceramic Concentrations in Area A, Groups 1 and 2.**

Group 3

Provenience: E1020 N1024, 100.11-100.00; BT 11 (no vertical provenience); E1016 N1020, Level 1; E1015 N1018, Level 1; E996 N1008, 99.65-99.50.

Associations: No features are associated with these sherds, although at least three distinct areas in the northern site area are represented.

Sherd Sizes: All size classes are represented (less than 1 cm to more than 4 cm). Most fall within the 3-4 cm diameter group.

Total Sherd Count: 12.

Morphological Characteristics: No rim sherds; fragments are presumed to be basal and body sherds.

Sherd Thickness Range: Area A, 0.65-0.85 cm; BT 11, 0.68-0.95 cm; E1020 N1024, 0.67-0.70 cm; E996 N1008, 0.62-0.65 cm; average, 0.65-0.78 cm.

Color Range: Exterior: Area A, 10 YR 3/1 (very dark gray)-10 YR 7/6 (yellow); E1020 N1024, 10 YR 5/4 (yellowish brown)-7.5 YR 5/6 (stony brown); BT 11 10 YR 6/4 (light yellowish brown); E996 N1008, 10 YR 4/2 (dark grayish brown)-10 YR 6/4.

Interior: Area A, 10 YR 5/2 (grayish brown)-10 YR 7/6 (yellow); E1020 N1024, 10 YR 5/2-10 YR 6/3 (pale brown); BT 11, 10 YR 5/2-10 YR 7/4 (very pale brown); E996 N1008, 10 YR 5/2-10 YR 5/4 (yellowish brown).

Exterior Surface: Undecorated. Tactilely smooth. Sherds from all areas exhibit similar surface characteristics. Dense, fine-grained materials; burnishing with no trace of brush strokes or coil lines. Luster is low and occurs as a slight sheen.

Interior Surface: All fragments exhibit smoothing in the form of burnishing, with the exception of a thicker sherd (basal fragment?) from BT 11. The sherd has been smoothed (burnished), but not to the extent of the other fragments.

Core: Area A: Dark gray carbonized material occurs across two-thirds of the interior and is slightly offset toward the exterior wall. Very small bone and chert fragments ca. 2 mm in length noted in paste.

E1020 N1024: Core streak is across one-half to two-thirds of the width of the sherd offset slightly toward the outer wall. Sand grains range from very

fine to fine on the Wentworth scale. Fine bone tempering materials noted in the paste.

E996 N1008: Core streak extends two-thirds distance across the width, slightly offset toward exterior wall. Silica grain size is silt (0.62-0.039 mm) to very fine (0.125-0.062).

Backhoe Trench 11: Core characteristics are given for each of the two collected sherds since interior attributes differ. Fragment 1: No visible carbon material in core cross section; paste silica grain size is silty, and bone tempering material is ca. 0.125 mm in diameter; paste appears moderately dense. Silica grains appear subrounded and are often clear or translucent. Bone fragments comprise ~5% of inner core surface. Fragment 2: Carbonized material extends completely across width of interior. Paste is moderately dense, and silica size ranges from silt to ca. 0.125 mm. Other characteristics are similar to Fragment 1.

Comments: Interior characteristics of ceramics from BT 11 differ somewhat from other samples, but attributes such as surface coloration, degree of tactile smoothness, temper, and grain size are more closely related. The differences in the extent of carbonized material in sherd cross sections may indicate fragments from different small vessels of similar manufacturing techniques or fragments of a larger vessel characterized by uneven firing processes. The wide distribution of this group across the site may indicate that fragments from several vessels are associated with this group.

Group 4

Provenience: E1010 N1029, 99.54-99.40; E1004 N987, 99.68-99.50; surface.

Associations: No features were associated with these fragments. See unit descriptions for details of levels.

Sherd Sizes: All ranges of diameter (from <1 cm to >4 cm) are represented.

Total Sherd Count: 10.

Morphological Characteristics: All sherds appear to be eroded and/or deteriorated; one possible rim sherd noted (rim area is eroded). Rim sherd appears direct in relation to the contour of the vessel body and does not suggest any thickening of the profile. Lip is round, and no grooving or decoration was noted. Surface attributes suggest similar manufacturing techniques. These sherds are possibly from the same vessel, although the relatively wide distribution of the group as a whole precludes any direct correlations.

Sherd Thickness Range: 0.58-0.77 cm.

Color Range: Exterior: 5 YR 5/8 (yellowish red)-5 YR 3/4 (dark reddish brown).

Interior: 2.5 YR 5/6 (red).

Exterior Surface: Undecorated, tactilely smoothed and polished (burnished), with a low to negligible luster. No brush strokes visible.

Interior Surface: Tactilely smoothed; inner surface is polished and has a low to moderate luster. Surface on all fragments is consistent and distinctive (2.5 YR 5/6). Curvature on all sherds is slight.

Core: Core streak varies from light gray to (diffusing toward edges) almost nonexistent. When observed, core streak covers ca. one-half of sherd width.

Grain Size: Fine to very fine, and temper (bone) usually ranges from 0.60-0.125 mm.

Temper: Bone, ca. 5-7% of total core composition.

Paste: Silty, very fine to fine materials. Larger silica grains are clear to translucent, subangular to subrounded.

Comments: The wide distribution of these distinctive sherds across the site may indicate either an extensive scattering of a single vessel or locations of concurrent activities as reflected by similar ceramics. Locations of Group 4 ceramics suggest a further collection of the materials might occur in the vicinity of E1004 N987.

Group 5

Provenience: E995 N994, 99.54-99.40; BT 4.

Associations: Spatially near Burned Rock Midden 2.

Sherd Sizes: <1 cm to ca. 3 cm in diameter.

Total Sherd Count: 7.

Morphological Characteristics: No rim sherds noted; only body sherds observed.

Sherd Thickness Range: 0.68-0.72 cm.

Color Range:	Exterior: 10 YR 4/2 (dark grayish brown).
	Interior: 10 YR 5/3 (brown)-10 YR 3/1 (very dark gray).
Exterior Surface:	Tactilely smoothed, burnished. Curvature of sherds is slight. Luster is low to moderate.
Interior Surface:	Inner surface is smoothed, presumably by a floating technique (no luster), but more rough than the exterior. Lack of sheen and comparative roughness suggest no burnishing of interior. Very few bone fragments noted.
Core:	Dark gray carbonized material extends across ca. one-half the width of the core. A distinct contact line between the carbon and lighter paste was noted, although very little diffusion of carbon along transition line was observed. Bone fragments vary in length from 0.50-1.0 mm.
Temper:	Finely ground bone composed ca. 7% of core material.
Paste:	Very fine, almost silty; very few larger silica grains noted.

Group 6

Provenience: E1004 N989 (50-cm^2 shovel test), Level 1 (0-20 cm).

Associations: A Group 4 sherd found in the same level.

Sherd Size: 1.5 cm in diameter.

Total Sherd Count: 1

Morphological Characteristics: One body sherd, no curvature noted.

Sherd Thickness:	0.58 cm.
Color Range:	Exterior 7.5 YR 3/2 (dark brown).
	Interior: 5 YR 5/4 (reddish brown).
Exterior Surface:	Appears floated, but not polished. Two distinct incised lines appear on fragment (parallel). Incised width varies from 0.4-0.8 mm. Depth of incisement is less than 0.4 mm.

Interior Surface:	Appears floated and possibly burnished, a slight luster noted. No tempering materials observed on surface.
Core:	No carbon noted. Core is uniform and a medium brown throughout width.
Temper:	Bone; size varies from 0.25 to 1.0+ mm; ca. 2-3% of total composition.
Paste:	Very fine to silty; moderately porous. Silica grains are clear to translucent; comprise ca. 3-5% of core materials.

Comments: This incised fragment is the only example of decoration from the prehistoric ceramic collection. It has broad morphological similarities to Group 4 plainware and may in actuality be of the same or a similar vessel, associations, and manufacturing techniques. The distinction of its exterior decoration and only limited association with Group 4, however, precludes any closer correlations on the basis of available data.

INTERPRETATIONS

The physical attributes of the 41 BX 228 prehistoric collection of ceramics suggest six distinct ceramic groups distinguished by manufacturing techniques and general morphological characteristics. These six groups (Fig. 43) are contrasted to the earlier 13 provenience groups.

Manufacturing techniques generally reflect distinct workmanship. With regard to quality of work, Group 1 appears the most crudely manufactured ceramics. Lack of burnishing and luster, irregular thickness of sherd walls, and slightly irregular vessel design are contrasted to the tactilely smoother and burnished sherds of consistent thicknesses in Groups 2 and 4.

With the exception of Group 1, and possibly Group 6, it is suggested that each morphological group represents a separate vessel. The large number of unreconstructible sherds of Group 1, while similar to the partially restored jarlike container, may be the remains of a smaller vessel.

Because of the small sherd size and thinness of Group 2 materials, combined with the obvious smoothing and burnishing of the interior surfaces, these materials are thought to be remains of a small, shallow, bowllike vessel with an estimated diameter of less than 10-12 cm.

Vessel shapes for other morphological groups are unknown, although the degree or extent of surface treatment and sherd thicknesses suggest thin, shallow, bowllike or cuplike vessels. If this assumption is valid, the morphological Groups 3, 4, 5, and 6 may be indicative of such vessels.

Broadly related artifactual material (i.e., **Perdiz** and **Scallorn** arrow points) imply a moderate to extensive Late Prehistoric occupation at the site,

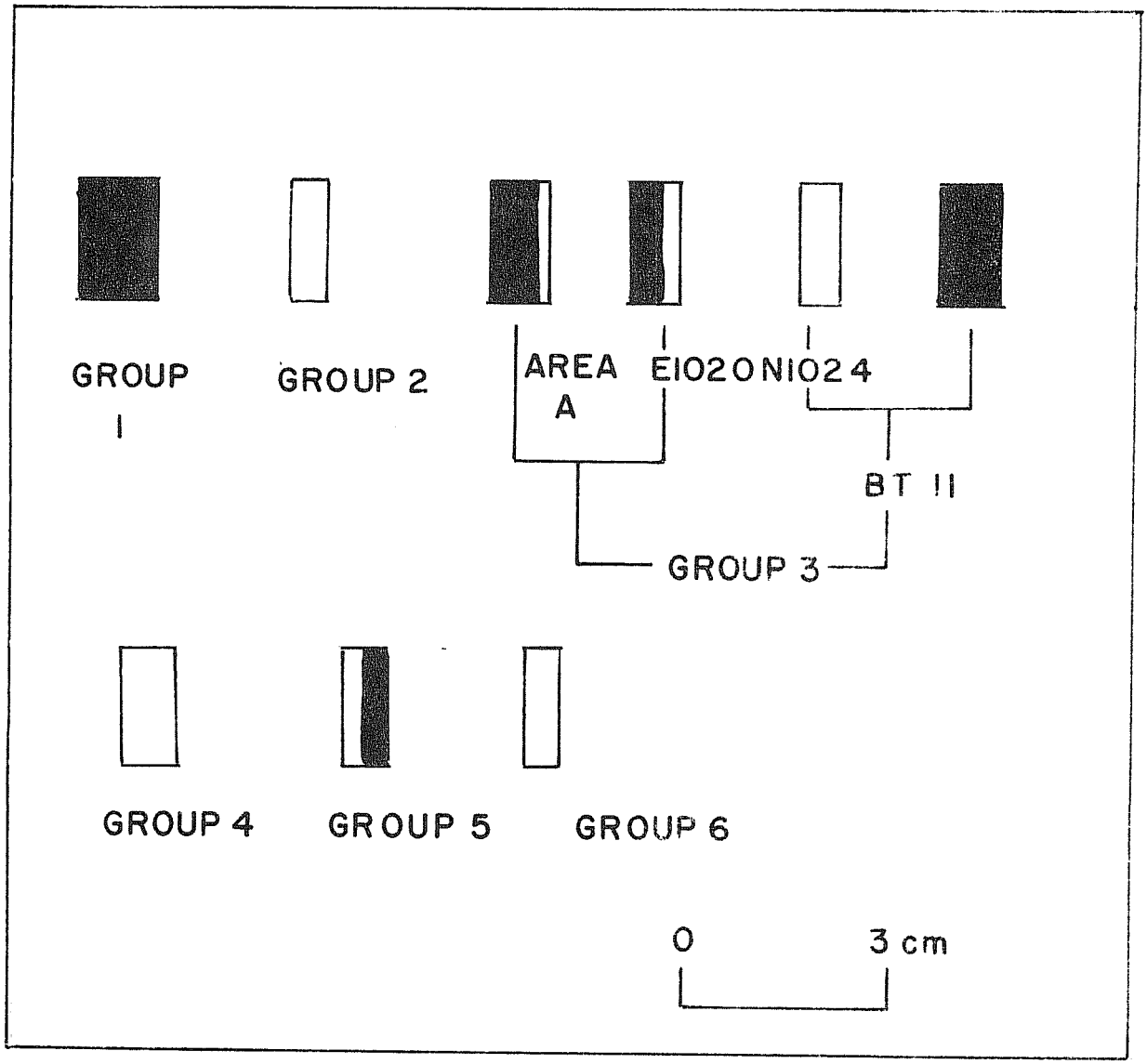


Figure 43. **Cross Sections of Morphological Ceramic Groups Showing Extent of Carbon Streak.**

although the postulated sherd groups and tentatively associated vessels are relatively few in comparison. Regardless of the broad temporal span and limitations of data recovery, the ceramic collection, while simple in technique, suggests only limited use in any specific occupational group.

Ceramic distribution across the site and the mixed artifact recovery make it difficult (if not impossible) to associate any particular morphological group of ceramics with chronologically diagnostic arrow points. A tentative exception to this broad statement was noted in Area E and Group 4 sherds. This widely scattered but distinctive group may be related to four **Perdiz** arrow points recovered from the same level (no other projectile points noted). Implications from this area are tantalizing; the sherd group is morphologically distinct from other groups and reflects a relatively higher quality of technology and/or workmanship. Group 4 and its **Perdiz**-related materials may be contrasted to the mixed lithic assemblage but presumably **Scallorn**-associated ceramics of Group 1 in Area A.

Sherds from two other sites near 41 BX 228 (41 BX 197 and 41 BX 338) suggest extensive and intensive Late Prehistoric occupation in the general study area. Site 41 BX 338, located ca. 1.0 km northwest of 41 BX 228, has been identified as a source of the largest prehistoric ceramic collection yet known in the county. Unfortunately, it is also known as one of the most extensively vandalized sites in the same area, and little professional work has been done at the site. Several relic collectors who have discussed the sites with the authors of this report indicated a large collection of **Perdiz** arrow points from major ceramic concentrations but only several **Scallorn** points. Interestingly, sherds recovered from the vicinity of these artifact concentrations reflect a hard, well-made ware, with moderately and highly burnished surfaces similar to the gross characteristics of Group 4. More definitive statements must await the results of voluntary salvage efforts from 41 BX 338.

Ceramics from 41 BX 228 generally fall within Hester and Hill's (1971) Group D finely crushed bone-tempered sherds and Group E bone-tempered and highly fired ceramics, although interiors of this latter group are generally smooth (polished) at 41 BX 228. It is hoped that the recovery of prehistoric ceramic sherds from 41 BX 228 and this subsequent discussion will contribute to the data bank of knowledge of south-central Texas ceramics. Morphological distinctions of sherd groups as well as enlarged sample sites should enlarge the perspective of this still little understood Late Prehistoric cultural phenomenon.

MODIFIED BONE AND ANTLER (Lynn Highley)

An unusual array of bone and antler artifacts was recovered from the Panther Springs Creek site. Bone implements, such as flakers and awls, which commonly occur at central Texas sites, were present. Several of the modified bone objects, however, appear to represent butchering and hide processing tools--a rare occurrence in recorded central Texas bone tool assemblages.

The bone and antler sample from the site was of a highly fragmented nature, but was well preserved. Spiral fractures, attributable to marrow extraction and tool production, were common. Although many tool types were obvious, the entire bone sample was examined several times to remove all specimens exhibiting rounded edges, polish, or scratches. Because most of the bone shows varying degrees of weathering, fragmentation, or rodent gnawing, it is probable that many indications of modification have been obscured.

All modified specimens were examined under a binocular microscope (10.5X). The modified specimens were initially grouped into two general categories--(1) specimens modified to perform a specific function, and (2) nontool specimens exhibiting random marks or flake scars. The types of wear observed on the functional tool types are discussed in the descriptions below. Numerous other fragments that do not represent tools exhibit slight modification in the form of superficial, parallel scratches which tended to occur in clusters. These marks are not as deep or as wide as rodent chew marks or trowel imprints. It is suggested that they represent chert tool cut marks resulting from butchering procedures. Provenience of these specimens is presented in Tables 27 and 28. Several of the bone fragments also exhibit one or two random flake scars. Other bone fragments have hinge fractures across one end that are typical of the type of break which occurs when bone is flaked.

The bone and antler artifact assemblage from 41 BX 228 includes beads, flaking tools, awls, and butchering or hide processing tools. Several other modified objects could not be classified according to function. The presence of similar bone and antler artifacts has been documented at other archaeological sites in central Texas (Jelks 1962; Johnson, Suhm, and Tunnell 1962; Sorrow, Shafer, and Ross 1967; Hester 1971; Prewitt 1974; Gerstle, Kelly, and Assad 1978; Highley **et al.** 1978).

Descriptions of each functional type of artifact are below. Metric data are presented in Table 29. Modified bone and antler from both the 1977 and 1979 field seasons are discussed. Unless designated otherwise, described artifacts are from the 1979 excavations.

BEADS

Two small bone beads were recovered. The surface of one specimen is highly polished. Each end of this bead has an irregular circumference which has been smoothed and rounded. The other bead is polished and has edges that show slight smoothing.

FLAKING TOOLS

Modified deer ulnas and sections of antler were utilized by prehistoric man to knap flint. For example, a billet made from the basal part of an antler was used in percussion flaking to apply hammerlike blows that could detach large flakes from a blank or preform (Crabtree 1972:8-9). Pressure flaking, a procedure used during the final stages of knapping, was accomplished with

TABLE 27. PROVENIENCE OF MODIFIED BONE AND ANTLER, 1977 EXCAVATIONS

Unit/Level	Artifact Type	Taxon/Element
B-3	1 awl (Fig. 44,j)	**Odocoileus**--metacarpal(?)
C-2	1 modified antler tine	**Odocoileus**--antler
D-2	1 antler billet(?)	**Odocoileus**--antler
D-3	1 modified antler tine	**Odocoileus**--antler
XX	1 drilled antler (Fig. 44,h)	**Odocoileus**--antler

ulna flakers and antler tines. The bone or antler tool was placed at the exact point where a small flake was to be removed and pressure was applied by hand (**ibid.**:14).

A possible antler billet fragment was recovered from the 1977 excavations. Part of the basal end was cut off, and numerous scratches are present on this wider end of the tool. The specimen is highly polished, and the entire surface has been worn smooth. The tool has been split longitudinally, but this does not appear to have been intentional. The specimen has been burned.

The other billetlike specimens were recovered in the 1979 excavations. The exterior on one specimen (Lot Number 355) is extremely weathered, and all traces of possible wear have been obliterated.

The other billetlike antler object (Lot Number 391) has been extensively rodent gnawed along both ends (Fig. 44,g). Only one small portion of the working end was not gnawed, and it is rounded and polished. The entire surface of the specimen is highly smoothed and polished.

Three ulna flakers, as well as several modified shaft fragments, were also recovered. One specimen (Lot Number 60) is relatively complete (Fig. 44,f); part of the proximal end has been broken off. The distal end has been cut off, and the remaining part of the shaft has been ground to a convex, almost pointed, working end. The distal end is highly polished; scratches occur on its right side and are perpendicular to the longitudinal axis of the tool. Scattered scratches occur on other parts of the specimen. The shaft of the specimen is also polished.

Another ulna flaking tool (Lot Number 480) is similar to the one above, although the distal end is blunt or only slightly convex (Fig. 44,e). Diagonal striations extend along either side of the distal end. This blunted specimen is similar to the type of implement Donald Crabtree used for notching dart points (Robert F. Scott IV, personal communication).

TABLE 28. PROVENIENCE OF MODIFIED BONE AND ANTLER, 1979 EXCAVATIONS

Area	Unit	Level	Lot Number	Artifact Type	Taxon/Element
A	E1015 N1018	4	438	1 scratched bone	
A	E1015 N1019	1	58	scratched/flaked bone	**Bison**
A	E1015 N1019	2	57	2 scratched bones	
A	E1015 N1019	2	57	1 butchering/fleshing tool (Fig. 44,a)	**Bison**--femur(?)
A	E1015 N1020	4	125	1 scratched bone(?)	
A	E1016 N1018	2	60	1 ulna flaker (Fig. 44,f)	**Odocoileus** cf. **heminous**--ulna
A	E1016 N1018	3	126	1 scratched bone	**Bison**--rib
A	E1016 N1019	1	44	1 modified antler tine	**Odocoileus**--antler
A	E1016 N1019	2	100	1 scratched bone(?)	
A	E1016 N1020	1	48	2 scratched bones (one with flake scar)	
A	E1017 N1018	1	46	1 ulna tool-shaft fragment	Deer size
A	E1017 N1018	2	51	1 flaked bone(?)	
A	E1017 N1019	2	82	1 scratched bone(?)	
A	E1017 N1020	1	52	1 butchering/fleshing tool (Fig. 44,b)	Bison size
A	E1018 N1020	1	53	awl fragment	
A	E1018 N1020	2	101	awl fragment	
A	E1017 N1020	3	129	1 scratched and cut bone (flaked?)	**Bison**
A	E1018 N1018	2	56	1 scratched bone	Deer size--metacarpal
A	E1018 N1019	1	229	1 scratched bone/awl(?)	
A	E1018 N1020	1	53	1 awl	
A	E1018 N1020	1	53	1 scratched bone(?)	
A	E1018 N1020	2	101	1 awl	
B	E995 N1008	2	481	1 modified antler tine	**Odocoileus**--antler
B	E995 N1009	1	480	1 ulna flaker (Fig. 44,e)	**Odocoileus** cf. **heminous**--ulna
B	E997 N1008	4	133	1 scratched bone	
C	E1005 N1022	4	240	1 ulna awl	**Odocoileus**
C	E1005 N1024	4	180	1 bead	
C	E1005 N1024	4	180	1 scratched bone	
C	E1006 N1024	3	127	1 ulna awl (Fig. 44,i)	**Odocoileus**--ulna
D	E1004 N987	3	164	1 scratched bone	
E	E1010 N1029	4	141	1 scratched bone	
E	E1010 N1029	5	166	1 bead	
E	E1010 N1029	5	166	1 incised bone	
G	E1015 N1004	2	232	1 scratched bone	
H	E1000 N963	4	380	1 modified antler tine	**Odocoileus**--antler
I	E994 N969	2	304	2 scratched bones	
I	E994 N969	3	329	1 scratched bone	
I	E994 N969	4	332	1 ulna tool	**Odocoileus**--ulna
I	E994 N969	4	332	1 antler-cut (?)	**Odocoileus**--antler
I	E994 N969	5	326	1 scratched bone	
I	E995 N968	5	320	1 modified ulna--shaft fragment	**Odocoileus**--ulna
M	E988 N974	1	355	1 antler billet(?) or handle(?)	**Odocoileus**--antler
M	E990 N974	6	428	1 incised bone	
Misc.	E1020 N1024	1	244	1 modified antler tine	**Odocoileus**--antler
Shovel Test	E1015 N1025	2	39	1 modified antler tine	**Odocoileus**--antler
BT 6			391	modified(?) tibia (Fig. 44,c)	**Bison bison**--tibia
BT 6			391	1 antler billet or handle (Fig. 44,g)	**Odocoileus**--antler
BT 10A			467	1 modified(?) tibia (Fig. 44,d)	**Bison bison**--tibia

TABLE 29. METRIC DATA FOR BONE AND ANTLER ARTIFACTS

Description	Lot Number	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)	Figure Reference
Bead	180	1.1	0.5	0.4	0.2	(not illustrated)
Bead	166	1.3	0.6	0.4	0.4	(not illustrated)
Antler Billet(?)	D-2	(6.4)	2.5	2.5	(16.0)	(not illustrated)
Antler Billet/ Handle(?)	355	(5.5)	3.1	2.7	(21.3)	(not illustrated)
Antler Billet/ Handle(?)	391	12.2	3.0	2.9	71.0	Figure 44,g
Ulna Flaker	60	(8.7)	3.8	--	(18.7)	Figure 44,f
Ulna Flaker	480	8.6	3.7	--	17.9	Figure 44,e
Ulna Flaker	332	(5.7)	3.4	--	(15.0)	(not illustrated)
Ulna Awl	240	(7.8)	--	--	(4.9)	(not illustrated)
Ulna Awl	127	(10.2)	--	--	(11.5)	Figure 44,i
Awl	B-3	(10.4)	2.3	0.7	(12.8)	Figure 44,j
Butchering/Hide Processing Tool	57	15.2	3.4	0.9	50.5	Figure 44,a
Butchering/Hide Processing Tool	52	14.0	2.6	0.7	19.9	Figure 44,b
Incised Bone	436	(4.3)	0.9	0.7	(2.7)	(not illustrated)
Incised Bone	150	(1.8)	(1.4)	(0.5)	(0.8)	(not illustrated)
Incised Bone	166	(1.7)	0.6	0.2	(0.1)	(not illustrated)
Drilled Antler	XX	8.2	2.6	2.1	17.5	Figure 44,h

Incomplete measurements are indicated by parentheses.

Figure 44. **Modified Bone and Antler.** a,b, split bison long bone tools; c,d, modified bison tibia choppers; e,f, deer ulna flakers; g,h, modified antler; i,j, bone awls.

The third ulna tool (Lot Number 332) is presumed to be a flaking tool, although most of the shaft is missing. The remaining part of the shaft is highly polished. Scratches parallel to the longitudinal axis of the tool extend across the proximal end. They are very obvious on one side; the other side is weathered, and only a few scratches are visible. The proximal end of the tool is broken off.

Six modified antler tine fragments were recovered. Two of the specimens are from the 1977 field season. Most bear scratches and have rounded or blunt tips. One specimen has two cuts near the tip. Numerous pieces of unmodified antler were also recovered.

AWLS

Bone awls were used for punching holes in skins or leather to facilitate sewing and were probably used as well in weaving basketry and matting.

Two of the specimens from 41 BX 228 are the broken tips of awls. Both have scratches parallel to the longitudinal axis of the tool. The smaller fragment (Lot Number 101) is highly polished; the larger fragment (Lot Number 53) is burned.

Several modified ulna fragments were recovered. Two items presumably used as awls (Lot Numbers 127 and 240) were found broken in several segments and were reconstructed. Both have long polished shafts with striations parallel to the long axis. Two ulna shaft fragments were also recovered; one was found in the same unit and level as one of the awls described above.

One awllike specimen was recovered in the 1977 excavation (Fig. 44,j). This split-bone artifact (Lot Number B-3) is missing the distal end, and the proximal end is also broken off. Shallow diagonal scratches appear in several clusters across the polished exterior surface. The lateral edges have several deep parallel scratches extending the length of the tool. On the interior side, the broken edges of the split bone have been rounded and smoothed. Deep longitudinal scratches have been cut into the interior side of the tool.

A metatarsal, possibly antelope, has been cut and split lengthwise (Lot Number 171). This is typical of bone awl production and probably represents the discarded bone from which the awl was removed (Robert F. Scott IV, personal communication).

BUTCHERING/HIDE PROCESSING TOOLS

Several of the bone artifacts from 41 BX 228 are morphologically similar to butchering tools that have been identified at several bison kill sites on the Plains (Frison 1970, 1974, 1978; Frison, Wilson, and Wilson 1976) and at the Lubbock Lake site (Johnson 1976; Johnson and Holliday 1980). Their presence has been noted in both Paleo-Indian and Late Prehistoric contexts.

Although 41 BX 228 is not a bison kill site, bison bone was present, as well as a large amount of other faunal material. Large game animals such as bison and deer were probably killed and partially butchered elsewhere (see Special Studies section). Favored portions were then taken back to the campsite, where the final stages of butchering and hide processing were completed. Johnson (1976:110) has identified similar activity areas at the Lubbock Lake site as "processing stations." They are characterized by widespread broken bone dispersal and the absence of certain bone elements.

The bone implements found at the Lubbock Lake site are referred to as "bone expediency tools" (**ibid.**:160). They were made and used "on the spot" to carry out the butchering processes of skinning, cutting up the carcass, hideworking, and marrow extraction. Upon completion of the various butchering tasks, the bone tools were discarded with the faunal debris (Johnson 1976:160).

Two unusual bison bone tools were recovered from Late Prehistoric (Local Period 10 or 11) contexts at 41 BX 228. Both artifacts are made from split bison long bones, have a rounded working edge on one end, and exhibit use-polish (Fig. 44,a,b). Although the two tools are similar to specimens recovered from the Lubbock Lake site, no comparable implements were found in the regional literature. Recently, two Late Prehistoric sites from the Choke Canyon Reservoir area in south Texas have yielded similar bone tools in association with bison remains, 41 MC 222 and 41 LK 201 (L. Highley, personal observation and Highley 1986). A single split bison long bone tool was recovered from each site.

The implement showing the greatest degree of modification is a split bison long bone (Lot Number 57) which has a convex, smoothed distal edge with smooth adjacent lateral edges (Fig. 44,a). The interior cancellous material has been smoothed along the distal end. The distal or working end is highly polished along both the exterior and interior faces. Several flakes have been removed through use on both faces, and the resulting scars are partially smoothed over and polished. The exterior surface is more highly polished than the interior and exhibits wear striations parallel to the long axis of the tool.

The second split bison long bone specimen (Lot Number 52) has a convex distal end and is particularly smoothed and rounded along the right lateral edge (dorsal view; Fig. 44,b). The interior surface exhibits polish along the smoothed lateral edge; the bone surface is worn and smooth. On the interior surface most of the blunting and polish occurs along the upper left lateral edge; there is a minimal amount of wear across the tip of the artifact. Several small areas of bright polish occur along a ridge on the right side of the interior surface. The ridge is smoothed and polished. The portion of the tool that was utilized (the right lateral edge viewed from the exterior) is approximately 2.5 cm in length. The polish on the interior corresponds in length to the smoothed edge.

Many of the larger bone fragments from 41 BX 228 exhibit spiral fractures. Undoubtedly, the bones were broken transversely to remove the marrow; however, the resulting bone configuration would often have been ideal for

bone tool use. The pointed end could have served as the working end while the proximal end served as a comfortable hand grip. Unfortunately, many of the spirally fractured bones at 41 BX 228 are weathered or rodent gnawed, thus, obscuring any traces of wear.

Two bison tibiae recovered from 41 BX 228 illustrate the problem. Both specimens (Fig. 44,c,d) are very similar to bison tibia choppers found at several bison kill sites on the northern Plains (Frison 1970, 1974, 1978). Frison (1974:29) states that the tibiae were used more frequently than other bison bone elements because of their shape and structural durability. The 41 BX 228 specimens are weathered and do not exhibit definite use-wear, while the 41 BX 228 specimens cannot be conclusively identified as tools. Their presence along with other definite bison bone butchering and/or hide processing tools is notable.

INCISED BONE

Several incised bone fragments were recovered. It is not known if the incised marks were decorative or functional. One unidentifiable bone splinter (Lot Number 436) has two incised lines that are parallel to the longitudinal axis of the fragment. Another small unidentifiable fragment (Lot Number 150) has a natural longitudinal groove that has been "artificially enhanced" (Richard C. Hulbert, Jr., personal communication). The bone could have been grooved longitudinally to split the bone (Robert F. Scott IV, personal communication). The specimen is polished; it has also been burned. A third unidentifiable fragment (Lot Number 166) has incised parallel lines on one side that are perpendicular to the longitudinal axis of the fragment. One diagonal line intersects two of the parallel lines. The other side of the specimen has one incised line which is parallel to the long axis.

DRILLED ANTLER OBJECT

An artifact recovered from the backdirt of a pothole during the 1977 excavations was a piece of modified antler with the basal portion and tine removed. A hole, drilled or gouged out, extends the length of the specimen (Fig. 44,h). The exterior of the antler is badly eroded. The function of this object is unknown. The drilled hole extending the full length of the specimen suggests use as a pipe. An alternate possibility is that the antler was used as a handle, although a hole the entire length of the object is not necessary for insertion of a flint or bone tool.

The billetlike tool described earlier (Lot Number 391; Fig. 44,g) could also have functioned as a handle. The distal end has been rodent gnawed, but an oval hole extending 3.5 cm into the core of the antler suggests use as a handle. Jackson (1938:106) has recorded the occurrence of several antler handles in central Texas.

MODIFIED SHELL

Six freshwater mussel shell fragments and one marine shell fragment have been modified as described below. Metric data are provided in Table 30.

Specimen 1: A tiny mussel shell fragment with cut lateral edges and a drilled (conical) perforation along one lateral edge.

Specimen 2: A small mussel shell fragment with striations on both faces that are perpendicular to the natural edge of the specimen. The striations are more pronounced on one face. The natural edge has been smoothed and rounded.

Specimen 3: A mussel shell fragment that appears to have had a section cut from it. Above this area is another cut which did not completely penetrate the shell.

Specimen 4: A mussel shell fragment with one smoothed, rounded edge. Striations along this modified edge occur near the wider end of the specimen. The original exterior has been worn away along this edge.

Specimen 5: A mussel shell fragment with parallel striations perpendicular to one edge.

Specimen 6: An almost complete mussel specimen with one cut, smoothed edge. One section of this edge has been smoothed.

Specimen 7: A tiny marine shell fragment has been cut and smoothed along one edge. The specimen appears to be a fragment of a ribbed marine bivalve. It is the only marine shell fragment recovered from 41 BX 228.

TABLE 30. MODIFIED SHELL METRIC DATA

Specimen	Lot Number	Length (cm)	Width (cm)	Weight (g)
1	112	(0.8)	1.4	(0.3)
2	367	2.0	0.7	0.3
3	106	3.0	2.9	3.6
4	43	4.8	1.9	3.0
5	350	4.5	1.4	2.1
6	389	8.5	3.9	14.0
7	26	1.2	0.7	0.2

Parentheses indicate incomplete measurements.

