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Prehistoric Camps Along Lower Nash Draw:

The NM 128 Project in Eastern Eddy County, New Mexico

Volume II: Analysis, Research Design, and Appendixes

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20 ⩡ Pottery Analysis

C. Dean Wilson

A total of 1001 sherds were analyzed from five sites investigated as part of the NM 128 project. These include 173 sherds from LA 113042, 798 sherds from LA 129214, 15 sherds from LA 129217, eight sherds from LA 129222, and seven sherds from LA 129300. No pottery was recovered from LA 129216 or 129218. The analysis of this pottery involved the recording of both descriptive attributes and typological categories. In order to compare trends noted at these sites to those in surrounding areas, analysis strategies and categories previously discussed in other studies were used here (Hill 1996; Jelinek 1967; Kelley 1984; Mera 1943; Runyan 1987; Wilson 2000a, 2000b, 2003; Wiseman 1991, 1996a, 2000a, 2002a, 2003c).

Descriptive Attributes

A range of ceramic descriptive attributes was recorded. Ceramic descriptive attributes recorded during this analysis include temper, surface manipulation, sherd thickness, and vessel-form.

Temper Categories

Temper categories were assigned to basic categories during the examination of freshly broken sherd surfaces through a binocular microscope. Almost of the tempers identified during the present study represent crushed igneous rock, and were divided into groups based on color, size, and crystalline structure.

The most common group is represented by a crushed leucocratic igneous rock containing both feldspar and quartz that may represent crushed granites or monzonites. This group is identified by relatively large temper particles dominated by milky white to clear gray grains probably representing feldspar along with some quartz. Dark fragments representing hornblende are often absent, and when present they consist of very small and sparse fragments.

Another temper group was distinguished by numerous very small and profuse clear, gray to white fragments, and is referred to here as Crystalline igneous rock. Larger grains are sometimes present and are usually roundish and crystalline in structure. These fragments appear to be sugary in appearance. This group may represent the use of Capitan aplites or granites.

The other temper group is represented by the dominance of Gray feldspar fragments presumably from syenites originating on the Sierra Blanca of southern New Mexico (Wiseman 2003c). Feldspar fragments tend to be similar in appearance, angular in shape, large compared to other temper fragments, and opaque gray to off-white in color. Smaller grains of other minerals are rare if present.

Temper in the NM 128 Chupadero Black-on-white sherds consists of combinations of Dark igneous and sherd particles. Both sherd and rock particles tend to be small and dark. These two types of particles can be difficult to distinguish from one another, particularly in vitrified pastes commonly found in Chupadero Black-on-white. Crushed rock particles appear as very fine, white to gray individual grains of feldspar and quartz. Sherd fragments are recognized by their dull appearances and range from dark gray to brown.

Surface Manipulation

Surface manipulation, reflecting the presence and types of surface textures and polishing, was recorded for both interior and exterior sherd surfaces. Plain unpolished refers to surfaces upon which coil junctures have been completely smoothed but are unpolished. Plain polished surfaces are those that have been intentionally polished after smoothing. Polishing implies intentional smoothing with a polishing stone to produce a compact and lustrous surface. Plain striated refers to the presence of a series of long shallow parallel grooves resulting from brushing with a fibrous tool on an unpolished surface. Surface missing refers to cases where a surface has been intensely worn or spalled. Surfaces of white wares to which a distinct, light-colored, low-iron slip was applied; these are classified as Polished white slip. A few sherds with faint but intentionally applied incised designs are assigned to a Parallel incised category.

Vessel Form

Sherd based vessel-form categories reflect shape or portion of the vessel from which a sherd was derived. Categories identified were based on rim shape or on the presence and location of polish and painted decorations. While it is often easy to identify the basic form (bowl versus jar) of body sherds from many Southwestern regions by the presence and location of polishing or painted decorations, such distinctions are often not possible for Jornada Brown Ware vessels. For example, Jornada Brown Ware bowl and jar sherds can be polished or smoothed on either side.

Therefore, body sherds were commonly assigned to descriptive categories based on the presence or absence of polishing on different surfaces. These categories include: body sherds polished on both surfaces; body sherds unpolished on both surfaces; body sherds polished on interior surface only; and body sherds polished on exterior surface only. Examples with missing surfaces were placed into an Indeterminate category. Jar neck sherds were identified by the presence of distinct saddle-shaped curves characteristic of jar necks. Jar rim sherds also exhibit the distinct shape of a necked jar. Seed jar rim refers to sherds derived from spherical vessels that do not exhibit distinct necks but have rounded openings near the top.

Wall Thickness

Wall thickness was recorded to the tenth of a centimeter for all sherds analyzed. This measurement was made on an area of the sherd that appeared to be most typical of the overall thickness.

Paste Profile

Paste profile refers to the basic color—or combination of colors—noted in the sherd profile and reflects the qualities of the clay and atmosphere in which a vessel was fired. Overall characteristics observed in profiles are very gradational, and it was often difficult to assign an example to a specific example. Categories identified during the present analysis include: Light gray; Gray to black; Brown to red; Red with black core; Gray to reddish streaks; and Light to reddish streaks.

Ceramic Types

Ceramic types represent groupings that relay information about combinations of traits with temporal, spatial, and functional significance. A total of 996 of the sherds examined from NM 128 Project sites are derived from El Paso Brown and Jornada Brown vessels while four sherds appear to be derived from Chupadero Black-on-white vessels.

Brown Ware Types

Brown ware pottery from various areas of the Jornada Region including the Carlsbad area has long been divided into a series of types based on combinations of attributes thought to be spatially sensitive. Distinctions of various types are based on differences in surface color, polish, and temper noted for plain brown ware ceramics thought to be associated with different regions of the Jornada Mogollon (Jelinek 1967; Jennings 1940; Lehmer 1948; Whalen 1994; Wilson 2000a, 2000b, 2003; Wiseman 1996a, 2003a). Unfortunately, some studies indicate potential for overlap in the attributes of brown utility ware tempering materials from different parts of the Jornada Mogollon (Hill 1996; Whalen 1994). These examinations indicate strong similarities in both pastes and manipulations of brown ware pottery found in riparian, basin, and mountain areas. Even petrographic analysis involving detailed characterizations of pastes and temper from distinct areas of the Jornada Mogollon encountered difficulties in distinguishing pottery in different areas of the Jornada Mogollon (Hill 1996). Therefore, many recent studies, especially those at the survey level, simply lump plain brown ware sherds into a single plain brown ware type or category of undifferentiated brown. At the excavation and laboratory analysis level, variation has been independently examined for various pastes and technological attributes (Hill 1996; Whalen 1994).

There is some indication, however, that subdivisions within Jornada Brown Ware pottery are in fact useful, although factors other than spatial variation may sometimes be reflected. For example, in recent studies Wiseman (1996a, 2000a, 2003b, and 2004) uses modified versions of brown ware types described by Jelinek (1967). My own recent attempts adapt these categories to Jornada Mogollon assemblages (Wilson 2000a, 2000b, 2003), indicate that these distinctions, while not perfect, provide useful tools to convey and monitor information of potential cultural, spatial, and temporal significance.

In this typology Jornada Brown, also recently referred to as Sierra Blanca variety (Wiseman 2003c), is described as generally having well-polished surfaces that obscure temper grains. Temper grains are often small, compared to those noted in El Paso Brown, and consist of a profusion of small equal-sized grains. Jornada Brown Ware vessels are usually thick (6 to 8 mm), and are most commonly represented as jars, although bowls are also relatively common.

Another category sometimes recognized is South Pecos Brown. This type is generally well smoothed, and polishing may be strong to absent. Temper is represented by sparse large gray feldspar crystals that appear to indicate syenite from the Sierra Blanca of southern NM; these crystals frequently show on the surface and result in blocky to tabular paste cross sections. Crystals that protrude onto sherd surfaces are usually surrounded by radial cracks because surface clays have contracted or shrunken toward the body clay.

The majority of brown ware sherds from all NM 128 sites examined during this study were assigned to El Paso Brown on the basis of paste and temper characteristics. Temper is usually characterized by a profusion of large fragments including rounded quartz grains that representing granite temper. These grains may protrude through the sherd surfaces.

Other examples may display temper characteristic of other Jornada Brown Ware groups, although almost all the sherds assigned to this type during this study contain large temper fragments. El Paso Brown sherds also tend to be soft and have less evidence of polish or luster and more scraping marks on interior surfaces. Pastes tend to be dark or brown with a dark core.

Two body sherds exhibiting similar characteristics noted for El Paso Brown, but with evidence of red painted decoration, were assigned to El Paso Polychrome. El Paso Polychrome is associated with later occupations (after AD 1100). Despite the presence of painted decorations, surfaces tend to be crudely smoothed or scraped. Vessels are commonly represented by very large and thin jars, although some examples are derived from bowls. Surfaces may be Brown and un-slipped or contain a thin red slip. A few sherds exhibited very thin vessel walls common in El Paso Polychrome, with a number being less than 4 mm thick. Examination of pottery from other sites without evidence of El Paso Polychrome or other later Jornada types indicate that the thickness of El Paso Brown is highly variable, and includes examples less than 4 cm in thickness (Wilson 2000a, 2003). In addition, none of the rim profiles exhibited shapes that are clearly indicative of El Paso Polychrome.

Most problems in the use of these brown ware types stem from various mixes in attributes used to define individual types. For example, the presence of a temper category used to define one type may occur along with surface manipulation commonly used to define another (Wiseman 1996a). Still, the use of different Jornada Brown Ware type categories may provide an opportunity to monitor variability in assemblages from sites in different areas that may be of spatial or temporal significance, yet may be cumbersome to monitor by distributions of attributes alone.

White Ware Types

Pottery assigned to white ware types are represented by four sherds that appear to be derived from Chupadero Black-on-white vessels. This type was first named and described by Mera (1931). Chupadero Black-on-white is described from sites scattered over a wide area of the Jornada Mogollon (Kelley 1984; Farwell et al. 1992; Mera 1931; Hayes et al. 1981; Vivian 1964). Chupadero Black-on-white was first manufactured between AD 1050 and AD 1100 and continued to have been produced to about 1550. Through most of this period, Chupadero Black-on-white was the dominant decorated type at sites scattered over wide areas of central and southeastern New Mexico (Mera 1931).

Chupadero Black-on-white usually exhibits a dense light gray to white paste reflecting the use of a low-iron clay firing to buff colors and a low-oxi-

Table 20.1. Distribution of ceramic types, by sites.

	LA 113042		LA 129214		LA 129218		LA 129222		LA 129300		**TOTAL**	
CERAMIC TYPE	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
El Paso Brown	158	91.3%	628	78.7%	15	100.0%	6	75.0%	4	57.1%	**811**	**81.0%**
Unpainted with Chupadero paste	–	–	1	0.1%	–	–	–	–	–	–	**1**	**0.1%**
Chupadero Black-on-white, solid design	1	0.6%	–	–	–	–	2	25.0%	–	–	**3**	**0.3%**
Jornada Brown	3	1.7%	56	7.0%	–	–	–	–	3	42.9%	**62**	**6.2%**
South Pecos Brown	11	6.4%	113	14.2%	–	–	–	–	–	–	**124**	**12.4%**
Total	**173**	**100.0%**	**798**	**100.0%**	**15**	**100.0%**	**8**	**100.0%**	**7**	**100.0%**	**1001**	**100.0%**

Table 20.2. Distribution of temper type, by ceramic type.

	EL PASO BROWN		CHUPADERO BLACK-ON-WHITE		JORNADA BROWN		SOUTH PECOS BROWN		**TOTAL**	
TEMPER	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
Large leucocratic igneous	811	100.0%	–	–	1	1.6%	–	–	**812**	**81.1%**
Fine Jornada	–	–	–	–	61	98.4%	–	–	**61**	**6.1%**
Dark igneous and sherd	–	–	4	100.0%	–	–	–	–	**4**	**0.4%**
Dark feldspar	–	–	–	–	–	–	124	100.0%	**124**	**12.4%**
Total	**811**	**100.0%**	**4**	**100.0%**	**62**	**100.0%**	**124**	**100.0%**	**1001**	**100.0%**

dizing or neutral atmosphere. Most of the Chupadero sherds from the NM 128 project correspond to the "White paste type" as defined by Wiseman (1986).

During the re-firing tests conducted for this project, the Chupadero sherds consistently fired to similar buff colors in an oxidizing atmosphere, in contrast to the red colors for sherds associated with other ceramic traditions examined during the present study. Temper is often dark and includes fine sherd and rock fragments. The undecorated surfaces of Chupadero Black-on-white are often unpolished with striated or scored treatments resulting from scraping. Jelinek (1967) divided Chupadero Black-on-white from his sites along the Pecos River north of Roswell into several types thought to be temporally sensitive. The differences are primarily based on the presence of slips, surface color, and temper type, but these distinctions do not appear to be warranted.

The Chupadero sherds from the NM 128 sites display a wide range of characteristics. Striated treatments occur on only one undecorated surface. Two sherds have exterior surfaces that are light gray in color with moderate polish. Three sherds are not slipped, and one has a white slip over a gray paste.

All four Chupadero sherds are tempered with *Dark igneous rock and sherd*, but a variety of rock to sherd mixes and grain sizes are represented, suggesting the vessels were derived from a number of sources.

Painted designs on Chupadero Black-on-white vessels often consist of combinations of hachured and solid motifs. The designs were executed in panels where the basic design was repeated every one or two sections. At least four and as many as eight panels may be present. Three NM 128 project sherds have partial designs, all of them consisting of solid elements.

Examination of Trends

An examination of types and attributes from the five sites excavated during the NM 128 project from which ceramics were recovered exhibit similar pottery. With the exception of four sherds from

Table 20.3. Distribution of vessel form, by ceramic type.

	EL PASO BROWN		CHUPADERO BLACK-ON-WHITE		JORNADA BROWN		SOUTH PECOS BROWN		**TOTAL**	
VESSEL FORM	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
Indeterminate	15	1.8%	2	50.0%	2	3.2%	10	8.1%	**29**	**2.9%**
Body sherd, polished interior surface only	3	0.4%	–	–	3	4.8%	10	8.1%	**16**	**1.6%**
Seed jar	1	0.1%	–	–	–	–	–	–	**1**	**0.1%**
Jar neck	9	1.1%	–	–	4	6.5%	3	2.4%	**16**	**1.6%**
Jar rim	2	0.2%	–	–	–	–	2	1.6%	**4**	**0.4%**
Body sherd, polished exterior surface only	20	2.5%	–	–	10	16.1%	26	21.0%	**56**	**5.6%**
Jar body	–	–	2	50.0%	–	–	–	–	**2**	**0.2%**
Body sherd, polished on both surfaces	3	0.4%	–	–	25	40.3%	26	21.0%	**54**	**5.4%**
Body sherd, unpolished on both surfaces	758	93.5%	–	–	18	29.0%	47	37.9%	**823**	**82.2%**
Total	**811**	**100.0%**	**4**	**100.0%**	**62**	**100.0%**	**124**	**100.0%**	**1001**	**100.0%**

Table 20.4. LA 113042, distribution of vessel form, by ceramic type.

	EL PASO BROWN		CHUPADERO BLACK-ON-WHITE		JORNADA BROWN		SOUTH PECOS BROWN		**TOTAL**	
VESSEL FORM	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
Indeterminate	1	0.6%	–	–	1	33.3%	–	–	**2**	**1.2%**
Jar rim	–	–	–	–	–	–	1	9.1%	**1**	**0.6%**
Body sherd, polished on exterior only	–	–	–	–	–	–	3	27.3%	**3**	**1.7%**
Jar body	–	–	1	100.0%	–	–	–	–	**1**	**0.6%**
Body sherd, polished interior and exterior	–	–	–	–	1	33.3%	1	9.1%	**2**	**1.2%**
Body sherd, unpolished	157	99.4%	–	–	1	33.3%	6	54.5%	**164**	**94.8%**
Total	**158**	**100.0%**	**1**	**100.0%**	**3**	**100.0%**	**11**	**100.0%**	**173**	**100.0%**

three sites that appear to have derived from Chupadero Black-on-white vessels, a slim majority of sherds represent the El Paso tradition (Table 20.1). The majority of these were designated El Paso Brown based on paste characteristics and surface manipulation (Tables 20.1 through 20.8). Almost all the rest belong to the Jornada tradition represented by Jornada Brown and South Pecos Brown (Tables 20.1 through 20.8).

Regional Trends

The majority of the pottery recovered during the NM 128 project represents brown ware types based on paste and surface characteristics.

El Paso Brown: The majority of these brown wares were assigned to El Paso Brown, a type associated with the Mesilla phase of the El Paso region (Whalen 1980, 1994). A small but significant amount of this pottery exhibits characteristics resulting in their assignment to northern Jornada Mogollon types and probably reflecting pottery produced at locations in the Capitan Mountains (Hill 2002). Early forms of Jornada Brown may have been produced at pithouse villages such as the Dunlap Salazar site (Rocek and Speth 1991, 1995). The presence of pottery that appears to have been produced in the Sierra Blanca of southern New Mexico and the El Paso region at sites in the Carlsbad area might indicate some kind of interaction with groups

Table 20.5. LA 129214, distribution of vessel form, by ceramic type.

	EL PASO BROWN		CHUPADERO BLACK-ON-WHITE		JORNADA BROWN		SOUTH PECOS BROWN		**TOTAL**	
VESSEL FORM	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
Indeterminate	14	2.2%	–	–	1	1.8%	10	8.8%	**25**	**3.1%**
Body sherd, polished interior only	3	0.5%	–	–	3	5.4%	10	8.8%	**16**	**2.0%**
Seed jar	1	0.2%	–	–	–	–	–	–	**1**	**0.1%**
Jar neck	9	1.4%	–	–	4	7.1%	3	2.7%	**16**	**2.0%**
Jar rim	2	0.3%	–	–	–	–	1	0.9%	**3**	**0.4%**
Body sherd, polished exterior only	9	1.4%	1	100.0%	10	17.9%	23	20.4%	**43**	**5.4%**
Body sherd, polished interior and exterior	2	0.3%	–	–	21	37.5%	25	22.1%	**48**	**6.0%**
Body sherd, unpolished	588	93.6%	–	–	17	30.4%	41	36.3%	**646**	**81.0%**
Total	**628**	**100.0%**	**1**	**100.0%**	**56**	**100.0%**	**113**	**100.0%**	**798**	**100.0%**

Table 20.6. LA 129218, distribution of vessel form, by ceramic type.

VESSEL FORM	EL PASO BROWN	
	COUNT	COL. %
Body sherd, polished on exterior only	10	66.7%
Body sherd, unpolished	5	33.3%
Total	**15**	**100.0%**

in these areas, despite evidence that groups in the Carlsbad area appear to have continued a non-horticultural, Archaic subsistence pattern similar to that associated with earlier Archaic groups (Akins 2003a; Katz and Katz 1994; Staley et al. 1996a, 1996b; Zamora 2000).

Tables 20.2, 20.3 and 20.9 through 20.12 illustrate characteristics of pottery assigned to various regional types. These distributions indicate that the majority of brown ware pottery recovered exhibits similar ranges of characteristics resulting in the assignment of most of these sherds to El Paso Brown, representing 81.1 percent of the sherds identified during analysis from the NM 128 sites.

The great majority of these sherds exhibit large igneous temper (Table 20.2). Both surfaces tend to be unpolished (Tables 20.3, 20.9 and 20.10), although soft pastes may also result in the common occurrences of unpolished surfaces. Polished surfaces are present but very rare in sherds assigned to El Paso Brown and are more common on interior than exterior surfaces (Tables 20.9 and 20.10). A low frequency of sherds exhibit distinct parallel grooves or striations on the interior surfaces (Tables 20.9 and 20.10).

Such manipulations were noted for both surfaces, but are more common on interior surfaces. The majority (80.8 percent) of paste profiles noted for sherds assigned to El Paso Brown are dark gray to black in color, reflecting exposures to a reduction atmosphere during the last stages of firing, although very low frequencies of sherds reflected a range of profiles indicating some variation in firing atmosphere (Table 20.11).

While the majority of sherds assigned to all brown ware types reflect gray to black pastes, this frequency is higher in those assigned to El Paso Brown. Sherds assigned to El Paso Brown exhibited considerable variation in thickness of vessel walls and include sherds that were very thick as well as

Table 20.7. LA 129222, distribution of vessel form, by ceramic type.

	EL PASO BROWN		CHUPADERO BLACK-ON-WHITE		**TOTAL**	
VESSEL FORM	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
Indeterminate	–	–	2	100.0%	**2**	**25.0%**
Body sherd, polished on exterior only	1	16.7%	–	–	**1**	**12.5%**
Body sherd, unpolished	5	83.3%	–	–	**5**	**62.5%**
Total	**6**	**100.0%**	**2**	**100.0%**	**8**	**100.0%**

Table 20.8. LA 129300, distribution of vessel form, by ceramic type.

	EL PASO BROWN		JORNADA BROWN		**TOTAL**	
VESSEL FORM	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
Body sherd, polished interior and exterior	1	25.0%	3	100.0%	**4**	**57.1%**
Body sherd, unpolished	3	75.0%	–	–	**3**	**42.9%**
Total	**4**	**100.0%**	**3**	**100.0%**	**7**	**100.0%**

a few exhibiting extremely thin walls generally attributed to El Paso Polychrome (Table 20.12). Two of these sherds were assigned to El Paso Polychrome.

Jornada Brown: A relatively low frequency (6.2 percent) of sherds examined during the present study exhibited characteristics resulting in their classification as Jornada Brown. The great majority of these exhibited a smaller and more crystalline temper than that noted in sherds assigned to El Paso Brown, and unlike other brown ware types, temper protruding through the surface was seldom noted. Most of the sherds assigned to this type were polished, with most displaying polish on both surfaces (Tables 20.3, 20.9, and 20.10).

Sherds exhibiting plain striated surfaces were noted but seem to be rarer than those noted for El Paso Brown. While a small majority (56.5 percent) of the paste profiles was noted for sherds assigned to Jornada Brown were gray to black, this frequency was lower than that noted for other brown ware types (Table 20.11). A higher frequency of sherds assigned to Jornada Brown exhibit reddish colors indicative of an oxidizing atmosphere during firing than is the case for El Paso Brown sherds. Sherds assigned to Jornada Brown also exhibit a great deal of variation in thickness for vessel walls, although there is a tendency for sherds assigned to this type to be fairly thick.

South Pecos Brown: A small but significant frequency (12.4 percent) of sherds from NM 128 sites was classified South Pecos Brown based on the presence of dark feldspar temper (Table 20.2). While many of these exhibit some of the distinct characteristics ascribed to this type, they also exhibit a wider range of surface characteristics than noted in the other brown ware types examined during this study. The sample of sherds assigned to South Pecos Brown during the present study appears to be made up of both an unpolished group more closely resembling El Paso Brown and a polished group that more closely resembles Jornada Brown. This is reflected in distributions of surface characteristics that fall between those noted for sherd assigned to El Paso Brown and Jornada Brown (Tables 20.3, 20.9, and 20.10).

The number of sherds with distinct striations on the interior surface is significantly higher than noted for other brown ware types. Differences in the frequency of polish have been noted for South Pecos from later sites in the Jornada Mogollon (Wiseman 2002a) and may suggest slight differences in technology in different areas. Distributions of pastes and surface characteristics of South Pecos Brown also fall between those noted for these other brown ware types (Table 20.11). While a wide range of wall thickness was noted for sherds assigned to this type, a larger number of sherds exhibit very thin walls than are noted for other brown ware types.

Table 20.9. Distribution of interior surface manipulation, by ceramic type.

INTERIOR SURFACE MANIPULATION	EL PASO BROWN		CHUPADERO BLACK-ON-WHITE		JORNADA BROWN		SOUTH PECOS BROWN		**TOTAL**	
	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
Plain, unpolished	767	94.6%	2	50.0%	36	58.1%	57	46.0%	**862**	**86.1%**
Plain, polished	3	0.4%	1	25.0%	23	37.1%	39	31.5%	**66**	**6.6%**
Polished, white slip	–	–	–	–	–	–	2	1.6%	**2**	**0.2%**
Plain, striated	27	3.3%	1	25.0%	1	1.6%	22	17.7%	**51**	**5.1%**
Micaceous slip	3	0.4%	–	–	–	–	–	–	**3**	**0.3%**
Surface missing	11	1.4%	–	–	2	3.2%	4	3.2%	**17**	**1.7%**
Total	**811**	**100.0%**	**4**	**100.0%**	**62**	**100.0%**	**124**	**100.0%**	**1001**	**100.0%**

Table 20.10. Distribution of exterior surface manipulation, by ceramic type.

	EL PASO BROWN		CHUPADERO BLACK-ON-WHITE		JORNADA BROWN		SOUTH PECOS BROWN		**TOTAL**	
EXTERIOR SURFACE MANIPULATION	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
Plain, unpolished	767	94.6%	2	50.0%	36	58.1%	57	46.0%	**862**	**86.1%**
Plain, polished	3	0.4%	1	25.0%	23	37.1%	39	31.5%	**66**	**6.6%**
Polished, white slip	–	–	–	–	–	–	2	1.6%	**2**	**0.2%**
Plain, striated	27	3.3%	1	25.0%	1	1.6%	22	17.7%	**51**	**5.1%**
Micaceous slip	3	0.4%	–	–	–	–	–	–	**3**	**0.3%**
Surface missing	11	1.4%	–	–	2	3.2%	4	3.2%	**17**	**1.7%**
Total	**811**	**100.0%**	**4**	**100.0%**	**62**	**100.0%**	**124**	**100.0%**	**1001**	**100.0%**

Discussion

Paste and surface characteristics of brown ware pottery identified during the present project may indicate pottery produced in several areas of the Jornada Mogollon region. The dominance of El Paso Brown at early NM 128 sites and elsewhere in the Jornada Mogollon may reflect the wide distribution and use of pottery produced in the El Paso region. The presence of Jornada Brown could indicate the production of relatively distinct brown ware forms in areas of the Sierra Blanca region of southern New Mexico that may include early pithouse villages such as the Dunlap-Salazar site. A greater variation in surface characteristics of pottery classified as South Pecos Brown on the basis of dark feldspar temper may indicate production in a particular resource area where a relatively variable technology was practiced.

It is highly unlikely that any of the pottery identified during the present study was produced in the Carlsbad Basin or elsewhere in the easternmost portions of the Jornada Mogollon (Wiseman 2003c). Leslie (1979) suggests the possibility that several brown ware varieties were produced east of the Pecos River, but with the exception of Ochoa Indented Corrugated (Alvarado 2008; Hill 2009), none of these have been confirmed by subsequent work.

Exchange of ceramic vessels with groups to the west could have easily met the demands for the small number of vessels in use during a given time at the NM 128 sites. Given the temporary nature of these occupations, it is also possible that these represent seasonal occupations by groups who either originated in or came into contact with areas to the west where this pottery was produced.

Pottery Function

Data concerning both the various characteristics and forms of pottery vessels recovered during excavation of the NM 128 Project sites might also provide clues about the use of ceramic vessels at seasonal sites in southeastern New Mexico. Unfortunately, it is almost impossible to determine the specific forms reflected by most brown ware sherds based on location of polishing on body sherds. Ex-

Table 20.11. Distribution of paste profile, by ceramic type.

	EL PASO BROWN		CHUPADERO BLACK-ON-WHITE		JORNADA BROWN		SOUTH PECOS BROWN		**TOTAL**	
PASTE PROFILE	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
White	6	0.7%	2	66.7%	1	1.6%	–	–	**9**	**0.9%**
Light gray	10	1.2%	2	66.7%	2	3.2%	6	4.8%	**20**	**2.0%**
Gray to black	655	80.8%	–	–	35	56.5%	78	62.9%	**768**	**76.7%**
Brown to red	61	7.5%	–	–	12	19.4%	23	18.5%	**96**	**9.6%**
Red with black core	41	5.1%	–	–	6	9.7%	4	3.2%	**51**	**5.1%**
Gray-to-reddish streaks	38	4.7%	–	–	6	9.7%	12	9.7%	**56**	**5.6%**
Light-to-reddish streaks	–	–	–	–	–	–	1	0.8%	**1**	**0.1%**
Total	**811**	**100.0%**	**3**	**100.0%**	**62**	**100.0%**	**124**	**100.0%**	**1001**	**100.0%**

amination of brown ware rim sherds from many Jornada Mogollon assemblages indicates that there is often no association between vessel shape and the presence or location of polishing. Therefore, sherds were not assigned to a particular vessel-form based on location of surface polishing. Attempts to recognize specific vessel forms were limited to a few rim and jar neck sherds exhibiting shapes characteristic of a particular form. The exception are two Chupadero Black-on-white body sherds that could be assigned to jars based on polish, slip, and painted design on exterior surfaces.

Tables 20.3 through 20.8 illustrate distributions of functional categories for all pottery recovered during this project as well as that for each site. As previously indicated, by far the most common group identified during the present study is represented by body sherds that are unpolished on both sides (82.2 percent of all sherds), most of which reflect sherds assigned to El Paso Brown. Unpolished brown body sherds make up the majority of pottery from all sites, except LA 129218—from which 15 sherds were recovered—and LA 129300—with seven sherds. Other groups represented by body sherds include: body sherd polished on both surfaces (5.4 percent of all sherds); body sherd polished on exterior surface only (5.6 percent); body sherd polished on interior surface only (1.6 percent); and indeterminate (2.9 percent). A low frequency (1.6 percent) of non-rim sherds was assigned to jar necks based on shape. Forms identified for rim sherds include seed (.1 percent) and necked jars (.4 percent). The single seed jar is unpolished on both sides. Three of the sherds derived from necked jar rims are unpolished on both sides; one is polished on the exterior surface and unpolished on the interior surface. For the 16 sherds from jar necks, six are unpolished on both sides, two are polished on both sides, and seven are polished on exterior and unpolished on interior surfaces.

Distributions associated with the brown wares from the NM 128 Project indicate a conservative range of forms, mostly reflecting unpolished brown ware jars. While most attention about the conservative nature of brown ware technology in areas of the Jornada Region have usually focused on chronological concerns, the apparent lack of any significant change in surface forms over many centuries may also have important functional implications. Ceramic assemblages and architectural forms from Jornada Mogollon sites are similar to those noted in the Mogollon highlands, Hohokom, and Anasazi regions. The difference is the presence of various degrees of changes in these other regions resulting in the presence of ceramics exhibiting various painted and textured treatments by the beginning of the seventh century.

As is the case for pottery in the eastern Mogollon region, ceramics associated with the earliest Southwest occupations tend to be relatively rare, and the earliest pottery from these regions are an undecorated polished brown ware produced with high-iron alluvial clays that often exhibit a dark paste (Wilson et al. 1996). A range of forms is associated with these early brown ware types including bowls, seed jars, and necked jars. Such ceramics are often associated with groups that practice agriculture, but still are quite mobile and dependent on wild food sources.

Table 20.12. Distribution of vessel thickness, by ceramic type.

THICKNESS RANGE (MM)	EL PASO BROWN		CHUPADERO BLACK-ON-WHITE		JORNADA BROWN		SOUTH PECOS BROWN		**TOTAL**	
	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	**COUNT**	**COL. %**
Not measured	45	5.5%	–	–	2	3.2%	15	12.1%	**62**	**6.2%**
3.0–4.0	35	4.3%	–	–	2	3.2%	–	–	**37**	**3.7%**
4.1–4.5	78	9.6%	–	–	2	3.2%	13	10.5%	**93**	**9.3%**
4.6–5.0	138	17.0%	–	–	4	6.5%	14	11.3%	**156**	**15.6%**
5.1–5.5	147	18.1%	–	–	9	14.5%	13	10.5%	**169**	**16.9%**
5.6–6.0	146	18.0%	1	25.0%	13	21.0%	39	31.5%	**199**	**19.9%**
6.1–7.0	172	21.2%	2	50.0%	23	37.1%	25	20.2%	**222**	**22.2%**
7.1–10.5	50	6.2%	1	25.0%	7	11.3%	5	4.0%	**63**	**6.3%**
Total	**811**	**100.0%**	**4**	**100.0%**	**62**	**100.0%**	**124**	**100.0%**	**1001**	**100.0%**

Characteristics of ceramics produced in many regions of the Southwest changed significantly by the beginning of the seventh century, when both painted and textured decorations, along with ware distinctions, become more prevalent. Such changes seem to correlate with increasingly sedentary lifestyles that may have resulted in increased specialized use, differentiation, and decoration of pottery vessels. For example, the increased distinction of decoration, paste, and form between utility and decorated wares may reflect increased reliance on specialized activities associated with sedentary agriculture including the boiling and serving of corn, rather than the generalized vessel assemblages associated with earlier mobile or seasonal strategies. The long dominance of similar brown ware forms in much of the Jornada Mogollon region may partly have resulted from the continuation of mobile or seasonal patterns of plant and game exploitation similar to those associated with earlier occupations elsewhere in the Southwest (Whalen 1994).

Such a scenario is also in agreement with the low frequency of pottery as compared with other artifacts, particularly flaked lithics. The lack of local production and the acquisition of very similar pottery forms by groups in the Carlsbad area and elsewhere in eastern Jornada Mogollon country, as compared to other areas of the Southwest, may ultimately reflect selective pressures relating to mobility on pottery acquisition and use. Characteristics of pottery vessels ultimately reflect their production for use as containers that reflect facilities that function to even out spatial and temporal heterogeneity in subsistence resources (Mills 1989). Preceramic groups dealt with resource heterogeneity through mobility, and reflect a pattern that appears to have continued during various occupations in the eastern part of the Jornada Mogollon.

Pottery, however, provides technological alternatives to full-scale mobility (Mills 1989). One model for understanding potential changes in ceramic production and manufacture involves the distinction between maintainable and reliable systems (Mills 1989). Maintainable systems sacrifice durability for other factors such as modularity and portability, while reliable systems are designed for increased durability.

The expected characteristics of containers reflecting maintainable systems include ease of manufacture and repair, involve little time for manufacture and use, lack backup systems, are considered portable, and are utilized for a limited number of tasks, and possess simple and easily transferred construction and firing techniques. Containers resulting from reliable productions systems tend to be abundant and sturdy, involve more specialized forms, are resistant to failure during a specific task, and may require more specialized manufacturing and firing techniques that may be relatively time consuming. It is not surprising that pottery used by groups in the eastern Jornada Mogollon, who appear to have continued patterns of mobility, would exhibit overall characteristics highly indicative of maintainable technology.

21 ⩔ Botanical Analysis

Pamela J. McBride and Mollie S. Toll

Flotation samples were analyzed from 129 thermal features, two possible postholes, three storage pits, and one limestone rock formation from seven sites along NM 128, in the Mescalero Plains of southeastern New Mexico, east of Carlsbad in Eddy County. In general, thermal features were shallow and basin-shaped. Many were dug into calcrete deposits that provided a natural, hardened base precluding the need for prehistoric occupants to line features with cobbles.

The environment in the project area was significantly different during the time of occupation by prehistoric inhabitants. The small playa with its surrounding alkali flats depicted in an 1882 map (Bureau of Land Management) was greatly enlarged into the existing giant salt lake we see today, a result of funneling water runoff from potash mining operations into the playa. Other playas in the area would have been natural reservoirs, holding monsoon rainfall with water moving into them from drainages such as Nash Draw. Seeps and springs could be found at the edges of the salt lake, two of which are shown on the Remuda Basin USGS Topographic Map (1985).

Harvey Hicks, a lifelong, knowledgeable resident of Carlsbad, describes vegetation before the 1940s as consisting of grasses, mostly little bluestem (*Schizachyrium scoparium*) and grama (*Bouteloua* spp.); very little mesquite (*Prosopis glandulosa*); clumps of shinnery oak (*Quercus havardii*); and the occasional soapberry (*Sapindus saponaria*) or hackberry (*Celtis reticulata*). Black walnut (*Juglans nigra*) grew in the bottom of draws (Harvey Hicks, personal communication, 2008). However, since black walnut is a transplant from the eastern United States, Harvey may have been confusing the native *Juglans microcarpa* with this larger fruited variety. According to Harvey, ducks wintered in the brackish lakes where brine shrimp flourished.

Marron and Associates (2000) conducted a biological study for the NMDOT for this project. They defined three vegetation communities: Plains-Mesa Sand Scrub that comprises 12 percent of the area; Closed Basin Alkali Riparian at 7 percent; and Chihuahuan desert scrub that makes up the greatest proportion of the area at 50 percent. The other 31 percent is gypsum bedrock. Within the Plains-Mesa Sand community is the most unique shinnery-oak community in the state of New Mexico. There are two Chihuahuan desert scrub communities in the study area, one that is dominated by creosote bush (*Larrea tridentata*), whitethorn (*Acacia constricta*), and snakeweed (*Gutierrezia sarothrae*) and the other where creosote bush and mesquite are the most common shrubs. Closed Basin Alkali Riparian vegetation type is found along all the salt playa lakes within the project area. Common plants that grow in this community—iodinebush (*Allenrolfea occidentalis*), black seepweed (*Suaeda nigrescens*), four-wing saltbush (*Atriplex canescens*), and alkali sacaton (*Sporobolus airoides*)—are adapted to saline conditions. The plants that grow in the gypsum bedrock community are endemic and include *Tiquilia hispidissima*, gypsumweed (*Sartwellia flaveriae*), and greggia (*Nerisyrenia linearifolia*).

In June of 2007, a vegetation survey was conducted (Toll and McBride 2007) in the project area along NM 128. The west end of the project area, between LA 129216 and LA 129214, was primarily coppice dunes stabilized by mesquite and littleleaf sumac (*Rhus microphylla*; Table 21.1). Some of the sumac thickets were enormous, ranging from 6 to 10 m across. The area between the coppice dunes was generally barren. Mesquite comprised the majority of the vegetation cover, in both relative cover (60 percent) and total cover (40 percent). Four-wing saltbush had the second highest percentages of relative cover (28 percent) and total cover (19 percent). Crownbeard (*Verbesina*) was abundant close to the road. *Ziziphus obtusifolia* or lotebush flourished around both sites, but diminished in frequency as distance from the sites and road increased. To the east of LA 129214, soil structure changed from loose

Table 21.1. LA 129214 and LA 129216, intercept values for plants of different species and ground cover encountered in 30-meter line transect sampling.

SPECIES		INTERVAL 0–6 M	INTERVAL 6–12 M	INTERVAL 12–18 M	INTERVAL 18–24 M	INTERVAL 24–30 M	∑ I CM	N	**TOTAL COVER**	RELATIVE COVER	DENSITY
ATCA	Cm	225	0	149	73	112	559	5 -1 = 4	**19%**	28%	80%
	N	1	0	1 split	1 split	2					
PRGL	Cm	484	306	353	0	45	1188	10 -2 = 8	**40%**	60%	80%
	N	1 split	5 + 1 split	3	0	1					
VEEN	Cm	0	8	15	0	0	23	4	**<1%**	1%	40%
	N	0	1	3	0	0					
GUSA	Cm	0	0	0	50	158	208	4 -1 = 3	**7%**	11%	40%
	N	0	0	0	1 split	4					
Total Plants		**709 cm**	**314 cm**	**517 cm**	**123 cm**	**315 cm**	**1978 cm**	**19**	**66%**	**100%**	–
L	Cm	78	54	107	64	85	388	17	**13%**	38%	100%
	N	1	2	5	2	7					
B	Cm	15	40	11	489	79	634	10	**21%**	62%	100%
	N	1	1	1	2	5					
Total Nonplants		**93 cm**	**54 cm**	**147 cm**	**553 cm**	**164 cm**	**1022 cm**	**27**	**34%**	**100%**	–

Cm = total centimeters coverage per taxon for interval length, N = number of incidences of taxon,
ATCA = *Atriplex canescens* , PRGL = *Prosopis glandulosa* , VEEN = *Verbesina encelioides* , GUSA = *Gutierrezia sarothrae,* L = litter, B = bare ground

or compacted red-Brown sand to limestone rubble and cryptogamic soils. Creosote bush, whitethorn, and snakeweed increased on the west slope of a ridge as did forbs (bladderpod (*Lesquerella sp.*) and senna (*Senna bauhinioides*; Table 21.2). At LA 113042 four-wing saltbush (*Atriplex canescens*) was abundant and specimens were robust and in fruit, most about 1.3 m high and 2 m in diameter. Viscid acacia (*Acacia neovernicosa*) shrubs were also observed in flower.

Four-wing saltbush was the dominant shrub species at LA 129222—about midway into the project area, in the broad lower valley of Nash Draw. There were also some large lotebushes and creosote bush was fairly common along with the occasional yucca (cf. *Y. campestris*) and scattered mesquite. Open ground—cryptogams and limestone rubble—was a prominent part of the landscape. Forbs include scorpionweed (*Phacelia* sp.), limoncillo (*Pectis angustifolia*), and pepperweed (*Lepidium montanum*). Grasses included grama and ring muhly (*Muhlenbergia torreyi*). This part of the project area appeared much more desolate than others, with large areas of bare ground and less robust and smaller plants.

Near LA 129217 and LA 129218, sites that are situated on top of Livingston Ridge (the landform that defines the eastern limit of Nash Draw and its valley), vegetation changed dramatically along with the presence of parabolic dunes (Table 21.3). Shinnery oaks occurred here on the dunes and on average were 0.5 to .08 m high, with some young acorns present. While to the west of the parabolic dunes mesquite covers the coppice dunes almost completely, it is equal in relative cover with shinnery oak (19 percent) on the parabolic dunes. Snakeweed is second (16 percent) to these two species in relative cover. Sandsage (*Artemisia filifolia*) had a very limited percentage of total and relative cover here. Crown-of-thorns (*Koeberlinia spinosa*) was another shrub observed growing sporadically in the area. Lotebush does not occur here, but another member of the buckthorn family does (javelinabush or *Condalia ericoides*). Grasses were more abundant (dropseed *(Sporobolus spp.)*, three-awns *(Aristida spp.)*), and sand-bur (*Cenchrus* sp.), as were cacti (prickly pear *Platyopuntia* sp., Christmas cactus *Cylindropuntia leptocaulis*).

Herbaceous plants observed like spotted beebalm (*Monarda punctata*), zinnias (*Z. grandiflora, Z. acerosa*), a low-growing purple vetch (*Astragalus* sp.), a purple aster (*Aster* sp.), and fleabane (*Erigeron* sp.) did not occur anywhere else in the project area. Spectacle pod (*Dimorphocarpa wislizenii*) and the sub-shrubs mariola (*Parthenium incanum*) and leatherweed (*Croton pottsii*) also occurred here as well as in the central portion of the project area.

Table 21.2. Ridge east of LA 129214, Intercept values for plants of different species encounter in 15-m line transect sampling.

Species		INTERVAL 0-3 M	INTERVAL 3–6 M	INTERVAL 6–9 M	INTERVAL 9–12 M	INTERVAL 12–15 M	∑ I CM	N	**TOTAL COVER**	RELATIVE COVER	DENSITY
LESQ	Cm	67	60	0	0	0	127	700%	**8%**	19%	40%
	N	4	3	0	0	0					
GUSA	Cm	19	0	44	23	65	151	9	**10%**	22%	80%
	N	1	0	3	2	3					
DESC	Cm	4	7	19	2	8	40	6	**3%**	6%	100%
	N	1	1	2	1	1					
LATR	Cm	41	3	0	25	0	69	3	**5%**	10%	60%
	N	1	1	0	1	0					
SEBA3	Cm	0	16	11	0	0	27	2	**2%**	4%	40%
	N	0	1	1	0	0					
UNK	Cm	0	0	3	0	0	3	1	**<1%**	<1%	40%
	N	0	0	1	0	0					
UNK BRAC	Cm	0	0	15	117	132	264	6	**18%**	39%	60%
	N	0	0	1	2	3					
Total Plants		**131cm**	**86 cm**	**92 cm**	**167 cm**	**205 cm**	**681 cm**	**27**	**46%**	**100%**	–
L	Cm	105	77	33	97	68	380	24 - 2 = 22	**25%**	46%	100%
	N	7+ 1 split	4	4	6 + 1 split	3					
PCB	Cm	72	139	175	34	19	439	22 - 2 = 20	**29%**	54%	100%
	N	3	5 + 1 split	10 + 1 split	3	1					
Total Nonplants		**177 cm**	**216 cm**	**208 cm**	**131 cm**	**87 cm**	**819 cm**	**42**	**54%**	**100%**	–

Cm = total centimeters coverage per taxon for interval length, N = number of incidences of taxon,
LESQ = *Lesquerella* sp., GUSA = *Gutierrezia sarothrae,* DESC = *Descurainia* sp., LATR = *Larrea tridentata* ,
LEGE 7 = unknown legume #7, UNK = unknown forb, UNK BRAC = unknown Brassicaceae, L = litter,
PCB = pebble-cryptogam-bare ground

Methods

The 381 soil samples collected during excavation were processed and analyzed at the Museum of New Mexico's Office of Archeological Studies. Methods used included flotation, full-sort analysis, and charcoal identification.

Flotation Processing: The simplified "bucket" version of flotation (Bohrer and Adams 1977) was used to process all samples. The volumes of flotation soil samples ranged from 0.4 to 7.3 liters. Water was sprayed at fairly high pressure into a bucket containing each soil sample, resulting in agitation and creation of a vortex and causing the lighter particles to float. A 30-40 second interval was allowed for settling of heavy particles. The solution was then poured through a fine screen (about 0.35 mm mesh) lined with a square of "chiffon" fabric, catching organic materials floating or in suspension. The squares of fabric were lifted out and laid flat on coarse-mesh screen trays until the recovered material had dried.

Full-sort Analysis: Each sample was sorted using a series of nested geological screens (4.0, 2.0, 1.0, 0.5 mm mesh), and then reviewed under a binocular microscope at 7-45x. Charred and uncharred reproductive plant parts (seeds and fruits) were identified and counted.

Flotation data are reported as a standardized count of seeds per liter of soil, rather than an actual number of seeds recovered. Relative abundance of non-reproductive plant parts such as stems and bark was estimated per liter of soil processed. Table 21.4 lists the Latin and common name, plant part, and plant category (annuals, perennials, etc.) of all charred plants recovered from the project.

To aid the reader in sorting out botanical occur-

Table 21.3. LA 129217 and LA 129218, intercept values for plants of different species and ground cover encountered in 30-meter line transect sampling.

SPECIES		INTERVAL 0–6 M	INTERVAL 6–12 M	INTERVAL 12–18 M	INTERVAL 18–24 M	INTERVAL 24–30 M	∑ I CM	N	**TOTAL COVER**	RELATIVE COVER	DENSITY
QUHA	Cm	126	80	0	0	0	206	9	**7%**	19%	40%
	N	5	4	0	0	0					
SPAI	Cm	6	0	58	0	0	64	3	**2%**	6%	40%
	N	1	0	2	0	0					
ASTR	Cm	2	0	0	0	0	2	1	**<1%**	<1%	20%
	N	1	0	0	0	0					
ERIG	Cm	15	0	0	0	0	15	1	**1%**	1%	20%
	N	1	0	0	0	0					
POAC	Cm	4	0	0	0	0	4	1	**<1%**	<1%	20%
	N	1	0	0	0	0					
ARLO 1	Cm	4	49	7	0	44	104	5	**3%**	10%	80%
	N	1	1	1	0	2					
LEGE 7	Cm	9	8	16	0	0	33	3	**1%**	3%	60%
	N	1	1	1	0	0					
CENC	Cm	0	12	0	0	0	12	1	**<1%**	1%	20%
	N	0	1	0	0	0					
SPCO	Cm	0	30	71	75	10	186	4	**6%**	17%	60%
	N	0	1	1	1	1					
UNK 9	Cm	0	10	0	0	0	10	1	**<1%**	1%	20%
	N	0	1	0	0	0					
GUSA	Cm	0	97	64	0	15	176	3	**6%**	16%	60%
	N	0	1 split	2	0	1					
PRGL	Cm	0	0	199	0	0	199	1	**7%**	19%	20%
	N	0	0	1	0	0					
SOLAN	Cm	0	0	0	3	14	17	3	**1%**	2%	40%
	N	0	0	0	1	2					
UNK Forb	Cm	0	0	0	0	10	10	2	**<1%**	1%	20%
	N	0	0	0	0	2					
ARFI	Cm	0	0	0	0	42	42	1	**2%**	4%	20%
	N	0	0	0	0	1					
Total Plants		**166 cm**	**286 cm**	**415 cm**	**78 cm**	**135 cm**	**1080 cm**	**39**	**36%**	**100%**	**–**
L	Cm	150	197	28	129	213	717	53	**24%**	37%	100%
	N	15 + 1 split	9	3	16 + 1 split	10					
B	Cm	292	109	163	387	250	1201	56	**40%**	63%	100%
	N	14	7	5	20	10					
Scat	Cm	0	1	0	1	0	2	2	**<1%**	<1%	–
	N	0	1	0	1	0					
Total Nonplants		**442 cm**	**307 cm**	**191 cm**	**517 cm**	**463 cm**	**1920 cm**	**111**	**64%**	**100%**	**–**

Cm = total centimeters coverage per taxon for interval length; N = number of incidences of taxon;
QUHA = *Quercus havardii;* SPA =I *Sporobolus airoides;* ASTR = Asteraceae; ERIG = *Erigeron* spp.; POAC = Poaceae;
ARLO 1 = *Aristida longiseta*; LEGE 7 = unknown legume #7; CENC = *Cenchrus* sp.; SPCO = *Sporobolus contractus;*
GUSA = *Gutierrezia sarothrae*; PRGL = *Prosopis glandulosa;* SOLAN = Solanceae; ARFI = *Artemisia fillifolia;* L = litter;
B = bare ground; UNK = unknown forb

Table 21.4. Charred plant taxa from flotation and macrobotanical samples.

LATIN NAME	COMMON NAME	PLANT PART
	Annuals	
Amaranthus	amaranth	seed
Cheno-Am	goosefoot/amaranth	seed
Chenopodium	goosefoot	seed
Mollugo	carpetweed	seed
Portulaca	purslane	seed
Talinum	hidden flower	seed
	Other	
Asteraceae	aster family	achene
Chenopodiaceae	goosefoot family	seed
Fabaceae	bean family	seed
Leguminosae	bean family	cotyledon
Monocotyledonae	monocot	stem
–	unknown	bark, embryo, plant part, stem, spine, twig
–	unidentifiable	seed
	Perennials	
Atriplex/ Sarcobatus	saltbush/ greasewood	wood
Condalia ericoides	javelinabush	wood
Echinocactus texensis	horse crippler	seed
Echinocereus	hedgehog cactus	seed
Larrea	creosotebush	wood
Platyopuntia	prickly pear cactus	seed
Prosopis	mesquite	seed, wood
–	unknown nonconifer	wood
Yucca	yucca	outer stem, stem

rences of cultural significance from the considerable noise of post-occupational intrusion, data in non-wood flotation tables are sorted into categories of "Cultural" (all carbonized remains) and "NonCultural." Material classified as noncultural includes unburned materials, especially taxa that are not economically useful, and other materials found in disturbed contexts together with modern roots, insect parts, scat, or other signs of recent biological activity.

Charcoal Identification: From each flotation sample with at least 20 pieces of wood charcoal present, a sample of 20 pieces was identified (a maximum of 10 pieces each from the 4 mm and 2 mm screens). In smaller samples, all charcoal from the 4 mm and 2 mm screens was identified. Each piece was snapped to expose a fresh transverse section, and then identified at 45x. Identified charcoal from each taxon was weighed on a top-loading digital balance to the nearest tenth of a gram and placed in labeled plastic bags or polypropylene capsules. Low-power, incident light identification of wood specimens does not often allow species- or genus-level precision, but can provide reliable information useful in distinguishing broad patterns of utilization of a major resource class.

Macrobotanical Samples: Macrobotanical charcoal specimens are treated in the same manner as those from flotation samples except that all fragments from a given sample are identified. Other plant material is identified, counted and weighed.

LA 113042

The numerous excavated thermal features from LA 113042 (n = 27) provided the greatest diversity of carbonized plant remains from the NM 128 project. In particular, Feature 46, a hearth, yielded seeds of two species of cactus (*Echinocereus* or hedgehog

Table 21.5. LA 113042, thermal features, flotation full-sort plant remains.

FEATURE NO.	28	34	35	36	37	43	45	46	49	54	55	56	58	60	61	62	63	64	65	66	67	69	71	73	74	76	79
FS NO.	541	685	709	713	710	772	786	810	842	970	971	972	997	993	994	1011	1013	1003	1023	1046	1019	1055	1033	1041	1042	1043	1049
Cultural																											
Annuals:																											
Cheno-Am	–	–	0.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chenopodium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5	–	–	–	1.4	–	2.4	–	–	–	–	–	–
Other:																											
Unknown taxon	–	–	–	–	–	–	–	–	–	0.3 pp	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.6 pp	–	–
Perennials:																											
Echinocactus texensis	–	–	–	–	–	–	–	2.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Echinocereus	–	–	–	–	–	–	–	1.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Platyopuntia	–	–	–	–	–	–	–	–	2.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Prosopis	0.8	–	–	–	–	–	–	–	55.6 frags.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yucca campestris	–	–	–	–	–	–	+ os	–	–	–	–	–	–	–	–	+++ os	–	–	–	–	–	–	–	–	–	–	–
cf. *Yucca campestris*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+ os, + s	+ os	–	–	–
Noncultural																											
Annuals:																											
Chenopodium	0.3	–	–	0.6	–	–	–	0.5	–	–	–	–	–	–	1.4	–	–	–	0.9	1.1	–	–	–	–	–	–	–
Cheno-Am	–	–	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Portulaca	0.3	0.3	4.8	6.3	–	1.7	3.1	–	–	0.1	–	–	0.4	–	–	–	1.7	–	–	4.2	–	1.9	–	–	0.5	0.5	3.3
Euphorbia	0.3	1.4	1.4	0.6	1.9	–	0.6	–	–	0.8	2.1	2.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Helianthus	–	–	–	–	–	–	–	–	–	–	–	–	–	1.2	1.0	–	–	–	–	–	–	–	–	–	–	–	–
cf. *Franseria acanthicarpa*	–	–	–	–	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kallstroemia	0.3	–	–	0.3	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Other:																											
Cryptantha	–	–	–	–	–	–	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Unidentifiable seed	–	–	–	–	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Unknown taxon	–	–	–	–	0.2 pp	0.3 pp	0.6 pp	2.1 pp	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Asteraceae	–	–	–	–	–	–	–	–	–	–	–	–	0.4	1.2	1.0	–	0.6	–	–	–	–	–	–	–	–	–	–

(Table 21.5, continued)

FEATURE NO.	28	34	35	36	37	43	45	46	49	54	55	56	58	60	61	62	63	64	65	66	67	69	71	73	74	76	79
FS NO.	541	685	709	713	710	772	786	810	842	970	971	972	997	993	994	1011	1013	1003	1023	1046	1019	1055	1033	1041	1042	1043	1049
Perennials:																											
Cassia	0.5	–	–	–	0.4	–	–	–	–	–	–	–	–	–	–	–	–	0.5	–	–	–	–	–	–	–	–	–
Larrea	–	–	–	+ leaf, 0.3	0.2 fruit	–	+ leaf	+ leaf	–	+ leaf	+ leaf	–	–	–	–	+ leaf	–	+ leaf	–	–	–	–	–	0.5 fruit, + leaf	+ leaf	+ leaf	–
Prosopis	–	–	–	–	–	–	–	+ leaf	–	–	–	–	–	–	–	–	–	–	1.4	–	–	–	+ leaf	–	+ leaf	–	–

cf. = resembles taxon, + = 1–10/liter, os = outer stem, pp = plant part and *Echinocactus texensis* or horse crippler). Prickly pear seeds were identified from Feature 49 (Tables 21.5, 21.6). Though mesquite represented 40 percent of vegetative cover in the site area (Table 21.2) and mesquite charcoal was heavily utilized (Table 21.7), Features 28 and 49 produced the only project-wide evidence of mesquite seed or pod exploitation. Other identifiable economic taxa included cheno-am and goosefoot seeds. Also recovered were examples of the caudex (persistent woody base of the stem) and stem of a yucca, probably *Y. campestris*, the hybrid yucca that was identified as the dominant species in the Los Medanos WIPP study area (Martin 1980). The identity of this plant material remained a mystery until fragments of the base of a yucca stem were examined during a Fall 2008 field trip to the area and were determined to match plant parts recovered in a number of features from the project.

The fruits of nearly every cactus are edible and were eaten either fresh or dried and also used as a source of sweetening. The recovery of burned seeds implies that site occupants may have been cooking the fruits.

Table 21.6. LA 113042, other features, flotation sample plant remains.

FEATURE NO.	50 POST MOLD	53 STORAGE PIT	72 STORAGE PIT
FS. NO.	800	989	1032
Noncultural			
Annuals:			
Portulaca	–	–	1.6
Other:			
Unknown taxon	–	1.1 pp	–
Perennials:			
Juniperus	+ leaf	–	–

+ = 1–10/liter, os = outer stem, pc = partially charred, pp = plant part, s = stem

Goosefoot and amaranth plants produce thousands of seeds and are disturbance-loving plants that proliferate around habitation sites, along highways, and in cultivated fields. The seeds have been recovered from sites of all ages and use types in the Southwest. The small number of seeds recovered begs the question of their origin. Were they in cultural deposits as a result of accidents during

Table 21.7. LA 113042, thermal features, flotation wood charcoal.