VII. SPECIAL STUDIES

VERTEBRATE FAUNAL REMAINS (Richard C. Hulbert, Jr.)

INTRODUCTION

All vertebrate remains uncovered **in situ** or collected on 1/4-inch mesh screen during the excavation of the Panther Springs Creek site were saved for analysis. The total number of bone fragments recovered was 19,795; included in this figure is material uncovered in the 1977 excavations and in the 1979 shovel tests and backhoe trenches. Fragments complete enough to be identified were compared with specimens from the Modern Skeleton Collection of the Vertebrate Paleontology Laboratory, Texas Memorial Museum in Austin, Texas. Bone preservation varied from very good to poor, generally becoming poorer with depth. Bones from the lowest levels excavated had pitted, eroded surfaces and were often at least partially coated with calcium carbonate. The bones from 41 BX 228 were extremely fragmented prior to burial, probably both for marrow extraction and tool making. The largest complete bones of the most common large species, **Odocoileus virginianus** and **Bison bison**, were astragali and phalanges. All limb bones from these species were broken, usually close to the end of the shaft. The midshaft regions of the bones were further broken into smaller fragments, many just large enough to be collected in the 1/4-inch mesh screens. The highly fragmented nature of most of the faunal remains produced a high percentage of unidentifiable bone fragments (94.25%); however, the size, thickness, and texture of most of the unidentifiable fragments indicate that they belong to large mammalian species. Following the identification of the remains, various analyses were done to study different aspects of faunal exploitation at 41 BX 228. As deer and bison were the most abundant species present at the site, the analyses concentrated on these two species.

NONMAMMALIAN REMAINS

With the exception of turtle fragments, nonmammalian (Osteichthyes, Amphibia, Reptilia, and Aves) remains were rare compared to the number of mammalian bones. A total of three fish bones (two vertebrae and one spine) and one amphibian bone (a fragment of a limb bone, possibly a salamander) was recovered from the site. The rarity of aquatic and semiaquatic vertebrates, including the absence of **Castor canadensis** (beaver) and **Ondata zibithicus** (muskrat) suggests that Panther Springs Creek was a shallow or an intermittent stream during occupation of the site, as it is today. Exploitation of nearby semipermanent streams or waterholes must have been modest and limited mainly to turtles. Turtle shell fragments were common (85, or 7.5% of the identified fragments), but turtle limb and skull bones were not. Most of the shell fragments were so small and fragmented that any identification was precluded, although one fragment had the characteristic dimpled appearance of **Trionyx** sp. Six snake vertebrae were complete enough to classify using the criteria of Auffenberg (1963) and Holman (1979). Four of the vertebrae were assigned to **Crotalus** cf. **atrox** and one vertebrae each to **Agkistrodon contortrix** and **Pituophis melanoleucus**. Bird bones were also uncommon at the Panther Springs Creek site. The only identified species were

Meleagris gallopavo, represented by a radius and a tibia. Table 31 summarizes the nonmammal occurrences from 41 BX 228. All species identified occur in the area today. The only nonmammals to contribute significantly to the diet were turtles.

MAMMAL REMAINS

Table 32 summarizes the mammalian occurrences at 41 BX 228. Rodents did not play a large role in the diet of the inhabitants of 41 BX 228, as indicated by the faunal remains. Only three taxa, **Sigmodon hispidus**, **Geomys** cf. **bursarius**, and **Neotoma** sp. were found. These are all ubiquitous members of the modern Texas fauna. The lack of squirrels, either **Spermophilus** or **Sciurus**, is puzzling, as both contain bones large enough to be recovered in the 1/4-inch screens. Their absence, along with other smaller rodents, indicates that they were either not included in the diet or were consumed in a manner which totally destroyed all the bones. In an effort to recover small mammal remains, heavy liquid flotation was used on matrix samples collected from the site. Many small fragments were recovered, but no identifiable bones or teeth. The absence of identifiable microfauna is probably more a factor of small flotation sample size than total absence from the site deposits.

Leporids (rabbits and hares) were found throughout the site. Both small and large leporids were recovered. The large specimens could belong to either **Lepus californicus** or **Sylvilagus aquaticus**. Both specimens are known to the San Antonio area; but since **S. aquaticus** is much rarer in this region and requires a plentiful water supply, its presence is doubtful. The small leporids could be either **Sylvilagus floridanus** or **S. audubonii**. None of the material is diagnostic in distinguishing these two similar species. This can be accomplished with complete upper or lower jaws (Hulbert 1979) or with auditory bullae. The leporids were assigned to **Lepus californicus** and **Sylvilagus floridanus** because these two are the most common leporids in the region and have been for the last 10,000 years. Bexar County is on the fringes of the ranges for both **Sylvilagus audubonii** and **S. aquaticus**, so their absence is not unexpected. The ration of small **Sylvilagus** sp. to **L. californicus** (3:1) is similar to other sites of comparable age in Texas (Centipede Cave, Val Verde County; Kincaid Shelter, Uvalde County; Levi site, Travis County) and may indicate that a trapping technique was used in their capture.

Carnivores do not make up a large proportion of the identified bones, but at least six different species were present. One of the specimens of **Mephitis mephitis** was a burned mandible, which may indicate that the animal was eaten. **Canis latrans** and unidentified medium-sized canids, possibly domesticated dogs, were the most abundant carnivores present. The specimens of **Canis lupus** are a nearly complete mandible, a lower incisor, and a first phalanx. Other mammalian carnivores found at the site were **Procyon lotor** (one specimen), **Taxidea taxus** (two specimens), and possibly a fox (cf. **Vulpes vulpes**, one specimen). The rarity of raccoon material is another indication that aquatic and semiaquatic environments were not heavily exploited by the inhabitants of 41 BX 228. No felid remains were found at the site. All

TABLE 31. NONMAMMALIAN TAXA IDENTIFIED FROM 41 BX 228

OSTEICHTHYES	
(?) *Ictalurus* sp.	(catfish)
Unidentified sp.	
AMPHIBIA	
Unidentified salamander sp.	
REPTILIA	
Pituophis melanoleucus	(pine snake)
Agkistrodon contortrix	(copperhead)
Crotalus cf. *atrox*	(Western diamondback rattlesnake)
Trionyx sp.	(spiny softshell turtle)
Unidentified turtle sp. or spp.	
AVES	
Meleagris gallopavo	(wild turkey)
Unidentified small bird spp.	

TABLE 32. MAMMALIAN TAXA IDENTIFIED FROM 41 BX 228

LAGOMORPHA	
Sylvilagus cf. *floridanus*	(Eastern cottontail rabbit)
Lepus californicus	(black-tailed jackrabbit)
RODENTIA	
Geomys cf. *bursarius*	(prairie pocket gopher)
Sigmodon hispidus	(common cotton rat)
Neotoma sp.	(woodrat)
CARNIVORA	
Canis latrans	(coyote)
Canis lupus	(gray wolf)
Canis sp.	(unidentifiable dog)
cf. *Vulpes vulpes*	(red fox)
Procyon lotor	(raccoon)
Mephitis mephitis	(common striped skunk)
Taxidea taxus	(badger)
ARTIODACTYLA	
Tayassu tajacu	(collared peccary)
Antilocapra americana	(pronghorn)
Odocoileus virginianus	(white-tailed deer)
Bison bison	(bison)
*Bos cf. taurus	(cow)
*Capra or Ovis sp.	(goat or sheep)

*Not native to the area

carnivores from the site occupy the area today, with the exception of **Canis lupus** which was eliminated from central Texas about 100 years ago (House 1978).

Large artiodactyls make up the remainder and the majority of the fauna. Two specimens of **Tayassu tajacu** (collared peccary) were found. One of the specimens, an ulna, was found in BT 6 and, thus, has an unknown stratigraphic or chronologic context. The other, a phalanx, was found associated with prehistoric artifacts (Lot Number 49). Peccaries have been recently found at one other prehistoric site, the Skillet Mountain site, 41 MC 222, in McMullen County (G. D. Hall, personal communication), associated with radiocarbon dates A.D. 1260-1290. Although **Tayassu** is a relatively late arrival to central Texas (Lundelius 1967), its appearance is not as late as was once thought. Two specimens, from a cow and a goat (or sheep), are the only bones from any recently introduced species found at the site. Large artiodactyls make up the rest of the fauna. **Antilocapra americana** was identified by its distinctive hypsodont cheek teeth with prominent buccal styles. Postcranial bones of **Antilocapra** can be distinguished from **Odocoileus** if complete articular surfaces of the bones are present. All bones that were reasonably complete were **Odocoileus** and not **Antilocapra.** Some of the more fragmentary bones identified as **Odocoileus** may in fact be **Antilocapra.** Pronghorn remains are not abundant at 41 BX 228 and seem to be limited to one, or possibly more, horizons.

Like many other central Texas archaeological sites, the faunal remains are dominated by deer bones. It became evident upon examining the deer bones from 41 BX 228 that a small fraction of them were 15-30% larger than the others. Two possible explanations were: (1) that these large bones were from **Odocoileus virginianus** specimens that were unusually large (i.e., more than two standard deviations above the population's mean size); or (2) that they were specimens of a larger species, **Odocoileus hemionus.** No specimens from the entire site were found with characteristics diagnostic in distinguishing these two deer species: the size of the lacramal fossa and the shape of the antler. A number of large complete deer antlers recovered from 41 BX 1, an Archaic cemetery site, were all identified as **O. virginianus** (Lukowski n.d.). Most of the deer bones resemble **O. virginianus** and are the same size as modern central Texas specimens.

Bison bison is a common element of the Panther Springs Creek site fauna, but most of the remains are fragments of enamel and not bones. From the few complete teeth found, it can be determined that juvenile, adult, and old individuals were hunted, although the numbers are too small to attempt any analysis of the **Bison** teeth. The most typical postcranial elements of **Bison** recovered were ribs and vertebrae fragments, with a slightly smaller number of hind limb bone fragments. The **Bison** specimens were relatively small, not much larger than **Bos.** The identification as **Bison bison** is based on the stratigraphic context of the bones and artifacts, as well as features described in Olsen (1960). **Bison,** as well as **Antilocapra** and **Canis lupus,** were native to the area until eradicated by white settlers in the 1800s.

FAUNAL ANALYSES

By analyzing what bones of an animal are present at a site, it can be determined whether a particular prey species was butchered where it was killed and only certain portions of the carcass brought to the site, or if the entire carcass was transported (Daly 1969). Table 33 contains the total number of bones from deer and bison skeletons found at 41 BX 228. Almost every bone from a deer's skeleton was present. The exception was caudal vertebra. Thus, complete deer carcasses were probably often brought to the camp for butchering. The greater number of skull and hind limb bones compared to the other types indicates that these portions were also transported separately back to camp. Forelimb bones, especially ulnae, humeri, and the proximal portions of radii, were also more common than pelvic bones and scapulae. Thus, some deer were butchered where they were killed, and only the easily transportable head and limbs brought back to camp. The skeleton of **Bison bison** is not as evenly represented at the campsite as that of the deer. Ribs, vertebrae, lower limb bones, and mandibles were much more common than other types of bones. This indicates that **Bison** was much more likely to be slaughtered at a kill site than **Odocoileus**, as would be expected by the relative sizes of the two species (**ibid.**).

By using eruption sequences and tooth wear, Severinghaus (1949) established a set of criteria by which deer lower jaws can be placed into age categories. Due to geographical differences (Severinghaus used white-tailed deer from the northwestern part of the United States) and dissimilar diets for fossil and recent deer, Severinghaus' (**ibid.**) categories should be used as relative rather than absolute groupings (Elder 1965; Daly 1969). The ages of Texas Memorial Museum specimens of **Odocoileus virginianus** were judged according to Severinghaus' criteria. To help account for variation within an age group, two to four specimens were used for each age category. Only deer from central Texas were chosen to lessen any effect of geographical variation. Skulls belonging to the same individuals as the "aged" lower jaws were used to determine the age of upper teeth. Each deer tooth (incisors excluded)

TABLE 33. TYPES OF DEER AND BISON BONES RECOVERED FROM 41 BX 228

Bone	Deer	Bison
Lower jaw/lower teeth	33	11
Skull/upper teeth	48	4
Vertebrae/ribs	19	24
Scapulae	8	1
Pelvic bones	9	0
Humerus/ulna/radius (proximal)	29	2
Radius (distal)/metacarpals/carpals	21	5
Femura/tibia (proximal)	13	7
Tibia (distal)/metatarsals/tarsals	51	11
Phalanges	62	8

complete enough to be identified as the particular tooth type was then "aged" by comparing it with teeth from the modern specimens. Fifty-two teeth were aged in this manner. Teeth of the same age found in the same area at the same level were assumed to belong to one individual (unless there was more than one of any particular tooth), so that a minimum of 31 individuals produced 52 teeth.

Figure 45 is a histogram showing the number of deer of each age class killed by the inhabitants of 41 BX 228. Elder (1965) presented a similar analysis of deer populations in Missouri for both prehistoric and historic Indian predation and modern hunters. The Texas and the prehistoric Missouri sites are similar in the low percentage of fawns (<8%), but differ considerably in the percentage of older deer (those >6.5 years old). In three Missouri sites, Elder (**ibid.**) found that 20-26% of the deer were at least 6.5 years old. At the Panther Springs Creek site only one individual, or 3.23%, reached that age. At another site in Bexar County (41 BX 36), Henderson

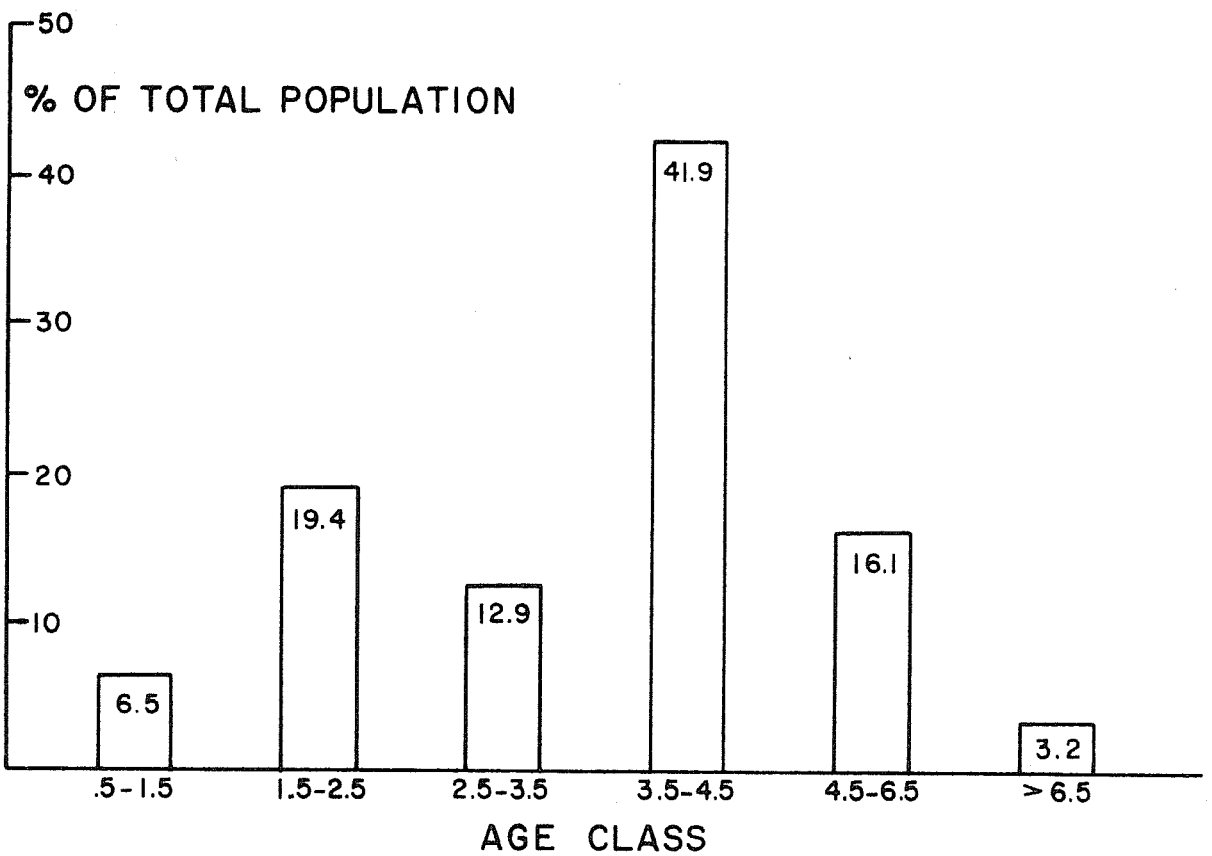


Figure 45. **Age Class Distribution of White-Tailed Deer from 41 BX 228.**

(1978) found only one very old adult **O. virginianus** out of 30 individuals. The Panther Springs Creek site and the two historic Indian sites from Missouri have very few fawns, few old individuals, and a vast majority of deer between 1.5 and 4.5 years of age. They differ in that the deer at 41 BX 228 peak at the 3.5-4.5 year age group, while the two Missouri populations peak at 2.5 to 3 years, and 41 BX 228 has a greater percentage (19.36%) older than 4.5 years. The deer at 41 BX 36 are similar to 41 BX 228, as 66.7% (20 out of 30) fall between three and five years of age (Henderson 1978), although that site has more juveniles than the Panther Springs Creek site. The deer killed in Missouri in 1958 and in Iowa in 1953 have very different proportions of age classes than any of the Indian-killed populations. Many more fawns were killed (>25%), and most of the deer were less than 2.5 years old when they were killed (Elder 1965). The low percentage of fawns at the Missouri archaeological sites was interpreted by Elder (**ibid.**) as active avoidance of killing young deer. He reasons that adult deer contain more meat and larger hides, making them more attractive prey. Elder probably underestimates the differential selection on preservation between adult deer and fawns. Not only are the softer bones of younger and smaller animals less likely to fossilize as Elder states, but also bones of younger animals are destroyed by camp dogs more often than bones of adults (Binford and Bertram 1977). Elder attributed the change in the deer age frequencies from his prehistoric to historic sites as increasing hunting pressures. Since the Panther Springs Creek site is intermediate between the two types of Missouri sites, the prehistoric inhabitants of central Texas may have been putting more pressure on the deer population than those of Missouri. Also central Texas is, and was, a less favorable habitat for **O. virginianus** than Missouri, which would allow fewer individuals to survive to very old age.

FAUNAL INVENTORY

All faunal elements and fragments were counted and identified as completely as possible as to species and specific element. Where appropriate--age, modification, and other characteristics were noted. A detailed inventory of the faunal material is on file at the CAR-UTSA and is available as noted in Appendix VI.

BOTANICAL ANALYSIS (Donna Dean Lannie)

CHARCOAL ANALYSIS

Methods

The charcoal samples were recovered **in situ** by excavators; they do not represent flotation samples. Consequently, there is the probability of sampling error due to differential recovery by individual excavators. Each fragment was snapped along the transverse section in order to expose a fresh surface. Each newly exposed area was examined using a dissecting microscope. Charcoal samples were identified by comparison to modern charcoal reference specimens.

Results

Identifications of the wood charcoal specimens are presented in Table 34. The "no identification" category consists of knots and friable pieces which do not yield a good cross section for viewing.

Those specimens recovered from the archaeological site represent species present in the vegetation today. Due to the limited sample size and its method of recovery, assessment of vegetational changes and cultural preferences was not attempted.

NUT ANALYSIS

Methods

Nut samples were recovered by excavators by means of flotation. Each vial of nut fragments was weighed. Each nut fragment was examined using a dissecting microscope. Nut fragments were identified by comparison to modern nut reference specimens.

Results

Identifications of the nut fragments are presented in Table 35. **Juglans microcarpa** Berl (**Juglans rupestris** Engelm) have small edible kernels. Yanovsky (1936) reports that they were eaten in New Mexico and Texas. **Juglans nigra** L. has a larger kernel, but the tree is less common in the study area. **Quercus** sp. have small edible kernels which may be eaten or pounded into a meal (**ibid.**).

SEED ANALYSIS

Methods

Seeds were recovered by means of flotation. Each vial of seeds was examined, with noncarbonized seeds except **Celtis** sp. disregarded. Carbonized seeds were quantified, weighed, and identified by comparison to modern seed reference specimens.

Results

Identification of carbonized seeds and **Celtis** sp. fruits are presented in Table 35. Generally, the noncarbonized seeds (except **Celtis** sp.) recovered represent contamination by recent or fresh seeds. The problem of seed contamination is not unique to the Panther Springs Creek site. Spector (1970:182) reported only a few charred seeds from the Harvey site, while "most of the seeds were in extremely good condition and showed little sign of alteration." There are numerous explanations for the presence of noncarbonized seeds. Modern plowing could deposit fresh seeds into the

TABLE 34. CHARCOAL IDENTIFICATION

Provenience	Elevation	Lot/Sample	Weight (g)	Identification
E998.61 N1010.20	99.50	Sample 10	0.571	**Juniperus** sp. (juniper)
E1015.83 N1018.60, Level 7	98.88-98.81	Sample 17	0.868	Hardwood
BT 4	98.82	Sample 19	0.868	**Juniperus** sp. (juniper)
E996 N1010, Level 2	99.60-99.50	Lot 91	0.419	No identification
E996 N1010, Level 6	99.20-99.10	Lot 218	0.221	**Acacia** sp. (acacia family)
E1022 N1008, Level 2	100.00-99.90	Lot 214	0.299	**Ulmus** sp. (elm family)
E1022 N1008, Level 4	99.80-99.70	Lot 221	0.413	**Quercus** sp. (oak family)
E1022 N1008, Level 7	99.50-99.40	Lot 231	0.123	**Prosopis glandulosa** (mesquite)
E996 N1011, Level 3	99.40-99.30	Lot 153	0.522	**Juniperus** sp. (juniper)
E995 N974, Level 9	98.70-98.60	Lot 308	0.500	**Juniperus** sp. (juniper)
E1017 N1020, Level 1	100.16-100.00	Lot 54	0.555	**Quercus** sp. (oak)
E995 N969, Level 2	99.30-99.20	Lot 294	0.644	**Carya** sp. (pecan/hickory)
E995 N968, Level 4	99.00-98.90	Lot 328	0.840	Hardwood
E994 N968, Level 7	98.70-98.60	Lot 340	0.104	Hardwood
E990 N976, Level 3	98.60-98.50	Lot 357	0.558	No Identification
E990 N974, Level 7	98.54	Sample 29	0.469	**Juglans** sp. (walnut)
E988 N974, Level 4 (A+B)	98.50-98.40	Lot 346+344	1.008	**Fraxinus** sp. (ash)
E988 N974, Level 5	98.40-98.30	Lot 371	0.449	**Acacia** sp. (acacia)
E1015 N1004, Level 2	99.90-98.80	Lot 232	0.753	**Juglans** sp. (walnut)
E1015 N1004, Level 4	99.70-99.60	Lot 270	0.504	**Juglans** sp. (walnut)
E1015 N1004, Level 5	99.60-99.50	Lot 266	0.271	**Ulmus** sp. (elm)
E1010 N1029, Level 4	99.20-99.10	Lot 141	0.709	**Salix** sp. (willow)

TABLE 35. SEED AND NUT IDENTIFICATION

Provenience	Elevation	Lot	Weight (g)	Quantity	Identification
Area K, Level F.8	(lower layer)	429	0.110	1 meat	**Quercus** sp. (oak)
E1005 N1023, Level 5	99.10-99.00	215	0.102	1 meat	**Quercus** sp. (oak)
E1016 N1020, Level 1	100.10-100.00	48	0.132	1 fragment	**Juglans microcarpa** (little walnut)
E1018 N1019, Level 2	100.00-99.90	229	0.170	1 fragment	**Juglans microcarpa** (little walnut)
E997 N1010, Level 3	99.40-99.30	151	0.621	1 fragment	**Juglans nigra** (black walnut)
E997 N1010, Level 3	99.40-99.30	151	0.041	1/2 seed	**Proboscidea** sp.
E1018 N1020, Level 2	100.00-99.90	101	0.078	1 fragment	**Juglans microcarpa** (little walnut)
E1004 N987, Level 5	99.30-99.20	160	0.209	1 fragment	**Juglans microcarpa** (little walnut)
E990 N974, Level 3	98.60-98.50	363	0.054	1-1/2 seeds	**Celtis** sp.* (hackberry)
E990 N974, Level 4	98.50-98.40	345	0.037	1/2 seed	**Celtis** sp.* (hackberry)
E990 N976, Level 4	98.50-98.40	349	0.031	1/2 seed	**Celtis** sp.* (hackberry)
E1010 N1029, Level 4	99.20-99.10	141	0.276	1 fragment	**Juglans microcarpa** (little walnut)
E988 N974, Level 4	98.45-98.40	344	0.074	1-1/2 seeds	**Celtis** sp.* (hackberry)
E988 N974, Level 3	99.60-99.50	364	0.021	1/2 seed	**Celtis** sp.* (hackberry)

*Specimen not carbonized

occupational zones. The tunnelling of small animals, including rodents, earthworms, and insects, facilitates the movement of seeds. Natural soil disturbances, such as cracks formed by annual freezing and thawing of the earth or cracks formed by drought, can facilitate the filtering of seeds from upper levels of the site (Spector 1970). Seed rain during the excavation of the site can also contribute to contamination. The noncarbonized seeds recovered from the Panther Springs Creek site are typically "weedy" species growing in proximity to the site today. These species produce a large amount of seed rain. Most of the noncarbonized seeds are members of the Gramineae (Grass) family, Caryophyllaceae (Pink) family, Euphorbiaceae (Spurge) family, and Oxalidaceae (Wood sorrel) family.

The **Celtis** sp. (hackberry) fruits are not carbonized. These seeds are durable and could date to the occupation of the site. Williams-Dean (1979) identified **Celtis** sp. fruits from human coprolites recovered at Hinds Cave in southwest Texas. The fruits have been reportedly eaten by Indians in the Rio Grande Valley (Yanovsky 1936). Hackberry fruits are rich in calcium (Yanovsky, Nelson, and Kingsbury 1952). It is also possible, however, that the fruits represent recent contamination.

Proboscidea sp. (unicorn plant) was utilized by aborigines in two different ways. Yanovsky (1936) and Palmer (1878) record that the succulent pods were cooked and consumed. Correll and Johnson (1970) say that the horn was used for fiber by certain groups in the Southwest. One charred seed from the family Euphorbiaceae was recovered; it is possibly **Croton** sp. According to Yanovsky (1936), an infusion of the flowering tops of **Croton pottsii** (Kl.) Muell. (**Croton corymbulosus** Engelm.) was used as a beverage in Texas. **Croton** sp. are common in the area. It is a "weedy" genera; subsequently, the carbonized seed may represent an accidental charring of a stray seed.

FLOTATION METHODOLOGY (A. Joachim McGraw)

The use of flotation techniques for maximum floral and faunal recovery from archaeological sites has greatly expanded the scope of prehistoric studies in the last decade. The increased information from such analyses has given researchers new insights into aboriginal natural plant collecting and subsistence patterns (Struever 1968). Although a variety of techniques have been developed (Broyles 1969; French 1971; Jarman, Legge, and Charles 1972; Limp 1974), comparatively little has been written concerning their efficiency or general performance characteristics. Wiant (ms.) has also addressed this problem while using a zinc chloride flotation solution at the Koster site.

Flotation techniques in south-central Texas have been limited to work by Jaquier (1976) using water and hydrogen peroxide, respectively. Water flotation has also been utilized on a more specific level for charcoal recovery during the Choke Canyon project (G. D. Hall, personal communication).

As part of an enlarged information collecting strategy for 41 BX 228, the systematic use of flotation techniques, used on a moderate scale, was employed to recover both microfaunal and floral materials. Soil samples for flotation were collected from all soil profile columns as part of a special

soil sample collection that also included phosphate, phytolith, and feature matrix samples.

Upon arrival in the laboratory, flotation sample materials were assigned lot numbers and allowed to air-dry for several days before any further processing took place. Zinc chloride ($ZnCl_2$) was chosen as the flotation medium. Hydrogen peroxide was also considered as an alternative, but relative cost, storage concerns, and inherent instability were compromising considerations. The disaggregation of soil by CO_2 in the hydrogen peroxide method was considered less feasible than the density flotation technique of zinc chloride.

A relatively inexpensive solution of $ZnCl_2$ and water having a specific gravity of 1.62 would almost instantaneously separate heavy and light fractions. Heavy fractions, for the purposes of this discussion, include those organic materials such as bone which sink in this solution. It also includes nonorganic debris such as small lithic debitage, gravels, and pebbles. The light fraction, the materials that are suspended or which float to the surface of the flotation solution (thus, having a specific gravity less than 1.62), includes charred and noncharred floral fragments, vegetal debris, some shell, and charcoal. It should be noted that charcoal collected from chemical flotation is generally unsuitable for future radiocarbon testing, although allowances may be made depending upon the nature of the sample and the organic or nonorganic chemical used (S. Valastro, personal communication).

A tub flotation procedure was utilized, modified from Struever's (1968) original methods. Unlike Struever (**ibid.**), who attempted to water separate materials into heavy and light fractions and then chemically flotate each fraction, current studies followed the format of Wiant (ms.), who water separated the sample from the soil conglomerate and then chemically flotated the entire sample into heavy and light fractions. These processes are presented in Figure 46. Wiant (**ibid.**), in explaining this method, suggested that this was a more efficient method than Struever's (1968) earlier work since preliminary water separation was the most tedious and time-consuming aspect of the flotation process.

While $ZnCl_2$ had distinct advantages over the other processes, several factors made it less attractive. Zinc chloride, as a residue, may negatively affect botanical materials (Jarman, Legge, and Charles 1972), although Wiant (ms.) suggests that this did not occur with his work. Zinc chloride is also a carcinogen, and adequate care must be taken in its storage, preparation, use, and disposal. Although a relatively "safe" chemical, this latter drawback was still the most serious consideration during processing; additional set-up time and breakdown time, adequate ventilation, monitoring of solutions to maintain specific gravity, and miscellaneous safety measures all affected processing time.

Because of ventilation factors, all zinc chloride operations were conducted outdoors, adjacent to the archaeology laboratory and with access to hoses and running water outlets. The processing took place in the spring, in clear weather with mild temperatures (70°F-mid 80°F) and with very little or no

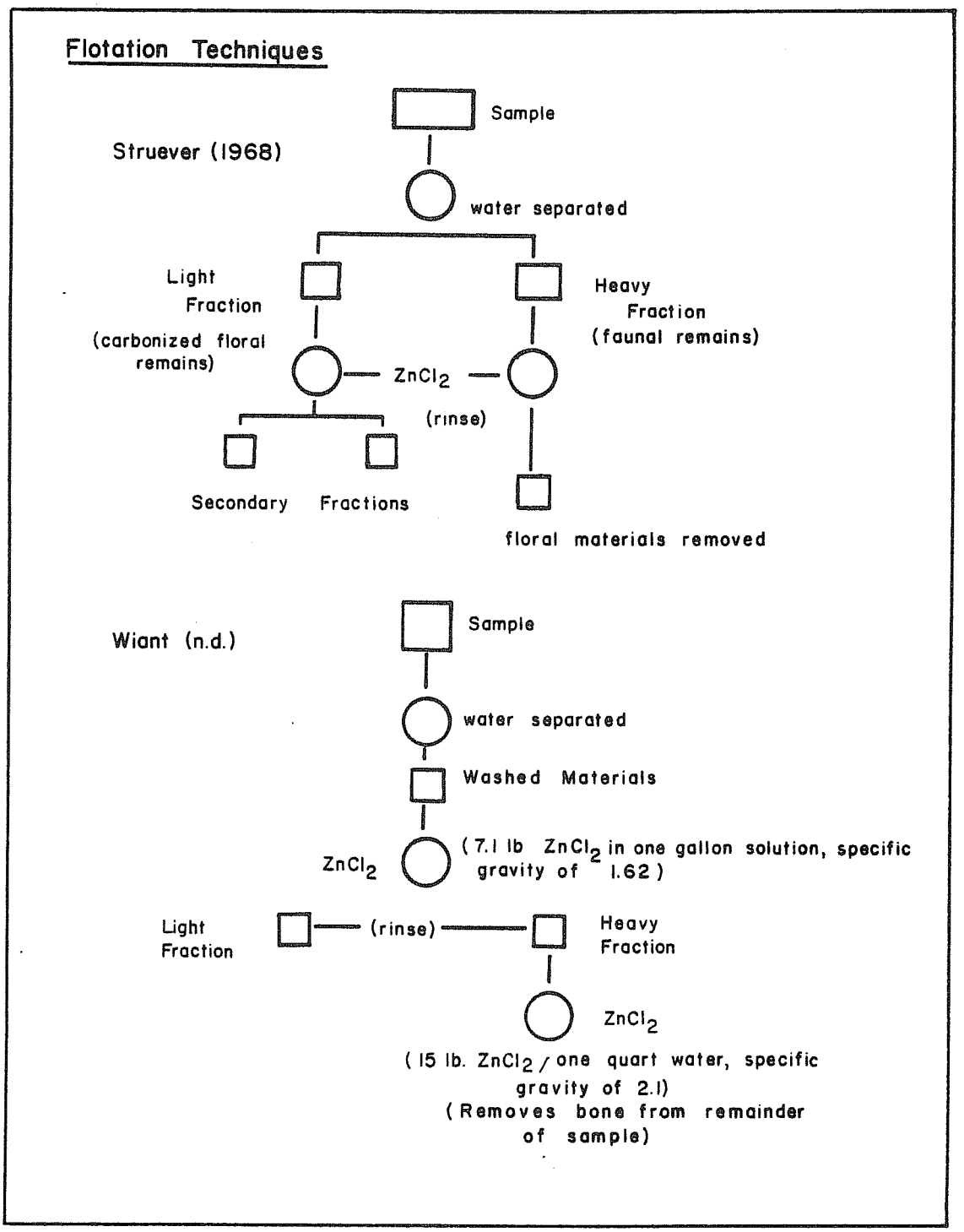


Figure 46. **Flow Chart, Flotation Techniques.**

wind. Rubber gloves, plastic aprons, goggles and/or glasses, and breathing masks were worn as safety precautions. Preliminary water separation of flotation materials from soil was accomplished in a number 12 size galvanized bucket. A 1.0 kg sample of soil was placed in a smaller galvanized screening bucket with a 14-cm opening. The bottom of this small bucket had been cut out and replaced with 40-mesh fine wire screen clamped in place by a series of small nuts, washers, bolts, and galvanized templates. This entire assembly was placed in a water-filled number 12 bucket and gently to moderately agitated to separate the soil conglomerate. Following the removal of most of the soil, the screened bucket was placed in a galvanized 1.9-liter (5 gallon) container half filled with a zinc chloride mixture. Specific gravity was monitored with a hydrometer. Removal of separated materials was accomplished with a small scoop lined with number 40 wire mesh, and materials were placed in a 100-mesh standard testing sieve and rinsed with water. The heavy fraction was similarly rinsed after the sieve had been cleaned. Materials were placed in cardboard box flats divided by taped cardboard.