FS NO.	FEATURE NO.	*ATRIPLEX/ SARCOBATUS* (SALTBUSH/ GREASEWOOD)		*CONDALIA ERICOIDES* (JAVELINA-BUSH)		*PROSOPIS* (MESQUITE)		*LARREA* (CREOSOTE-BUSH)		UNKNOWN NONCONIFER		**TOTAL WEIGHT (G)**
		COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	
541	28	–	–	14	0.15	2	0.02	–	–	–	–	**0.17**
710	37	–	–	–	–	20	0.53	–	–	–	–	**0.53**
713	36	–	–	13	0.34	7	0.28	–	–	–	–	**0.62**
737	41	–	–	5	0.09	14	0.42	–	–	–	–	**0.51**
739	40	–	–	–	–	20	1.04	–	–	–	–	**1.04**
786	45	–	–	–	–	17	0.54	3	0.07	–	–	**0.61**
810	46	–	–	4	0.10	16	0.34	–	–	–	–	**0.44**
842	49	–	–	8	0.21	–	–	–	–	8	0.14	**0.35**
971	55	–	–	–	–	18	0.26	–	–	–	–	**0.26**
972	56	17	0.32	–	–	3	0.02	–	–	–	–	**0.34**
993	60	5	0.03	1	0.01	9	0.1	–	–	–	–	**0.14**
994	61	11	0.35	–	–	8	0.21	–	–	1	0.01	**0.57**
997	58	–	–	2	0.04	18	0.38	–	–	–	–	**0.42**
1003	64	10	0.37	2	0.05	1	0.03	–	–	–	–	**0.45**
1013	63	–	–	–	–	20	0.71	–	–	–	–	**0.71**
1023	65	–	–	5	0.12	15	0.29	–	–	–	–	**0.41**
1031	68	–	–	3	0.13	17	1.15	–	–	–	–	**1.28**
1041	73	–	–	13	0.75	7	0.75	–	–	–	–	**1.50**
Total weight (g)			**1.07**		**1.99**		**7.07**		**0.07**		**0.15**	**10.35**
Total weight (%)			**10.0%**		**19.0%**		**69.0%**		**1.0%**		**1.0%**	
Total count		**43**		**70**		**212**		**3**		**9**		**337**

Table 21.8. LA 113042, macrobotanical wood charcoal taxa.

FS NO.	FEATURE NO.	*ATRIPLEX/ SARCOBATUS* (SALTBUSH/ GREASEWOOD)		*CONDALIA ERICOIDES* (JAVELINABUSH)		*PROSOPIS* (MESQUITE)		**TOTAL WEIGHT (G)**
		COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	
541	28	–	–	18	0.2	–	–	**0.2**
1034	33	–	–	28	0.9	2	0.2	**1.0**
713	36	–	–	–	–	17	0.5	**0.5**
710	37	–	–	–	–	40	1.9	**1.9**
739	40	–	–	–	–	14	2.7	**2.7**
737	41	–	–	–	–	21	0.5	**0.5**
772	43	–	–	–	–	5	0.0	**0.0**
786	45	–	–	–	–	21	1.5	**1.5**
810	46	–	–	–	–	5	1.4	**1.4**
842	49	–	–	15	0.3	–	–	**0.3**
971	55	–	–	–	–	45	1.1	**1.1**
972	56	27	0.4	–	–	–	–	**0.4**
997	58	–	–	–	–	6	0.5	**0.5**
1003	64	10	0.4	–	–	–	–	**0.4**
1013	63	–	–	–	–	2	2.6	**2.6**
1019	67	–	–	–	–	6	1.3	**1.3**
1031	68	–	–	–	–	4	1.5	**1.5**
1041	73	–	–	–	–	3	1.1	**1.1**
1071	75	–	–	–	–	15	1.1	**1.1**
1068	77	–	–	–	–	9	0.5	**0.5**
1069	78	–	–	–	–	4	2.1	**2.1**
1072	80	–	–	2	0.7	3	1.2	**1.9**
1077	81	–	–	–	–	3	3.0	**3.0**
1070	82	–	–	–	–	5	0.3	**0.3**
Total weight (g)			**0.8**		**2.0**		**25.0**	**27.8**
Total weight) (%)			**3.0%**		**11.0%**		**86.0%**	
Total count		**37**		**63**		**230**		

their preparation or were they blown into thermal features and subsequently charred?

Mesquite-wood charcoal was by far the most common type identified in flotation samples, both by count and weight in grams (Table 21.7). Six features were an exception to this pattern, where either lotebush or saltbush/greasewood charcoal was more prevalent than mesquite. The dimensions and morphologies of the anomalous features were not different in any significant way from those in which the wood-charcoal assemblage was composed primarily of mesquite; hence fuel type or feature function may not correlate with feature morphology.

Mesquite seed fragments were found in features where either very little mesquite wood (Feature 28) or none at all (Feature 49) was identified. Processing the pods for food does not appear to be related to mesquite-wood use. At LA 113042, macrobotanical wood assemblages mirror those from flotation except for Feature 36, where flotation wood was primarily lotebush and the macrobotanical wood was entirely mesquite (Table 21.8).

LA 129214

One hundred ninety-three samples were analyzed from LA 129214, with soil volume totaling 623.22 liters. Approximately 357 carbonized plant parts were counted and, of these, most were caudex fragments of a yucca and unknown plant parts. The rest consisted of 96 goosefoot seeds, 60 purslane seeds, 3 cheno-am seeds, 32 unidentifiable seeds, 1 monocot stem, 2 hedgehog cactus seeds, 1 flame flower seed, and 4 goosefoot family seeds (Tables 21.9 through 21.11). Unlike LA 113042, the record of perennial plant use is minimal. The woody yucca caudex fragments found in 13 of the 38 features that yielded carbonized plant material and hedgehog cactus seeds were present in

Table 21.9. LA 129214, thermal features, flotation full-sort plant remains.

FEATURE NO.	39	43	46	47	48	49	50		51	52	53		55		56	57	58	59	61	62	64	78	79	80		114		116		129		131		133		141	149	157
	W 1/2	W 1/2	E 1/2	W 1/2			W 1/2	S 1/2		E 1/2	Block 7	E 1/2	E 1/2	W 1/2	W 1/2, LEVEL 2	E 1/2		N 1/2	N 1/2	W 1/2		W 1/2	S 1/2	N 1/2	S 1/2	N 1/2	S 1/2	N 1/2	S 1/2	N 1/2	S 1/2	W 1/2	E 1/2	N 1/2	S 1/2	N 1/2	W 1/2	N 1/2
FS NO.	341	340	524	574	564	553	579	593	573	586	509	598	596	597	626	623	622	658	657	697	682	896	894	908	908	1469		1470		1497		1522	1522	1615	1616	1664	1748	1747
Cultural																																						
Annuals:																																						
Chenopodium	–	0.4	–	0.5	–	–	0.7	0.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	0.1	0.2	0.3	–	0.1	–	–	–	0.1	–	–	0.2	–	–
Cheno-Am	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Portulaca	–	–	0.4	–	–	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–	1.1	–	–	0.7	0.2	–	0.2	–	–	–	–	–	–	0.6	–	–	–	0.4	–
Talinum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Unknown taxon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.6 pp	–	–
Other:																																						
Chenopodiaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Unidentifiable seed	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–	–	–	–	–	–	–
Unknown taxon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4 pp	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Perennials:																																						
cf. *Yucca campestris*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+++ os	–	–	–	+++ os	–	+ os	–	–	+++ os	++ os	+ os	+ os	–	–	+ os	+ os		+ os	+ os		+ os
Noncultural																																						
Annuals:																																						
Amaranthus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4	–	–	–	–	–	–	–	–	–	–
Chenopodium	–	–	–	–	0.8	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5	0.5	–	0.1	–	–	–	–	–	0.2	–	0.3	0.3	–	–	–	0.4	0.3
Croton	–	–	–	–	–	–	0.4	–	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Euphorbia	–	–	–	–	0.8	–	1.8	1.5	–	0.7	–	–	1.8	1.3	–	–	0.1	–	–	–	–	–	–	–	0.4	–	–	–	–	–	0.3	–	–	–	2.8	–	–	0.3
Kallstroemia	–	–	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Helianthus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Portulaca	–	–	–	–	–	–	–	–	–	–	–	1.7	–	0.2	–	–	0.1	–	–	–	0.4	–	–	–	–	–	–	–	–	0.2	–	–	–	0.9	2.1	–	–	4.8
Other:																																						
Asteraceae	–	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	0.1	–	–	–	–	–	–	–	–	–
Astragalus	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2	2.1	–	0.1	–	–	–	–	–	–	–	0.1	–	–	–	–	–	–	–	–	–	1.4	–	–	–
Chenopodiaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–
Cryptantha	0.9	1.1	15.2	0.5	9.2	4.4	4.0	9.0	–	4.4	–	–	22.7	2.3	3.3	4.8	0.2	0.1	0.9	4.5	0.5	7.3	0.2	0.3	0.6	–	–	–	–	1.2	0.9	–	0.1	0.4	0.7	–	–	3.8
Datura	–	–	–	–	0.8	–	–	–	0.3	–	–	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–	–	–	–	–
Fabaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–	–	–	–	–	–	–
Unidentifiable seed	–	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Unknown taxon	0.3 pp, + spine	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1 pp	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Perennials:																																						
Atriplex	–	0.4	–	–	–	0.6	–	–	–	–	–	–	–	–	–	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Juniperus	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Prosopis	+ leaf, 0.3	–	–	–	–	–	–	–	+ leaf	–	–	+ leaf	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.7	–	–	–	–	–	–	–	–	–
Rhus	–	–	–	–	–	–	–	–	–	–	–	2.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

+ = 1–10/sample, ++ = 11–25/samples, +++ = 25–100/sample, cf. = resembles taxon, os = outer stem, pp = plant part

Feature 156. Annual seeds of goosefoot and purslane were the most commonly identified plant parts, found in 28 of the 38 features. It would seem the focus of plant foraging was on weedy, annual seed collection. This was the largest of all the sites, with a dense distribution of thermal features on both sides of NM 128. Neither goosefoot nor purslane plants were observed during a vegetation survey conducted in June of 2007. Since these plants are disturbance loving (sometimes called camp followers), their absence in the existing environment implies that they diminished when heavy use of the area by foragers was discontinued. There were also a number of springs in the area that disappeared; these probably harbored a variety of plants that are now unable to thrive.

In most features the macrobotanical wood assemblage was primarily mesquite (Table 21.12). However, in flotation samples, with generally smaller pieces, several features produced more lotebush wood than mesquite (Table 21.13). There was only one flotation sample (Feature 52) where saltbush/greasewood was more common than the other two wood taxa.

Table 21.10. LA 129214, other features and grids, flotation full-sort plant remains.

FEATURE NO.	44 LIMESTONE ROCK FORM W 1/2 LEVEL 7	63 POSSIBLE POSTHOLE W 1/2
FS NO.	355	663
Noncultural		
Other:		
Unidentifiable seed	–	0.8
Unknown taxon	0.4 pp	–

Plant materials are seeds unless indicated otherwise.
Cultural plant material is charred, noncultural is uncharred.
pp = plant part

LA 129216

Annuals were recovered from all eight samples with carbonized plant material, but Feature 19 yielded the greatest number of carbonized plant taxa including amaranth, cheno-am, carpetweed, purslane, and aster family seeds and yucca caudex fragments (Tables 21.14 and 21.15). This site is just to the west of LA 129214 and it is not surprising that it shares a similar focus on annuals in the floral assemblage. Flotation sample wood composition is quite different from macrobotanical wood (Tables 21.16 and 21.17). Mesquite dominated macrobotanical wood, while lotebush was often more prevalent in flotation samples. The two sets of samples were from different features, but again since the morphology and dimensions of features are not significantly different, the type of food prepared in a feature may have had nothing to do with wood selection.

LA 129217

Three features were examined for carbonized plant remains from LA 129217. Only one contained burned goosefoot seeds (Table 21.18). The other two contained only noncultural annual, grass, and hidden flower seeds and mesquite leaves. Wood charcoal was not recovered.

LA 129218

Three out of 10 features at LA 129218 produced carbonized plant remains. Yucca caudex fragments were recovered from Features 8 and 10, while unknown plant parts were recorded from Features 8 and 11 (Table 21.19). Both the flotation and macrobotanical wood assemblages consisted entirely of mesquite wood (Tables 21.20 through 21.21).

LA 129222

Plant material recovered from LA 129222 was noncultural in origin and included unburned annual seeds like mustard, caltrop, purslane, and aster family seeds, and creosote bush fruit and leaves (Table 21.22). The archaeobotanical remains, therefore, do not give any clues as to what foods might have been prepared or stored in the two thermal features and one storage pit.

LA 129300

Carbonized plant material from thermal features at LA 129300 consisted of caudex fragments of a yucca, goosefoot, purslane, unidentifiable seeds, and unknown plant parts (Tables 21.23 through 21.24). Data from wood-charcoal analysis of flotation and macrobotanical samples complement each other by providing either matching or addi-

Table 21.11. LA 129214, thermal features, flotation sample scan plant remains.

FEATURE NO.	56	65	66	68	69	69	70	70	71	72	73	74	75	76	77	87	92	94	96	103	110	110	118	118	119	119	120	120	132	156	159	165	165	173	187	485N/ 538E
	W 1/2	W 1/2		PP 2	N 1/2	S 1/2	S 1/2	N 1/2		W 1/2		E 1/2		PP 2		N 1/2		S 1/2		S 1/2	W 1/2	E 1/2	N 1/2	S 1/2	N 1/2	S 1/2	W 1/2	E 1/2	N 1/2			N 1/2	S 1/2	BOTTOM 1/2	W 1/2	STRATUM 2
	LEVEL 2																																			LEVEL 2
FS NO.	626	695	710	728	734	734	763	764, 765	755	766	774	841	850	876	886	1064	1033, 1036	1057	1366	1186	1344	1343	1367		1346		1433	1433	1536	1717, 1718	1751	1846	1846	1899	1916	816
Cultural																																				
Annuals:																																				
Chenopodium	–	–	0.6	0.5	–	–	–	–	–	–	0.1	0.3	–	–	–	–	0.9	–	–	–	–	–	–	–	–	–	0.3	0.1	0.2	0.8	1.1	cf. 0.2	–	–	–	–
Cheno-Am	–	–	–	–	–	–	–	–	–	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Portulaca	–	–	–	–	–	–	0.9	0.4	–	–	–	0.3	–	0.2	–	–	–	–	–	–	–	–	0.3	–	–	–	0.2	0.6	–	0.2	0.3	–	–	0.6	–	–
Other:																																				
Unidentifiable	–	–	–	–	–	–	–	0.2	–	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monocot	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+ stem	–	–	–	–	–	–	–	–	–
Unidentifiable seed	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–	–	–	–
Unknown taxon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4 pp	–	–	0.1 pp	+ cf. bark	–	–	–	–	0.1 pp, + stem	–	–	0.1	–	–	–	–	–	1.9 e
Perennials:																																				
Echinocereus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–	–
cf. *Yucca campestris*	–	–	–	–	–	–	–	–	–	–	–	–	0.2 os	–	–	–	–	–	–	–	+ os	–	–	–	–	–	–	+ os	–	–	–	–	–	–	–	–
Noncultural																																				
Annuals:																																				
Chenopodium	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	+	–	–	–	–	–	–
Descurainia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
Euphorbia	+	+	+	+	–	+	–	–	+	+	+	–	–	+	+	+	+	–	–	–	–	+	–	–	+	+	+	–	+	++	+	+	+	+	++	+
Mollugo	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–	–	–	+	–	–	–	–	–	–
Portulaca	–	+	–	–	–	+	–	–	–	–	+	–	+	–	–	+	–	–	+	–	–	–	–	–	+	+	–	+	+	+	+	+	–	–	+	+
Grasses:																																				
Poaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+ floret	–	–	–	–	–	–	+ floret	+ spikelet	–	–	–	–	–	–	–	–
Sporobolus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
Other:																																				
Asteraceae	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–	–	+	–	–
Chenopodiaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Astragalus	+	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
cf. *Croton*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–	–
Cryptantha	–	–	+	–	+	+	–	+	+	+	+	–	+	+	+	+	–	–	+	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	+
Fabaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–	+	–
Datura	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
Dicotyledonae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+ leaf	–	–	–	–	–	–
Unknown taxon	–	–	–	–	–	+ fruit	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+ pp	–	–	–	–	–	–	–	–	–	–	–
Unidentifiable seed	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	+	+	–	–	–	–	+
Verbesina	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–
Perennials:																																				
Atriplex canescens	–	–	–	–	–	–	–	–	–	–	–	–	–	+ fruit	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Juniperus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+ twig	–	–	–	–	–	–	–	–	–	–	–
Larrea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+ leaf	–	–	–	–	+ leaf	+ leaf	–	–	–
Prosopis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+ leaf	–	–	–	–	–	–	–	–	–	–	+ leaf	+ leaf	–	+ leaf	–	+ leaf	+ leaf	–	+ leaf	–

Plant materials are seeds unless indicated otherwise.
Cultural plant material is charred, noncultural is uncharred.
+ = 1–10/sample, ++ = 11–25/sample, cf. = resembles taxon, e = embryo, os = outer stem, pp = plant part

Table 21.12. LA 129214, macrobotanical wood charcoal taxa.

FS NO.	FEATURE NO.	*ATRIPLEX/ SARCO-BATUS* (SALTBUSH/ GREASE-WOOD)		*CONDALIA ERICOIDES* (JAVELINA-BUSH)		*LARREA* (CREOSOTE-BUSH)		*PROSOPIS* (MESQUITE)		UNKNOWN NON-CONIFER		UNKNOWN		**TOTAL WEIGHT (G)**
		N*	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	
509	47	–	–	–	–	–	–	48	5.7	–	–	–	–	**5.7**
524	46, E 1/2	1	0.1	–	–	–	–	57	10.5	–	–	–	–	**10.6**
578	50, E 1/2	–	–	7	0.9	–	–	38	7.9	13	3.6	–	–	**12.4**
574	53, W 1/2	1	0.2	–	–	–	–	6	2.0	–	–	–	–	**2.2**
597	55, W 1/2	–	–	1	0.1	–	–	22	1.2	6	0.2	–	–	**1.5**
622	58	1	0.1	–	–	9	2.3	25	3.4	–	–	–	–	**5.8**
654**	485N/ 539E	–	–	–	–	–	–	4	0.3	–	–	–	–	**0.3**
655	485N/ 539E	–	–	–	–	–	–	34	2.0	–	–	–	–	**2.0**
658	59	2	0.1	–	–	–	–	54	6.9	–	–	–	–	**7.0**
663**	63, W 1/2	–	–	3	0.5	–	–	43	9.0	–	–	–	–	**9.5**
698	67	–	–	–	–	–	–	5	0.1	–	–	–	–	**0.1**
729	68, S 1/2	–	–	8	1.4	–	–	34	5.1	–	–	–	–	**6.5**
766**	72, W 1/2	–	–	12	0.6	–	–	–	–	–	–	–	–	**0.6**
841	74, E 1/2 fill	1	0.0	–	–	–	–	51	23.3	–	–	–	–	**23.3**
895	79	–	–	35	9.9	6	0.9	31	6.1	–	–	–	–	**16.9**
908	80/S1/2	–	–	–	–	–	–	39	7.0	–	–	–	–	**7.0**
908	80/N 1/2	–	–	–	–	–	–	47	8.5	–	–	–	–	**8.5**
909	82	–	–	–	–	–	–	20	0.8	–	–	–	–	**0.8**
915	83	–	–	–	–	–	–	6	0.2	–	–	–	–	**0.2**
994	84	–	–	–	–	–	–	64	1.7	–	–	–	–	**1.7**
943	85	–	–	–	–	–	–	11	0.1	–	–	–	–	**0.1**
961	86	–	–	–	–	–	–	28	0.6	–	–	–	–	**0.6**
1064	87	1	0.1	–	–	–	–	18	5.8	–	–	–	–	**5.9**
1003	88	–	–	–	–	–	–	11	0.2	–	–	–	–	**0.2**
1004	89	–	–	–	–	–	–	9	0.1	–	–	–	–	**0.1**
1065/ 1067	93	–	–	–	–	–	–	55	2.5	–	–	–	–	**2.5**
1057	94, S 1/2	–	–	6	1.7	–	–	34	10.2	–	–	1	0.9	**12.8**
1106	95	–	–	–	–	–	–	31	2.1	–	–	–	–	**2.1**
1366**	96	–	–	–	–	–	–	84	24.1	–	–	–	–	**24.1**
1112	97	–	–	–	–	–	–	–	–	9	1.1	–	–	**1.1**
1135	98	–	–	–	–	–	–	6	0.8	–	–	–	–	**0.8**
1157	99	–	–	16	0.9	–	–	–	–	–	–	–	–	**0.9**
1189	101	–	–	–	–	–	–	5	1.1	–	–	–	–	**1.1**
1237	102	–	–	–	–	–	–	15	1.1	–	–	–	–	**1.1**
1185	103, N 1/2	1	0.1	3	0.5	2	0.2	–	–	–	–	–	–	**0.8**
1186	103, S 1/2	2	0.1	3	0.1	11	0.8	1	0.1	–	–	–	–	**1.1**
1190	104	–	–	–	–	–	–	13	0.8	–	–	–	–	**0.8**
1239	105	–	–	–	–	–	–	8	1.3	–	–	–	–	**1.3**
1188	106	–	–	9	0.9	–	–	–	–	–	–	–	–	**0.9**
1349	108	–	–	8	0.6	–	–	–	–	–	–	–	–	**0.6**
1304	109, W 1/2	–	–	2	0.1	–	–	6	0.4	–	–	–	–	**0.5**
1334	111	1	0.1	–	–	–	–	27	3.8	–	–	–	–	**3.9**
1329	112	–	–	–	–	–	–	7	0.1	–	–	–	–	**0.1**
1396	113	–	–	–	–	–	–	6	0.1	–	–	–	–	**0.1**
1469	114	–	–	–	–	–	–	10	6.5	–	–	–	–	**6.5**
1469	114	–	–	–	–	–	–	20	1.9	–	–	–	–	**1.9**
1397	115	–	–	–	–	–	–	15	0.5	–	–	–	–	**0.5**

(*Table 21.12, continued*)

FS NO.	FEATURE NO.	*ATRIPLEX/ SARCO-BATUS* (SALTBUSH/ GREASE-WOOD)		*CONDALIA ERICOIDES* (JAVELINA-BUSH)		*LARREA* (CREOSOTE-BUSH)		*PROSOPIS* (MESQUITE)		UNKNOWN NON-CONIFER		UNKNOWN		**TOTAL WEIGHT (G)**
		N*	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	
1470	116	2	0.2	–	–	–	–	17	3.4	–	–	–	–	**3.6**
1433	120	–	–	7	0.7	–	–	28	7.6	–	–	–	–	**8.3**
1429	121	–	–	9	0.6	–	–	–	–	–	–	–	–	**0.6**
1394	122, E 1/2	–	–	–	–	–	–	63	26.4	–	–	–	–	**26.4**
1401	123	–	–	80	7.5	–	–	21	1.4	–	–	–	–	**8.9**
1434	124	–	–	11	0.8	–	–	–	–	–	–	–	–	**0.8**
1461	128	–	–	–	–	–	–	–	–	4	0.5	–	–	**0.5**
1497	129/N 1/2	–	–	5	0.4	–	–	28	4.6	4	0.3	–	–	**5.2**
1497	129/S 1/2	–	–	6	1.0	–	–	64	9.3	2	0.2	–	–	**10.5**
1522**	131/E 1/2	–	–	–	–	–	–	19	7.7	–	–	–	–	**7.7**
1522**	131/W 1/2	–	–	–	–	–	–	57	13.7	–	–	–	–	**13.7**
1615	133	–	–	6	0.6	–	–	–	–	–	–	–	–	**0.6**
1617	133	2	0.3	28	2.7	–	–	–	–	–	–	–	–	**3.0**
1555	134	–	–	6	0.6	–	–	–	–	–	–	–	–	**0.6**
1542	135	5	0.2	2	0.5	3	0.2	34	4.2	–	–	–	–	**5.1**
1605	136	–	–	–	–	–	–	11	3.6	–	–	–	–	**3.6**
1605	136/ E 1/2	–	–	1	0.1	–	–	46	8.0	–	–	–	–	**8.1**
1556	137	–	–	–	–	–	–	11	0.5	–	–	–	–	**0.5**
1606	138	–	–	68	15.1	–	–	29	7.9	–	–	–	–	**23.0**
1664	141, N 1/2	–	–	106	17.7	2	0.1	3	0.2	–	–	–	–	**18.0**
1660	142	1	0.2	53	25.9	4	1.7	3	0.9	–	–	–	–	**28.7**
1678	143	–	–	–	–	–	–	1	0.8	–	–	–	–	**0.8**
1662	144	–	–	–	–	–	–	9	0.5	–	–	–	–	**0.5**
1677	145	–	–	–	–	–	–	7	0.6	–	–	–	–	**0.6**
1745	146, S 1/2	2	0.2	25	8.3	–	–	27	12.0	–	–	–	–	**20.5**
1691	148	–	–	–	–	–	–	11	0.6	–	–	–	–	**0.6**
1748	149, W1/2	–	–	–	–	–	–	7	2.2	–	–	–	–	**2.2**
1666	151	–	–	–	–	–	–	10	0.6	–	–	–	–	**0.6**
1714	152	–	–	–	–	–	–	1	1.0	–	–	–	–	**1.0**
1715	152	1	0.1	58	19.6	–	–	47	17.3	–	–	–	–	**37.0**
1867	153	–	–	–	–	–	–	30	7.7	2	0.1	–	–	**7.8**
1868	154	–	–	8	0.5	–	–	–	–	–	–	–	–	**0.5**
1866	155	–	–	–	–	–	–	9	0.6	–	–	–	–	**0.6**
1747	157	7	0.9	–	–	–	–	23	4.4	–	–	–	–	**5.3**
1769	158, W 1/2	–	–	36	5.1	–	–	15	2.0	–	–	–	–	**7.1**
1865	160	–	–	6	0.1	–	–	–	–	–	–	–	–	**0.1**
1953	162	–	–	–	–	–	–	10	0.3	–	–	–	–	**0.3**
1901	163	–	–	5	0.3	–	–	–	–	–	–	–	–	**0.3**
1874	167	–	–	11	3.1	–	–	15	2.4	–	–	–	–	**5.5**
1873	171	–	–	12	1.1	–	–	42	8.4	–	–	–	–	**9.5**
1899	173	–	–	103	30.8	–	–	4	0.4	–	–	–	–	**31.2**
1813	177	–	–	–	–	–	–	13	2.1	–	–	–	–	**2.1**
1912	178	–	–	–	–	–	–	4	0.3	–	–	–	–	**0.3**
1810	180	–	–	–	–	–	–	13	0.3	–	–	–	–	**0.3**
1811	181	–	–	–	–	–	–	3	0.5	–	–	–	–	**0.5**
1812	182	–	–	–	–	–	–	18	0.5	–	–	–	–	**0.5**
1917	188, N 1/2	–	–	16	2.3	–	–	1	0.0	–	–	–	–	**2.3**
1919	190	–	–	–	–	–	–	36	9.7	–	–	–	–	**9.7**
1962	198	2	0.1	2	0.2	1	0.0	9	0.6	–	–	–	–	**1.0**
1963	199	3	0.2	–	–	–	–	77	12.3	–	–	–	–	**12.5**
1964	200	–	–	–	–	–	–	44	8.3	–	–	–	–	**8.3**

(Table 21.12, continued)

FS NO.	FEATURE NO.	*ATRIPLEX/ SARCOBATUS* (SALTBUSH/ GREASEWOOD)		*CONDALIA ERICOIDES* (JAVELINA-BUSH)		*LARREA* (CREOSOTE-BUSH)		*PROSOPIS* (MESQUITE)		UNKNOWN NON-CONIFER		UNKNOWN		**TOTAL WEIGHT (G)**
		N*	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	
1965	202, W 1/2	–	–	20	4.7	–	–	54	8.9	–	–	–	–	**13.6**
1966	203	–	–	1	0.01	–	–	22	2.1	–	–	–	–	**2.1**
Total weight (g)			**3.1**		**162.9**		**6.2**		**351.9**		**4.4**		**0.9**	**529.4**
Total weight (%)			**0.6%**	**0.0%**	**30.8%**	**0.0%**	**1.2%**	**0.0%**	**66.5%**	**0.0%**	**0.8%**	**0.0%**	**0.2%**	**100.0%**
Total count (N)		**36**		**720**		**38**		**1607**		**27**		**1**		**2429**

*N = count

** charcoal stored in plastic containers

tional information from the four features that had samples from both categories. Features 21 and 32 yielded mesquite wood in flotation and macrobotanical samples, while flotation wood from Feature 23 was entirely mesquite and the one macrobotanical wood specimen from this feature was identified as creosote bush (Tables 21.25 through 21.26). Flotation-sample wood from Feature 43 was half mesquite and half lotebush; macrobotanical wood consisted of 17 pieces of lotebush and no mesquite. Wood from other macrobotanical samples was primarily mesquite, with a few exceptions: there was more lotebush from Feature 37, and it was the only taxon recovered from Features 41 and 44. Creosote bush was the sole taxon identified from Feature 38.

Discussion

Sites of the NM 128 project encompass both an Archaic signature and what Lord and Reynolds (1985) label Neo-Archaic. At sites of the ceramic periods in the Hondo Valley or intermontaine basins of south-central New Mexico, agriculture makes an appearance and prehistoric inhabitants can be classified as collector/farmers. At contemporaneous sites east of the Pecos, however, the Neo-Archaic adaptation shows no evidence for farming and a lifestyle that is most similar to full-time hunter-gatherers is evident. The Neo-Archaic subsistence mode is primarily focused on foraging (OAS Staff 2006), but can include more than one strategy. With this mobile adaptation, one would expect the plant remains at any given site to reflect single-season collection. If mesquite pods are the target resource, late June is usually the best time to visit that site, whereas if cactus fruits were the objective, then August or September would be a better choice. Most annual seeds mature in mid-late summer. So if we look at the assemblage of plant material, particularly from LA 113042, where yucca caudex fragments, mesquite, hedgehog, prickly pear, horse-crippler cactus, and goosefoot seeds were recovered, the implication is that the site was occupied from June to September, either sporadically or continuously. Alternatively, the archaeobotanical record at LA 113042 may represent a site that was visited over many years. Seasonal occupation would have been dependent on fluctuating environmental conditions affecting plant or animal resource abundance.

Unfortunately, those features with solid Archaic period dates from LA 129218 (Features 14, 16, and 23) and LA 129300 (Features 20 and 23) did not yield any non-wood carbonized plant remains, so neither temporal nor regional subsistence comparisons involving the Archaic component can be made for this project. Regional sites, with either comparable occupation periods or similar feature types, are compared with NM 128 in Table 21.27. Sites are located in the Mesilla Bolson, canyons, mountain foothills, river valleys, and Cornucopia Draw, between the Guadalupe Mountains and Otero Mesa.

What is common to the majority of sites is the marked focus on a variety of perennials (cacti, leaf succulents, shrub/tree fruits) and a shorter list of annuals. The annuals largely consist of weedy taxa that produce prolific seed crops, and are found at sites across the Southwest and throughout the prehistoric spectrum (amaranth, goosefoot, and purslane). The

Table 21.13. LA 129214, flotation sample wood charcoal taxa.

FS NO.	FEATURE NO.	*ATRIPLEX/ SARCOBATUS* (SALTBUSH/ GREASEWOOD)		*CONDALIA ERICOIDES* (JAVELINABUSH)		*LARREA* (CREOSOTEBUSH)		*PROSOPIIS* (MESQUITE)		UNKNOWN NONCONIFER		**TOTAL WEIGHT (G)**
		N*	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	
240	–	–	–	–	–	–	–	20	0.3	–	–	**0.3**
341	39	–	–	7	0.2	–	–	13	0.6	–	–	**0.8**
340	43	1	0.0	–	–	–	–	19	0.5	–	–	**0.5**
524	46	1	0.0	–	–	–	–	19	1.5	–	–	**1.5**
509	47	–	–	–	–	–	–	20	0.5	–	–	**0.5**
573	48	–	–	16	2.1	–	–	4	0.8	–	–	**2.9**
553	49	–	–	3	0.1	–	–	14	0.8	3	0.1	**1.0**
579	50, W 1/2	1	0.0	17	2.4	–	–	2	0.3	–	–	**2.7**
586	52	6	0.1	–	–	–	–	2	0.0	–	–	**0.2**
598	53	–	–	–	–	–	–	20	1.0	–	–	**1.0**
593	54	–	–	–	–	–	–	2	0.1	–	–	**0.1**
596	55	–	–	–	–	–	–	6	0.1	–	–	**0.1**
623	57, E 1/2	1	0.0	–	–	–	–	6	0.2	–	–	**0.2**
623 3/3	57, E 1/2	–	–	7	0.5	–	–	13	0.5	–	–	**1.0**
622 1/3	58	–	–	–	–	–	–	19	0.8	1	0.1	**0.9**
622 2/3	58	–	–	–	–	–	–	20	2.1	–	–	**2.1**
658 1/2	59	1	0.0	–	–	–	–	19	0.8	–	–	**0.8**
658 2/2	59	1	0.0	–	–	–	–	19	0.9	–	–	**0.9**
657	61	–	–	3	0.1	–	–	17	0.8	–	–	**0.9**
697 1/2	62	1	0.1	2	0.0	–	–	11	0.5	–	–	**0.6**
697 2/2	62	–	–	5	0.1	–	–	13	0.3	–	–	**0.4**
663 PP No. 2	63	–	–	3	0.1	–	–	17	0.6	–	–	**0.7**
682 2/2	64	–	–	1	0.0	–	–	16	0.4	–	–	**0.4**
710	66	3	0.1	–	–	–	–	17	2.0	–	–	**2.0**
728 2/2	68, N 1/2	2	0.1	5	0.1	–	–	13	0.7	–	–	**0.9**
763	70, S 1/2	–	–	–	–	–	–	8	0.1	–	–	**0.1**
764	70, N 1/2	–	–	1	0.0	–	–	11	0.2	–	–	**0.3**
765	70, N 1/2	–	–	3	0.1	–	–	16	0.5	–	–	**0.6**
755 1/4	71	–	–	–	–	–	–	4	0.1	–	–	**0.1**
766	72	1	0.0	19	0.8	–	–	–	–	–	–	**0.8**
Total weight (g)			**0.5**		**6.6**				**18.0**		**0.1**	**25.2**
Total weight (%)			**1.8%**	**0.0%**	**26.3%**			**0.0%**	**71.4%**	**0.0%**	**0.5%**	**100.0%**
Count (subtotal)		**19**		**92**				**380**		**4**		
774 1/3	73	–	–	2	0.1	–	–	15	0.8	3	0.2	**1.0**
774 2/3	73	1	0.0	–	–	–	–	19	1.4	–	–	**1.5**
774 3/3	73	–	–	3	0.1	–	–	17	0.5	–	–	**0.5**
841 PP#2	74	1	0.0	–	–	–	–	19	0.9	–	–	**0.9**
850	75	–	–	–	–	–	–	1	0.2	–	–	**0.2**
876 1/2	76	–	–	–	–	–	–	3	0.0	–	–	**0.0**
876 2/2	76	–	–	–	–	–	–	15	0.3	–	–	**0.3**
886	77	–	–	1	0.0	–	–	15	0.2	–	–	**0.2**
893	79, N 1/2	–	–	12	0.7	–	–	8	0.3	–	–	**1.0**
894 1/2	79, S 1/2	1	0.0	8	0.3	–	–	11	0.4	–	–	**0.7**
1033	92, W 1/2	–	–	73	2.8	–	–	7	0.2	–	–	**3.0**
1036	92, E 1/2	–	–	11	0.2	–	–	2	0.0	–	–	**0.2**
1343 1/4	110	1	0.0	9	0.3	–	–	2	0.2	–	–	**0.5**
1343 2/4	110	–	–	14	0.4	–	–	6	0.3	–	–	**0.7**

(Table 21.13, continued)

FS NO.	FEATURE NO.	*ATRIPLEX/ SARCO-BATUS* (SALTBUSH/ GREASE-WOOD)		*CONDALIA ERICOIDES* (JAVELINA-BUSH)		*LARREA* (CREOSOTE-BUSH)		*PROSOPIIS* (MESQUITE)		UNKNOWN NONCONIFER		**TOTAL WEIGHT (G)**
		N*	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	N	WEIGHT (G)	
1343 3/4	110	–	–	16	0.7	–	–	4	0.1	–	–	**0.8**
1343 4/4	110	–	–	14	0.5	–	–	6	0.9	–	–	**1.4**
1367	118	1	0.0	–	–	–	–	28	1.0	–	–	**1.0**
1367 1/2	118	–	–	1	0.1	–	–	110	4.9	–	–	**5.0**
1367 2/2	118	–	–	3	0.1	–	–	64	2.7	–	–	**2.8**
1345	119	–	–	4	0.3	–	–	–	–	–	–	**0.3**
1346	119	–	–	47	1.1	–	–	9	0.3	–	–	**1.4**
1536	132	4	0.1	23	0.8	–	–	13	0.3	–	–	**1.2**
1718	156	2	0.1	9	0.5	–	–	46	2.0	–	–	**2.6**
1751	159	2	0.1	18	0.6	–	–	35	1.4	–	–	**2.1**
1846	165, N 1/2	–	–	11	1.2	–	–	7	0.1	–	–	**1.3**
1846	165, S 1/2	–	–	11	0.1	–	–	5	0.1	–	–	**0.2**
1916	187	–	–	18	0.8	15	0.5	40	1.4	–	–	**2.7**
Total weight (g)			**0.9**		**19.1**		**0.5**		**39.2**		**0.3**	**59.9**
Total weight (%)			**1.4%**	**0.0%**	**31.8%**	**0.0%**	**0.8%**	**0.0%**	**65.4%**	**0.0%**	**0.5%**	**100.0%**
Total Table Count		**32**		**416**		**15**		**891**		**7**		

*N = count

Table 21.14. LA 129216, thermal features, flotation scan plant remains.

FEATURE NO.	10	13	15	17	18	20	
	NW 1/4					N 1/2	S 1/2
FS NO.	36	53	69	77	76	91	91
Cultural							
Annuals:							
Chenopodium	0.1	–	–	–	–	–	0.1
Portulaca	–	–	–	0.1	–	0.1	0.1
Perennials:							
cf. *Yucca campestris*	–	–	–	–	–	+ os	+ os
Noncultural							
Annuals:							
Chenopodium	+	–	–	+	+	–	+
Euphorbia	+	–	–	+	–	+	+
Kallstroemia	–	–	–	+	+	–	–
Mollugo	+	–	–	+	–	–	+
Portulaca	–	–	–	+	+	+	+
Grasses:							
Poaceae	–	–	–	–	+	–	–
Other:							
Asteraceae	–	+	–	–	–	+	–
Solanum	–	–	–	–	–	+	–
Unidentifiable seed	+	–	+	–	+	–	+
Perennials:							
Atriplex canescens	+ leaf	–	–	–	–	–	–
Larrea	–	–	–	–	+ leaf	–	–

+ = 1–10/sample, cf. = resembles taxon, os = outer stem

Table 21.15. LA 129216, thermal features, flotation full-sort plant remains.

FEATURE NO.	11		14	16		19
	NE 1/4	S 1/2		W 1/2	E 1/2	E 1/2
FS NO.	67	75	66	64	65	90
Cultural						
Annuals:						
Amaranthus	–	–	–	–	–	0.1
Chenopodium	–	–	–	0.3	0.1	–
Cheno-Am	–	–	–	–	–	0.1 pc
Mollugo	–	–	–	–	–	0.1
Portulaca	–	–	0.5	–	–	0.1
Other:						
Asteraceae	–	–	–	–	–	0.1
Unknown taxon	–	–	–	–	–	0.1 pp
Perennials:						
cf. *Yucca campestris*	–	–	–	–	–	+ os
Noncultural						
Annuals:						
Amaranthus	–	–	–	–	0.1	–
Chenopodium	0.7	0.1	0.5	0.1	0.1	0.4
Descurainia	0.1	0.1	–	–	–	–
Dicoria	–	–	–	–	0.1	–
Euphorbia	–	0.4	–	0.1	0.1	1.4
Mollugo	0.1	0.1	–	–	–	–
Portulaca	0.6	0.3	0.9	–	0.1	0.3
Grasses:						
Poaceae	–	0.1 floret	–	0.1	0.1	0.2
Sporobolus	–	–	–	–	–	0.1
Other:						
Cryptantha	–	0.2	–	–	–	–
Physalis	–	–	0.5	–	–	–
Unidentifiable seed	–	0.1	0.9	0.1	0.1	0.1
Unknown taxon	–	–	0.5 flower	–	–	–
Perennials:						
Atriplex canescens	0.1 fruit, + leaf	–	–	–	–	+ leaf
Cassia	–	–	–	–	–	0.1
Larrea	+ leaf	–	+ leaf	–	+ leaf	+ leaf
Pinus edulis	–	–	–	–	+ needle	–
Prosopis	0.2, + leaf	0.3, + leaf	0.5	–	+ leaf	+ leaf

+ = 1–10/sample, cf. = resembles taxon, pp = plant part, pc = partially charred, os = outer stem

only site with a substantial list of grass genera was High Rolls Cave in the Sacramento Mountains. The reason for this is not clear, but is probably related to Bohrer's long experience with grass identification, enabling her to name more taxa. Ethnographic studies from the historic era point to a heavy focus on concentrated perennial resources such as leaf succulents, cacti, and mesquite (Baseheart 1974; Bell and Castetter 1937, 1941; Castetter and Opler 1936; Castetter et al. 1938). Indeed, these three perennial resource types are clearly reflected in archaeobotanical data as important components of the diet.

The prominence of fire-cracked rock features at Archaic and Neo-Archaic sites has prompted considerable speculation about land-use and subsistence patterns. Archaic settlements in various topographic situations were presumed to reflect seasonal procurement ventures that included collection of agave hearts in the mountain foothills or gathering mesquite in the lower Hueco Bolson and

Table 21.16. LA 129216 flotation sample wood charcoal taxa.

FS NO.	FEATURE NO.	*ATRIPLEX/ SARCOBATUS* (SALTBUSH/ GREASEWOOD)		*CONDALIA ERICOIDES* (JAVILINABUSH)		*PROSOPIS* (MESQUITE)		**TOTAL WEIGHT**
		COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	
66	14	1	0.0	–	–	127	7.8	**7.8**
64	16, W 1/2	34	1.2	338	16.2	7	0.2	**17.6**
65	16, E 1/2	96	4.0	420	22.1	10	0.5	**26.6**
90	19, E 1/2	–	–	157	8.3	43	3.1	**11.3**
Total weight (g)			**5.2**		**46.6**		**11.6**	**63.3**
Total weight (%)			**8.2%**		**73.5%**		**18.3%**	**100.0%**
Total count		**131**		**915**		**187**		**1233**

Table 21.17. LA 129216, macrobotanical wood charcoal taxa.

FS NO.	FEATURE NO.	*CONDALIA ERICOIDES* (JAVELINABUSH)		*PROSOPIS* (MESQUITE)		**TOTAL WEIGHT (G)**
		COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	
37	10, NW 1/4	–	–	3	0.8	**0.8**
38	10, NE 1/4	–	–	2	0.6	**0.6**
53	13	–	–	13	0.4	**0.4**
66	14	–	–	10	0.3	**0.3**
69	15	31	0.8	4	0.1	**0.9**
77	17	–	–	5	0.4	**0.4**
76	18	–	–	8	0.2	**0.2**
Total weight (g)			**0.8**		**2.7**	**3.6**
Total weight (%)			**23.2%**		**76.8%**	**100.0%**
Total count		**31**		**42**		**73**

Deming Basin (Brethauer 1978; Carmichael 1981). Until recently, little evidence was available to substantiate these postulated subsistence activities. One exception was the recovery of mesquite seeds and one monocot (yucca or agave) carpel at Zone 4 of the Key Stone Dam Site 33 in northwest El Paso (thought to be a longer-term Archaic winter camp; O'Laughlin 1980). Another was the identification of a yucca pod and a stalk or pod in the agave family from pits and pit-structure fill at sites identified during the Distributional Survey project on the west mesa of the Mesilla Bolson near El Paso, Texas (O'Laughlin 1988).

More recent studies from Archaic deposits at Cornucopia Draw and High Rolls Cave have produced more evidence of leaf succulent use (McBride 1996; Toll and McBride 1999; Bohrer 2006). Yucca caudex fragments recovered at NM 128 sites form 24 percent of the samples with charred remains (157) and could be evidence for the use of leaf succulents as food in the Neo-Archaic period. Ethnobotanical accounts compiled by Bell and Castetter (1941) describe the collection of young flower stalks of *Y. glauca* by the Mescalero Apache. They were roasted on a bed of embers for a short time, about 15 minutes, and then the burned portion was scraped away, leaving the central, white portion that was regarded as the best part of the plant. The crowns were also gathered by the same group, from mid-March to the end of summer.

"The portion between the ground and the leaves was peeled and baked overnight in an underground oven" (Bell and Castetter 1941:19), applying a method similar to that used for roasting agave hearts. The product of this process was then dried in the sun and stored for future use when pieces were softened in water to render them edible. The outer bark-like material from the base of the stem (recovered from all sites except LA 129217 and LA 129222) could represent residue from preparing the stems or crowns as described above. Equally plausible is the possibility

Table 21.18. LA 129217, thermal features, flotation full-sort plant remains.

CONTEXT	470N/ 543E	FEATURE 10		FEATURE 11
	SW 1/4	NE 1/4		
FS N0.	22	37	38	139
Cultural				
Annuals:				
Chenopodium	–	0.3	–	–
Noncultural				
Annuals:				
Chenopodium	–	–	–	0.3
Euphorbia	–	0.7	0.5	–
Mollugo	–	–	–	0.3
Grasses:				
Poaceae	–	2.1	5.1	–
Sporobolus	–	–	0.5	–
Other:				
Cryptantha	–	0.3	0.5	–
Perennials:				
Prosopis	+ leaf	–	–	–

+ = 1–10/sample

Table 21.19. LA 129218, thermal features, flotation full-sort plant remains.

FEATURE NO.	8	10	11	12	13	14, N 1/2	15	16	22	23
FS NO.	19	76	85	100	101	136	132	138	149	154
Cultural										
Perennials:										
cf. *Yucca campestris*	+ os	+ os	–	–	–	–	–	–	–	–
Possibly Cultural										
Other:										
Unknown taxon	0.5 pp	–	0.4 pp	–	–	–	–	–	–	–
Noncultural										
Annuals:										
Chenopodium	1.6	0.3	0.2	–	–	–	0.9	–	–	–
Euphorbia	–	–	0.4	–	–	–	–	–	–	–
Mollugo	9.7	–	3.4	0.7	20.0	1.3	9.8	2.6	20.0	2.5
Portulaca	–	–	–	–	–	0.3	–	–	–	1.3
Perennials:										
Chamaesaracha	–	0.3	–	–	–	–	–	–	–	–
Juniperus	–	–	–	–	–	+ twig	–	–	–	–

+ = 1–10/sample, cf. = resembles taxon, pp = plant part, os = outer stem

Table 21.20. LA 129218 flotation wood charcoal taxa.

FS NO.	FEATURE NO.	*PROSOPIS* (MESQUITE)		TOTAL WEIGHT (G)
		COUNT	WEIGHT (G)	
85	11	20	2.2	**2.2**
100	12	20	0.5	**0.5**
101	13	18	0.2	**0.2**
138	16	20	0.3	**0.3**
Total		**78**	**3.2**	**3.2**

Table 21.21. LA 129218 macrobotanical wood charcoal taxa.

FS NO.	FEATURE NO.	*PROSOPIS* (MESQUITE)		TOTAL WEIGHT (G)
		COUNT	WEIGHT (G)	
19	8	5	0.6	**0.6**
85	11	5	0.6	**0.6**
100	12	22	0.5	**0.5**
101	13	22	0.2	**0.2**
136	14	12	0.6	**0.6**
133	15	5	0.0	**0.0**
140	16	6	0.5	**0.5**
155	23	4	0.6	**0.6**
Total		**81**	**3.6**	**3.6**

Table 21.22. LA 129222, flotation full-sort and scan plant remains.

FEATURE NO.	4 THERMAL	5 THERMAL	7 STORAGE PIT
FS NO.	225	275	330
Noncultural			
Annuals:			
Descurainia	1.5	–	–
Euphorbia	1.5	–	–
Kallstroemia	0.9	–	–
Lepidium	0.3	–	–
Mollugo	0.9	–	–
Phacelia crenulata	8.2	–	0.5
Other:			
Asteraceae	0.6	–	–
Unknown taxon	–	+ plant part	–
Unidentifiable seed	–	+	–
Perennials:			
Atriplex	–	–	–
Larrea	14.0 fruit, + leaf	+ fruit, + leaf	–

Cultural plant remains are carbonized, noncultural are not.
Plant parts are seeds unless indicated otherwise.

Table 21.23. LA 129300, thermal features, flotation scan plant remains.

FEATURE NO.	1				15	17	18		20	22	24	25	26	28	35	37	38	41	42	44
	N 1/2, PP 1	N 1/2, PP 2	S 1/2, PP3	S 1/2, PP 4	S 1/2	S 1/2	N 1/2	S 1/2									W 1/2		E 1/2	
FS NO.	216				314	167	190	191	349	246	297	391	392	418	409	435	433	457	484	481
Cultural																				
Annuals:																				
Chenopodium	–	–	–	–	–	–	–	0.5	–	–	–	0.3	–	–	–	–	–	–	–	–
Portulaca	–	–	–	–	–	–	–	–	–	–	–	–	0.6	–	–	–	–	–	–	–
Other:																				
Fabaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5	–	–	–	–	–
Unidentifiable seed	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.1	–	–	–	–	–
Unknown taxon	–	–	–	–	–	–	1.3 pp, 0.4 cf. spine	4.4 pp, + twig	–	–	1.7 pp	–	–	–	–	–	0.5 pp	–	–	–
Perennials:																				
cf. *Yucca campestris*	–	–	–	–	–	–	–	–	–	+ os	–	–	–	–	–	–	–	++ os	–	–
Noncultural																				
Annuals:																				
Euphorbia	+	–	–	+	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
Portulaca	–	–	–	–	–	–	–	+	–	–	–	+	–	–	–	–	–	–	–	–
Kallstroemia	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mollugo	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–	+	–	–	–	+
Portulaca	–	–	–	+	+	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–
Talinum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grasses:																				
Poaceae	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
Other:																				
Asteraceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–
Croton	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–
Unidentifiable seed	–	+	–	–	–	–	+	–	–	+	–	–	–	–	+	–	–	–	–	–
Unknown taxon	–	–	–	+ pp	–	–	–	–	–	–	–	–	–	–	+ leaf, + peduncle	–	–	–	–	–
Perennials:																				
Echinocereus	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cassia	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–

(Table 21.23, continued)

FEATURE NO.	1				15	17	18		20	22	24	25	26	28	35	37	38	41	42	44
	N 1/2, PP 1	N 1/2, PP 2	S 1/2, PP3	S 1/2, PP 4	S 1/2	S 1/2	N 1/2	S 1/2									W 1/2		E 1/2	
FS NO.	216				314	167	190	191	349	246	297	391	392	418	409	435	433	457	484	481
Larrea	+ fruit, + leaf	–	+ fruit, + leaf	–	–	–	–	–	+ leaf	–	–	–	–	–	–	–	–	–	–	–
Prosopis	+ leaf, + spine	+ leaf	+	–	–	–	+, + leaf	–	–	–	–	–	–	–	–	–	–	–	+ leaf	–

Cultural plant remains are carbonized, noncultural are not.
Plant parts are seeds unless indicated otherwise.
+ = 1–10/sample, ++ = 11–25/sample, cf. = resembles taxon, os = outer stem, pp = plant part

Table 21.24. LA 129300, thermal features, flotation full-sort plant remains.

FEATURE NO.	21	23	30	32	36	39, S 1/2	40	43
	W 1/2		W 1/2			S 1/2	N 1/2	
FS NO.	252	390	416	432	424	456	464	480
Cultural								
Perennials:								
cf. *Yucca campestris*	–	–	–	–	–	–	–	+ os
Noncultural								
Annuals:								
Mollugo	–	–	–	–	2.1	–	–	–
Perennials:								
Cassia	–	0.6	–	–	–	–	–	–
Larrea	2.4	0.6 fruit, + leaf	–	0.2 fruit, + leaf	–	–	–	–
cf. *Parthenium*	–	–	+ leaf	–	–	–	–	–
Prosopis	+ leaf	+ leaf	–	–	–	+ leaf	–	–
Rhus	–	–	–	0.2	–	–	–	–
Other:								
Asteraceae	–	0.6	0.3	–	–	–	–	–
Cryptantha	–	–	–	–	–	–	10.3	–

Cultural plant remains are carbonized, noncultural are not.
Plant parts are seeds unless indicated otherwise.
+ = 1–10/sample, cf. = resembles taxon, os = outer stem

that the very dry, easily gathered material was used as tinder.

Other sites with components that date between AD 535 and AD 1020 and have a Neo-Archaic adaptation signature, (Piñon and Wind Canyon) provide further confirmation that agave and other leaf succulents were exploited (Toll and McBride 1999; Bohrer 1994). Finally, a ring midden at Wind Canyon that dates to AD 1200 produced more proof of agave, sotol, and yucca use as well as cacti (Bohrer 1994).

One goal of the current study was to document human use of the shinnery oak. Stands of shinnery oak are present on parabolic dunes near LA 129217 and LA 129218. This distinctive oak species, with a very local distribution, produces a concentrated energy source of very large acorns that may not have needed the lengthy leaching process that other species require. Unfortunately, evidence for acorn use was not found at any of the NM 128 sites. Acorns could have provided a critical source of fat and carbohydrates for both humans and animals in this corner of New Mexico. Acorns of *Q. havardii* from near the two NM 128 sites, as well as some collected near Roswell, were assayed for their nutritional values by Paleoresearch Institute (see Chapter 26, this volume) and compared to nutritional data on acorns of unspecified taxa available through the USDA.

Paleoresearch found that the nutritional content of acorns differs significantly, both between populations of the same species and those of different species, possibly depending on where the oaks are growing and how much water is available to a given population. We do know that some types of acorns provide a source of very high-quality protein: a one ounce serving of acorn flour supplies 142 calories, with nearly equal contributions from carbohydrates and fat (www.nutritiondata.com). Acorns of *Quercus gambelii*, another Southwestern scrub oak, provide 6.9 mg/g of protein and 8.2 mg/g of fat (Hiles 1993:72). Dried acorns, as opposed to raw acorns or acorn flour, are higher in protein, fat, and fiber (Hiles 1993:73).

According to Ford (1976), Gambel oak acorns do not require leaching prior to consumption. Acorns were shelled and eaten raw or roasted in ashes. Shinnery oak acorns, although unpleasantly dry and mealy in texture, can be collected and eaten raw,

Table 21.25. LA 129300, thermal features, flotation wood taxa, count and weight in grams.

FEATURE NO.	21 W 1/2	23	32	43	**TOTAL**	
FS NO.	252	390	432	480	**WEIGHT (G)**	**COL. %**
Nonconifers						
cf. *Condalia ericoides*	–	–	–	9/.18	**0.18**	**12.3%**
Prosopis	17/.42	11/.13	20/.56	7/.17	**1.28**	**87.7%**
Total	**17/.42**	**11/.13**	**20/.56**	**16/.35**	**1.46**	**100.0%**

cf. = resembles taxon

Table 21.26. LA 129300, macrobotanical wood charcoal taxa.

FS NO.	FEATURE NO.	*CONDALIA ERICOIDES* (JAVELINABUSH)		*PROSOPIS* (MESQUITE)		*LARREA* (CREOSOTE-BUSH)		**TOTAL WEIGHT (G)**
		COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	COUNT	WEIGHT (G)	
347	20	–	–	9	0.5	–	–	**0.5**
252	21	–	–	3	0.8	–	–	**0.8**
390	23	–	–	–	–	1	0.6	**0.6**
391	25	–	–	11	0.5	–	–	**0.5**
392	26	–	–	2	0.6	–	–	**0.6**
428	32	–	–	10	0.6	–	–	**0.6**
435	37	30	0.6	10	0.3	–	–	**0.9**
433	38	–	–	–	–	18	0.5	**0.5**
465	40	–	–	5	0.1	–	–	**0.1**
457	41	2	0.6	21	0.5	–	–	**1.1**
480	43	17	0.2	–	–	–	–	**0.2**
481	44	3	0.5	–	–	–	–	**0.5**
Total weight (g)			**2.0**		**4.0**		**1.1**	**7.1**
Total weight (%)			**28.1%**		**56.1%**		**15.8%**	**100.0%**
Total count		**52**		**71**		**19**		**142**

with only a slightly bitter aftertaste (Don Tatum, personal communication, 2009). The Apache (presumably both Mescalero and Chiricahua) gathered ripe acorns, roasted and pounded them, and mixed the meal with dried meat or fat that was then stored in hide containers (Castetter and Opler 1936:42). The San Felipe, Acoma, and Laguna boiled and ate the nuts or ground them into a meal (Castetter 1935:47). Castañeda, documenting the journey of Coronado in AD 1528-1543, referred to the Indians of the Southwest as making acorn cakes "like sugar plums with dried coriander seeds" (1907). The inclusion of coriander seeds in the cakes may be an error since documentary evidence suggests that this Old World spice was not brought into New Mexico until the Oñate entrada in AD 1598 (Hammond and Rey 1953: 524, 539).