Flotation materials were then air-dried on laboratory storage racks. All samples were later viewed under an Olympus stereoscopic, variable-power (7-30X) microscope to separate charcoal, seeds, bone, and shell fragments. All collected materials were stored in labeled five-dram plastic vials.

During processing, a chemical flotation worksheet was initiated as a control for sampling and as an aid to processing (Appendix II, Fig. 64). Processing time for zinc chloride flotation, per total sample, ranged from nine to 34 minutes, and ca. 20 minutes with one to two people working. This rather dismal rate included all preparation and clean-up time, as well as actual processing.

A majority of this time was spent in preliminary water separation of soils from flotation materials. Soils from this site were known to be moderately to extremely calcareous and clayey and, rather than passing through the 40-mesh screen, would usually turn into an insoluble mush. An attempt was made to speed up the processing time by presoaking the sample soils in water prior to water separation. Experimental presoak times varied from 15 minutes to 24 hours, and a decrease in processing time was noted for the materials with an increased presoak period (total actual processing time of these presoaked samples was reduced by ca. 10 minutes). Still not satisfied with the processing speed, laboratory personnel consulted Dr. Donald Lewis for suggestions to increase productivity. The presoak concept was expanded, and a 5% acetic solution was substituted for water. It was suggested that this mild acetic solution might break down the relatively weak calcareous clay bonds of the soil and allow more efficient preliminary separations. The acetic presoak was first used for a period of up to 24 hours on a noncritical control sample to test for possible adverse effects to fragile bone, shell, and other organic materials. No delimiting factors were observed, and the inexpensive acetic presoak became standard procedure with the 18th sample. The acid was mixed with approximately equal amounts of soil (ca. 450 ml of acetic acid per sample). Results of the acid presoaks were comparatively spectacular, cutting water separation time from up to 30 minutes to less than five. The clayey materials appeared to be the main drawback in the separation of heavy and light fractions, and it was noted that, following

water separation of soils, the light fraction materials were clearly suspended and could easily be removed at this point. Total processing (not including presoak) of water separation took approximately 10 minutes per sample with one individual working. Total number of samples processed daily still varied considerably, since this was dependent upon number of samples presoaked, preparation of other samples for presoaking, storage of processed samples, etc. An increase in the production effort may have also been due to a reorganization of the processing indoors. The washing sinks, water facilities, and working area of the laboratory could be used since safety and ventilation were not major concerns (as in $ZnCl_2$).

Since flotation separation appeared adequate without zinc chloride processing, all further soil samples were processed by only acetic acid presoaks followed by water flotation. It should be noted that the efficiency of presoaking was directly related to the pH level of the soil. If samples contained a high concentration of organic matter (corresponding to a pH lower than 7.0), the ability of the acid to break down soil bonds was adversely affected.

SOILS CHEMISTRY (A. Joachim McGraw)

INTRODUCTION

The use of various physical and chemical archaeometric techniques has greatly expanded the capacity of archaeologists to interpret artifactual and nonartifactual materials within the last decade. While most of the techniques developed from attempts at refining dating methods, archaeometric applications have broadened in scope to include cultural material studies and intersite and/or intrasite activity analyses. The latter may often be determined by soils chemistry testing in the form of phosphate, organic carbon content, pH, or elements analysis. This report emphasizes phosphate sampling since it was considered the most productive archaeometric application.

The interpretation of phosphate samples systematically collected both horizontally and vertically across an archaeological site often may indicate the location as well as extent of prehistoric site activities. Detailed discussions of phosphate sampling results, techniques, and influencing factors have been presented by Eidt (1977) and Lewis (1978).

These methods may be in the form of convenient field spot tests or in more lengthy (and accurate) laboratory procedures involving phosphate fractionation, a sequence of extraction processes ranging from a gentle wash to a hot, strong acid treatment. These extraction processes may be defined as labile phosphate, bound phosphate, and mineral phosphate treatments. All three phosphate methods as a whole and their group distributions may be considered as indicators of man-induced soil changes (Eidt 1977). Lewis (1978) has summarized this as a (1) determination of the nature and type of land use; (2) estimation of population density; (3) extent of land use; and (4) determination of occupational chronologies.

SOILS CHEMISTRY (PHOSPHATE) BACKGROUND

Human enrichment of soil phosphate has been recognized since the middle of the 19th century (Woods 1975) and probably much earlier. Wagganman (1969) points out that in the latter 1800s European battlefields and old cattle ranges were sought out because of the high demand for bone fertilizers. Farmers in the United States have also noted that crops grow better at prehistoric Indian sites (Woods 1975).

It was not until the 1920s, however, that information of this sort was applied systematically and scientifically by social scientists. A Swedish soil scientist, O. Arrhenius, first published the relationships between phosphate soil enrichment and human activities after noting it would be helpful in detecting abandoned settlements (Arrhenius 1929, 1931). This work actually followed an earlier Swedish soil survey by the Swedish Sugar Manufacturing Company, which investigated 500,000 hectares of land to test for beet farming potential. During the processing of 500,000 samples, the company studied several pedological properties, including pH and phosphoric acid. This early work was significant because of the large scale of the operations; general principles were evolved in the commercial venture which could not have been worked out for academic reasons due to the costs involved (Woods 1975).

In 1932, I. Shell first used the Arrhenius technique to establish phosphate contour mapping. W. Christensen (1935) followed up this work on early Iron Age sites. By 1939, the Arrhenius method was employed outside northern Europe by French scientists in Indochina (Vietnam).

Woods (1975) suggests that the most significant development in this area other than initial research was made by the German geographer W. Lorch (1939), who explained a simplified field and laboratory phosphate testing method. His "Die Siedelungsgeographische Phosphatmethode" (Lorch 1940) is considered by some to be the classic treatise on patterns of phosphate distributions.

Although soils research continued in Europe, it was not until 1948 that phosphate studies were carried out in the United States by social scientists. Solecki (1953), in his work with Adena burial mounds, introduced the concept of settlement phosphate analysis in the United States and recommended that further work be done. Other significant works followed this period, including Lutz (1951), Haury (1950), Dietz (1957), Cruxent (1962), and Cook and Heizer (1965). In 1970, R. C. Eidt of the Department of Geography at the University of Wisconsin at Milwaukee adapted the techniques of soil phosphate analysis at the prehistoric site of Aztalan, Wisconsin. Eidt employed the qualitative Gundlach spot test method developed in Switzerland (Gundlach 1961), as well as the qualitative sequential soil fractionation methods developed by Chang and Jackson (1957). Eidt modified both strategies drastically and evolved a new settlement geography phosphate methodology in 1972. As work continued to the present, Berlin *et al.* (1977), White (1980), Lewis (1978), and others have discussed and applied various techniques of phosphate sampling to a variety of archaeological interests.

SOILS CHEMISTRY AT 41 BX 228

The actual soils chemistry analysis was performed by Archaeological Services, Inc., Stevenson, Maryland, represented by Bradley Marshall. The emphasis on phosphate distribution was intended to identify phosphate-rich, culturally related activity areas. Data Set 1 consisted of 50 soil columns and matrix samples that were analyzed for organic carbon, pH, calcium, and phosphorus. Data Set 2 consisted of an additional 64 samples that were analyzed only for phosphorus.

The resulting data are statistically summarized in Table 36 and presented in Table 37 and Table 38. These data enable the reader to (1) draw accurate inferences on the nature of soils chemistry distributions, independent of the interpretations presented here, and to (2) recognize that the value of high resolution soils chemistry lies not only in the current studies but in its potential contribution to future comparative works.

Calcium (Ca) Distributions

The distribution of calcium (Ca) expressed in parts per million (ppm) varied from a minimum of 2530 ppm to a maximum of 3520 ppm, with an average sample reading of 2838.7 ppm. The standard deviation, 177.08, was moderately high. Significant sample frequencies having a standard deviation of ± 86 were noted. Interpretations of Ca are difficult at this point; little comparative data exist. The degree of variation within the site does imply unknown factors affect the deposit of Ca, which generally increases with depth. Interestingly, the content of Ca in matrix Samples #34-50 is generally only slightly higher than those samples removed from soil columns.

pH Distributions

The pH levels varied throughout the site and typically become more base in lower elevation samples. The distribution of pH from selected excavation areas (B, C, I, and M) is illustrated in Figure 47. Soil pH varied comparatively little at 41 BX 228, ranging from a minimum value of 7.5 (more

TABLE 36. STATISTICAL SUMMARY OF SOILS CHEMISTRY DATA

Data	N	Mean	Standard Deviation	Skew	Kurtosis
Calcium	50	2838.70	177.08	0.93	2.34
Organic Carbon	50	3.90	1.69	0.32	-0.37
pH	50	7.92	0.18	0.06	-0.50
Phosphorus	50	3.87	8.86	5.56	33.15
Phosphorus	114	5.84	12.06	3.53	12.36

TABLE 37. SOILS CHEMISTRY ANALYSIS, DATA SET 1

Sample Number	Provenience	Approximate Elevation	Context	pH	Phosphorus (ppm)	Calcium (ppm)	Organic Carbon (%)
1	Column #1, Sample #1	98.05	Gravel	8.1	0.1	2640.0	0.9
2	Column #1, Sample #2	98.15	Gravel	8.0	0.3	3020.0	0.6
3	Column #1, Sample #3	98.35	Transition Zone	8.0	0.4	2780.0	1.6
4	Column #1, Sample #4	98.45	Transition Zone	8.1	0.2	2800.0	1.9
5	Column #1, Sample #5	98.55	Transition Zone	8.1	0.4	2840.0	2.4
6	Column #1, Sample #6	98.75	Midden 2	8.0	0.6	2770.0	3.7
7	Column #1, Sample #7	99.00	Midden 2	7.8	2.1	2760.0	5.6
8	Column #1, Sample #8	99.35	Topsoil	7.8	5.2	2590.0	7.4
9	Column #2, Sample #1	98.45	Gravel	8.0	0.5	2700.0	1.3
10	Column #2, Sample #2	98.65	Transition Zone	7.9	0.1	2720.0	2.1
11	Column #2, Sample #3	98.85	Midden 2	7.8	0.5	2820.0	2.9
12	Column #2, Sample #4	99.05	Midden 2	7.7	1.5	2530.0	3.9
13	Column #2, Sample #5	99.25	Topsoil	7.7	4.1	2640.0	5.5
14	Column #3, Sample #1	99.15	Gravel	7.8	0.3	2720.0	2.2
15	Column #3, Sample #2	99.25	Upper Gravel	7.7	0.6	2660.0	3.0
16	Column #3, Sample #3	99.45	B-Horizon	7.9	4.4	2690.0	4.5
17	Column #3, Sample #4	99.55	B-Horizon	7.8	7.3	2540.0	5.5
18	Column #3, Sample #5	99.65	Topsoil	7.6	10.2	2610.0	6.4
19	Column #4, Sample #1	99.50	B-Horizon	7.8	2.2	2720.0	4.4
20	Column #4, Sample #2	99.75	B-Horizon	8.0	1.9	2720.0	4.0
21	Column #4, Sample #3	99.95	B-Horizon	7.8	6.0	2730.0	6.3
22	Column #4, Sample #4	100.05	Topsoil	7.7	6.8	2790.0	7.5
23	Column #5, Sample #1	98.95	Gravel	7.9	0.2	2980.0	2.5
24	Column #5, Sample #2	99.05	B-Horizon	8.0	0.6	3020.0	2.9
25	Column #5, Sample #3	99.15	B-Horizon	7.9	1.6	3060.0	3.6
26	Column #5, Sample #4	99.25	B-Horizon	7.8	4.2	3000.0	4.0
27	Column #5, Sample #5	99.35	Topsoil	7.8	12.2	2980.0	5.2
28	E1002 BT 7, Sample #1	98.70	Below Midden	8.0	0.1	3000.0	2.8
29	E1002 BT 7, Sample #2	98.90	Midden 1	7.8	0.6	3090.0	3.7
30	E1002 BT 7, Sample #3	99.20	Above Midden	7.5	61.6	2640.0	4.6
31	E1019 BT 10, Sample #1	99.65	Below Midden	7.8	1.1	3520.0	4.0
32	E1019 BT 10, Sample #2	99.85	Midden 4	7.9	0.7	3020.0	4.7
33	E1019 BT 10, Sample #3	100.20	Above Midden	7.7	3.5	2920.0	7.8
34	Area K, Feature 8 (342)	--	Upper Fill	7.7	0.2	2910.0	4.3
35	Area K, Feature 8 (470)	--	Lower Fill	7.8	0.1	2920.0	3.9
36	E994 N969, Level 9 (369)	--	Transition Zone	8.1	0.4	2820.0	2.5
37	E1017, N1019, Feature 1 (204)	100.06	Upper Fill	8.0	8.7	2720.0	6.3
38	E996 N1010, Feature 3 (197)	--	--	8.1	5.4	2780.0	4.0
39	E1015 N1018, Feature 5 (208)	--	--	8.1	6.3	2790.0	5.1
40	E997 N1009, Feature 2 (199)	99.55	--	8.0	13.4	2710.0	5.3
41	E1022 N1008, Level 2 (238)	99.92	Rock Cluster	7.9	4.7	2660.0	6.1
42	E1005 N1024, Level 6 (403)	--	--	8.1	0.9	2975.0	2.4
43	E1005 N1024, Feature 6 (205)	99.30	Upper Fill	7.9	4.0	2950.0	3.9
44	E988 N976, Level 5 (352)	98.35	Pit Fill	8.3	1.0	2860.0	2.4
45	E988 N976, Level 5 (348)	98.35	Pit Fill	8.1	0.8	2980.0	3.8
46	E988 N976, Level 5 (353)	98.35	Pit Fill	8.2	0.9	3000.0	3.5
47	E990 N974, Level 4 (295)	98.55	Pit Fill	8.3	0.7	2960.0	3.1
48	E990 N974, Level 4 (296)	98.55	Outside Pit	8.2	0.7	2950.0	1.4
49	E999 N963, Level 3 (259)	99.05	Upper Cluster	8.0	2.8	2980.0	4.6
50	E990 N974, Level 3 (358)	99.54	Rock Cluster	8.2	0.6	2950.0	2.9

Column #1 = Area M - South Wall BT 4
Column #2 = Area I - North Wall E995 N969
Column #3 = Area B - East Wall E998 N1008
Column #4 = Area A - North Wall E1016 N1020
Column #5 = Area C - West Wall E1005 N1024

Note: The samples from the backhoe trenches were taken at regular intervals at the approximate East coordinate (all sampled trenches ran roughly east-west).

TABLE 38. SOILS CHEMISTRY ANALYSIS, DATA SET 2

Sample Number	Provenience	Approximate Elevation	Context	Phosphorus (ppm)
51	Column #6, Sample #1	97.85	Lower Gravels	0.5
52	Column #6, Sample #2	98.25	Upper Gravels	0.5
53	Column #6, Sample #3	98.45	Oxidized Clay	0.1
54	Column #6, Sample #4	99.20	Topsoil	64.0
55	E988 BT 4, Sample #3	98.85	--	4.6
56	E988 BT 4, Sample #1	98.55	--	0.5
57	E988 BT 4, Sample #2	98.65	--	2.9
58	E990 BT 4, Sample #1	98.50	Below Midden	0.5
59	E990 BT 4, Sample #3	99.30	Above Midden	15.7
60	E990 BT 4, Sample #2	99.00	Midden 2	2.6
61	E992 BT 4, Sample #1	98.50	Below Midden	0.7
62	E992 BT 4, Sample #2	99.00	Midden 2	1.1
63	E992 BT 4, Sample #3	99.30	Above Midden	6.2
64	E994 BT 4, Sample #1	98.50	Below Midden	0.7
65	E994 BT 4, Sample #2	98.90	Midden 2	1.2
66	E994 BT 4, Sample #3	99.40	Above Midden	7.4
67	E996 BT 4, Sample #1	98.70	Below Midden	0.3
68	E996 BT 4, Sample #2	99.00	Midden 2	1.2
69	E996 BT 4, Sample #3	99.40	Above Midden	6.1
70	E998 BT 4, Sample #1	98.70	Below Midden	0.3
71	E998 BT 4, Sample #2	99.00	Midden 2	2.0
72	E998 BT 4, Sample #3	99.40	Above Midden	6.8
73	E1000 BT 4, Sample #1	98.40	Gravel	0.4
74	E1000 BT 4, Sample #2	98.90	--	1.2
75	E1000 BT 4, Sample #3	99.30	--	5.7
76	E1002 BT 4, Sample #1	98.50	Gravel	0.7
77	E1002 BT 4, Sample #2	98.90	--	1.3
78	E1002 BT 4, Sample #3	99.30	--	5.4
79	E1000 BT 7, Sample #2	99.00	Midden 1	0.9
80	E1000 BT 7, Sample #3	99.15	Above Midden	40.7
81	E1000 BT 7, Sample #1	98.65	Below Midden	0.1
82	E1004 BT 7, Sample #1	98.65	Below Midden	0.1
83	E1004 BT 7, Sample #2	99.00	Midden 1	0.4
84	E1004 BT 7, Sample #3	99.20	Above Midden	51.8
85	E1008 BT 7, Sample #1	98.60	Gravel	0.6
86	E1008 BT 7, Sample #2	98.85	--	0.6
87	E1008 BT 7, Sample #3	99.20	--	60.0
88	E1012 BT 7, Sample #1	98.65	--	0.1
89	E1012 BT 7, Sample #2	98.90	--	0.7
90	E1012 BT 7, Sample #3	99.10	--	38.2
91	E1003 BT 10, Sample #1	99.50	--	1.4
92	E1003 BT 10, Sample #2	99.65	--	2.6
93	E1003 BT 10, Sample #3	99.85	--	12.8
94	E1007 BT 10, Sample #1	99.30	Gravel	1.7
95	E1007 BT 10, Sample #2	99.75	--	2.0
96	E1007 BT 10, Sample #3	99.95	--	11.9
97	E1011 BT 10, Sample #1	99.55	--	1.3
98	E1011 BT 10, Sample #2	99.80	--	5.2
99	E1011 BT 10, Sample #3	00.05	--	7.7
100	E1015 BT 10, Sample #1	99.40	Below Midden	2.4
101	E1015 BT 10, Sample #2	99.70	Midden 4	2.7
102	E1015 BT 10, Sample #3	100.20	Above Midden	11.5
103	E1023 BT 10, Sample #1	99.65	Below Midden	1.0
104	E1023 BT 10, Sample #2	99.90	Midden 4	2.9
105	E1023 BT 10, Sample #3	100.15	Above Midden	11.1
106	E1027 BT 10, Sample #1	99.70	--	0.7
107	E1027 BT 10, Sample #2	99.90	--	1.4
108	E1027 BT 10, Sample #3	100.15	--	7.8
109	BT 18, Sample #1	-40 cm	Below Surface	1.5
110	BT 18, Sample #2	-15 cm	Below Surface	4.9
111	E1020 N1024 West Wall #1	-10 cm	Below Surface	15.1
112	BT 20, Sample #1	-115 cm	Gravels	0.1
113	BT 20, Sample #3	-15 cm	Topsoil	27.6
114	BT 20, Sample #2	-65 cm	Oxidized Clay	0.1

Column #6 = BT 2 - ca. E1005

Note: The samples from the remaining backhoe trenches were taken at regular intervals at the approximate East coordinate (all sampled trenches ran roughly east-west).

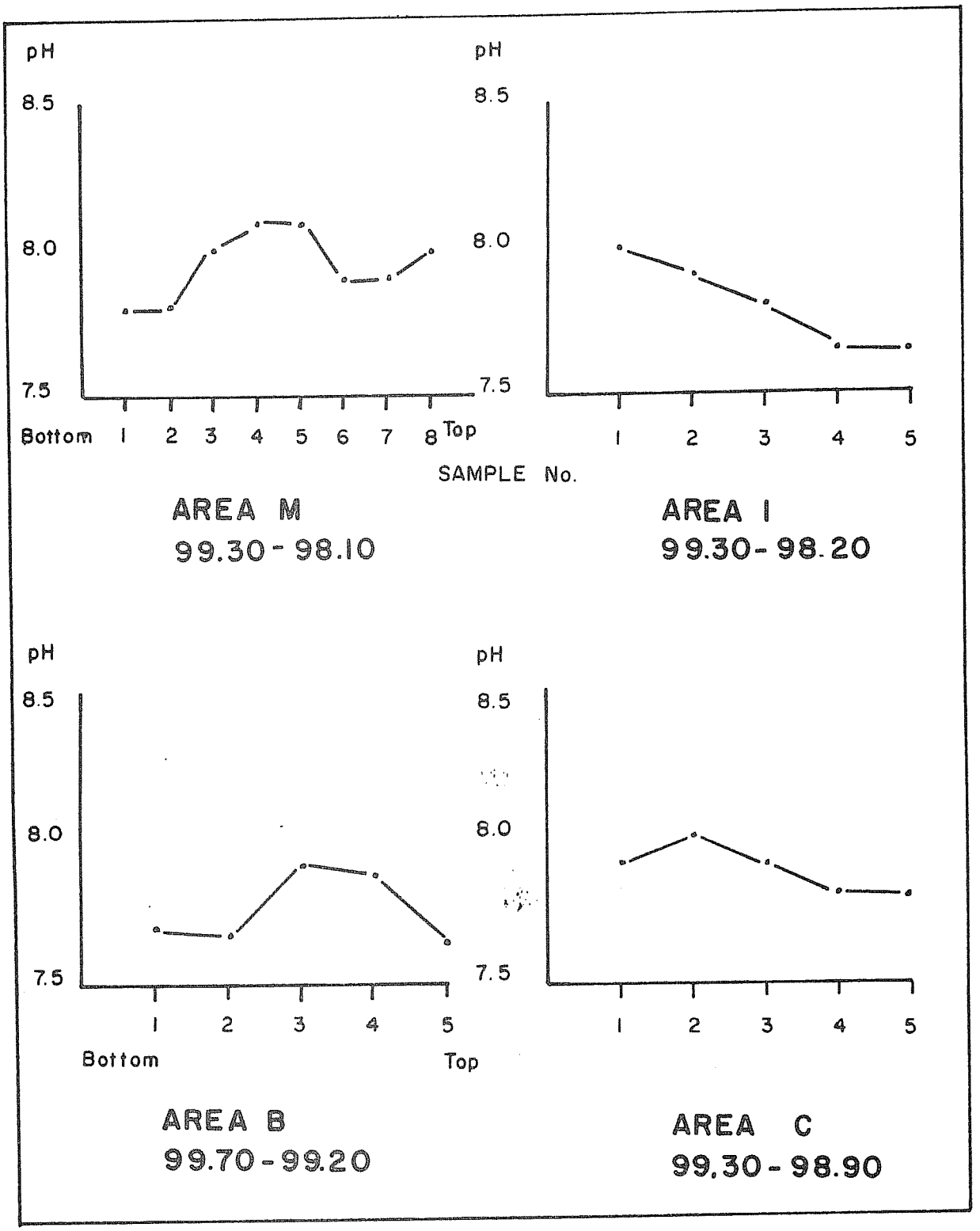


Figure 47. Vertical Distribution of pH from Select Area Excavation Profiles.

acetic) to a maximum value of 8.5 (more basic). All values were basic, which is consistent with the usual alkaline nature of calcareous soils. The slight anomalies apparent in Figure 47 (peaks in the vertical distributions) may be related to localized cultural activities. No additional evidence of the postulated activities could be correlated with the pH anomalies. One interesting anomalie was identified from a soil sample not analyzed in Data Set 1. This sample, Column #6, Sample #4, was measured in the CAR laboratory and was found to have a pH of 6.0. This definite anomalie also had the same location as the highest phosphate reading from the site. The nature of the anomalie is unknown, but the sample is from a topsoil context and may have been recently contaminated.

The pH value of matrix samples was generally higher (by approximately 0.5) than soil column samples. Little variation of pH was noted in the pH range between the top and bottom midden samples of Area M (Column #1, Samples 5 through 7).

The distribution and amount of pH across the site indicate that pH frequency may be too sensitive and too variable of a sample indicator within local/ regional archaeological sites. The results of work at 41 BX 228 suggest such sampling of pH levels must necessarily be combined with other comparative chemical techniques.

Organic Carbon Distributions

Organic carbon content of the 50 samples varied from a minimum of 0.6% to a maximum of 7.8%. The average was 3.9%, with a standard deviation of 1.69. On an average, organic carbon content of various feature matrix Samples #34-50 was not higher than column samples. The highest sample value was recorded for E1019, BT 10, Sample #3. Its location near the surface may indicate contamination by modern organic debris. Organic carbon content of the midden-related areas in the vicinity of Area M (Samples #6 and 7) was not noticeably distinct from nonmidden levels.

The correlation coefficient between calcium and organic carbon was comparatively low ($r = 0.22$). This may suggest that most of the organic carbon results from decayed plant matter rather than faunal material.

Organic carbon content statistics fall within the range of other samples from sites in the Camp Bullis study area (Gerstle, Kelly, and Assad 1978:219). Organic carbon content of 41 BX 228 tends to be slightly higher. Unfortunately, a wide range of causations, primarily natural, may contribute to these differences.

Phosphorus (P) Distributions

The distribution of phosphorus in parts per million of both 50 samples and an aggregate total of 114 samples indicated a mean value of 3.87 (for 50 samples) to 5.84 ppm (for 114 samples) with very little standard deviation from this mean. Minimum and maximum values for phosphorus, respectively,

ranged from 0.1 (Column #6, Sample #3) to 64.0 (Column #6, Sample #4). Curiously, the maximum and minimum value for the site occurs in adjacent levels of the same soil column. No associated cultural features were noted for Column #6, and an explanation for this phenomenon is beyond the scope of this report; it may be speculated that natural contamination by extensive organic debris may have contributed phosphorus.

A distribution of phosphorus in Areas A, B, C, I, and M and Backhoe Trenches 4 and 7 is illustrated in Figure 48. Phosphorus ranges, particularly of Area M and BT 4, are consistent but extremely small; apparently a phosphorus reading of 0.3-0.4 ppm may still be associated with cultural levels. A decrease in phosphorus is noted in all columns as depth increases, with the exception of Sample #1, Area A. (A slight increase of 0.3 ppm was observed.)

Apparently specific intrasite localities reflect a diminutive but distinctive change in relative phosphorus values particularly in the lower levels. Different relative values vary only by approximately two parts per million; maximum, but relative trends occur north to south across the site. Areas M and I show both lower minimum phosphorus values as well as a dissimilar projection curve of total amounts in all levels. Units B and C, when compared to Areas M and I, show higher minimum and maximum values with no "drop-off" of phosphorus values in the lowest levels (generally associated with values of less than one ppm).

Causes of the physical changes reflected in these values cannot be positively identified as to natural or man-induced effects. It is interesting to note, however, that after comparisons of site middens, chronologically diagnostic materials, and features, the authors speculate that an unidentified prehistoric refuse area may be located in the general vicinity of Areas B and C. Such a feature would, by an increase in the amount of deteriorated organic matter, reflect higher soils chemistry (phosphorus) values. Its central location to the established activity areas (Areas B and C) imply the practical utilization of such a locality.

Comments

The interpretation of soils chemistry samples from 41 BX 228 is somewhat limited by the lack of comparative data from other sites.

The samples from current field excavations were carefully collected and controlled and represent a broad cross section of soil deposits throughout subsurface cultural zones. The resulting data, as such, are considered to be a valid and reliable representation of the subtle changes in soils chemistry throughout the site.

The distribution of pH, P, Ca, and organic carbon varied broadly from north to south across the site; this is most obvious in the relative amount of phosphorus, which was higher in northern subsurface levels (in Areas A, B, and C) than in southern portions of the site (Areas I and M and Backhoe Trenches 4 and 7).

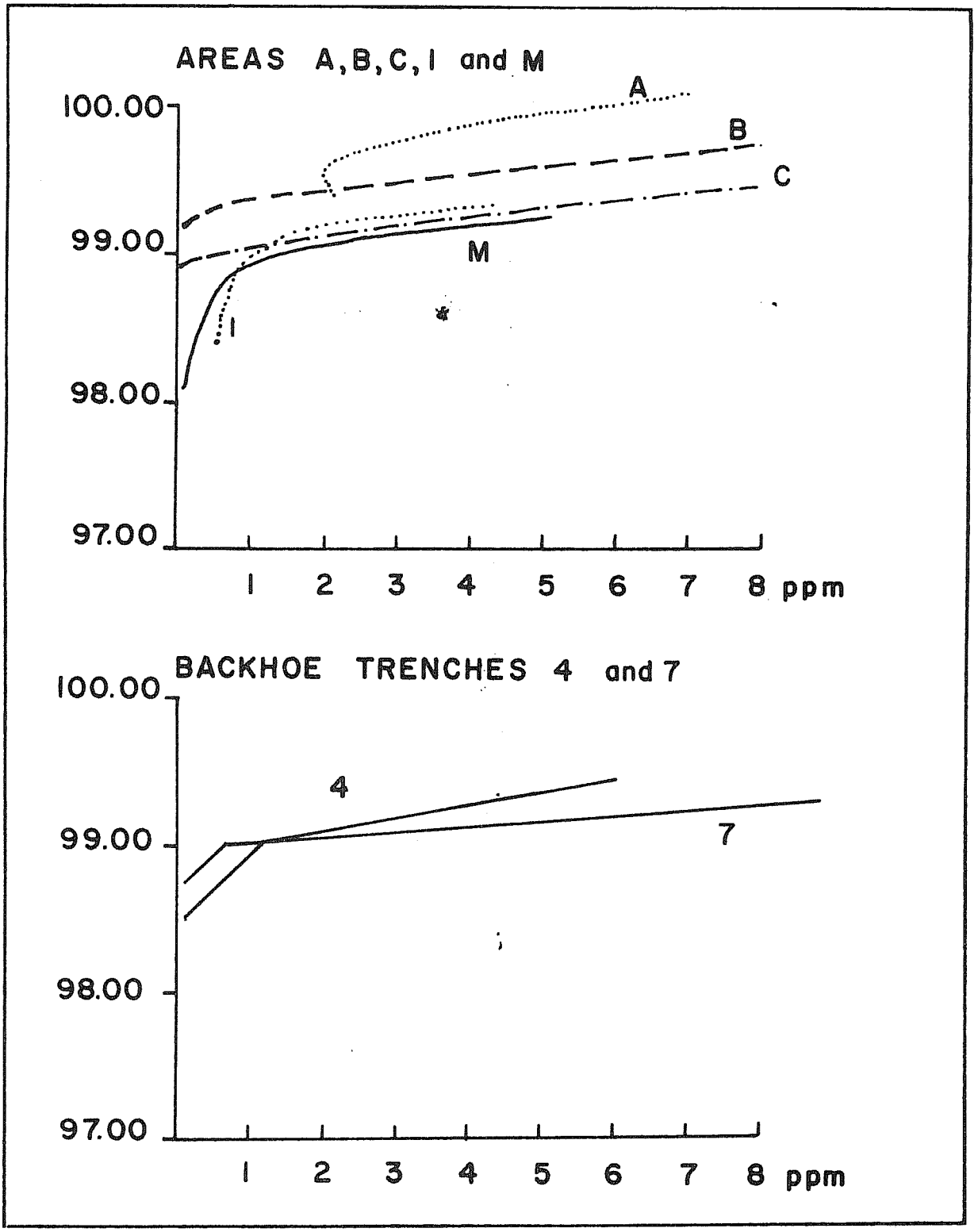


Figure 48. **Vertical Distributions of Phosphate from Select Excavation Area Profiles and Backhoe Trench Profiles.**

This may in part be due to the apparent increase in erosion southward and correspondingly shallower cultural levels. Differing intensities of past cultural activities are also assumed to affect these distributions.

Upper level samples, particularly of Areas B and C and portions of Backhoe Trenches 4 and 7, are presumed to indicate background contamination of phosphorus and perhaps other chemical samples. Data from 41 BX 1 (Lukowski n.d.), a prehistoric cemetery site, indicate that pH and phosphorus samples in ppm correspond generally to soils data from 41 BX 228. Site 41 BX 1 is located approximately six miles southeast of 41 BX 228. For comparative purposes, pH and P values for both sites are presented in Table 39.

While very little comparative data exists, the data in Table 39 can generally be compared to the Gerstle, Kelly, and Assad (1978) study at three sites at Camp Bullis approximately seven miles northwest of 41 BX 228 (Table 40).

For phosphorus determinations, little comparative work may be done with the data of Gerstle, Kelly, and Assad (1978). The limited sample size per site and lack of duplicate and control samples do little to contribute to intersite analysis. The phosphorus readings presented by them are quite high, comparatively, and this might be the result of (1) contamination in regard to sampling; (2) inaccuracies or lack of sensitivity in the analytical methods or equipment; (3) actual significant variations of phosphorus deposits between sites due to unknown causes; (4) inaccurate conversion methods; or (5) other as yet unidentified causes. Since the 50/114 samples from 41 BX 228 and the 70 from 41 BX 1 contain both control and duplicate samples, the consistency of the results and the greater sensitivity of equipment indicate a better potential for validity.