Although acorns would have been an easily gathered source of protein, they have been conspicuously absent from most Southwest archaeobotanical assemblages. Acorns are rarely recovered from sites, and then often as unburned, rodent-gnawed specimens in caves or dry shelters, where their presence may not be related to prehistoric subsistence at all (e.g., Adams and Huckell 1986:297). Three sites from southeastern New Mexico provide some evidence of acorn utilization. In the WIPP core area a few kilometers to the east of LA 129217 and LA 129218, both charred and uncharred acorn nutshell fragments were recovered from two features (dating to AD 260 ± 150 and AD 670 ± 60) at ENM 10230 (Lord and Clary 1985).

Floral material recovered from a subterranean structure (LA 2112) date to the AD 1300-1350 occupation of the site and included 34 oak cotyledons and two acorns (Ford 1976). In addition, Bohrer

Table 21.27. Presence of carbonized plant remains from sites in the El Paso region; Wind Canyon, Texas; south-central New Mexico, and NM 128.

SITES	NO. OF SAMPLES	ANNUALS	GRASSES	PERENNIALS	CULTIGENS	OTHER
Archaic: Distributional Survey* 1150± 270 BC–AD 325± 260 West Mesa, Mesilla Bolson[1]	25F, 2M	Am, Port	Poaceae, Sp	*Yucca pod*	–	Agavaceae stalk or pod, *Astragalus* ?
Keystone Dam Site 33, Zone 4 2500–1800 BC eastern edge, Mesilla Bolson[2]	?F, 1M	Ch-Am, Port, Poly	Poaceae, Erag	Atrip, Echinoc hor, Platy, *Prosopis, Rumex, Scirpus*, poss. *Yucca/Agave* carpel	–	–
Piñon LA 121839, 420 BC, LA 107601, F. 12, AD 120 Cornucopia Draw[3]	5F	Oen	–	Agave, Platy	–	–
High Rolls Cave 1500 BC–AD 250 Sacramento Mountains[4]	33F	Am, Art drac, Boer wr, Ch-Am, Ch, Hel/Vig, Lep, Nicot, Port	Ach hy, *Elymus*, Erag, Paniceae, Sp, Stipa neo	Jun, P. ed/cemb, Platy, *Prosopis,* Sph, *Typha*, Yba	*Zea mays*	Apiaceae
Fresnal Shelter 1600 BC–AD 1 Sacramento Mountains[5]	17? F, 44 screened levels	Am, Ch	*Panicum*, Sp, St neo	Agave, Atrip, Cuc foe, Echinoc hor, Jun, Mir, P. ed, Platy, *Prosopis*, *Rhus, Yucca*	*Phaseolus, Zea mays*	–
LA 129573 AD 130–560 Ruidoso/Hondo Valleys[6]	18F	Ch-Am, Ch	Poaceae, Sp	*Pinus* bark, *Prosopis*	*Zea mays*	–
Sunset Archaic open site (LA 58971), AD 1-400 foothills, Sierra Blanca[7]	26F	Ch, Desc, Port	Sp	P. ed, *Prosopis*, *Rhus*	*Phaseolus, Zea mays*	–
Possibly Archaic: Tintop Cave (LA 71167, stratum 4, levels 8, 9) foothills, Sierra Blanca[7]	4F	Am, Ch, Hel, Port	Sp	Echin	*Zea mays*	–
Archaic/ Neo-Archaic: Diamond Shamrock* * 2920 BC– AD 1425 Cornucopia Draw[8]	21F	Am, Ch, Port, Tal	Poaceae, Sp	*Agave*, Cac, Cyl, Echin, Mam, Platy, Sph, Yba	–	–
ENM 10222, 10230, 10418 320 BC–AD 1500 Mescalero Plains, east of Pecos River[9]	32F	*Circium*, Dith, Euph	*Setaria*	*Prosopis, Quercus havardii*	–	Malvaceae, *Salvia/ Brassica*
NM 128 AD 100-1400 Mescalero Plains, east of Pecos River	381F	Am, Ch-Am, Ch, *Mollugo,* Port, Tal	–	Echin, Echinoc, Platy, *Prosopis, Yucca*	–	–
Piñon LA 121837, F.11, AD 535 LA 121838, F. 7, AD 885 Cornucopia Draw[3]	2 F	Ch	–	*Agave, Platy*	–	–
Wind Canyon AD 1020 eastern slope of Eagle Mountains[10]	1F	Ch, *Iva, Mollugo*, Oen, Port, Tal	–	*Agave/Yucca*, *Carex*, Echin, Platy	–	–

(Table 21.27, continued)

SITES	NO. OF SAMPLES	ANNUALS	GRASSES	PERENNIALS	CULTIGENS	OTHER
Wind Canyon AD 1200 eastern slope of Eagle Mountains[10]	6?F, ?M	Am, Ch, Euph, Hel, *Iva, Mollugo, Oen, Pectis* type, Port, Tal	–	*Agave, Agave/Yucca* , *Carex* , Echin, Platy, Das, *Yucca,* Yba	–	*Astragalus*

F = flotation, M = macrobotanical

[1]O'Laughlin 1988; [2]O'Laughlin 1980; [3]Toll and McBride 1999; [4]Bohrer 2006; [5]Bohrer 1981;[6]McBride and Toll 2008; [7]Toll 1996; [8]McBride 1996; [9]Lord and Clary 1985; [10]Bohrer 1994

*Unit 45SE, Unit 48NW; ** LA 107597, LA 107600, LA 107601, LA 107602, LA 107661

Annuals: **Am**aranthus, **Art**emisia **drac**unculus, **Boer**havia **wr**ightii, **Ch**enopodium, **Ch**eno-A**m**, **Desc**urainia, **Dith**ryera, **Euph**orbia, **Hel**ianthus, **Hel**ianthus/**Vig**uiera, **Lep**idium, **Nicot**iana, **Oen**othera, **Poly**gonum, **Port**ulaca, **Tal**inum

Grasses: **Ach**natherum **hy**menoides, **Erag**rostis, **Sp**orobolus, **St**ipa **neo**mexicana

Perennials: **Atrip**lex, **Cac**taceae, **Cyl**indropuntia, **Cuc**urbita **foe**tidissima, **Echin**ocereus, **Echino**cactus **hor**izonthalonius, **Jun**iperus, **Mam**millaria, **Mir**abilis, **P**inus **ed**ulis, **P**inus **ed**ulis/**cemb**roides, **Platy**opuntia, **Sph**aeralcea, **Y**ucca **ba**ccata

found small numbers of partially carbonized acorns at Fresnal Shelter (1972:214). Pettit (1986) estimates shinnery oak acorn crops occur 3 out of 10 years on average, while Peterson and Boyd found “heavy local crops of acorns occurred somewhere every year [between 1977 and 1997], but in a specific location crops occurred not more than 3 years in 5” (1998:10).

Acorns may form a similar dietary niche to piñons—a concentrated energy source produced variably from year to year, and warranting foraging missions across the landscape. Oak thickets provide food and cover for animals and birds (e.g., lesser prairie chickens whose winter food is comprised of 69 percent acorns; Peterson and Boyd 1998) that may serve as important indirect resources.

Wood data was available from seven of the 10 projects compared in Table 21.27. Projects with locations that afforded occupants access to both lowland and upland resources had the most diverse wood assemblages. Included were conifers and shrubs of the mountain foothills as well as shrubs of the Chihuahuan desert scrub community (Table 21.28).

Until the advent of wheeled transportation, wood use was primarily a function of availability. People generally used what resources were closest to hand and easiest to gather. This does pose the question that if littleleaf sumac was growing as it is today in dense thickets just to the west of LA 129216, and oak on parabolic dunes near LA 129217 and LA 129218, then why wasn’t either used for fuel?

Instead we see the co-dominance of lotebush and mesquite. At least one of the condalias (lotebush was formerly *Condalia obtusifolia*) has been described as a hardwood with properties of “hot firewood” (www.catnapin.com/wildweeds/treeshrub/tree-buckthorn.htm). Mesquite has equally admirable fuel qualities in that it is a dense wood providing “a bed of hot, slow burning coals” (Ford 1977:200), that would have made it a highly preferred fuel material.

Wood use is also determined by site use, as with the high percentage of ocotillo wood found at the Diamond Shamrock site (McBride 1996) and to some extent at the Piñon Early Mesilla Phase ring midden (Feature 11; Toll and McBride 1999) that may be linked to agave pit roasting.

Pennington (1963:130) describes the use of dead stalks of a tall cactus that grows in western canyons and middle sections of canyon slopes in the Tarahumara country of Mexico. The spiny branches were laid crosswise upon the layer of plants that cover the stones in the roasting pit and the mescal hearts were placed on top of the branches and then covered with a layer of grass or pine needles. Ocotillo branches could have been used in the same manner as cactus stalks, accounting for the unusually high percentage of ocotillo in the charcoal assemblages at Diamond Shamrock and Piñon.

Table 21.28. Flotation wood assemblages from sites in the El Paso region; Wind Canyon, Texas; south-central New Mexico, and NM 128.

SITES	NO. OF SAMPLES	% WEIGHT		% PIECES	% SAMPLES
		CONIFERS	NONCONIFERS		
Archaic: Keystone Dam eastern edge, Mesilla Bolson[1]	92 M	–	–	–	apache plume 6% cottonwood 13% creosotebush 19% desert willow 6% mesquite 69% wolfberry 6%
Piñon LA 121839 Cornucopia Draw[2]	2 M	–	S/G 2% tarbush 94% Unk noncon 4%	–	–
LA 129573 Ruidoso/Hondo Valleys[3]	18 F	juniper 10% pine <1% piñon 13% Unk Conif <1%	cf mtn. mah. 5% oak <1% S/G 3% Unk noncon 70%	–	–
Sunset Archaic open site (LA 58971) foothills, Sierra Blanca[4]	26 F	juniper 10% piñon <1% Unk Conif <1%	cf acacia 12% box elder 4% C/W 1% creosotebush 19% greasewood 3% hackberry 1% mesquite 10% oak 7% sagebrush 4% saltbush <1% unknown 9% Unk noncon 12% walnut 8%	–	–
Possibly Archaic: Tintop Cave (LA 71167, stratum 4, levels 8, 9) foothills, Sierra Blanca[4]	4 F	–	–	juniper 24% C/W 1% creosotebush 31% greasewood 2% mesquite 10% sage 9% saltbush 2% unknown 15% walnut 6%	–
Archaic/ Neo-Archaic: Diamond Shamrock* * Cornucopia Draw[5]	13 F	juniper 2%	cholla 8% creosotebush <1% mesquite 17% mormon tea 2% ocotillo 58% S/G 13%	–	–
NM 128 Mescalero Plains, east of Pecos River	104F	–	creosotebush 1% javelinabush 49% mesquite 45% S/G 5% Unk noncon <1%	–	–

(Table 21.28, continued)

SITES	NO. OF SAMPLES	% WEIGHT		% PIECES	% SAMPLES
		CONIFERS	NONCONIFERS		
Piñon LA 121837, F. 11, Cornucopia Draw[2]	2 M	juniper <1%	creosotebush 3% ocotillo 29% S/G 3% tarbush 39% unknown 2% Unk noncon 24%	–	–

[1]O'Laughlin 1980; [2]Toll and McBride 1999; [3]McBride and Toll 2008; [4]Toll 1996; [5]McBride 1996
** LA 107597, LA 107600, LA 107601, LA 107602, LA 107625, LA 107661
cf = resembles taxon, C/W = cottonwood/willow, SG = saltbush/greasewood, Unk noncon = unknown nonconifer

Summary and Conclusions

The use of several annual and perennial taxa was documented in the archaeobotanical assemblages of NM 128 sites. The assemblages represent seeds or fruits of plants that would have been available beginning in mid-summer, annual seeds and mwesquite pods, and into early fall, cactus fruits, indicating repeated visits by prehistoric foragers or seasonal occupation of the area. Previous researchers have placed emphasis on the use of a limited number of plant resources by prehistoric inhabitants of the region.

However, unless we dismiss the rather extensive list of annuals found at some sites and the few grasses and domesticates present at others, rather than saying that leaf succulents, mesquite, and cacti were the primary focus of subsistence activity, it seems more accurate to assume that a variety of species was exploited. Indeed, Dering (1999) points out that roasting agave hearts in earth ovens is a high-cost endeavor for a relatively low return and leaf succulents never formed the mainstay of the diet, but were an important component of a broad-spectrum economy. Prehistoric populations living in an environment that is cyclically dry and hot might reasonably choose a varying and flexible economic strategy, growing domesticates in some instances, and journeying to the nearby mountain foothills and higher-elevation basins for exploitable resources.

22 ⸙ Pollen Analysis

Owen K. Davis

Pollen analyses of archaeological context samples from the NM 128 project are described in this chapter. The sites are situated along NM 128 a few kilometers northeast of the village of Loving, New Mexico. The location is 32 degrees, 20 minutes 14 seconds north latitude, 103 degrees, 55 minutes, 46 seconds west longitude, elevation 915 m amsl.

The prehistoric upland vegetation of the project region is Chihuahuan desert scrub (Brown and Lowe 1980; Brown 1982), characterized by creosote bush (*Larrea tridentata*) and tarbush (*Flourensia cernua*). According to Brown (1982) Vegetation near the project area consisted of occasional mesquite (*Prosopis glandulosa*) and members of the Chenpodiaceae (*Allenrolfea* sp., *Atriplex* sp.).

The postglacial vegetation history of the northern Chihuahuan desert can be summarized as the presence of woodland element (pine, juniper, oak) until ca. 10,000 years ago (8900 ^{14}C), with contemporary vegetation becoming established about 4500 (4000 ^{14}C) (Van Devender 1990).

Twenty-two sediment samples were analyzed (Table 22.1).

Methods

Pollen was extracted from the sediment samples by routine acid digestion (Gray 1965). One *Lycopodium* tablet (13,911 spores) was added to each sample (volume 5 cc) to permit calculation of pollen concentration.

When possible, 300 grains of the pollen of upland plants are counted per sample, but the abundance was too low in the NM 128 samples. Pollen of aquatic plants, spores of ferns and fungi, algae, charcoal, and other microfossils are not included in the sum. Ordinarily, more than 1000 microfossils are recorded per sample. Pollen clumps (aggregates) are counted as four grains and not recorded separately.

The pollen sum of the upland grains is the divisor for determining the percentages of all pollen types, spores, charcoal, and other microfossils. Therefore, since the percentages of miscellaneous types (for example charcoal) are divided by pollen, the percentages routinely exceed 100 percent. The pollen concentration is calculated for the pollen sum.

Results

The pollen concentration is low (average 2102 grains/cc) and averaged just 123 grains per sample; pollen preservation is poor, with percentages of deteriorated pollen averaging 16 percent (Table 22.2). The pollen assemblage is dominated by 4 percent Ambrosia (*Flourensia*; "tarbush"), 63 percent Other Compositae ("sunflower family"), and 12 percent Chenopodiaceae-Amaranthus ("salt sage") pollen (Table 22.2; Fig. 22.1).

Fungal spores were very abundant (average 1197 percent of pollen). Most of these are dark Demateaceae-type soil fungi, likely deposited after the site was buried. Amoeba tests were consistently very abundant (average 27.3 percent of pollen). This is 10 to 100 times typical percentages in archaeological samples. Charcoal was abundant (average 459 percent of pollen) but not extraordinary for archaeological samples.

No pollen of corn (*Zea*) or any other cultigens was found in any of the 22 samples, neither the four counted samples (Table 22.2) nor the 18 scanned samples.

Other than tarbush (*Flourensia*), no pollen of shrubs was recovered. It is noteworthy that pollen of mesquite (*Prosopis*) was not recovered. Likewise, the absence of grass pollen is curious. Various species are expected at low elevation near water. Honey sweet (*Tidestromia*) is the most abundant herb, and the only one exceeding 1 percent of the pollen rain. This common weed is a disturbance indicator.

Two "early" (late Paleoindian/Early Archaic)

Table 22.1. Pollen sample proveniences.

SITE	FS NO.	BLOCK NO.	FEATURE TYPE	ASSOCIATION
Full Count Samples				
LA 129216	67	9	rock feature	Feature 11, interpol. 9,020 BP OSL*
	81	7	fire pit	Feature 10, intercept cal AD 340 date**
	87	9	fire-cracked rock	Feature 12, interpol. 10,650 BP OSL
	90	8	fire pit	Feature 19, intercept cal AD 540 date
Scanned Samples				
LA 113042	–	1	posthole	beneath mano in posthole (Feature 32)
	540	1	–	beneath mano
	591	2	pit	beneath metate in pit (Feature 54)
	844	1	rock cache	beneath rock at top of cache (Feature 44)
	960	3	pit	bottom of pit (Feature 48)
	1013	14	–	beneath mano
	1032	12	cache	beneath mano from pit fill
LA 129214	–	–	fire pit	beneath mano associated with Feature 152
	722	5	–	beneath mano
	1219	9	fire pit	beneath mano on bottom of Feature 156
	1373	12	fire pits	beneath metate associated with 110/119
	–	6	cache	beneath mano in Feature 46
	1613	13	–	beneath mano
	1614	13	post support	beneath Feature 140 post-support rocks
	1760	16	fire pit	beneath mano in Feature 164
	1777	19	–	beneath mano
	–	18	rocks	beneath rocks
LA 129217	22	4	fire-cracked rock	beneath burned rock in dune above blowout bottom
LA 129218	130	9	fire pit	bottom of lightly-used feature
LA 129222	225	2	surface	beneath rock impressed into surface
LA 129300	483	7	–	beneath mano

*interpolated OSL (optically stimulated luminescence) date
**calibrated radiocarbon intercept date

samples, FS 67 and 87, were compared with two "late" (Late Prehistoric) samples, FS 81 and 90. The early samples have more pine (*Pinus*), salt sage (Chenopodiaceae-Amaranthus), and amoeba tests, and the late samples have more tarbush, algae spores, and charcoal.

Conclusions

The absence of corn or other cultigens in this area is consistent with the sites' usage as seasonal camp sites, without cultivation taking place on-site. But, the abundance of pollen of Honey sweet (*Tidestromia*) and the abundant charcoal are both consistent with moderate to heavy disturbance of the local habitat.

The absence of mesquite and grass pollen, however, is curious. Their pollen was not tallied in the four "full count" samples, nor were they noted in the "scans." Perhaps the samples were taken far from the shorelines that might have harbored these plants.

The early-to-late sample comparison is consistent with the vegetation history for the northern Chihuahuan desert, with essentially modern vegetation persisting into the early Holocene.

Table 22.2. LA 129216, full-count pollen percentages for Late Paleoindian, Early Archaic, and Late Prehistoric samples.

	LATE PALEOINDIAN	EARLY ARCHAIC	LATE PREHISTORIC	
	10,650 BP*	9,020 BP*	1,610 BP**	1,410 BP**
	FS 87	FS 67	FS 81	FS 90
Sum	90.0	145.0	138.0	120.0
Tracers	97.0	640.0	778.0	4702.0
Concentration of grains/ cubic centimeter	2582.0	630.0	494.0	4702.0
Deteriorated	11.1	15.2	15.2	24.2
Pinus	2.2	1.4	0.7	–
Ambrosia	–	4.1	4.3	8.3
Artemisia	–	1.4	0.7	–
Other Compositae	72.2	54.5	66.7	58.3
Cheno-Am	10.0	20.0	8.7	8.3
Allionia	–	0.7	0.7	–
Boerhaavia	–	–	0.7	–
Eriogonum	–	0.7	0.7	0.8
Euphorbia	–	–	0.7	–
Lilliaceae	–	0.7	–	–
Onagraceae	–	0.7	–	–
Tidestromia	4.4	0.7	0.7	–
Salix	–	0.7	–	–
Fern spores	–	–	0.7	–
Algae	1.1	2.1	2.9	1.7
Concentracystes	–	2.8	–	–
Glomosporium	–	–	0.7	–
Podospora	–	2.8	–	–
Sordaria	–	2.1	–	–
Sporormiella	1.1	–	–	–
Tilletia	1.1	0.7	–	–
Other fungal spores	1031.1	1815.9	689.9	1244.2
Arcella	2.2	–	–	–
Conioshaeta	1.1	–	1.4	–
Cyclopyxis eurystoma	–	0.7	–	–
Phyrganella arcopodis	46.7	29.7	21.7	3.3
Other testate amoebae	1.1	0.7	–	–
Arthropod feces	–	8.3	2.2	–
Charcoal	437.8	173.8	105.8	1119.2
Stomata	–	8.3	–	–
Trees	13.3	16.6	15.9	24.2
Comps, chenos, grass	82.2	80.0	80.4	75.0
Herbs	4.4	3.4	3.6	0.8
Wetground and riparian	–	0.7	–	–
Ferns and friends	–	–	0.7	–
Algae	1.1	4.8	2.9	1.7
Fungi	1033.3	1821.4	690.6	1244.2
Amoebae	51.1	31.0	23.9	3.3
Miscellaneous	437.8	190.3	108.0	1119.2

* Interpolated OSL (optically stimulated luminescence) date

** Calibrated radiocarbon intercept date converted to BP date

23 ⊻ Faunal and Shell Analyses

Nancy J. Akins

Bone was recovered from seven of the NM 128 sites and freshwater mussel shell from four (Table 23.1). Most have small samples and flotation samples, accounting for about a quarter of the assemblage overall. Only one site had a fairly large sample that contributed most of the identifiable fauna. Preservation was generally poor with fairly large proportions burned or etched by soil conditions.

Most of the identified animals are small forms, mice and rabbits, one bird, and an array of post-occupational reptiles and amphibians. Preservation of larger forms was particularly poor and artiodactyls are often represented by small pieces of tooth enamel. Both of the more common Pecos River mussels were found, mainly as small fragments but also as a few valve and margin pieces.

General research questions for the project focus on the nature of the occupations, the kinds of activities represented in the artifact assemblage, basic subsistence practices, exchange and mobility, dating, and use of the shin-oak community. For fauna, questions focus on how groups may have adapted to demographic and environmental changes and include the following: Is there evidence that these people extracted increasing amounts of resources from smaller areas? Was there a change in use from larger to smaller animal forms as mobility became limited by an increasing regional population? Is there evidence of a more intense and broader use of species that would suggest constraints on mobility and attempts to exploit a smaller area more effectively? Is there evidence that the sites at the western and eastern ends of the project area exploited a different range of animal resources? Does fauna provide information on the microenvironments around the playas?

Before turning to these questions, the general methods and the faunal assemblage from each site will be described. The sites are sequenced from west to east to reflect the changes in environment along NM 128. The west end is a few kilometers east of the Pecos River in an area of dissected plains that includes LA 129216, LA 129214, and LA 113042. It then drops down into a playa-filled basin where LA 129300 is located. LA 129222 is at the east edge of this basin. The two eastern-most sites (LA 129218 and LA 129217) are in a dune field at the edge of a shin-oak vegetation zone (OAS Staff 2006).

General Methods

All of the bone and mussel and eggshell from the NM 128 project was analyzed. The OAS comparative faunal collection and standard references were used to make the identifications. Data were recorded in a computer format and analyzed using SPSS. The following briefly identifies the variables recorded and how they were defined.

Provenience-Related Variables: Site numbers and field specimen (FS) numbers are the primary links to more detailed proveniences within the site. Each line is also assigned a lot number that identifies a specimen or group of specimens that fit the description recorded in that line. The count identifies how many specimens were described by that data line. In addition to count, the freshwater mussel shell was weighed (grams).

Taxon: Taxonomic identifications are made as specific as possible. Specimens that cannot be identified to the species, family, or order are assigned to a range of indeterminate categories based on the size of the animal and whether it is a mammal, bird, or other animal, or if that cannot be determined. Assignments to an artiodactyl-size taxon are based on shape, cortex characteristics, and site-specific observations on how this order preserves. Unidentifiable fragments often constitute the bulk of a faunal assemblage. When identification is less than certain, this is indicated in the certainty variable.

Each specimen (bone or shell) is counted only once, even when broken into a number of pieces by the archaeologist. If the break occurred prior to ex-

Table 23.1. Faunal remains, by site.

		LA 113042		LA 129214		LA 129216		LA 129217		LA 129218		LA 129222		LA 129300		**Total**	
COMMON NAME	TAXON	n	COL. %	n	COL. %	n	COL. %	n	COL. %	n	COL. %	n	COL. %	n	COL. %	n	**COL. %**
Unknown small	unknown small	2	1.2%	16	2.1%	1	20.0%	–	–	–	–	3	13.6%	–	–	**22**	**2.2%**
Small mammal or bird	small mammal/bird	–	–	1	0.1%	–	–	–	–	2	18.2%	–	–	–	–	**3**	**0.3%**
Small mammal	small mammal	84	49.7%	394	51.4%	–	–	–	–	–	–	–	–	9	29.0%	**487**	**48.5%**
Small–medium mammal	small–medium mammal	3	1.8%	34	4.4%	–	–	–	–	–	–	–	–	–	–	**37**	**3.7%**
Medium-to-large mammal	medium–large mammal	7	4.1%	27	3.5%	–	–	–	–	1	9.1%	–	–	–	–	**35**	**3.5%**
Large mammal	large mammal	–	–	15	2.0%	–	–	–	–	–	–	–	–	–	–	**15**	**1.5%**
Spotted ground squirrel	*Spermophilus spilosoma*	–	–	2	0.3%	–	–	–	–	–	–	–	–	–	–	**2**	**0.2%**
Pocket mouse	*Perognathus* sp.	–	–	–	–	–	–	–	–	–	–	1	4.5%	–	–	**1**	**0.1%**
Ord's kangaroo rat	*Dipodomys ordii*	–	–	2	0.3%	–	–	–	–	–	–	–	–	–	–	**2**	**0.2%**
Banner-tailed kangaroo rat	*Dipodomys spectabilis*	–	–	1	0.1%	–	–	–	–	–	–	–	–	–	–	**1**	**0.1%**
Northern grasshopper mouse	*Onychomys leucogaster*	–	–	–	–	–	–	–	–	–	–	–	–	2	6.5%	**2**	**0.2%**
Woodrat	*Neotoma* sp.	–	–	5	0.7%	–	–	–	–	4	36.4%	–	–	1	3.2%	**10**	**1.0%**
White-throated woodrat	*Neotoma albigula*	1	0.6%	5	0.7%	–	–	–	–	–	–	–	–	–	–	**6**	**0.6%**
Small rodent	Small rodent	3	1.8%	–	–	–	–	–	–	–	–	1	4.5%	–	–	**4**	**0.4%**
Medium-to-large rodent	medium–large rodent	2	1.2%	19	2.5%	–	–	–	–	2	18.2%	1	4.5%	–	–	**24**	**2.4%**
Cottontail rabbit	*Sylvilagus* sp.	4	2.4%	56	7.3%	1	20.0%	1	100.0%	–	–	–	–	3	9.7%	**65**	**6.5%**

(Table 23.1, continued)

		LA 113042		LA 129214		LA 129216		LA 129217		LA 129218		LA 129222		LA 129300		**Total**	
COMMON NAME	TAXON	n	COL. %	n	COL. %	n	COL. %	n	COL. %	n	COL. %	n	COL. %	n	COL. %	n	**COL. %**
Black-tailed jackrabbit	*Lepus californicus*	3	1.8%	36	4.7%	1	20.0%	–	–	–	–	–	–	5	16.1%	**45**	**4.5%**
Artiodactyl	artiodactyl	–	–	1	0.1%	–	–	–	–	–	–	–	–	–	–	**1**	**0.1%**
Medium artiodactyl	medium artiodactyl	–	–	7	0.9%	–	–	–	–	–	–	–	–	–	–	**7**	**0.7%**
Medium-to-large artiodactyl	medium–large artiodactyl	2	1.2%	9	1.2%	–	–	–	–	–	–	–	–	–	–	**11**	**1.1%**
Deer	*Odocoileus* sp.	–	–	2	0.3%	–	–	–	–	–	–	–	–	–	–	**2**	**0.2%**
Cattle or bison	*Bos* sp.	–	–	3	0.4%	–	–	–	–	–	–	–	–	–	–	**3**	**0.3%**
Medium bird	medium bird	–	–	–	–	–	–	–	–	2	18.2%	–	–	–	–	**2**	**0.2%**
Medium-large bird	medium–large bird	–	–	1	0.1%	–	–	–	–	–	–	–	–	–	–	**1**	**0.1%**
Eggshell	eggshell	1	0.6%	1	0.1%	–	–	–	–	–	–	–	–	–	–	**2**	**0.2%**
Quail	*cf. Callipepla* sp.	–	–	–	–	1	20.0%	–	–	–	–	–	–	–	–	**1**	**0.1%**
Passerine	Passeriformes	–	–	1	0.1%	–	–	–	–	–	–	–	–	–	–	**1**	**0.1%**
Lizard	Sauria	–	–	7	0.9%	–	–	–	–	–	–	–	–	–	–	**7**	**0.7%**
Snake	Ophidia	–	–	4	0.5%	–	–	–	–	–	–	–	–	–	–	**4**	**0.4%**
Lizard or amphibian	lizard or amphibian	1	0.6%	1	0.1%	–	–	–	–	–	–	–	–	–	–	**2**	**0.2%**
Frog and toad	Salienta	–	–	2	0.3%	–	–	–	–	–	–	–	–	7	22.6%	**9**	**0.9%**
Spadefoot toad	*Scaphiopus* or *Spea* sp.	–	–	11	1.4%	–	–	–	–	–	–	–	–	–	–	**11**	**1.1%**
Freshwater mussel	Unionidae	49	29.0%	85	11.1%	1	20.0%	–	–	–	–	15	68.2%	4	12.9%	**154**	**15.3%**
		(67.0g)	–	(55.3g)	–	(.3g)	–	–	–	–	–	(.9g)	–	(.3g)	–	**(123.9g)**	**–**
Pope's mussel	*cf. Popenaias popeii*	1	0.6%	4	0.5%	–	–	–	–	–	–	–	–	–	–	**5**	**0.5%**
		(6.5g)	–	(8.2g)	–	–	–	–	–	–	–	–	–	–	–	**(14.7g)**	**–**
Pecos pearly mussel	*Crytonaias tampicoensis*	6	3.6%	14	1.8%	–	–	–	–	–	–	1	4.5%	–	–	**21**	**2.1%**
		(62.6g)	–	(106.9g)	–	–	–	–	–	–	–	(4.8g)	–	–	–	**(174.4g)**	**–**
Total		**169**	**100.0%**	**766**	**100.0%**	**5**	**100.0%**	**1**	**100.0%**	**11**	**100.0%**	**22**	**100.0%**	**31**	**100.0%**	**1005**	**100.0%**
Total from flotation		**103**	**60.9%**	**119**	**15.5%**	**1**	**20.0%**	**–**	**–**	**–**	**–**	**4**	**18.2%**	**1**	**3.2%**	**228**	**22.7%**

cf. = resembles taxon

cavation, the pieces are counted separately and their articulation noted in a variable that identifies conjoinable pieces, parts that were articulated when found, and pieces that appear to be from the same individual. Animal skeletons are considered as single specimens so as not to inflate the counts for accidentally and intentionally buried taxa.

Element (Body Part): The skeletal element (e.g., cranium, mandible, humerus) is identified then described by side, age, and the portion recovered. Side is recorded for the element itself or for the portion recovered when it is axial, such as the left transverse process of a lumbar vertebra. Age is recorded at a general level: fetal or neonate, immature, young adult (near or full size with unfused epiphysis or young bone), and mature. The criterion used for assigning an age is also recorded. This is generally based on size, epiphysis closure, or texture of the bone. The portion of the skeletal element represented in a particular specimen is recorded in detail to aid in estimating how many individuals could be represented in an assemblage.

Completeness: Completeness refers to how much of that skeletal element is represented by the specimen, less than 10, 10 to 50, 50 to 75, 75 to 90 or 100 percent complete. It provides information on whether a species is intrusive and on processing, environmental deterioration, animal activity, and thermal fragmentation.

Taphonomic Variables: Taphonomy is the study of the degree to which bones are preserved or destroyed due to the action of natural processes that affect the condition or frequencies found in an assemblage (Lyman 1994:1). Environmental alteration includes pitting or corrosion from soil conditions, sun bleaching from extended exposure, checking or exfoliation from exposure, root etching from the acids excreted by roots, and fresh or greasy indicating it is fairly recent. Animal alteration is recorded by source or probable source, e.g., carnivore, rodent gnawing, owl pellet, and carnivore scat.

Burning: Burning can occur as part of the cooking process, part of the disposal process, when bone is used as fuel, or after burial. For the NM 128 assemblage, it was recorded as burned black, calcine (white), partially burned, scorched, dry burn (Brown outside with a black core), and possibly boiled (rounded and/or waxy).

Butchering: Evidence of butchering is recorded as cuts, impacts, spiral breaks, de-fleshing, or snaps. The location of the butchering is also recorded. A conservative approach is taken to the recording of marks and fractures that could be indicative of processing animals for food, tools, or hides since many natural processes result in similar marks and fractures. Given the poor condition of bone from this project, only two bones have any suggestion of processing, a deer rib and a cottontail metatarsal with portions removed, both from LA 129214.

Modification: Deliberate modifications are indicated through this variable. For this project, the only modification was ground edges on freshwater mussel and etching or incising on another mussel shell, all from LA 129214.

Comments: A coded comment column flags specimens recovered by flotation or indicates a verbal comment.

Site Assemblages

LA 129216

Only five pieces of fauna were recovered from this site. The mussel shell was a surface find from the far northwestern portion of the site and could be unrelated to fauna sample. All of the bones are from Block 9, which included two thermal features. A flotation sample from Feature 12 contained a tiny piece of material that could be bone, the unidentified small animal, or some other inclusion in the soil. None of the Block 9 bones was burned and was better preserved than those from other project sites. The Stratum 1 bones are a portion of a young cottontail humerus and a mature jackrabbit tibia. The quail humerus shaft from Stratum 2 could be either a scaled or Montezuma's quail. Given the preservation, it is possible these were deposited relatively recently and may or may not be human subsistence remains.

LA 129214

Just over 80 percent of the fauna recovered during this project came from this site. Fifteen of the block excavations and 22 features produced fauna. For data presentation the site is divided into three areas: east, west, and south. South consists of the blocks south of NM 128. The east-west division was arbitrarily placed between Blocks 12 and 9 with Block 15 included in the west.

Table 23.2. Faunal remains from the southern portion of LA 129214.

	GRID EXCAVATIONS				FEATURES													
	SURFACE AND STRATUM 1		STRATUM 2		138		143		144		146		148		150		**TOTAL**	
	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %
Taxon																		
Unknown small	–	–	1	0.3%	2	9.5%	–	–	7	58.3%	–	–	–	–	–	–	**10**	**2.0%**
Small mammal	33	73.3%	264	68.0%	19	90.5%	5	71.4%	3	25.0%	1	50.0%	10	90.9%	13	92.9%	**348**	**69.6%**
Small–medium mammal	4	8.9%	23	5.9%	–	–	2	28.6%	–	–	1	50.0%	1	9.1%	–	–	**31**	**6.2%**
Medium-to-large mammal	2	4.4%	12	3.1%	–	–	–	–	2	16.7%	–	–	–	–	–	–	**16**	**3.2%**
Spotted ground squirrel	1	2.2%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0.2%**
Banner-tailed kangaroo rat	–	–	1	0.3%	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0.2%**
White-throated woodrat	–	–	4	1.0%	–	–	–	–	–	–	–	–	–	–	–	–	**4**	**0.8%**
Medium-to-large rodent	–	–	11	2.8%	–	–	–	–	–	–	–	–	–	–	–	–	**11**	**2.2%**
Cottontail rabbit	2	4.4%	22	5.7%	–	–	–	–	–	–	–	–	–	–	1	7.1%	**25**	**5.0%**
Black-tailed jackrabbit	2	4.4%	26	6.7%	–	–	–	–	–	–	–	–	–	–	–	–	**28**	**5.6%**
Medium artio-dactyl	–	–	1	0.3%	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0.2%**

(Table 23.2, continued)

	GRID EXCAVATIONS				FEATURES												TOTAL	
	SURFACE AND STRATUM 1		STRATUM 2		138		143		144		146		148		150			
	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %
Medium-to-large artio-dactyl	–	–	7	1.8%	–	–	–	–	–	–	–	–	–	–	–	–	**7**	**1.4%**
Spade-foot toad	–	–	7	1.8%	–	–	–	–	–	–	–	–	–	–	–	–	**7**	**1.4%**
Fresh-water mussel	–	–	8	2.1%	–	–	–	–	–	–	–	–	–	–	–	–	**8**	**1.6%**
Pope's mussel	1	2.2%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0.2%**
Pecos pearly mussel	–	–	1	0.3%	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0.2%**
Total	45	100.0%	388	100.0%	**21**	**100.0%**	**7**	**100.0%**	**12**	**100.0%**	**2**	**100.0%**	**11**	**100.0%**	**14**	**100.0%**	**500**	**100.0%**
Total from flotation					**21**	**100.0%**	**7**	**100.0%**	**12**	**100.0%**	**1**	**50.0%**	**8**	**72.7%**	**14**	**100.0%**	**63**	**12.6%**
Completeness																		
<10%	44	97.8%	354	91.2%	19	90.5%	7	100.0%	6	50.0%	2	100.0%	11	100.0%	14	100.0%	**457**	**91.4%**
10–50%	1	2.2%	15	3.9%	–	–	–	–	1	8.3%	–	–	–	–	–	–	**17**	**3.4%**
50–75%	–	–	9	2.3%	–	–	–	–	1	8.3%	–	–	–	–	–	–	**10**	**2.0%**
75–95%	–	–	2	0.5%	–	–	–	–	4	33.3%	–	–	–	–	–	–	**6**	**1.2%**
complete	–	–	8	2.1%	2	9.5%	–	–	–	–	–	–	–	–	–	–	**10**	**2.0%**
Burning																		
Unburned	20	44.4%	142	36.6%	9	42.9%	2	28.6%	11	91.7%	–	–	6	54.5%	4	28.6%	**194**	**38.8%**
Discard burn-charred	11	24.4%	87	22.4%	8	38.1%	2	28.6%	–	–	1	50.0%	4	36.4%	7	50.0%	**120**	**24.0%**
Calcined	12	26.7%	100	25.8%	4	19.0%	3	42.9%	–	–	1	50.0%	1	9.1%	3	21.4%	**124**	**24.8%**
Graded partial burn	–	–	48	12.4%	–	–	–	–	1	8.3%	–	–	–	–	–	–	**49**	**9.8%**
Scorched	1	2.2%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**	**0.2%**
Dry burn	1	2.2%	11	2.8%	–	–	–	–	–	–	–	–	–	–	–	–	**12**	**2.4%**

(Table 23.2, continued)

	GRID EXCAVATIONS				FEATURES													
	SURFACE AND STRATUM 1		STRATUM 2		138		143		144		146		148		150		**TOTAL**	
	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %
Environmental Alteration																		
Not applic-able/ mussel shell	1	2.2%	9	0.0%	–	–	–	–	–	–	–	–	–	–	–	–	**10**	**2.0%**
None	26	57.8%	236	60.8%	13	61.9%	5	71.4%	8	66.7%	1	50.0%	5	45.5%	10	71.4%	**304**	**60.8%**
Pitting/ corros-ion	2	4.4%	127	32.7%	8	38.1%	2	28.6%	4	33.3%	–	–	6	54.5%	4	28.6%	**153**	**30.6%**
Sun bleached	15	33.3%	1	0.3%	–	–	–	–	–	–	–	–	–	–	–	–	**16**	**3.2%**
Checked/ exfoliated	1	2.2%	2	0.5%	–	–	–	–	–	–	–	–	–	–	–	–	**3**	**0.6%**
Root etched	–	–	13	3.4%	–	–	–	–	–	–	1	50.0%	–	–	–	–	**14**	**2.8%**

Southern area: The two blocks south of NM 128 are treated together because most of the site's fauna comes from Block 16 (n = 498) with only two specimens from Block 20. Most are from grid excavations (86.6 percent) and the rest from thermal features (Table 23.2). All but four of the feature bones were recovered in flotation samples.

Fauna recovered from the grid excavations is mainly from the cultural stratum (89.4 percent) but also includes three collected from the surface (all small-mammal long bones, one unburned, two calcine) and a small amount from the upper stratum (Stratum 1). Except for one each of the cottontail and jackrabbit bones, the burning is of the unidentifiable forms. Almost all of the bones are small pieces. A considerable amount is sun bleached and few are pitted, suggesting some could have been deposited relatively recently.

Stratum 2 produced much of the bone for this site (77.6 percent). Cottontail and jackrabbit are fairly common and are represented by a wide range of parts. All of the medium artiodactyl and many of the medium-to-large artiodactyl specimens are tooth enamel, of which three pieces are burned. The wood rat parts are both unburned pieces of cranium that are probably post-occupational. The single kangaroo rat and one of the rodent bones are burned suggesting some rodents were eaten. Partial skeletons of spadefoot toads were found in two separate grids and a scattering of parts in a third. Mussel shell is scattered throughout seven separate grids. The largest concentrations were in 435N 475E with 6 g of freshwater mussel shell and 437N 474E with 3.4 g of Pecos pearly mussel shell. Half of a modern bivalve shell of the latter weighs just over 84 g, so that all of the mussel shell from the south area (11.12g) is only a fraction of a complete shell. Much more of the bone in the cultural stratum is pitted from soil conditions, including some that is also burned. One piece was carnivore gnawed, and five pieces appear to have been from scat.

With the exception of a single cottontail specimen (a burned metacarpal fragment) and two from medium-to-large mammal long-bone fragments (one unburned and one partially burned), almost all of the feature bone is small, burned pieces that were hard to assign to a size of animal. The exceptions are an unknown element, a rib shaft, and a long-bone fragment from a small form that could be reptile, amphibian, mammal, or bird. None are burned, suggesting they are from post-occupational occupants of the site area.

Western area: The western area includes Blocks 12, 13, 15, and 19 and the features found within each (Table 23.3a and Table 23.3b). Only 150 faunal specimens were recovered. Block 15 has the largest sample, comprising 45 percent of the western fauna. Flotation samples account for 20 percent of the western-area sample, mostly from features but also from Stratum 1 in Block 12. Burning was relatively rare in the western blocks but considerable amounts of bone were pitted from soil conditions.

Very few pieces of bone and mussel shell were recovered from Block 12 (n = 20). Only one piece of bone from the grid excavations is burned, a small-mammal long-bone fragment from Stratum 2 that is calcine. A jackrabbit vertebra fragment has a greasy look and may be intrusive or could be from scat. Undoubtedly the most interesting find is a large portion of a Pecos pearly mussel shell (34.5 g) with a ground edge from Stratum 2 in 489N 431E. Four features produced eight pieces of bone and mussel shell: Feature 91 a piece of freshwater mussel shell; Feature 102 a fragment of a jackrabbit tibia; Feature 104 pieces of small-mammal long and flat bones; and Feature 121 a fragment of a flat bone from a medium-to-large bird.

Block 13 has a larger sample (n = 48) but few from any one stratum or feature. Stratum 1 had a single piece of undifferentiated freshwater mussel shell that was ground. It also had much of a Pope's mussel shell (4.7 g, a complete comparative valve weighs 10.9g) with a ground edge from 489N 431E, and a large portion of a Pecos pearly mussel valve (24.2 g) from 467N 419E, also with a ground edge. Most of the burning was of the unidentifiable taxa (small mammal, medium-to-large mammal, large mammal) but the two cottontail bones from Stratum 3 are calcine. The cattle or bison specimens are pieces of etched tooth infundibulum that could be from either species. These are from the cultural layer (Stratum 2), suggesting it could be bison. A piece of freshwater mussel shell was recovered from Feature 132, and two burned pieces of small-mammal long bones from Feature 135.

Block 15 has the largest sample of bone for the west area (n = 67), most are from fill. Stratum 1 has all but one of the rabbit bones and the squirrel while the rodent, artiodactyl, and toad bones are from Stratum 2. The large number of cottontail bones in-

Table 23.3a. Faunal remains from the western portion of LA 129214; Blocks 12 and 13.

	BLOCK 12						BLOCK 13									
	STRATUM 1		STRATUM 2		FEATURES		SURFACE		STRATUM 1		STRATUM 2		STRATUM 3		FEATURES	
	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %
Taxon																
Unknown small	1	20.0%	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Small mammal/ bird	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Small mammal	–	–	1	14.3%	5	62.5%	1	33.3%	1	5.3%	1	4.8%	–	–	2	100.0%
Small–medium mammal	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Medium-to-large mammal	1	20.0%	–	–	–	–	1	33.3%	1	5.3%	3	14.3%	–	–	–	–
Large mammal	–	–	–	–	–	–	–	–	4	21.1%	–	–	–	–	–	–
Spotted ground squirrel	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ord's kangaroo rat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
White-throated woodrat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Medium-to-large rodent	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cottontail rabbit	–	–	–	–	–	–	–	–	–	–	–	–	2	66.7%	–	–
Black-tailed jackrabbit	–	–	1	14.3%	1	12.5%	–	–	–	–	–	–	–	–	–	–
Medium artiodactyl	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Medium-to-large artiodactyl	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cattle or bison	–	–	–	–	–	–	–	–	–	–	2	9.5%	–	–	–	–
Medium-large bird	–	–	–	–	1	12.5%	–	–	–	–	–	–	–	–	–	–
Snake	–	–	–	–	–	–	–	–	–	–	1	4.8%	–	–	–	–
Lizard or amphibian	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Frog and toad	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Spade-foot toad	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Freshwater mussel	3	60.0%	3	42.9%	1	12.5%	1	33.3%	8	42.1%	9	42.9%	1	33.3%	–	–
Pope's mussel	–	–	–	–	–	–	–	–	1	5.3%	2	9.5%	–	–	–	–
Pecos pearly mussel	–	–	2	28.6%	–	–	–	–	4	21.1%	3	14.3%	–	–	–	–
Total	5	100.0%	7	100.0%	8	100.0%	3	100.0%	19	100.0%	21	100.0%	3	100.0%	2	100.0%
Total from flotation	2	40.0%			6	75.0%									2	100.0%

(Table 23.3a, continued)

	BLOCK 12						BLOCK 13									
	STRATUM 1		STRATUM 2		FEATURES		SURFACE		STRATUM 1		STRATUM 2		STRATUM 3		FEATURES	
	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %
Completeness																
<10%	4	80.0%	5	71.4%	8	100.0%	3	100.0%	16	84.2%	19	90.5%	1	33.3%	2	100.0%
10–50%	1	20.0%	1	14.3%	–	–	–	–	1	5.3%	1	4.8%	2	66.7%	–	–
50–75%	–	–	–	–	–	–	–	–	2	10.5%	1	4.8%	–	–	–	–
75–95%	–	–	1	14.3%	–	–	–	–	–	–	–	–	–	–	–	–
complete	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Burning																
Unburned	5	100.0%	6	85.7%	8	100.0%	1	33.3%	13	68.4%	18	85.7%	1	33.3%	–	–
Discard, burn/charred	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	100.0%
Calcined	–	–	1	14.3%	–	–	2	66.7%	4	21.1%	3	14.3%	2	66.7%	–	–
Scorched	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dry burn	–	–	–	–	–	–	–	–	2	10.5%	–	–	–	–	–	–
Environmental Alteration																
Not applicable/shell	3	60.0%	5	71.4%	1	12.5%	1	33.3%	13	68.4%	14	66.7%	1	33.3%	–	–
None	2	40.0%	1	14.3%	5	62.5%	1	33.3%	3	15.8%	2	9.5%	2	66.7%	2	100.0%
Pitting/corrosion	–	–	–	–	1	12.5%	1	33.3%	3	15.8%	3	14.3%	–	–	–	–
Checked/exfoliated	–	–	–	–	1	12.5%	–	–	–	–	2	9.5%	–	–	–	–
Root etched	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fresh/greasy	–	–	1	14.3%	–	–	–	–	–	–	–	–	–	–	–	–

Table 23.3b. Faunal remains from the western portion of LA 129214; Blocks 15 and 19.

	BLOCK 15						BLOCK 19				TABLE TOTAL	
	STRATUM 1		STRATUM 2		FEATURES		STRATUM 2		FEATURES			
	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	**COL. %**
Taxon												
Unknown small	–	–	–	–	1	10.0%	–	–	–	–	**2**	**1.3%**
Small mammal/ bird	–	–	–	–	–	–	–	–	1	9.1%	**1**	**0.7%**
Small mammal	10	28.6%	–	–	1	10.0%	1	25.0%	–	–	**23**	**15.3%**
Small–medium mammal	–	–	1	4.5%	–	–	–	–	–	–	**1**	**0.7%**
Medium-to-large mammal	2	5.7%	1	4.5%	–	–	–	–	–	–	**9**	**6.0%**
Large mammal	–	–	–	–	–	–	–	–	8	72.7%	**12**	**8.0%**
Spotted ground squirrel	1	2.9%	–	–	–	–	–	–	–	–	**1**	**0.7%**
Ord's kangaroo rat	–	–	2	9.1%	–	–	–	–	–	–	**2**	**1.3%**
White-throated woodrat	–	–	1	4.5%	–	–	–	–	–	–	**1**	**0.7%**
Medium-to-large rodent	–	–	1	4.5%	6	60.0%	–	–	–	–	**7**	**4.7%**
Cottontail rabbit	17	48.6%	1	4.5%	–	–	–	–	–	–	**20**	**13.3%**
Black-tailed jackrabbit	2	5.7%	–	–	–	–	1	25.0%	–	–	**5**	**3.3%**
Medium artiodactyl	–	–	2	9.1%	–	–	–	–	2	18.2%	**4**	**2.7%**
Medium-to-large artiodactyl	2	5.7%	–	–	–	–	–	–	–	–	**2**	**1.3%**
Cattle or bison	–	–	–	–	–	–	–	–	–	–	**2**	**1.3%**
Medium-large bird	–	–	–	–	–	–	–	–	–	–	**1**	**0.7%**
Snake	–	–	–	–	–	–	–	–	–	–	**1**	**0.7%**
Lizard or amphibian	–	–	–	–	1	10.0%	–	–	–	–	**1**	**0.7%**
Frog and toad	–	–	1	4.5%	–	–	–	–	–	–	**1**	**0.7%**
Spadefoot toad	–	–	3	13.6%	–	–	–	–	–	–	**3**	**2.0%**
Freshwater mussel	1	2.9%	9	40.9%	1	10.0%	2	50.0%	–	–	**39**	**26.0%**
Pope's mussel	–	–	–	–	–	–	–	–	–	–	**3**	**2.0%**
Pecos pearly mussel	–	–	–	–	–	–	–	–	–	–	**9**	**6.0%**
Total	**35**	**100.0%**	**22**	**100.0%**	**10**	**100.0%**	**4**	**100.0%**	**11**	**100.0%**	**150**	**100.0%**
Total from flotation					**9**	**90.0%**			**11**	**100.0%**	**30**	**20.0%**
Completeness												
<10%	16	45.7%	15	68.2%	6	60.0%	4	100.0%	11	100.0%	**110**	**73.3%**
10–50%	7	20.0%	3	13.6%	1	10.0%	–	–	–	–	**17**	**11.3%**
50–75%	3	8.6%	2	9.1%	2	20.0%	–	–	–	–	**10**	**6.7%**
75–95%	3	8.6%	1	4.5%	1	10.0%	–	–	–	–	**6**	**4.0%**
complete	6	17.1%	1	4.5%	–	–	–	–	–	–	**7**	**4.7%**

(Table 23.3b, continued)

	BLOCK 15						BLOCK 19				TABLE TOTAL	
	STRATUM 1		STRATUM 2		FEATURES		STRATUM 2		FEATURES			
	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	COL. %	COUNT	**COL. %**
Burning												
Unburned	35	100.0%	22	100.0%	9	90.0%	3	75.0%	2	18.2%	**123**	**82.0%**
Discard, burn/charred	–	–	–	–	–	–	–	–	6	54.5%	**8**	**5.3%**
Calcined	–	–	–	–	1	10.0%	1	25.0%	–	–	**14**	**9.3%**
Scorched	–	–	–	–	–	–	–	–	3	27.3%	**3**	**2.0%**
Dry burn	–	–	–	–	–	–	–	–	–	–	**2**	**1.3%**
Environmental Alteration												
Not applicable/shell	1	2.9%	9	40.9%	1	10.0%	2	50.0%	–	–	**51**	**34.0%**
None	6	17.1%	7	31.8%	8	80.0%	1	25.0%	11	100.0%	**51**	**34.0%**
Pitting/corrosion	27	77.1%	6	27.3%	1	10.0%	1	25.0%	–	–	**43**	**28.7%**
Checked/exfoliated	–	–	–	–	–	–	–	–	–	–	**3**	**2.0%**
Root etched	1	2.9%	–	–	–	–	–	–	–	–	**1**	**0.7%**
Fresh/greasy	–	–	–	–	–	–	–	–	–	–	**1**	**0.7%**

cludes a specimen from a very young rabbit and portions of two feet. All are heavily etched and none are burned. The artiodactyl and medium- to large-mammal bones are tooth enamel.

The unidentified frog or toad is a partial skeleton. Rodent gnawing was observed on one of the Stratum 1 bones, and one each from Stratum 1 and 2 appear to be from scat. Feature 142 contained all but the medium-to-large rodent bone, which was from Feature 155. Those from Feature 142 are all small forms with only one small-mammal bone that is calcined.

Only two bones—a calcined small-mammal long bone and an unburned jackrabbit tibia fragment that is probably from scat—and two freshwater mussel shell fragments were recovered from fill in Block 19. The rest were found in a flotation sample from Feature 173. Two of the large-mammal bones and the medium artiodactyl rib fragment from the feature are burned.

Eastern area: Fauna and mussel shell were recovered from nine blocks in the eastern area. Blocks 5, 7, and 14 are adjacent and considered together. All of the blocks have small samples, especially when divided by stratum and feature fill (Table 23.4a and 23.4b). Of the strata, Stratum 1 produced 56 percent of the fauna with the rest divided between the other strata and features.

Only two of the Block 1 specimens are burned and at least the lizard bones (long-bone and cranial fragments) are post-occupational. Except for the lizard long bone, all are fragmentary. Feature 39 produced three specimens, but two (the medium-to-large mammal) are identified as from Stratum 1 rather than feature fill and are included in those counts, both are calcine. The lizard elements are from Feature 43.

The Block 4 fauna is also from the upper fill and could be post-occupational or at least deposited after the main occupation of the sites. These include two unburned pieces of deer rib and fragments of tooth enamel from a large bovid (cattle or bison).

Blocks 5, 7, and 14 have the largest sample, all from strata. A single specimen from Feature 114 (an unburned, small-mammal carpal or tarsal fragment) is coded as Stratum 1 and included in those counts. Rabbits, mostly cottontails, are common but are mainly (all but two) from feet, largely complete, and unburned, suggesting natural deposition. The only piece of eggshell from the project is from this block. The burned bone in Stratum 2 is a portion of a wood rat femur, suggesting wood rats were a food item.

The Block 6 fill bone includes a cottontail vertebra from Stratum 1 that is probably from scat and a jackrabbit phalanx that is calcine. Feature 55 contained a long-bone fragment, from a small animal, and long-bone fragments from small mammals, two of which are scorched. The only worked mussel shell from the project is from this block.

The small sample from Block 8 is mainly freshwater mussel shell, the larger pieces of Pecos pearly mussel weighing 8.4 g (Stratum 1) and 2.1 g (Stratum 4). None are burned. Feature 64 held a partial lizard skeleton; Feature 69 the unknown small and snake bones, probably post-occupational; and Feature 70 the freshwater mussel shell.

Specimens from Block 9 grid excavations are two pieces of freshwater mussel shell and a piece of artiodactyl tooth enamel. Feature 96 produced the small-mammal long bones, one charred, five calcine, and two scorched, Feature 156 an unknown small animal flat bone, and Feature 192 a medium artiodactyl long-bone fragment.

The final block, Block 11 produced a single specimen. A piece of freshwater mussel recovered from the upper stratum.

Discussion: With such a wide range of dates for any particular block, yet alone areas, it is hard to reach any firm conclusions about this site. It was undoubtedly a favored location but the fauna tells us little about what attracted these people to this place. The south area is the most distinctive in its larger quantities of fauna and it is the only block that has more jackrabbit than cottontail and also has the least amount of freshwater mussel—11.1 g compared to 129.9 g for the west and 26.3 g for the east. More of the bone in the south area is highly fragmented, comprising less than 10 percent of an element (91.4 percent compared to 64.7 and 73.3 percent). This is not due to a larger proportion of flotation bone, as it has the least amount (12.6 percent as compared to 22.4 percent for the east and 20.0 percent for the west). Rather, it is due to the large proportion of burned bone. Even with the mussel shell excluded from the totals, only 37.6 percent of the south bone is not burned compared to 81.8 percent for the east and 72.7 percent for the west. The combination of burning, which makes bone more friable and easily broken, and activity in the area resulted in the greater fragmentation.

Table 23.4a. Faunal remains from the eastern portion of LA 129214; Blocks 1, 4-7, and 14.