The limited sample size and testing methodology of soils chemistry operations were initiated to test the feasibility of such work to interpretations of cultural activities both horizontally and vertically. The patterns of these results, as well as their significance, are limited by the extremely small resulting figures and lack of comparative information.

That potentially significant distributions occur is evident from the consistency of the data, and while no conclusive statements may be made, several general comments will be presented concerning inferences from soils chemistry data at the site, as well as observations for similar comparative work in the future:

(1) Correlation coefficients which have compared Ca and pH to organic matter, phosphorus to Ca, and pH to Ca are quite low, and little discernible relationship exists between them, from the perspective of defining related chemical phenomena.

(2) Phosphorus counts in ppm are extremely low throughout the site, even in areas of extensive cultural activities. Whether this is due to the intermittent hunting and gathering patterns of prehistoric peoples at the site (which apparently would produce less concentrated organic debris) or is the result of errors in sampling or interpretation cannot be determined at this time. The consistency of results tentatively suggests the former case;

TABLE 39. COMPARISON OF pH AND PHOSPHORUS IN SOIL SAMPLES FROM 41 BX 1 AND 41 BX 228

41 BX 1 (Lukowski n.d.)

Total Sample = 70

	Mean	Standard Deviation	Minimum	Maximum	Skewness
pH	8.27	0.15	8.0	8.5	-0.01
P	1.51	0.91	0.1	4.7	1.26

41 BX 228

Total Sample = 50 (unless otherwise noted)

	Mean	Standard Deviation	Minimum	Maximum	Skewness
pH	7.92	0.18	7.5	8.3	0.06
P	3.87	8.86	0.1	61.6	5.56
P*	5.84	12.06	0.1	64.0	3.53

*(114 cases)

Note: Both sample groups were processed by Archaeological Services, Inc., Stevenson, Maryland, 1980-1981.

it may be that soils chemistry samples, particularly phosphorus, must be interpreted on a regional basis rather than any other type of comparative perspective. That distinctive changes do occur in phosphorus values on an intrasite level at certain south-central Texas sites, however, is an encouraging discovery. Such an observation must be further substantiated by continued research at other sites.

(3) Soils chemistry samples from above, through, and below middens indicate little change in soils chemistry that can be attributed to the midden phenomena. This may be due to the burned rocks being simply an accumulation of stones rather than specific areas of food processing (the latter would be reflected by potentially higher concentrations of organic matter and phosphorus). Unknown natural causes, such as leaching, however, may have played a significant role in affecting these chemical deposits, the former interpretation must be considered highly speculative.

(4) Organic content and phosphorus determination offer the broadest methods for interpretations of cultural activities at the site; pH is considered to be more useful on a feature or individual sample-specific basis.

TABLE 40. CAMP BULLIS, COMPARATIVE SOILS DATA

	Mean			
	ph	Phosphorus*	Phosphorus in ppm¤	Organic Matter (9%)
41 BX 36 (6 samples)	8.3	523.0	265.00	1.30
41 BX 377 (9 samples)+	8.4	19.2	9.61	0.05
41 BX 428 (9 samples)	8.1	143.5	71.70	3.24

*in lbs. per acre
¤lbs. per acre conversion according to E. Ehrenhard (1978:24)
+"possible error in this level" (Gerstle, Kelly, and Assad 1978:219)

(5) For further studies, a systematic and controlled methodology must be used if any comparative work is envisioned. Duplicate as well as off-site control samples are recommended to supplement samples, and these control samples could be sent to at least two different soils analysts.

(6) For maximum potential, a systematic sampling grid independent of any area excavations is suggested, as well as the more usual feature or unit column sampling.

The value of soils chemistry at archaeological sites lies primarily in its high resolution ability to discern otherwise unidentifiable activity patterns across a site area. The operations at 41 BX 228 have shown that control, systematic consistency, and multiple samples are necessary elements not only in interpreting past intrasite activity distributions, but in contributing to a broader bank of comparative data for future work.

ADDITIONAL OBSERVATIONS ON SOILS CHEMISTRY DISTRIBUTIONS (Stephen L. Black)

During the final editing of this report in early 1984, the senior author took another look at the soils chemistry data and decided to take a somewhat different approach to analyzing the distributional patterns from that taken previously by McGraw. The following observations are based on a study of the data from Tables 37 and 38. For each element and/or measurement the mean values from the following site deposits are compared: topsoil (includes "above midden" samples), midden (Middens 1, 2, and 4 sampled), B-horizon (stratigraphic equivalent to midden in nonmidden areas), transition zone and

gravels. The numbers of samples from these deposits are comparatively small. Nonetheless, the mean values for most measurements show consistent stratigraphic trends. Samples from feature matrix samples are compared to the mean values from the deposit containing the features. Some definite patterns and anomalies can be correlated with several features and deposits. The differences in the soils chemistry measurements are for the most part, subtle rather than dramatic. Some correlation with cultural activities was documented.

Phosphorus

The statistical mean for phosphorus presented in Table 36 for both data sets is somewhat skewed by anomalous values from some of the topsoil samples. When Sample 30 (P=61.6) is removed from Data Set 1, the mean of the remaining 49 samples is only 2.69. Similarly, when the seven samples with P readings of over 20 are removed from Data Set 2, the remaining 107 samples have a mean of 3.00. These revised means are more useful for making intrasite comparisons.

Phosphorus distribution is negatively correlated with depth below the surface all across the site. The deposits had the following mean readings for phosphorus: gravels (total=13), 0.50; transition zone (total=10, includes "below Midden 2"), 0.40; midden (total=16), 1.61; B-horizon (total=8), 3.52; topsoil (total=22 including values over 16), 21.6; topsoil (total=15, without values over 16), 8.77.

It is interesting that the midden mean (1.61) is significantly lower than the mean from the B-horizon mean (3.25). The samples from these two deposits are roughly equivalent in depth below the surface.

Several of the feature matrix samples had anomalous phosphate readings in comparison with the surrounding deposit means. Feature 1 in Area A had a reading of 8.7 which is in line with the topsoil mean but 1.9 ppm higher than the highest value measured from Column #4 (Area A). Feature 2 in Area B had a reading of 13.4 which is higher than the topsoil and B-horizon means and 3.2 ppm higher than the highest reading from Column #3 (Area B). The four samples from the pit feature in Area M had a mean reading of 0.85 which is over twice as high as the mean of the transition zone. One final example of higher phosphorus values correlated with cultural features comes from Area F. Sample #41 was collected from an apparent rock cluster that was assumed to be the top of Midden 4. The phosphorus reading was 4.7 ppm which is noticeably higher than any other midden reading. This suggests that the Area F rock cluster may well have been a distinct culture feature placed atop the midden.

Thus, while the differences are subtle, several of the most discrete cultural features have noticeably higher phosphate readings than the surrounding deposits. All of these features are burned rock and charcoal stained clusters that are interpreted as cooking features. The two features interpreted as burned tree stumps, Feature 3 (Area B) and Feature 5 (Area C) had phosphate readings slightly higher than the deposit means but noticeably less than the features cited above. The two samples from Feature 8 (Area K)

have very low readings, however, there are no other comparable samples from Area K.

Organic Carbon

The organic carbon distribution was consistently correlated with depth. There is only meager evidence that organic carbon readings are significantly higher from the cultural feature matrices. The deposits had the following means: gravel (total=6), 1.25; transition zone (total=5), 2.1; midden (total=7), 4.37; B-horizon (total=8), 4.4; and topsoil (total=7), 6.34.

The only evidence of higher organic carbon readings from the features come from Areas F and M. The rock cluster in Area F (Sample #41) had a reading of 6.1 which is significantly higher than the midden and B-horizon means. Once again, this suggests this cluster was a discrete feature. In Area M, the pit feature samples (total=4) had a mean of 3.2 which is higher than the surrounding transition zone.

Calcium

The distribution of calcium is not as well correlated with depth as phosphate and organic carbon. The highest means were from the midden and B-horizon samples while the lowest mean was from the topsoil samples. The deposit means are as follows: gravel (total=6), 2787; transition zone (total=5), 2792; midden (total=7), 2807; B-horizon (total=8), 2810; and topsoil (total=7), 2738.

Several interesting correlations with cultural features were detected. The two samples from Feature 8 (Area K) had readings of 2910 and 2920, which is comparatively high. The pit fill samples (total=4) from Area M had a mean of 2950 which is distinctly higher than the surrounding transition zone or the overlying midden.

Calcium readings appeared to have some correlation with the different areas of the site. For example, the three major excavation areas in the northern site area, Areas A, B, and C, had respective column means of 2740 (Area A, total=4), 2644 (Area B, total=5), and 3008 (Area C, total=5).

pH

The distribution of pH is also correlated reasonably well with depth. The most acetic readings come from the topsoil samples, and the most basic readings come from the transition zone and gravel samples. The deposit means are as follows: gravels (total=6), 7.92; transition zone (total=5), 8.04; midden (total=7), 7.84; B-horizon (total=8), 7.88; and topsoil (total=7), 7.69.

Most of the cultural features have slightly more basic readings than the deposit means. The most distinct feature is the pit feature in Area M. The

four samples from the pit fill had a mean pH of 8.22 which is higher than the surrounding transition zone or the overlying midden.

RADIOCARBON DATES

A total of nine radiocarbon assays was obtained from 41 BX 228; six of these were recovered from charcoal samples obtained during the 1979 excavations, and three additional samples were previously collected during the 1977 testing operations. Data on all nine assays are presented below. Additional contextual information is presented in the following section of this report. All samples were processed by the Radiocarbon Laboratory at The University of Texas at Austin, identified by the prefix "TX." In parentheses beside the radiocarbon assays are indicated the MASCA "corrected dates" based on the calibration studies of Ralph, Michael, and Han (1973). A summary of these data are presented in Table 41.

1979 ASSAYS

TX-3854, 1030 ± 70 B.P.*; A.D. 920 (Corrected date: A.D. 980): This assay was obtained from a wood charcoal fragment ca. 11-16 cm below the surface in Area A, E1017 N1020, at an approximate elevation of 100.05-100.00. The sample was directly associated with a large burned rock feature (Feature 1). A concentration of prehistoric ceramic sherds and several arrow points was associated with this feature. Minor rootlet contamination was noted throughout the sample area. This date may be considered somewhat early for prehistoric ceramics and Scallorn projectile points.

TX-3856, 980 ± 60 B.P.; A.D. 970 (Corrected date: A.D. 1020): A charcoal sample associated with a baked clay feature (Feature 5) was the source of this assay. The sample was taken from Area A excavations, E1015.83 N1018.60, at an elevation of 98.31 m, approximately 31 cm below the surface. The baked clay feature is similar to Feature 3 (see TX-3855) and is interpreted as a burned tree stump. A fire-fractured Pedernales projectile point was found in physical association with this feature. The tree burning event obviously took place thousands of years after the Pedernales point was deposited.

TX-3852, 2660 ± 60 B.P.; 710 B.C. (Corrected date: 800 B.C.): This assay was obtained from a charcoal sample obtained from the center profile of a burned rock midden (Midden 2) exposed in BT 4, north wall, at a depth of 16-20 cm below the surface. While no significant artifacts were associated with this sample, Late Archaic and Late Prehistoric materials were found above the midden, and Early Archaic materials were recovered from below the accumulation. This date confirms that Midden 2 was in use during Local Period 7.

TX-3855, 1010 ± 150 B.P.; A.D. 940 (Corrected date: A.D. 1000): This composite sample was collected from Feature 3, a baked clay mass in Area B

*B.P.: before present. A.D. 1950 is used by radiocarbon laboratories in making the conversion to A.D./B.C. dates.

TABLE 41. SUMMARY OF RADIOCARBON DATA, 41 BX 228

Radiocarbon Laboratory Number	Uncorrected Date	A.D./B.C.	MASCA Corrected Date
TX-2810 (1977 assay)	480 ± 140 B.P.	A.D. 1470	A.D. 1420
TX-2811 (1977 assay)	940 ± 180 B.P.	A.D. 1010	A.D. 1050
TX-2812 (1977 assay)	1110 ± 110 B.P.	A.D. 840	A.D. 910
TX-3852 (1979 assay)	2660 ± 60 B.P.	710 B.C.	800 B.C.
TX-3853 (1979 assay)	4300 ± 130 B.P.	2350 B.C.	2920 B.C.
TX-3854 (1979 assay)	1030 ± 70 B.P.	A.D. 920	A.D. 980
TX-3855 (1979 assay)	1010 ± 150 B.P.	A.D. 940	A.D. 1000
TX-3856 (1979 assay)	980 ± 60 B.P.	A.D. 970	A.D. 1020
TX-3912 (1979 assay)	4720 ± 170 B.P.	2770 B.C.	3380 B.C.

excavations, E996.88 N1011.45, at an elevation of 99.34, approximately 25 cm below the surface. This date, like TX-3856 discussed previously, apparently dates activities within the upper cultural deposits at the site. Feature 3 is also interpreted as the remains of a burned tree stump.

TX-3853. 4300 ± 130 B.P.; 2350 B.C. (Corrected date: 2920 B.C.): This assay was obtained from charcoal collected from the lowest cultural level at Area C excavations, E1005.80 N1024.90, at an elevation of 98.92 m, approximately 58 cm below the surface.

TX-3912. 4720 ± 170 B.P.; 2770 B.C. (Corrected date: 3380 B.C.): A charcoal sample collected from Area I excavations, E994 N969, at an elevation of 98.60, approximately 84 cm below the surface, yielded this radiocarbon date. This assay was collected from a lower soil "transition" zone which contained Early Archaic (Local Period 5) diagnostic materials (refer to Excavation Area Descriptions and Interpretations section, Area I summary). While some contamination was noted within the level, the sample is considered a valid assay at one of the earliest cultural components recognized at the site.

1977 ASSAYS

TX-2810. 480 ± 140 B.P.; A.D. 1470 (Corrected date: A.D. 1420): This date was obtained from N100 W99 (1977 grid) at the center of the excavation from 10-20 cm below the surface. The charcoal sample was associated with Edwards,

Frio, and Montell projectile points (Late Prehistoric to Late Archaic artifacts).

TX-2811, 940 ± 180 B.P.; A.D. 1010 (Corrected date: A.D. 1050): This assay was obtained from a wood charcoal sample at N100 W99 near the center of the excavation, from a depth 10-30 cm below the surface. While no chronologically diagnostic artifacts were associated with this sample, other adjacent units indicate Late Archaic to Late Prehistoric artifact types.

TX-2812, 1110 ± 110 B.P.; A.D. 840 (Corrected date: A.D. 910): A charcoal sample collected at a depth of 20-30 cm below the surface in Unit N108 W104 was associated with a Frio projectile point. Because the Frio form appears to vary in age from central to southern Texas, this date will contribute to our understanding of the chronological sequence in the south-central Texas margins.

VIII. EXCAVATION AREA DESCRIPTIONS AND INTERPRETATIONS

Descriptions of each of the excavation areas as well as test pits that were not assigned an area designation are presented. Emphasis is placed on the major excavation areas (A, B, C, I, and M) where most of the field time was concentrated. Interareal comparisons and summaries of the occupational sequences are provided for the major excavation areas. Table 42 presents the excavation area and test pit totals of most artifact categories. Table 43 presents the debitage, burned rock, and bone weight totals and unit-level averages for the excavation areas and test pits. These tables provide a basis for a gross comparison of the excavation areas. Two atypical areas, Area K and Area M, are not included in these tabulations. A unit-level breakdown for major cultural material categories is presented in Appendix VI.

AREA A

Location: Area A was placed on a slight rise in the northern part of 41 BX 228 approximately 25 m east of the bluff edge. Figure 9,a shows the Area A excavations in progress.

Southwest Corner: E1015 N1018.

Area Size: 4 m (east-west) x 3 m (north-south).

Units: Twelve 1-m^2 excavation units.

Levels: 59 unit-levels.

Surface Elevations: 100.21-100.09.

Maximum Depth: 70 cm below the surface, 99.40, E1016 N1020.

Radiocarbon Assays: TX-3854, TX-3856.

TABLE 42. ARTIFACT TOTALS BY EXCAVATION AREA

Area	Total Unit-Levels	Arrow Points**	Dart Points**	Thick Bifaces	Thin Bifaces**	Cores	Unifaces	Perfo-rators	Distally Beveled Tools***	Ceramics
A	59	42 (21)	91 (59)	25	239 (52)	46	5	3	4	180
B	64	16 (5)	90 (68)	23	121 (31)	48	1	3	0	2
C	31	7 (2)	64 (41)	17	96 (25)	43	3	2	0	0
D	7	1 (1)	6 (4)	3	15 (5)	0	0	1	0	7
E	11	10 (4)	19 (10)	5	15 (3)	9	3	0	0	1
F	9	0	10 (5)	5	12 (3)	2	1	1	0	0
G	7	3 (1)	16 (11)	2	22 (6)	6	3	0	0	0
H	12	5 (3)	30 (19)	3	44 (6)	9	1	0	0	0
I	35	6 (4)	48 (30)	12	96 (22)	31	4	0	3	0
J	14	6 (4)	10 (6)	7	33 (11)	5	1	0	0	7
E1010 N950	5	0	2 (2)	1	2 (1)	2	0	0	0	0
E1010 N940	7	0	4 (1)	1	9 (0)	3	1	0	0	0
E1005 N929	8	1 (0)	7 (6)	1	17 (4)	1	1	0	0	0
E1020 N1029	1	1 (1)	2 (1)	0	10 (1)	0	0	0	0	0
E1020 N1024	3	2 (2)	4 (3)	0	5 (2)	2	0	0	0	4
TOTALS	273	100 (48)	403 (266)	105	736 (172)	207	24	10	7	201

*Does not include Areas K and M.
**Complete/identifiable specimen subtotals in parentheses.
***Includes only Groups 1-3.

TABLE 43. DEBITAGE, BURNED ROCK, AND BONE WEIGHT TOTALS BY EXCAVATION AREA*

Area	Total Unit-Levels	Total Debitage Weight (g)	Unit-Level Average	Total Burned Rock Weight (g)	Unit-Level Average	Total Bone Weight (g)	Unit-Level Average
A	59	52,216	885	2095.88	35.52	3430	58.14
B	64	43,013	672	1514.50	23.66	2988	46.69
C	31	34,899	1126	684.28	22.07	4021	129.71
D	7	4021	574	98.29	14.04	442	63.14
E	11	6890	626	171.35	15.58	524	47.64
F	9	3717	413	481.20	53.47	362	40.22
G	7	3971	567	160.08	22.87	109	15.57
H	12	11,300	942	283.10	23.59	534	44.50
I	35	24,726	706	583.68	16.68	2640	75.43
J	14	4405	315	1010.39	72.17	248	17.71
E1010 N950	5	1006	201	35.17	7.03	6	1.20
E1010 N940	7	2277	325	71.06	10.23	35	5.00
E1005 N929	8	3885	486	132.30	16.54	66	8.25
E1020 N1029	1	521	521	17.40	17.40	91	91.00
E1020 N1024	3	1905	635	124.64	41.55	123	41.00
TOTALS/AVERAGES	273	198,752	728	7463.86	27.34	15,619	57.21

*Does not include Area K and Area M.

Geomorphology and Soils: The surface of Area A was obscured by a layer of leaf litter roughly 10 cm in thickness. Beneath the leaf litter was a 5 to 10 cm thick layer of dark brown (almost black) topsoil containing scattered cultural materials. The topsoil graded into a lighter colored more compact gray brown loam (B-horizon). The B-horizon contained most of the cultural material recovered from Area A including a large amount of burned rock associated with Midden 4. In profile, the B-horizon and the midden matrix gradually became lighter in color and more compact with depth. The topsoil and B-horizon deposits in Area A evidenced numerous disturbances including extensive oak tree root systems, rodent burrows, and poorly defined areas that were noticeably less compact than surrounding deposits. These areas of loose soil probably represent filled-in animal burrows or other disturbances.

An unusual aspect of Area A was the occurrence of limestone bedrock boulders underlying the B-horizon. The upper surfaces of the boulders were encountered between 99.70-99.50 in several units. These boulders are part of the eroded bedrock remnant that accounts for the topographic rise on which Area A is located. Small pockets of culturally sterile gravels were found in crevices between several of the limestone boulders.

Cultural Materials: Table 44 summarizes the vertical distribution of select artifact types in Area A. The reader is reminded that Area A, like most of the excavation areas at 41 BX 228, was placed on a slight slope and that the first level ranged between 10 and 19 cm in thickness. Thus, two artifacts from the same elevation range may have been found at different depths below the surface. Nevertheless, it is readily apparent that the Area A deposits have been disturbed and are not stratified. In fact, Area A evidenced the greatest degree of mixing of chronologically sensitive artifacts of any excavation area. In comparison with other excavation areas and test pits, Area A had high frequencies of ceramics, arrow points, debitage, thin bifaces, and burned rock (Table 42). Area A had low frequencies of cores and about average frequencies of bone, dart points, and thick bifaces. Overall, the Area A deposits were very rich in cultural materials.

Area A was roughly bisected by the northwestern edge of Midden 4. The midden edge was irregular and difficult to detect in profile; however, much larger quantities of burned rock were recovered from the east half of Area A than the west half. The unit-levels associated with Midden 4 in Area A also had relatively high frequencies of debitage and other cultural materials.

Feature 1: Feature 1 was a distinct concentration of burned rock, charcoal, fragmented animal bone, and other cultural materials uncovered in the eastern half of Area A, 10 to 20 cm below the surface (Fig. 49,a). The feature was poorly defined on a horizontal basis and only partially exposed (continued into north, south, and east walls). The burned rock was concentrated in Units E1017 N1019 and E1018 N1019 and scattered across Units E1017 N1020, E1018 N1018, and E1017 N1018. The burned rocks lay in a single layer that ranged in elevation from 100.12 to 100.00 (top of highest rock to bottom of lowest rock). Charcoal was scattered throughout Feature 1 and concentrated between the rocks in the central feature area. A radiocarbon assay was obtained on wood charcoal from the central feature area (TX-3854, A.D. 980, MASCA calibrated).

TABLE 44. VERTICAL DISTRIBUTION OF SELECT CULTURAL MATERIALS--AREA A

Elevation	Ceramics	Perdiz (A1)	Edwards (A2:1)	Scallorn (A2:2)	Frio (D1:1)	Ensor (D1:2)	Fairland (D1:3)	Montell (D2:1)	Castroville (D2:2)	Pedernales (D3:1)	Langtry (D3:2)	Bulverde (D3:4)	Travis (D3:6)	Nolan (D3:7)	Kinney (D6:1)
100.20	177	1	4	7	2	3		3	3	4				3	1
100.00	3			4			1	1				1			
99.90		2	2						2	2			1		
99.80							1	1	2	5	1	1		2	
99.70										1	1		1		1
99.60								1							
99.50										1		1			
99.40															

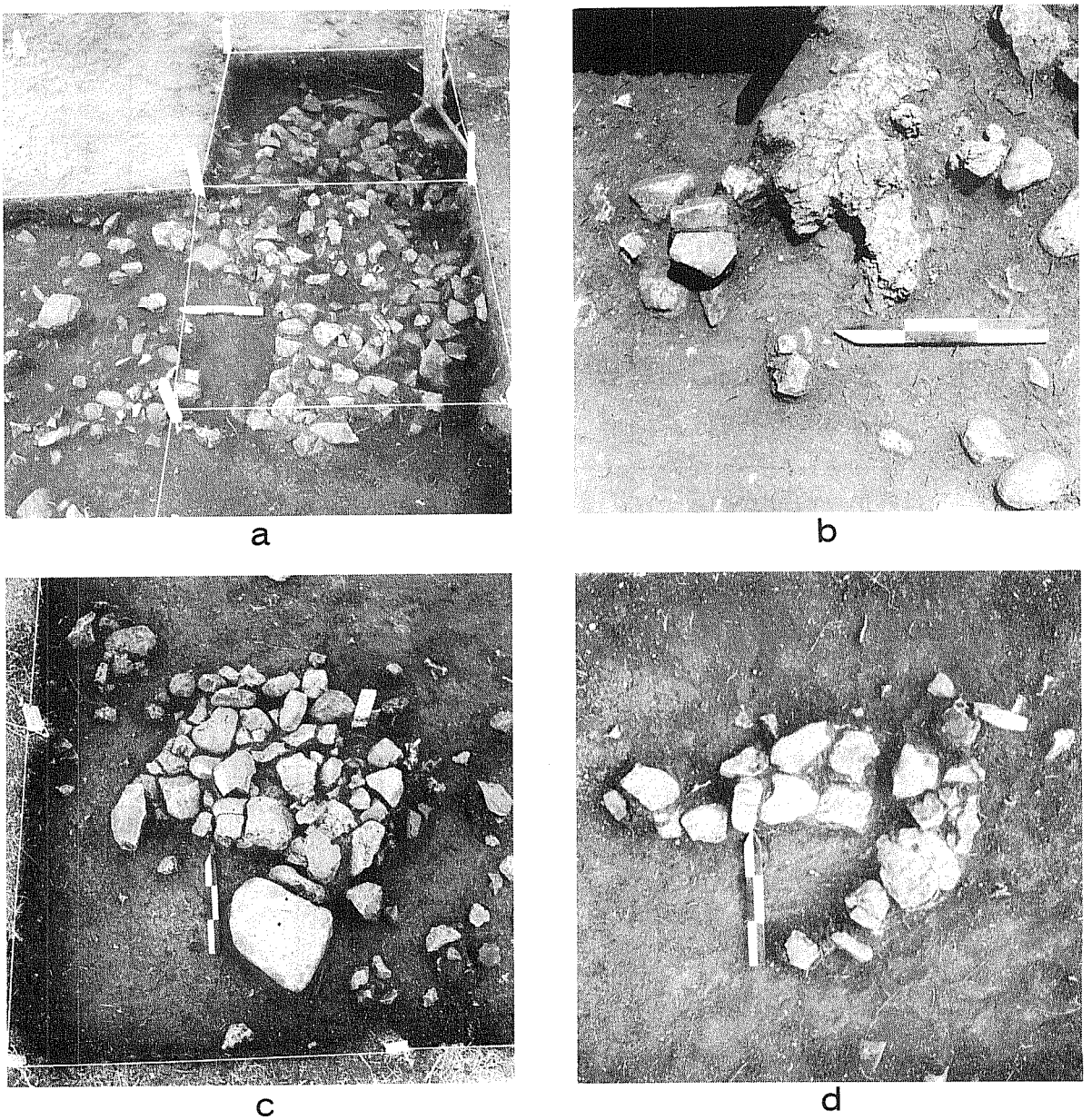


Figure 49. **Features.** a, Feature 1, partially exposed, Area A; b, Feature 3, Area B; c, Feature 2, upper rock layer, Area B; d, Feature 2, lower rock layer, Area B.

A wide variety of cultural materials was recovered from within, above, and adjacent to Feature 1 including several dart points known to date hundreds or thousands of years earlier in time. Most of the seemingly out of place dart points occur in the peripheral areas of the feature. The only chronologically sensitive artifacts that can be definitely associated with Feature 1 are the fragmented ceramic vessel shown in Figure 41 and a **Scallorn** arrow point found tightly wedged between two burned rocks in the central feature area. Other cultural materials believed to be associated with Feature 1 include several **Edwards** arrow points, a bison bone tool (Fig. 44,a), several cores, fragmented animal bone, fragmented mussel shell, and numerous broken thin bifaces. A wood charcoal fragment from Feature 1 was identified as oak. Several charred walnut hull fragments were recovered from adjacent to and just beneath Feature 1. The matrix sample from Feature 1 that was analyzed for soils chemistry had comparable measurements with the surrounding deposits except for phosphate. Feature 1 had the highest phosphate readings from Area A.

Feature 1 is interpreted as a scattered cooking feature and refuse accumulation. A formal hearth or roasting oven probably produced the burned rock and charcoal. This hypothesized feature was subsequently scattered, and the area was used for discarding various cultural materials. The resulting accumulation is a thin refuse deposit not unlike an Archaic burned rock midden except in size and associated artifact assemblage.

Feature 4: Feature 4, a concentration of burned rock, was uncovered in Units E1018 N1018 and E1017 N1018 between 99.95-99.85. The feature was never well defined due to the proximity of Feature 1 which overlay Feature 4 and due to the large amount of burned rock underlying and surrounding the feature that was later recognized as the edge of Midden 4. Feature definition was also complicated by the fact that Feature 4 continued into the south wall of Area A. In retrospect, Feature 4 may simply have been a poorly defined cluster of burned rock within Midden 4 that was partially an artifact of the arbitrary level excavation sequence.

Feature 5: Feature 5 consisted of a concentration of intensively baked clay and charcoal uncovered within an area measuring roughly 60 cm (north-south) by 40 cm (east-west). Feature 5 was centered just west of grid point E1016 N1019 and ranged in elevation from 99.91 to 99.74. The baked clay was buff colored with reddened fringes. Several intact pieces of charred wood were found directly beneath the baked clay. The soil matrix around the feature was stained orange as were several isolated patches 20-40 cm away from the central clay mass. The feature shape was rather amorphous, although the central clay mass had several smooth semicircular indentations. A fire-fractured **Pedernales** dart point was found in direct association with the main clay mass. Several burned rocks were found around the feature but may not have been directly associated. A radiocarbon assay (TX-3856) was determined from Feature 5 charcoal (A.D. 1020, MASCA calibrated).

Feature 5 is interpreted as the remains of the lower portion of a burned tree stump. The dead tree was apparently burned during the Late Prehistoric (Local Period 10) occupation in the Area A vicinity. The ground surface elevation at the time of burning would have been about 100.00 (Feature 1).

The roots of the tree stump burned long and hot enough to bake the clay-rich soil adhering to the roots. Modern examples of similar phenomena are common in recently cleared areas of the Gulf Coastal Plain in south Texas (Black 1978:28). This interpretation would explain the shape and composition of Feature 5, the vertical orientation of the feature, and the discrepancy between the radiocarbon assay and the stratigraphic position of the burned **Pedernales** point.

Occupational Sequence: Area A was an eroded limestone knoll on the edge of the gravel terrace adjacent to Panther Springs Creek during the initial Local Period 5 occupation of 41 BX 228. Little or no cultural material was deposited in the Area A vicinity during this time. Some time later, probably during Local Period 6, burned rock accumulation began just north of Area A (Midden 4). Fires may have been built directly on the limestone boulders during this time as some boulders show evidence of burning. As the midden grew in size, a layer of burned rock and midden soil built up over Area A covering the limestone boulders. The lower levels of Area A contained large quantities of rock but only moderate quantities of other types of cultural materials.

Most of the midden accumulation at Area A took place during Local Periods 7 and 8. During these occupational periods Area A was located on the edge of Midden 4. The nature of the midden accumulation changed somewhat in the upper portions of the midden as much larger quantities of refuse other than rock were noted. Animal bone, chert debitage, and many broken and unfinished chert tools were deposited along with the burned rock in the Area A vicinity. The process of midden formation ended with Local Period 8 in Area A. Artifacts attributable to Local Period 9 are much less numerous in comparison with the preceding or succeeding occupations in Area A. The Local Period 9 artifacts mostly occur in the disturbed deposits above the midden layers.

Perhaps the most intensive occupation in Area A took place during Local Period 10 between roughly A.D. 900 to 1100. The Local Period 10 occupation added large quantities of debitage, thin biface fragments, broken animal bone, fire-fractured chert, and other cultural materials to the Area A deposits. A large concentration of burned rock, charcoal, and other refuse (Feature 1) was left behind. A dead tree was set on fire and burned for several days (Feature 5). Charred walnuts, broken animal bone, a bison bone tool, and fragmented mussel shell give evidence of the varied subsistence techniques employed during the Local Period 10 occupation in the Area A vicinity.

The occurrence of a broken, poorly made cylindrical jar from Local Period 10 contexts in Area A is of particular interest. The A.D. 980 date from Feature 1 is the earliest documented occurrence of ceramics in south-central Texas. If this date is correctly associated with the ceramic jar, the people who camped in and around Area A were one of the first groups in southern or central Texas to use ceramics. The vessel is much thicker and cruder than the other ceramic groups from the site, and the bone-tempered pottery in the region lends support to the interpretation that it is one of the earliest examples of ceramics in the region.

AREA B

Location: Area B was placed near the bluff edge in the northern part of the site.

Southwest Corner: E996 N1008.

Area Size: 4 m (north-south) x 3 m (east-west); the northeast corner unit was not excavated.

Units: Eleven 1-m^2 excavation units.

Levels: 64 unit-levels.

Surface Elevations: The surface sloped from a high of 99.72 in the southeast corner of Area B to a low of 99.59 in the northwest corner.

Maximum Depth: Unit E996 N1008 was excavated to 98.73, 92 cm below the surface. The other units were excavated to 99.10.

Radiocarbon Assays: TX-3855.

Geomorphology and Soils: Area B, like most areas at 41 BX 228, lacked well-defined soil layers. The upper 25-35 cm consisted of a dark gray brown silty loam that gradually became less organic (lighter in color) and more clayey with depth. From 30-55 cm below the surface the soil was a lighter brown compact clayey loam that gradually became lighter in color with depth. At 50-55 cm below the surface small calcareous gravels began appearing. The underlying gravel terrace deposits were encountered at 60 cm below the surface. These gravels appeared orange in color and were at least 40 cm in thickness. Most of the cultural material in Area B was recovered from the upper 50 cm. Occasional flakes were noted in the upper few centimeters of the gravel deposits. Rodent burrows and root disturbances were noted in Area B but were less common than in Area A. One deep pit outline was observed in the west wall profile of Unit E996 N1009. This pit may be related to a disturbed burial as will be discussed below.

Cultural Materials: Table 45 shows the vertical distribution of select projectile point types in Area B. This distribution evidences considerable disturbance; however, the stratigraphic trends are much better defined than in Area A. In comparison with other excavation areas and units at 41 BX 228, Area B had about average overall frequencies of debitage, burned rock, bone, thick bifaces, and dart points but below average frequencies of arrow points, thin bifaces, and cores. Area B lies within the northwestern margin of Midden 3. Midden 3 was about 30 cm in thickness and occurred between 99.50 and 99.20 in the southeast corner of Area B and between 99.40 and 99.10 in the northwest corner. Associated with the midden deposits were high frequencies of bone, debitage, cores, dart points, and bifaces. The above midden deposits, by comparison, had much lower bone, debitage, and burned rock frequencies.