	BLOCK 1				BLOCK 4		BLOCKS 5, 7, AND 14						BLOCK 6					
	STRATUM I		FEATURES		STRATUM I		STRATUM I		STRATUM 2		STRATUM 3		STRATUM I		STRATUM 2		FEATURES	
	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %
Taxon																		
Unknown small	–	–	–	–	–	–	1	2.9%	–	–	–	–	–	–	–	–	1	20.0%
Small mammal	–	–	–	–	–	–	10	29.4%	–	–	–	–	–	–	–	–	4	80.0%
Small–medium mammal	–	–	–	–	–	–	2	5.9%	–	–	–	–	–	–	–	–	–	–
Medium–large mammal	2	33.3%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Large mammal	2	33.3%	1	14.3%	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Woodrat	–	–	–	–	–	–	2	5.9%	1	9.1%	–	–	1	25.0%	1	14.3%	–	–
Medium–large rodent	–	–	–	–	–	–	1	2.9%	–	–	–	–	–	–	–	–	–	–
Cottontail rabbit	–	–	–	–	–	–	10	29.4%	–	–	–	–	1	25.0%	–	–	–	–
Black-tailed jackrabbit	–	–	–	–	–	–	2	5.9%	–	–	–	–	–	–	1	14.3%	–	–
Artiodactyl	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Medium artiodactyl	–	–	–	–	–	–	1	2.9%	–	–	–	–	–	–	–	–	–	–
Deer	–	–	–	–	2	66.7%	–	–	–	–	–	–	–	–	–	–	–	–
Cattle or bison	–	–	–	–	1	33.3%	–	–	–	–	–	–	–	–	–	–	–	–
Eggshell	–	–	–	–	–	–	1	2.9%	–	–	–	–	–	–	–	–	–	–
Passerine	–	–	–	–	–	–	1	2.9%	–	–	–	–	–	–	–	–	–	–
Lizard	–	–	6	85.7%	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Snake	–	–	–	–	–	–	1	2.9%	–	–	–	–	–	–	–	–	–	–
Frog and toad	–	–	–	–	–	–	1	2.9%	–	–	–	–	–	–	–	–	–	–
Spadefoot toad	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	14.3%	–	–
Freshwater mussel	1	16.7%	–	–	–	–	1	2.9%	10	90.9%	2	100.0%	2	50.0%	3	42.9%	–	–
Pecos pearly mussel	1	16.7%	–	–	–	–	–	–	–	–	–	–	–	–	1	14.3%	–	–
Total	6	100.0%	7	100.0%	3	100.0%	34	100.0%	11	100.0%	2	100.0%	4	100.0%	7	100.0%	5	100.0%
Total from flotation			7	100.0%													4	80.0%
Completeness																		
<10%	6	100.0%	6	85.7%	1	33.3%	11	32.4%	10	90.9%	2	100.0%	2	50.0%	4	57.1%	4	80.0%
10–50%	–	–	–	–	–	–	6	17.6%	–	–	–	–	2	50.0%	1	14.3%	1	20.0%
50–75%	–	–	1	14.3%	1	33.3%	6	17.6%	–	–	–	–	–	–	1	14.3%	–	–
75–95%	–	–	–	–	1	33.3%	6	17.6%	1	9.1%	–	–	–	–	–	–	–	–
complete	–	–	–	–	–	–	5	14.7%	–	–	–	–	–	–	1	14.3%	–	–
Burning																		
Unburned	4	66.7%	7	100.0%	3	100.0%	34	100.0%	10	90.9%	2	100.0%	4	100.0%	6	85.7%	3	60.0%
Discard, burn/charred	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

(Table 23.4a, continued)

	BLOCK 1				BLOCK 4		BLOCKS 5, 7, AND 14						BLOCK 6					
	STRATUM I		FEATURES		STRATUM I		STRATUM I		STRATUM 2		STRATUM 3		STRATUM I		STRATUM 2		FEATURES	
	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %
Calcined	2	33.3%	–	–	–	–	–	–	1	9.1%	–	–	–	–	1	14.3%	–	–
Scorched	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	40.0%
Environmental Alteration																		
Not applicable	2	33.3%	–	–	–	–	1	2.9%	10	90.9%	2	100.0%	2	50.0%	4	57.1%	–	–
None	–	–	6	85.7%	–	–	19	55.9%	1	9.1%	–	–	1	25.0%	2	28.6%	3	60.0%
Pitting/corrosion	2	33.3%	1	14.3%	1	33.3%	12	35.3%	–	–	–	–	–	–	–	–	2	40.0%
Sun bleached	–	–	–	–	–	–	–	–	–	–	–	–	1	25.0%	–	–	–	–
Checked/exfoliated	2	33.3%	–	–	1	33.3%	–	–	–	–	–	–	–	–	1	14.3%	–	–
Root etched	–	–	–	–	1	–	2	5.9%	–	–	–	–	–	–	–	–	–	–

N = count

Table 23.4b. Faunal remains from the eastern portion of LA 129214; Blocks 2, 8, and 9.

	BLOCK 8						BLOCK 9				BLOCK 2		**TABLE TOTAL**	
	STRATUM I		STRATUM 4		FEATURES		STRATUM I		FEATURES		STRATUM 2			
	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %
Taxon														
Unknown small	–	–	–	–	1	20.0%	–	–	1	9.1%	–	–	4	3.4%
Small mammal	–	–	–	–	–	–	–	–	9	81.8%	–	–	23	19.8%
Small–medium mammal	–	–	–	–	–	–	–	–	–	–	–	–	2	1.7%
Medium–large mammal	–	–	–	–	–	–	–	–	–	–	–	–	2	1.7%
Large mammal	–	–	–	–	–	–	–	–	–	–	–	–	3	2.6%
Woodrat	–	–	–	–	–	–	–	–	–	–	–	–	5	4.3%
Medium–large rodent	–	–	–	–	–	–	–	–	–	–	–	–	1	0.9%
Cottontail rabbit	–	–	–	–	–	–	–	–	–	–	–	–	11	9.5%
Black-tailed jackrabbit	–	–	–	–	–	–	–	–	–	–	–	–	3	2.6%
Artiodactyl	–	–	–	–	–	–	1	33.3%	–	–	–	–	1	0.9%
Medium artiodactyl	–	–	–	–	–	–	–	–	1	9.1%	–	–	2	1.7%
Deer	–	–	–	–	–	–	–	–	–	–	–	–	2	1.7%
Cattle or bison	–	–	–	–	–	–	–	–	–	–	–	–	1	0.9%
Eggshell	–	–	–	–	–	–	–	–	–	–	–	–	1	0.9%
Passerine	–	–	–	–	–	–	–	–	–	–	–	–	1	0.9%
Lizard	–	–	–	–	1	20.0%	–	–	–	–	–	–	7	6.0%
Snake	–	–	–	–	2	40.0%	–	–	–	–	–	–	3	2.6%
Frog and toad	–	–	–	–	–	–	–	–	–	–	–	–	1	0.9%
Spadefoot toad	–	–	–	–	–	–	–	–	–	–	–	–	1	0.9%
Freshwater mussel	14	93.3%	1	50.0%	1	20.0%	3	100.0%	–	–	1	100.0%	38	32.8%
Pecos pearly mussel	1	6.7%	1	50.0%	–	–	–	–	–	–	–	–	4	3.4%
Total	15	100.0%	2	100.0%	5	100.0%	3	100.0%	11	100.0%	1	100.0%	116	100.0%
Total from flotation					4	80.0%			11	100.0%			26	22.4%
Completeness														
<10%	13	86.7%	1	50.0%	1	20.0%	3	100.0%	10	90.9%	1	100.0%	75	64.7%
10–50%	2	13.3%	1	50.0%	1	20.0%	–	–	1	9.1%	–	–	15	12.9%
50–75%	–	–	–	–	3	60.0%	–	–	–	–	–	–	12	10.3%
75–95%	–	–	–	–	–	–	–	–	–	–	–	–	8	6.9%
complete	–	–	–	–	–	–	–	–	–	–	–	–	6	5.2%
Burning														
Unburned	15	100.0%	2	100.0%	5	100.0%	3	100.0%	3	27.3%	1	100.0%	102	87.9%
Discard, burn/charred	–	–	–	–	–	–	–	–	1	9.1%	–	–	1	0.9%

(Table 23.4b, continued)

	BLOCK 8						BLOCK 9				BLOCK 2		TABLE TOTAL	
	STRATUM I		STRATUM 4		FEATURES		STRATUM I		FEATURES		STRATUM 2			
	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %
Calcined	–	–	–	–	–	–	–	–	5	45.5%	–	–	9	7.8%
Scorched	–	–	–	–	–	–	–	–	2	18.2%	–	–	4	3.4%
Environmental Alteration														
Not applicable	15	100.0%	2	100.0%	1	20.0%	2	66.7%	–	–	1	100.0%	42	36.2%
None	–	–	–	–	4	80.0%	–	–	7	63.6%	–	–	43	37.1%
Pitting/corrosion	–	–	–	–	–	–	–	–	4	36.4%	–	–	22	19.0%
Sun bleached	–	–	–	–	–	–	–	–	–	–	–	–	1	0.9%
Checked/exfoliated	–	–	–	–	–	–	–	–	–	–	–	–	4	3.4%
Root etched	–	–	–	–	–	–	1	33.3%	–	–	–	–	4	3.4%

N = count

The eastern area had the smallest sample of bone with the largest amount from flotation. For a small sample, it has considerable variability in taxa. More of this comes from burrowing rodents, reptiles, and amphibians. It has the least amount of burning, least amount of highly fragmented bone, and the least amount of environmental alteration.

As noted, much of the freshwater mussel was from the western area and several pieces were ground. It is intermediate in most other observations.

Poor preservation of unburned bone undoubtedly affects the assemblage content and may overly emphasize the use of small forms. Yet even artiodactyl tooth enamel that preserves better than bone is relatively rare. Animal subsistence throughout the occupation appears to have been the opportunistic taking of what was available, mainly rabbits and some of the larger rodents. An occasional deer, pronghorn, or bison may have been taken near the site or parts brought along with a mobile group. Freshwater mussels were transported from the Pecos River, maybe as a food source but also as a raw material for scraping.

LA 113042

Just a few meters east of LA 129214, this site has the second largest sample of bone and mussel shell (Table 23.5) but almost all of the bones—92 percent of the bone and 61 percent of the bone and mussel shell—were recovered from flotation samples. The sample came from the general surface and eight blocks. Most of the features were in Block 12. All are thermal features (Table 23.6).

The only artiodactyl bone is from the surface and is made up of two small pieces of tooth enamel, which preserves better than other body parts unless they are burned, and a large piece of Pecos pearly mussel shell that may be a preform for an ornament. Block 1 produced few bones and several pieces of mussel shell from five strata and one feature (Feature 49). The bones include small pieces of cranium from a small mammal and a maxillary molar from a jackrabbit. Neither is burned and could post-date the site occupation. All of the Block 2 specimens are from Strata 1, 2, and 3 and are mussel shell, except for a piece of eggshell. Block 3 produced a single cranial fragment from a rodent, which is probably post-occupational. Block 6 contained only mussel shell, including a nearly complete Pope's mussel and over half of a Pecos pearly mussel shell.

Bone from the upper fill of Block 12 (n = 15) includes both burned and unburned pieces, eight of which were recovered through flotation. The flotation sample included burned and dry burned small-mammal and cottontail bones that are probably cultural. Unburned small-mammal (n = 2), medium-to-large mammal (n = 6) and cottontail (n = 1) bones may or may not be cultural. The Stratum 2 specimens are a burned small-mammal long bone and three pieces of mussel shell. The Strata 12 and 23 specimens are both small pieces of mussel shell. Of the eight small-mammal and small rodent specimens in Feature 58, two (small-mammal long-bone fragments) are burned. The unburned specimens, especially those from small rodents that are not pitted and include a rodent first phalanx, could very well be post-occupational. Feature 60 produced mainly unidentifiable small-mammal bones (n = 24) a single burned jackrabbit metatarsal, and a piece of modified mussel shell. More of the small-mammal bone is unburned (n = 16) than burned and it is heavily pitted suggesting it could be cultural. Feature 61 has a combination of burned or calcine (n = 9) and unburned (n = 25) bone. Most are small fragments from small mammals (n = 29) but also include small pieces of unburned long-bone shafts from a small-to-medium mammal, a burned cottontail metatarsal fragment, and a piece of a vertebra from a lizard or amphibian. The Feature 65 sample is more diverse in that it also has a medium-to-large mammal long-bone and a medium-to-large rodent tooth (both unburned) along with an unburned unknown small long-bone and burned (n = 2) and unburned (n = 14) small-mammal bones. There is also a burned cottontail metatarsal. With more unburned than burned bone, it is probable that some of the bone is post-occupational.

Block 14 produced two specimens, an unburned small-mammal long bone from Feature 63 and a piece of mussel shell from Stratum 2. The Block 18, Feature 76 specimen is a near complete white-throated wood rat skeleton that is undoubtedly post-occupational. The only fauna recovered from Feature 21 is an unburned unknown small-animal flat bone.

Taken as a whole, the assemblage from this site tells us little about animal subsistence practices. Burned cottontail and jackrabbit bones, all foot parts, indicate these species were eaten and probably that waste parts were discarded into the fires. The lack of

Table 23.5. LA 113042, faunal remains, mussel weight in grams.

	SURFACE		BLOCK 1		BLOCK 2		BLOCK 3		BLOCK 4		BLOCK 12		BLOCK 14		BLOCK 18		BLOCK 21		**TOTAL**	
	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %
Taxon																				
Unknown small	–	–	–	–	–	–	–	–	–	–	1	0.9%	–	–	–	–	1	100.0%	2	1.2%
Small mammal	–	–	1	4.2%	–	–	–	–	–	–	82	75.2%	1	50.0%	–	–	–	–	84	49.7%
Small–medium mammal	–	–	–	–	–	–	–	–	–	–	3	2.8%	–	–	–	–	–	–	3	1.8%
Medium–large mammal	–	–	–	–	–	–	–	–	–	–	7	6.4%	–	–	–	–	–	–	7	4.1%
White-throated woodrat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	100.0%	–	–	1	0.6%
Small rodent	–	–	–	–	–	–	–	–	–	–	3	2.8%	–	–	–	–	–	–	3	1.8%
Medium–large rodent	–	–	–	–	–	–	1	100.0%	–	–	1	0.9%	–	–	–	–	–	–	2	1.2%
Cottontail rabbit	–	–	–	–	–	–	–	–	–	–	4	3.7%	–	–	–	–	–	–	4	2.4%
Black-tailed jack-rabbit	–	–	2	8.3%	–	–	–	–	–	–	1	0.9%	–	–	–	–	–	–	3	1.8%
Medium–large artiodactyl	2	66.7%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1.2%
Eggshell	–	–	–	–	1	4.5%	–	–	–	–	–	–	–	–	–	–	–	–	1	0.6%
Lizard or amphibian	–	–	–	–	–	–	–	–	–	–	1	0.9%	–	–	–	–	–	–	1	0.6%
Freshwater mussel	–	–	19	79.2%	20	90.9%	–	–	4	66.7%	5	4.6%	1	50.0%	–	–	–	–	49	29.0%
Mussel weight	–	–	13.9g	–	36.8g	–	–	–	5.4g	–	9.9g	–	1.0g	–	–	–	–	–	67.0g	–
Pope's mussel	–	–	–	–	–	–	–	–	1	16.7%	–	–	–	–	–	–	–	–	1	0.6%
Mussel weight	–	–	–	–	–	–	–	–	6.5g	–	–	–	–	–	–	–	–	–	6.5g	–
Pecos pearly mussel	1	33.3%	2	8.3%	1	4.5%	–	–	1	16.7%	1	0.9%	–	–	–	–	–	–	6	3.6%
Mussel weight	17.6g	–	30.4g	–	2.1g	–	–	–	10.9g	–	1.6g	–	–	–	–	–	–	–	62.6g	–
Total	3	100.0%	24	100.0%	22	100.0%	1	100.0%	6	100.0%	109	100.0%	2	100.0%	1	100.0%	1	100.0%	169	100.0%
Total from flotation											101	92.7%	1	50.0%			1	100.0%	103	60.9%
Burning																				
Unburned	3	100.0%	24	100.0%	22	100.0%	1	100.0%	6	100.0%	79	72.5%	2	100.0%	1	100.0%	1	100.0%	139	82.2%
Discard burn-charred	–	–	–	–	–	–	–	–	–	–	28	25.7%	–	–	–	–	–	–	28	16.6%

(Table 23.5, continued)

	SURFACE		BLOCK 1		BLOCK 2		BLOCK 3		BLOCK 4		BLOCK 12		BLOCK 14		BLOCK 18		BLOCK 21		**TOTAL**	
	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %
Calcined	–	–	–	–	–	–	–	–	–	–	1	0.9%	–	–	–	–	–	–	1	0.6%
Dry burn	–	–	–	–	–	–	–	–	–	–	1	0.9%	–	–	–	–	–	–	1	0.6%
Environmental Alteration																				
Not applicable/shell and eggshell	1	33.3%	21	87.5%	22	100.0%	–	–	6	100.0%	6	5.5%	1	50.0%	–	–	–	–	57	33.7%
None	–	–	–	–	–	–	–	–	–	–	37	33.9%	–	–	1	100.0%	1	100.0%	39	23.1%
Pitting/corrosion	2	66.7%	3	12.5%	–	–	1	100.0%	–	–	62	56.9%	1	50.0%	–	–	–	–	69	40.8%
Checked/exfoliated	–	–	–	–	–	–	–	–	–	–	3	2.8%	–	–	–	–	–	–	3	1.8%
Root etched	–	–	–	–	–	–	–	–	–	–	1	0.9%	–	–	–	–	–	–	1	0.6%

bones from larger animals is probably due in part to preservation. Bone that was not discarded into fires was generally not preserved. Freshwater mussel shell from both species, including some that are near complete valves, comprise significant proportions of the Block 1, Block 2, Block 6, and Block 14 assemblages. By weight, most was recovered from Blocks 1 (44.3 g), 2 (38.9 g), and 6 (22.9 g).

LA 129300

Four blocks (Table 23.7) and one feature at this site had bone or freshwater mussel shell. Block 1 had only mussel shell, and Block 5 only had the post-occupational remains of at least three toads. Four bones from the same toad were found in 512N 549E, Stratum 2, and three bones from two toads (one probably a spadefoot, given its size) in 514N 547E, Stratum 3. The Block 10, Feature 23 sample held two pieces of freshwater mussel shell and a burned small-mammal long-bone fragment recovered from flotation.

The largest assemblage came from Block 11, Stratum 2. None of the bones are burned and some are probably post-occupational. At least two, and probably all three of the jackrabbit foot bones, are dissolved and rounded indicating they passed through a carnivore's digestive system. Likewise, the fragile and well-preserved cranial and vertebra from the grasshopper mouse and the caudal vertebra from a wood rat were probably not left by humans. The pitted small-mammal bones, cottontail bones, and one jackrabbit bone could be cultural.

Little can be said about the use of animals for subsistence at this site. Only one unidentifiable piece of bone is burned, and while present, at least some of the rabbit bone is from scat. The presence of multiple toads in Block 5 is probably due to its proximity to the drainage.

LA 129222

The small sample of bone and freshwater mussel shell recovered from this site came from the general site surface, four blocks, and one feature. None are burned. It is quite possible that with the exception of the mussel shell, none of the fauna is cultural.

Two pieces of freshwater mussel shell were collected from the surface of the site. Block 1, Stratum 2 produced the valve portion of a Pecos pearly mussel. Block 2 had 12 pieces of mussel and a vertebra from a medium-to-large rodent. The cultural stratum from Block 4 produced a partial cranium from a pocket mouse and a flotation sample from Feature 2, three small fragments of an unknown small animal, and a first phalanx from a small rodent. Block 6 had a single piece of freshwater mussel shell.

LA 129218

Unfortunately, this probable Archaic site produced few bones, none of which are burned. None were recovered from flotation samples.

All of the bone is from Block 1, and a good portion looks like it was deposited through owl pellets—the small mammal or bird, at least three wood rats, all of the medium-to-large rodent, and possibly the medium bird bone. The medium- to-large mammal fragment has a fresh greasy appearance and is rodent gnawed, suggesting it is also post-occupational. The final bone is a fragment of wood rat cranium that could also be intrusive.

LA 129217

The only fauna recovered from this site is an unburned phalanx from a cottontail found in Block 3. It is from the upper eolian fill and is probably not cultural.

Discussion

The NM 128 sites generally have either small samples of fauna or could not be broken down into discrete temporal components. This, combined with poor preservation of bone, makes it impossible to address the research questions except for very general subsistence. Repeated short-term use of the same locations and opportunistic use of the small animal forms found there seems to be a pattern repeated over a long period of time.

Other southeastern sites have produced similar assemblages. However, the better known sites tend to be located on major rivers or tributaries and some have architectural evidence of more lengthy occupations. These assemblages tend to be larger and more diverse, all have more cottontail than jackrabbit, fairly large amounts of large mammal and artiodactyl bone, and considerable amounts of freshwater mussel (e.g., the Fox Place, Akins 2002;

Table 23.6. LA 113042, faunal remains, by feature and block.

BLOCK NO.	1		12								14		18		21		TOTAL	
FEATURE	49		58		60		61		65		63		76		80			
	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	COL. %	N	**COL. %**
Common Name																		
Unknown small	–	–	–	–	–	–	–	–	1	5.0%	–	–	–	–	1	100.0%	**2**	**2.2%**
Small mammal	–	–	5	62.5%	24	92.3%	29	0.9	16	80.0%	1	100.0%	–	–	–	–	**75**	**81.5%**
Small–medium mammal	–	–	–	–	–	–	3	0.1	–	–	–	–	–	–	–	–	**3**	**3.3%**
Medium–large mammal	–	–	–	–	–	–	–	–	1	5.0%	–	–	–	–	–	–	**1**	**1.1%**
White-throated woodrat	–	–	–	–	–	–	–	–	–	–	–	–	1	100.0%	–	–	**1**	**1.1%**
Small rodent	–	–	3	37.5%	–	–	–	–	–	–	–	–	–	–	–	–	**3**	**3.3%**
Medium–large rodent	–	–	–	–	–	–	–	–	1	5.0%	–	–	–	–	–	–	**1**	**1.1%**
Cottontail rabbit	–	–	–	–	–	–	1	0.0	1	5.0%	–	–	–	–	–	–	**2**	**2.2%**
Black-tailed jackrabbit	–	–	–	–	1	3.8%	–	–	–	–	–	–	–	–	–	–	**1**	**1.1%**
Lizard or amphibian	–	–	–	–	–	–	1	0.0	–	–	–	–	–	–	–	–	**1**	**1.1%**
Freshwater mussel	1	100.0%	–	–	1	3.8%	–	–	–	–	–	–	–	–	–	–	**2**	**2.2%**
Total	**1**	**100.0%**	**8**	**100.0%**	**26**	**100.0%**	**34**	**1.0**	**20**	**100.0%**	**1**	**100.0%**	**1**	**100.0%**	**1**	**100.0%**	**92**	**100.0%**
Total from flotation			**8**	**100.0%**	**25**	**96.2%**	**34**	**100.0%**	**20**	**100.0%**	**1**	**100.0%**			**1**	**100.0%**	**89**	**96.7%**
Burning																		
Unburned	1	100.0%	6	75.0%	17	65.4%	25	73.5%	17	85.0%	1	100.0%	1	100.0%	1	100.0%	**69**	**75.0%**
Discard, burn/charred	–	–	2	25.0%	9	34.6%	8	23.5%	3	15.0%	–	–	–	–	–	–	**22**	**23.9%**
Calcined	–	–	–	–	–	–	1	2.9%	–	–	–	–	–	–	–	–	**1**	**1.1%**

Table 23.7. LA 129300, faunal remains.

	BLOCK 1		BLOCK 5		BLOCK 10 FEATURE 23		BLOCK 11		**TOTAL**	
	COUNT	COL %	COUNT	COL %	COUNT	COL %	COUNT	COL %	**COUNT**	**COL %**
Taxon										
Small mammal	–	–	–	–	1	33.3%	8	42.1%	**9**	**29.0%**
Northern grasshopper mouse	–	–	–	–	–	–	2	10.5%	**2**	**6.5%**
Woodrat	–	–	–	–	–	–	1	5.3%	**1**	**3.2%**
Cottontail rabbit	–	–	–	–	–	–	3	15.8%	**3**	**9.7%**
Black-tailed jackrabbit	–	–	–	–	–	–	5	26.3%	**5**	**16.1%**
Toad	–	–	7	100.0%	–	–	–	–	**7**	**22.6%**
Freshwater mussel	2	100.0%	–	–	2	66.7%	–	–	**4**	**12.9%**
Total	**2**	**100.0%**	**7**	**100.0%**	**3**	**100.0%**	**19**	**100.0%**	**31**	**100.0%**
Environmental Alteration										
Not applicable	2	100.0%	4	57.1%	2	66.7%	–	–	**8**	**25.8%**
None	–	–	3	42.9%	1	33.3%	–	–	**4**	**12.9%**
Pitting/corrosion	–	–	–	–	–	–	19	100.0%	**19**	**61.3%**

Los Molinos, Akins and Moga 2004; Townsend, Akins 2003b).

Other small, short-term sites are like those along NM 128, they have small samples and relatively few artiodactyl bones, or no bone at all (e.g., Macho Dunes, Moga 2000; Corn Camp, Akins 1996). Still others have poor preservation but possess an abundance of artiodactyl teeth, suggesting they may have been more specialized hunting sites (e.g., Bob Crosby Draw, Akins 2000). While it is tempting to suggest that the location has much to do with the faunal assemblage, multicomponent sites such as Townsend suggest changes in animal subsistence over time (Akins 2003b:307-310), for at least some areas. Whether this is true for sites to the south cannot be answered by the assemblages from NM 128.

24 ⊻ Geomorphology Study

Stephen A. Hall and Ronald J. Goble

A Late Quaternary Geology and Associated Prehistoric Sites, Western Mescalero Plain, Eddy County, New Mexico

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The study area is located near Salt Lake and other playas, in a basin formed by the dissolution of underlying Permian salt beds and the collapse of overlying strata. The bedrock geology outcropping at the surface is characterized by Permian red beds—especially the Rustler Formation (Henderson and Jones 1952) (Fig. 24.1). Detailed geologic studies of the area have been conducted as related to Project Gnome (Gard 1968) and to the Waste Isolation Pilot Plant project (Vine 1963; Bachman 1976, 1980, 1981). Several recent studies of the geology of southeastern New Mexico have been recorded in Love et al. (1993) and Land et al. (2006).

Mescalero Plain and Mescalero Sand Sheet: The archaeological sites in this investigation occur in the western half of the Mescalero Plain, defined by Bretz and Horberg (1949) as an erosional surface between the Llano Estacado, or the High Plains, and the Pecos River, in southeastern New Mexico. The Mescalero Plain is a broad area of eroded Permian and Triassic red beds capped by caliche and overlying thin deposits of the eolian sand of the Mescalero sand sheet. Small areas of comparatively high parabolic dunes occur in the central portions of the sand sheet. Near Loco Hills, the dunes are locally called the Mescalero Sands. The small area of large parabolic dunes along NM 128 in the present study area is called Los Medanos (Spanish for "the sandhills").

The geomorphology, stratigraphy, and archaeological geology of the Mescalero sand sheet near Loco Hills was reported by Hall (2002) and Hall and Goble (2006, 2008, 2011, 2012). The sand sheet consists of two sand units, a Lower unit and an Upper unit. The Lower unit is generally red in color due to the presence of the Berino paleosol. The Berino is an argillic, clay-rich non-calcic paleosol developed during the wetter climate of the Wisconsin glaciation. The red color of the eolian sand is due to the iron-rich clay in the Bt horizon of the Berino paleosol (Hall and Goble 2012). The Lower sand is thin, the top eroded and missing in most areas. The Lower eolian sand does incorporate preserved dunes or dune structures, although twentieth century coppice dunes are present on its eroded surface. The Upper eolian sand unit is generally reddish yellow and is the principal sand body in the sand sheet. The large parabolic dunes in the Mescalero Sands are developed in the Upper eolian sand.

The first attempt to determine the age of the Mescalero sand sheet in southeastern New Mexico was made by Hall (2002) and Hall and Goble (2006). Optically stimulated luminescence (OSL) dating was applied to the eolian sand units in the Loco Hills area. The Lower unit is OSL-dated c. 90,000 to 50,000 years and the Upper unit is dated 18,000 to 5000 years (Hall and Goble 2011). Both of these sand units occur in the NM 128 project area and have been OSL-dated, extending the chronology for the development of the sand sheet. Results are discussed below.

Mescalero Paleosol: The caliche that occurs on the eroded Permian-Triassic red beds and at the top of the Gatuña Formation is Mescalero paleosol (Figs. 24.2 through 24.5). Vine (1963) mapped the caliche in the NM 128 area but did not name it. Bachman (1976, 1980) informally called it the Mescalero caliche. Hall (2002) and Hall and Goble (2006, 2008) referred to the caliche as Mescalero paleosol, the name used in this report. In the NM 128 area, the Mescalero paleosol calcrete formed on Permian bedrock, overwhelming the red shale and siltstone of the Rustler Formation; fragments of the shale and siltstone occur in the lower part of the calcrete. The

Figure 24.1. Geologic map of the NM 128 project area; from west to east, LA 129216, LA 129214, LA 113042, LA 129300, LA 129222, and LA 129217. Studied archaeological sites are marked with black dots. Key: Qa = Alluvium, Qp =Piedmont alluvial deposits, Qoa = Older alluvial deposits, Qpl = Lacustrine and playa deposits, Qep = Eolian and piedmont deposits, Pr = Rustler Formation (Upper Permian), Pqr = Quartermaster and Rustler formations (Upper Permian), Pqm = Quartermaster Formation (Upper Permian); from Geologic Map of New Mexico (2003) New Mexico Bureau of Geology and Mineral Resources, Socorro, NM.

calcrete also contains rounded quartzose pebbles up to 4 cm diameter. The pebbles were probably present as lag gravel on the eroded surface of the Permian bedrock prior to the formation of the calcrete. The calcrete varies in thickness from 1 to 2 m, with variable thickness perhaps related to the degree of local weathering and preservation.

The upper 30 cm of the calcrete is a cemented mass of dense nodules 1 to 8 cm in diameter. Upon weathering, the nodules form a scalloped surface. At some of the archaeological excavations, loose nodules that had weathered free from the calcrete may have been stacked into a feature. In places, the calcrete is capped by a 2 cm thick layer of carbonate lacking internal laminar structure, dissimilar to laminar structure observed in Stage IV calcretes.

The lower half of the calcrete is soft and poorly cemented. The Mescalero paleosol calcrete is characteristic of Stage III carbonate morphology (Birkeland 1999). The age of the calcic paleosol has not been determined, although it may be Late Pleistocene. The Mescalero sand sheet occurs on the weathered and eroded surface of the Mescalero paleosol.

OSL Analysis and Sample Preparation

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Sample Preparation/Dose-Rate Determination: OSL dating and sample processing was carried out by the Luminescence Geochronology Laboratory, Department of Earth and Atmospheric Sciences, University of Nebraska—Lincoln, under the direction of Dr. Ronald J. Goble. Sample preparation was carried out under amber-light conditions. Samples were wet-sieved, to extract the 90 to 150 µm fraction and treated with 1 N HCl to remove carbonates. Quartz and feldspar grains were extracted by flotation using a 2.7 gm/cc sodium polytungstate solution and then treated for 75 minutes in 48 percent HF, followed by 30 minutes in 47 percent HCl. The sample was then re-sieved and the < 90 µm fraction discarded to remove residual feldspar grains. The etched quartz grains are mounted on the innermost 2 mm or 5 mm of 1 cm aluminum disks using Silkospray.

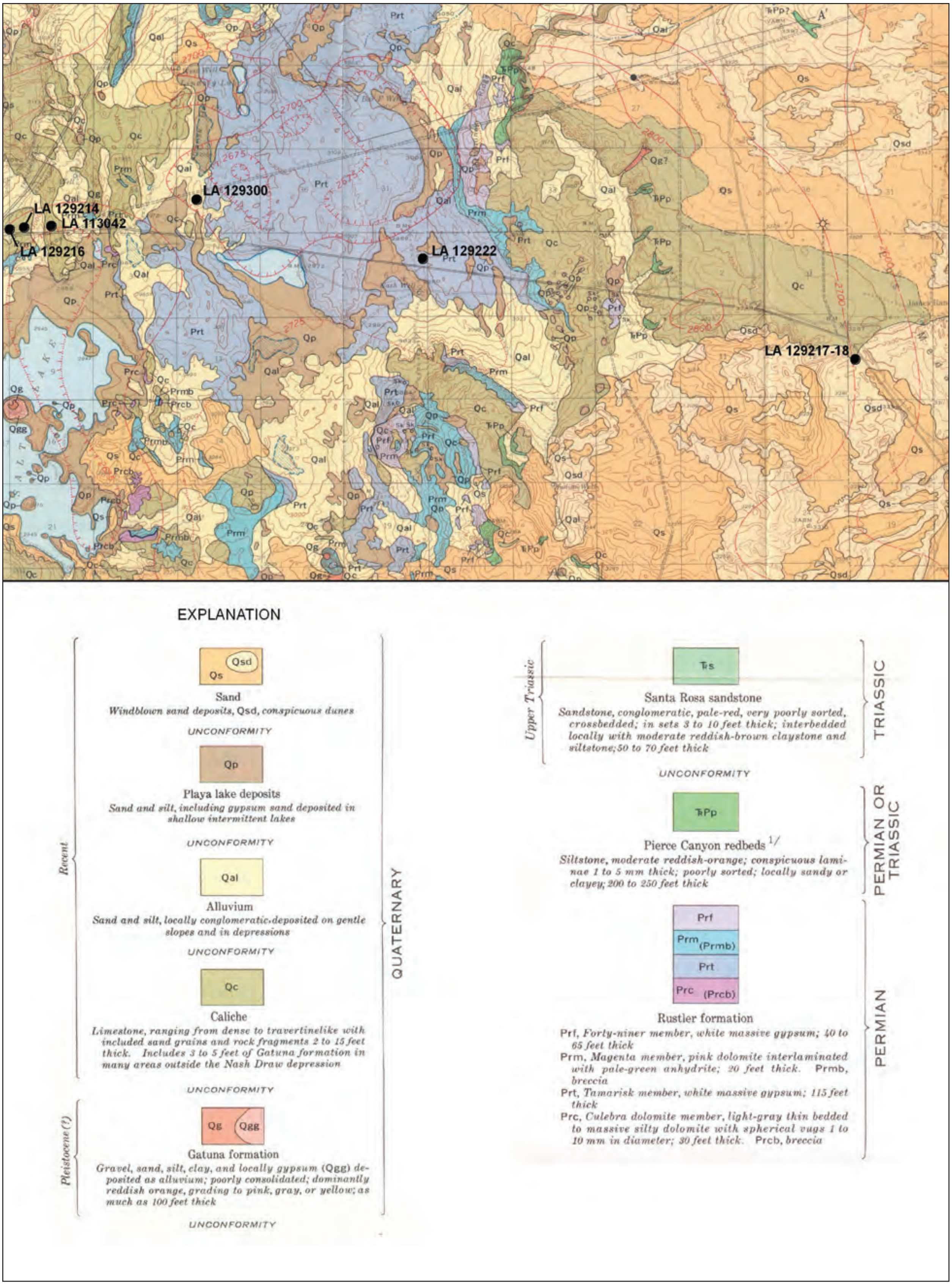


Figure 24.2. Surficial geologic map of the NM 128 project area, from Vine (1963).

Figure 24.3. Caliche of the Mescalero paleosol on red beds of the Quartermaster and Rustler formations (Upper Permian), west of NM 31.

Chemical analyses were carried out by Chemex Labs, Inc., Sparks, Nevada, using a combination of ICP-MS and ICP-AES. Dose-rates were calculated using the method of Aitken (1998) and Adamiec and Aitken (1998). The cosmic contribution to the dose-rate is determined using the techniques of Prescott and Hutton (1994).

Optical Measurements: Optically stimulated luminescence analyses were carried out on a Riso Automated OSL Dating System Model TL/OSL-DA-15B/C, equipped with blue and infrared diodes, using the Single Aliquot Regenerative Dose (SAR) technique (Wintle and Murray 2006). All De values were determined using the Central Age Model (Galbraith et al. 1999), unless data analysis indicated partial bleaching, in which case the Minimum Age Model (Galbraith et al. 1999) was used. Preheat and cut-heat temperatures were based on pre-heat plateau tests between 180º and 280º C.

Dose-recovery and thermal transfer tests were also conducted (Wintle and Murray 2006). Growth curves were examined to determine whether the samples were below saturation (D/Do < 2 (Wintle and Murray 2006). Optical ages were based on a minimum of 20 aliquots. Individual aliquots were monitored for insufficient count-rate, poor quality fits (i.e. large error in the equivalent dose, De); poor recycling ratio; strong medium versus fast component; and detectable feldspar. Aliquots deemed unacceptable based upon these criteria were discarded from the data set prior to averaging.

Averaging was carried out using the Central Age Model (Galbraith et al. 1999), unless the De distribution (asymmetric distribution; skew > 2 sigma, Bailey and Arnold 2006), indicated that the Minimum Age Model (Galbraith et al. 1999) was more appropriate. OSL laboratory measurements and associated data are presented in Table 24.1.

OSL Ages

OSL ages are in calendar years. While radiocarbon ages are reported in radiocarbon years before AD 1950, OSL ages have not yet been normalized to a "zero" time. In practice, OSL ages are reported as the number of years before the sample was collected in the field, thus removing it from the geologic source of the luminescence signal.

In this investigation, OSL samples were collected in 2007, thus OSL ages represent calendar years before 2007. This is, of course, somewhat moot—dealing with ages that are many thousands of years. However, if an OSL age were recent and determined to be 200 ± 10 years, that age would correspond to AD 1807 ± 10.

OSL-Dating: Applications to Archaeology

One of the important discoveries in recent years is that the age of the archaeological site and the age of the sedimentary substrate on which the site is formed are seldom the same. More often than not, the ages of archaeological sites on sand sheets and in dune fields were previously assumed to be the same as the age of the associated sediments, or, in other words, that the occupation of the site and the deposition of the sediments occurred simultaneously.

Recent studies in southern New Mexico, where OSL-dating has been applied, have shown that sediment and site ages are often hundreds or thousands of years apart. While this may not be a surprise to the experienced field worker, it is of significance in archaeological geology, providing new information regarding the formation, preservation, and visibility of the prehistoric record.

In the present investigation along NM 128,

Figure 24.4. Old NM 128 road cut at LA 113042, caliche of the Mescalero paleosol. Paleosol developed directly on red shale of the Rustler Formation (Upper Permian).

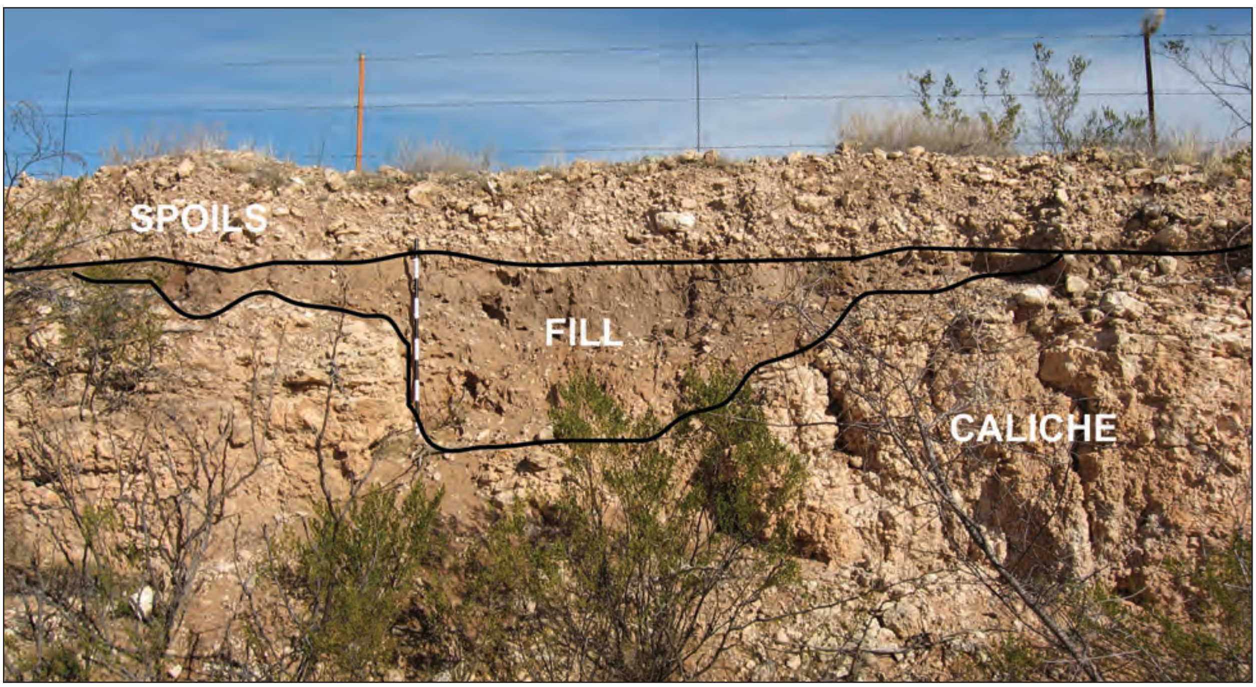


Figure 24.5. Old NM 128 road cut at LA 113042, solution cavity at top of Mescalero paleosol caliche, filled with recent eolian colluvial sand and pebbles.

Table 24.1 OSL laboratory data and ages from eolian sand deposits, by site.

UNL SAMPLE NO.	FIELD NO.	BURIAL DEPTH	H_2O	K_2O	U	Th	COSMIC	DOSE RATE	D_e	RECUP-ERATION	NO. OF ALIQUOTS	AGE
		(m)	(%)*	(%)	(ppm)	(ppm)	(Gy)	(Gy/ka)	(Gy)†	(%)		(ka)§
LA 129216												
Trench 1												
UNL-1982	LL-3	0.16	0.7	0.94	0.8	3.5	0.24	1.44 ± 0.07	7.20 ± 0.37	1	25	4.99 ± 0.37
UNL-1981	LL-2	0.39	0.6	1.00	0.8	4.0	0.23	1.52 ± 0.07	13.61 ± 0.36	1	26	8.94 ± 0.53
UNL-1980	LL-1	0.78	1.8	1.01	0.9	4.5	0.22	1.56 ± 0.07	19.86 ± 1.00	0.97	21	12.75 ± 0.94
Block 5, South Wall												
UNL-1983	LL-4	0.35	0.4	0.90	0.7	3.1	0.24	1.37 ± 0.06	5.72 ± 0.35	1	23	4.19 ± 0.34
LA 129214												
Trench 11, North End, East Wall												
UNL-1987	LL-8	0.35	2.3	0.92	0.7	2.9	0.24	1.33 ± 0.06	8.00 ± 0.05	1	24	6.00 ± 0.32
UNL-1986	LL-7	0.64	0.9	0.90	0.6	2.7	0.23	1.30 ± 0.06	11.97 ± 0.23	1	26	9.23 ± 0.53
UNL-1985	LL-6	1.00	0.6	0.87	0.7	2.7	0.22	1.29 ± 0.06	15.31 ± 0.45	1	20	11.9 ± 0.70
Trench 10, North Wall												
UNL-1984	LL-5	0.66	0.9	0.89	0.8	3.2	0.23	1.37 ± 0.06	14.66 ± 0.64	1	22	10.7 ± 0.7
LA 113042												
Trench 6, East End												
UNL-1989	LL-10	0.12	0.4	0.78	0.7	2.8	0.24	1.25 ± 0.06	2.91 ± 0.20	2	29	2.32 ± 0.20
UNL-1988	LL-9	0.54	0.4	0.89	0.5	2.2	0.23	1.24 ± 0.06	6.90 ± 0.28	1	25	5.56 ± 0.37
LA 129300												
Trench 3, West Wall												
UNL-1993	LL-14	0.11	0.8	0.95	0.7	3.0	0.24	1.40 ± 0.06	7.96 ± 0.06	1	24	5.68 ± 0.31
UNL-1992	LL-13	0.47	1.0	1.01	0.8	3.6	0.23	1.50 ± 0.07	28.69 ± 1.00	1	51	19.1 ± 1.2‡
UNL-1991	LL-12	0.88	0.5	0.95	0.7	2.5	0.22	1.35 ± 0.06	48.36 ± 1.17	1	21	36.0 ± 2.1
UNL-1990	LL-11	1.26	0.7	0.96	0.5	2.5	0.21	1.29 ± 0.06	63.85 ± 2.17	1	23	49.4 ± 3.1
Block 6, East Wall, Associated with Paleoindian Point												
UNL-1994	LL-15	0.18	1.4	1.04	0.8	3.8	0.24	1.54 ± 0.07	5.69 ± 0.35	1	20	3.71 ± 0.30
LA 129217												
Trench 1, East Wall												
UNL-1999	LL-20	0.26	0.9	0.57	0.4	1.6	0.24	0.91 ± 0.05	1.92 ± 0.03	2	51	2.11 ± 0.13
UNL-1998	LL-19	0.62	0.2	0.69	0.5	2.1	0.23	1.07 ± 0.05	2.33 ± 0.02	2	50	2.18 ± 0.12
UNL-1997	LL-18	1.09	1.3	0.75	0.5	2.4	0.22	1.12 ± 0.05	4.76 ± 0.02	1	50	4.26 ± 0.24
UNL-1996	LL-17	1.36	0.7	1.01	0.7	3.8	0.21	1.47 ± 0.08	76.89 ± 2.07	1	51	52.2 ± 3.1
UNL-1995	LL-16	1.67	2.3	1.04	0.7	3.9	0.20	1.47 ± 0.07	86.59 ± 2.15	1	50	59.1 ± 3.5

Note: Laboratory analyses by Dr. Ronald J. Goble, Department of Geosciences, University of Nebraska-Lincoln (UNL) 2007; collected by S. A. Hall, February–September 2007.

*in-situ moisture content

†Error on D_e is 1 standard error.

§Error on Age includes random and systematic errors calculated in quadrature.

‡minimum age model (Galbraith et al. 1999)

OSL dating revealed that the local sand sheet was deposited during the period about 13,000 to 5000 years ago. High-resolution radiocarbon dating of archaeological sites on the sand sheet revealed a 1400 year period of prominent occupation and land use from about 1900 to 500 years ago. The local sand sheet was a stable surface for about 3000 years prior to its occupation by prehistoric inhabitants. One question that arises from this chronology is, since the sand sheet was available for occupation over the past 5000 years, what circumstances resulted in the heavy occupation of these sites during the specific period c. 1900 to 500 years ago?

Two sites along NM 128 have Early Archaic components. Both sites were found in very thin eolian sand, directly upon caliche of the Mescalero paleosol. These sites were discovered because they were visible at the surface and were not buried by the local sand sheet. Thus, the geographic distribution of Early Archaic sites in the study area can be related to the presence or absence of the sand sheet. Early pre-3000 BC sites are probably present in the area but are buried in the sand sheet and not visible. Two buried features were discovered by chance during geomorphic backhoe excavation at a NM 128 site and will be discussed later; OSL dating indicated that the buried features were late Paleoindian.

Bear Grass Draw

A noteworthy case study, comparing OSL and radiocarbon dating, was conducted recently at four archaeological sites on the Mescalero sand sheet along Bear Grass Draw in Eddy County, NM (Condon et al. 2008). Four paired samples of buried A horizon soil, each from the side walls of test excavations, were collected. Mean OSL dates ranged from 3000 ± 300 to 12,800 ± 2300 years, while the accompanying AMS radiocarbon dates ranged from 890 ± 40 to 1360 ± 40 ^{14}C years BP (Condon et al. 2008). The investigators regarded the radiocarbon ages as correct for the age of the prehistoric sites (the A horizon was probably a weak anthrosol). However, the OSL ages were dismissed as too old for the age of both the A horizon soil and the associated archaeology.

The optical age of the sand in which the A horizon soil formed, however, could well be the sediment's true age. The quartz sand grains at the site could be a product of mixing that occurred during occupation of the site. Because of sediment mixing during site occupation, it is unlikely that OSL dating would yield an age of the site itself. The OSL age of sand grains within the site footprint may always predate the age of the site. Hall and Rittenour (2010) point out that, because of sediment mixing in a site footprint, OSL dating might not be an appropriate tool for determining the age of an archaeological site.

In the Bear Grass Draw study, three of the OSL samples showed bimodal-age signals, another sample showed trimodal-age signals, evidence of a mixture of sediment of different ages (Condon et al. 2008:201, 303). It can also be concluded that OSL dating, as well as radiocarbon dating of soils and sediments, should be conducted at a distance from prehistoric cultural activity if the goal is to establish the age of the geomorphic deposits (Hall and Rittenour 2010).

One aspect of the Bear Grass Draw OSL dating laboratory methodology deserves a footnote: In all conventional OSL dating, the number of aliquots or subsamples analyzed will determine the accuracy of the OSL age. The greater the number of aliquots, the lower the sigma, and the higher the resolution of age. The number of aliquots measured in the Luminescence Dating Laboratory of the University of Georgia for each of the four OSL dates ranged from four to 11, resulting in 1 sigma deviation as high as 18 percent (Condon et al. 2008:303). In the investigation in 2007 along NM 128 by the Luminescence Geochronology Laboratory of the University of Nebraska-Lincoln, OSL ages were determined from 20 to 29 aliquots each, resulting in 1 sigma deviations as low as 6 percent (Table 24.1). More recently, a minimum of 50 aliquots has been recommended for high-resolution OSL dating (Rodnight 2008).

Stratigraphic and Sedimentologic Methods

The descriptions in this report follow the nomenclatural standards for informal units outlined in the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 2005). The descriptions of sediments follow the various guidelines in Powers (1953), Terry and Chilingar (1955), and Folk (1968). Sediment colors are determined from Munsell Soil Color Charts (1975),

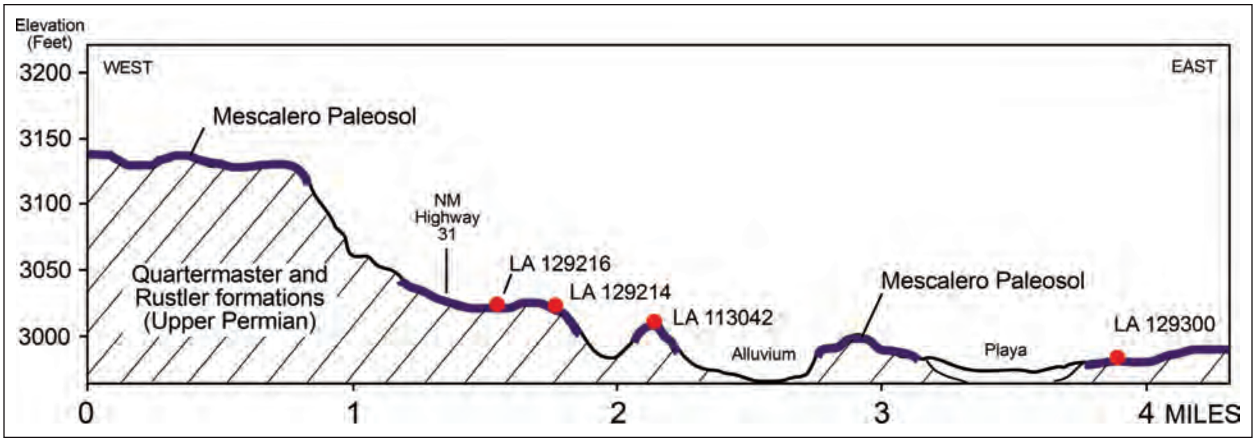


Figure 24.6. Topographic profile of the central Salt Lake basin, where four sites occur in the NM 128 study. The thick purple line denotes the presence of Mescalero paleosol calcrete underlain by Permian red beds. Mescalero paleosol is missing from the two unnamed alluvial valley floors west and east of LA 113042.

and soil descriptions and characterizations are from Soil Survey Staff (1994) and Birkeland (1999).

The percentages of gravel, sand (1 phi categories), silt, clay, carbonate, organic carbon, and total phosphate are determined by the Milwaukee Soil Laboratory in Milwaukee, Wisconsin. Sediment textures follow the Wentworth scale (1922). Percentages of calcium carbonate are determined by the Chittick method, and percentages of organic carbon are determined by the Walkley-Black method. Description of the sand grains is based in part on X10 and X30 inspection of the sediment with a Swift Stereo Eighty® binocular microscope.

Archaeological Sites

The archaeological sites investigated in the NM 128 project fall into four separate geomorphic environments: Sites LA 129216, LA 129214, and LA 113042 have a similar setting, all occurring on the surface of eolian cover sand and capped by twentieth century coppice dunes, although LA 113042 is severely eroded with only a thin veneer of eolian sand (Fig. 24.6). LA 129300 and LA 129218 are located on very thin deposits of eolian sand; the thin eolian sand rests directly on the eroded surface of the Mescalero paleosol calcrete. LA 129222 occurs on the weathered surface of Permian gypsum that is covered in places by a thin layer of very fine sand and dust. LA 129217 occurs a few hundred feet east of LA 129218 in thick eolian sand at the western edge of Los Medanos dune field.

Most of the above archaeological sites have been found to have comparatively young components, radiocarbon-dated younger than 2000 years, and occur at the surface of and intrude into the Upper eolian sand unit that is OSL-dated c. 13,000 to 5000 years.

The two sites associated with older surfaces, LA 129300 and LA 129218, have Early Archaic components. Two buried features at LA 129042 have OSL ages that indicate they are late Paleoindian. The archaeological geology of the six sites and their geologic context will be addressed in the following sections of this chapter.

LA 129216

The site occurs on a low-gradient topographic slope characterized by small mesquite coppice dunes on thin, eolian cover sand. The dunes are widely spaced. The local cover sand, excluding the dunes, is generally less than 1 m thick. Burned rock and other artifacts occur in the eroded areas between low dunes on the site. An organic crust is present on the undisturbed surface of the eolian sand. The vegetation is shrub grassland, dominated by mesquite, creosote bush, acacia, and four-wing saltbush. The eolian cover sand rests directly on dense calcrete of the Mescalero paleosol. The calcic paleosol is locally about one-half meter thick and is developed directly on an eroded surface of shale of the Rustler Formation (Upper Permian). The eolian sand cover is evidently too thin for mapping, and the locality is shown as caliche by Vine (1963).

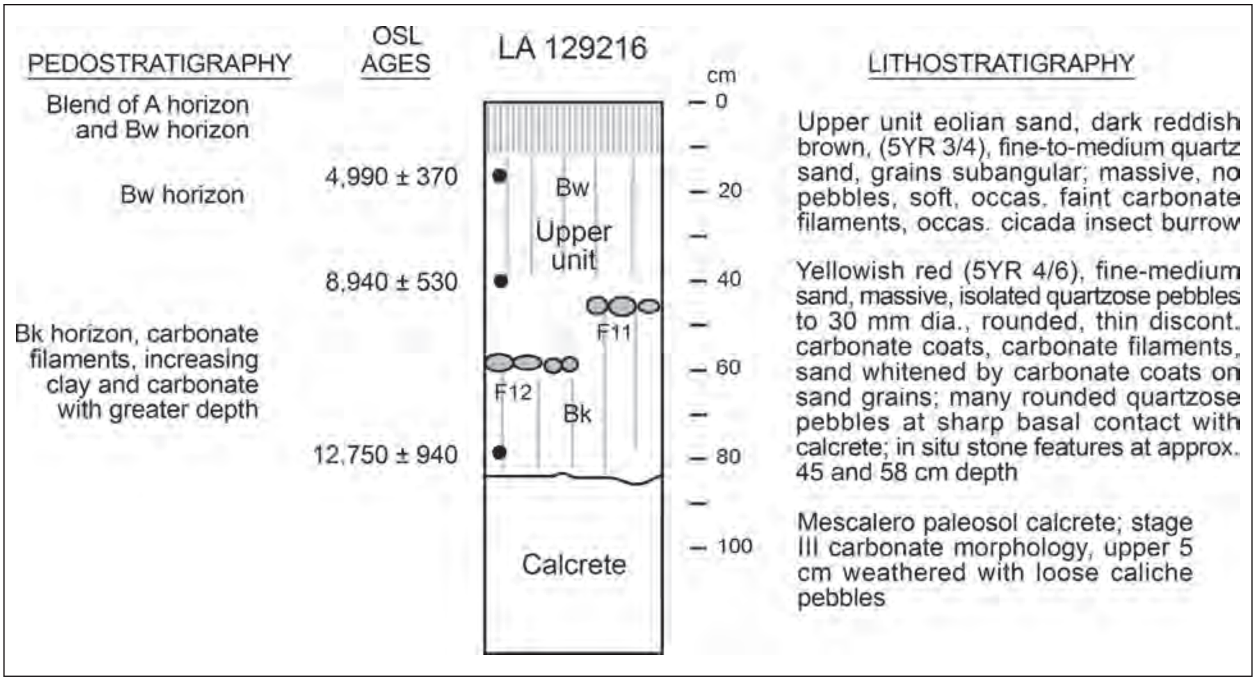


Figure 24.7. LA 129216, BHT 1, summary stratigraphy, sediments, and soils with position of OSL dates and Features 11 and 12.

Geology and Soil Geomorphology

Eolian Cover Sand: Site LA 129216 is located on the surface of eolian cover sand at the western edge of the Mescalero sand sheet. The eolian sand correlates with the Upper unit of Hall and Goble (2006). It is reddish brown (5YR 4/4) to yellowish red (5YR 4/6) and is made up of uniformly fine-to-medium-textured quartz grains throughout its 80 cm thickness where analyzed in Trench 1 (Fig. 24.7). The grains are sub-angular, and the extent of carbonate coats increases from zero at the top to approximately 95 percent at the base, reflected in the increase in percentages of carbonate with greater depth. Small pellets of caliche occur at the base of the sand where in contact with underlying Mescalero paleosol. The sand unit is massive without visible internal bedding or unconformities.

B Horizon Paleosol: At the margins of the site, the eolian sand is undisturbed and is characterized by weak Bw and Bk soil horizons that extend through the entire thickness of the sand (Fig. 24.8). The presence of the soil indicates that the surface of the eolian cover sand has been stable for the period of time since the sand was deposited. Based on OSL dating, deposition of the cover sand ended 5000 years ago. Thus, the weak B horizon associated with these sand deposits formed during the past 5000 years.

Field and laboratory data from Trench 1 show that percentages of both clay and carbonate increase with greater depth, and carbonate filaments are present in the lower half of the column, all indicating the presence of a weak Bk horizon with Stage I carbonate morphology (Fig. 24.9) (Table 24.2) (Birkeland 1999:357). The slight darkening or discoloration of the upper 30 cm of the sand in Trench 1 characterizes the weak Bw horizon; its color is dark reddish brown (5YR 3/4). The uppermost 10 cm, however, may be a mix of the Bw horizon with a superimposed local A horizon soil that is much younger than the Bw horizon (Fig. 24.7). The quartz sand grains in the Bw horizon lack clay coats; the darker color of the horizon is due to mineral stain on the grains, probably iron oxide.

A Horizon Soil: An A horizon soil is preserved beneath twentieth century coppice dunes at the site. The A horizon soil and the local anthrosol, discussed below, merge in the core area of the site. At the margins of the site and on low-gradient slopes, the A horizon soil is missing due to recent erosion.

Variable Thickness of Eolian Sand

Trenching and augering at the site have shown that the thickness of the Upper unit eolian sand overlying calcrete is not uniform but varies from 30 to

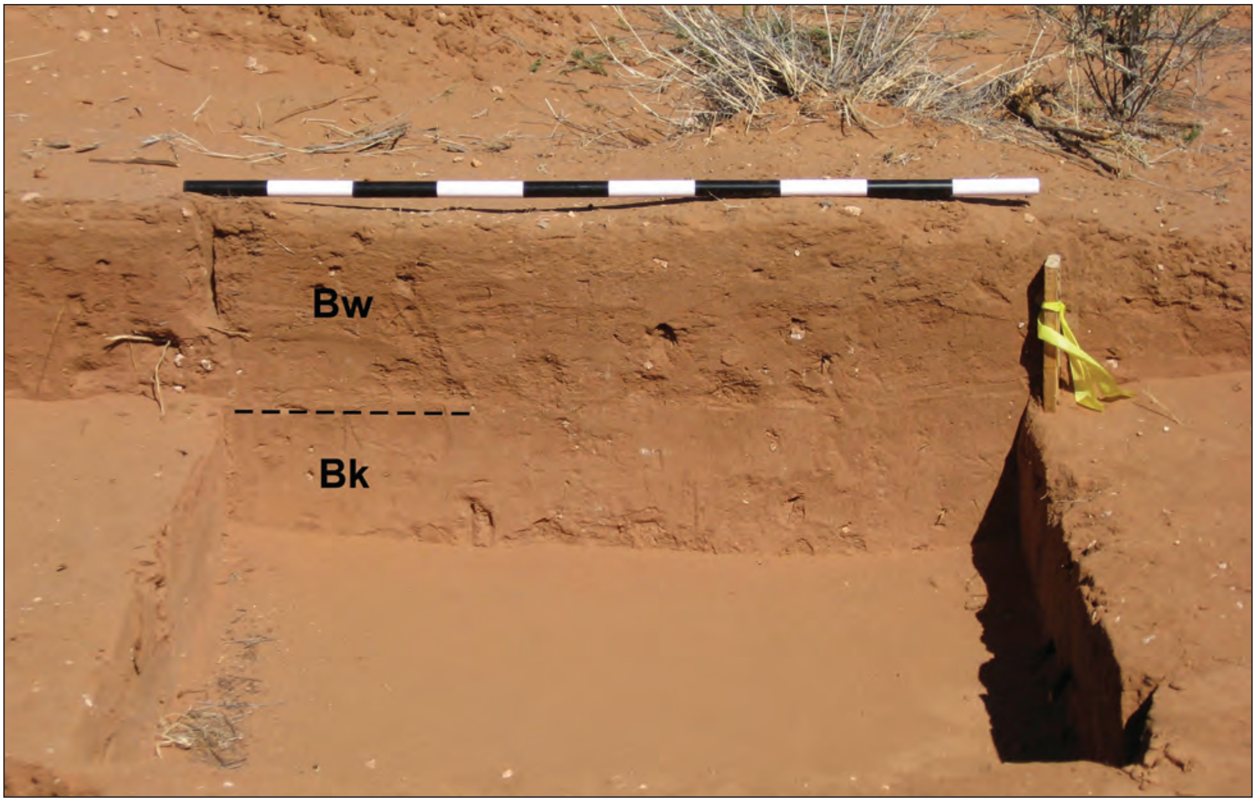


Figure 24.8. LA 129216, Block 5, north wall, upper unit eolian sand. The sand contains isolated caliche pebbles. A weak Bw horizon occurs in the upper 26 cm (10.24 inches), with a weak Bk horizon below.

160 cm. Some of the variable thickness of the sand may be related to the irregular eroded surface of the calcrete on which the eolian sand was deposited. Trench 4 encountered exceptionally deep sand to 225 cm where trenching arbitrarily ended. This thick sand is entirely Upper unit with weak Bw and Bk soil horizons extending to 120 cm, similar to the soil exposed in other trenches around the site. The older Lower unit red sand (seen only at LA 129217) is not present in the deep cut, and the Mescalero paleosol calcrete was not encountered. The sand may extend far below 225 cm depth. In this case, the thick Upper unit sand may fill a solution pipe in the calcrete, similar to a situation at LA 129300.

Geochronology of the Eolian Sand

Three OSL ages from the Upper unit eolian sand at LA 129216 indicate that the sand was deposited during the period c. 13,000 to 5000 years. Three close-interval OSL samples were collected in a column in Trench 1. The earliest OSL age is from a sample collected 5 cm above the calcrete at 78 cm depth and is 12,750 ± 940 years; the youngest age from 16 cm depth is 4990 ± 370 years (Fig. 24.10). It is notable that both the earliest and latest OSL ages from the Upper unit sand in this project are from the same stratigraphic column.

An isolated OSL sample was collected from 35 cm depth in Block 5 and dated 4190 ± 340 years (Fig. 24.11). The eolian sand in Block 5 is thin and mantles the irregular surface of the underlying calcrete. The single OSL age may represent sediment from the site footprint, yielding an age that is slightly younger than the age of the Upper unit.

Sedimentation Rate

The series of three OSL dates provide a sedimentation rate of the Upper unit eolian cover sand. The net accumulation rate of the sand, based on linear regression analysis of OSL age versus depth, is 0.080 mm/year (Fig. 24.10). The OSL ages, the uniformity of the laboratory sediment texture throughout the column, the absence of visible unconformities, and the absence of buried paleosols all indicate that the

Table 24.2. LA 129216, sediment data from Trench 1.

FS NO. (CM)	SAND (MM) 2.0–1.0 VERY COARSE	1.0–0.5 COARSE	0.5–0.25 MEDIUM	0.25–0.125 FINE	0.125–0.0625 VERY FINE	RECALCULATED SAND	SILT	CLAY <3.9 µm	OC (%)	CaCO3 (%)	DRY COLOR
Twentieth-century Eolian Sand											
39 (+10–18)	–	0.7	23.6	57.9	17.8	89	5	6	0.24	1.6	5YR 4/3
40 (+2–10)	–	1.3	25.5	53.1	20.1	89	5	6	0.22	1.4	5YR 4/3
Upper Unit Eolian Sand											
41 (0–10)	–	2.5	29.3	50.3	17.9	85	6	9	0.19	1.5	5YR 3/4
42 (10–20)	–	2.2	28.1	51.0	18.7	84	6	10	0.19	1.8	5YR 3/4
43 (20–30)	–	2.5	29.6	50.5	17.4	84	5	11	0.18	2.0	5YR 4/4
44 (30–40)	–	2.6	28.0	51.0	18.4	82	6	12	0.15	2.1	5YR 4/4
45 (40–50)	0.1	2.6	28.1	51.2	18.0	82	6	12	0.13	3.2	5YR 4/6
46 (50–60)	0.1	2.2	26.7	51.8	19.2	81	5	14	0.13	4.1	5YR 4/6
47 (60–70)	0.1	2.9	29.5	50.8	16.7	79	4	17	0.13	4.5	5YR 4/6
48 (70–80)*	0.3	4.3	33.4	46.5	15.5	77	6	17	0.17	6.5	5YR 4/6

Note: Numbers are percentages; OC = % organic carbon determined by Walkley-Black method; % carbonate determined by Chittick method; numbers in parentheses are centimeters depth; Wentworth scale; dry color from Munsell® Soil Color Chart; analyses by Milwaukee Soil Laboratory, 6917 W. Oklahoma Ave., Milwaukee, WI 53219.
* Eolian sand rests directly on caliche of the Mescalero paleosol.

cover sand accumulated slowly and continuously at this locality for a period of 8000 years. Similar slow sedimentation rates are documented for cover sand deposits in the Pierce Canyon area (Hall 2007a) and in the Bolson sand sheet in the Hueco Bolson at Fort Bliss near El Paso, Texas (Hall 2007b; Hall et al. 2010).

Archaeological Geology of LA 129216

The site was formed on the stable surface of the Upper unit eolian sand. The age of the site ranges from 1710 ± 40 to 990 ± 40 ^{14}C years BP based on seven AMS radiocarbon dates (data in this report). Features and artifacts are intruded into and are mixed with the eolian sand.

Buried Cultural Features in Eolian Sand

An unexpected discovery in Trench 1 is the presence of two in situ stone features buried in the eolian sand (Figs. 24.12 and 24.13). Neither artifacts nor charcoal was recovered from the features during excavation. Feature 11 occurred approximately 45 cm depth and Feature 12 is approximately 58 cm below the top of Upper unit eolian sand in the measured section (Fig. 24.7). The stones are composed of dense calcrete and are approximately 20 to 70 mm in diameter; some of the stones are darkened or "burned" such as occurs when heated by fire. Neither feature is associated with an identifiable surface within the eolian sand. Indeed, the sand is massive without visible bedding and without internal stratigraphy in the trench where the stone features are exposed. However, stones of this size are entirely out of place in an eolian environment. On geological grounds, the features are likely cultural in origin.

The interpolated age of Feature 11 is c. 8970 years and the interpolated age of Feature 12 is c. 10,600 years based on age-depth relationship shown in Fig. 24.10. However, there is a possibility that both isolated stone features may occur on the same irregular prehistoric surface and are components of the same buried site. The features both occur at the transition of the Bw with the underlying Bk soil horizon even though the depths below the present-day surface are slightly different. While soil development is post-deposition of the sand, soil horizons generally follow the local topography. If this is the case in Trench 1, the two features may be on the same paleosurface, even though there is no other physical evidence for an old surface, such as a continuous stone line or a change in sediment

Figure 24.9. LA 129216, BHT 1, sediment data. The increase in amounts of clay and carbonate with greater depth is related to soil development.

texture. In addition, the alignment of the stones dips slightly, indicating that the surface on which they were placed was irregular or at a low gradient.

Site Footprint

The prehistoric occupation of LA 129216 has resulted in two changes to the geology of the eolian cover sand: the disturbance of the cover sand and the mixing of cultural materials with the upper levels of the sand and the development of a thick anthrosol. The anthrosol and the zone of mixing are together a site footprint that is formed in the pre-existing eolian sand substrate. The site footprint at LA 129216 and at the other sites as well is a consequence of cultural activity that mixed and modified the sediment, producing a site-specific sedimentary product that is unique to archaeological sites and not found in the landscape outside of site boundaries. As presented before, the OSL age 4190 ± 340 years is probably from the site footprint.

Anthrosol

An anthrosol is defined as a soil that has formed by cultural activity. It differs from naturally occurring soils, although in some cases it may be difficult to differentiate an anthrosol and a natural soil. Interpreting a soil at an archaeological site as a possible anthrosol requires a comparative investigation of nearby soils that are off-site. In the sandy substrates of eolian cover sands in southeastern New Mexico, an anthrosol is generally recognized by its unusual thickness and dark Brown to gray color, the dark color due to the addition of solid organic matter and the greater thickness due to mixing during site occupation.

A number of archaeological sites in the Mescalero Plain have anthrosols, especially those sites with a long history of occupation. LA 129216 is such a site. In areas of the site that have been protected from recent erosion by twentieth century coppice dunes, the anthrosol is well preserved (Fig. 24.14). It is reddish brown to dark reddish brown (5YR 3/3-5/4) and is 30 to 40 cm thick. Laboratory data from the anthrosol at LA 129216 are not available. However, laboratory data from the well-developed anthrosol at nearby LA 129214 are presented and discussed below in that section. A broad review of anthrosols and their properties can be found in Holliday (2004).

LA 129214

The site occurs on a low topographic rise with a view of the surrounding terrain. The vegetation is a shrub land dominated by creosote bush, acacia, mesquite, and a few patches of bunchgrass. The surface has a thin biological soil crust. Coppice dunes are absent, although some eolian sand has accumulated recently around small shrubs. East of the site, mesquite coppice dunes occur in the small valley of the unnamed wash.

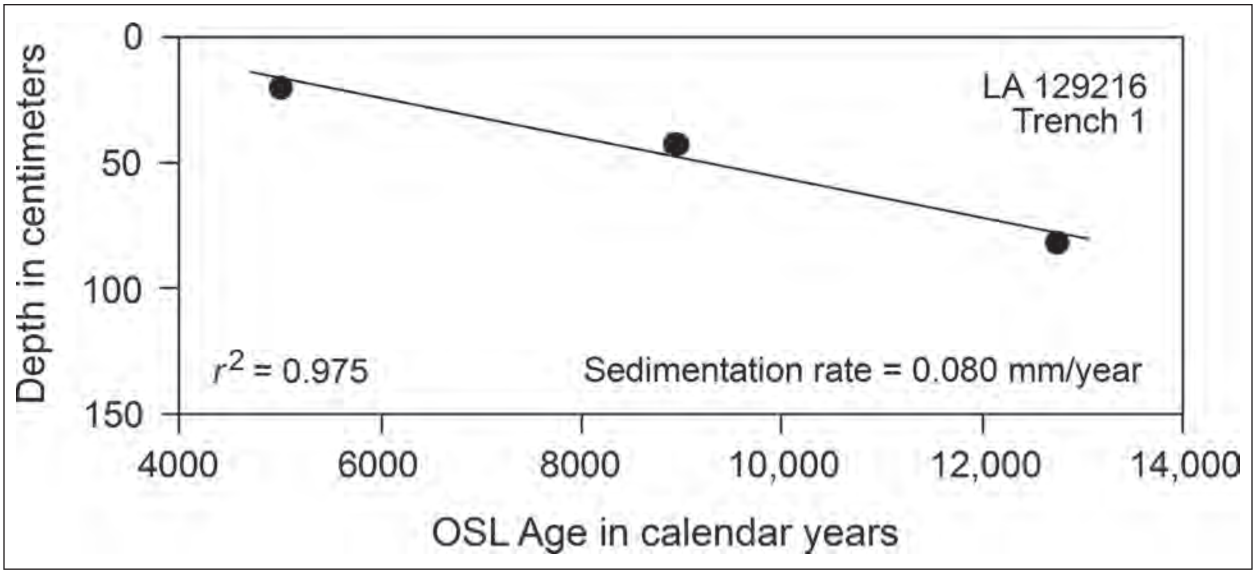


Figure 24.10. LA 129216, BHT 1, OSL age versus centimeters depth, Upper unit eolian sand.

Geology and Soil Geomorphology

Eolian Cover Sand: The surficial geology at LA 129214 is characterized by eolian cover sand that mantles the underlying Mescalero paleosol calcrete. The surficial geology is identical to that described at nearby LA 129216. The cover sand is the Upper unit eolian sand and is approximately 1 m thick, although the thickness varies across the site. The sand is yellowish red to reddish brown (5YR 4/6, 5YR 5/4) fine-to-medium quartz sand. The grains are sub-rounded; the sand contains 1 percent dark minerals and 1 to 2 percent caliche grains. The sand is massive, without visible internal bedding or unconformities (Fig. 24.15).

B Horizon Paleosol: A weak soil with Bw and Bk horizons has developed on the stable surface of the Upper unit cover sand. The Bw horizon extends from the present-day surface to 25 to 40 cm depth. It does not have soil structures. It is reddish brown (5YR 4/4) in the upper 20 cm and yellowish red (5YR 4/6) at 20 to 40 cm depth. Laboratory analyses show that it does not have secondary clay content (Fig. 24.16). The paleosol has a weak zone of secondary carbonate extending from about 50 cm depth to the base of the sand at 100 cm depth at its contact with underlying calcrete. The weak Bk horizon has a few faint carbonate filaments and many well-formed filaments in the lower 10 cm of the sand column. Sand grains are coated by carbonate and occasional pellets of carbonate-cemented sand 2 to 3 mm diameter are present. Laboratory analyses show that the Bk horizon has 5 to 7 percent carbonate (Fig. 24.16) (Table 24.3), supporting a Stage I carbonate morphology (Birkeland 1999). Based on the OSL age of the Upper unit sand at LA 129214, the weak paleosol formed over a period of 5000 years, similar to the situation at LA 129216.

A Horizon Soil: An A horizon soil occurs on eolian sand at the eastern edge of LA 129214 where the topography drops into the unnamed wash. The A horizon soil is exposed in two trenches, one trench south of the old NM 128 southeast of the site, and the other trench east of the site at the edge of the unnamed wash. In both cases, the A horizon soil is formed on the top of 60 to 80 cm of massive eolian sand. South of the old highway, the soil is buried by historic coppice dune sand. At the edge of the wash, the soil is buried by 26 cm of recent alluvium. Bulk sediment from the A horizon at the edge of the wash is radiocarbon-dated 1090 ± 40 14C years BP, and the A horizon south of the highway is radiocarbon-dated 1130 ± 40 14C years BP. The A horizon soil exposed in the two trenches occupies the same position on the landscape, indicating that they are the same soil. Their radiocarbon age is statistically identical as well (Table 24.4).

Geochronology of Eolian Sand

A series of three OSL ages from a column at Trench 11 at LA 129214 provide a chronology for the Upper

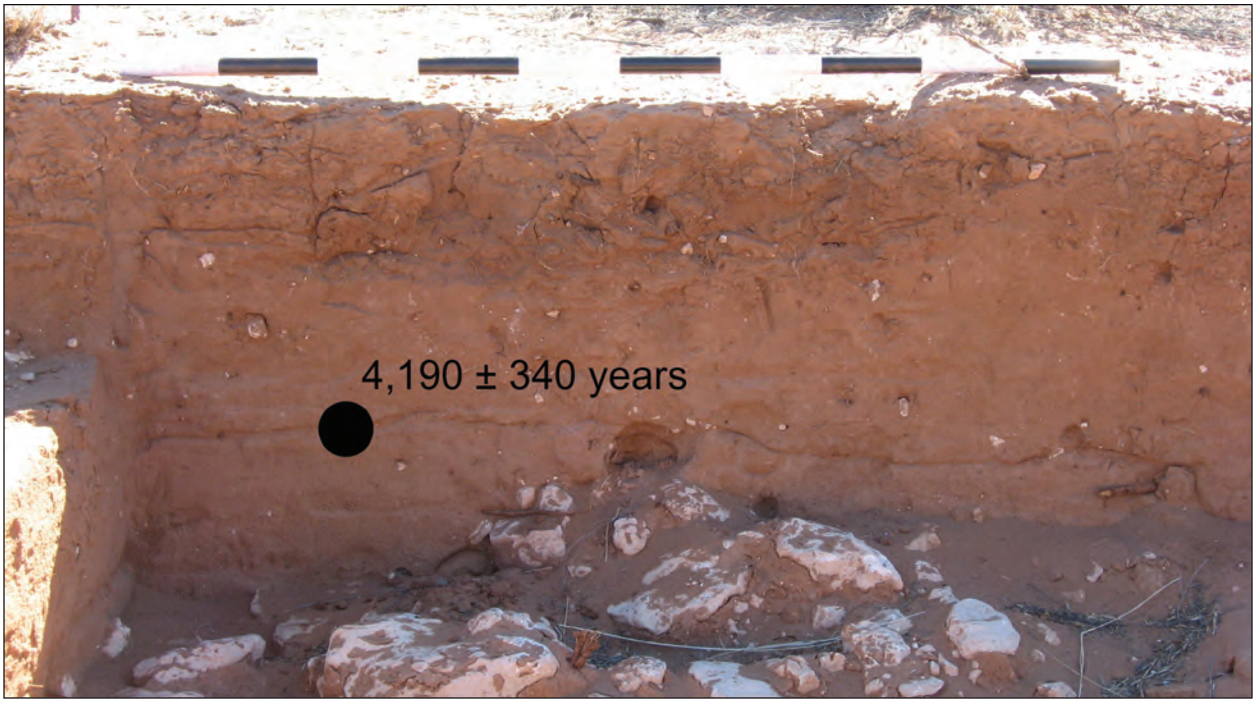


Figure 24.11. LA 129216, Block 5, south wall, eolian sand. OSL age obtained from 35 cm (13.78 inches) depth, near the eroded surface of the Mescalero paleosol calcrete.

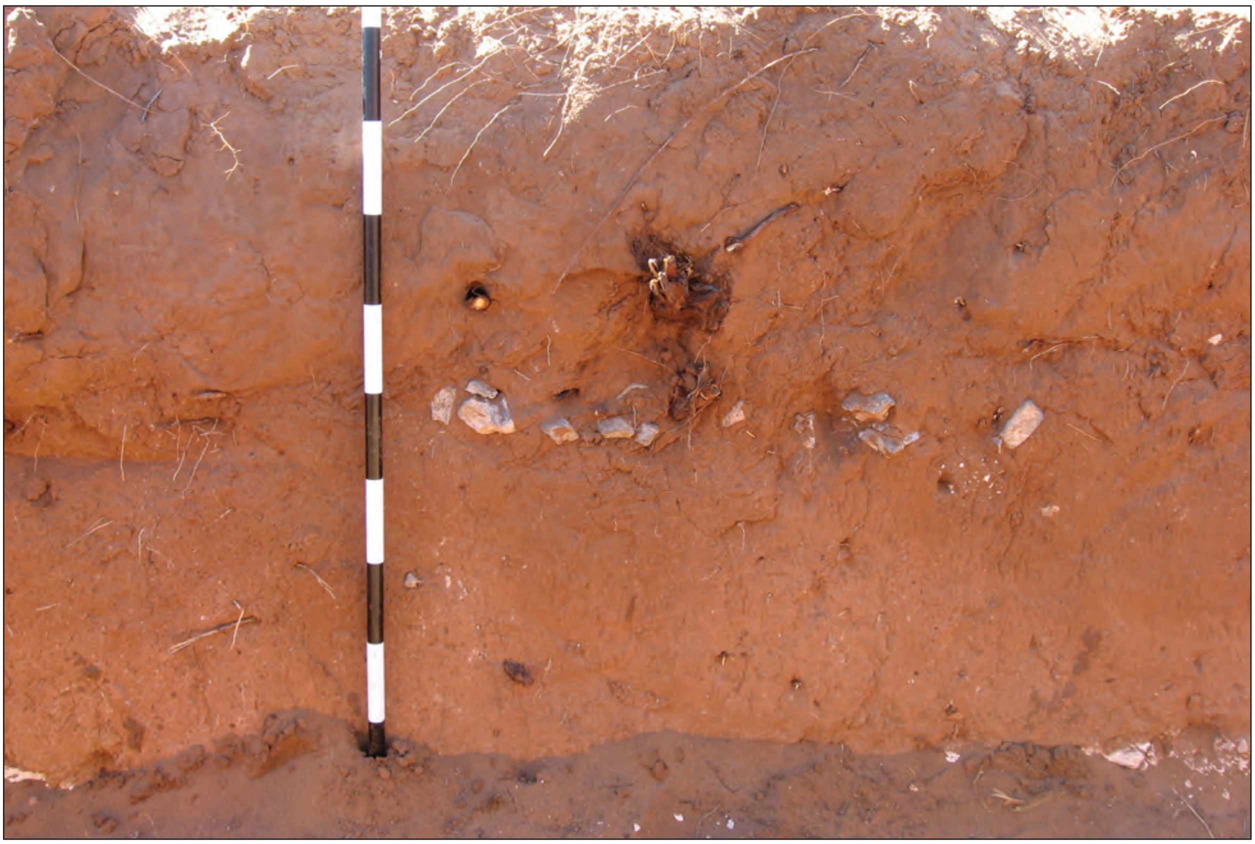


Figure 24.12. LA 129216, BHT 1, Feature 11 at 45 cm (17.72 inches) depth below the top of Upper unit eolian sand. Interpolated OSL age is 8970 years; the feature occurs at the Bw-Bk transition.

Figure 24.13. LA 129216, BHT 1, Feature 12 at 58 cm (22.83 inches) depth below the top of Upper unit eolian sand. Interpolated OSL age is 10,600 years; the feature occurs at the Bw-Bk transition, similar to Feature 11.

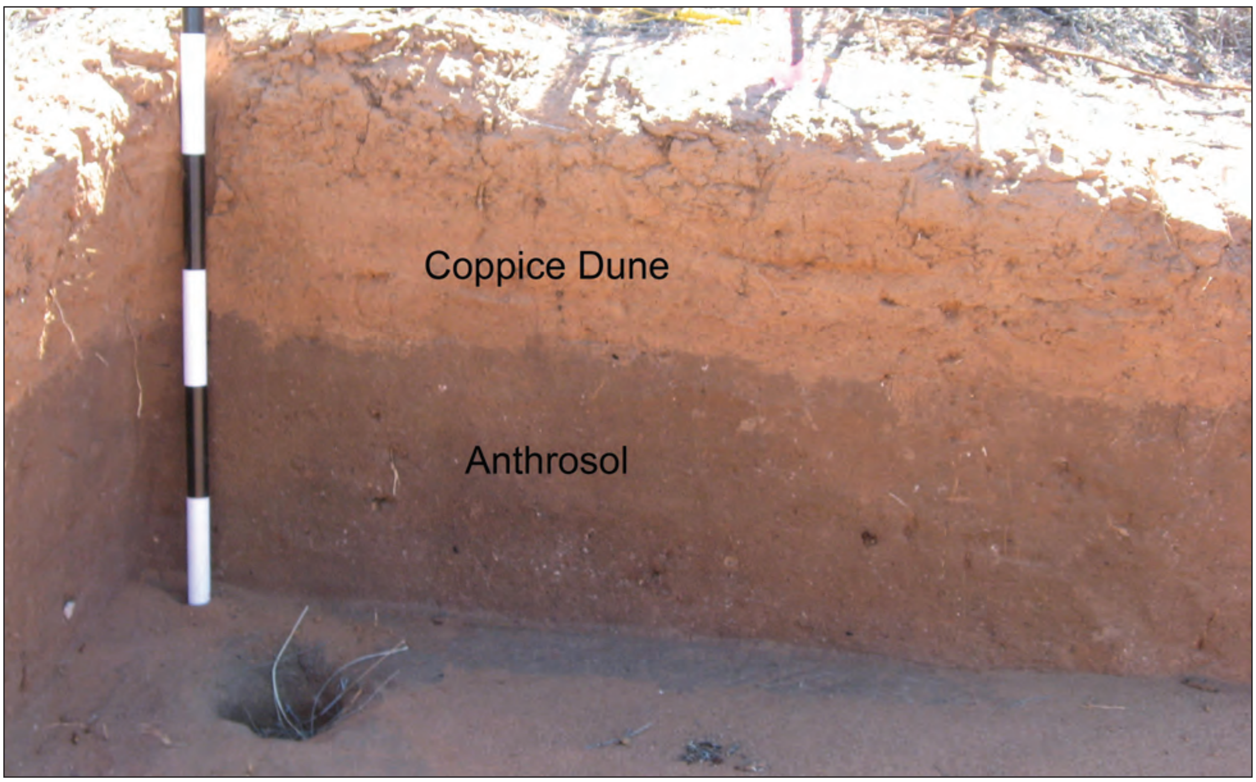


Figure 24.14. LA 129216, Block 3, anthrosol covered by twentieth-century coppice dune sand.

Table 24.3. LA 129214, sediment data from Trench 11.

FIELD SAMPLE NO. (CM)	SAND (MM)					RECALCULATED					
	2.0–1.0	1.0–0.5	0.5–0.25	0.25–0.125	0.125–0.0625	SAND	SILT	CLAY	OC	CaCO3	DRY COLOR
	VERY COARSE	COARSE	MEDIUM	FINE	VERY FINE			<3.9 μm	(%)	(%)	
Upper Unit Eolian Sand											
28 (0–10)	–	0.9	20.6	58.2	20.3	89	5	6	0.18	1.4	5YR 4/4
29 (10–20)	–	0.8	20.7	58.8	19.7	89	5	6	0.17	1.3	5YR 4/4
30 (20–30)	–	0.8	20.0	58.6	20.6	90	4	6	0.14	1.1	5YR 4/6
31 (30–40)	–	0.8	21.2	58.0	20.0	89	5	6	0.11	1.6	5YR 4/6
32 (40–50)	–	0.8	20.8	57.6	20.8	89	6	5	0.13	2.8	5YR 4/6
33 (50–60)	0.3	1.1	22.1	55.2	21.3	86	8	6	0.10	5.5	5YR 5/6
34 (60–70)	0.1	1.2	22.4	55.7	20.6	86	7	7	0.09	4.7	5YR 5/6
35 (70–80)	0.1	1.1	22.6	55.7	20.5	86	7	7	0.07	5.2	5YR 5/4
36 (80–90)	0.3	1.2	23.3	55.4	19.8	86	7	7	0.06	6.2	5YR 5/4
37 (90–100)	0.2	1.1	23.5	55.3	19.9	86	7	7	0.05	6.3	5YR 5/4
38 (100–110)*	0.3	1.3	23.5	55.4	19.5	82	10	8	0.06	7.2	5YR 5/4

Note : Numbers are percentages; OC = % organic carbon determined by Walkley-Black method; % carbonate determined by Chittick method; numbers in parentheses are centimeters depth; Wentworth scale; dry color from Munsell® Soil Color Chart; analyses by Milwaukee Soil Laboratory, 6917 W. Oklahoma Ave., Milwaukee, WI 53219.
* Eolian sand overlies Mescalero paleosol calcrete.

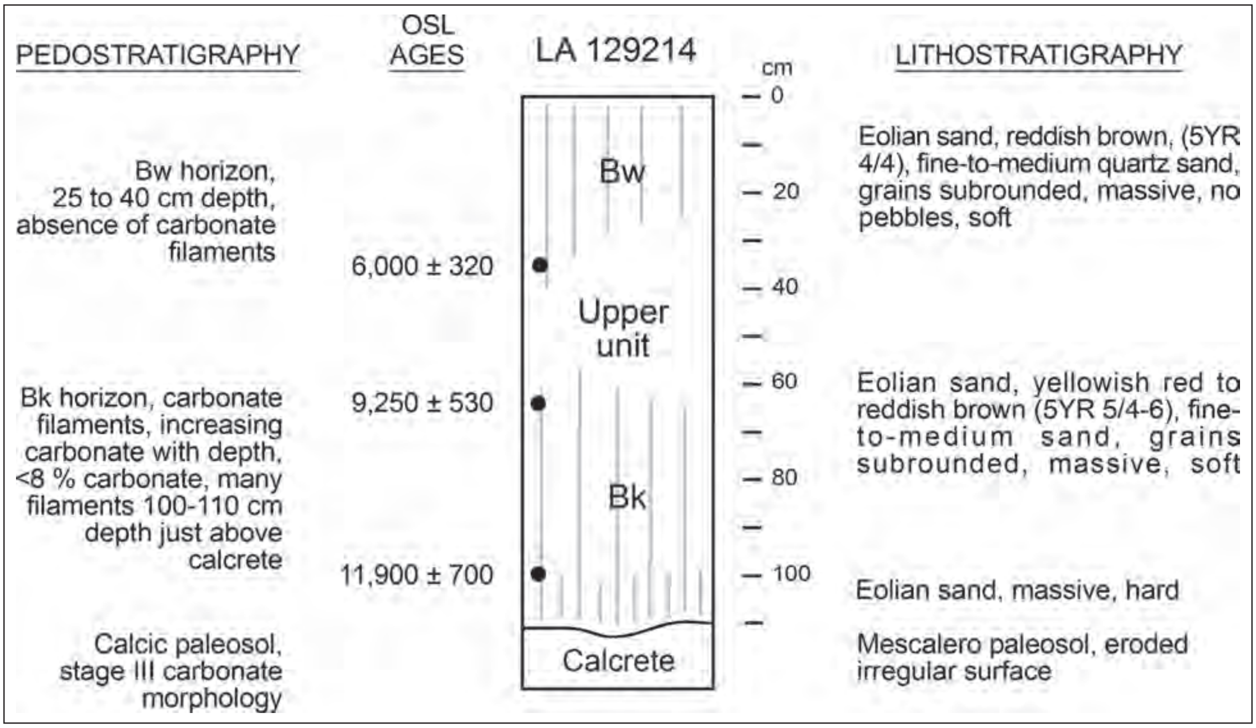


Figure 24.15. LA 129214, BHT 11, stratigraphy, soils, and chronology of Upper unit eolian sand.

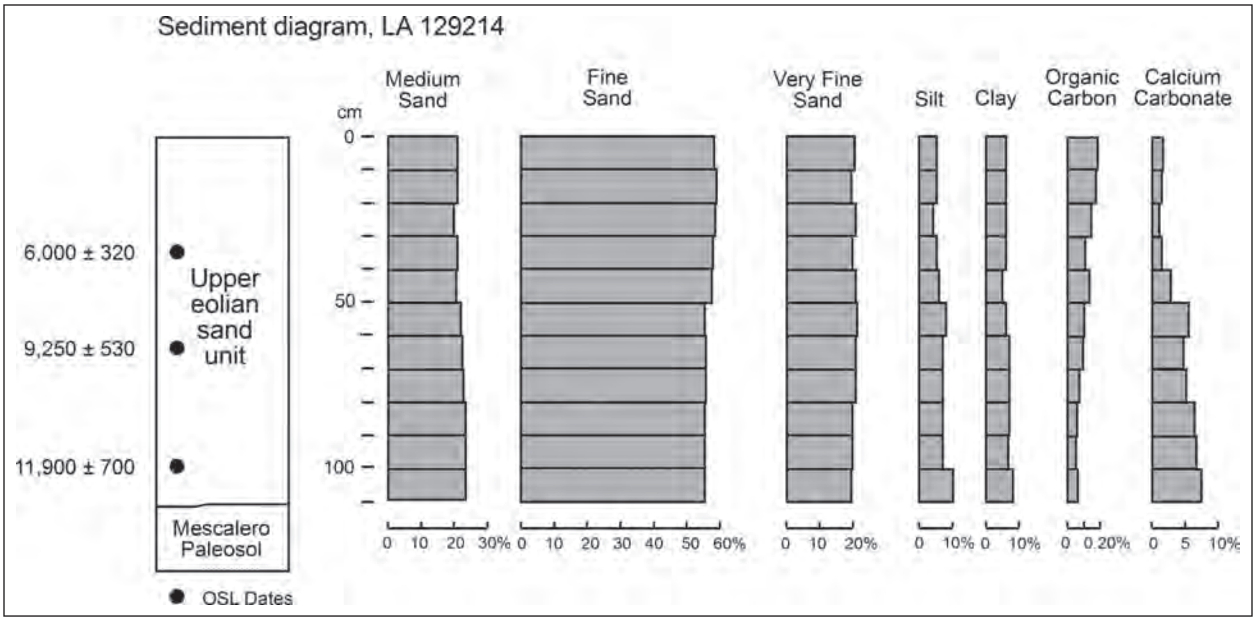


Figure 24.16. LA 129214, BHT 11, sediment data from Upper unit eolian sand. Increased carbonate content with depth indicates Bk horizon development.

unit sand that is nearly identical to that from LA 129216. The stratigraphically lowest sample at 100 cm depth and 10 cm above the contact with the underlying calcrete is 11,900 ± 700 years; the youngest OSL age is 6000 ± 320 years from 35 cm depth (Fig. 24.15).

The eolian sand from which series of three OSL samples were collected incorporates the local Bw/Bk soil horizons, indicating that the sediment column has not been disturbed by prehistoric cultural activity. A single OSL age was obtained from 66 cm below the top of the well-developed anthrosol in the core area of the site and is 10,700 ± 700 years. Linear regression of the three OSL ages versus their depth in the Upper unit sand at Trench 11, LA 129214, yields a rate of accumulation of 0.11 mm/year, similar to the value obtained at LA 129216 (Fig. 24.17). An isolated OSL date from the eolian sand beneath the anthrosol and just above the irregular surface of the weathered caliche at Trench 10 is 10,700 ± 700 years (Fig. 24.18).

Archaeological Geology of LA 129214

The age of LA 129214 ranges from 1900 ± 40 to 740 ± 40 ^{14}C years BP based on 94 AMS radiocarbon dates on charcoal from site features. In Trench 11, the eolian sand is OSL-dated c. 12,000 to 6000 years, although the age of the sand column at nearby LA 129216 is c. 13,000 to 5000. Accordingly, the surface of the eolian sand had been stable for at least 3000 years before the first occupation of this site began.

Anthrosol

The eolian sand in the core area of the site is characterized by many prehistoric cultural features, especially hearths. Charcoal from hearths is dispersed throughout upper levels of the sand, resulting in an anthrosol that thickens and thins laterally. In places, the upper surface of the anthrosol is covered by recent eolian sand, forming a sharp contact. Elsewhere, the anthrosol extends to the present-day surface where it appears as dark stains.

The anthrosol itself is a cultural soil, formed by the mixing of charcoal, artifacts, and cultural features with the preexisting older eolian sand. Before prehistoric occupation of LA 129214 at this locality, the surficial geology consisted of about 1 m of eolian sand with weak Bw and Bk soil horizons. During the occupation of LA 129214, the sand in the site area was continuously trampled, dug into, and otherwise disturbed, forming a mix of cultural debris and sand. The result is a cultural footprint at the site, and the dark colored anthrosol is a major component of that footprint (Fig. 24.18). Consequently, the anthrosol incorporates some characteristics of the sand that were present before the site was oc-

Table 24.4. Radiocarbon dates from geologic context.

FIELD NO.	LAB NO.	MATERIAL DATED	MEASURED RADIOCARBON AGE	D13c %	CORRECTED RADIOCARBON AGE*	2-SIGMA CALIBRATED AGE**
LA 129214						
A-Horizon soil on eolian sand, buried by alluvium in wash east of site:						
Geo-1	Beta-247593	Bulk sediment	1060 ± 40	-23.1	1090 ± 40	AD 880–1020
A-Horizon soil on eolian sand, buried by coppice dune sand, base of slope and in wash, south of old highway:						
Geo-2	Beta-247594	Bulk sediment	1050 ± 40	-19.9	1130 ± 40	AD 780–1000
LA 113042						
A-Horizon soil on colluvium, buried by 10 cm eolian sand, Trench 1A:						
Geo-3	Beta-247595	Bulk sediment	520 ± 40	-19.9	600 ± 40	AD 1290–1420
Fine Alluvium§						
A-Horizon soil at top of alluvial section in wash east of site, 2–10 cm depth measured from top of soil:						
Geo-4	Beta-247596	Bulk sediment	490 ± 40	-19.4	580 ± 40	AD 1300–1430
Alluvium, 45–55 cm depth measured from top of soil:						
Geo-5	Beta-247597	Bulk sediment	1880 ± 40	-17.6	2000 ± 40	BC 90–AD 80
Alluvium, 90–100 cm depth measured from top of soil:						
Geo-6	Beta-247598	Bulk sediment	2850 ± 40	-18.1	2960 ± 40	BC 1310–1040

* AMS, Beta Analytic, Inc., Miami, Florida; Libby half-life
** INTCAL 04; Stuiver and Reimer, 1993; Reimer et al., 2004
§ Alluvial section, see Fig. 27

cupied as well as properties that are a result of cultural activity.

Because of the well-developed state of the anthrosol at LA 129214, a well-exposed locality in Trench 10 was chosen for detailed investigation (Fig. 24.18). The anthrosol is approximately 50 cm thick, although the upper 30 cm of the study column has a more pronounced development of the anthrosol. The Munsell color of the anthrosol is dark reddish brown (5YR 3/3-4) in the upper 30 cm and reddish brown (5YR 4-5/4) in the 30 to 45 cm interval. Below 45 cm depth, the sand is yellowish red (5YR 5/6), the lighter color due in part to the presence of carbonate coats on sand grains. The texture of the sand in the anthrosol is very fine-to-very fine quartz sand, identical to that in the underlying undisturbed eolian sand (Fig. 24.19). The sand grains in the anthrosol are sub-rounded to rounded and sub-angular although the grains below the anthrosol are sub-angular to angular. The sand grains have rare or no thin carbonate coats; below the anthrosol, the sand is whitened by the presence of carbonate coats. Throughout, the sand includes caliche grains and cemented masses of sand 1 to 3 mm in diameter, giving the anthrosol its carbonate content; the caliche grains are less than 1 percent of the volume. The upper 30 cm of the anthrosol has lower percentages of silt and clay, possibly due to wind deflation of the fine particles upon disturbance. The carbonate content of the upper 30 cm is also low compared to that in the lower eolian sand, perhaps related to disturbance as well. The most significant result of the laboratory analysis is the comparatively high percentages of organic carbon in the anthrosol, ranging from 0.27 to 0.45 percent in the upper 30 cm. This compares with the low percentages of organic carbon in the underlying eolian sand ranging from 0.10 to 0.12 percent (Figs. 24.19 and 24.20) (Table 24.5).

Total Phosphorous Analysis

The same sediment samples that were analyzed for texture and organic carbon from the anthrosol at Trench 10 were also analyzed for total phosphorous (Ptot) by the Milwaukee Soil Laboratory using a sulfuric-nitric acid digestion with an ascorbic acid method for colorimetry (M. Schabel, personal communication, 2009). Many forms of phosphorous have been investigated as an index to cultural

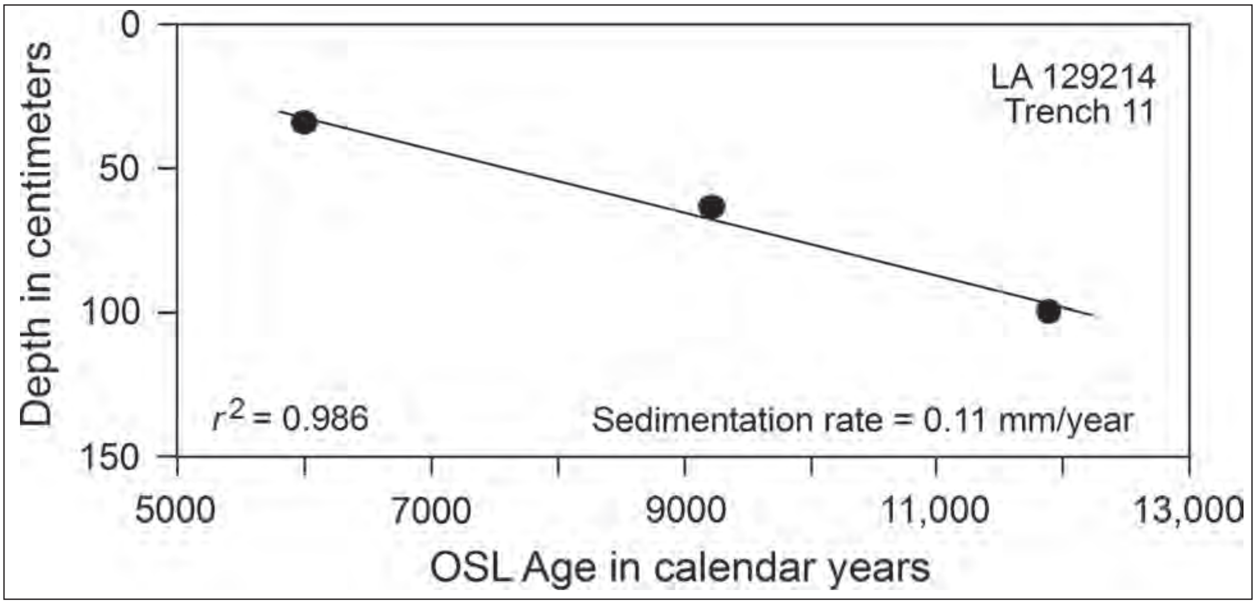


Figure 24.17. LA 129214, BHT 11, OSL age versus Depth, Upper unit eolian sand.

presence in sediments, and many techniques have been used to determine phosphorous. Overall, Ptot has been cited as a good indicator of cultural activity (Holliday 2004:313, 358–359).

The analytical values of Ptot range from 87.0 to 109.5 mg/kg in both the anthrosol and eolian sand beneath the anthrosol (Table 24.6; Fig. 24.20). The Ptot content of the anthrosol and underlying sand is identical.

The significance of this is not entirely certain. The OSL age of the underlying sand is 10,700 ± 700 years and the presence of whitened sand grains and low organic carbon content together suggest that the lower sand has not been disturbed by cultural activity. A possibility exists that the phosphate may have migrated down profile from the anthrosol into the underlying sand. Further Ptot analyses from different cultural and noncultural soils on the sand sheet are justified in order to document any relationship of the phosphate content to cultural activity.

LA 113042

The site is located on the crest of a low hill between the drainage basins of two small washes. The top of the hill is marked by calcrete of the Mescalero paleosol that has been exposed by recent sheet erosion. The calcrete is formed on red shale of the Rustler Formation (Permian). Small mesquite coppice dunes occur on the hillside east of the site. The vegetation at the site is dominated by creosote bush.

Geology and Soil Geomorphology

Eolian Cover Sand: The core area of LA 113042 is mantled by thin ephemeral patches of eolian sand of irregular thickness. Measured thickness in Trench 5 ranges from 6 to 45 cm and averages 27 cm (Fig. 24.21). The irregular thickness of the sand may be related to the irregular surface of the underlying eroded calcrete. The east side of the hill has a cover of colluvial-eolian sand that contains many caliche pebbles. Local gullies cut through the colluvial-eolian sand where present, exposing calcrete. Small mesquite coppice dunes are present on the hillside and in the wash east of the site. Where trenches expose long segments of the surficial geology, calcrete is present at the top of the hill and along the hillside where it is underlain by Permian red beds. Farther downslope, the weathered calcrete is reduced to a thin zone of caliche rubble on top of the red beds. The calcrete is missing from trench exposures at the base of the hill east of the site due to its erosion. Where the calcrete is missing, the colluvial-eolian sand directly overlies Permian red beds. An isolated OSL age of 5560 ± 370 years was obtained on a thin bed of *in situ* but eroded eolian sand overlain by colluvium in Trench 6. Based on its age, it evidently correlates with the Upper unit documented

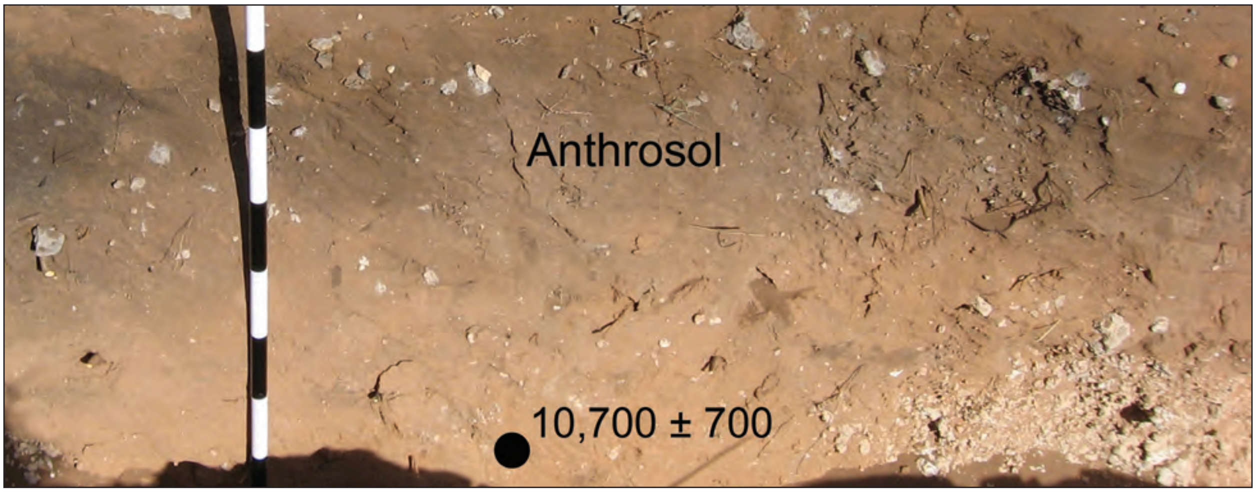


Figure 24.18. LA 129214, BHT 10, north wall, anthrosol, AMS radiocarbon dates on charcoal from features at the site range from 1900 to 740 14C years BP. The OSL date is from undisturbed eolian sand just above the weathered, broken calcrete on the Mescalero paleosol, lower right.

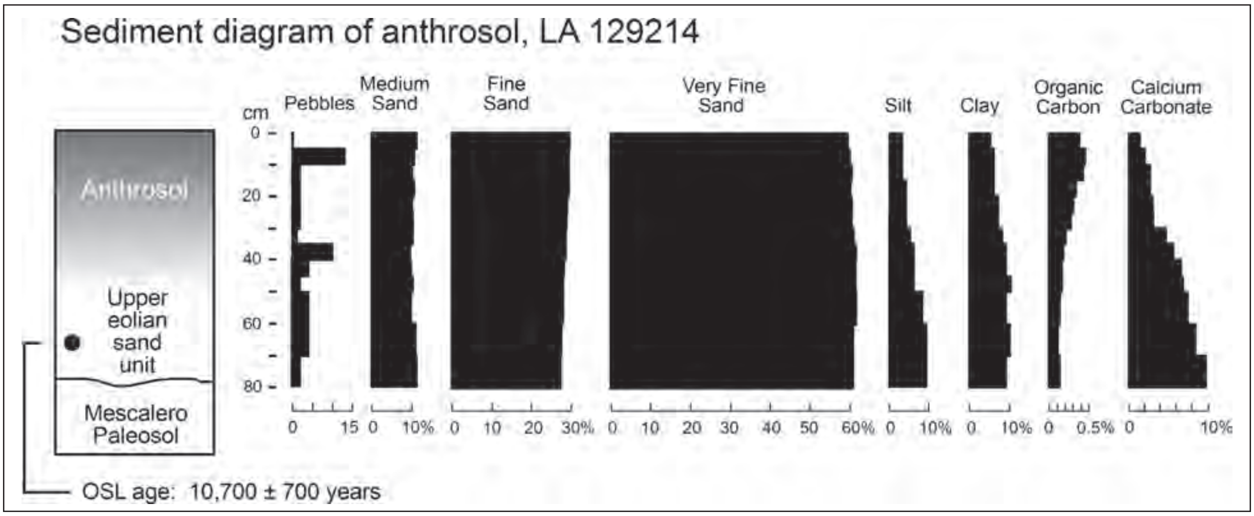


Figure 24.19. LA 129214, BHT 10, north wall, laboratory sediment data from anthrosol. Upper sediment intervals are 5 cm (1.97 inches), below 50 cm (19.67 inches) the intervals are 10 cm (3.94 inches); OSL date from undisturbed sediment beneath anthrosol.

at nearby LA 129216 and LA 129214. A soil with a Bw horizon is present in the thin eolian cover sand at LA 113042; a Bk horizon is absent (Fig. 24.22).

Colluvium: A deposit of colluvium was discovered in trench exposures at the base of the hillside at the edge of the unnamed wash east of LA 113042. Colluvium is defined as "a general term applied to any loose, heterogeneous, and incoherent mass of soil material and/or rock fragments deposited by rainwash, sheet wash, or slow continuous downslope creep, usually collecting at the base of gentle slopes or hillsides" (Neuendorf et al. 2005:128). The colluvium is about 40 cm thick in Trench 6 (Fig. 24.23) and 110 cm thick in Trench 1A (Fig. 24.24). The color of the colluvium is reddish brown (5YR 4/4) and its texture is very fine-to-very fine quartz sand, identical to that of the Upper unit eolian sand. The presence of many caliche pebbles distinguishes the colluvium from eolian sand (Table 24.7). In the case of the exposure in Trench 6, the colluvium has significantly less carbonate than the eolian sand (Fig. 24.25). The lower percentages of carbonate may be a result of abrasion of the eolian sand grains and loss of their carbonate coats upon colluvial reworking of the sand.

The colluvium stratigraphically overlies the

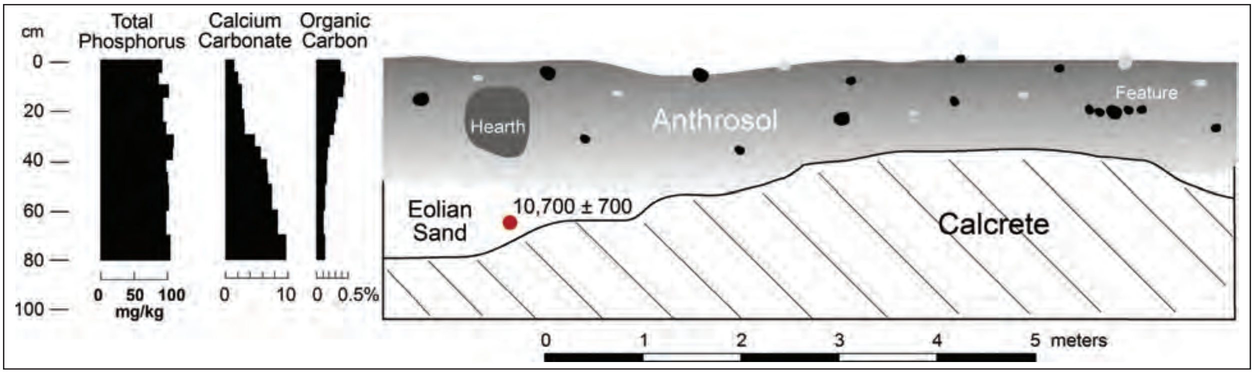


Figure 24.20. LA 129214, BHT 10, north wall, sketch of anthrosol along with OSL date and percentages of calcium carbonate, organic carbon, and total phosphorous. Sediment interval is 5 cm (1.97 inches) from 0 to 50 cm (0 to 19.67 inches) depth, and is 10 cm (3.94 inches) below 50 cm (19.67 inches).

dated eolian sand, thus its age is younger than 5000 years. A single OSL age of 2320 ± 200 years was obtained from the colluvium exposed in Trench 6. The colluvium is capped by an A horizon soil, and a radiocarbon age on bulk sediment from the soil is 600 ± 40 14C years BP (Fig. 24.24). Thus, the period of accumulation of the colluvium is roughly c. 5000 to 600 years ago.

A Horizon Soil: An A horizon soil occurs on colluvium and alluvium on the hillside and in the wash east of LA 113042. Field studies and trench exposures show that the A horizon at the top of hillside colluvium and at the top of the adjacent alluvial sequence in the wash is the same soil. The soil at the top of the alluvial sequence is dark reddish brown (5YR 3/4) and has 0.95 to 1.05 percent organic carbon. Laboratory analysis of the sediment reveals sandy and clayish silt. The sand fraction is very fine-to-very-fine quartz sand and the grains are sub-rounded. Bulk sediment from the A horizon soil on the hillside colluvium is radiocarbon-dated 600 ± 40 14C years BP. The radiocarbon age of the A horizon soil at the top of the alluvial sequence is 580 ± 40 14C years BP (Table 24.4). The two radiocarbon ages of the A horizon soil are statistically identical.

Late Holocene Fine-Textured Alluvium: Trenches through the recent gravelly sand in the channel of an unnamed wash east of LA 113042 exposed a buried 1 m thick deposit of fine-textured alluvium (Fig. 24.26). The alluvium is dark reddish brown (5YR 3/4) in the upper 70 cm and reddish brown (5YR 4/4) in the lower 30 cm of the exposure (Fig. 24.27). The sediment is characterized by fine-to-very fine quartz sand with high percentages of silt and clay, averaging approximately 40 percent of the sediment particles (Fig. 24.28; Table 24.8). The base of the silty alluvium was not exposed in the trench. It is not known how deep the fine-textured alluvial deposit may extend or what lies under it. The silty alluvium contrasts with recent channel sand that is coarser with a fine-to-very fine and medium quartz sand with a total of only 10 percent silt and clay (Fig. 24.29).

An A horizon soil occurs in the upper 20 cm of the fine alluvium and has 60 percent silt and clay as well as 0.95 to 1.05 percent organic carbon (Table 24.8). The higher percentages of silt and clay in the A horizon soil may be a consequence of atmospheric transport and accumulation of dust on the stable surface of the valley floor where the soil was forming. A similar situation with higher amounts of silt in Holocene soils as a result of atmospheric input has been observed elsewhere in the broad region (Hall and Periman 2007; Muhs and Benedict 2006).

Three radiocarbon dates on bulk sediment from the fine-textured alluvium and A horizon soil range from 2960 ± 40 at the base of the exposure to 580 ± 40 ^{14}C years BP at the top. The sedimentation rate is 0.37 mm/years (linear regression, $r^2 = 0.986$), similar to the slow sedimentation rate of cumulic A horizon soils in the southern Great Plains (Hall 1990).