TABLE 45. VERTICAL DISTRIBUTION OF SELECT PROJECTILE POINT TYPES--AREA B

Elevation	Perdiz (A1)	Edwards (A2:1)	Scallorn (A2:2)	Frio (D1:1)	Ensor (D1:2)	(D1:4)	Montell (D2:1)	Castroville (D2:2)	Williams (D2:5)	Pedernales (D3:1)	Langtry (D3:2)	Bulverde (D3:4)	Nolan (D3:7)	(D3:9)	(D6:3)
99.70															
99.60				1											
99.50	1		3	1		1	2	2	1	1		1			
99.40		1		3	3		4	1	2	1		1		2	
99.30				2	2		8	2	1	3					
99.20						1	4	2		2	1		1		3
99.10								1	1				1		

A partial human maxilla was recovered from E996 N1008, Level 4. No other human bone was recovered despite a careful search. The maxilla showed no burning or butchering marks. As mentioned, the outline of a deep pit was observed in the west wall of the adjacent unit (E996 N1009). It is suggested that the maxilla represents a disturbed burial located to the west of the excavation unit. This area was partially tested in May 1980 when a group of volunteers returned to the site. Unfortunately, looters had disturbed the area between the end of the field season and the return visit. No additional indication of a human burial was observed in this disturbed area. Various unconfirmed rumors have been circulated about the recovery of another burial from the site by looters in 1981 or 1982.

Feature 2: Feature 2 was a distinct double-layered cluster of burned limestone cobbles associated with a limestone grinding boulder. Feature 2 was uncovered between 99.66 and 99.50 in Units E997 N1009 and E997 N1010. The upper layer of rock (Fig. 49,c) measured approximately one meter in diameter and was circular in shape, while the lower layer (Fig. 49,d) was much smaller and irregular in shape. Most of the rocks in the upper layer ranged between 15-20 cm in diameter and were not as severely heat fractured as the average burned rock fragment in the upper deposits. Bone fragments, charcoal, debitage, and chert tools were recovered from in and around Feature 2 but not in particularly high frequencies. No chronologically sensitive artifacts were found in close association with the feature. The amount of charcoal recovered from the feature was not adequate for a radiocarbon assay. A soils chemistry analysis of a matrix sample from the feature showed significantly higher levels of phosphate were present in comparison with other Area B samples.

Feature 2 is interpreted as a cooking and plant processing station that remained exposed on the surface long enough to weather away most of the charcoal, ash, and botanical remains that must have been present. Based on the stratigraphic position, Feature 2 can most likely be attributed to the Local Period 10 occupation.

Feature 3: Feature 3 was an irregular cluster of baked clay, charcoal, and discolored soil uncovered near grid point E997 N1011. Feature 3 is similar to Feature 5 in Area A except that it is better preserved. Orange to reddish soil was first observed at approximately 99.52 in the southwest corner of Unit E997 N1011 and the northeast corner of Unit E996 N1010. The base of Feature 3 was not reached until 99.33. Figure 49,b shows the feature partially exposed in Unit E997 N1011. The central clay mass was well fired and appeared orange to red in color. Several "fingers" of baked clay protruded out and sloped down from the main mass. As the feature was excavated, a circular depression some 14 cm in diameter was exposed within the main clay mass. The depression tapered inward with depth and was revealed to be a hole through the main mass. The hole was filled with loose reddish-colored soil. The baked clay edge of the hole was smooth and fired very hard. Comparatively large quantities of charcoal were recovered from in and around Feature 3. Some of the charcoal from the lower part of the feature was incompletely carbonized. A radiocarbon assay (TX-3855) was determined from Feature 3 charcoal (A.D. 1000, MASCA calibrated).

Feature 3 is interpreted as the remains of a burned tree stump. The tapered hole appears to be a root cast formed when the burning stump fired the clay adhering to the outside of one of the roots. The baked clay matrix contained snail and bone fragments, flint flakes, and a heat-fractured **Ensor** dart point. These items are suggested to be soil constituents accidentally fired by the burning stump. The incompletely carbonized charcoal from the lower feature area probably resulted from a lack of oxygen as the stump roots burned below the ground.

Occupational Sequence: Cultural materials were first deposited in Area B during Local Period 6 when burned rock accumulation began at Midden 3. The midden was centered some five meters southeast of Area B. As Midden 3 grew in size a layer of rock built up over the slightly sloping surface of the gravel terrace deposit. Small quantities of debitage and a few chert tools were mixed with the burned rock in the lower layers of Midden 3 during Local Period 6. Midden accumulation continued during Local Period 7 in the Area B vicinity. Based on the relative frequencies of dart point types in Area B, the Local Periods 6 and 7 occupations were not as intensive in comparison to the succeeding period. Local Period 8 dart point types (particularly **Montell**) account for almost 50% of all projectile points recovered from Area B. During Local Period 8 thousands of chert flakes and chips as well as many broken dart points, bifaces, and bones were added to the burned rock accumulation. Area B may have been the actual scene of the extensive flintknapping activities suggested by the cultural materials. Alternatively, Area B may simply have been the dumping ground for refuse relating to activities carried out nearby.

Frio and **Ensor** points were found mixed in the upper layers of Midden 3 in Area B. This suggests that midden accumulation may not have ended in Area B until Local Period 9. Local Period 9 is the second most intensive occupation in Area B as evidenced by the comparatively large quantities of debitage, burned rock, and other cultural materials associated with the upper midden deposits. Local Period 9 dart points make up 18% of all projectile points recovered from Area B.

The last major occupation at Area B occurred during Local Period 10. At this time Feature 2, a cooking and plant processing station, was built in Area B. At about the same point in time, a dead tree stump (Feature 3) was set on fire and burned for several days. Interestingly, a similar event also occurred in Area A (Feature 5) during Local Period 10. Based on the cultural material frequencies, the Local Period 10 occupation in Area B was less intense than the preceding two periods. The only definite trace of the final occupational period (Local Period 11) in Area B was a single **Perdiz** arrow point and two small sherds.

AREA C

Location: Area C was placed between and north of Areas A and B.

Southwest Corner: E1005 N1022.

Area Size: 3 m (north-south) x 2 m (east-west).

Units: Six 1-m^2 excavation units.

Levels: 31 unit-levels.

Surface Elevations: The surface sloped from a high of 99.63 in the southeast corner of Area C to a low of 99.46 in the northwest corner.

Maximum Depth: 56 cm below the surface, 98.90 in Unit E1005 N1024.

Radiocarbon Assays: TX-3853.

Geomorphology and Soils: The Area C deposits were capped by a thin layer of dark brown (almost black) topsoil that contained comparatively little cultural material. The deposits gradually increased in compaction and became lighter in color from 5 to 35 cm below the surface within the B-horizon. The B-horizon was a gray brown silty loam that was very rich in cultural materials. Below 35 cm the B-horizon was noticeably lighter in color and contained small gravels. An undulating gravel and cobble surface approximately 50 cm below the ground surface underlay the soil deposits in Area C. This gravel and cobble surface was unlike the upper terrace deposits in other areas of the site in that many comparatively large chert and limestone cobbles were present. Cultural material was found mixed within the upper part of the gravel-cobble deposit. The large size of the gravels (cobbles) suggests that this is a traction load deposit of Panther Springs Creek during high energy flooding. This occurred prior to any known occupation of the site area, perhaps during the Late Pleistocene.

Cultural Materials: Table 46 shows the vertical distribution of select projectile point types in Area C. This distribution is somewhat skewed by the topographic slope across Area C, nonetheless, it is apparent that the Area C deposits were disturbed (i.e., not well stratified) like most of the deposits at 41 BX 228. The Area C deposits were very rich in cultural materials. In comparison with other excavation areas and units at 41 BX 228, Area C had very high overall frequencies of bone (25% by weight of all excavated bone from the site), debitage, thin bifaces, cores, thick bifaces, and dart points; average frequencies of burned rock; and low frequencies of arrow points, and no ceramics.

As noted above, large quantities of animal bone were recovered from Area C. Over 100 faunal elements were identified including: deer (58% of the identified elements), bison (24%), cottontail rabbit (5%), turtle (5%), unidentified bird (2%), raccoon (1%), antelope (1%), jackrabbit (1%), rat (1%), and unidentified Canis (1%). The deer and bison elements occurred throughout the Area C deposits but were concentrated between 99.40-99.10 (Levels 2-4). The concentration of bone coincided with burned rock concentrations including Features 6 and 7.

Feature 6: Feature 6 consisted of a discrete concentration of burned rocks uncovered between 99.30 and 99.15. Feature 6 was roughly circular in shape (maximum diameter 106 cm) and was centered in Unit E1005 N1024. The larger

TABLE 46. VERTICAL DISTRIBUTION OF SELECT PROJECTILE POINT TYPES--AREA C

Elevation	Perdiz (A1)	Scallorn (A2:2)	Frio (D1:1)	Montell (D2:1)	Castroville (D2:2)	Marshall (D2:3)	Pedernales (D3:1)	Langtry (D3:2)	(D3:3)	Bulverde (D3:4)	Travis (D3:6)	Pandale (D3:10)	Martindale (D4:3)	Carrizo (D6:2)	(D6:3)
99.60															
99.50							1								
99.40	1	1	2	2		1	3								
99.30			3	2			3				1		1		
99.20				3	1	1	2	1		1		1			
99.10					1		4		1	1				1	1
99.00										1					

rocks within the feature were arranged in a single layer. A few smaller rocks were found above and below the main layer. The feature matrix appeared similar to the surrounding soil deposits and did not contain significant quantities of charcoal. The soils chemistry sample from the upper fill matrix of Feature 6 had similar readings to the surrounding deposits in all categories. Debitage, biface fragments, and bone splinters were found in and around the feature in somewhat lesser amounts than in the surrounding deposits. The absence of charcoal and associated chronologically sensitive artifacts makes it difficult to date Feature 6. Based on stratigraphic position, either a Local Period 7 or 8 occupational association is possible. Feature 6 is interpreted as a hearth that was exposed on the surface long enough for most of the charcoal and ash to weather away.

Feature 7: Feature 7 was a poorly defined irregular cluster of burned rock exposed in Units E1006 N1022 and E1006 N1027 between 99.50-99.30. The rock from the feature was observed to be tightly packed, suggesting intentional placement. Relatively high frequencies of debitage, dart points, thick biface fragments, and burned bone were recovered from within the feature as well as from the surrounding deposits. Although charcoal flecks were observed within the rock concentration, no significant quantities were recovered.

As the excavations in Area C progressed, it became obvious that rather than being a discrete cluster, Feature 7 was merely a concentrated rock and debris deposit within a much wider layer of burned rock. A burned rock midden was not defined in the vicinity of Area C, however, a layer of rock roughly 20 cm thick was recorded in all units in Area C between 20 and 45 cm below the surface. In retrospect, Area C probably lies on the edge of an undefined buried burned rock midden. Feature 7 is interpreted as a concentration within this undefined midden. Feature 7 may represent a single episode of burned rock and refuse dumping on the edge of the posited midden.

Occupational Sequence: The first cultural materials deposited in Area C occur in the upper layer of the underlying gravel-cobble terrace deposits. Charcoal collected from Unit E1005 N1024 at 98.92 was radiocarbon assayed at 2920 B.C. (TX-3853, MASCA calibrated). This date is believed to represent the initial Local Period 6 occupation in Area C. Comparatively low frequencies of cultural material were deposited in Area C during Local Period 6. One intriguing aspect of the Local Period 6 occupation is the occurrence of a charred acorn in E1005 N1024, Level 5. Based on the stratigraphic position relative to the radiocarbon date, it is estimated that the charred acorn dates to before 2000 B.C. This is considered very significant due to the fact that burned rock midden accumulation begins in Local Period 6 at 41 BX 228 and, as discussed later in this report, may well be related to acorn processing.

Occupational intensity in Area C was very high during the subsequent Local Periods 7 and 8. Large quantities of bone, debitage, burned rock, dart points, cores, and bifaces were deposited across Area C. Local Periods 7 and 8 occupations in Area C cannot be stratigraphically separated, hence, they are considered as a single occupational zone. This zone contained unusually large quantities of butchered deer and bison bone as well as burned rock.

Features 6 and 7 occur within this intensive zone. As mentioned above, Area C appears to lie within the edge of an undefined midden centered to the northwest of Area C. The variety of materials associated with the posited midden deposit and the Local Periods 7 and 8 occupational zone suggests that many types of activities took place in Area C or nearby, such as flint-knapping, tool refitting, deer and bison butchering, plant processing, cooking (Feature 6), and refuse dumping (Feature 7).

The occupation associated with Local Period 9 appears to lie above most of the intensive zone discussed above. Based on the relative frequency of chronologically sensitive point types, Local Period 9 occupation contributed comparatively little cultural material to the Area C deposits. The Late Prehistoric occupations contributed even less as Local Periods 10 and 11 are each represented by only a single arrow point.

AREA D

Location: Area D was placed between and east of Areas B and M in the central area of the site about 18 m east of the bluff edge.

Southwest Corner: E1004 N987.

Area Size: 1-m^2.

Levels: 7 unit-levels.

Surface Elevation: 99.68.

Maximum Depth: 99.00.

Geomorphology and Soils: Area D had a comparatively deep soil profile with little obvious evidence of disturbance. A thin topsoil layer was underlain by a thick B-horizon that gradually changed from a dark gray brown to a red-colored clay loam by 99.15. Beneath the clay loam was the typical gravel terrace deposit containing little or no cultural material.

Cultural Materials: Area D had moderate to low frequencies of cultural materials. Seven sherds and an unidentified arrow point were recovered from Levels 1 and 2. Two dart points (D1:4 and D1:10) were found in Levels 3 and 4 and were associated with moderately high frequencies of burned rock and debitage. The most intensive occupation zone sampled in Area D occurred in the lower half of Level 5 and in Level 6. Several Local Period 6 dart points (Nolan and D3:5) were associated with a debitage concentration, a perforator made on a Nolan point and several thin biface fragments. Little cultural material was recovered below Level 6. No cultural features were recorded in Area D.

AREA E

Location: Area E was placed about five meters northeast of Area C in the northern end of the site.

Southwest Corner: E1010 N1028.

Area Size: 2 m x 2 m - 1 m^2.

Units: Three 1-m^2 units. Area E was originally staked out as a 2 m^2; only Unit E1010 N1029 was excavated below Level 2.

Levels: 11 unit-levels.

Surface Elevations: 99.61-99.54.

Maximum Depth: 84 cm below the surface, 98.70.

Geomorphology and Soils: Area E had a thin topsoil and a very deep, well-developed B-horizon. The dark brown friable loam present in the upper levels gradually became lighter in color and more compact as depth and clay content increased. Gravel deposits were encountered in the lowest level (98.80-98.70). A number of animal burrows and major root disturbances were noted in the upper four levels.

Cultural Materials: Area E had moderate frequencies of most cultural materials. Debitage and burned rock frequencies increased with depth to very high peaks in Level 4 followed by a gradual decrease through Level 8. Level 4 serves as a stratigraphic break for Area E. Levels 1-3 were very disturbed and contained stratigraphically mixed ceramics, arrow points (**Perdiz**), and dart points (**Frio, Ensor, Castroville, Pedernales,** and **Marshall**). Levels 5 and 6 appeared little disturbed and contained **Pedernales** (Level 5) and **Travis** (Level 6) dart points along with several dart point fragments. The layer of burned rock and debitage in Level 4 may be related to the edge of the posited unidentified midden north of Area C. No cultural features were recorded in Area E.

AREA F

Location: Area F was placed about 10 m southeast of Area A on the southern slope of the topographic rise in the northeast part of the site.

Southwest Corner: E1022 N1008.

Area Size: 1 m^2.

Levels: 9 unit-levels.

Surface Elevation: 100.13.

Maximum Depth: 93 cm below the surface, 99.20.

Geomorphology and Soils: Area F was placed near the center of Midden 4, hence, the soil profile was dominated by a massive accumulation of burned rock. Above the midden the soil was a very dark gray brown loam. The midden matrix was slightly lighter in color (more calcareous). Gravels began appearing at 99.40. By 99.30, the excavation was within the orange-colored gravel terrace deposits. Several disturbances were noted in the upper levels.

Cultural Materials: Midden 4 was encountered in Level 2 and continued until Level 8. Debitage and tool fragments were numerous above the midden and in the upper midden levels. Below Level 3 debitage and artifact recovery was very low. A few identifiable dart points were recovered from Levels 2-4, but these were obviously displaced (Level 2, **Nolan**; Level 3, **Frio** and **Marcos**; Level 4, D3:5).

Cultural Features: One possible feature was recorded. A cluster of burned rock was exposed in Level 2. The apparent cluster covered the eastern two-thirds of the unit and was underlain by burned rock Midden 4. It was believed that this cluster was merely the upper surface of the midden, hence, it was not assigned a feature number. A matrix sample collected from the most concentrated area of the cluster was analyzed for soils chemistry (sample 41). The resulting data showed higher readings for phosphate and organic carbon than other samples from Midden 4. This suggests that the cluster may represent a discrete deposit placed upon the upper surface of the midden. The lack of charcoal or chronologically sensitive artifacts in association with this possible feature hampers dating. Based on the stratigraphic position, a Local Period 10 placement is most likely.

AREA G

Location: Area G was placed about seven meters southeast of Area F in the north-central site area.

Southwest Corner: E1015 N1004.

Area Size: 1 m^2.

Levels: 7 unit-levels.

Surface Elevation: 99.96.

Maximum Depth: 66 cm below the surface, 99.30.

Geomorphology and Soils: Area G had a typical soil profile: a thin dark topsoil, a thick B-horizon, and a gravel terrace deposit encountered at approximately 99.40. No obvious disturbances were noted.

Cultural Materials: Two occupation horizons or zones were sampled by Area G. The upper three levels had moderate frequencies of cultural materials and a mixture of projectile points attributable to Local Periods 7-11. Levels 5 and 6 had high frequencies of burned rock and debitage associated with

numerous Local Period 6 dart points (**Nolan** [two], **Travis**, **Bulverde**, and D3:9). The Local Period 6 occupation zone at Area G may represent the southern edge of Midden 4 which was begun during this time. No features were recorded in Area G.

AREA H

Location: Area H was placed about eight meters east of the bluff edge in the southern part of the site.

Southwest Corner: E999 N963.

Area Size: 1 m^2 and 2 m^2. The former was excavated completely while the latter was terminated in Level 4 due to time restraints.

Levels: E999 N963, Levels 1-8; E1000 N963, Levels 1-4.

Surface Elevations: 99.28-99.26.

Maximum Depth: 76 cm below the surface, 99.50.

Geomorphology and Soils: The upper 55 cm of the Area H deposits had a gray brown clay loam that gradually became more compact and lighter in color with depth. A transition zone deposit of compact light reddish brown clay occurred between 99.80 and 99.60. The lower transition zone was mixed with gravels from the underlying terrace deposits. The 98.60 excavation floor showed several pockets of silty soil within the gravel deposits. These pockets probably represent erosional features on the gravel terrace surface.

Cultural Materials: The Area H deposits had relatively low frequencies of cultural materials. The upper deposits were stratigraphically mixed. A variety of Late Prehistoric and Archaic projectile points were recovered from the upper four levels including: **Edwards**, **Scallorn**, **Frio**, **Ensor**, **Castroville**, **Marcos**, **Pedernales**, **Langtry**, **La Jita**, and **Nolan**. In the lower part of Level 5 and in Level 6 an increase in debitage occurred along with numerous thin biface and dart point fragments. This apparent flintknapping activity area was associated with a **La Jita** and a **Martindale** point (Local Periods 5 and 6). In Level 7 a fragment of a **Guadalupe** tool was found in one of the silt pockets surrounded by gravel.

Features: Two cultural features were recorded in Area H; neither was assigned a feature number. The upper feature was a cluster of large limestone cobbles that continued into the north and west walls of E996 N999, Level 3. This feature was partially bisected by BT 3 and had a shallow basin appearance in profile. No chronologically sensitive artifacts or charcoal samples were recovered from this feature. The second feature was a baked clay cluster that was partially exposed in the northeast corner of E996 N999 in Level 4. Although only a small portion of the baked clay feature was uncovered, it appeared similar to Features 3 and 5 in Areas B and A, respectively.

AREA I

Location: Area I was placed between Area M and Area H in the southern part of the site about six meters east of the bluff edge.

Southwest Corner: E994 N968.

Area Size: 2 m^2.

Units: Four 1-m^2 units.

Levels: 35 unit-levels.

Surface Elevations: 99.36-99.31.

Maximum Depth: 96 cm below the surface, 98.40.

Radiocarbon Assays: TX-3912.

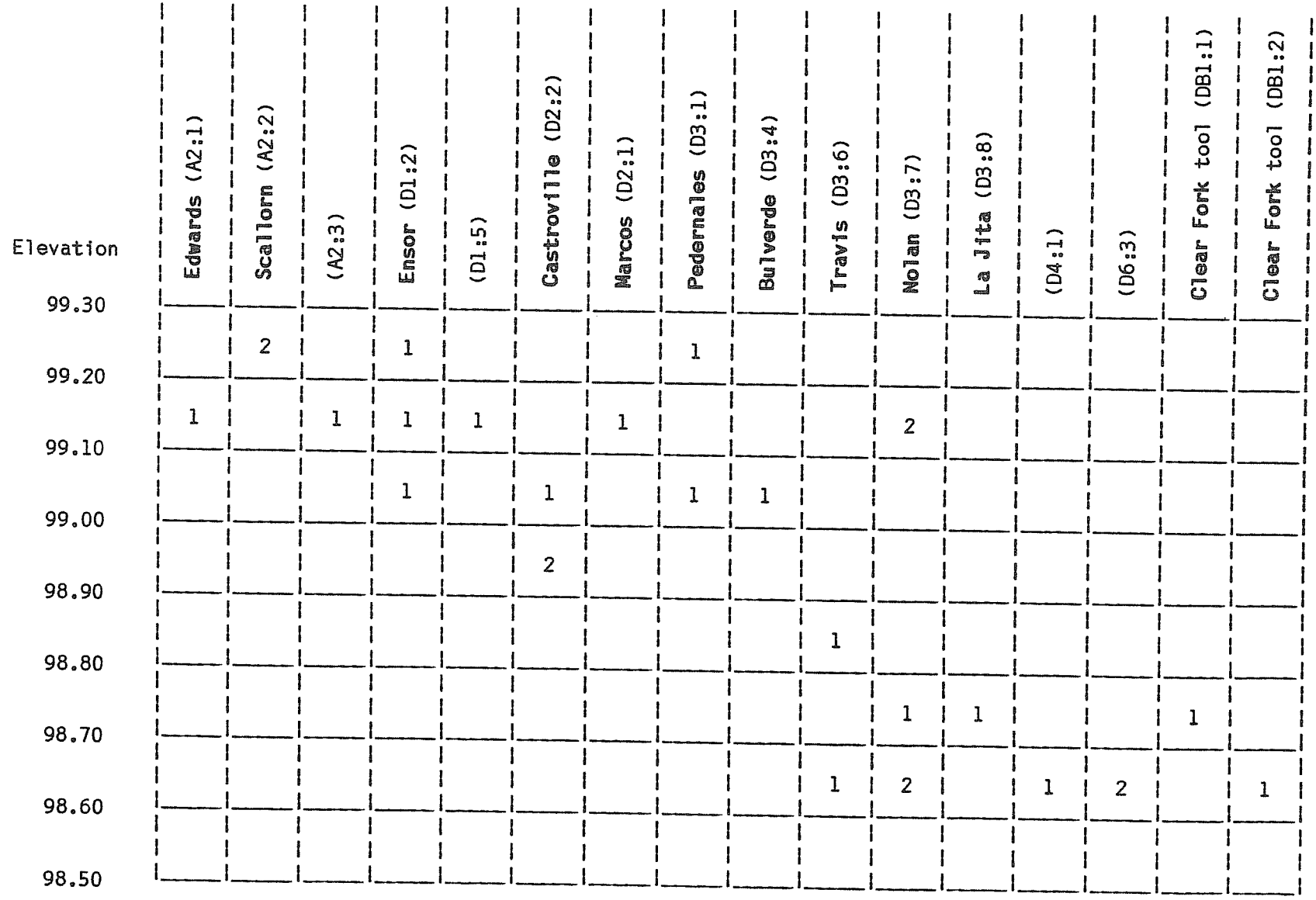
Geomorphology and Soils: Area I had one of the deepest soil profiles at the site. The deposits consisted of a thin dark topsoil, a thick B-horizon gray brown clay loam that gradually became more compact and lighter in color with depth, a transition zone, and the underlying gravels. Of particular interest is the transition zone which occurred between 98.80 and 98.50. This zone is part of the isolated deposit excavated in Area M which contained the earliest component at 41 BX 228.

Cultural Materials: The deposits in Area I were relatively rich in cultural materials and were better stratified than most deposits at the site. In comparison with overall frequencies across the site, Area I had very high quantities of animal bone and average quantities of debitage, dart points, and thin bifaces. The frequencies of cores, thick bifaces, burned rock, and arrow points were somewhat low by comparison.

Burned rock and debitage quantities generally covaried throughout the Area I deposits, however, several interesting anomalies were recorded. In all units except E995 N969 a substantial increase in burned rock occurred between 99.20 and 99.10, however, the two southernmost units did not have a corresponding increase in debitage. Area I lies on the edge of Midden 2, which may explain the burned rock increase. A similar anomaly was observed in Unit E995 N969 between 99.00 and 98.90 where a large increase in burned rock occurred with a substantial decrease in debitage. These variations probably reflect localized activity areas or discard piles partially sampled by the excavation units.

Table 47 shows the vertical distribution of select artifact types in Area I. The upper deposits contained artifacts from Local Periods 7-10. Below 98.90, only Local Periods 5 and 6 artifacts were recovered. A radiocarbon assay was determined from charcoal collected in Unit E994 N969 at 98.52 just above the gravel deposits (TX-3912; 3380 B.C., MASCA calibrated). This is the earliest radiocarbon date from 41 BX 228 and provides a chronological estimate of the Local Period 5 occupation. No cultural features were recorded in Area I.

TABLE 47. VERTICAL DISTRIBUTION OF SELECT ARTIFACT TYPES--AREA I



Elevation	Edwards (A2:1)	Scallorn (A2:2)	(A2:3)	Ensor (D1:2)	(D1:5)	Castroville (D2:2)	Marcos (D2:1)	Pedernales (D3:1)	Bulverde (D3:4)	Travis (D3:6)	Nolan (D3:7)	La Jita (D3:8)	(D4:1)	(D6:3)	Clear Fork tool (DB1:1)	Clear Fork tool (DB1:2)
99.30																
99.20		2		1				1								
99.10	1		1	1	1		1				2					
99.00				1		1		1	1							
98.90						2										
98.80										1						
98.70											1	1			1	
98.60										1	2		1	2		1
98.50																

AREA J

Location: Area J was adjacent to Area M in the southern part of the site about eight meters east of the bluff edge.

Southwest Corner: E994 N974.

Area Size: 1 m x 2 m.

Units: Two 1-m^2 units.

Levels: 14 unit-levels.

Surface Elevations: 99.54-99.53.

Maximum Depth: 114 cm below the surface, 98.40.

Geomorphology and Soils: Area J had the deepest profile at the site due to its location near the center of Midden 2. A thick topsoil layer covered the top of the midden. The midden began about 99.35 and continued uninterrupted until 98.70. The midden matrix was dark gray in color and gradually became lighter in color and more compact near the bottom of the midden. A 20 cm thick transition zone occurred beneath the midden and on top of the underlying gravel terrace deposit that was encountered at about 98.50.

Cultural Materials: The Area J deposits can be divided into three occupation zones: an upper zone, the midden zone, and the transition zone. The upper zone contained mixed Late Prehistoric and Archaic artifacts along with reasonably high debitage quantities. Several disturbances were obvious. The thick midden zone had the highest frequencies of burned rock recorded anywhere in the site (an average of 95.4 kg per 10 cm level). Interestingly, the same levels had very little debitage or other cultural material. Thus, the midden appeared almost devoid of anything but burned rock. A **La Jita** and a D6:3 were recovered from the lowest level of the midden. A slight increase in debitage occurred at the bottom of the midden and in the transition zone. The transition zone did not contain much evidence of the Local Period 5 component that was so rich just a few meters to the east in Area M. A partially fluted unfinished lanceolate point (Fig. 22,m) was recovered at 98.48 in the very top of the gravel deposit. This point may represent an otherwise undocumented Paleo-Indian occupation at 41 BX 228.

AREA K

Location: Area K was placed on Herb's Knoll which is located on an isolated terrace remnant west of the bluff edge (Fig. 1).

Southwest Corner: The grid coordinates are approximately E958 N1017; they are not precisely known, as Herb's Knoll lies well west of the main site and was oriented parallel to BT 17 rather than on the site grid.

Area Size: 1 m x 2.5 m.

Units: Test Pit A, a 1 x 1.5-m unit and Test Pit B, a 1-m^2 unit.

Levels: Four unit-levels. Each test pit had an upper feature level and a lower feature level.

Surface Elevations: Not tied into site vertical datum.

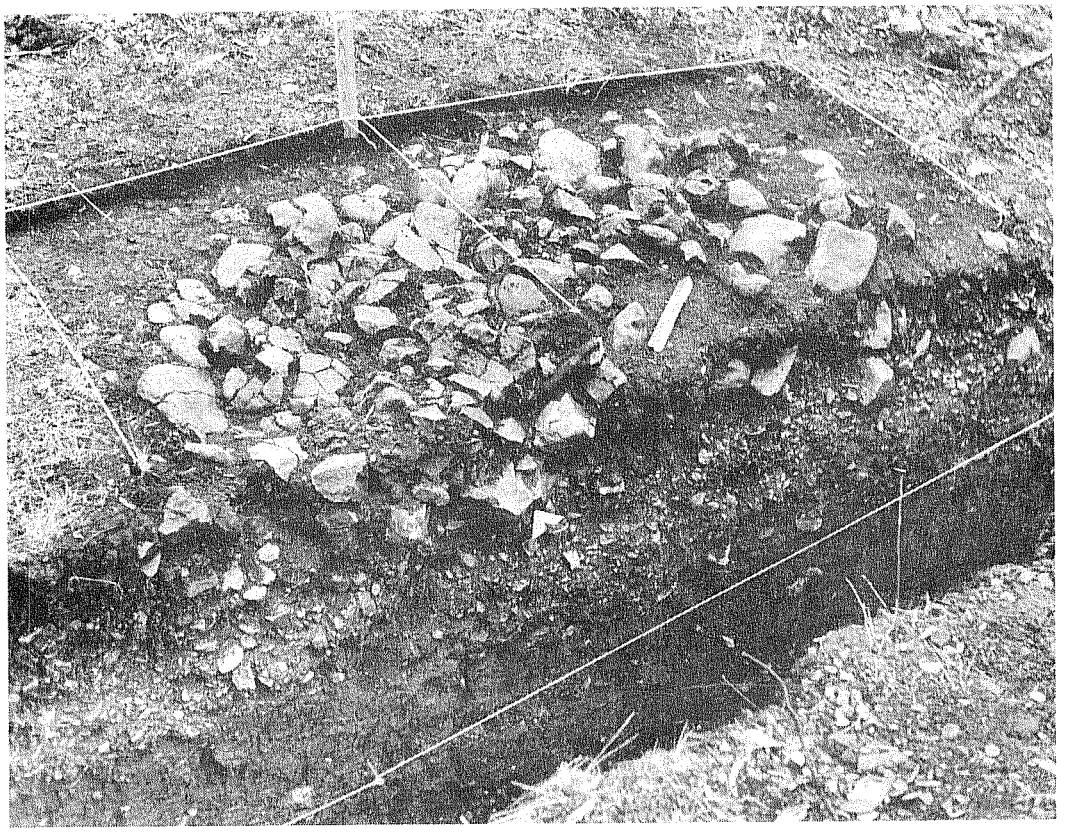
Maximum Depth: Approximately 35 cm below the surface.

Geomorphology and Soils: The Area K excavations were very shallow; however, they were adjacent to BT 17 which had a deep and informative profile. Herb's Knoll was an isolated terrace remnant composed of alternating layers of gravel deposits and fine-grained sediment deposits. The BT 17 profile also revealed several erosional surfaces that truncated various soil layers. The profile can be divided into four major zones. Zone 4 was the upper 15 cm of silty loam and topsoil that contained cultural material including Feature 8. Below this was the upper gravel layer, Zone 3, which was 30-40 cm thick and had small gravel and pebbles in several thin lenses. No cultural material was noted in the upper gravel except for the lower layer of Feature 8. Below the upper gravel was a 70-80 cm thick zone composed mostly of clay. Zone 2 was partially divided by truncated sand and gravel lenses that occurred on both sides of Herb's Knoll. These truncated sand and gravel lenses appear to represent a high energy flood deposit that was subsequently truncated by erosion and covered with low energy flood deposits (clay and silt). Scattered cultural materials occurred in the upper two-thirds of Zone 2. The lowest piece of cultural material was a patinated core exposed in the profile just below the truncated sand and gravel deposit, some 85 cm below the surface. Beneath Zone 2, at the bottom of the trench and at the base of Herb's Knoll, was a lower gravel deposit. Zone 1 was at least 25 cm thick and appeared similar to the gravel deposits underlying the main site area.

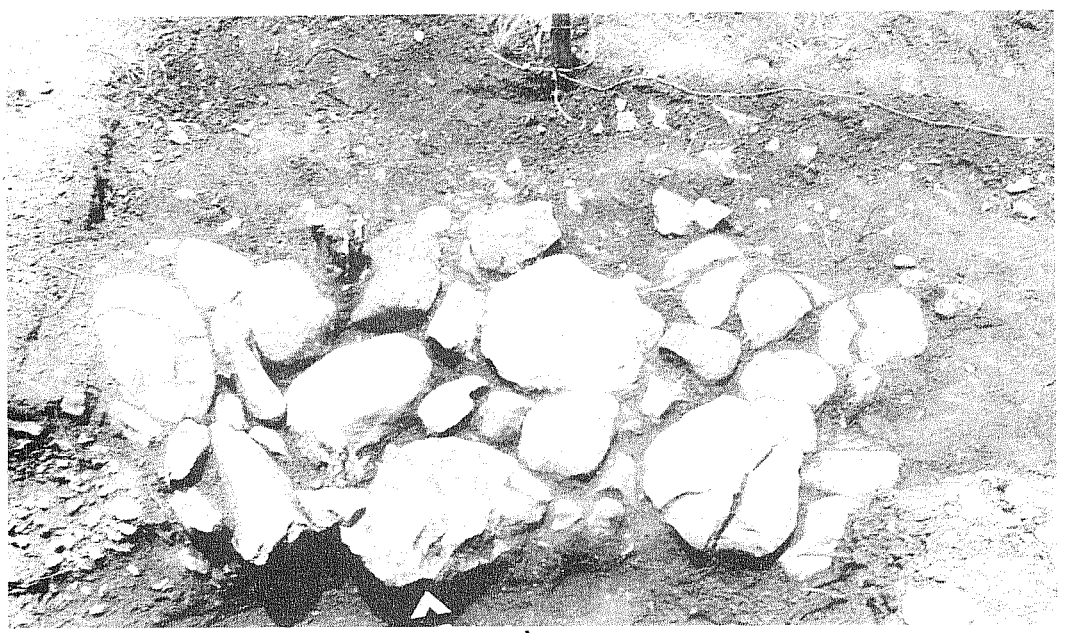
Cultural Materials: The sole purpose of the Area K excavations was to expose Feature 8. A shovel test was excavated four meters northwest of Area K. This test revealed low frequencies of cultural material. Scattered flakes and a piece of red ochre were recovered from Zone 4. Scattered flakes were also found in Zone 2. The shovel test was terminated at 75 cm below the surface after a concentration of burned rock was encountered. This layer of rock may represent a cluster feature or a thin midden layer. No chronologically sensitive materials were recovered from Herb's Knoll.

Feature 8: Feature 8 was a large cluster of burned limestone rocks with an oval outline shape. BT 17 partially truncated Feature 8, removing roughly the southeastern third of the feature. The remaining portion of the feature measured about 2.5 m (northeast-southwest) x 1.25 m (southeast-northwest). The feature had two distinct layers of rock and was basin shaped in profile. The upper rock layer was just beneath the surface within the dark topsoil (Zone 4). The lower layer of rock extended into the upper gravel layer (Zone 3).

The upper layer of Feature 8 is shown in Figure 50,a. This layer is composed of highly fragmented pieces of burned limestone. The only cultural materials found in the upper layer other than the burned rock were a couple of chert



a



b

Figure 50. **Burned Rock Feature, Herb's Knoll.** a, upper rock layer and BT 17 profile; b, lower rock layer. White arrow points to same rock.

flakes, some charcoal flecks, and a charred acorn. The lower layer of rock (Fig. 50,b) was composed of large limestone cobbles and small boulders. These rocks were not burned as intensively as the upper layer rocks. Most were unfractured, although a few were broken in place. Other than a few charcoal flecks, the lower layer contained no cultural materials except for one limestone cobble with red ochre inclusions. This rock showed evidence of ochre inclusions that had been gouged and scratched out.

Feature 8 was a unique feature at 41 BX 228. Unfortunately, no chronologically sensitive artifacts were recovered and not enough charcoal was present for a radiocarbon assay. Judging from the stratigraphic position, Feature 8 probably dates late in the occupational sequence. Two possible feature interpretations are considered.

The most likely interpretation is that Feature 8 is a specialized acorn processing oven. The feature was constructed by excavating a large shallow pit some 25-30 cm below the existing surface into Zone 3, the upper gravel layer. The basin-shaped pit was then lined with large limestone stream-rolled cobbles and small boulders. The absence of severe heat fracture suggests that the fire was not built directly over the lower layer. Perhaps the upper layer was placed over the lower rocks while the former were still intact. Presumably a fire was then constructed over the feature and the acorns roasted (buried within the upper layer?). The upper layer was obviously disturbed, probably to remove the acorns.

An alternative explanation is suggested by several inconsistencies with the first hypothesis. First, the overall absence of charcoal other than a few flecks is puzzling. If the feature was used to roast acorns in the manner described above then one would expect a fair amount of charcoal, ash, and possibly charred acorns to have fallen between the lower layer of rocks during the cleaning out of the oven. Second, one also wonders what purpose the lower layer of rocks would have served given the absence of evidence of direct burning. The alternative interpretation is that the charred acorn was fortuitous, and the feature served as a steam bath.

Several lines of evidence can be used to support the steam bath interpretation. It should be noted that Feature 8 is located well away from the main site area near the major water source (the collapsed sinkhole, Fig. 1 and Fig. 2,a). The steam bath scenario would have involved the excavation of the shallow pit over which a temporary hide or brush structure was constructed. A nearby fire could have been used to heat the large limestone rocks which were brought into the steam house and covered with a second layer of hot rocks. Next a container of water would have been brought in and thrown on the hot rocks. This would have produced plenty of steam and would have thermally fractured the upper layer of rock. Another clue, which may support the steam bath hypothesis, is the occurrence of the ochre bearing rock and the small piece of ochre found in the upper layer of the shovel test. Red ochre was often used in prehistoric societies for body paint and other ritual ornamentation. The envisioned scene would have involved a small group of male hunters who used the steam bath to ritually cleanse themselves and used the ochre to prepare their bodies for some unknown ceremony or activity.

AREA M

Location: Area M was placed near the bluff edge in the south-central site area. Figure 8 shows several views of the Area M excavations.

Southwest Corner: E988 N974.

Area Size: 4 m^2.

Units: Four 2-m^2 units.

Levels: 24 unit-levels.

Surface Elevations: As discussed in the Methodology section, the Area M excavations were begun roughly 90 cm below the surface at the bottom of Midden 2 between 98.84-98.70.

Maximum Depth: Approximately 140 cm below the surface, 98.20.

Geomorphology and Soils: The stratigraphy of Area M has been previously discussed in several sections of this report and will only be briefly summarized. Area M had a profile very similar to that of adjacent Area J except that the transition zone was thicker as shown in Figure 4 at the west end of BT 4. The transition zone was roughly 40 cm thick in Area M. The massive overlying midden accumulation was removed by the backhoe.

Cultural Materials and Features: The purpose of the Area M excavations was to expose a large area of the transition zone deposits. The excavations began with the lower layer of Midden 2. All chronologically sensitive artifacts recovered from Area M can be attributed to either Local Period 5 or 6. Most of the Local Period 6 artifacts were found within the lower layers of the burned rock midden. It proved difficult to precisely define the transition zone/midden interface during the Area M excavations. This interface was very abrupt in profile but very irregular in plan. The midden appeared some 20-30 cm deeper in elevation in the northern two-thirds of Area M than the southern third due to the presence of a probable pit oven feature. Artifact, debitage, and bone recovery were much lower within the midden and the pit area than in the underlying transition zone.

Large numbers of Local Period 5 artifacts were recovered from the transition zone deposits in Area M. These included the "early expanding stem" dart points, distally beveled tools, "early thinned-base triangular" dart points, thin bifaces, unifaces, modified debitage, cores, and other artifact types. Table 48 shows the vertical distribution of the various artifacts recovered from Area M by unit and level. As further discussed below, feature definition proved difficult in Area M due to the concentration of material. A number of artifact and burned rock clusters were recorded although their boundaries were often poorly defined. Over 200 artifacts were recorded *in situ* and plotted on plan maps along with most of the burned rock in Area M. Five plan maps were drawn (Level 1 consisted of a burned rock midden deposit in all units and was shoveled out).

TABLE 48. VERTICAL DISTRIBUTION OF SELECT ARTIFACTS--AREA M

Northern 2-m^2 Units (E988 N976 and E990 N976)

Elevation	D3:5	D3:6, Travis	D3:7, Nolan	D3:11, Bell	D4:1	D4:2	D4:3, Martindale	D5:2	D6:3	DB1:1, Clear Fork	DB1:3, Clear Fork	DB2:1, Guadalupe	DB2:2, Guadalupe	DB3:1	DB3:2	DB4:2	U2:1	U3:1	U3:2	U3:3	Cores	Thick Bifaces	Thin Bifaces
98.70			1																			1	1
98.60								1													1		3
98.50		1	1				1				1									1	6		6
98.40				1	1	3	1						1				1			1	9	2	17
98.30						1						1						1			5	1	3
98.20																							
98.70	3		1			1	1														2	4	10
98.60				1				1	3		1						1	2	1		7	2	16
98.50			1		5	2	1		2	1		6	1			1					16	6	24
98.40					1	1	1		2		1	1		1	1						8	1	18
98.30																					3		1
98.20																							

Artifact Category

Southern 2-m^2 Units (E988 N974 and E990 N974)

Plan Map 1, 98.70-98.60, recorded the burned rock midden in the northern two-thirds of Area M and mixed Local Periods 5 and 6 artifacts in the southern third (not illustrated). One interesting cluster of three reworked dart points was found in E990 N974 between 98.64 and 98.62. These "stubby" points (D3:5) are probably reworked **Bulverde** points that have been repeatedly resharpened. This cluster may represent a location where a hunter removed his unserviceable points from their hafts and replaced them.

Plan Map 2, 98.60-98.50, also recorded dark midden deposits in the northern two-thirds of Area M (not illustrated). The southern third and balk area (30-40 cm strip between Area M and BT 4) had large quantities of small burned rock along with a mixture of Local Period 5 artifact types. Distinct rock clusters were not defined although several concentrations of burned rock were observed within the rock scatter south of the midden. As shown in Table 48 many more artifacts were recovered from the southern units than the northern units at this level. The interface between the midden and the transition zone was not easy to define; however, the midden deposit seemed to form a semicircle centered in the northern two units.

Plan Map 3, 98.50-98.40, is shown in Figure 51. The semicircular pattern observed in the above level became better defined as the excavation progressed. By 98.45, the midden deposit was confined to a circular area that was smaller and better defined on the 98.40 floor as shown. The circular area is interpreted as a pit as discussed below. Three Local Period 6 dart points were recovered from within the pit along with a few other artifacts including one Local Period 5 dart point. South and west of the pit over 50 artifacts were uncovered. Most of the artifacts were clustered in Unit E990 N974. The artifact cluster consisted of eight cores, eight thick and thin biface fragments, five distally beveled tools, four pieces of modified debitage, and a D6:3. Three "early expanding stem" dart points were found on the northern edge of the cluster. All of the chronologically sensitive artifacts recovered outside the pit can be attributed to Local Period 5. The large quantity and variety of artifacts associated with the artifact cluster suggest that this location was the scene of several different activities. These may have included tool making as evidenced by the many cores and biface fragments as well as specialized activities suggested by the distally beveled tools and the D6:3 (deer butchering?).

The soil within the apparent pit appeared to be typical midden matrix: dark gray loam that was fine textured and comparatively loose. The area that contained the pit was overlain only by midden deposits. One consequence of the decision to excavate Area M as a block area was that we were unable to view a cross section of the pit. The bottom of the pit was poorly defined but occurred between 98.40 and 98.30. Based on the plan maps and field observations the pit probably originated from a surface between 98.70 and 98.60. The pit measured some 3.5 x 2.5 m when first detected and was oval in outline. The pit is interpreted as a cleaned out pit oven. The pit oven was constructed during Local Period 6. The hypothesized sequence of events involved digging a large, shallow basin some 30-40 cm in depth, layering heated rocks with some type of vegetal material (sotol or yucca?), allowing this to bake, and finally uncovering the oven and removing the baked material. The absence of charcoal at the bottom of the pit suggests that the

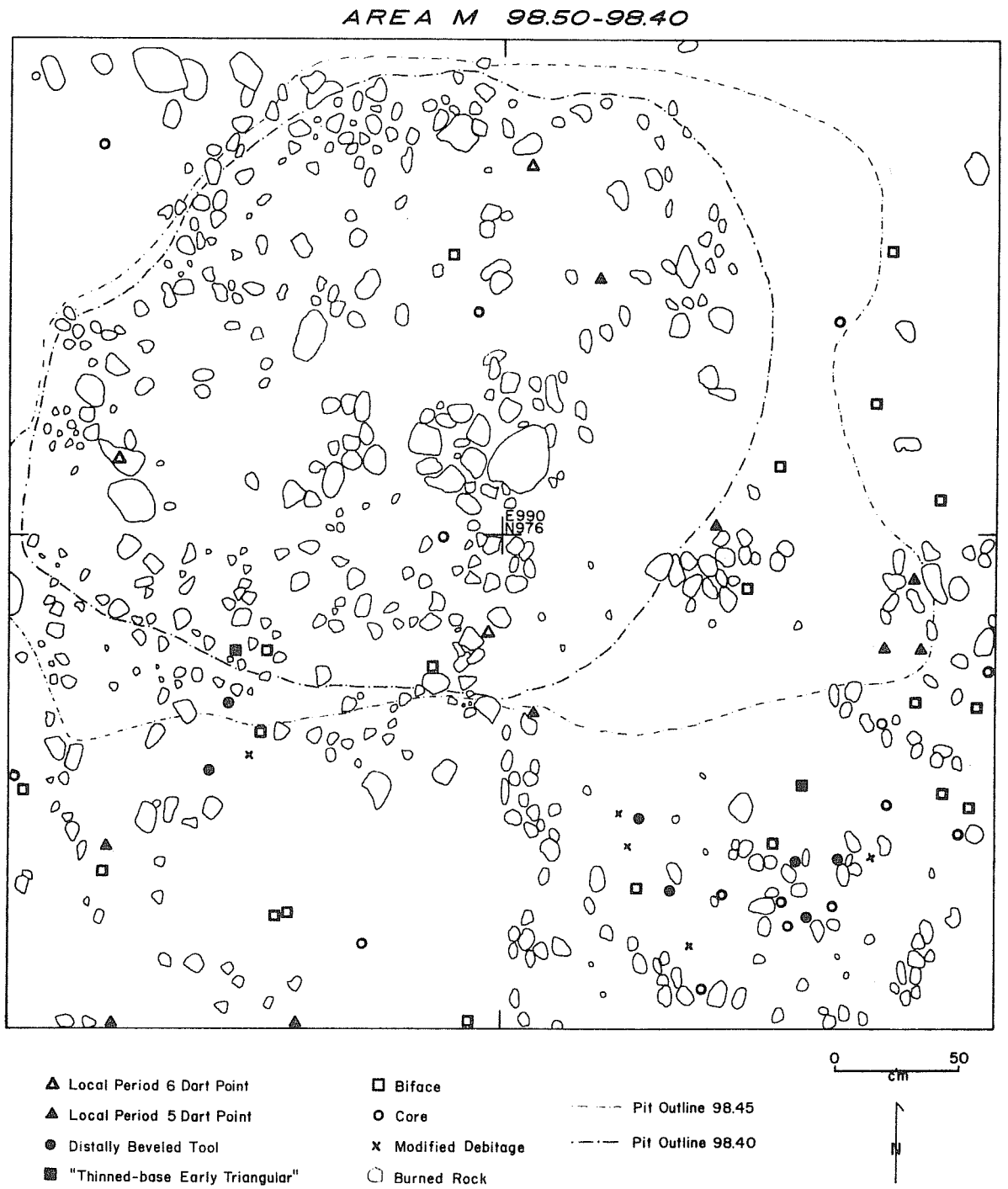


Figure 51. **Plan Map 3 of Area M, 98.50-98.40.**

rocks were already heated when placed in the pit. Additional heat may have been provided by building a fire on top of the oven. The pit oven may well have been reused several times. Subsequently, the pit was covered over by the burned rock midden. Additional implications of the pit oven will be discussed in following sections of this report.

Plan Map 4, 98.40-98.30, is shown in Figure 52. The lowest trace of the pit oven is believed to be the tightly packed larger limestone cobbles centered just north of grid point E990 N976. Very few artifacts were found within the darker soil between and above this rock cluster. The lower rocks were resting on typical transition zone soil. The southern two units had no trace of the dark soil associated with the pit oven. Instead a number of poorly defined rock clusters were uncovered along with some 40 artifacts. Some of the smallest rocks drawn on the field map were left out of Figure 52 to emphasize the rock clusters. Four clusters are outlined in the illustration. A comparison of Figures 51 and 52 shows that larger quantities of rock occurred in the lower level. Absent were the charcoal and soil staining that would indicate a hearth. This suggests that either the clusters represent small rock dumps from nearby hearths or cooking features or surface hearths that remained exposed long enough to destroy any traces of charcoal. The artifacts from Level 5 were not as well clustered as those from Level 4.

Plan Map 5, 98.30-98.20, recorded the bottom of the transition zone deposits (not illustrated). As Table 46 clearly shows, artifact recovery dropped dramatically in Level 6. Some burned rock was present, but as the 98.20 floor was reached, gravel deposits were encountered. Only a few flakes and burned rock were found within the upper layer of gravel.

UNIT E1005 N929 (no area designation)

Location: This unit was placed near the bluff edge in the extreme southern end of the site.

Unit Size: 1 m^2.

Levels: Eight 5-cm levels.

Surface Elevation: 98.96.

Maximum Depth: 41 cm below the surface, 98.55.

Geomorphology and Soils: The soil profiles at the southern end of the site were very shallow as can be seen in Figure 7. Two zones are present: a dark clay loam and a gravel deposit. The clay loam is almost black in color at the surface and gradually becomes lighter with depth. The underlying gravels were encountered at about 30 cm below the surface.

Cultural Materials: Unit E1005 N929 had comparatively high frequencies of debitage, burned rock, dart points, and thin bifaces. Bone and charcoal were very poorly preserved. The unit was excavated in 5 cm levels due to the shallow soil profile. The upper three levels had mixed Local Periods 7 and 8

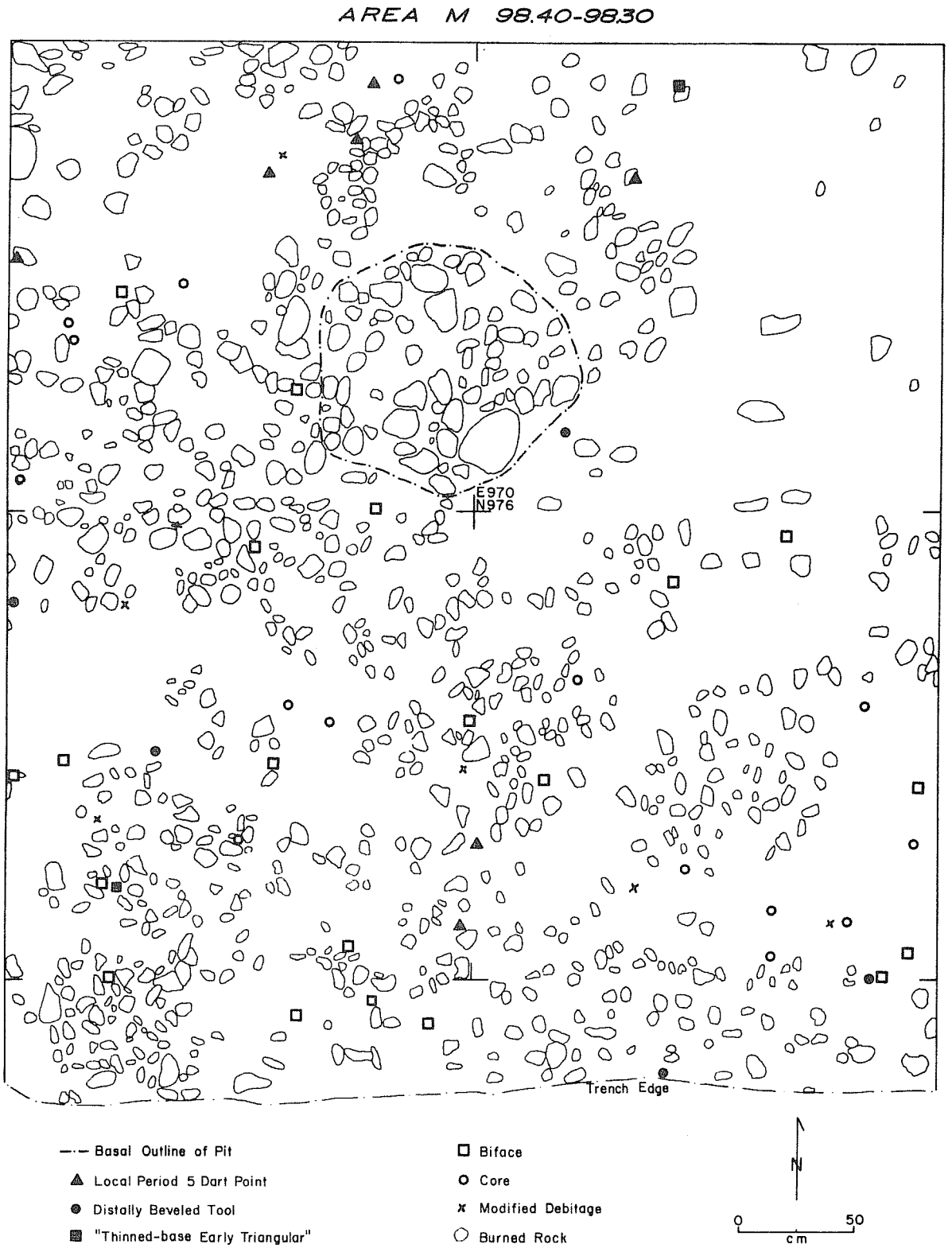


Figure 52. Plan Map 4 of Area M, 98.40-98.30.

dart points (**Lange, Williams, Pedernales,** and D3:9). A Local Period 5 dart point (**Bell**) was recovered from the lowest level.

UNIT E1010 N940 (no area designation)

Location: This unit was placed about 12 m northwest of Unit E1005 N929 in the southern end of the site.

Unit Size: 1 m^2.

Levels: Seven 5-cm levels.

Surface Elevation: 99.16.

Maximum Depth: 36 cm below the surface, 98.80.

Geomorphology and Soils: The soil profile was very similar to that of Unit E1005 N929. Two zones were present: a dark clay loam and a gravel deposit. The clay loam was almost black in color at the surface and gradually became lighter with depth. The underlying gravels were encountered at about 25 cm below the surface. One interesting phenomena was encountered at the top of the gravel. The northern half of the unit consisted of a gravel conglomerate cemented by leached calcium carbonate (caliche).

Cultural Materials: No chronologically sensitive artifacts were recovered from Unit E1010 N940. Debitage and burned rock frequencies were comparatively low except in the lower levels where a burned rock and debitage increase was recorded. Bone and charcoal were not well preserved.

UNIT E1010 N950 (no area designation)

Location: This unit was placed 10 m northwest of Unit E1010 N940 in the southern end of the site.

Unit Size: 1 m^2.

Levels: Five regular 10-cm levels.

Surface Elevation: 99.21.

Maximum Depth: 51 cm below the surface, 98.70.

Geomorphology and Soils: Three zones were observed: a dark clay loam, a red clay, and the typical gravels. The red clay was a thin layer containing some gravels that is similar to the transition zone found further north.

Cultural Materials: Only two chronologically sensitive artifacts were recovered from Unit E1010 N950, an **Ensor** and a **Marshall** dart point. Both were found in the first level. Cultural material frequencies were

comparatively low. Bone and charcoal were not well preserved. No cultural features were recorded.

UNIT E1020 N1024 (no area designation)

Location: This unit was placed 5 m north of Area A in the northern end of the site.

Unit Size: 1 m^2.

Levels: Three levels.

Surface Elevation: 100.11.

Maximum Depth: 31 cm below the surface, 99.70.

Geomorphology and Soils: This unit was only partially excavated. A thin topsoil, a B-horizon, and midden matrix of undetermined thickness was present.

Cultural Materials: Four sherds and a **Perdiz** arrow point were recovered from Level 1 along with a **Pedernales** dart point. Two more **Pedernales** points and an **Edwards** arrow point were found in Level 2. The top of Midden 4 was also encountered in Level 2. Midden 4 continued in Level 3.

UNIT E1020 N1029 (no area designation)

Only one level of this 1-m^2 unit was excavated. A **Scallorn** arrow point and a **Langtry** dart point were found in Level 1 along with moderate quantities of burned rock and debitage.

IX. SITE OVERVIEW: SUMMARY AND INTERPRETATIONS

Past occupations are summarized as they are understood from the context of the archaeological record. The spatial dimensions of the site, the identified cultural changes through time (temporal dimensions), and subsistence data will be reviewed and interpreted to present a brief picture of 41 BX 228 as a locus of human activity. Panther Springs Creek as a burned rock midden locality will be discussed in section X, and section XI will focus on the site as part of both local and regional cultural patterns.

SITE SIZE

The size of 41 BX 228 was unknown prior to 1979. The earlier widely varying estimates (100-36,000 m^2) can be attributed to several major problems which prevented more accurate estimates. These problems are pertinent to other sites within the Salado Creek drainage, as well as the region. As discussed, 41 BX 228 lies within a stream valley that is currently choked with brush.

The extremely dense nature of the whitebrush and mesquite (primary brush species) effectively prohibits surface reconnaissance, except along animal trails, roads, erosional features, and cleared fields. A second problem is the intense nature of occupation within the Walker Ranch area. This is undoubtedly related to the ecotonal location of the Walker Ranch and the wide availability of chert as a lithic resource. It is difficult to walk anywhere within the Walker Ranch with adequate archaeological exposure (bare ground) without finding chert debitage (flakes). Where does one site end and another begin? What constitutes a "site?" The answers to these questions are particularly difficult in intensively occupied areas (cf. Thoms, Montgomery, and Portnoy 1981).

During the 1979 season at 41 BX 228, the authors were able to examine the site much more carefully than were the previous researchers, through brush clearing, extensive testing, and backhoe trenching. Based on this work, the area covered by the subsurface extent is estimated to be approximately 3200 m^2. Subsurface extent is herein defined as the area containing significant artifact densities. It is fully recognized that low densities of cultural material can be found over a much larger area, but in view of the intensity of occupation in the stream valley, this is regarded as background "noise." The subsurface site configuration is roughly teardrop-shaped with the widest dimension at the northern end of the site. The maximum dimensions are roughly 120 (north-south) x 45 (east-west) m.

CULTURAL COMPONENT SUMMARIES

The term cultural component is defined as portions of the site which contain distinctive cultural remains that are assumed to represent a group or groups of closely related people (cf. Rouse 1972). Each component (with one exception) is believed to represent occupation at the site during a single period (see section XI). The discussions of components summarize the associated cultural remains and the implications of those remains for each period. It is recognized that the local periods and their equivalents in regional chronologies, such as the central Texas Archaic phases (Weir 1976a), represent a simplified outline of material culture change. The components recognized at 41 BX 228 provide little evidence to support recent proposed refinements in the central Texas chronology (Prewitt 1981).

The Panther Springs Creek site, like many central Texas sites, was intermittently occupied over a relatively long time span (at least 5000 years). The rate of natural soil deposition and of cultural deposition at 41 BX 228, like that at many central Texas sites, was extremely slow during the approximately 5000 year time span in which the site was occupied. In general, most of the occupation during this same time span was intense, although not continuous; i.e., a lot of cultural activity was taking place at periodic intervals that resulted in large quantities of cultural refuse. Given a long occupation span, an extremely slow deposition rate, and an intermittent intensive occupation, stratigraphic mixing is a predictable and unavoidable result. The authors characterize 41 BX 228 as a semistratified site; i.e., while younger materials generally overlie older materials, there is a considerable amount of stratigraphic mixing. It was repeatedly observed that instances of

known older materials, occurring in obviously later contexts, were much more common than the reverse. For example, no arrow points were found in the lower cultural levels anywhere in the site, yet dart points known to be several thousand years old were often found in the uppermost cultural levels.

The cultural components discussed below do not occur as isolated archaeological units separated by sterile deposits. Instead, the cultural components occur as overlapping occupations, one after another with little or no evidence of site abandonment. This is not to say that the site was continuously occupied but rather that the site was never unoccupied for a long enough time to leave a sterile soil zone between components. The following component discussions are based on stratigraphic trends rather than on distinct units. The earliest component is also the most isolated, with comparatively little apparent mixing. All of the succeeding components evidence a greater degree of disturbance. The validity of the component sequence is borne out by the overall stratigraphic trends and vertical distribution patterns. Occupational intensity varies on a vertical basis between many of the components.

The cultural component summaries were prepared by defining the least disturbed excavation areas and levels and using these "best cases" to define material assemblages for each component. This subjective process is based on relative frequencies of chronological indicators, radiocarbon date locations, comparisons with adjacent excavation areas, vertical distributions, horizontal distributions, and intuition based on over two and one-half years of work with this project. The authors are well aware of the hazards of this approach and have attempted to be as objective as possible. Most statements concerning the cultural components are qualified. Statements of fact were made only where the authors had little doubt of their interpretations. It is fully recognized that errors in interpretation may have been made; however, it is felt that the benefits from carefully reasoned interpretations far outweigh the inherent dangers.

The faunal remains provide the best subsistence data from 41 BX 228. Due to the problems of stratigraphic mixing, as discussed above, only a sample of faunal remains was used for the component summaries. This sample varies in size from component to component and has no "statistical validity." No attempt has been made to determine minimum individual numbers or the amount of meat and/or weight represented. The subsistence interpretations are based on the relative frequencies of faunal-species element count from the unit-levels chosen as "best cases" for each component. This approach is inadequate for many purposes. The faunal changes discussed in the subsistence section of each component represents <u>trends</u> rather than statistically demonstrated facts. Despite the tenuous nature of this approach, the authors feel confident that most of the observed trends represent cultural realities at the Panther Springs Creek site.

LOCAL PERIOD 5 COMPONENT

<u>Chronological Indicators</u>: **Guadalupe** tools (DB2:1 and DB2:2), "early expanding stem" (D4:1 and D4:2), **Martindale** (D4:3), "thinned-base early

triangular" (D6:3), **Bell** (D3:11), and **Clear Fork** tools (DB1:1, DB1:2, and DB1:3).

Associated Artifacts: Cores (nine forms), ovate thick bifaces (TK3), thick bifaces (nine forms), thin bifaces (15 forms), miscellaneous distally beveled tools (DB3:1 and DB3:2), unifacial tools (U2:1 and U3:2), burin spalls (U3:3), manos (GP:1), and grinding slabs (GP:2).

Associated Radiocarbon Dates: TX-3912, 3380 ± 170 B.C. (MASCA calibrated).

Associated Features: No features were formally recorded from Local Period 5 contexts; however, several rock clusters were mapped in Area M. These may represent scattered hearths, cleaned out rock ovens, or stone boiling dumps. Several artifact clusters containing most of the above artifact types were present in Area M. These probably represent multipurpose activity areas where tool making and haft refitting of several artifact forms occurred, as well as other less obvious activities.

Spatial Distribution: The Local Period 5 component is definitely clustered in the southern half of the site, unlike all succeeding components. The Local Period 5 component is concentrated adjacent to the bluff within the "transition zone" soils (Areas I and M). Local Period 5 artifacts were consistently found in the lowest cultural zone directly above the gravel deposits. Local Period 5 indicators occur only rarely in the northern half of the site and in the upper deposits.

Subsistence: Preservation of charcoal and faunal materials was generally poor in Local Period 5 contexts. Faunal species identified from Local Period 5 include white-tailed deer, cottontail rabbit, jackrabbit, badger, pocket gopher, turtle, and possibly, raccoon, red fox, and **Canis**. Of the 42 identifiable elements, 62% are from deer, 12% from cottontail rabbit, and 12% from jackrabbit; the remaining species are represented by only one element each. Wood species identified from charcoal fragments include walnut, ash, and acacia. Mussel shell was extremely uncommon. Uncharred hackberry seeds were common in Local Period 5 contexts; however, these may be associated with poorly defined rodent disturbances.

Inferred Activities: Hunting is indicated by the presence of projectile points and faunal materials. The chipped stone assemblage evidences a variety of activities: flake biface reduction (thin bifaces and projectile points), core trimming reduction (**Guadalupe** tools), flake production (exhausted cores and modified debitage), and hafted tool resharpening (**Guadalupe** tools and "thinned-base early triangular"). The various distally beveled tools indicate that specialized activities requiring heavy hafted tools were taking place, such as woodworking or possibly hide processing. The presence of grinding implements suggests that plant processing (of nuts?) occurred. Burned rock clusters, charcoal fragments, and burned bone indicate that fires were built, and food was prepared.

Discussion: The Local Period 5 component represents the earliest major occupation of the site. The most striking aspect of this component is the diversity of the artifact assemblage. From this diversity one can infer that

a wide variety of activities was taking place at the site. The Local Period 5 component, like succeeding components, appears to represent a multifunctional base camp occupation. The faunal assemblage, although meager, is more diverse than the following two components (Local Periods 6 and 7) in terms of numbers of species. The diversity in artifact assemblage, inferred activity, and faunal assemblage supports Weir's (1976a:119) contention that the San Geronimo phase (which would include Local Period 5) represents a nonspecialized system of hunting and gathering.

The overall system may be nonspecialized (i.e., does not rely on a narrow range of resources), but specialized chipped stone tool forms are more prevalent in the Local Period 5 component than any other component. The following Local Period 5 chipped stone artifact forms appear to be specialized tools: "thinned-base early triangular," **Guadalupe** tools, **Clear Fork** tools, miscellaneous distally beveled tools (DB3:1 and DB3:2), and two uniface forms (U2:1 and U3:2). These same artifact forms evidence a wider range of chert-knapping skills than are found in later components. In addition to the "standard" techniques used in virtually all components, several specialized techniques were employed during Local Period 5. Longitudinal basal thinning occurs in later components, but closely resembles true "fluting" only on several "dart point" forms (D6:3 and D5:2) exclusively associated with the Local Period 5 component. The core trimming reduction technique hypothesized for the **Guadalupe** tool appears to be unique both to the component and to the tool form. A final specialized chert-knapping technique, the burin technique, which appears to be unique to Local Period 5, is suggested by two uniface fragments (U3:3) which seem to be burin spalls.