The texture of the silty alluvium and its slow rate of accumulation suggest that the alluvium formed in an environment with more extensive ground cover than exists today. A drainage basin with dense vegetation will hold water and sediment, and the low volume of runoff from rainstorms will transport only fine sediment such as silt and clay. The vegetation present in the drainage

Table 24.5. LA 129214, Trench 10, sediment data from anthrosol column.

FIELD SAMPLE NO. (CM)	SAND (MM)					RECALCULATED					
	2.0–1.0	1.0–0.5	0.5–0.25	0.25–0.125	0.125–0.0625	SAND	SILT	CLAY	OC	CaCO3	DRY COLOR
	VERY COARSE	COARSE	MEDIUM	FINE	VERY FINE			<3.9 µm	(%)	(%)	
Anthrosol											
67 (0–5)	–	0.3	11.0	29.4	59.3	92	3	5	0.37	1.3	5YR 3/3
68 (5–10)	–	0.3	10.4	29.4	59.9	91	3	6	0.45	2.0	5YR 3/3
69 (10–15)	–	0.3	10.0	29.4	60.3	91	3	6	0.42	2.6	5YR 3/3
70 (15–20)	–	0.3	10.3	29.4	60.0	90	4	6	0.33	2.6	5YR 3/3
71 (20–25)	0.1	0.3	10.1	29.2	60.3	89	4	7	0.30	2.9	5YR 3/3
72 (25–30)	–	0.4	10.2	29.1	60.3	89	4	7	0.27	3.0	5YR 3/4
73 (30–35)	0.1	0.4	10.1	28.7	60.7	87	5	8	0.20	4.6	5YR 4/4
74 (35–40)	0.1	0.4	9.6	28.5	61.4	85	6	9	0.17	5.5	5YR 5/4
75 (40–45)	0.1	0.5	9.8	28.3	61.3	85	6	9	0.15	6.5	5YR 5/4
76 (45–50)	0.1	0.5	10.1	28.0	61.3	84	6	10	0.15	6.7	5YR 5/6
Upper Unit Eolian Sand											
77 (50–60)	0.1	0.5	9.8	28.0	61.6	83	8	9	0.12	7.2	5YR 5/6
78 (60–70)	0.2	0.7	10.7	27.6	60.8	81	9	10	0.10	8.2	5YR 5/6
79 (70–78)*	0.2	0.8	10.8	27.4	60.8	82	9	9	0.12	9.6	5YR 5/6

Note : Numbers are percentages; OC = % organic carbon determined by Walkley-Black method; % carbonate determined by Chittick method; numbers in parentheses are centimeters depth; Wentworth scale; dry color from Munsell® Soil Color Chart; analyses by Milwaukee Soil Laboratory, 6917 W. Oklahoma Ave.,Milwaukee, WI 53219.

* Eolian sand rests directly on eroded surface of calcrete (Mescalero paleosol).

basin at the time that the alluvium was deposited c. 3000 to 600 years ago may have been desert shrub grassland. The floor of the wash also may have been covered by grasses. The ^{de}lta ^{13}C values of the radiocarbon ages from the alluvium are -18.1 and -17.6 percent, indicating the dominance of C_4 grasses in the local vegetation, probably representing a desert grassland community (Nordt et al. 2008). Today, grasses are largely depleted from the landscape and the local vegetation is dominated by shrubs, especially with a high proportion of bare ground. In contrast, the delta ^{13}C values from the A horizon soils in this investigation indicate the dominance of C_3 plants such as woody shrubs; further studies in this arena are justified.

Cornfield? No!

One of the issues in southeastern New Mexico archaeology is prehistoric agriculture, whether or not economic plants such as maize (*Zea*) were grown locally or brought in from other areas. The fine, sandy, organic-rich sediment on the broad alluvial surface of the wash east of LA 113042 should provide a good substrate for growing maize and other cultigens. Pollen analysis of the 1 m thick alluvium—radiocarbon-dated c. 1200 BC to AD 1350 and spanning the prehistoric occupation of nearby LA 113042 and the other sites along NM 128— yielded no pollen grains of *Zea* or other known, culturally related plants (Fig. 24.30). Examining the possibility that economic pollen might be present in too-low numbers to be tabulated during pollen analysis, full scans of all of the pollen on all of the slides, involving approximately 450,000 pollen grains, produced no pollen of *Zea* or of any other agricultural species. While the search for potential agricultural fields was not exhaustive, the unnamed wash east of LA 113042 was a good candidate. In addition, if economic plants were being grown anywhere within the small watershed, their pollen grains may have been carried into the wash by runoff. However, the exhaustive investigation failed to recover pollen grains from any known economic plant.

Late Holocene Paleoenvironments

Pollen Analysis and Past Vegetation: The late Holocene alluvium from the unnamed wash east of LA 113042 was analyzed for pollen. Ten alluvial

Figure 24.21. Eroded creosote bush shrubland at LA 113042. Weathered calcrete of local Mescalero paleosol is exposed at the surface. Arrow on the right points to an exposed taproot of creosote bush.

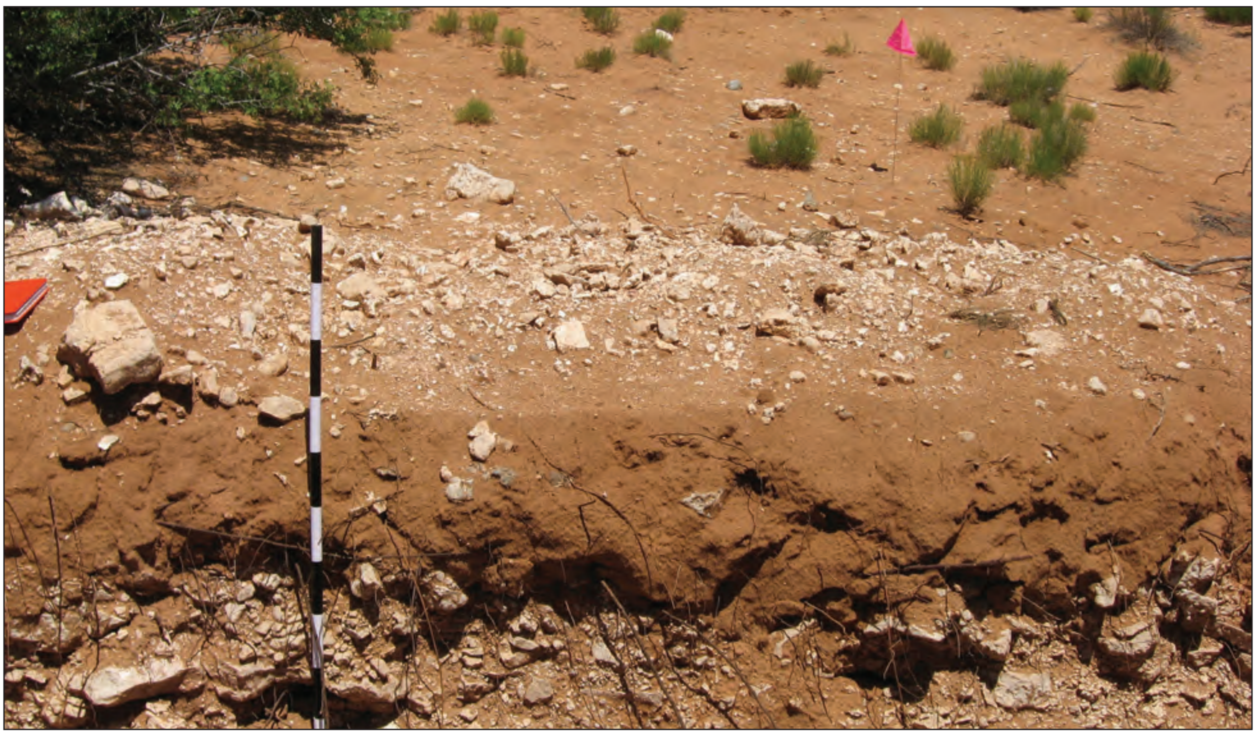


Figure 24.22. LA 113042, BHT 5. Thin deposit of eolian sand with Bw soil horizon overlying weathered caliche of Mescalero paleosol. The caliche on the surface is spoils from backhoe trenching.

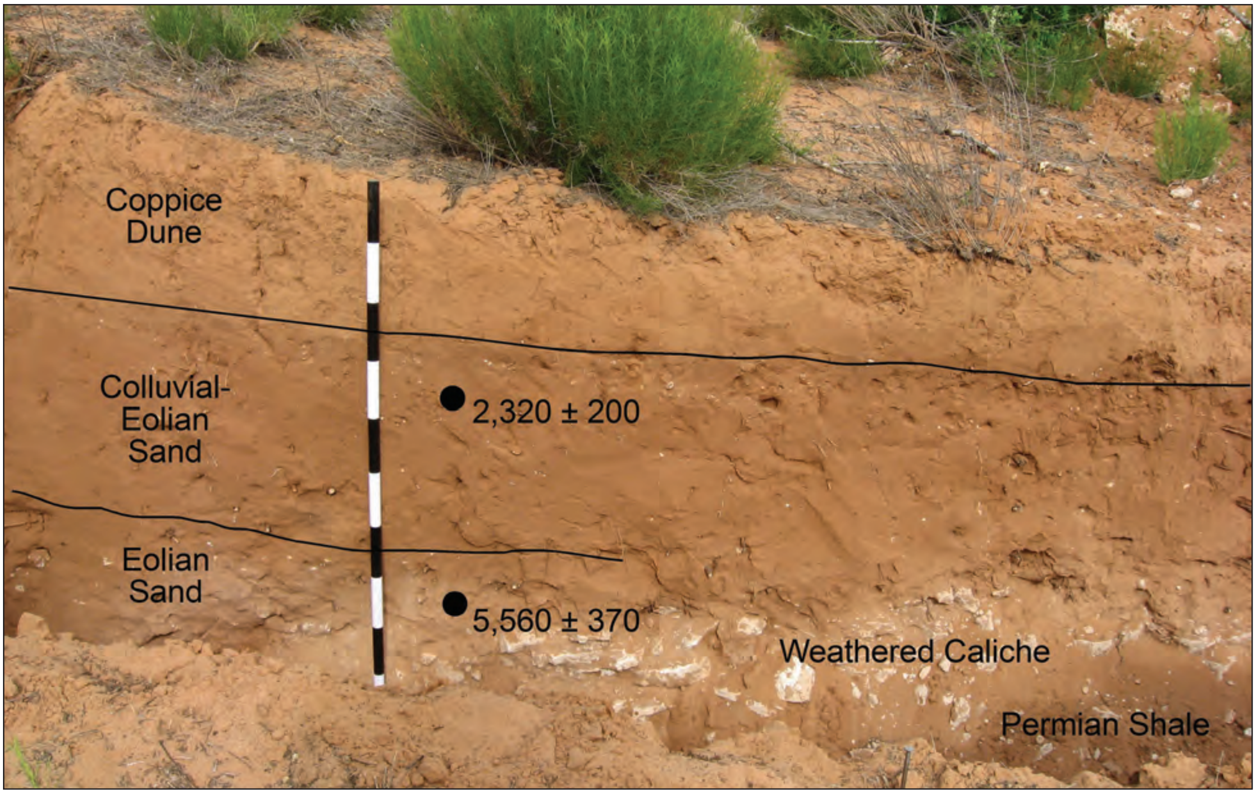


Figure 24.23. LA 113042, BHT 6, south end and east wall, colluvial-eolian sand. Two OSL ages are shown. The age of the eolian sand indicates that it correlates with the Upper unit. The site area is strongly eroded, and sand has accumulated as colluvium at the east end, where the topography descends into a local unnamed wash.

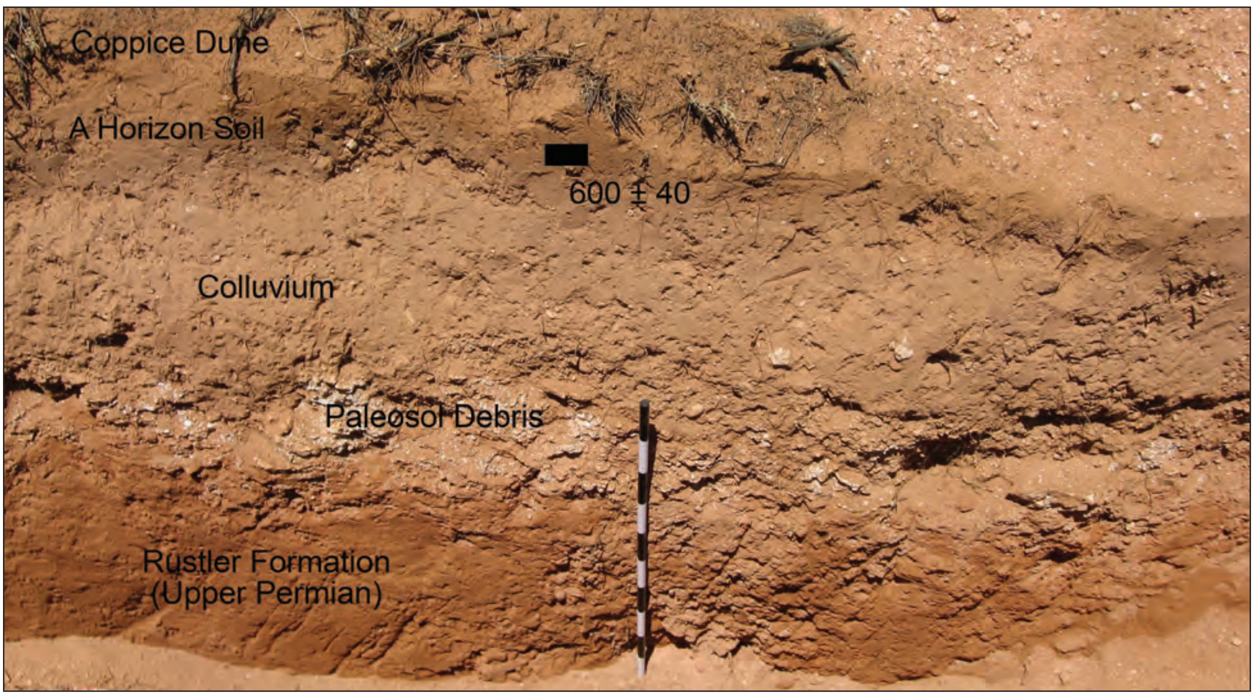


Figure 24.24. LA 113042, east end of BHT 1A, north wall, colluvium with radiocarbon dated A horizon soil overlying eroded debris of the Mescalero paleosol with red shale of the Rustler Formation (Upper Permian) at the base of the exposure. The colluvium and A horizon soil are covered locally by coppice dune sand.

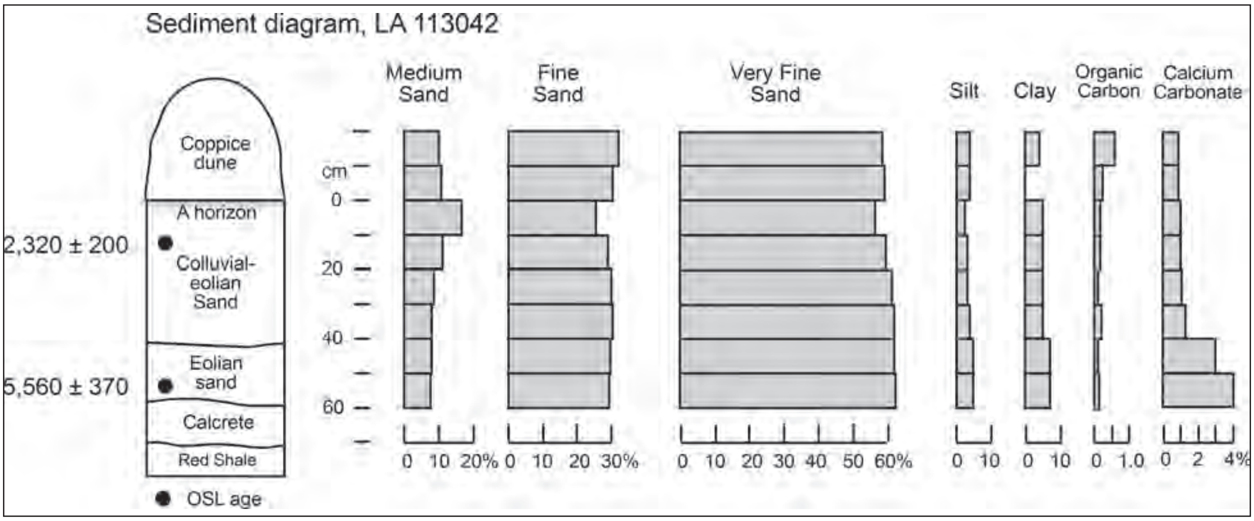


Figure 24.25. LA 113042, BHT 6, sediment data from eolian sand, overlying colluvial-eolian sand, and mesquite coppice dune sand. The texture of the eolian sand, colluvial sand, and dune sand is similar, indicating that the colluvium and coppice dune sand may be derived from older eolian sand.

and three modern surface samples were collected by the writer and processed by Dr. Vaughn M. Bryant, Jr., at the Palynology Laboratory, Texas A & M University at College Station, Texas. A spike of Lycopodium spores (batch no. 307862, 13,500 ± 310 spores per tablet) was added to each sample prior to processing. The pollen residues were stained in safranin O, mounted on slides, and counted by the writer at Red Rock Geological Enterprises, Santa Fe, New Mexico (pollen and charcoal data in Table 24.9).

The pollen record spans 1 m of fine-textured alluvium. Three radiocarbon dates from the alluvium provide a chronology for the pollen sequence, from c. 3000 to 600 radiocarbon years BP. The preservation of the pollen grains is moderate, with 10 to 20 percent unknown and indeterminable; the indeterminable category reflects the number of grains too poorly preserved to identify. Pollen concentration ranges from 6000 to 139,000 grains per gram of sediment processed. The highest concentration occurs in the upper 30 cm where the A horizon soil is present; the high concentrations in the soil are probably a result of slow sedimentation rate.

The pollen percentages from the three surface samples show the present-day dominance of local desert shrub vegetation (Fig. 24.30). Samples A and B are from the hillslope with high percentages of *Ambrosia* and Chenopodiineae (Chenopodiaceae and Amaranthus) totaling 60 percent of the pollen assemblage (Table 24.9). Surface Sample C from the wash is dominated by Chenopodiineae and *Ambrosia*. The surface pollen and the alluvium pollen percentages differ significantly, and it is not clear what this means in terms of specific differences between present-day and prehistoric vegetation. Overall, the dominant taxa then and now are probably very much the same. Percentages of grasses

Table 24.6. LA 129214, Trench 10, total P from anthrosol column.

FIELD SAMPLE NO. (CM)	TOTAL P (MG/KG)
Anthrosol	
67 (0–5)	**90.7**
68 (5–10)	**87.0**
69 (10–15)	**102.7**
70 (15–20)	**92.2**
71 (20–25)	**90.8**
72 (25–30)	**98.4**
73 (30–35)	**109.5**
74 (35–40)	**108.0**
75 (40–45)	**97.9**
76 (45–50)	**99.8**
Upper Unit Eolian Sand	
77 (50–60)	**102.6**
78 (60–70)	**98.4**
79 (70–78)*	**103.2**

*Eolian sand rests directly on eroded surface of calcrete (Mescalero paleosol).
Note: Analysis by Milwaukee Soil Laboratory, 6917 W. Oklahoma Ave., Milwaukee, WI 53219.

Figure 24.26. Unnamed wash east of LA 133042. Gravely sand in the channel overlies late Holocene fine-textured alluvium.

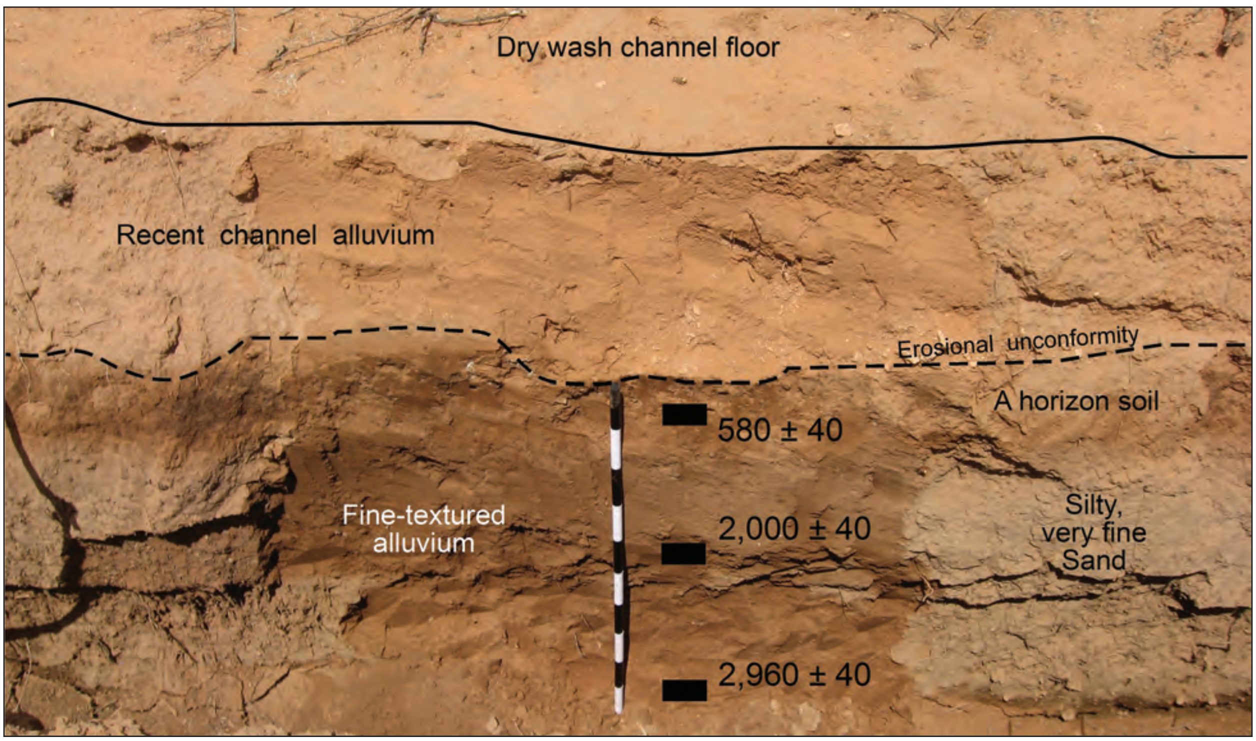


Figure 24.27. Unnamed wash east of LA 113042, late Holocene fine-textured alluvium. Silty alluvium accumulated slowly on the broad, flat valley floor and is topped by an A horizon soil. The top of the soil has been eroded by recent channel scouring; the silty alluvium and A horizon soil are buried by recent channel sand and gravel.

Table 24.7. LA 113042, Trench 6, sediment data.

	SAND (MM)					RECALCULATED					
FIELD SAMPLE NO. (CM)	2.0–1.0 VERY COARSE	1.0–0.5 COARSE	0.5–0.25 MEDIUM	0.25–0.125 FINE	0.125–0.0625 VERY FINE	SAND	SILT	CLAY <3.9 µm	OC (%)	CaCO3 (%)	DRY COLOR
Twentieth-century Coppice Dune Sand											
80 (+10–20)	–	0.1	10.0	31.4	58.5	92.0	4.0	4.0	0.6	0.9	5YR 4/6
81 (+0–10)	1.0	0.2	10.5	30.0	59.3	96.0	4.0	0.0	0.2	0.9	5YR 4/6
Colluvial-eolian Sand											
82 (0–10)	0.1	0.7	16.8	25.9	56.5	93.0	2.0	5.0	0.1	1.0	5YR 4/4
83 (10–20)	–	0.3	11.0	28.8	59.9	92.0	3.0	5.0	0.1	1.0	5YR 4/4
84 (20–30)	–	0.2	8.5	29.9	61.4	92.0	3.0	5.0	0.1	1.1	5YR 4/4
85 (30–40)	–	0.1	8.0	30.1	61.8	91.0	4.0	5.0	0.2	1.3	5YR 4/6
Upper Unit Eolian Sand											
86 (40–50)	0.1	0.2	8.0	29.9	61.8	88.0	5.0	7.0	0.1	3.0	5YR 4/6
87 (50–60)*	0.1	0.2	7.6	29.7	62.4	88.0	5.0	7.0	0.1	4.1	5YR 4/6

Note : Numbers are percentages; OC = % organic carbon determined by Walkley-Black method; % carbonate determined by Chittick method; numbers in parentheses are centimeters depth; Wentworth scale; dry color from Munsell® Soil Color Chart; analyses by Milwaukee Soil Laboratory, 6917 W. Oklahoma Ave., Milwaukee, WI 53219.
*Sample overlying fractured calcrete of Mescalero paleosol.

(*Poaceae*) do not significantly change; Aster and *Artemisia* percentages are similar.

Tree and some shrub taxa show important differences in comparison of prehistoric and modern surface pollen. Pine (*Pinus*), juniper (*Juniperus*), oak (*Quercus*), mesquite (*Prosopis*), and creosote bush (*Larrea*) all exhibit higher percentages in modern samples than are present in the prehistoric fine alluvium. These differences are likely real and not an artifact of poor preservation of pollen grains. This means that between c. 600 years ago, the youngest age of the fine alluvial pollen record, and today, all of the above taxa (pine, juniper, oak, mesquite, creosote bush) have increased in abundance. The increases in pine and juniper have occurred at a distance from the NM 128 study area since these taxa are not present in the immediate area today; their pollen grains have been carried by long-distance transport. The increase in *Quercus* pollen may reflect a historic expansion of shinnery oak (*Q. havardii*) in the area of the Los Medanos dune field at the east end of the study area. Higher percentages of *Quercus* pollen were also observed in surface samples at the Garnsey bison kill site (Hall 1984). A study of nineteenth century land survey records shows that shinnery oak has increased its range in the area during the twentieth century, possibly due to fire suppression (York and Dick-Peddie 1969). Mesquite and creosote bush have also increased their abundance locally; from these data, however, except for the historical records of shinnery oak, it is not possible to infer when, during the past 600 years, the change in abundance took place.

The vegetation represented by the alluvial pollen record is desert shrub grassland dominated by chenopods, *Ambrosia*, and grasses, probably not much different from present-day northern Chihuahuan Desert plant communities. Pollen grains from wet-ground plants that would indicate a nearby source of water, such as a spring, a wet meadow, a high water table, ponded water, or cienega, are absent from the record. The increase in unknown-indeterminable grains (representing poor preservation) and the dramatic decrease in pollen concentration with greater depth indicate a significant increase in the deterioration and loss of pollen grains. The deterioration and loss of pollen with greater depth may account for the absence of some pollen taxa in the sediment column.

Charcoal Concentrations: Charcoal particles less than 25 µm in length were counted separately after pollen analysis. Charcoal concentrations per gram of sediment processed, compared with pollen concentration values, can be seen in Figure 24.31 (Table 24.9). The concentration of charcoal and pollen grains in the fine-textured alluvium shows

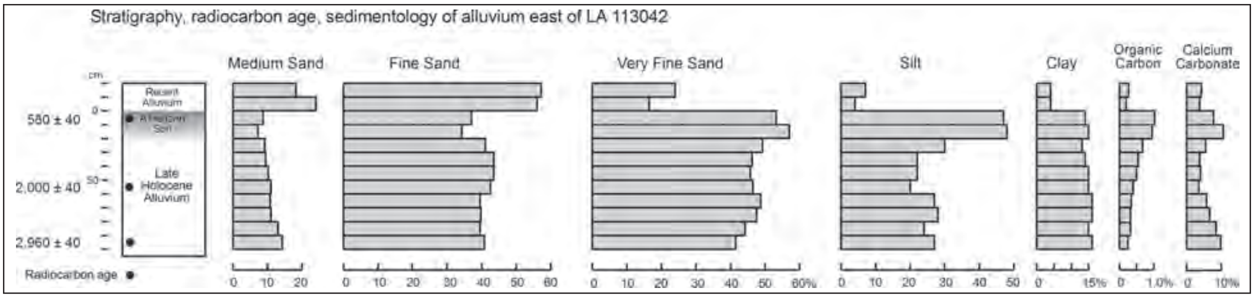


Figure 24.28. Sedimentology of the alluvium that fills the small valley east of LA 113042. Note the comparatively high percentages of silt and organic carbon in the A horizon soil in the upper 20 cm (7.87 inches) of the alluvial deposits.

similar trends. Both charcoal and pollen grains are organic particles that exhibit the same sedimentology in the fluvial depositional environment. In alluvium, the amounts of charcoal and pollen should occur together in the same general levels of magnitude. Fluvial sorting results in larger amounts of organic particles in finer-textured deposits; higher concentrations of organic particles will also accumulate in deposits with low sedimentation rates.

The charcoal-to-pollen ratio, however, indicates the amount of charcoal relative to pollen grains. If the values are more than 100, more charcoal than pollen is present. If the values are less than 100, more pollen is present than charcoal. In this study, the ratios of charcoal to pollen concentration show a secondary trend beyond the depositional trend. The charcoal-to-pollen ratio shows a dramatic shift indicating an unusually large influx of charcoal into the wash between 60 and 50 cm deep.

The 45 to 55 cm interval of the alluvium is dated 2000 ± 40 ^{14}C years BP. The chronology of the alluvium indicates that the higher proportion of charcoal coincides with the beginning of prehistoric occupation of LA 113042 and other adjacent sites c. 1900 years BP. The amount of charcoal, although still substantial, becomes less upwards in the sequence, in comparison with the amount of pollen. The significance of the decrease in ratios, whether cultural or natural, is not established at this time. Another factor that affects the charcoal-to-pollen ratio is the gradual deterioration and loss of pollen through natural weathering processes, as documented in this study. During deterioration processes, charcoal is less affected than pollen grains, thus the higher proportions of charcoal may simply represent greater losses of pollen.

As a footnote to the above, all sediments have a charcoal component that is a consequence of natural fires across the landscape. The charred particles are recovered by routine palynologic laboratory procedures, the same procedures used to recover pollen grains. Fire histories of forests and woodlands in the Southwest have been established by tree-ring analysis of fire scars. For example, analysis of more than 3000 fire scars from trees in the Jemez Mountains has shown fire frequencies ranging from 5 to 15 years during the period AD 1500 to 1900 (Allen et al. 1996). Fire frequencies of desert grasslands are more difficult to determine, although it has been noted that a fire frequency of 4 to 9 years is sufficient to perpetuate desert grassland plant communities, keeping invading shrubs in check (Gebow and Halvorson 2005).

Land Snail Fauna and Paleoecology: The fine-textured alluvium in the unnamed wash contains four species of land snails, all indicative of desert grassland in southeastern New Mexico: P*upoides albilabris*, *Gastrocopta pellucida*, *Hawaiia minuscula,* and Succineidae (Table 24.10) (Metcalf and Smartt 1997). Aquatic species that could indicate permanent or semi-permanent water are absent. The four land snail species are among the common snails found today in dry habitats in southern New Mexico and the northern Chihuahuan Desert. However, their presence indicates that the small drainage basin may have provided a denser desert grassland environment with fewer, less-open xeric shrub habitats similar to those that dominate the creosote bush-mesquite shrub vegetation in the area today. Living snails were not observed at the locality recently.

Archaeological Geology of LA 113042

The surficial geology at LA 113042 is characterized by erosion (Fig. 24.32). The eolian sand is thin, and weathered fragments of the underlying calcrete are

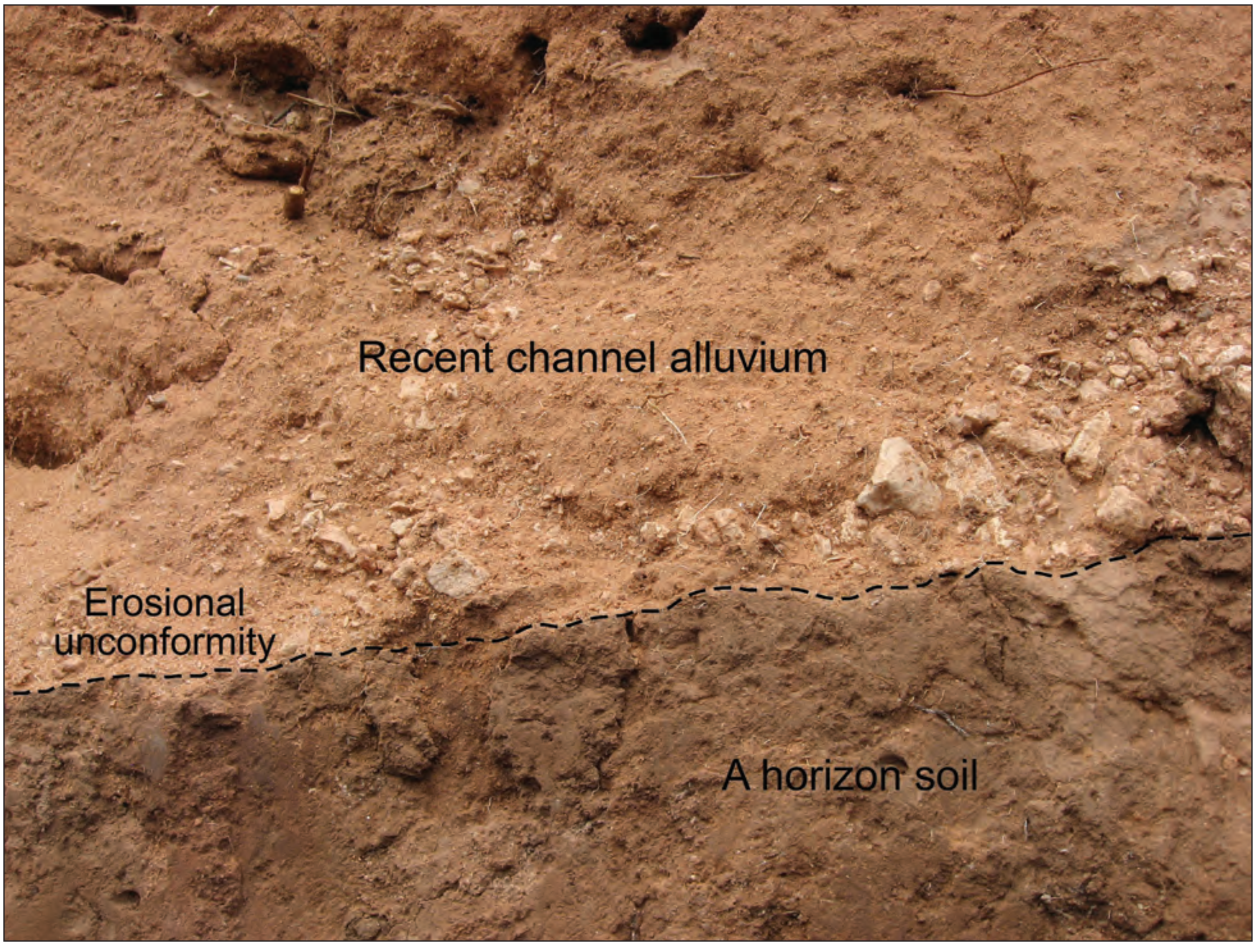


Figure 24.29. Close-up of scouring surface separating the A horizon soil and recent channel alluvium. The change from fine alluvial depositional environment to channel sand and gravel environment of deposition is a major shift in local fluvial response to climate and vegetation change. The A horizon soil here is radiocarbon dated 580 ± 40 ^{14}C years BP.

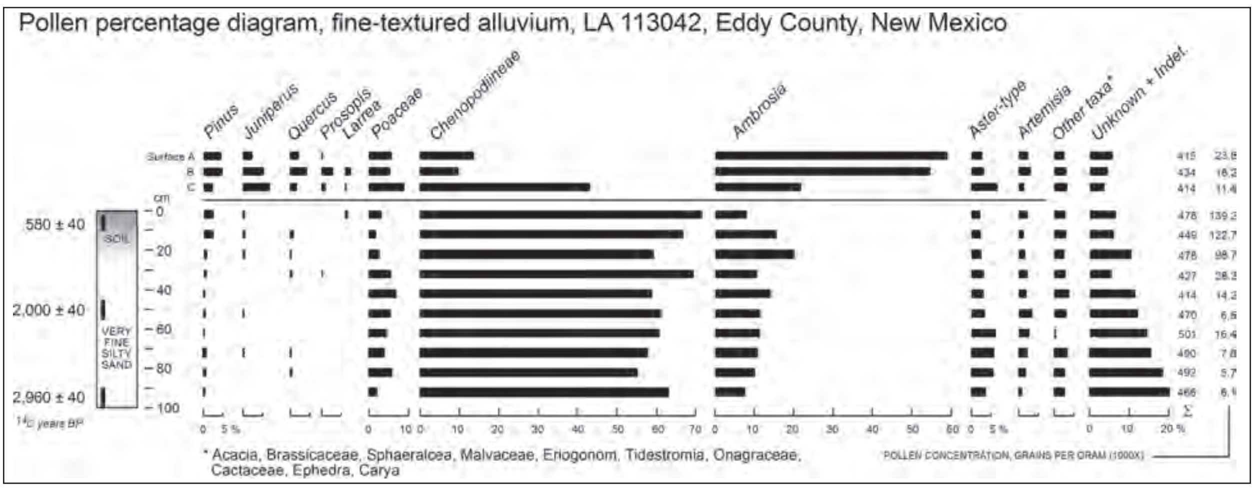


Figure 24.30. Pollen percentage diagram, silty alluvium, east of LA 113042. Surface sample A is from the upper hillslope, B is from the lower hillslope, and C is from the present-day sandy surface of the wash. Pollen analysis by Stephen A. Hall.

Table 24.8. *Sediment data from late Holocene alluvial fill from small unnamed wash east of LA 113042.*

	SAND (MM)					RECALCULATED					
FIELD SAMPLE NO. (CM)	2.0–1.0 VERY COARSE	1.0–0.5 COARSE	0.5–0.25 MEDIUM	0.25–0.125 FINE	0.125–0.0625 VERY FINE	SAND	SILT	CLAY <39 µm	OC (%)	CaCO3 (%)	DRY COLOR
Alluvium Overlying A-Horizon Soil											
1 (+10–20)	0.4	1.2	17.2	57.2	24.0	89.0	7.0	4.0	0.3	4.2	5YR 4/6
2 (+0–10)	0.9	2.2	24.0	56.7	16.2	92.0	4.0	4.0	0.2	3.9	5YR 4/6
A-Horizon Soil and Underlying Fine Alluvium											
3 (0–10)	0.2	0.4	8.7	37.2	53.5	39.0	47.0	14.0	1.1	7.9	5YR 3/4
4 (10–20)	–	0.3	7.4	34.1	58.2	37.0	48.0	15.0	1.0	10.7	5YR 3/4
5 (20–30)	–	0.3	9.2	41.0	49.5	57.0	30.0	13.0	0.7	5.6	5YR 3/4
6 (30–40)	–	0.3	9.7	43.8	46.2	64.0	22.0	14.0	0.5	3.8	5YR 3/4
7 (40–50)	–	0.3	10.1	43.8	45.8	63.0	22.0	15.0	0.5	4.0	5YR 3/3
8 (50–60)	–	0.4	11.0	42.3	46.3	65.0	20.0	15.0	0.4	3.4	5YR 3/4
9 (60–70)	0.2	0.7	10.6	39.7	48.8	57.0	27.0	16.0	0.4	5.8	5YR 3/4
10 (70–80)	0.2	0.8	11.3	39.9	47.8	56.0	28.0	16.0	0.3	6.7	5YR 4/4
11 (80–90)	1.3	1.4	13.3	39.8	44.2	61.0	24.0	15.0	0.3	8.5	5YR 4/4
12 (90–100)	2.0	1.6	14.1	40.8	41.5	57.0	27.0	16.0	0.3	9.9	5YR 4/4

Note : Numbers are percentages; OC = % organic carbon determined by Walkley-Black method; % carbonate determined by Chittick method; numbers in parentheses are centimeters depth; Wentworth scale; dry color from Munsell® Soil Color Chart; analyses by Milwaukee Soil Laboratory, 6917 W. Oklahoma Ave., Milwaukee, WI 53219.

commonly exposed by sheet erosion and gullying. The eroded condition of the surface may account for the presence of colluvial deposits at the base of the slope east of the site.

Prehistoric features at the site may also be eroded. An anthrosol was not observed at LA 113042. The A horizon soil that is preserved at the base of the hillside east of the site does not occur on the site itself. Field evidence suggests that if an A horizon soil or anthrosol were present at one time, they are now removed entirely by recent erosion.

LA 129300

The site occurs on the crest of a low hill with playa basins to the north and west. The surficial geology consists of a thin layer of eolian sand overlying the Mescalero paleosol calcrete. The calcrete is formed on the eroded surface of coarse crystalline gypsum of the Rustler Formation (Upper Permian).

The eroded surface at the top of the low hill at the site has a lag gravel of rounded quartz and quartzite pebbles and occasional fragments of dark red siltstone, all less than 4 cm diameter. The calcrete is weathered into small fragments generally less than 15 mm diameter, although some weathered slabs 60 cm across occur at the surface. A thin cover of eolian sand, generally less than 40 cm thick, occurs on the weathered calcrete on the east side of the site, and the sand is thicker on the eastward lee side of the low hill.

The sand has a weak soil consisting of Bw and Bk horizons (Fig. 24.33); the thin eolian sand is likely correlative to the Upper unit described at other sites in this investigation. The chronology of LA 129300 ranges from 1730 ± 40 to 1160 ± 40 14C years BP based on 12 AMS radiocarbon ages, similar to the age of other sites along NM 128 that occur at the surface of the Upper unit eolian sand. Two ages, however, are much older, 5710 ± 40 and 5390 ± 40, indicating Early Archaic occupation of the thin eolian sand.

Thick Section of Eolian Sand: A small area at the southeast edge of the site in Trench 3 has an exceptionally thick deposit of eolian sand extending more than 140 cm below the surface (Fig. 24.34).

The thick section of eolian sand may occur in a deep soil pipe or solution feature in the calcrete and underlying Permian gypsum; neither calcrete nor Permian gypsum was exposed in the trench. The thick sequence of eolian sand, although it was unrepresentative of the cover sand of the Mescalero

Table 24.9. Palynologic data from fine alluvium east of LA 113042.

	SURFACE			FINE ALLUVIUM (CM DEPTH)									
	A	B	C	0–5	10–15	2—25	30–35	40–45	50–55	60–65	70–75	80–85	90–95 (BASAL SAMPLE)
Pollen Count													
Pinus	18	20	9	11	10	3	2	1	2	1	4	3	1
Juniperus	9	22	28	2	3	3	0	0	1	2	1	0	0
Quercus	9	14	7	0	4	1	2	0	0	0	1	1	0
Prosopis	1	12	4	0	0	0	1	0	0	0	0	1	0
Larrea	0	6	1	3	0	0	0	0	0	0	0	0	0
Acacia	1	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	24	23	37	15	8	13	24	29	26	24	19	29	10
Chenopodiineae	56	42	178	342	300	283	296	244	287	290	283	271	292
Ambrosia	244	236	90	38	69	95	45	58	53	56	51	48	34
Aster (spine 2–4 µm)	6	8	25	6	8	10	13	10	12	24	19	16	12
Aster (spine >4 µm)	5	5	2	4	2	1	0	2	3	6	9	10	4
Artemisia	9	13	5	10	5	7	9	8	15	13	10	9	6
Brassicaceae	5	9	7	10	6	6	6	13	13	8	14	11	12
Sphaeralcea	2	0	0	1	0	0	1	0	0	1	0	0	0
Malvaceae	0	0	1	0	0	0	0	0	0	1	0	0	0
Eriogonum	0	1	1	3	2	0	2	0	0	1	1	0	0
Tidestromia	0	0	2	0	0	0	2	0	0	0	0	0	0
Onagraceae	0	0	0	0	0	1	0	0	0	0	0	0	0
Cactaceae	1	0	0	1	0	0	0	0	0	0	0	0	0
Ephedra	1	2	2	1	5	5	0	2	1	3	2	2	1
Carya	0	1	0	0	0	0	0	0	0	0	0	0	0
Unknown	9	16	4	12	9	1	10	12	9	8	6	3	5
Indeterminate	15	4	11	19	18	49	14	35	48	63	70	88	89
Pollen sum	415	434	414	478	449	478	427	414	470	501	490	492	466
Spike counts	81	80	175	13	13	18	64	101	274	104	214	269	252
Sediment processed (g)	11.6	16.1	11.2	21.4	22.8	21.8	19.1	23.3	21.4	23.8	23.7	26.1	24.7
Spike intro. (1000X)	54	54	54	81	81	81	81	81	81	81	81	81	81
Pollen conc./g (1000X)	23.8	18.2	11.4	139.2	122.7	98.7	28.3	14.2	6.49	16.4	7.8	5.7	6.1
Charcoal Data													
Charcoal >25 µm	198	250	257	165	213	572	208	137	431	93	309	228	245
Spike counts	32	76	58	4	4	16	15	12	63	69	165	191	155
Charcoal conc. (1000X)	28.8	11	21.4	156.1	189.4	132.8	58.8	39.7	25.9	4.6	6.4	3.7	5.2
Charcoal/pollen ratio	1.21	0.61	1.88	1.12	1.54	1.35	2.08	2.78	3.99	0.28	0.82	0.65	0.8

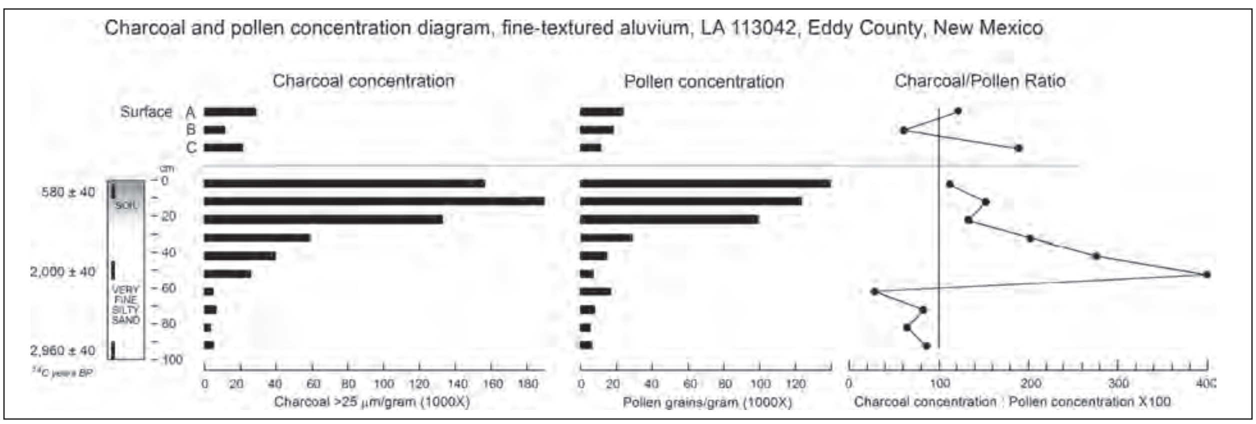


Figure 24.31. Charcoal and pollen concentrations and concentration ratios; the higher proportions of charcoal (ratios>100) coincide with the period of prehistoric occupation of nearby LA 113042.

Table 24.10. Land snails from late Holocene fine alluvium at unnamed wash east of LA 113042.

SPECIES	COUNT	COL. %	NOTES AND HABITAT
Pupoides albilabris	3	4.4%	It is common and widespread in southern and eastern New Mexico and is found at low elevations in the northern Chihuahuan Desert (1); also found in dry sagebrush grasslands (2); one of the more common pupillids in Texas (3).
Gastrocopta pellucida	35	51.5%	The synthesis of *G. pellucida* with *G. p. hordeacella* is followed (1). This is one of the more common land snails at low elevations in southern New Mexico and Texas in the northern Chihuahuan Desert (1, 3). It is found under large stones (1) and in dry, sandy places (4). Shells are common in late Holocene alluvium in the Pecos and Rio Grande drainages of southern New Mexico (1).
Hawaiia miniscula	21	30.9%	This is a common snail in New Mexico at low elevations on dry floodplains (1) and on bare ground (4). It is found widely across the continent in lowland and upland habitats (2).
Succineidae	9	13.2%	"The identification of succineids is notoriously difficult because the shells of many species are similar, even those of different genera (1, p. 47)." Accordingly, the shells in this study are not referred to genus or species.
Total	68	100.0%	The small faunal assemblage is consistent with a desert grassland environment.

Note*:* Shells collected and identified by S. A. Hall; the shell-bearing alluvium is radiocarbon dated ca. 3000 to 600 14C years BP.
Wash coordinates are 13595529E, 3578795N; elevation 2981 feet.
(1) Metcalf and Smartt 1997
(2) Leonard 1959
(3) Cheatum and Fullington 1973
(4) Hubricht 1985

sand sheet, was selected for OSL dating and sediment analysis.

The thick sequence is composed of dark reddish brown (2.5YR 3/4) to red (2.5YR 4/6-8) fine-to-very fine quartz sand. Most all of the sand grains are subangular and uniformly coated by iron oxide.

The sand sequence is generally homogeneous throughout with a subtle shift to a slightly increased coarseness from base to top with an increase in medium and a decrease in very fine sand (Fig. 24.35).

An increase in clay to 11 to 13 percent occurs between 30 to 80 cm depth indicating the presence of a very weak soil Bt horizon (Table 24.11).

A zone of visible whitening in outcrop and higher percentages of carbonate, 1.8 to 2.6 percent, occurs below 70 cm depth indicating the presence of a very weak soil Bk horizon.

In addition, a weak Bw horizon is present in the upper 30 cm of the sand. The formation of a very weak soil in the thick sand is similar to weak B horizon development in the Upper unit sand elsewhere in the area.

OSL Geochronology and Sedimentation Rate

Four OSL ages were obtained from the exceptionally thick eolian sand. The ages from the column range from 49,400 ± 3100 to 5680 ± 310 years. Linear regression of depth versus OSL age yields a sedimentation rate for the sand of 0.027 mm/year ($r2 = 0.992$).

The uniformity of the sand and silt texture throughout the column and the unchanging rate of sedimentation together indicate that the sand was deposited without interruption from at least 50,000 to 5000 years ago.

Elsewhere on the Mescalero Plain, the accumulation of the Mescalero sand sheet exhibits a hiatus between c. 50,000 to 18,000 years when eolian sand was not being deposited. The thick section of eolian sand at LA 129300 is anomalous with no known parallel on the sand sheet. The long-term, slow deposition of sand is at odds with shorter-term eolian sand accumulation on geomorphic surfaces on the sand sheet, such as the Upper unit. The long-term accumulation of sand in a local deep solution pit, however, may be expected. The sedimentation rate of the thick section of eolian sand

Figure 24.32. LA 113042, lag gravel of fresh and burned calcrete formed by sheet erosion of the thin eolian cover sand. Quartzose pebbles derived from weathered calcrete are also present.

Figure 24.33. LA 129300, Upper unit eolian sand, weak B horizon soil with Bw and Bk horizons. This is an unusually thick section of the eolian sand. Many rodent burrow fills (arrows) are visible due to the contrast in color of the dark fill from the Bw horizon against the whitish Bk horizon.

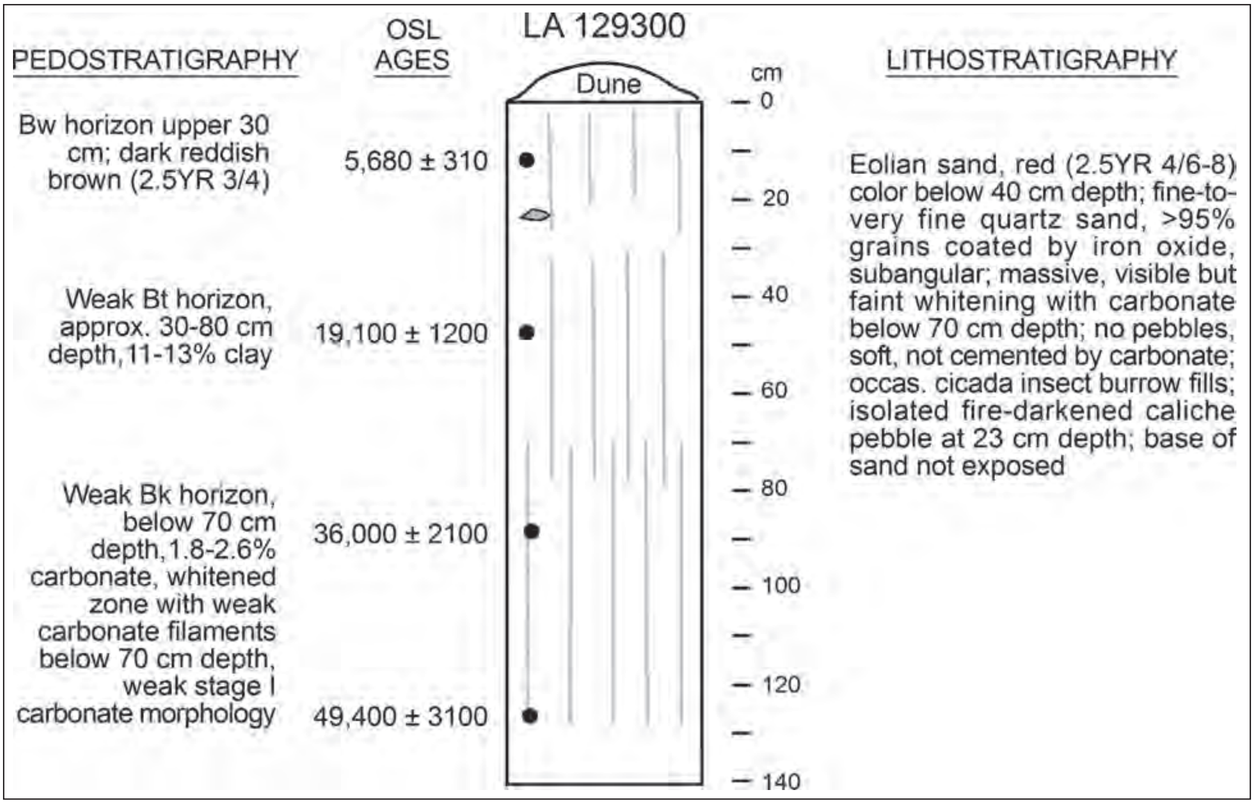


Figure 24.34. LA 129300, BHT 3, west wall, stratigraphy of a thick eolian sand deposit in a solution feature. The base of the sand deposit was not exposed. The OSL age of the section, extending from 50,000 to 5000 years, is unique for the Mescalero sand sheet.

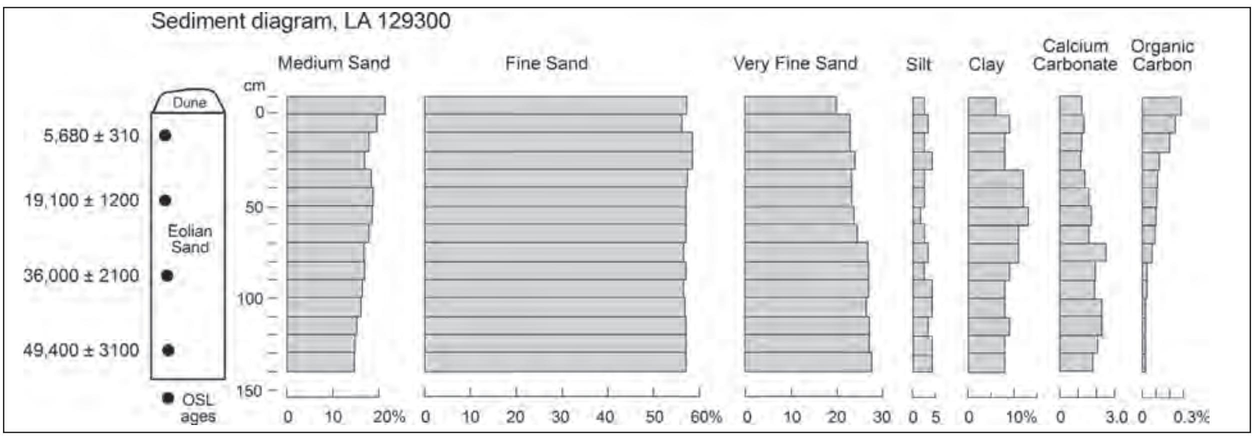


Figure 24.35. LA 129300, BHT 3, west wall, sediment data from thick eolian sand in a solution pit.

is significantly lower than accumulation rates of the Upper unit elsewhere in this investigation (Fig. 24.36).

OSL Age of Sediment Adjacent Paleoindian Point

An isolated late Paleoindian point was recovered from the southeast corner of Block 6 at about 18 cm below the present-day surface (Fig. 24.37).

To test the antiquity of the sediment at that location, an OSL age was obtained on sand from the east wall a few centimeters from the position of the point. The age of the sand is 3710 ± 300 years. The stratigraphy, soil geomorphology, and age of the sand are inconsistent with the age of the Paleoindian artifact. Thus, the projectile point was likely introduced to LA 129300 by the prehistoric inhabitants of this site.

Table 24.11 LA 129300, Trench 3, sediment data.

	SAND (MM)					RECALCULATED					
FIELD SAMPLE NO. (CM)	2.0–1.0 VERY COARSE	1.0–0.5 COARSE	0.5–0.25 MEDIUM	0.25–0.125 FINE	0.125–0.0625 VERY FINE	SAND	SILT	CLAY <3.9 µm	OC (%)	CaCO3 (%)	DRY COLOR
Twentieth-century Coppice Dune											
13 (+0–10)	0.3	0.9	21.4	57.5	19.9	91.0	3.0	6.0	0.3	1.2	5YR 4/6
Eolian Sand											
14 (0–10)	0.1	0.8	19.8	56.4	22.9	87.0	4.0	9.0	0.3	1.3	2.5YR 3/4
15 (10–20)	–	0.7	17.9	58.5	22.9	89.0	3.0	8.0	0.2	1.2	2.5YR 3/4
16 (20–30)	0.1	0.6	17.0	58.3	24.0	87.0	5.0	8.0	0.2	1.2	2.5YR 4/4
17 (30–40)	0.1	0.7	18.4	57.5	23.3	85.0	3.0	12.0	0.2	1.4	2.5YR 3/6
18 (40–50)	–	0.8	18.6	57.3	23.3	85.0	3.0	12.0	0.2	1.6	5YR 4/6
19 (50–60)	–	0.7	18.5	57.0	23.8	85.0	2.0	13.0	0.2	1.7	5YR 4/6
20 (60–70)	–	0.6	17.9	57.1	24.4	86.0	3.0	11.0	0.1	1.6	5YR 4/6
21 (70–80)	0.1	0.6	16.6	56.3	26.4	85.0	4.0	11.0	0.1	2.6	5YR 4/6
22 (80–90)	–	0.7	16.8	56.9	25.6	88.0	3.0	9.0	0.0	1.9	2.5YR 4/8
23 (90–100)	–	0.6	16.4	56.5	26.5	87.0	5.0	8.0	0.0	1.9	5YR 4/6
24 (100–110)	0.1	0.6	16.1	56.9	26.3	87.0	5.0	8.0	0.0	2.3	2.5YR 4/8
25 (110–120)	0.1	0.5	15.3	57.0	27.1	87.0	4.0	9.0	0.0	2.3	2.5YR 4/8
26 (120–130)	0.1	0.6	15.0	57.2	27.1	87.0	5.0	8.0	0.0	2.1	2.5YR 4/8
27 (130–140)	0.1	0.6	14.7	56.8	27.8	87.0	5.0	8.0	0.0	1.8	2.5YR 4/8

Note: Numbers are percentages; OC = % organic carbon determined by Walkley-Black method; % carbonate determined by Chittick method; numbers in parentheses are centimeters depth; Wentworth scale; dry color from Munsell® Soil Color Chart; analyses by Milwaukee Soil Laboratory, 6917 W. Oklahoma Ave., Milwaukee, WI 53219.

LA 129222

The site occurs on a low shelf of land that extends into the basin with modern playas north, west, and south of the site. The shelf on which the site occurs is formed by massive white gypsum bedrock (Fig. 24.38).

The 50 m thick gypsum, with a component of calcite, is the Tamarisk Member of the Rustler Formation (Upper Permian). It has been mapped by Vine (1963) and the extent of its outcrop is shown in Figure 24.2. The upper portion of the gypsum was exposed in several trenches. Narrow vertical fractures and karst cavities as wide as 25 cm were observed in the gypsum. The cavities are open and partly filled with gypsum fragments and gypsum crystals on the cavity walls. None of the fracture fills or cavities contained archaeological materials.

The surface of the topographic shelf at LA 129222 is dominated by a biological soil crust formed on the weathered gypsum (Fig. 24.39). The term biological soil crust is also known by the terms cryptobiotic, cryptogamic, and microbiotic soil crusts. Soil crusts are biological in origin and are formed by populations of cyanobacteria (formerly known as blue-green algae), green algae, and fungi (Rosentreter et al. 2007).

Small shallow depressions a few meters across are present on the surface of the gypsum, formed perhaps by local solution (Fig. 24.40). The depressions are filled with very fine sand, silt, and clay. Coppice dunes, although common in the region, are absent here. Local winds that transport sand by saltation are predominantly from the west and southwest. The gypsum shelf at LA 129222 is cut-off from sand transport by the presence of playa basins in the upwind directions. Thus, only dust (silt and clay) and very fine sand deflated from dry playa floors are present at LA 129222. A few low clumps of dust a few centimeters across have accumulated around the base of creosote bush, ephedra, grasses, and small shrubs. Dunes and other eolian landforms are absent.

The fill of a small depression exposed in Trench 1 is typical of the depressions on the present-day surface. The upper 40 cm of the depression sediment is Brown (7.5YR 5/4) and the lower part is light Brown (7.5YR 6/4) and pink at the base (7.5YR 7/4). The sediment is mostly silt and clay with very fine quartz sand. The sand grains are sub-rounded with

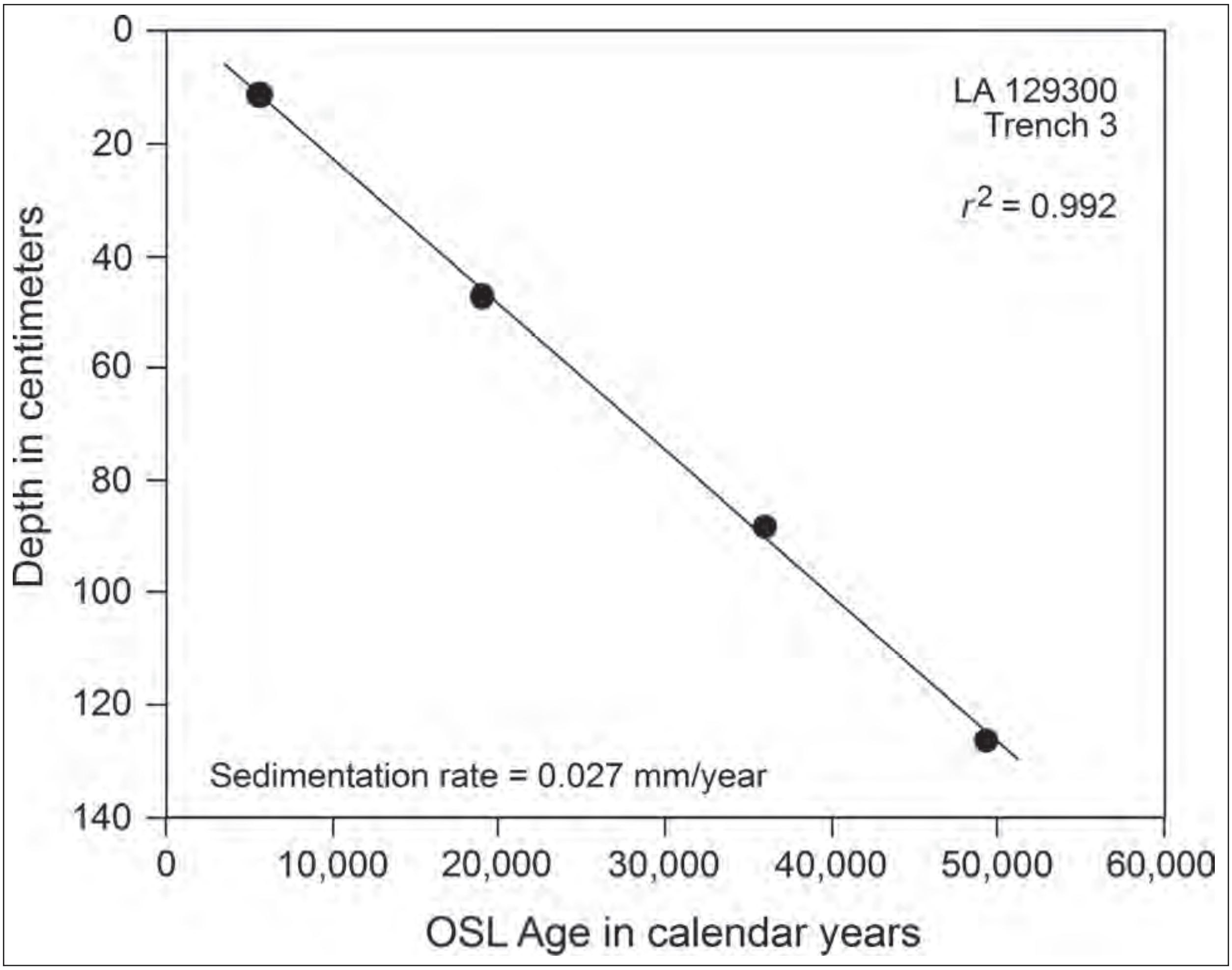


Figure 24.36. LA 129300, BHT 3, OSL age versus depth in centimeters from the thick section of eolian sand.

weak carbonate-cemented masses of sand; grain coats at the base of the sequence may be gypsum.

Laboratory analysis of the depression fill sediment shows a decrease in percentages of silt and clay towards the top of the sequence (Fig. 24.41) (Table 24.12). This may be related in part to changing water content of the nearby playas upwind from the site. The playa floors are a local source of eolian silt and clay; with longer periods of inundation in the playas, the dust source would be diminished. The age of the depression fill is not known, although in situ archaeology is associated with the fill deposit.

Archaeological Geology of LA 129222

A sediment cover that could contain archaeology on the gypsum shelf is largely absent. Consequently, artifacts and cultural materials occur on or in the biological soil crust at the surface of the gypsum. The small shallow depression fills also contain archaeology.

An archaeological feature that was exposed by excavation is very shallow, and the top of it has the appearance of being removed by erosion. A thin, dark zone occurs in the shallow sediments exposed in an excavation block. The thin dark layer is a soil crust that formed on a former surface that is now buried. The local archaeology seems to be associated with the buried soil crust.

LA 129217

The site occurs at the western edge of Los Medanos, an area of comparatively large parabolic dunes on the Mescalero sand sheet. Prehistoric artifacts and features occur on the deflated surface of blowouts associated with the dunes.

Figure 24.37. LA 129300, an OSL age from Block 6, east wall. Sample collected from 18 cm (7.09 inches) depth measured from the modern surface or 42 cm (16.54 inches) below datum. Sample placement was selected to coincide with the position of a Paleoindian point that was recovered a few centimeters west of the east wall.

Figure 24.38. View across LA 129222 with playas in the distance. Trench spoils are from the massive white Permian gypsum that immediately underlies the surface, except for a few centimeters of eolian dust and shallow depressions.

Table 24.12. LA 129222, Trench 1, sediment data from depression fill.

	SAND (MM)					RECALCULATED					
FIELD SAMPLE NO. (CM)	2.0–1.0 VERY COARSE	1.0–0.5 COARSE	0.5–0.25 MEDIUM	0.25–0.125 FINE	0.125–0.0625 VERY FINE	SAND	SILT	CLAY <3.9 μm	OC (%)	CaCO3 (%)	DRY COLOR
Depression Fill											
88 (0-10)	0.0	0.2	4.9	25.0	69.9	67.0	25.0	8.0	0.8	5.7	7.5YR 5/4
89 (10-20)	0.1	0.3	6.2	24.8	68.6	53.0	34.0	13.0	0.7	15.7	7.5YR 5/4
90 (20-30)	0.0	0.3	6.1	24.3	69.3	49.0	36.0	15.0	0.7	18.3	7.5YR 5/4
91 (30-40)	0.1	0.3	5.8	23.6	70.2	40.0	40.0	20.0	0.6	23.1	7.5YR 5/4
92 (40-50)	0.0	0.4	6.5	24.3	68.8	41.0	38.0	21.0	0.5	20.1	7.5YR 6/4
93 (50-60)	0.1	0.4	6.0	22.4	71.1	35.0	35.0	30.0	0.5	20.4	7.5YR 6/4
94 (60-66)*	0.8	3.5	8.2	17.9	69.6	25.0	48.0	27.0	0.5	16.9	7.5YR 7/4

Note: Numbers are percentages; OC = % organic carbon determined by Walkley-Black method; % carbonate determined by Chittick method; numbers in parentheses are centimeters depth; Wentworth scale; dry color from Munsell® Soil Color Chart; analyses by Milwaukee Soil Laboratory, 6917 W. Oklahoma Ave., Milwaukee, WI 53219.
*Sample immediately overlying Permian gypsum

Feature 24.39. LA 129222, biological soil crust directly on the present-day surface of weathered gypsum. The gypsum is the Tamarisk Member of the Rustler Formation (Upper Permian) (Vine, 1963). The light-colored patches are pockets of wind-transported dust that has accumulated on the surface.

Figure 24.40. LA 129222, shallow depression fill at the top of white massive gypsum of the Tamarisk member, Rustler Formation (Upper Permian) exposed at the west end of Trench 1. This is the largest depression fill observed in the several trenches cut through the site area. The platter-shaped depression is approximately 5 meters (5.47 yards) wide and 68 cm (26.8 inches) deep at its center. The sediment fill is largely very fine quartz sand and dust (silt + clay).

The dune sand is characterized by shinnery oak (*Quercus havardii*) with some mesquite, sand sage, yucca, and tall grasses (Fig. 24.42) (Peterson and Boyd, 1998).

Geology and Soil Geomorphology

Deep trenches through the edges of the dunes down to underlying caliche expose a complete sequence of eolian sand preserved in Los Medanos. Three separate units of eolian sand are preserved in the sand dunes. Each unit has a characteristic sedimentology, and each body of sand accumulated during distinct periods as shown by OSL dating.

Lower Unit, Red Eolian Sand: The oldest sand that occurs as the base of the eolian sequence is the Lower unit red sand. The red sand is present only at LA 129217 in the NM 128 study area.

The Lower unit sand is 47 cm thick in Trench 1 and rests directly on weathered calcrete of the Mescalero paleosol. Nearby in Trench 3, west of Trench 1, the red sand is 25 cm thick, also occurring directly on weathered calcrete. The red sand thins towards the west where in a short distance it is entirely missing due to erosion. The red sand is reddish brown (7YR 4/5) very fine to fine quartz sand. The sand is massive without bedding. The red color is due to the presence of an argillic soil Bt horizon with

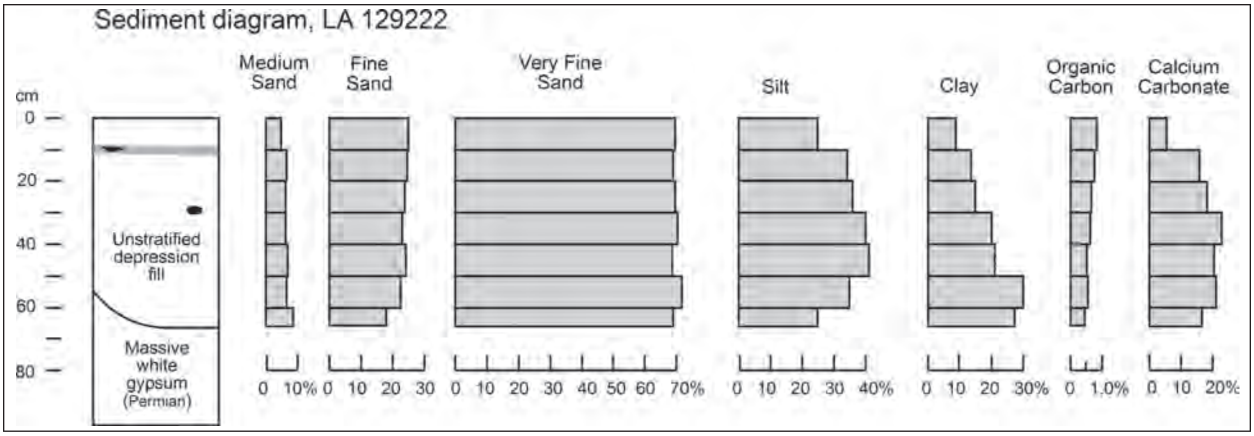


Figure 24.41. LA 129222, sediment data from a depression fill exposed at the west end of BHT 1. The sediment fill is massive, lacking internal stratification and bedding. The sediment is composed of very fine quartz sand and dust (silt + clay). A gray-colored zone occurs at 10 cm (3.94 inches) depth and is interpreted as a buried biological soil crust. An in situ chert flake was observed in the buried soil crust and a fire-burned caliche pebble was observed at 30 cm (11.81 inches) depth; since there is no local source for caliche, it must have been transported to the site. The massive gypsum in which the depression is formed is the Tamarisk Member of the Rustler Formation (Upper Permian) (Vine, 1963).

Figure 24.42. LA 129217, Los Medanos parabolic dunes form the core of the Mescalero sand sheet south of NM 128. OSL dating indicates the accumulation of dune sand has occurred over the past 2000 years.

a comparatively high clay content ranging from 14 to 24 percent. Ped structures are absent, but clay coats are present on sand grains and on the surface of small fractures in the soil. Visible carbonate is absent although the percentage of carbonate ranges from 1.7 to 3.3 percent (Fig. 24.43) (Table 24.13). The red sand had a higher silt content, 2 to 3 percent, compared with the overlying sand units.

Berino Paleosol: The Lower unit eolian sand has been described elsewhere in the Mescalero sand sheet (Hall 2002; Hall and Goble 2006, 2011). The red color of the Lower sand is a consequence of pedogenesis and the formation of an argillic soil called the Berino paleosol (Bachman 1976, 1980; Hall and Goble 2006, 2011, 2012).

The Berino paleosol has been formally named

Table 24.13. LA 129217, Trench 1, sediment data.

	SAND (MM)					RECALCULATED					
FIELD SAMPLE NO. (CM)	2.0–1.0 VERY COARSE	1.0–0.5 COARSE	0.5–0.25 MEDIUM	0.25–0.125 FINE	0.125–0.0625 VERY FINE	SAND	SILT	CLAY <3.9 µm	OC (%)	CaCO3 (%)	DRY COLOR
Twentieth-century Eolian Sand											
49 (+10–20)	–	0.1	30.8	62.8	6.3	97.0	–	3.0	0.1	0.6	5YR 5/6
50 (+0–10)	–	0.1	30.0	62.2	7.7	96.0	1.0	3.0	0.1	0.6	5YR 5/6
Los Medaños Sand											
51 (0–10)	–	0.5	26.2	66.9	6.4	96.0	–	4.0	0.1	0.6	5YR 5/6
52 (10–20)	–	0.5	27.1	65.9	6.5	97.0	–	3.0	–	0.6	
53 (20–30)	–	0.1	19.6	72.0	8.3	95.0	2.0	3.0	–	0.6	5YR 5/7
54 (30–40)	–	0.1	22.1	69.8	8.0	97.0	–	3.0	–	0.6	5YR 5/7
55 (40–50)	–	0.1	19.8	69.5	10.6	95.0	–	5.0	–	0.7	5YR 5/7
56 (50–60)	–	0.1	16.0	67.3	16.6	96.0	–	4.0	–	0.8	5YR 5/8
57 (60–70)	–	0.1	15.2	65.9	18.8	94.0	2.0	4.0	–	0.8	5YR 5/6
58 (70–80)	–	0.1	14.8	65.9	19.2	95.0	1.0	4.0	–	0.8	5YR 5/6
59 (80–90)	–	0.1	15.2	63.4	21.3	93.0	2.0	5.0	–	0.9	5YR 4/6
60 (90–100)	–	0.2	17.3	63.9	18.6	93.0	2.0	5.0	0.1	0.9	5YR 4/6
Eolian Sand Bed											
61 (100–110)	–	0.1	8.3	32.3	59.3	92.0	2.0	6.0	–	1.0	5YR 4/6
62 (110–120)	–	0.1	7.7	31.7	60.5	92.0	1.0	7.0	–	1.2	5YR 4/6
Lower Unit Eolian Sand											
63 (130–140)	–	0.1	9.8	30.3	59.8	80.0	3.0	17.0	0.1	2.1	5YR 4/6
64 (140–150)	–	0.1	9.3	30.3	60.3	84.0	2.0	14.0	–	1.7	2.5YR 4/7
65 (150–160)	–	0.1	8.8	30.4	60.7	81.0	2.0	17.0	–	2.1	5YR 4/6
66 (160–170)*	–	0.1	9.6	30.1	60.2	73.0	3.0	24.0	0.1	3.3	5YR 4/6

Note: Numbers are percentages; OC = % organic carbon determined by Walkley-Black method; % carbonate determined by Chittick method; numbers in parentheses are centimeters depth; Wentworth scale; dry color from Munsell® Soil Color Chart; analyses by Milwaukee Soil Laboratory, 6917 W. Oklahoma Ave., Milwaukee, WI 53219.
* Sample immediately overlying calcrete of the Mescalero paleosol

as a pedostratigraphic unit (Hall and Goble 2012). The red argillic soil observed in Trench 1 at LA 129217 is the Berino paleosol. The top of the paleosol and the Lower unit sand was eroded long before the deposition of the overlying eolian sand bed. The unconformity between the sand units is sharp and is characterized by the presence of many rounded quartz and quartzite pebbles 2 to 14 mm in diameter. The pebbles represent lag gravel that formed on the eroded surface of the Lower unit sand and Berino paleosol.

Eolian Sand Bed: The eolian sand bed is yellowish red (5YR 4/6) fine-to-very fine quartz sand, a texture that is similar to that of the Lower unit at this locality. The deposit is only 26 cm thick in Trench 1. It is massive without bedding or visible stratigraphy. It does not contain evidence of argillic or calcic soil formation. The clay content is 6 to 7 percent and the carbonate content is 1.0 to 1.2 percent. The eolian sand bed was not observed elsewhere in this investigation, and it is not correlated with the Upper unit sand or other informal sand units at this time. The sand bed lacks B horizon development. Elsewhere on the sand sheet, the Upper sand is typically whitened by the presence of a weak Bk soil horizon with a reddish Bw horizon toward the top of the unit. In addition, the OSL age of the sand bed is 4260 ± 240 years, slightly younger than the age of the Upper unit at other sites along NM 128. For now it is regarded as anomalous, pending future studies.

Los Medanos Sand: Late Holocene eolian sand is encountered only at LA 129217. Los Medanos sand is 100 cm thick in Trench 1. The sand is yellowish red (5YR 5/6-8) massive fine-to-medium quartz sand with very small amounts of silt and

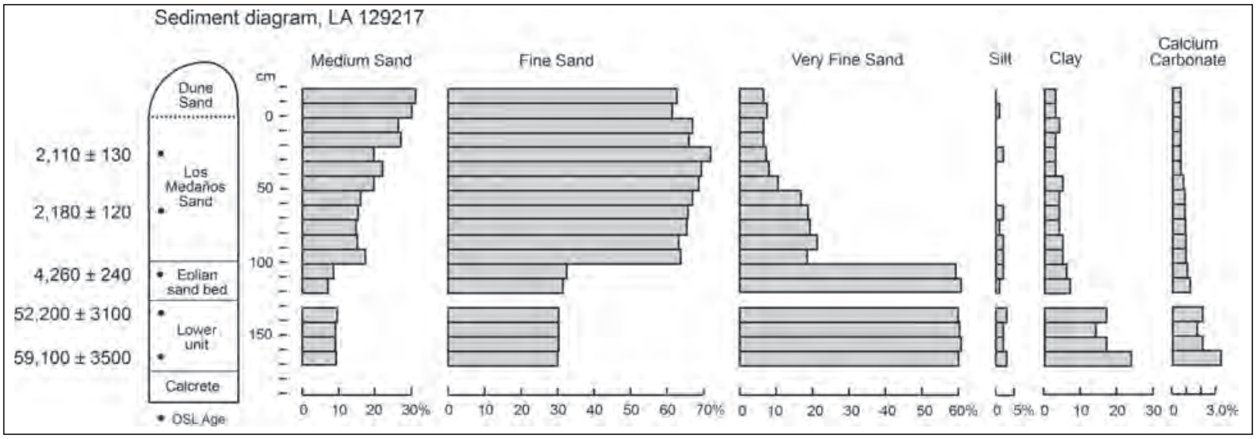


Figure 24.43. LA 129217, BHT 1, east wall, sediment data from the Lower unit, an eolian sand bed, and Los Medanos sand. The erosional unconformity between the Lower unit and overlying eolian sand is sharp and marked by many small quartz and quartzite pebbles that represent a buried lag gravel. The boundary between the eolian sand bed and Los Medanos sand is not visible in the field although the unconformity shows up clearly in laboratory sediment data.

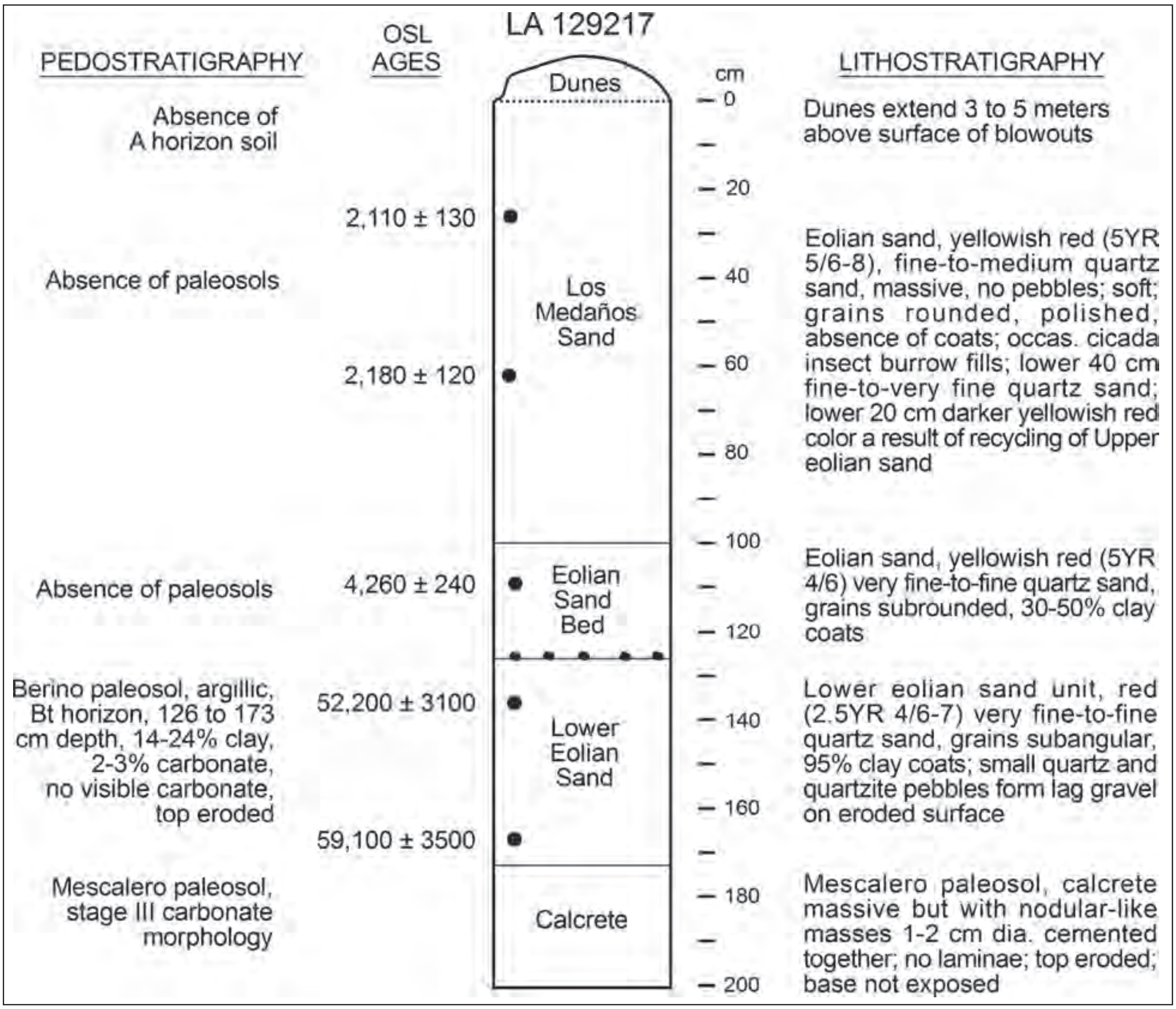


Figure 24.44. LA 129217, center of BHT 1, stratigraphy at measured section.

clay (Fig. 24.43). Sand grains are polished and rounded to sub-rounded in shape with the degree of roundness increasing upwards with coarsening of the sand. The grains lack clay or mineral coats; about 1 to 2 percent of the grains are non-quartz dark minerals. The dune sand has low percentages of silt, clay, and carbonate compared with the older, underlying sand units. Soils are absent within the sand although a very weak A horizon soil is partly preserved at the top of the sand at the contact with the base of nearby parabolic dunes.

Geochronology of the Eolian Sand at LA 129217

Lower Unit: Two OSL dates from the Lower unit sand are 59,100 ± 3500 and 52,200 ± 3100 years (Fig. 24.44). The ages are younger than those obtained previously from the Lower unit sand elsewhere on the Mescalero sand sheet. A total of six OSL ages have been obtained from the Lower unit, including those from this investigation, ranging from c. 90,000 to 50,000 years (Hall and Goble 2012, this study).

Eolian Sand Bed: A single OSL age from the sand bed overlying the Lower unit is 4,110 ± 230 years. The age is slightly younger than the age range of the Upper unit, 18,000 to 5000 years, established from this and other investigations. With further studies, this isolated record may fit into a new regional pattern in the core of the sand sheet.

Los Medanos Sand: Two OSL ages from the dune sand at Trench 1 are 2180 ± 120 and 2110 ± 130 years. The ages are statistically identical. The ages indicate late Holocene eolian sand deposition, a period of eolian activity not previously documented on the Mescalero sand sheet. The OSL ages reveal for the first time that the Los Medanos landform in the core of the Mescalero sand sheet is a product of eolian activity over the past 2000 years.

Archaeological Geology of LA 129217

The site occurs in the midst of the large parabolic dunes of Los Medanos. Fire-burned calcrete and artifacts occur in blowouts in the parabolic dunes. The large dunes extend about 3 m above the quasi-stable surface of the dune sand, and blowouts extend approximately 80 cm below that surface. Deflation produces a concentration of fire-burned rock and artifacts on the floor of the blowouts. The cultural materials originate from the upper 80 cm of the eolian sand (Fig. 24.45). Charcoal for radiocarbon dating was not recovered from LA 129217.

LA 129218

Archaeological Geology of LA 129218: Site LA 129218 occurs at the edge of Los Medanos where the eolian sand thins in a short distance, becoming absent due to erosion and exposing the weathered surface of the calcrete. The site is immediately west of LA 129217, which occurs in dune sand (Fig. 24.46). The eolian sand at LA 129218, where cultural features are present, is about 40 cm thick and rests directly on calcrete. A 10 to 15 cm thick A horizon soil occurs on the surface of the sand. The soil may be a weak anthrosol; it does not occur at the surface of the thicker eolian in the dunes of LA 129217. Recent eolian sand deposits around shrubs form a sharp contact with the underlying A horizon soil.

The age of LA 129218 ranges from 1040 ± 40 to 930 ± 40 ^{14}C years BP, based on four AMS dates and corresponding to other NeoArchaic sites along NM 128. However, three features are Early Archaic and are AMS dated 5720 ± 40, 5520 ± 40, and 5480 ± 40 ^{14}C years BP. The visibility of the Early Archaic features is related to the very thin eolian sand cover that rests directly on the calcrete of the Mescalero paleosol.

Geology and Geochronology

Mescalero Paleosol: The Mescalero paleosol is a prominent feature of the surficial geology in the Mescalero Plain. The Mescalero paleosol formed directly on the eroded surface of Permian and Triassic sedimentary rocks in southeastern New Mexico. Its age is unknown, although its stratigraphic relationship to other geologic features and its Stage III carbonate morphology indicate that it may be late Pleistocene.

Mescalero Sand Sheet: The stratigraphy and geomorphology of the Mescalero sand sheet are described by Hall and Goble (2006). The Mescalero sand sheet is developed on the eroded surface of the Mescalero paleosol. In this investigation of the western half of the Mescalero sand sheet, three stratigraphic units of eolian sand are identified (Fig. 24.47). All three units as well as associated paleosols, where present, are OSL-dated and their sedimentary characteristics determined by laboratory

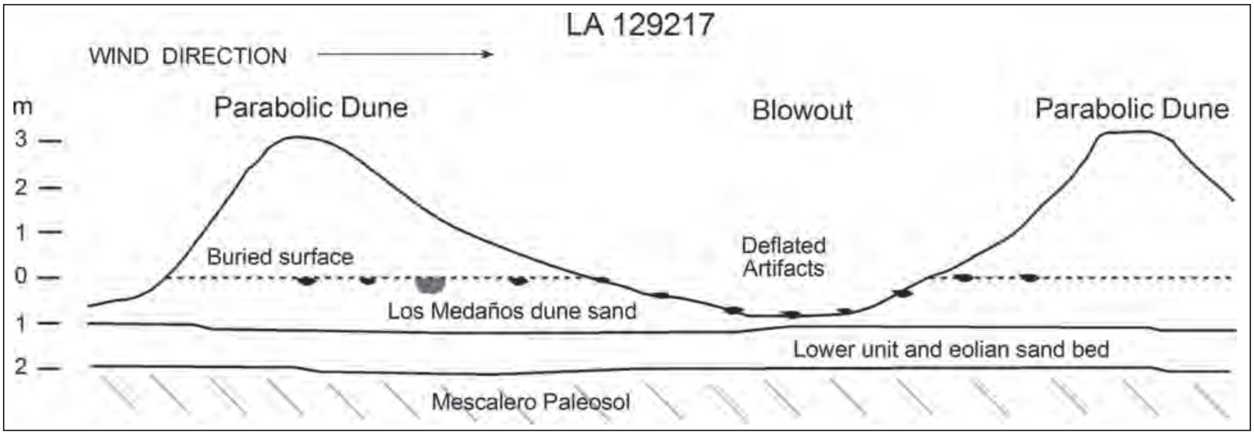


Figure 24.45. Sketch of parabolic dunes and blowout in Los Medanos dune field, showing the deflation of the buried surface and hypothetical occurrence of site LA 129217 as well as the concentration of artifacts in the blowout.

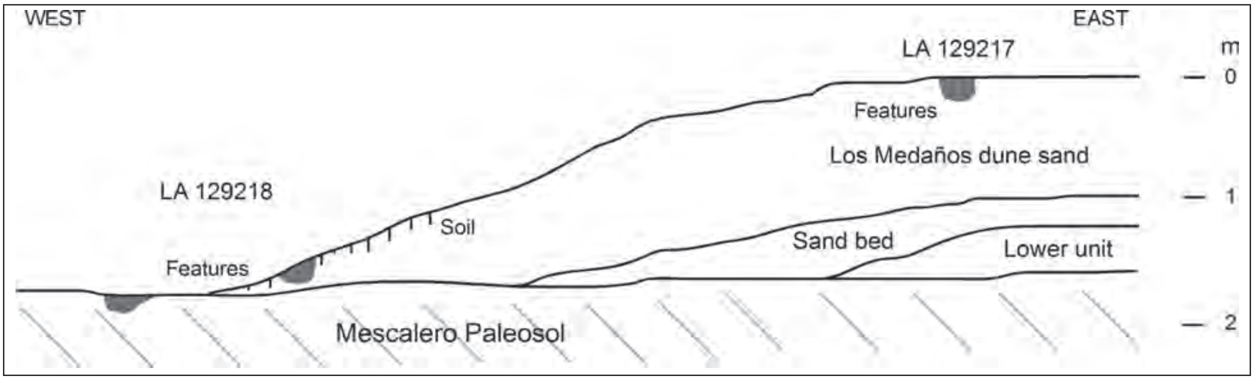


Figure 24.46. LA 129217 and LA 129218, cross-section sketch. The A local horizon soil at LA 129218 may be in part an anthrosol. The A horizon soil is largely missing from LA 129217 due to recent erosion.

analysis. Twentieth century coppice and parabolic dunes occur commonly on the surface of the sand sheet.

All of the eolian sand deposits have a Munsell color with a 5YR hue, in the middle of the yellow-red hue, and moderate to high values and chromas. The redness of the eolian sand might possibly be a result of the grains derived from local outcrops Permian-Triassic red beds. The late Pleistocene Lower unit eolian sand has a 2.5YR hue because of the formation of the argillic Berino paleosol in the sand. Some of the red color of the younger eolian sand may also a result of reworking of sand from the Lower unit.

Lower Unit Eolian Sand: The Lower unit, or red sand, is the basal sand unit of the sand sheet, overlying the weathered, eroded calcrete of the Mescalero paleosol. The red sand does not occur everywhere. Trenches through the sand sheet down to the calcrete reveal the red sand at only one site, LA 129217. In a similar study in the Pierce Canyon area, the red sand was exposed in only four of 15 trenches that were excavated to caliche. Absent red sand was removed by late Pleistocene erosion.

The Lower unit is red (2.5YR 4/6-7) fine-to-very fine quartz sand with a comparatively high clay content. The Lower sand is generally finer-textured than the other eolian units in the region (Fig. 24.48). The grains are sub-angular, and 90 to 95 percent of the grains have clay and iron coats. The clay and iron are secondary features, a result of the formation of the argillic Berino soil during the late Pleistocene.

The geochronology of the Lower red sand is 60,000 to 50,000 years, based on two OSL dates from LA 129217. Collectively, six OSL ages from the Lower unit range from c. 90,000 to 50,000 years. An unrepresentative thick sequence of eolian sand at LA 129300 has OSL dates from 49,000 to 5000 years, indicating a possible connection with the Lower unit. However, the eolian sequence does not include the Berino paleosol and is an anomaly and unrepresentative of the sand sheet, perhaps due to the accumulation of the sand in a deep solution pit instead of on a broad geomorphic surface.

Upper Unit Eolian Sand: The Upper unit yellowish-red sand is the primary eolian sand body on the sand sheet. It is best exposed in trenches at LA 129214 and LA 129216. It is a fine to medium quartz sand generally less than 1 m thick that mantles the eroded surface of the Mescalero paleosol. It has a weak B horizon soil with a Bw horizon at the top and a weak Bk horizon below. The Bk horizon has rare carbonate filaments with a carbonate content of less than 7 percent, giving it a weak Stage I carbonate morphology.

Eight OSL ages indicate that the Upper unit was deposited between c. 13,000 to 5000 years. Thus, the period of weak B horizon development is within the past 5000 years.

3000 Year Hiatus? An unanticipated result of the OSL geochronology of the Upper unit sand is a gap in the ages between c. 9000 to 6000 years (Fig. 24.47). Field observations and laboratory data, however, do not indicate a hiatus in the sedimentation of the eolian sand. North of NM 128, an OSL age of 7180 ± 320 was obtained from the Upper unit (Hall and Goble 2011). As additional studies are conducted on the sand sheet, the "gap" may be filled.

Extrapolated Age of the Upper Unit: The net sedimentation rate of the Upper unit has been calculated by linear regression of sets of three OSL ages versus depth at LA 129214 and LA 129216; the resulting accumulation rates are 0.11 and 0.080 mm/year, respectively, with high correlation coefficients (r^2) 0.986 and 0.975. Using these accumulation rates and extrapolating the age of the sand to zero depth (the modern surface), the age of the top level of the Upper unit sand at LA 129214 is 2820 years and at LA 129216 is 2990 years.

These data indicate that the Upper unit sand may have accumulated until 3000 years ago, significantly later than the 5000 year age interpreted in this report from direct OSL ages. Although it is attractive to use the extrapolated 3000 year age for the end of the deposition of the Upper unit, doing so may be premature and misleading until more is learned about the geochronology and stratigraphy of the sand sheet.

Los Medanos Sand: Los Medanos dune sand is restricted to a narrow area along NM 128. LA 129217 occurs in the dune sand. The sediment is yellowish red massive fine-to-medium quartz sand with very small amounts of silt and clay. Sand grains are polished and rounded to sub-rounded. The grains lack clay or mineral coats. Soils are absent. Large parabolic dunes as much as 3 m high have formed in the sand, and local blowouts extend 1 m below the surface of the sand. Two OSL dates indicate that Los Medanos dune sand was deposited within the past 2000 years, after the stabilization of the Upper unit eolian sand. An equivalent of Los Medanos dune sand was not documented in the Mescalero Sands (Hall and Goble, 2006). However, further investigations of the core of the sand sheet may yield cases of dune sand of similar age.

Coppice Dune Sand: Coppice dunes around Torrey mesquite (*Prosopis glandulosa torreyana*) shrubs occur in most areas of the sand sheet. The dunes are small, generally no more than 50 to 100 cm in height and 3 to 5 m across. Larger coppice dunes occur on the east-facing or leeward slopes of low hills. Occasionally, adjacent dunes merge, forming a larger dune mass. In general, the color and texture of the coppice dune sand mimic the sand on which the dunes have formed. Most of the coppice dune sand analyzed in the laboratory is fine-to-medium or fine-to-very fine quartz sand. The age of the coppice dunes was not determined in this study. The only coppice dune in the Mescalero Plain that is dated is one northeast of Loco Hills where OSL and ^{13}C dating indicate that it began forming in the earliest part of the twentieth century (Hall et al. 2003).

Parabolic Dune Sand: Parabolic dunes occur only in the central area of the Mescalero sand sheet where the sand is protected by shinnery oak (*Quercus havardii*). The sub-circular dunes are generally about 10 to 15 m across and 2 m high above the floor of adjacent blowouts. In the area locally called Los Medanos, parabolic dunes extend 3 to 5 m above the blowouts. The age of the parabolic dunes in the study area was not determined, although in the Mescalero Sands, the dunes overlie the Loco Hills soil. From that stratigraphic relationship, it is concluded that the parabolic dunes are twentieth century (Hall 2002; Hall and Goble 2006).

Colluvium: A deposit of colluvium derived from eroded eolian sand with a mix of caliche pebbles occurs at the base of the hillslope east of LA 113042, along the margin of an unnamed wash. This

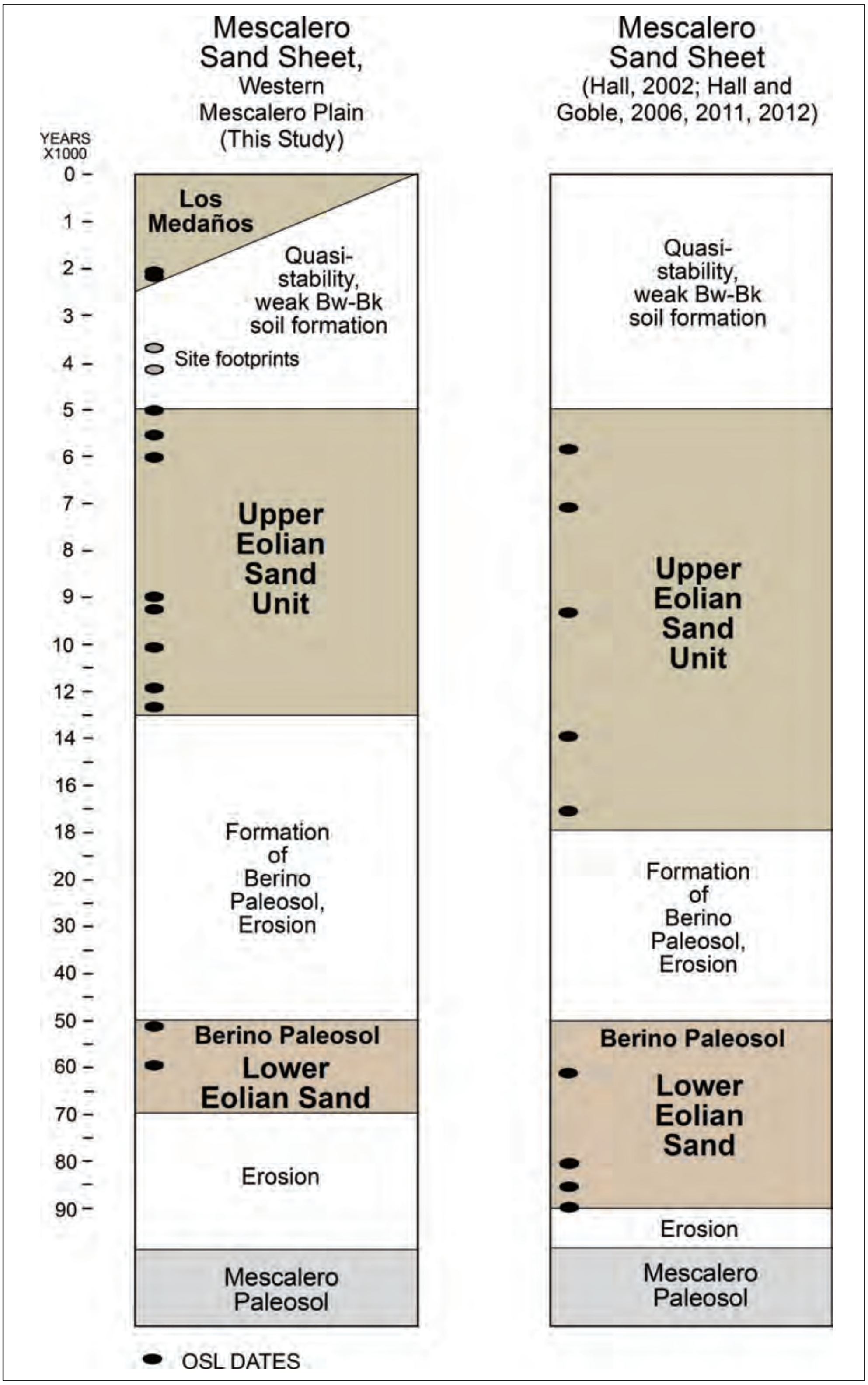


Figure 24.47. Summary stratigraphy of the Mescalero sand sheet on the western Mescalero Plain (this study) and correlation with previously published studies of the Mescalero sand sheet, Eddy County, New Mexico. Twentieth-century coppice and parabolic dunes have been omitted from this diagram. The age of the Mescalero paleosol is unknown at this time; scale changes at 10 and 20 ka.

is the only case of significant colluvial deposits in the study area.

The sediment is fine-to-very fine quartz sand, identical to the adjacent Upper unit eolian sand. A single OSL date from the colluvium is 2320 ± 200 years, indicating a post-Upper unit age.

Fine-Textured Alluvium: All of the ephemeral washes in the area contain deposits of gravelly sand in their present-day channels. The sand is derived from erosion of nearby eolian sand, and the gravel is largely siltstone and caliche pebbles eroded from Permian rocks and the Mescalero paleosol that outcrop locally in the small watersheds.

An unexpected discovery of a fine-textured alluvial deposit beneath the recent channel alluvium was made in trenches east of LA 113042, at the edge of an unnamed wash. The fine alluvium is reddish brown to dark reddish brown, fine-to-very fine quartz sand with very high amounts of silt, clay, organic matter, and carbonate. It contrasts sharply with the coarse-textured, gravelly alluvium in the present-day wash. Only the upper 1 m of the fine alluvium was exposed in the study trench. It is not known how thick the alluvial deposit is or what sediment or rock underlies it. Three radiocarbon ages on bulk sediment indicate that the upper 1 m of the fine alluvium was deposited between 3000 and 600 ^{14}C years BP. The 600 year age is from an A horizon soil at the top of the alluvial deposit.

Four species of land snails occur in the fine alluvium. Their ecology indicates the presence of desert grassland vegetation in the drainage basin. The land snails appear to be absent from the area today; a search of the ground surface yielded no living specimens or recently abandoned shells.

Pollen analysis of the fine alluvium indicates desert grassland vegetation, similar to that of today, but with fewer shrubs. Pollen grains representing wet-ground plants are absent. Therefore, it is unlikely that the fine alluvium was deposited in a wet, meadow environment.

Paleosols: A paleosol is a soil that formed in the past under environmental and geomorphic conditions that do not exist today at that locality. In the United States, formal stratigraphic nomenclature recognizes soils and uses the term "geosol" as the pedostratigraphic unit (North American Commission on Stratigraphic Nomenclature 2005). However, by definition a geosol must be buried, a condition that does not apply to many occurrences of ancient soils, including the soils in southeastern New Mexico. Thus, the term paleosol is used in this report.

Berino Paleosol: The Berino paleosol was first recognized and named by Bachman (1976) for the red paleosol that occurs at the top of the Mescalero paleosol in Eddy County. Bachman thought that the red soil might be the upper Bt horizon of the Mescalero paleosol. However, it was later shown that the red soil and the Mescalero paleosol are separate stratigraphic units with different origins and ages (Hall 2002). The red paleosol largely defines the Lower sand unit in the Mescalero Sands (Hall and Goble 2006). The Lower unit eolian sand of this report also incorporates the Berino paleosol, although only a thin, truncated remnant of it is preserved. Present-day exposures of the Lower unit and Berino paleosol are rare in the study area.

The Lower unit eolian sand in which the Berino paleosol occurs is fine-to-very fine quartz sand, the finest textured eolian sand in the study area. Only the lower 47 cm of the Berino paleosol is preserved where it rests directly on caliche of the Mescalero paleosol; the top of the Berino is eroded and missing. The preserved soil Bt horizon is reddish yellow and has 14 to 24 percent secondary clay. It also has 1.7 to 3.3 percent carbonate although visible carbonate is absent. Soil peds are not evident in the Berino, although small fractures in the Bt have discontinuous, thin clay linings.

Based on the geochronology of the eolian sand in the area, Berino soil may have formed during the broad period between c. 50,000 to 13,000 years, allowing no more than 37,000 years for the development of the Berino. The overlying Upper unit eolian sand began to accumulate c. 13,000 years ago, thus burying the Unit 2 sand and ending the formation of the Berino soil in this area. Of course, the erosion of the Lower unit and the associated top of the Berino paleosol took place during this period as well, after the formation of the Berino soil. At present, there is little basis for establishing the period of post-Berino erosion.

Bw/Bk Horizon Paleosol: A weak Bw horizon paleosol occurs in the Upper unit eolian sand. A dark reddish-brown Bw horizon is present in the upper 20 to 40 cm of the sand. The dark color of the Bw is due to the presence of iron oxide coats on the quartz sand grains. A weak Bk horizon occurs approximately 50 to 80 cm depth below the Bw horizon. The sediment has a whitened color due to the presence of carbonate coats on sand grains; some weak carbonate filaments are present. The carbonate content is generally less than 7 percent, indicating a weak Stage I carbonate morphology. The soil does not have measurable secondary clay. Given the OSL chronology of the Upper unit, the weak Bw/Bk paleosol formed in the past 5000 years.

A Horizon soils: Two areas of thin A horizon soils are documented in the project area. Both soils are only A horizons without B horizon development. At LA 129214, the A horizon soil occurs at the top of eolian sand at the base of a hillside where it is buried by recent alluvium and coppice dunes. The soil is 10 to 14 cm thick. Two AMS radiocarbon dates on bulk sediment indicate the soil formed c. 1100 14C years BP (Table 24.14).

An A horizon soil also occurs on colluvium and at the top of fine alluvium east of LA 113042. The soil is 10 to 15 cm thick and is buried by coppice dune sand and recent alluvium. Two AMS radiocarbon dates on bulk sediment indicate that the soil formed c. 590 14C years BP (Table 24.14).

While both A horizon soils at LA 129214 and LA 113042 have the same morphology and similar geomorphic expression, their radiocarbon ages are significantly different. Both of these A horizon soils are somewhat older than the Loco Hills soil in the Mescalero Sands that is radiocarbon-dated younger than 400 years BP (Hall and Goble 2006). It is not known why the ages of these similar soils differ from each other.

Sedimentology of the Eolian Sand: Textural analysis of sediments by geo-technical laboratories has been de-emphasized since the 1970s with the general feeling in sedimentary geology that high-resolution sand-silt-clay data was of less importance to the description and paleoecology of the stratigraphic layers of broadly occurring rock formations. Soil specialists continue to rely on textural data, especially percentages of clay as an index to B horizon development, but generally disregard the significance of variations in sand content as related to the primary depositional regime of the sedimentary body in which a soil has formed.

In this investigation, high-resolution textural data were determined by the Milwaukee Soil Laboratory. In the field, stratigraphic sections that are representative of the local eolian geology were selected for detailed sampling. Sediment samples consisting of about 200 to 250 grams were collected in continuous 10 cm intervals, especially from columns where OSL dating was conducted. If a recognizable stratigraphic break was present, sediment samples were collected above and below the break, not across it.

Detailed field descriptions of the sediment, noting especially lateral variability in the stratigraphy and coarse-scale features such as burrow fills and pebbles, are vital for comparison with the laboratory data. In the office, the sediments are inspected again at 10X and 30X with a binocular microscope, noting grain mineralogy, grain roundness, grain coats, and other properties as well as Munsell color. The combined information on the sediments from field, office, and laboratory analyses provides the essential descriptive signature of the sediments that make up the stratigraphic units.

Laboratory analysis of the sand is at 1-phi categories: very coarse, coarse, medium, fine, and very fine (Wentworth scale). This degree of resolution of sand texture has proved valuable in the characterization and differentiation of the sand units.

Sand texture also testifies to the homogeneity of the sand in a deposit, or, on the other hand, textural data can indicate the presence of an nonconformity in a sand column that may not be visible in the field. With the accumulation of textural data from the units on the sand sheet, it may be possible to assess the wind direction and sand source from which the eolian sands were derived. Accessory laboratory data on percentages of clay, calcium carbonate, and iron provide key information on soil development.

Textural Differences Between Sand Units: A plot of "medium sand percentages" versus "silt and clay percentages" shows that the three prehistoric sand units in this investigation, Lower, Upper, and Los Medanos, have significantly different sand populations (Fig. 24.48). As the percentage of medium sand increases, the overall texture of the sand coarsens. Accordingly, the Lower unit sand is the finest textured, while the Upper unit sand is generally the coarsest.

The Los Medanos sand texture is more variable than that of the other units with regard to percentages of medium sand. While it is clear that the texture of the three sand units differs from each other, additional sand data from a wider geographic area are necessary in order to draw conclusions on its significance to the source of the sand.

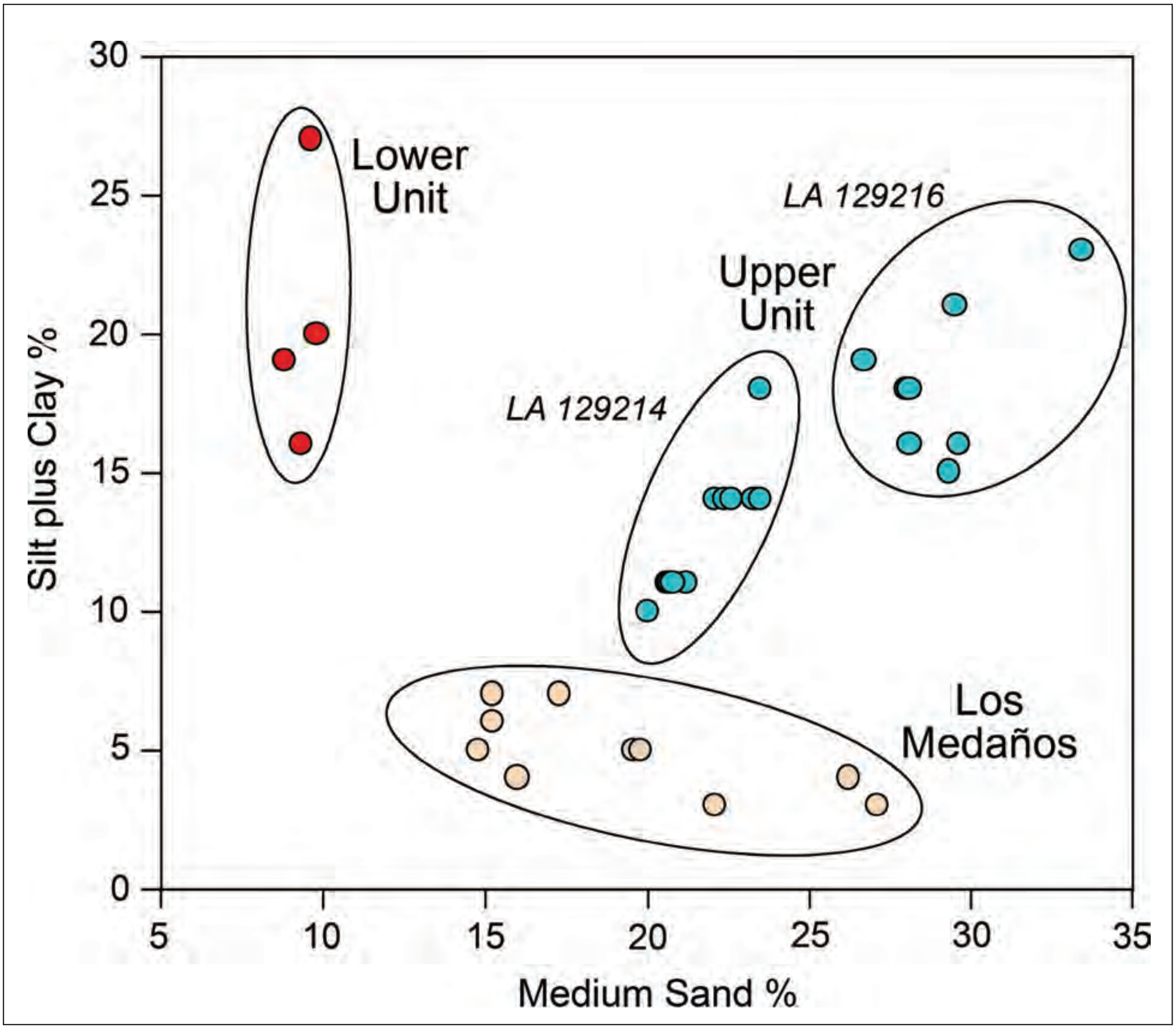


Figure 24.48. Plot of percentages of Medium Sand versus Silt and Clay from eolian sand deposits at LA 129214, LA 129216, and LA 129217. The percentages of medium sand and percentages of silt + clay are independent of each other.