The Local Period 5 component, although distinct from succeeding components, begins a long occupational sequence exhibiting considerable cultural continuity through time. Deer hunting and chipped stone tool making remain important activities throughout the succeeding components. The Local Period 5 component predates burned rock midden accumulation; however, the relatively large quantities of burned rock mapped in Area M may indicate that the specialized cooking and/or processing that is represented by midden accumulation had already begun. An additional indication of cultural continuity is the initial occurrence of artifact forms during Local Period 5 which also occur in the following component (see Local Period 6 component discussion).

The Local Period 5 component is an example of a broad pattern of Early Archaic adaptation which is at present very poorly understood (Black 1980, 1981). McKinney (1981) has recently done an excellent job of summarizing this long-lived, yet poorly known interval in central and southwestern Texas. As McKinney notes, a variety of concepts have been applied to this interval, including Sollberger and Hester's (1972) "pre-Archaic," Weir's (1976a) "San Geronimo Phase," Story's (1980) "Early Archaic," and Prewitt's (1981) recent multiphase approach. Black (1980, 1981) has argued that, given the present state of knowledge, Story's broad concept of the Early Archaic is the most useful model presented to date. More recently, Prewitt (1981) has proposed a multiphase central Texas chronology that contains four phases attributed to the Early Archaic. These include the Circleville phase (ca. 6500-5000 B.C.),

the redefined San Geronimo phase (ca. 5000-4000 B.C.), the Jarrel phase (4000-3000 B.C.), and the Oakalla phase (ca. 3000-2600 B.C.).

As McKinney (1981:13) has noted, evidence for at least a two-part division of the Early Archaic is now accepted. Based on a comparison with other relatively dated components in the region and on radiocarbon dates at 41 BX 228 and Granberg II (41 BX 271), the Local Period 5 component at 41 BX 228 is an example of the latest portion of the Early Archaic (ca. 3300 B.C.). The artifact assemblage contains examples of "Key Index Markers" ("projectile points") that Prewitt has assigned to two successive phases, the Jarrel and the Oakalla. No evidence of stratigraphic or vertical separation of these two phases was observed at 41 BX 228. The authors question the validity of the Oakalla phase which Prewitt (1981:79) admits is "probably the least well defined of the Central Texas phases." The only "Key Index Markers" for the Oakalla phase are the **Baird** and **Taylor** "projectile points." The authors have included these artifacts under the descriptive term "thinned-base early triangular" and have argued that these triangular bifaces functioned as knives rather than projectile points. At 41 BX 228, these artifacts, whatever their actual function, co-occur with a range of morphologically distinct "early expanding stem" projectile points. Although triangular bifaces continue to occur in the succeeding component (Local Period 6) at 41 BX 228, they are much more common in the Local Period 5 component, along with artifacts similar to those Prewitt (1981) attributes to the Jarrel phase.

The geographical distributions of many Local Period 5 component artifact forms are not restricted to south-central Texas or central Texas. Many authors (cf. Sollberger and Hester 1972; Weir 1976a; Story 1980; Black 1980, 1981; McKinney 1981) have noted that Early Archaic artifact forms and adaptation patterns occur over very broad areas far beyond regional boundaries. The distribution of **Bell** and similar points exemplifies these observations; triangular forms with narrow basal notching (**Bell, Calf Creek, Charcos**) occur from Coahuila, Mexico, to southern Missouri (Parker and Mitchell 1979). The "early expanding stem" dart point forms (**Martindale**, "early barbed," "early corner notched") also have a very wide distribution over central, south, and southwestern Texas and possibly in adjacent areas of Mexico. The **Guadalupe** tool, as noted, has a broad distributional pattern (Fig. 29) which seems to be linked to the drainage systems flowing toward the Texas gulf coast from the Edwards Plateau. The broad distributional patterns of many Early Archaic tool forms question the validity of defining Early Archaic cultural phases within geographically restricted areas. This is especially relevant to central Texas in view of the paucity of well-controlled excavation data.

PERIOD 6 COMPONENT

Chronological Indicators: **Nolan** (DB3:7), **Travis** (D3:6), **La Jita** (D3:8), D3:5, D3:9, **Bulverde** (D3:4), **Pandale** (D3:11), "early thinned-base triangular" (D6:3), and **Clear Fork** tools (DB1:1).

Associated Artifacts: Cores (seven forms), thick bifaces (four forms), thin bifaces (12 forms), perforators (P:1), modified debitage, grinding slabs (GP:3), and unifaces (U3:2 and U3:4).

Associated Radiocarbon Dates: TX-3853, 2920 ± 130 B.C. (MASCA calibrated).

Associated Features: Burned rock midden accumulations appear to have begun at all four middens during Local Period 6. No smaller rock clusters (hearths) were associated with Local Period 6. Sharp increases in debitage and core and biface fragments in levels corresponding to Local Period 6 indicate the presence of a chert-knapping activity area in the vicinity of Area I.

The most interesting and significant feature recorded in Local Period 6 context is the pit oven feature in Area M. This feature was a large shallow pit dug into the Local Period 5 deposits in the transition zone. The pit is estimated to have been about 40 cm deep. The pit matrix was comparatively loosely packed, ashy, dark stained and had higher phosphate, organic carbon, calcium, and pH values than the transition zone. Large quantities of highly fragmented burned rocks were present in and around the pit. Artifact recovery was very low from within the pit. Very high densities of Local Period 5 artifacts just outside (south) of the pit may be partially due to displacement by the digging of the pit.

The pit oven at 41 BX 228 was overlain by burned rock Midden 2. The feature/midden interface was not apparent; in fact, there did not appear to be a stratigraphic break between the pit and the overlying midden. The use of the backhoe to remove the Area M overburden unfortunately prevented a careful recording of a profile through the pit oven. It is clear that Midden 2 completely covered the pit oven feature and did not evidence any other indications of a pit. Nor did any other midden at the site.

The pit oven feature would have been the center of a small ring midden during the early part of Local Period 6. The massive midden accumulation that later covered the pit effectively concealed any indication of the central depression. It is suggested that Midden 2 began as a pit oven (ring midden) during Local Period 6. By Local Period 5, the ring midden was sealed by the unstructured midden deposit that characterizes most of the extent of Midden 2 and all of the other middens at the site.

The Local Period 6 pit oven represents a large communal feature used to process some type of plant requiring a long cooking period. Similar features are common in west-central Texas and further to the west. These pit ovens are associated with ring or crescent middens (Greer 1968) and are usually interpreted as agave, yucca, or sotol processing features. Yucca and sotol are both present in small numbers in northern Bexar County. Neither are prevalent in the immediate site area today. It is suggested that both yucca and sotol would have been more common during the drier climatic episodes such as postulated for portions of the Early Archaic (Story 1980). Local Period 6 would have begun at the end of this drier cycle. The absence of pit oven features in later midden contexts at 41 BX 228 may suggest that the Local

Period 6 pit oven represents the processing of a different vegetal material than that represented by most of the midden accumulation.

A similar feature, roughly contemporaneous, was excavated by the WPA at the Devil's Hollow site, west of Austin in 1939 (Collins 1972). Collins interpreted a small ring midden at the Devil's Hollow site as an earth oven dating to the early Middle Archaic (associated with **Bulverde** dart points). At 41 BX 228, a cluster of three severely reworked dart points (D3:5) similar to **Bulverde** points were recovered from Area M a few meters south of the pit feature at approximately the same elevation as the origination of the pit. As Collins notes, ring middens and earth ovens are usually associated with later time periods in west-central Texas. The documented occurrence of two pit (earth) oven features at approximately the same time period in central and south-central Texas has implications for the regional cultural adaptations.

Spatial Distribution: The Local Period 6 component has the widest horizontal distribution of any component at 41 BX 228. Local Period 6 indicators were recovered from almost all units at the site. On a vertical basis, the Local Period 6 component occurs stratigraphically as the lowest, hence earliest, occupation in the northern half of the site. In the southern half of the site, particularly in Areas M and I, the Local Period 6 component overlies, and is slightly mixed with, the underlying Local Period 5 component.

Subsistence: Bone preservation was poor in Local Period 6 contexts. Only 19 elements were identified from excavation levels that were associated with relatively undisturbed Local Period 6 contexts. Deer remains comprised 68% of the identifiable elements, turtle 10%, and bison, cottontail rabbit, jackrabbit, and coyote one element each. Four wood species were identified from charred wood fragments associated with the Local Period 6 component: elm, mesquite, acacia, and juniper. Two charred nuts were recovered from Local Period 6 contexts: a small walnut hull and an acorn fragment.

Inferred Activities: Projectile points and faunal remains suggest deer hunting. Nut collecting and processing can be inferred from the charred nuts and possibly supported by the grinding slabs. Chert tool making is obvious from the quantities of debitage and broken unfinished tools (primarily thin bifaces). The presence of specialized lithic tools, such as perforators and unifaces, suggests that perishable materials were being worked (leather and/or wood?). The beginnings of burned rock accumulation suggest that some type(s) of specialized food processing occurred on a fairly large scale. The pit oven feature from Area M documents the use of a communal oven.

Discussion: Local Period 6 marks the beginning of a process which was to remain important for several thousand years--burned rock midden accumulation. Perhaps associated with this process is an apparent population increase or at least an increase in occupational intensity which can be inferred from (1) a wider horizontal distribution and (2) an approximate 50% increase in chronological-indicator frequency from the preceding component. The presence of an apparent pit oven and of charred nuts (walnuts and acorns) in Local Period 6 contexts evidences the importance of plant resources. The inferred population increase may be in part attributable to more sophisticated plant

processing techniques represented by the middens. The apparent chert-knapping locality in Area I represents an activity just outside the south edge of Midden 2 that may be contemporaneous with the pit oven feature.

Overall, the Local Period 6 component reflects cultural continuity with both the preceding and succeeding components. Continuity in the faunal assemblage is indicated by the continued predominance of deer. Bison apparently occurs for the first time during Local Period 6. The uniface types present in Local Period 6 are more similar to those associated with Local Period 5. Another trait shared with Local Period 5 is the diversity of projectile point forms in marked contrast with Local Period 7. The Local Period 6 component occurs both in the southern half of the site where Local Period 5 is concentrated and in the northern half where Local Period 7 is concentrated. Burned rock midden accumulation suggests continuity with the succeeding Local Period 7.

LOCAL PERIOD 7 COMPONENT

Chronological Indicators: **Pedernales** (D3:1), **Langtry** (D3:2), **Bulverde** (D3:4), and D3:3.

Associated Artifacts: Cores (nine forms), thick bifaces (10 forms), thin bifaces (11 forms), unifaces (U1:1, U1:3, and U2:2), perforators (P:1), modified debitage (GP:1), and grinding slabs (GP:3).

Associated Radiocarbon Dates: TX-3852, 800 ± 60 B.C. (MASCA calibrated).

Associated Features: Burned rock accumulation continued at the three northernmost middens and possibly at Midden 1. Local Period 7 appears to have been the major period of accumulation for Middens 2 and 4. Smaller rock clusters (hearths) were not recorded from Local Period 7 contexts. Several artifact clusters were associated with Local Period 7, including a probable chert-knapping locality (high quantities of cores, debitage, and thin biface fragments) in Area C and a cluster of three unifaces in Area G.

Spatial Distribution: The Local Period 7 component is concentrated in the northern half of the site, although widely scattered indicators occur over the entire site, as well as adjacent to the site (particularly to the north). Local Period 7 indicators appear to be concentrated in peripheral midden areas (Areas A and B) and between the three northernmost middens. Area C and Backhoe Trenches 6 and 11 contain larger concentrations of Local Period 7 indicators and may represent occupation areas associated with adjacent middens. The vertical distribution is less patterned than the horizontal distribution. Local Period 7 indicators are absent in the lowest cultural levels. They predominate the middle levels in the northern half, but are often mixed with Local Periods 6 and 8 indicators and occasionally with Local Periods 9, 10, and 11 indicators.

Subsistence: Bone and charcoal preservation is generally good in Local Period 7 contexts. Forty-eight faunal elements were identified from excavation levels associated with Local Period 7. Deer comprise 69% of the identifiable elements; bison comprise 21%, cottontail rabbit 4%, and turtle,

pocket gopher, and **Canis**, one element each. Wood species identified from charred wood fragments include willow, walnut, and oak. A charred walnut hull was recovered from Local Period 7 contexts. Increasing quantities of grinding implements may indicate a heavier reliance on plant foods.

Inferred Activities: Deer and bison hunting can be inferred from the presence of projectile points and faunal elements. Scraping tools (unifaces) with rounded working edges infer hide processing. Concentrations of chert debris and broken uncompleted tools evidence chert tool working. Plant collecting and processing is inferred from the charred walnut hull and grinding implements. Specialized cooking (stone boiling nuts?) is suggested by the midden accumulation.

Discussion: Local Period 7, like Local Period 6, evidences both cultural continuity and culture change. The overall focus of activity at 41 BX 228 shifts to the northern end of the site for the first time during Local Period 7. Change is represented by a significant increase in bison remains during Local Period 7. This increased emphasis on bison may reflect the increased availability of bison, due to a changing environment (cf. Dillehay 1974). Several changes were observed in the chipped stone assemblage: unifacial forms change to unifaces with rounded working edges; distally beveled tools are no longer used; thick bifaces become more common and more diverse, perhaps indicating more core biface reduction; and projectile point forms become noticeably less diverse. This latter change is reflected in the overwhelming predominance of the **Pedernales** point.

Cultural continuity is suggested by a number of similarities between the Local Period 7 component and preceding and succeeding components. Midden accumulation continues during Local Period 7 at three or possibly all four middens. Deer continue to dominate the faunal assemblage with roughly the same percentage as preceding and succeeding components. Thin biface diversity is approximately the same in Local Periods 6 and 7, in apparent conflict with Weir's (1976a:129) contention that biface diversity increases during the Round Rock phase (Local Period 7). Nut collection and processing continue to occur. A similar multifunctional occupation at 41 BX 228 is suggested for Local Period 7, as with all other periods.

LOCAL PERIOD 8 COMPONENT

Chronological Indicators: **Montell** (D2:1), **Castroville** (D2:2), and **Marcos** (D2:5).

Associated Artifacts: Grinding slabs (GP:2), thick bifaces (11 forms; TK1, TK2, TK13, and TK14 forms predominate), thin bifaces (22 forms; TN3:1, TN5:1, TN10:1, TN13:2, and TN14 forms are most common), and perforators (P:1, P:3, and P:4).

Associated Radiocarbon Dates: None assayed.

Associated Features: Burned rock middens (?). Possible continued activities associated with burned rock Middens 3 and 4.

Spatial Distributions: **Montell**- and **Castroville**-associated materials are more concentrated in the northern and central site areas. A discrete **Castroville**- and **Marcos**-related activity area was also identified between burned rock Middens 1 and 2; all Local Period 8 occupations are situated relative to the margins of burned rock accumulations. Stratigraphically, **Marcos** points overlie or are coeval with the upper deposits of **Montell** and **Castroville** materials. The distribution of **Marcos** materials from 99.50-99.40 in Area B (slightly above other horizon markers for this period) and the distinctive activity patterns around the burned rock accumulations suggest a temporal change, as well as an activity pattern change for **Marcos**-associated peoples. **Montell** points were concentrated around Area B and frequently occurred in Areas A and E and BT 6. **Castroville** points were associated with **Montell** point distributions in Areas A and C, and with **Montell** and **Marcos** points in Area B. A southern site distribution of **Castroville** and **Marcos** points was identified between Middens 1 and 2.

Subsistence: Identifiable faunal remains associated with Local Period 8 were recovered from Area B, 99.40-99.30, 99.60-99.50; Area C, 99.30-99.20; and Area I, 99.10-98.90. A possible **Marcos**-related collection of faunal materials was also identified in Area B, 99.60-99.50. **Bison** and **Odocoileus** fragments predominated the faunal elements from each area as shown in Table 49. In addition, **Antilocapra** remains were noted at 99.50-99.40 (one element) and at 99.20-99.10 (three elements). **Antilocapra** remains found at 99.50-99.40 in Area B may actually overlap, in terms of stratigraphy and faunal assemblage, into Local Period 8. Other species identified, but represented by only a few elements, included turtle, **Ictalurus**, **Canis** sp., and **Geomys**. One human maxilla fragment was also recovered from Area B, 99.40-99.30. Within each of the defined Local Period 8 deposits, **Odocoileus** dominated the identifiable faunal remains (an average of 52%). **Bison** remains were also present, but less frequent, and in all associated levels they represent an apparent secondary food source. **Odocoileus** is again the most common fauna recovered from Area I, and **Bison** remains appear only as a very small portion of the recovered material. For unknown reasons, Local Period 8, reflected by deposits in Area I represents a much more diversified (exploited) faunal assemblage, and Area I was predominantly associated with **Castroville** points. Bone fragments of turtle and catfish fragments were recovered in the faunal collection, suggesting that aquatic resources were at least a supplemental food source. Two samples of charred wood, **Juniperus** sp., were recovered from Area B. Charred fragments of **Juglans nigra** (black walnut) hull and **Proboscidea** sp. (unicorn plant) seed, representing prehistoric food remains, were also collected.

Inferred Activities: As noted, Local Period 8-related artifacts are situated in the vicinity of burned rock middens, primarily Middens 3 and 4. **Marcos** projectile points were often recovered within the spatial area of the actual midden rather than adjacent to it. **Montell**-related activities were situated north of burned rock Midden 3 and west of Midden 4; **Castroville**-related activities occurred between Middens 3 and 4. A much higher ratio of bison and/or deer faunal remains was noted in Areas B and C than in Area I; minimal bison materials were collected from Area I.

TABLE 49. PERCENTAGE OF FAUNAL ELEMENTS ASSOCIATED WITH LOCAL PERIOD 8, BY SELECTED UNITS

	Area B 99.40-99.30	Area B 99.60-99.50	Area C 99.30-99.20	Area I 99.10-98.90
Odocoileus	48.5	29.6	55.1	72.7
Bison	28.5	33.3	27.5	6.0
Sylvilagus	--	7.4	--	3.0
Total	77.0	70.3	82.6	81.7

Associated lithic materials for Local Period 8 are characterized by a wide morphological variety of cores, thick and thin bifaces, and perforators. Lithic activities at the site during this period were extensive, with a diverse collection of tools and related activities.

Discussion: Stratigraphically, **Marcos** projectile points slightly overlie **Castroville** points. As horizon markers, the **Marcos** and **Castroville** points are assumed to be contemporaneous, but the former is characterized by more extensive vertical deposits. Although the distribution of **Montell** and **Castroville** projectile points and their presumed associated activity areas are thought to be similar to the earlier spatial distributions represented by Local Period 7-related materials, **Marcos** points and their related cultural associations reflect distinctive if not different activity areas (i.e., rather than being located on the margins of middens, these materials were often found slightly overlying burned rock accumulations or within them). It should be restated that the distribution (which overlaps the defined cultural deposits of Local Period 8 [upper levels] and Local Period 9 [lower levels]) of **Marcos** points may represent another discrete local period at the site. Alternatively, **Marcos**-associated materials may be related to Local Period 9. On the basis of both spatial and vertical distributions of **Marcos** projectile points, this report favors the latter postulation; however, the problem will remain unresolved until further data is available.

Although deer and bison still predominate the overall faunal assemblages related to Local Period 8, there is a discernible decrease in the percentage of these faunal elements in this period. Bison and deer compose approximately 75% of the remains from Local Period 8 and approximately 90% of the faunal remains associated with Local Period 7. The faunal anomaly associated with **Castroville**-related materials and identified in Area I (i.e., the very low ratio of deer to bison remains) may suggest either a short-term, localized processing area or a more widespread faunal change.

In summary, cultural remains of Local Period 8 are a continuation of extensive activities in the north and central site locations; intensive lithic activities are reflected by the large and diverse collection of debitage and tool forms. Subsistence exploitation follows the patterns of

Local Period 7, but a marked increase of exploited faunal species other than deer and bison was noted.

LOCAL PERIOD 9 COMPONENT

Chronological Indicators: **Ensor**, **Frio**, and **Fairland** projectile points.

Associated Artifacts: Grinding slabs (GP:3), manos (GP:1), grinding boulders (GP:2), thick bifaces (TK1, TK5, TK6, TK8, TK11, TK13, and TK14), thin bifaces (TN5:1, TN5:2, TN10:1, TN14 are most frequent), and perforators (P:1).

Associated Radiocarbon Dates: None assayed.

Associated Features: (1) Possibly Feature 7 of Area C (99.50-99.30), E1006 N1022. This irregular concentration of burned limestone rock (cf. Area C, Feature 7, Excavation Area Descriptions and Interpretations section) was poorly defined and may actually be the upper level of a large scatter of burned rock at lower levels. (2) Feature 2, Area B (99.66-99.50); a circular concentration of burned limestone rocks ca. one meter in diameter. A grinding boulder was associated with this feature. No diagnostic materials were directly related to the rock concentration; stratigraphic position suggests a Local Period 9 context.

Spatial Distributions: Local Period 9 artifacts are scattered throughout the northern and central portions of the site, with the exception of **Ensor**-related artifacts, which are broadly scattered throughout the entire site area. **Frio**-associated materials were noted primarily in Areas B and C. No concentrations of **Fairland** projectile points were noted during the excavations. Local Period 9 materials were located at varying depths throughout the site, and some intermixing of horizon markers was noted stratigraphically within the excavated units. All northern site areas identified as related to Local Period 9 are represented by a collection dominated by **Frio** points. **Ensor** materials, in an apparently discrete distribution, were excavated from southern Units H, I, and E1010 N950.

Subsistence: Areas B (99.50-99.40), C (99.40-99.30), E (99.50-99.40), and I (99.20-99.10) contained faunal remains associated with Local Period 9 activity. Eleven faunal species were recorded for Local Period 9; four elements are presented by percentage per area by selected units in Table 50.

The presence of **Antilocapra** (Area B, 99.50-99.40; Area I, 99.20-99.10) indicates an intrusion of pronghorn into the upper Salado Creek drainage during Local Period 9. The lack of **Bison** and the occurrence of **Antilocapra** suggest an increased exploitation of deer and smaller fauna, perhaps related to changing environmental conditions. Such conditions may have caused significant shifts in the migration patterns of Plains-associated herd fauna such as **Bison** and **Antilocapra** (cf. Dillehay 1974). The faunal remains from Area I are particularly significant because these materials represent the remains of a predominantly (if not single) **Ensor**-related cultural activity.

TABLE 50. PERCENTAGE OF FAUNAL ELEMENTS ASSOCIATED WITH LOCAL PERIOD 9, BY SELECTED UNITS

	Area B 99.50-99.40	Area C 99.40-99.30	Area E 99.50-99.40	Area I 99.20-99.10
Odocoileus	60.8	68.8	37.5	66.6
Bison	21.7	19.4	12.5	8.3
Sylvilagus	4.3	5.5	50.0	4.1
Antilocapra	4.3	--	--	6.2
Total	91.1	93.7	100.0	85.2

The occurrence of **Antilocapra** elements within this area indicates the presence of pronghorn associated with **Ensor** points.

Other species identified, but occurring infrequently, include turtle, bird, snake, and fish.

No identifiable flora were recovered from levels associated with Local Period 9.

Inferred Activities: The distribution of Local Period 9 materials is similar to the general distribution of materials for Local Period 8; materials from both periods are adjacent to burned rock middens. This is especially noticeable in the central site area where the recovery of materials from Local Periods 8 and 9 suggests an extensive occupation location between burned rock Middens 2 and 4. The actual spatial distribution of Local Period 9-related material is broader than the distribution of the preceding Local Period 8-associated materials; however, absolute frequencies of chronologically diagnostic projectile points decrease. Compared to the earlier period, the distribution of Local Period 9 materials suggests a larger site population or limited, but more widely scattered, recurrent occupation at the site. The **Ensor**-related occupation in the southern portion of the site marks the chronologically last, extensive occupation in the southern area.

Lithic materials associated with Local Period 9 activities consist of thin biface forms and an indented-base perforator. The frequency of lithic materials in Local Period 9 generally is much lower than the diverse collection of lithic materials from Local Period 8. The stone tool and debitage collection indicates a reduction in lithic processing, as compared to Local Period 8.

Discussion: Local Period 9 is one of the distinctive south-central Texas cultural manifestations that is not accurately reflected in Prewitt's (1981) recent chronology. The Twin Sisters and Driftwood phases are temporarily equivalent to Local Period 9, however, these late/transitional phases do not include the widely distributed south-central Texas projectile point, the **Frio**. This may in part reflect the fact that the Driftwood phase (**Mohamet**

projectile points and Hare bifaces) is a phenomena restricted to only the eastern (and northern) portion of central Texas as noted by Prewitt (ibid.:82).

The Local Period 9 component at 41 BX 228 did not evidence the apparent gathering emphasis suggested by Prewitt for the Twin Sisters phase. No distinctive ratio of bifacial and unifacial tools was noted in Local Period 9 levels, but faunal remains do indicate that **Odocoileus virginianus** was a primary food source, with **Bison** only infrequently exploited. General faunal trends, as noted, suggest a decreased emphasis on **Bison** as a resource and a corresponding increase in the exploitation of deer and other fauna. The presence of pronghorn, coupled with the infrequency of **Bison**, may indicate as yet unidentified environmental changes that caused substantial subsistence adaptations during the span of Local Period 9. It should be noted that, while **Antilocapra** remains are identified only in Local Period 9 levels, pronghorn remains have been identified in Late Prehistoric contexts in southern Texas (Hester and Hill 1975:16). Although other explanations may exist, this phenomenon may indicate a gradual southern migration of this species.

LOCAL PERIODS 10 AND 11 COMPONENTS

Considerable mixing, probably due to bioturbation, of materials from Local Periods 10 and 11 was noted throughout most of the site. Although these periods can still be separated from earlier components, the elements related to Local Periods 10 and 11 can only be distinguished in areas containing only artifacts from a single period or a specific feature directly linked to diagnostic materials. Since lithic debitage and faunal remains cannot be easily divided, Local Periods 10 and 11 are discussed as one entity rather than individually.

Chronological Indicators: **Scallorn** (Local Period 10), **Edwards** (Local Period 10), and **Perdiz** (Local Period 11) projectile points; incised and undecorated ceramics.

Associated Artifacts: Thick biface (TK15), thin bifaces (six forms; TN3:1, TN7:1, TN7:2, TN9, TN11:1, and TN13:1), perforators (P:1), unifaces (U1:2, U2:1).

Associated Radiocarbon Dates: TX-3856, A.D. 980 $\pm$ 70, MASCA calibrated; related to **Scallorn**-associated Feature 1, Area A.

Associated Features: Feature 1 located in Area A was composed of a burned rock cluster and associated cultural debris. Numerous ceramic sherds, mussel shell fragments, charred walnut hulls, several small quartz flakes, and one **Scallorn** arrow point were found in close association. A partially reconstructed ceramic vessel indicated that associated debris from this feature was scattered throughout most of Area A, but concentrated in the northern units. Although disturbance has caused some mixing of Local Periods 10 and 11 materials throughout the excavation area, this identifiably discrete

feature is considered an intact, localized activity area dating to Local Period 10.

Feature 3 (Area B) and Feature 5 (Area A) are baked clay and charcoal features dating to Local Period 10. These features are interpreted as the remains of burned tree stumps. The presence of two burned tree stumps some 20 m apart suggests some type of widespread activity. Two possibilities are considered: an uncontrolled forest fire or controlled burning. In absence of a lens of charcoal and burned fallen logs that would result from an uncontrolled fire it is more likely considered that the burned tree stumps were the result of controlled burning. Perhaps the northern site area was partially cleared during Local Period 10.

Spatial Distributions: Local Period 10 materials, like those of Local Period 11, were concentrated in the northern portion of the site, primarily within the vicinity of Area A, although a high activity center was also noted in Area B, and a southern manifestation of Local Period 10 artifacts was identified in Areas I and J. **Scallorn**-associated materials identified in Local Period 10 contexts were more spatially discrete than Local Period 11 artifacts. Fifty-eight percent (12) of the excavated **Scallorn** points were recovered from Area A, and 75% of these points were found in the northern site area.

Edwards projectile points, also related to Local Period 10, were recovered primarily from Area A. A single **Edwards** point was excavated from Area G and another from Area I. Two others were recovered from the upper levels of the extensively disturbed Area H.

Local Period 11 materials were concentrated in the northern portion of the site and around or within excavation Areas A, B, C, E, and E1020 N1024. Although considerable mixing was noted, Local Period 11 artifacts were usually found in the upper two levels of those units. Vertical distributions ranged from surface to approximately 15 cm below surface. In addition to the northern site activity area, a single **Perdiz** point was found in association with five ceramic sherds in the upper levels of Area J. The sherds from Area J are morphologically similar to Group 4 ceramics also found in Area E (E1010 N1029). Area E sherds, as noted, appear to be related to **Perdiz**-associated materials. A small incised sherd from Area D (Ceramic Group 6) may be linked to Local Period 11, based on the morphological similarities between Area D ceramics and Area E **Perdiz**-related ceramics.

Subsistence: Seventeen faunal species remains were associated with Local Periods 10 and 11 diagnostic materials. A percentage breakdown of four of the more frequent faunal materials from Local Periods 10 and 11 are summarized in Table 51.

Collected and identified faunal materials indicated that **Odocoileus virginianus** fragments were the most common skeletal materials (comprising approximately 44%). **Bison** remains contributed approximately 14.5% to the overall faunal assemblages. Turtle and **Sylvilagus** skeletal remains occurred only infrequently. Other faunal remains, which also occurred infrequently, included **Meleagris** sp., **Canis**, unidentified snake, **Tayassu**, rodent, fish, and

TABLE 51. FAUNAL ELEMENTS ASSOCIATED WITH LOCAL PERIODS 10 AND 11, BY SELECTED UNITS

	Area A	Area E	Area I
Odocoileus	47.1%	16.6%	33.3%
Bison	15.0%	16.6%	50.0%
Turtle	16.0%	-	16.6%
Sylvilagus	1.9%	50.0%	-
Total	80.0%	83.2%	99.9%

Lepus. The presence of **Tayassu** from Area A apparently links javelina to Local Periods 10 and 11. The frequency of turtle remains during Local Periods 10 and 11 reflects a significant increase in the exploitation of this species; this may represent a diversification of resource exploitation strategy to include aquatic food resources.

Faunal materials from Local Periods 10 and 11 represent the most diversified faunal assemblage related to any cultural component at the site. This diversity may be explained by (1) the better preservation of these materials and/or (2) an actual prehistoric emphasis on the exploitation of much more diversified faunal resources.

Inferred Activities: Multifunction occupational activities are postulated for cultural manifestations associated with Local Periods 10 and 11. Intrasite distributions of these activities, as noted, were concentrated in the northern site area, especially in the vicinity of Area A. A ceramic associated location, Area D, may represent the remains of a nonlithic activity locus.

Lithic materials associated with Local Periods 10 and 11 are characterized by a series of thin biface types and two distinct forms of unifaces. The low overall frequency of lithic forms suggests a low intensity of lithic processing; this may be due to a low population size or a prehistoric emphasis on nonlithic activities during site occupation.

The distribution of Local Periods 10 and 11 materials across the site and the artifact concentrations in the northern portion of the site suggest a specific factor(s) which influenced the location of activity areas. This factor may have been a tendency to locate Local Periods 10 and 11 occupations near earlier burned rock midden accumulations. A secondary exploitation of midden rocks may be another explanation for this situation.

Discussion: The presence of ceramics associated with an apparent **Scallorn**-related feature in Area A is an anomaly in the archaeological record of central and south-central Texas. Prewitt (1981:83) does not recognize ceramics as a representative artifact of the Austin (**Scallorn**-associated) phase, and he suggests that the addition of ceramics occurred during the Toyah (**Perdiz**-related) phase. The discrete physical characteristics of the **Scallorn** and ceramic feature in Area A, as well as a MASCA-calibrated radiocarbon date that falls well within Prewitt's (**ibid.**) own estimated age of the Austin phase, suggest an earlier manifestation of ceramics in south-central Texas.

Based on faunal remains, **Bison** was not a primary food resource in Local Periods 10 and 11, rather faunal exploitation was apparently directed toward **Odocoileus virginianus** with a more diverse assemblage noted than in previous components. Hester and Hill (1975) have noted a large diversity of faunal remains in Late Prehistoric sites in southern Texas, specifically 41 ZV 155; extensive faunal remains have also been noted at 41 JW 8, an apparent single-component, **Perdiz**-associated site (Hester 1977).

THE IMPORTANCE OF WHITE-TAILED DEER AT 41 BX 228 (A. Joachim McGraw)

White-tailed deer (**Odocoileus** [or **Dama**] **virginianus**) predominated the identifiable faunal deposits throughout the cultural deposits at 41 BX 228, and as such, these remains represent a primary food source. Prehistoric hunting groups that occupied the site are thought to have developed a preference for **Odocoileus** and to have adapted specific subsistence strategies to exploit this resource most effectively.

The identifiable deer bones from the faunal assemblages at the site included almost every bone from a deer skeleton, except the candal vertebra; this implies that complete deer carcasses were brought to the site for butchering. The greater number of skull and hind limb bones also indicate that sometimes only portions were transported to the occupation area. Forelimb bones (especially ulnae, humeri, and the proximal portions of radii) were also more common than pelvic bones and scapulae. When age could be determined, deer faunal material from the site was arranged in age groups. Very few fawns or old individuals were noted, and the majority of the deer was between 1.5-4.5 years old. Hulbert (Special Studies section VII) noted that a small percent of the deer bones from 41 BX 228 were 15-30% larger than modern white-tailed deer from central Texas. This could be attributed to the presence of either a second species such as mule deer (**Odocoileus hemionus**) or very large white-tailed deer. The second possibility is considered more likely. The prehistoric presence of large white-tailed deer in an area that historically is well known for small-sized deer is interesting. This suggests that the prehistoric habitat was better in quality than the modern habitat. In view of historic patterns of overgrazing, erosion, and urban settlement in central Texas, it is an unsurprising suggestion. A discussion of the modern distribution, patterns of behavior, and environmental preferences of **Odocoileus** will be briefly presented to more clearly relate this faunal resource to prehistoric cultural activities.

White-tailed deer are at present found across much of North America, Central America, and northern South America (Kellogg 1956; Hall and Kelson 1959). In northern and eastern North America, white-tailed deer occupy deciduous and coniferous forests, although forest openings have been shown to be an important component of the environment. In western and southwestern North America, deer occupy a more open range and commonly feed in broad plains and savannah regions, but retreat to brush-covered areas during inactive periods (Hirth 1977). Hirth (**ibid.**) also noted that at no point in its range is this species a true open-plains animal as is **Bison bison** or **Antilocapra americana**, but there are great differences in the amount of dense, woody cover utilized by white-tailed deer in various localities. In Texas, white-tailed deer occur almost entirely in hardwood locations except for the southeastern portion of the state where the dominant vegetation is a mixture of pines and hardwoods (Davis 1974:257). White-tailed deer are extremely territorial and have a small home range and browsing radius. When conditions are adequate, deer tend to stay in one locality for long periods. In the Edwards Plateau, deer marked for experimental purposes have remained in the same section of 640 acres for at least three years. A few were noted as far away as five miles (**ibid.**).

Feeding habits of deer vary both seasonally and spatially. In the Edwards Plateau range, the most-favored foods are grasses and weeds, grain, Spanish oak, acorns, spite rush, **Forestiera**, and turkey pear. The importance of acorns in the white-tailed deer diet has been reported on many ranges; Dunkeson (1955) has suggested that deer feed less on browse when acorns are available. White (1973) indicated that deficiencies in forage quality are common in southern deer ranges and that those which provide a mast crop (fallen, on-ground acorns and nuts used as food) are the best deer ranges.

It is assumed that the selection of 41 BX 228 as an occupation site was directly linked to proximity of water, lithic, vegetal, and faunal resources. Bison and deer were thought to be the most highly exploited animals, but faunal remains indicate that the exploitation of deer dominated the hunting aspect of prehistoric activities. Local physiographic features within 1 km^2 of the site[1] indicated high resource productivity areas that may be associated with prehistoric activites. Plotted on an USGS topographic map, such a 0.5-km radius around the site is dominated by a Recent and Pleistocene floodplain, as well as a major water source along Panther Springs Creek. It should be noted that the floodplain, as a physiographic, exploited resource area, contains the highest productivity values of any environmental resource area. The location of 41 BX 228, within an ecotonal region generally and in a high productivity area specifically, represents the optimum situation for utilization of not only vegetal elements but for exploitation of the specific dominant fauna, **Odocoileus virginianus**.

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[1]Following Chisholm's (1968) model that the bulk of any community's economic activities are conducted within 1 km of the community.

X. SITE 41 BX 228 AS A BURNED ROCK MIDDEN SITE

(Stephen L. Black)

Several of the research problems investigated at 41 BX 228 concern the burned rock middens at the site. Burned rock middens and the sites that contain them are striking and distinctive phenomena associated with central Texas prehistory. For over 60 years, archaeologists have investigated these sites, and yet, despite a hundred or more excavations and many pages of speculation, no one has effectively demonstrated what specific cultural activities resulted in these accumulations. The definitive discussion of the history of burned rock midden investigation and interpretation remains unpublished (Prewitt n.d.), hence we have provided the following background discussion.

THE CENTRAL TEXAS BURNED ROCK MIDDEN

A central Texas burned rock midden is a pile of burned and broken limestone rocks. A number of differences exist, however, between middens from different sites or even within a single site. Some sites have a single midden, while others contain up to 52 middens (Weir 1976a:34). The middens range in size from five meters in diameter to several acres in area. They vary from a single layer of rock to over two and one-half meters in thickness. Some middens are completely exposed on the surface, while others are subsurface features marked by only a slight, almost imperceptible rise in the modern ground surface. Considerable differences have also been noted in the amount of cultural debris associated with the middens; some middens contain little more than rock, while others contain abundant cultural remains, including lithic debitage, chipped stone tools, bone fragments, mussel shell, ground stone, and other occupational debris.

Weir (ibid.) defined four types of burned rock middens based solely on morphological characteristics. Type 1 middens are unique to central Texas and are the most numerous midden type; they are oval to circular in outline, plano-convex in cross section, and display no apparent internal structure. Type 2 middens, commonly called "ring middens," are torus-shaped, i.e., they resemble a doughnut, having a raised ring of rock around a central depression that appears to be a pit. Type 3 middens are "crescent middens" and are similar to Type 2 middens except one side of the ring has a noticeably higher buildup of rock. Type 3 middens also have a central pit. Type 4 middens are more commonly known as "burned rock scatters," consisting of a single or double layer of rock with an oval to circular outline. These probably represent incipient middens or disturbed hearth features.

Ring and crescent middens have been effectively demonstrated to be specialized pit ovens with a surrounding mound of discarded burned rock (Greer 1968). These middens are usually interpreted as agave-, yucca-, or sotol-processing features, although as Brown, Prewitt, and Dibble (1976:14-15) point out, no one has carefully excavated a pit oven and identified the plant remains. Both the location of these features adjacent to stands of agave, yucca, and sotol, and ethnographic accounts (ibid.) support the Greer

interpretation. Both midden types occur primarily in the western half of central Texas and extend westward through the Trans-Pecos area and beyond.

Weir's midden Type 1 is a problematic type with no internal structure and no ethnographic analogy. A number of hypotheses have been advanced to explain the formation of these middens. It is widely agreed that Type 1 middens (hereafter referred to as burned rock middens or middens) result from some sort of activity involving fire and food resources. Beyond that, there is a noticeable lack of agreement on the mechanics of processing and on what was being processed.

J. E. Pearce began systematic exploration and speculation on burned rock middens in 1919. Pearce called them "kitchen middens" and believed they resulted from the use of limestone slabs to "keep the fire together and for cooking and boiling water." After several heatings, "rain would cause them to break up into smaller fragments that were no longer serviceable" (Pearce 1919:230). The fragments were then tossed back into a heap. Pearce's explanation, which could be termed the "kitchen heap" hypothesis, anticipates aspects of almost all succeeding hypotheses.

Huskey (1935) defined two varieties of burned rock middens along the Nueces River near Uvalde, Texas. Huskey's variety "B" middens are apparently Late Prehistoric features, while his variety "A" middens are equivalent to Weir's (1976a) Type 1 midden. Huskey believed variety "A" middens were incidental accumulations formed "through the years of more or less continuous inhabitation" (Huskey 1935:105). He goes on to suggest that the burned rock fragments resulted from the use of rock slabs to roast "chunks of meat" by indirect heating. The "rock slab" hypothesis has been seldom discussed in recent years.

In an article published in **American Antiquity**, Kelley and Campbell (1942:320) argued that burned rock middens were unintentional accumulations that were formed by repeated constructions of stone-lined hearths in the same area "resulting in a complex assemblage of superimposed and intersecting hearths." Later hearths disturbed earlier hearths resulting in "a more or less homogeneous deposit" (**ibid.**). Unfortunately, Kelley and Campbell based their article on still unpublished excavations done by the WPA along the Colorado River. Little has been published in intervening years to substantiate the "intersecting hearth" theory.

Sorrow (1969) and Hester (1970, 1971) reviewed burned rock midden formation and suggested that middens were not the focus of cultural activity, but instead represented "communal dumps" or locations where fragmented hearth stones were purposefully discarded. The main foci of activity, camping and cooking, were centered outside the midden. Both Sorrow and Hester have cited excavation data that show noticeably greater artifact densities outside the middens to support this contention. Data from other burned rock midden sites, such as the Shep site (Luke 1980), also support the idea that at many midden sites most cultural activity was centered outside the middens rather than within or on top of them.

Collins (1972) proposed several hypotheses regarding burned rock middens in central Texas in connection with his analysis of an apparent ring midden at the Devil's Hollow site. The internal structure (central ash pit) of the Devil's Hollow midden led Collins (ibid.:98) to suggest that "earth ovens" may be present in other central Texas middens. The absence of apparent internal structure noted for most central Texas middens (Weir 1976a:34) questions the applicability of this hypothesis to midden types other than ring middens. More relevant to most central Texas middens is Collins's (1972:98) proposal that "social groups of large size" were responsible for some midden accumulations. Collins used mussel consumption rate estimates and an observed homogeneity in projectile point form to support his idea that the Devil's Hollow midden could have been formed over a very short time by a macroband. Collins (ibid.:97) cites homogeneity of projectile point form at several middens in central Texas as a possible indication of burned rock accumulation "by large groups for short periods of time." Collins's proposal could be termed the "macroband" hypothesis of midden formation.

Weir (1976a:125) hypothesized that burned rock middens may have developed as the result of "specialized nut processing." "A greater density of oak, an apparent expanded human population, and the development of the diagnostic Burned Rock Midden Type 1 . . ., all occurring at about or shortly after 5000 B.P. is no coincidence." Weir views the beginnings of burned rock midden accumulation as a specialized adaptation to the full acorn harvest. He goes on to link burned rock middens and acorn harvesting to deer hunting, pointing out that deer are acorn browsers. Weir does not offer an explanation of the mechanics of acorn processing.

Prewitt (n.d.) presented the "vegetable bake" hypothesis that combines elements of several previous interpretations:

> Burned rock middens are both intentional and unintentional products of a cultural pattern in which certain favored loci were repeatedly used over long periods of time for the construction and maintenance of formal stone-lined hearths and/or rock ovens which were used primarily for the processing of specialized vegetable foods (acorns and/or sotol?), but which saw service as common cooking loci as well; the primary locus of activity was not necessarily at or near the hearth and/or rock oven in use at that time, but fluctuated with the needs of the people and was situated off the midden in some instances and on middens which were not in other use in some instances.

While Prewitt's theory covers many possibilities, his background discussion leading up to the formal theory presentation places a significant emphasis on sotol processing. Prewitt notes that sotol does not grow now in the eastern portion of the Edwards Plateau, but he speculates that sotol was present all across central Texas during the period of midden accumulation and largely disappeared (except in the west) during an inferred mesic interval ca. 2500 B.P. Prewitt believes that sotol processing continued in west-central Texas after 2500 B.P. as evidenced by ring middens.

A final mechanism for the formation of burned rock middens has been mentioned by numerous authors but never formally hypothesized. Pearce (1919), Hester (1973a), Witkind (1977), Weir (1976a), and Jones (1981) suggest that "stone boiling" may account for some of the fire-cracked limestone which make up the burned rock middens. Several authors have suggested that the limestone cobbles used for stone boiling or pit steaming might neutralize the tannic acid in acorns. Witkind's (1977) experiments with stone boiling indicated that limestone cobbles lose some heat-retention capability upon reuse. Jones (1981) alternated limestone cobbles between a fire and a container of water and was able to maintain boiling water for 35-40 minutes before the cobbles fractured. Jones detected a one-hundredfold drop in acidity in an acorn gruel after only 15 minutes of limestone-cobble boiling. While these limited experiments cannot prove that burned rock middens result from stone boiling acorns, they do show that limestone cobbles can effectively be used for stone boiling. They also demonstrate that limestone cobbles used for stone boiling will fragment within a fairly short time and resemble the burned rock found in middens. Jones's experiment further suggests that limestone could have been used to neutralize the tannic acid which renders most acorns unpalatable.

Most of the above-mentioned hypotheses focus only on limited aspects of burned rock midden accumulation and are not mutually exclusive. For example, it is possible to combine the "communal dump," "macroband," "stone boiling," and "specialized nut processing" theories. In such an explanation, midden accumulation would be attributed to macrobands forming during the fall to harvest and stone boil acorns. The fractured rock would be discarded at a designated communal dump, thus forming a burned rock midden. All of the proposed explanations have shortcomings as touched on. Midden characteristics across central Texas vary to such an extent that, as Hester (1971:126) has noted, almost any theory could be proven by considering only select sites. Weir (1976b:63) and many others have suggested that burned rock middens accumulated as the result of several different processes rather than any one specific activity.

BURNED ROCK MIDDEN DATA FROM 41 BX 228

Four buried burned rock middens (Fig. 53) were encountered during the 1979 field season at 41 BX 228. The examination techniques applied toward these features included backhoe trenching, test excavation, and soil sampling. The limits of these subsurface features were determined by backhoe trenching, which also provided profiles of each midden. Test excavations were conducted within and outside three of the middens. All burned rock fragments from each excavation unit-level were counted and weighed in the field prior to discard. In addition, several soil columns were collected from within and outside the middens to provide samples for matrix flotation, soils chemistry, and phytolith identification. The two longest backhoe trenches that bisected one or more middens were chosen for soils chemistry interval sampling. Small soil samples were collected at one-meter intervals above, within, and below burned rock middens, and at similar depths outside the middens along the backhoe trench profiles. A summary of the data from each midden follows.

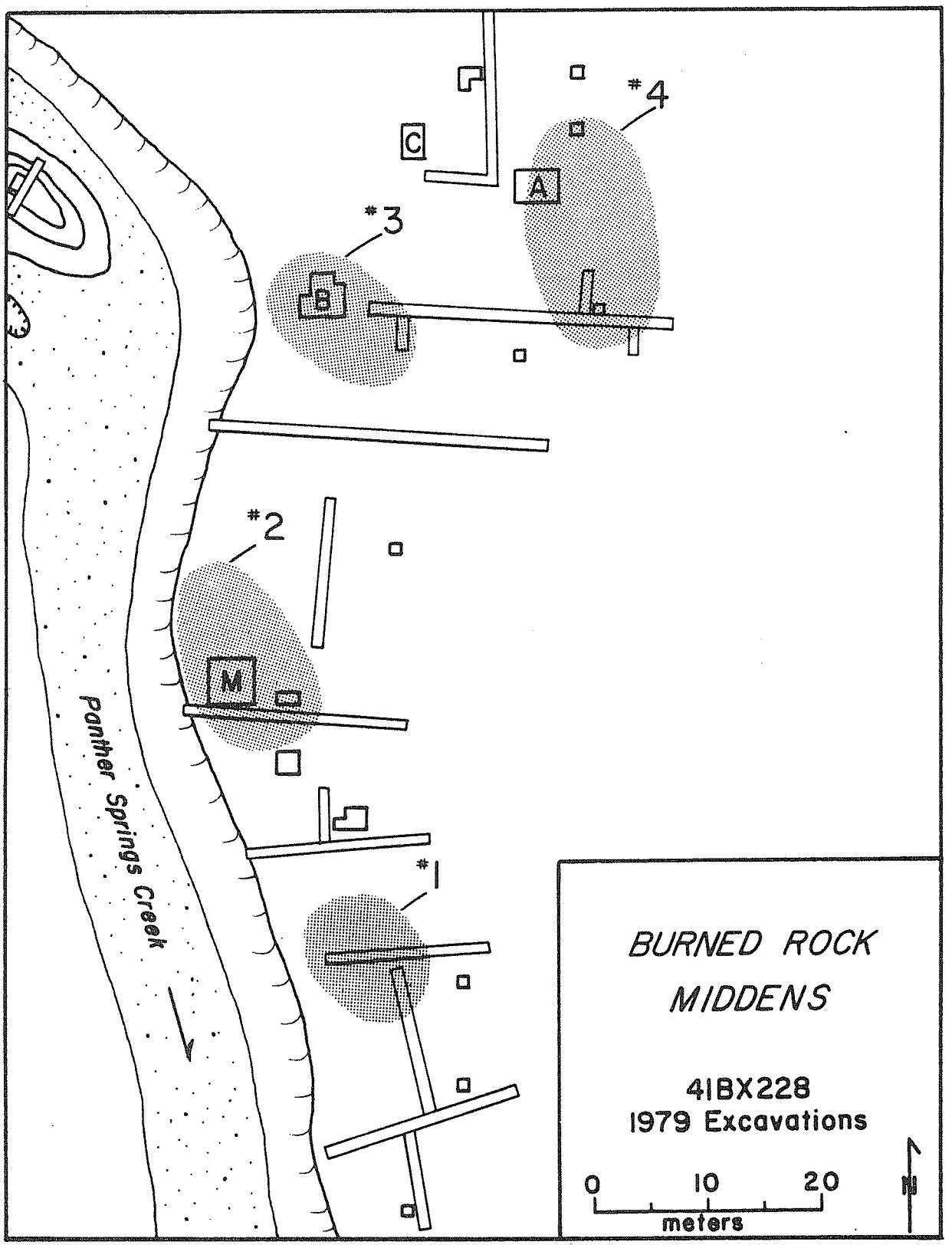

Figure 53. **Burned Rock Middens, 1979 Excavations.**

MIDDEN 1

Location: south end of site on bluff edge; E1002.5 N950.5 (approximately midpoint)

Trench profiles: BT 7 and BT 8

Maximum depth: 55 cm below surface

Maximum thickness: 45 cm

Dimensions: 12 (NNW-SSE) x 9 (ENE-WSW) m

Estimated rock density: unknown, 500 kg per m^3 used for estimates

Estimated area: 84.8 m^2

Estimated volume: 19.13 m^3

Estimated total burned rock weight: 9566 kg

Discussion: No units were placed within Midden 1. Careful examination of trench profiles and backhoe trench spoil piles revealed very little cultural debris except burned rock. Little or no charcoal or ash was observed. One small excavation unit, E1050 N950, was excavated approximately three meters east of Midden 1. Compared with most other units at the site, cultural material density was very low in this unit. The only chronological indicators recovered (Local Periods 8 and 9) were found in the uppermost level and probably reflect occupation long after Midden 1 was accumulated. Midden 1 cannot be confidently dated from the data available; however, based on the overall horizontal distribution of chronological indicators, the accumulation most likely can be attributed to Local Period 6.

MIDDEN 2

Location: south-central site area on bluff edge; E990 N978 (approximately midpoint)

Trench profiles: BT 4

Maximum depth: 85 cm below surface

Maximum thickness: 80 cm

Dimensions: 18 (NNW-SSE) x 10 (ENE-WSW) m

Estimated rock density: 953.9 kg per m^3

Estimated area: 141.4 m^2

Estimated volume: 56.82 m^3

Estimated total burned rock weight: 54,198 kg

Discussion: Midden 2 had by far the highest rock density of any of the middens at 41 BX 228. Area J was excavated through the thickest part of the midden. Debitage, bone, and fire-cracked chert quantities decreased proportionally to the increase in rock. The densest level (1 m^2/10 cm level) had 135.1 kg of burned rock and almost no other cultural material. The cross section of Midden 2, seen in the profile of BT 4 (Figs. 2,d; 4), is an almost ideal plano-convex lens. A large charred wood fragment was exposed during the cleaning of the midden approximately 18 cm below surface. The sample was radiocarbon dated to 800 B.C. $\pm$ 60 (MASCA calibrated), a determination that falls at the end of Local Period 7. As discussed in the Methodology section, the upper 60-70 cm of Midden 2 was removed by the backhoe prior to the excavation of Area M. The upper portion of the Area M excavations contained the lower portion of Midden 2, where a number of chronological indicators were attributable to Local Period 6. Based on the radiocarbon date and the chronological indicators from Area J and Area M, Midden 2 appears to have been formed during Local Periods 6 and 7.

A unique aspect of Midden 2 is the apparent pit oven feature (Area M) underlying the main burned rock accumulation. This feature is believed to represent a small ring midden (communal rock oven with a shallow central pit) used during Local Period 6. It should be noted that due to the massive burned rock accumulation overlying the Local Period 6 ring midden there was no surface indication of a pit depression. It is suggested that the pit oven was used prior to the burned rock accumulation of Midden 2 at 41 BX 228 (early in Local Period 6). No later pit features or indications of ring middens are associated with burned rock midden accumulation at the site.

MIDDEN 3

Location: north-central site area on bluff edge; E1000 N1007 (approximately midpoint)

Trench profile: BT 10A

Maximum depth: 65 cm below surface

Maximum thickness: 40 cm

Dimensions: 14 (SW-SE) x 9 (SW-NE) m

Estimated rock density: 432.5 kg per m^3

Estimated area: 99 m^2

Estimated volume: 19.83 m^3

Estimated total burned rock weight: 8675 kg

Discussion: Midden 3 had the lowest burned rock density of any midden at 41 BX 228. Area B was excavated through Midden 3, and nonburned rock cultural materials were much more numerous than in Middens 1 and 2. Based on the relative frequencies of chronological indicators above, within, and below the midden, rock accumulation began as early as Local Period 6, reached a height in Local Periods 7 and 8, and may have continued until Local Period 9. The midden levels in Area B evidence considerable disturbance and contain relatively high quantities of lithic debris (debitage, cores, and bifaces) and bone.

MIDDEN 4

Location: northeast site area 30-40 m from the bluff edge; E1020 N1012 (approximately midpoint)

Trench profile: BT 10, BT 10B, and BT 10C

Maximum depth: 80 cm below surface

Maximum thickness: 70 cm

Dimensions: 21 (N-S) x 12 (E-W) m

Estimated rock density: 568.2 kg per m^3

Estimated area: 197.9 m^2

Estimated volume: 69.45 m^3

Estimated total burned rock weight: 39,463 kg

Discussion: Area F was excavated through the thickest part of Midden 4; Area A and E1020 N1024 were excavated in the northern periphery of the midden. Rock density is higher, and debitage, artifact, and bone densities are lower in the southern portion of Midden 4 (Area F). Area A resembles Area B (Midden 3) in that the deposits are disturbed and contain relatively high quantities of debitage, artifacts, and bone and relatively low quantities of burned rock. The lower portion of Midden 4 was built on the limestone outcrop beneath Area A. Based on relative frequencies of chronological indicators, Midden 4 appears to have been accumulated during Local Periods 6, 7, and 8, with Local Period 7 the major period of accumulation.

SOIL SAMPLING RESULTS

As discussed in the Special Studies section, a major effort was made to collect soils chemistry data from 41 BX 228. A primary reason for this effort was to test the premise that specialized activities produced the burned rock middens and that these activities would be reflected by changes in soils chemistry. Toward this goal, soil samples were collected at even intervals along several of the backhoe trenches that intersected one or more

middens and from columns through several middens. Tables 37 and 38 summarize the soils chemistry results. With respect to the middens, these results seemed disappointing at first. No dramatic differences were noted between the soils chemistry of the midden and nonmidden areas. Upon more careful study some subtle and possibly significant differences were noted.

The soil samples collected from the midden deposits (total=16) averaged 1.61 ppm in phosphate while the eight samples collected from the B-horizon in nonmidden areas averaged over 3.5 ppm. Comparisons of organic carbon, calcium, and pH showed little or no difference between the midden and nonmidden B-horizon samples. The apparent increase of phosphate in the nonmidden areas may be significant. The nonmidden areas that had higher phosphate levels were also some of the areas of the site with the most concentrated cultural debris (other than rock). Several hearth features had noticeably higher phosphate levels. If burned rock middens resulted from intersecting hearths, then one would expect an increase in phosphate within the middens. This is clearly not the case.

It is interesting to note that while the calcium readings were similar in the midden and nonmidden B-horizon samples (2807 and 2810 ppm, respectively), they are also the highest mean values of any of the site deposits. The midden and nonmidden B-horizon calcium values were much higher than the overlying topsoil (2738 ppm) and higher than both the transition zone (2792 ppm) and the gravel deposits (2787 ppm). How to interpret this increase in calcium is not known. It seems reasonable to assume the higher calcium values are due to the increase in limestone rock, although if this were the case, how are the B-horizon samples explained with less calcium?

It should be pointed out that the actual numbers of soil samples that were analyzed from midden and nonmidden contexts were comparatively small except for phosphate. Subtle differences may require much more extensive sampling to accurately define. Based on the limited results of the midden and nonmidden sampling from 41 BX 228 there would appear to be greater phosphate levels in between midden areas than within the middens.

POSSIBLE GRINDING BOULDER ASSOCIATIONS

Two large grinding boulders (Material Culture section, ground and pecked stone) were recovered from midden contexts during backhoe trenching. Both artifacts were observed as the backhoe bucket scraped across the upper surface of a midden. In both instances (Middens 2 and 4), the grinding boulder appeared to have been positioned upright on the top of the thickest (highest) portion of the midden. Because of the circumstances of recovery, it cannot be definitely stated that the grinding boulders were contemporaneous with the final episode of midden accumulation. One is tempted to speculate that the middens were used as platforms for some type of plant processing during later occupations after midden accumulations had ceased, rather than contemporaneously with midden occupation.

VOLUMETRICS

One problem that hampers comparison between burned rock middens is the lack of consistently recorded data. If descriptive data, such as that recorded for the 41 BX 228 middens, were available from more sites, intramidden comparisons would be greatly facilitated. Paul Lukowski (ms.) has recently attempted a volumetric comparison of several burned rock middens using what little information was available (usually only diameter and thickness). In an attempt to provide fairly accurate estimates of midden volume, density, and total rock weight, the present author used the following data, assumptions, and formula. As mentioned earlier, all burned rock from each 1-m^2 unit, 10-cm level was counted and weighed. The rock density estimates were derived by dividing the total rock weight from all levels within a given midden by the number of levels, thus giving an average rock weight for a 1-m^2, 10-cm level. This figure was multiplied by 10 to give an estimate of rock density per m^3. The area estimates were made by assuming an elliptical outline and multiplying $\pi \times 1/2$ length $\times$ 1/2 width, i.e.,

$$(\pi \frac{l}{2} \frac{w}{2}).$$

The volume was estimated by assuming that the cross section of each midden was plano-convex and by using the mathematical formula for the volume of a spherical section. Where h = maximum midden thickness, a = 1/2 length, and b = 1/2 width, $1/6\ \pi\ h(h^2 + 3ab)$. The volume was then multiplied by the estimated density to give the estimated total rock weight.

The value of these estimates is not merely that the total tonnage of burned rock can be calculated but that with the same information from a number of sites, one could estimate the relative amounts of labor represented by each midden. Such comparisons, of course, will have to await confirmation of one or more of the midden-formation hypotheses to be able to relate specific behavioral patterns. For example, if it were established that burned rock middens primarily result from stone-boiling of acorns, then one might devise a means of calculating estimates of how much food per midden was processed. A substantial amount of experimental processing would be required to establish the necessary variables. If all this seems farfetched, the point is that archaeologists must record more information on burned rock middens during excavation so that these data can be later used to elucidate these interesting and long-lived phenomena.

SUMMARY AND INTERPRETATIONS

Four burned rock middens are known to be present at 41 BX 228, and a fifth north of Midden 3 is suspected. The four known middens range in estimated area from 84.8 to 197.9 m^2, in estimated rock density from 432.5 to 953.9 kg per m^3, and in estimated volume from 19.12 to 69.45 m^3. The total weight of rock at all four middens is estimated to be 104,084 kg or 104 metric tons. Most of these estimates are conservative; the actual figures are probably higher. Burned rock accumulation appears to have begun in Local Period 6 (ca. 2500 B.C.) at all three datable middens. Local Period 7 appears to have

been the major period of accumulation in Middens 2 and 4. Local Period 8 appears to have been the major period of accumulation in Midden 3. Midden 2 was apparently abandoned by Local Period 8, Midden 4 by Local Period 9, and Midden 3 may not have been abandoned until some time during Local Period 9. Middens 1 and 2 contain comparatively few artifacts, while Middens 3 and 4 contain numerous artifacts, especially in their peripheral areas.

It is of interest to note that three of the middens are located on the bluff edge close to the probable source of limestone rock, the creek bed. Rounded limestone cobbles were apparently chosen over limestone slabs, but this probably reflects availability more than preferential choice. All four middens were formed on existing relatively high topographic positions that were obviously further accentuated by the midden accumulation. Of the middens with clear stratigraphic profiles (Middens 1, 2, and 4), maximum areal extent seems to have been established during the initial period of accumulation. The excavations in Areas A and B, both of which are located in peripheral midden areas, demonstrate vertical and horizontal differences in rock density. These differences could be interpreted as indicating considerable disturbance (prehistoric or animal digging?) or alternatively, overlapping debris dumps. The central midden areas such as Areas J and F show more consistency in rock density, at least on a vertical basis.

The presence of a small apparent ring midden (pit oven) at the bottom of Midden 2 and the absence of any other indication of central pits in later midden contexts suggest that the earliest period of midden accumulation at 41 BX 228 may have witnessed the use of plant processing techniques unlike that used in succeeding periods. Thus, Midden 2 may have begun as a shallow pit oven (<u>vegetable bake</u>) but this feature was soon covered over with a typical Type 1 midden. The absence of any indication of pit ovens in later midden contexts suggests that the Type 1 middens represent a different plant processing technique.

Based on the excavations at 41 BX 228, the four burned rock middens are thought to represent <u>intentional</u> accumulations of fire-cracked limestone. Specific areas of the site were designated as rock refuse dump areas ("communal dump" hypothesis) and were repeatedly used as such. Other cultural materials, such as chipped stone tools and fragmented animal bone, occur over an area much larger than the concentrated rock deposits. During most of the occupation of the site, the middens would have been standing rock piles. These piles may have been work platforms for plant processing, such as the presence of grinding boulders suggests, or other activities. The edges of Middens 3 and 4 at the northern end of the site seem to have been chert-knapping localities. Luke (1980:27) provides a very graphic demonstration of a chert-knapping locality on the edge of a midden at the Shep site.

This author would argue that the middens at 41 BX 228 and many other central Texas sites represent communal dumps of discarded (unserviceable) fragmented limestone. The limestone fragments are suggested to result from some type(s) of specialized plant processing requiring fresh, unbroken limestone cobbles. The location of virtually all burned rock midden sites adjacent to water sources may also suggest that water was required in the posited plant processing. Two primary vegetal foodstuffs have been suggested: acorns

(Hester 1973a; Weir 1976a) and sotol (Prewitt n.d.). In the present-day absence of sotol over much of central Texas and lacking conflicting paleo-distributional information, sotol is considered unlikely as a primary resource at 41 BX 228. The often-noted correlation between burned rock middens and oak groves (Hester 1973a; Weir 1976a; Creel 1978), coupled with the postulated oak expansion occurring just before midden accumulation began (Weir 1976a), suggests that acorns were the primary vegetal resource at 41 BX 228.

If the above suppositions are correct, then the process(es) that produced the burned rock at 41 BX 228 also combined fresh limestone cobbles, water, and acorns. Two possibilities are considered: pit steaming and stone boiling. Pit steaming would presumably involve inducing steam by adding water to a pit filled with heated cobbles and hulled acorns or perhaps loaves made from ground acorns. The author finds this process more difficult to envision with acorns than for sotol. Stone boiling acorn mush in basketry or skin pouches seems more likely. Ethnographic accounts from California provide possible analogies. Acorns were a major food staple among many California Indian groups, and Heizer and Elsasser (1980:91-100) have summarized the acorn-processing methods used by California groups. Acorns were harvested in large quantities during a relatively brief season in the fall. Tannic acid or tannin was removed from the acorns in two ways. Burying the whole acorns in mud preserved the nuts for months and "sweetened" the bitter nuts by removing the tannic acid. The most common method was to leach out the tannic acid by pouring hot water over ground acorn meal and was usually accomplished in a shallow pit lined with grass or pine needles. The water was heated by stone boiling in tightly woven baskets. The bitter tannin flavor was removed after several hot-water leachings. The leached flour was then either baked on a flat stone to form a cake or, preferably, cooked into a mush. The acorn mush or gruel was prepared by adding water to the leached acorn meal and stone boiling the mixture in a watertight basket. Ethnographic accounts of acorn exploitation in Texas are extremely limited; Keller (1981) cites several brief accounts of acorn gathering among various Caddoan groups in east Texas and adjacent areas.

Ethnographic analogies from California cannot alone be used to demonstrate that the central Texas burned rock middens resulted from the stone boiling of acorns. It is of interest to note the importance of stone boiling in acorn processing among historic Indian groups who relied heavily on acorns. The correlation among burned rock middens, water sources, and oak groves has only been conclusively demonstrated for a small area of west-central Texas (Creel 1978:299). The experimental work on stone boiling (Jones 1981; Witkind 1977) suggests that limestone cobbles could effectively boil acorn mush and possibly neutralize the tannic acid. Final conclusions regarding the function of burned rock middens at 41 BX 228 and at hundreds of other central Texas sites cannot yet be proven. This author argues that burned rock middens must be studied as areal phenomenon, rather than from a single-site perspective. A comprehensive study of the distribution of burned rock middens through time and space with respect to cultural associations, topography, climate, vegetation, and hydrology is long overdue.

XI. AN OVERVIEW OF THE PREHISTORY OF THE UPPER SALADO CREEK WATERSHED

(A. Joachim McGraw)

The current knowledge of the nature, distribution, and significance of prehistoric cultural resources within the upper Salado Creek watershed, northern Bexar County, Texas will be examined in this section. Such an overview is imperative, not only because of the large numbers and types of archaeological sites recorded in the area but also because of the increasing threat of the destruction of these sites.

The identification of many of the prehistoric sites along Salado Creek and its tributaries is related to a variety of interests that have focused attention on the watershed in recent years. Archaeological investigations, conducted primarily by the CAR-UTSA (for the City of San Antonio, private developers, the Soil Conservation Service, and the San Antonio River Authority), have included large portions of Salado Creek, Mud Creek, East and West Elm Creeks, Panther Springs Creek, and Long (or Elm Waterhole) Creek. The net result of these efforts to date has been the recording of over 163 prehistoric sites, numerous testing operations, and four major, individual site excavations.

The significant quality of many of these sites constitutes an additional reason for this overview. The largest identified and investigated prehistoric, stratified sites within the county, as well as a National Register Historic District, are located along Salado Creek and its tributaries. Significant sites include 41 BX 228, the Panther Springs Creek site; 41 BX 229, the St. Mary's Hall site; 41 BX 271 and 41 BX 300, major Archaic period campsites; and 41 BX 338, the Haase site. The last, a recently identified site along a tributary of Panther Springs Creek, has yielded the largest collection of Late Prehistoric ceramics in the county.[1] The importance of these and other sites within the upper Salado Creek watershed lies not only in their uniqueness but also that at present they represent the diversity and extent of prehistoric cultural activities within the study area.

Expanding development in the form of subdivisions and commercial enterprises seriously threatens the preservation of cultural resources in many portions of the drainage system. Subdivisions such as Encino Park (ca. 2000 acres) and Walker Ranch (ca. 1000-1500 acres) will very shortly and permanently change not only the archaeological resources within the watershed but the drainage itself.

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[1]Relic collectors have removed hundreds of sherds from this locality. A CAR 1-m^2 test unit yielded 101 sherds within 15 cm of the surface.