Local Correlation of Eolian Sand

The chronology of deposition and erosion of the Mescalero sand sheet is in the early stage of discovery using OSL dating. At present, the age of the Lower unit is estimated to be 90,000 to 50,000 years, while the age of the Upper unit is 18,000 to 5000 years (Hall and Goble 2011, 2012, this report).

Southern High Plains, Texas, and New Mexico: The age of the Mescalero sand sheet diverges sharply from the eolian record in the Southern High Plains. The eolian sand deposits of the southern Plains have been investigated repeatedly by many geologists and soil scientists. The most recent summary of those investigations is reported by Holliday (2001). The sand in most of the dune fields is generally younger than 4000 ^{14}C years BP, and many of those date younger than 1500 ^{14}C years BP. Archaeological sites provide a chronology for some dune activity between 11,000 to 8000 years, although eolian deposits on sand sheets between 8000 to 3000 years are rare, in stark contrast to the Mescalero sand sheet. Geological and paleoclimatic explanations for the strong age differences between the Mescalero sand sheet and the adjacent sand sheets on the High Plains are elusive. The only possibility that comes to mind is that most of the chronology of the High Plains eolian deposits is based on radiocarbon dates from associated archaeological sites that in turn may not be contemporaneous with eolian sand deposition, such as the case at Fort Bliss (Hall et al. 2010). Future OSL dating of the eolian sand on the High Plains will clarify the record.

Salt Basin, Texas: A sequence of mid- to late-Holocene eolian sand, radiocarbon-dated by charcoal from five prehistoric hearths and one bulk sediment sample, is reported from the Salt Basin west of the Guadalupe Mountains in Texas (Wilkins and Currey 1999). The ages range from 6350 to 350 ^{14}C years BP. The sedimentary sequences are exposed along arroyos and are a mix of deposits of both eolian and fluvial origin. The eolian sand sequence may not be representative of the local sand sheet because the sand accumulated along ephemeral washes and contains some alluvial deposits. A "neopluvial" period was also interpreted for the sequence based on the presence of 3 to 5 cm thick lacustrine mud exposed in the middle of eolian sand in a road cut. Clearly, the local, late Quaternary geologic sequence in the Salt Basin is a complex of eolian, alluvial, and lacustrine deposits that require further study.

In addition, Wilkins and Currey (1999) base a paleoclimatic reconstruction on delta ^{13}C values from the six charcoal radiocarbon ages. They equated low (high negative) values of delta ^{13}C with a Holocene "neoglacial" and C_3 plants that are generally held to be indicators of cool-season grasslands. However, the more abundant woody plant species in the northern Chihuahuan Desert are creosote bush (*Larrea tridenta*), honey mesquite (*Prosopis glandulosa*), sticky range ratany (*Krameria glandulosa*), joint-fir (*Ephedra trifurca*), all-thorn (*Koberlinia spinosa*), sotol (*Dasylirion wheeleri*), mariola (*Parthenium incanum*), and ocotillo (*Fouquieria splendens*). All of these are C_3 species (Kemp 1983), and charcoal from local brush fires or prehistoric hearths will likely contain remains of these woody shrubs. Accordingly, the Wilkins-Currey paleoclimatic reconstruction may be in error. Paleoclimatic inferences based on delta ^{13}C values from radiocarbon-dated charcoal in the Chihuahuan Desert (and elsewhere) must be treated with caution owing to the large number of C_3 woody species present in local plant communities.

Tularosa Valley-Hueco Bolson, New Mexico and Texas: The Bolson sand sheet at Fort Bliss has been OSL-dated and correlated with the Mescalero sand sheet. The Bolson sand sheet consists of two sand bodies. The older sand body (Q2) has a single OSL date of 44,000 years. The younger (Q3) eolian sand was deposited 22,000 to 5000 years ago. A weak Bw/Bk soil occurs in the Q3 sand, similar to the weak paleosol in the Upper unit sand in the Mescalero sand sheet. At present, the Upper unit sand and Q3 sand appear to have been deposited during the same period, although deposition of the Lower unit on the Mescalero sand sheet was initiated earlier. As additional OSL dates become available, the correlation and relationship of the Mescalero and Bolson sand sheets will be better defined (Hall 2007b; Hall et al. 2010).

Paleoecology and Regional Paleoclimate

Hard, reliable data on past climates of the American Southwest are difficult to find. On the other hand, a plethora of speculations about past climates is based on incomplete and over-interpreted studies that cite each other, perpetuating a confusing and often wrong picture of past climatic and paleoenvironmental conditions. To discern the truth is not easy. A summary and discussion of the results from the NM 128 investigation are presented below.

Past Vegetation: The 3000 to 600 year BP pollen record from fine-textured alluvium near LA 113042 indicates that the vegetation was desert shrub grassland, similar to northern Chihuahuan Desert plant communities today. A comparison of prehistoric and modern surface pollen assemblages indicate that pine, juniper, oak, mesquite, and creosote bush have increased in abundance between 600 years ago and today. The alluvial pollen record lacks evidence for wet-ground plants. High proportions of charcoal in the upper 55 cm of the alluvial section, however, may represent nearby prehistoric cultural activity at LA 113042.

Land Snail Fauna: The four land snail species recovered from the late Holocene fine alluvium are all indicative of local shrub grassland vegetation in the northern Chihuahuan Desert. Aquatic snails that occur in springs, wet meadows, or ponds were not found in the alluvium.

Fluvial Environments: The discovery of a deposit of fine-textured alluvium buried beneath the channel sand and gravel in the wash east of LA 113042 is significant. The silty alluvium most likely accumulated 3000 to 600 years ago under geomorphic, climatic, soil, and plant-cover conditions that differ from those of today. The climate was slightly moister with more rainfall, at least until

Table 24.14. GPS locations of stratigraphic sections, OSL, radiocarbon, pollen, and mollusk collecting sites.

	SITE	UTM COORDINATES (ZONE 13, NAD 27*)	LATITUDE (NORTH)	LONGITUDE (WEST)	ELEVATION (FT)
Stratigraphy, OSL 1–3, Trench 1	LA 129216	13 594304E 3578459N	32° 20' 27.15"	103° 59' 54.30"	3025
OSL 4, Block 5	LA 129216	13 594227E 3578485N	32° 20' 28.02"	103° 59' 57.23"	3023
Geo–2 radiocarbon, A-horizon soil south of highway, buried by coppice dune sand	LA 129214	13 594879E 3578447N	32° 20' 26.58"	103° 59' 32.31"	2985
Geo–1 radiocarbon, A-horizon soil, buried by alluvium	LA 129214	13 594842E 3578550N	32° 20' 29.94"	103° 59' 33.68"	2988
Anthrosol, OSL 5, sediment, total P, Trench 10	LA 129214	13 594595E 3578550N	32° 20' 30.02"	103° 59' 43.13"	3020
Stratigraphy, OSL 6–8, Trench 11	LA 129214	13 594625E 3578583N	32° 20' 31.08"	103° 59' 41.97"	3013
Fine alluvium, pollen, Geo–4–6 radiocarbon, mollusks	LA 113042	13 595529E 3578795N	32° 20' 37.69"	103° 59' 7.32"	2981
Stratigraphy, OSL 9–10, colluvium, Trench 6	LA 113042	13 595346E 3578669N	32° 20' 33.65"	103° 59' 14.36"	3001
Stratigraphy, Geo–3, radiocarbon, colluvium, Trench 1-A	LA 113042	13 595461E 3578732N	32° 20' 35.66"	103° 59' 9.94"	2984
Stratigraphy, OSL 11–14, Trench 3	LA 129300	13 597990E 3579269N	32° 20' 52.31"	103° 57' 33.01"	2975
OSL 15, near Paleoindian point, Block 6	LA 129300	13 597990E 3579206N	32° 20' 50.27"	103° 57' 33.03"	2980
Stratigraphy, sediments	LA 129222	13 602338E 3577904N	32° 20' 6.58"	103° 54' 47.22"	3025
Stratigraphy, OSL 16–20	LA 129217	13 610825E 3576247N	32° 19' 9.87"	103° 49' 23.32"	3304

* UTM locations taken with Magellan 300.

1000 years ago (based on Carlsbad speleothems). The local vegetation was likely desert grassland without as many shrubs as seen today. An A horizon soil associated with the grassland vegetation was likely present over the landscape and may be the soil radiocarbon-dated c. 1100 years BP at LA 129214. Given the presence of a grassland and soil, water from rainstorms will tend to soak into the ground with less runoff that seen today.

The low volume of runoff would carry small particles, such as very fine sand-silt-clay, to the valley floor. Muddy water from hillslope runoff would spread across the valley, depositing the fine sediment and building up a thick accumulation of silty very-fine sand. The picture changed with the shift to a drier climate 1000 years ago. The history of the small alluvial valley parallels the nearby archaeological record and provides supporting evidence for moister conditions during the late Holocene.

Carlsbad Caverns Speleothems: A series of recent studies of speleothems from the Carlsbad Caverns area has yielded a record of past rainfall in the Guadalupe Mountains of southeastern New Mexico that is independent of previous investigations. One record extends back to 164 ka, and the mineralogy, chemistry, and ^{13}C and ^{18}O isotopes show that mid- and late-Pleistocene episodes of greater precipitation in the Guadalupe Mountains correspond to periods of glaciation elsewhere in the world (Brook et al. 2006). Unfortunately, hiatuses in precipitation of speleothem growth bands occur during extended dry periods, resulting in data gaps for those times. The Holocene is one of the periods for which climatic information is missing from the 164 ka sequence.

A high-resolution study of late Holocene speleothems from Carlsbad Caverns and Hidden Cave in the Guadalupe Mountains, however, show that a wetter period was initiated by c. 4000 years with increased rainfall extending from c. 3000 to 1000 years ago. After that time, the climate dried and a hiatus formed in the stalagmite record, corresponding to the "Medieval warm period". A brief episode of wetter weather returned to the region between c. 460 and 170 years BP and is correlated with the Little Ice Age (Polyak and Asmerom, 2001; Polyak et al. 2001; Rasmussen et al., 2006).

While the speleothem paleoprecipitation record leaves some unanswered questions, such as to the nature of the climate during hiatuses in speleothem growth , the Carlsbad Caverns area sequence shows a significant change that correlates with the eolian geology of the western edge of the Mescalero sand sheet. The shift to a wetter climate by c. 4000 years ago correlates broadly with the end of eolian sand deposition on the sand sheet c. 5000 years ago (Fig. 24.49). Why, or even if, this was the case is not clear. It may relate to the yet-unidentified source of the sand. A moister climate would promote greater growth of grasses and other soil-binding plants, thereby cutting off the source of sand to the sand sheet. Even though winds may still be sufficiently strong enough to transport sand, a loss of sand supply would end the accumulation of the sand and the sand sheet would stabilize. In addition, as is documented by field studies, the stability of the sand sheet surface during the past 5000 years set the stage for the formation of the weak Bw/Bk soil that occurs in the sand. Moister local conditions over the past 5000 years would foster denser plant communities on the sand sheet itself, thereby contributing to the stability of the sand as well as to soil development. In an apparent contradiction, Los Medanos sand began to accumulate about 2000 years ago during the middle of the moist period. Many questions regarding climate, vegetation, and eolian processes and their relationships to each other and to prehistoric human ecology on the Mescalero Plain are yet unanswered.

Neoglaciation in New Mexico: Following the late Wisconsinan Glacial maximum about 18,000 radiocarbon years ago, alpine glaciers dramatically receded and may have disappeared entirely in the western states by about 14,000 years BP (Davis 1988). During the late Holocene, however, glaciers reappeared in many parts of the world and have been documented in the Front Range of Colorado. Glacial advances during the Holocene are called neoglaciation.

The record of alpine glaciation is generally regarded as a core index to past climatic conditions. The glacial geology of the Sangre de Cristo Range of northern New Mexico was mapped, described, and summarized by Ellis (1931, 1935), although he included some areas, such as the Moreno Valley, that are now known not to have been glaciated. Subsequently, Ray (1940) mapped the glacial moraines of northern New Mexico even though moraines representing larger advances of ice on steep mountain slopes are today situated in local spruce-fir forests and are difficult to recognize and map in the field. The glacial geology of the southern Rocky Mountains was well summarized by Richmond (1965). Benedict (1973) put together an important summary of Front Range alpine glaciation in central Colorado, largely a product of his own mapping and related studies. More recent summaries of alpine glaciation are by Davis (1988), who comments on many previous studies, especially the Colorado records for neoglaciation, and Davis et al. (2009), who present a state-of-the-art assessment of the broad field of alpine glaciation.

The Sangre de Cristo Range of northern New Mexico occurs at more southerly latitudes than elsewhere in the Rocky Mountains and consequently the expected extent of Neoglaciation may be less well developed than farther north. Two noteworthy investigations of the local glacial geology are by Wesling (1987, 1988) and Armour et al. (2002). The investigation by Wesling involved the mapping of high elevation moraines and the comparative study of soil formation on those moraines. Unfortunately, age control for the mapped moraines was relative, based almost entirely on topography, soils, and weathering rinds on cobbles, and must be considered provisional at best. Wesling obtained one radiocarbon date during his investigation. Charcoal from the base of a 16 cm deposit of loess that rests on what he identified as a glacial moraine yielded an age of 3,570 ± 145 ^{14}C years BP (DIC-3058). The radiocarbon-dated charcoal was collected from above the till at the loess-till contact; he described the underlying till as having a well-defined Bt horizon (Wesling, 1987, 1988).

Subsequently, the sedimentary and chemical analysis of three cores, two of them AMS dated, from a bog in the same Windsor Creek basin investi-

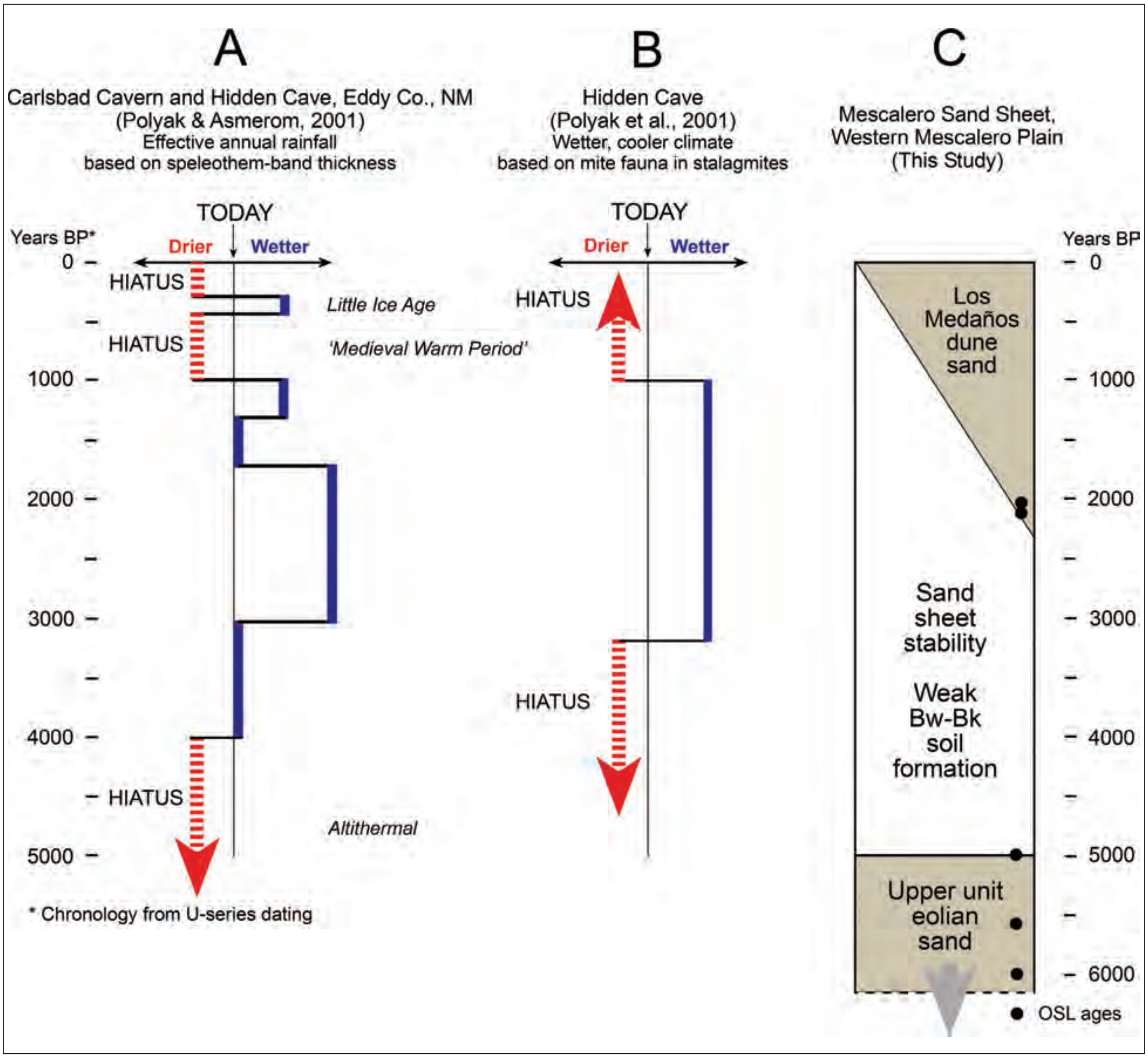


Figure 24.49. A) Effective annual rainfall based on growth-band-width measurements of five U-series dated stalagmites from Carlsbad Caverns and Hidden Cave, Eddy Co., New Mexico. Hiatuses are absences of growth bands and represent drier-than-today climate (from Polyak and Asmerom, 2001; Rasmussen et al., 2006). B) Wetter and cooler climate at Hidden Cave based on presence of 18 species of mites and their ecology (from Polyak et al., 2001). C) Composite summary of middle and late-Holocene eolian geology of the Mescalero sand sheet, Eddy Co., NM (this study).

gated by Wesling was interpreted as indicating local glaciation (Armour et al. 2002). Layers of clastic particles in the cores were equated with glacial and periglacial events. The glacial events were correlated with the Younger Dryas and with the Neoglaciation.

The Younger Dryas is a brief period of glacial advance and cool climate occurring about 10,900 to 10,000 ^{14}C years BP; Haynes 2008; Hall et al. 2012; and Armour et al. 2002, correlated the late Holocene clastic layer from the bog core with one of the moraines that Wesling mapped and above which he had obtained a radiocarbon age of 3,570 ± 145 ^{14}C years BP.

However, Armour et al. (2002:724) stated: "An inset lateral moraine within the Lake Katherine cirque with little soil development and a very sharp surface profile was assigned a late Holocene age. A radiocarbon date of 3570 ± 145 ^{14}C years BP from charcoal underlying till at the base of this moraine shows a late Holocene glacial advance." Wesling (1987, 1988) was very clear that he collected the charcoal sample from above the till, not below it. Why Armour et al. (2002) thought that the dated charcoal came from beneath the till and not above it, as reported by Wesling, is unknown.

Pollen analysis of the two AMS-dated cores, the same cores collected by Armour et al. (2002), has been reported by Jiménez-Moreno et al. (2008). They briefly comment on the local neoglacial record and state: “Wesling (1988) described the presence of a late Holocene lateral moraine within the Lake Katherine cirque and interpreted it as a glacial advance” (Jiménez-Moreno et al. (2008:1449). However, this again misrepresents Wesling’s work. Wesling interpreted the moraine, with the overlying radiocarbon date of 3570 ± 145 ^{14}C years BP, as a middle Holocene glacial event (Wesling 1991). Instead, it was Armour et al. (2002) who misinterpreted the moraine as late Holocene.

Jiménez-Moreno et al. (2008:1449) further state that the local pollen record does not support late Holocene glaciation and that Wesling’s late Holocene moraine “could also be a protalus rampart.” Again, to set the record straight, Wesling did not report a late Holocene age moraine. Indeed, Wesling (1988:161–162) specifically stated that, during the past 5000 years, the area was characterized by protalus ramparts and colluviation. In a critical review of Neoglaciation in the Rocky Mountains, however, Davis (1988) concludes that the evidence for middle Holocene glaciers is sparse and questionable.

A new study involves ^{10}Be dating of boulders from the moraines that Armour et al. (2002) regarded as Younger Dryas and Neoglacial. Both moraines are pre-Younger Dryas and late Pleistocene in age (Davis et al. 2009:2024). Consequently, evidence of Neoglaciation in New Mexico has now vanished. Unfortunately, a reliable glacial history of the Sangre de Cristo Range of northern New Mexico with directly dated moraines and glacial deposits remains, for now, an unrealized goal.

Summary of the Archaeological Geology

The archaeological sites along the NM 128 project occur in four different geologic settings, discussed below (Fig. 24.50). The geologic environment determines the visibility of the archaeological record.

Mescalero Sand Sheet with Coppice Dunes: Three archaeological sites, LA 129216, LA 129214, and LA 113042, occur on the Mescalero sand sheet. Twentieth century coppice dunes are present, covering parts of the eroded sites. Eolian sand deposits are thin, and coppice dunes are sparse at LA 113042. The archaeological sites are much younger than the eolian sediments on which the sites occur. Based on OSL dating, the sand sheet began deposition c. 13,000 years ago and continued accumulating until c. 5000 years ago when the local sand sheet stabilized. During the past 5000 years, a weak Bw and Bk soil formed on the stable sand and is visible in all exposures except where the sand is disturbed by prehistoric habitation. The ages of most of the archaeological sites fall within the period of sand sheet stability, especially about 1900 to 500 years ago. However, two site features buried in the Upper unit eolian sand at LA 129216 are OSL-dated late Paleoindian.

Anthrosols: Prehistoric occupations produce a site “footprint” of disturbed sand and, where habitation was prolonged, an anthrosol. An anthrosol is especially noteworthy at LA 129216 and LA 129214 where it is about 40 to 50 cm thick. The anthrosol is characterized by high organic carbon, up to 0.45 percent, and 87.0 to 109.5 mg/kg of total phosphorus. The anthrosol is strongly visible in exposures because of its dark color, a result of its abundant charcoal content. Bw soil horizons in the eolian sand are generally obliterated due to disturbance and mixing of the sand during site formation.

Mescalero Paleosol Calcrete: Two sites, LA 129300 and 129218, occur in very thin eolian sand directly on calcrete of the Mescalero paleosol. Both sites have Early Archaic features. If the sites had been located elsewhere on the sand sheet associated with thicker deposits of the Upper unit eolian sand, the Archaic sites would be buried.

Permian Gypsum with Shallow Basins: Site LA 129222 occurs on a topographic bench that is formed by resistant Tamarisk Member gypsum of the Rustler Formation (Upper Permian). The surface of the weathered gypsum is covered by a biological soil crust, and small shallow depressions contain deposits of dust (silt and clay). Artifacts were scattered over the surface of the eroded gypsum, in the soil crust, and in the shallow pockets of silt and clay.

Los Medanos Sand with Parabolic Dunes: Site LA 129217 occurs in thick eolian sand on the edge of Los Medanos, an area of high parabolic dunes in the central axis of the Mescalero sand sheet. Artifacts are eroded from the site and concentrated in blowouts in the dune field. From field observations, the stratigraphic position of the site within the dune sand was not entirely clear. Owing to the absence of radiocarbon dates from the site, however, its correlation with the eolian sand sequence is uncertain.

Buried Archaeology: Buried archaeology was discovered only once during the geological investigations. Two lines of stones were found at 45 and 58 cm below the top of the Upper unit eolian sand in Trench 1 at LA 129216. The features had no associated artifacts or charcoal. Based on interpolation of OSL ages from the sand in which the features occurred, the features are c. 8970 and 10,600 years old. However, the stone features are oriented at a slight incline to the present-day top of the Upper unit and may have been constructed on the same now-invisible paleosurface. Two sites, LA 129300 and LA 129218, have components that are Early Archaic in age. The dated features at these sites are visible and exposed because they occur close to the eroded surface of the Mescalero paleosol calcrete. If the sites occurred on the sand sheet, they would be buried in the Upper unit sand and likely hidden from discovery.

Local Archaeology and Paleoecology: The major period of prehistoric occupation in the study area occurred between about AD 350 and AD 1250 with the most intense site use from about AD 900 to 1100. After AD 1100, the number of features at all dated sites declines sharply (Fig. 24.50). Based on the above paleoclimatic review of the study area, the most informative record is from cave speleothems in the Carlsbad Caverns National Park in the southern Guadalupe Mountains about 40 km (25 miles) southwest of NM 128. Stalagmite growth bands show that the period from about 3000 to 1000 years ago was characterized by rainfall significantly higher than that of today. Thus, the archaeological record along NM 128 may have a connection to a period of slightly moister local climate. Furthermore, the cave-speleothem records end c. 1000 years ago with shift from a comparatively wet climate to a dry one, coinciding with the beginning decline in number of dated features at the NM 128 sites.

Synopsis

1. The Mescalero sand sheet in the western Mescalero Plain consists of three late Quaternary, eolian sand bodies, excluding recent coppice and parabolic dunes.

2. The oldest, the Lower unit eolian sand, was observed only at LA 129217 and was OSL-dated between 60,000 and 50,000 years. Its red color is due to the presence of the argillic Berino paleosol.

3. The Upper unit eolian sand is the principal sand body on the sand sheet; it occurs throughout the western Mescalero Plain and, in this investigation, was OSL-dated 13,000 to 5000 years. It is yellowish red in color and has weak Bw and Bk soil horizons that formed over the past 5000 years.

4. The youngest sand body, Los Medanos sand, was observed only in the core area of a local dune field and is OSL-dated less than 2000 years. It does not occur widely on the sand sheet and appears to be restricted to the dune fields. This is the first record of late Holocene eolian deposits on the sand sheet that post-date the Upper unit.

5. The Lower red eolian sand directly overlies the calcrete of the Mescalero paleosol. Where the Lower unit is missing due to erosion or non-deposition the Upper unit sand rests directly on the calcrete.

6. Many of the archaeological sites and features are associated with Upper sand. Sites younger than 3000 BC occur on the surface of the Upper sand, while older sites are buried in the sand.

7. Two rock features with OSL-interpolated ages of 8970 to 10,600 are buried at 45 and 58 cm depth, respectively, at LA 129216. The ages indicate that they are late Paleoindian in origin.

8. Prolonged prehistoric occupation at the sites has resulted in the development of site-disturbance footprints, including a 40 cm thick anthrosol in the Upper sand at LA 129214 and LA 129216.

9. The dark reddish-brown anthrosol at LA 129214 is characterized by 0.20 to 0.45 percent organic carbon and 87 to 109 mg/kg total phosphate. While it was thought that high total phosphate content would be related to cultural activity, it evidently is not. High amounts of total phosphate also occur in noncultural sand below the anthrosol. The high level of total phosphate values and high percentages of organic carbon are also present in the noncultural, naturally occurring Loco Hills A horizon soil on the sand sheet (Hall unpublished data).

10. Two OSL ages from site footprints at LA 129216 and LA 129300 are 4190 ± 340 and 3710 ± 300, respectively. Each age is slightly younger than the undisturbed Upper unit sand dated 13,000 to 5000 years along NM 128.

11. About 40 to 50 cm of colluvium occurs on

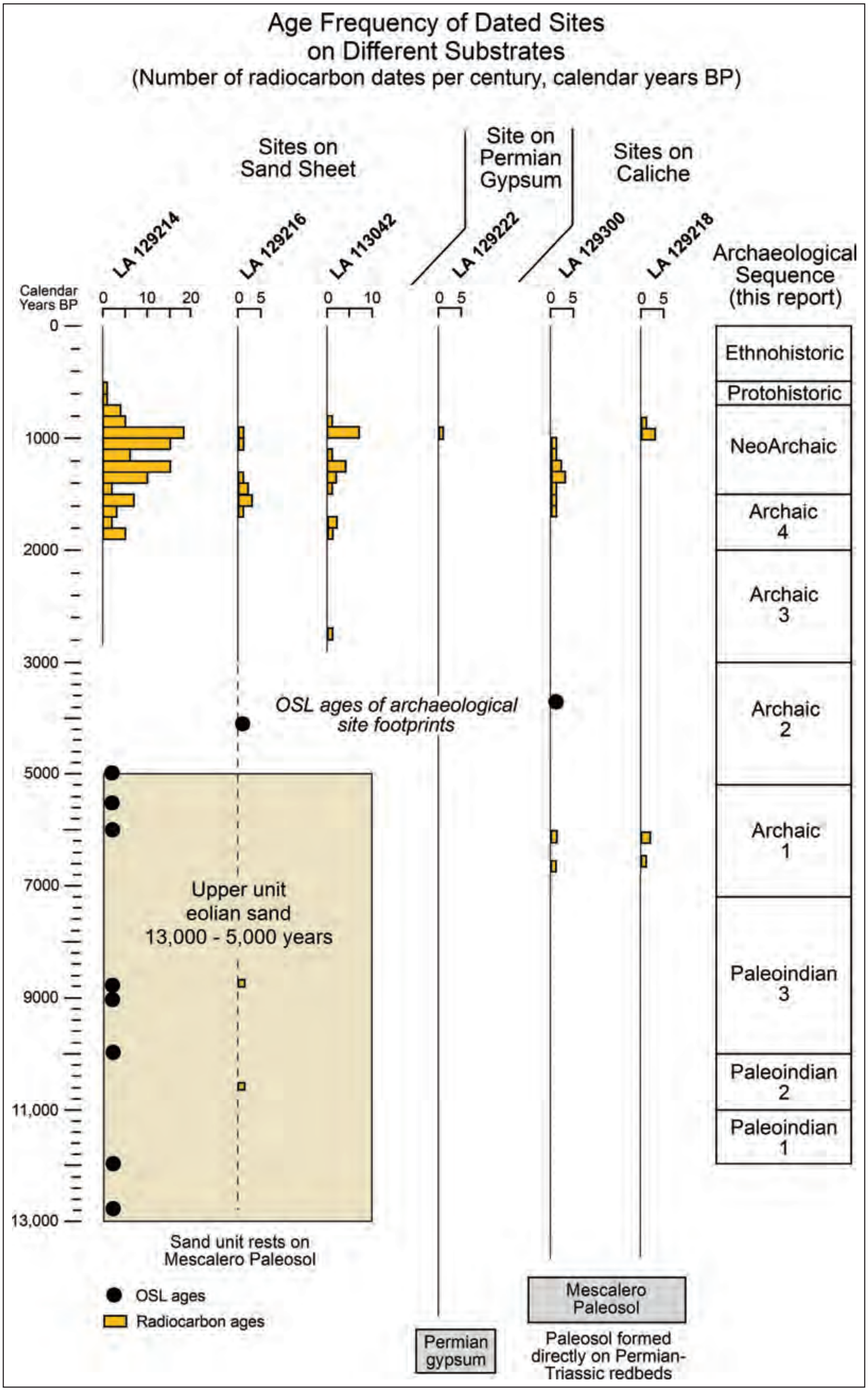


Figure 24.50. Age-frequency – 142 AMS dates – of radiocarbon-dated features at six archaeological sites arranged by geologic environment, NM 128, Eddy County, NM.

the east hillside of LA 113042. The colluvium is a mix of eolian sand and caliche gravel derived by slopewash. An OSL age from the colluvium is 2320 ± 200 years, considerably younger than the age of the local Upper unit eolian sand.

12. A thin, buried A horizon soil occurs in the vicinity of LA 129214 and is AMS radiocarbon-dated c. 1100 years BP. This may represent a grassland soil formed across the landscape during the period of a local, moister-than-today climate. In most places in the study area, however, the soil is absent due to recent erosion. The soil has delta ^{13}C values of -23.1 and -19.9 percent, indicating the predominance of organic matter from C_3 plants, probably semi-arid shrubs.

13. Fine-textured alluvium occurs beneath recent sand and gravel in the larger washes. Near LA 113042, a 1 m section of silty alluvium was AMS dated 3000 to 600 years BP.

14. The silty alluvium and the A horizon soil, the soil probably associated with grassland vegetation, are a consequence of locally moister conditions. The alluvium has delta ^{13}C values of -18.1 and -17.6 percent, indicating the predominance of organic matter from C_4 plants, probably desert grasses.

15. Pollen analysis of the silty alluvium indicates the presence of desert shrub grassland during the period 3000 to 600 years BP, similar to present-day northern Chihuahuan Desert vegetation. Pollen representing wet ground plants, however, is absent.

16. The identity of the shrubs in the late Holocene pollen record is uncertain, although they are mostly chenopods and *Ambrosia* type (Asteraceae family). Today, the shrub grassland is dominated by creosote bush (*Larrea tridentata*) and honey mesquite (*Prosopis glandulosa*) along with minor amounts of acacia (*Acacia* sp.) and four-wing saltbush (*Atriplex canescens*). Creosote bush and mesquite were evidently less common during the late Holocene.

17. Pollen grains of maize (*Zea mays*) or other economic plants were not observed in the alluvial pollen section.

18. Charcoal-to-pollen concentration ratios from the fine alluvium show a large spike in charcoal influx to the wash c. 2000 years BP, coinciding with local occupation of prehistoric sites. The large influx of charcoal into the wash may have originated from wood fires at the archaeological sites.

19. Four species of land snails occur in the fine alluvium; all are local species, indicative of desert shrub grassland.

20. Speleothem records from the Carlsbad Caverns area show that local levels of precipitation increased beginning c. 4000 years ago. By c. 3000 years ago, the climate became comparatively wetter with the moist conditions persisting until c. 1000 years ago. After 1000 years, the climate changed, becoming drier than today, corresponding to the "Medieval warm period". A brief period of increased precipitation occurred between c. 460 to 170 years ago, correlating with the Little Ice Age. Prior to 4000 years ago, during the middle Holocene, speleothem growth was not occurring, indicating a drier-than-present climate.

21. The prehistoric occupation of the sites along NM 128 coincided largely with the broad period of moister climate.

22. The eolian accumulation of the Upper unit sand ceased 5000 years ago, about 1000 years before a local increase in precipitation as based on speleothems. The wetter climate and accompanying denser ground cover may have stabilized the sand source, thereby shutting down the eolian transport system. When the precipitation decreased c. 1000 years ago, the local eolian system apparently did not reactivate.

23. An unsolved puzzle from this investigation involves Los Medanos sand that apparently accumulated over the past 2000 years, at a time when the remainder of the sand sheet was stable and inactive. The activation and deposition of Los Medanos sand in the core area of the sand sheet does not seem to correspond in any way to other observed geomorphic or paleoenvironmental events in the region.

24. This investigation is one of several small steps taken in the region to decipher the relationship of the sand sheet to biotic, climatic, and human landscapes.

Acknowledgments

Stephen A. Hall would like to thank Bonnie Newman for guidance in the field and for pointing out archaeological features at each site, Robert Dello-Russo for support and encouragement, and Regge N. Wiseman for sharing information and his insights to southeastern New Mexico archaeology and for providing helpful editorial comments on an earlier version of this report. He would like to thank the Office of Archaeological Studies (OAS), Museum of New Mexico, for their help and support of this study. He also would like to thank Ronald Goble, University of Nebraska—Lincoln, for producing pivotal OSL dates from the eolian sediment and Mary Jo Schabel of the Milwaukee Soil Laboratory, for the careful textural analyses of the sediments and soils, as well as the New Mexico Department of Transportation (NMDOT) and the Carlsbad Office of the Bureau of Land Management (BLM) for their interest and support of this investigation. GPS locations of the study localities discussed in this report are listed in Table 24.14.

25 ⩡ Summary of Radiocarbon (OxCal) Analysis

Steven A. Lakatos

Radiocarbon determinations from 20 (Fig. 25.1) sites representing five projects (NM 128; Acklen and Railey 2001; Cunnar 1997; Jones 2009; Lord and Reynolds 1985) were compiled to examine the level of human activity in and around a large geographic feature in southeastern New Mexico known as Nash Draw.

In all, 206 radiocarbon determinations are included in the analysis, see Appendix 3. Determinations were coded to provide mnemonic information about the site, provenience, material submitted for analysis, and finally the reported conventional radiocarbon age. This information was recorded hierarchically beginning with the site number, field number or, as with the sites investigated by the OAS, the last three digits of the LA number. For example: 214-13-135m:920±40BP is LA 129214, Block 13, Feature 135, mesquite; ENM10418-FL? is Site number ENM10418, Feature L, unknown material; and 109294FS#49?* is LA 109294, Field Specimen 49, unknown material, standard or extended count.

Most determinations were derived by Accelerator Mass Spectrometry (AMS); however, 15 were derived by standard or extended count measurements as denoted by an asterisk at the far right of the provenience number. Most of the dated material (n = 132/64 percent) consisted of charred mesquite with *condalia/ziziphus* (n = 12/6 percent), Fabaceae woody legume (n = 4/2 percent), *atriplex*/*sarcobatus* (n = 4/2 percent), and finally a single specimen of creosote bush. Roughly 25 percent (n = 52) of the conventional dates used in this analysis were derived from unknown material.

Based on the conventional radiocarbon age there were noticeable gaps in several of the determinations, particularly in the earlier (5720 to 1900 BP) and later (800 to 220 BP) parts of the entire sequence (Figs. 25.1 through 25.4). Relatively short gaps in the determinations, compared to the early and late part of the sequence, were also observed in the mid portion of the sequence (1880 to 840 BP). Together, these gaps were considered to represent potential periods of minimal human activity that may have been conditioned by fluctuations in climatic conditions or available resources. While acknowledging the variation in dated materials, laboratory procedures, analysis methods, and the presence of many undated archaeological sites in the study area, the overall frequency of radiocarbon determinations from the Nash Draw study area provides an opportunity to examine if the observed gaps punctuated statistically different periods of activity and if there was any spatial patterning in human activity over time.

Conventional radiocarbon dates obtained from the study area were calibrated using OxCal v3.10 and calendar dates generated through Markov Chain Monte-Carlo (MCMC) sampling method (Ramsey 2002; Striver et al. 1998). Initially, all dates were put in the same sequence; however, within this long temporal span some determinations could be grouped based on the observed temporal gaps. This was particularly true for the early dated contexts. The analysis identified an early (4690 BC to AD 300), middle (AD 110 to 1210) and late sequence (AD 1180 to 1850), each comprised of individual periods of statistically similar determinations. Sequences and periods were refined by shifting individual determinations into the preceding or subsequent group until they offered the best overall agreement.

Within the early sequence determinations were grouped into four periods representing the initial yet sporadic occupation of the Nash Draw study area. Calibrated probabilities for Nash Draw radiometric determinations can be found in Appendix 3 (OxCal). The analysis also determined that many of the observed gaps in the radiometric determinations in the middle sequence were not representative of a break in activity. In fact, what this analysis demonstrates is that the standard deviations of radiometric determinations beginning the Period 5

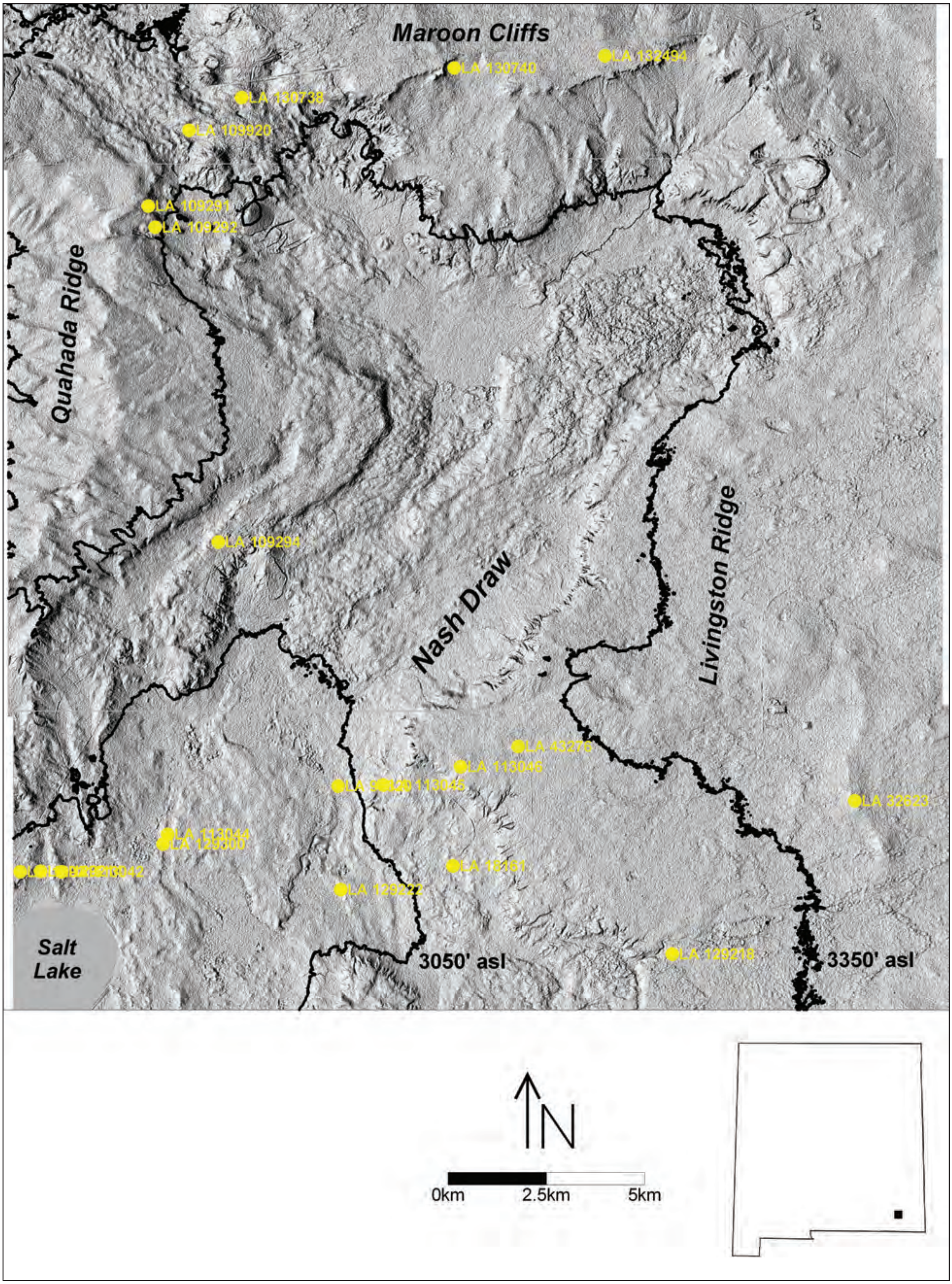


Figure 25.1. Map of site locations used in this study.

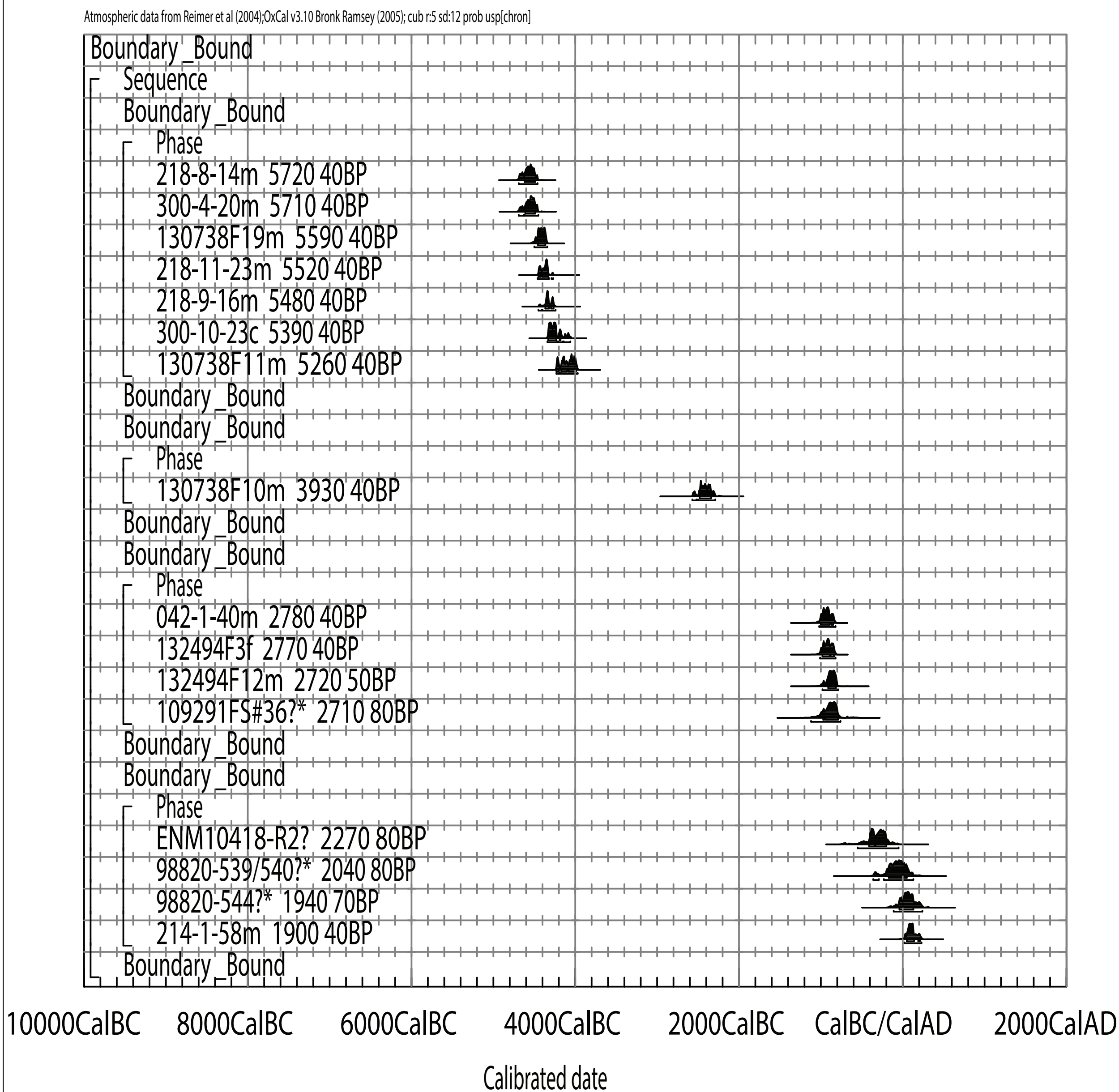
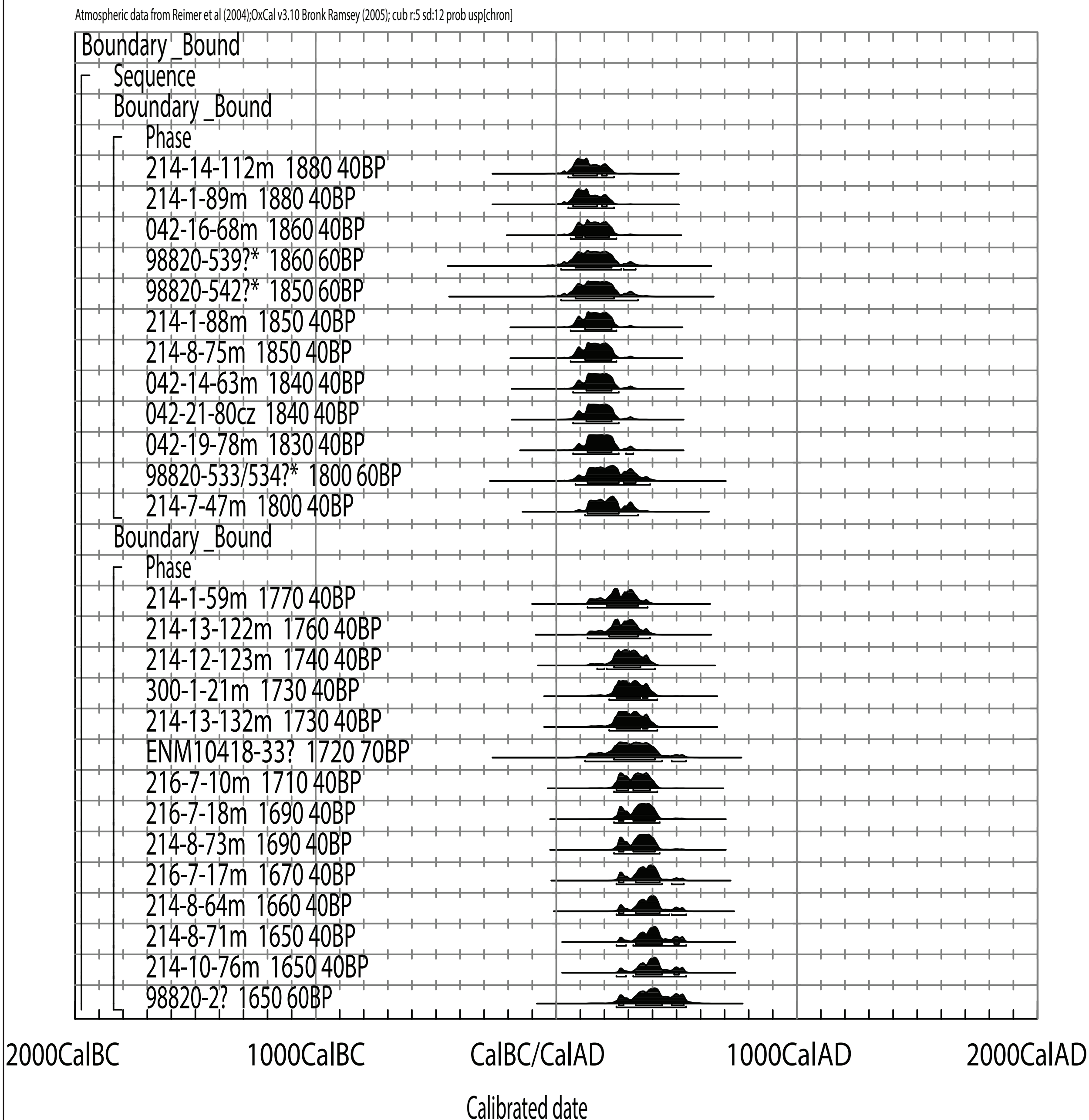


Figure 25.2. Graph of OxCal results.



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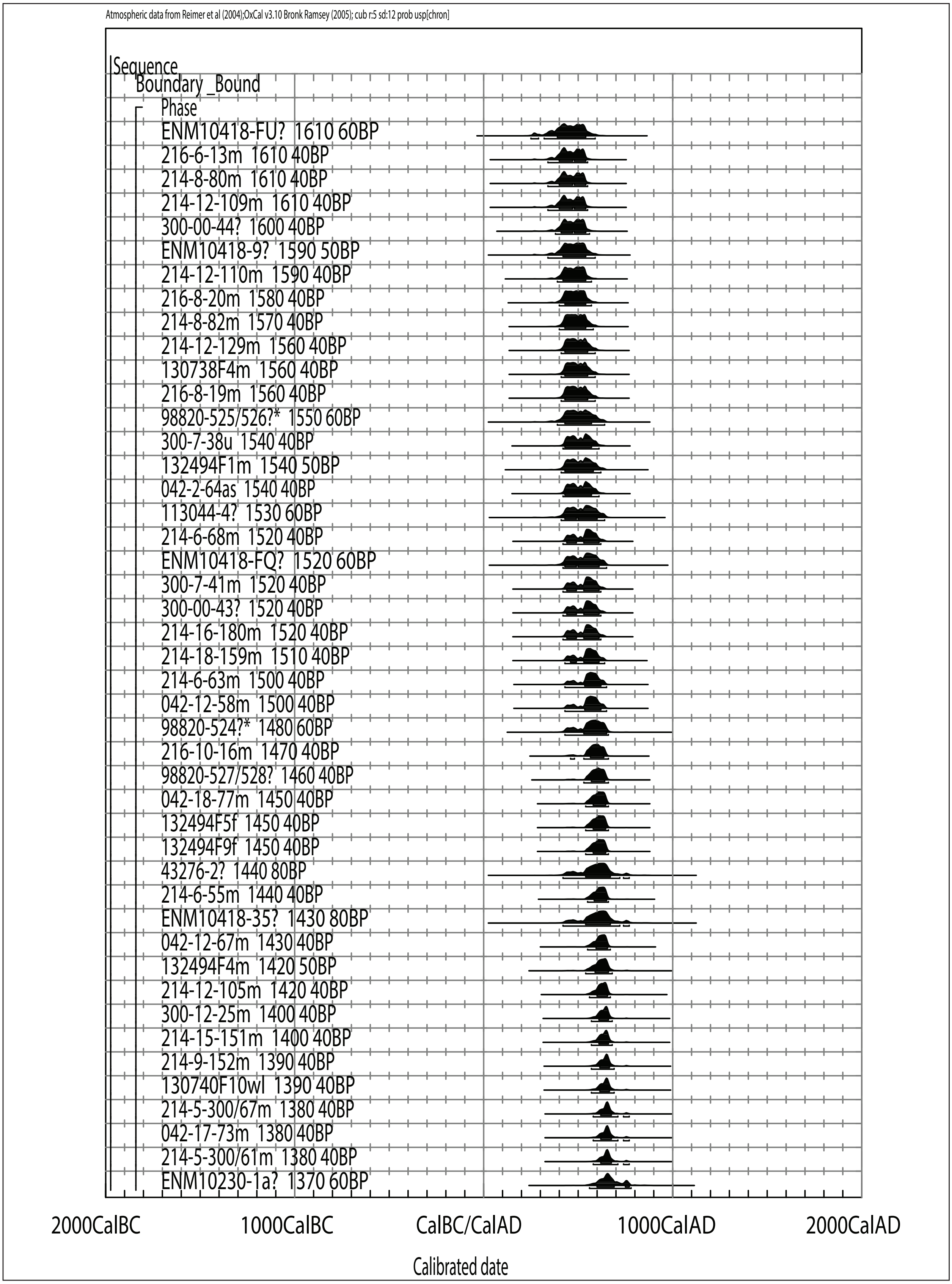

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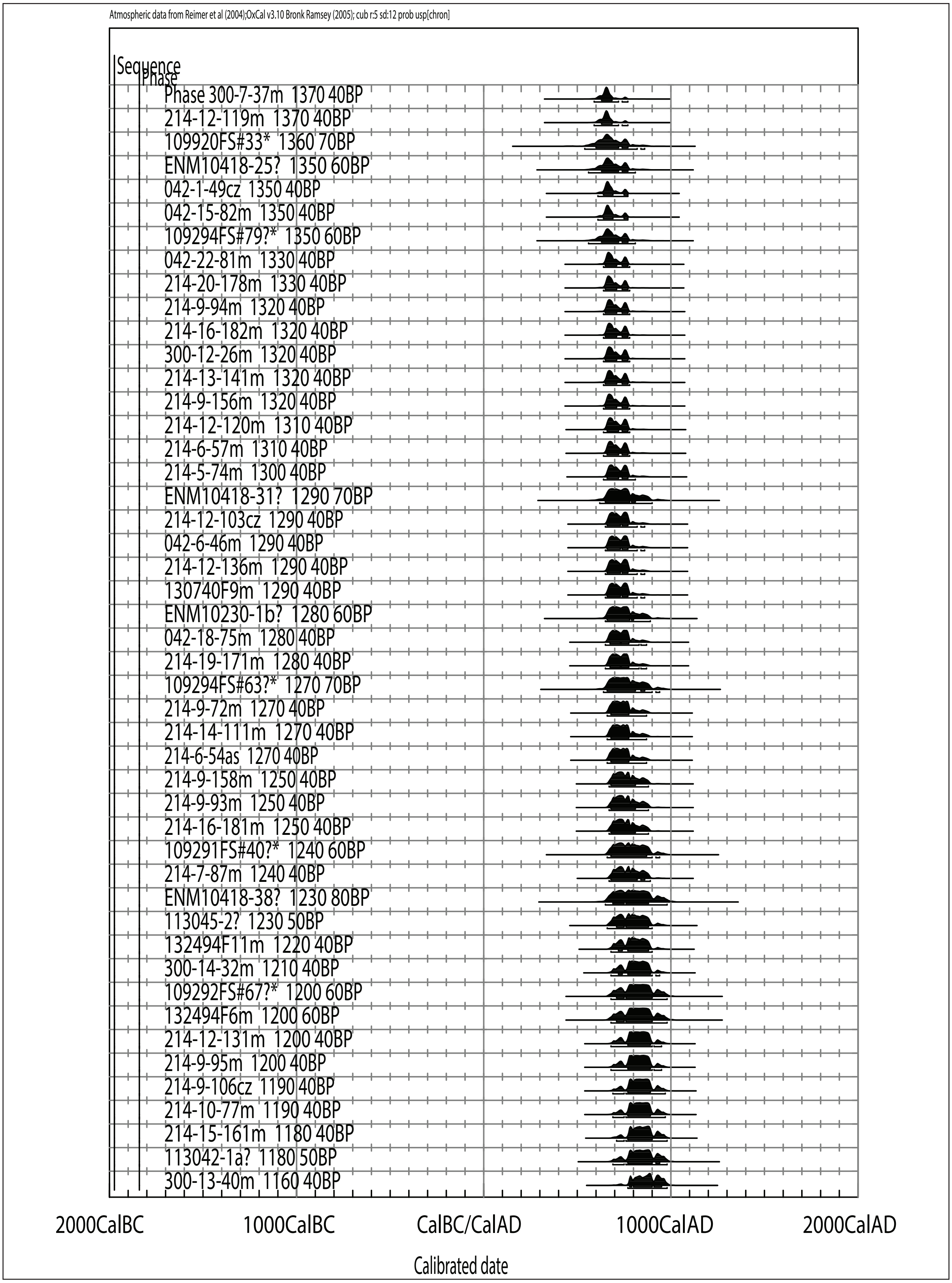

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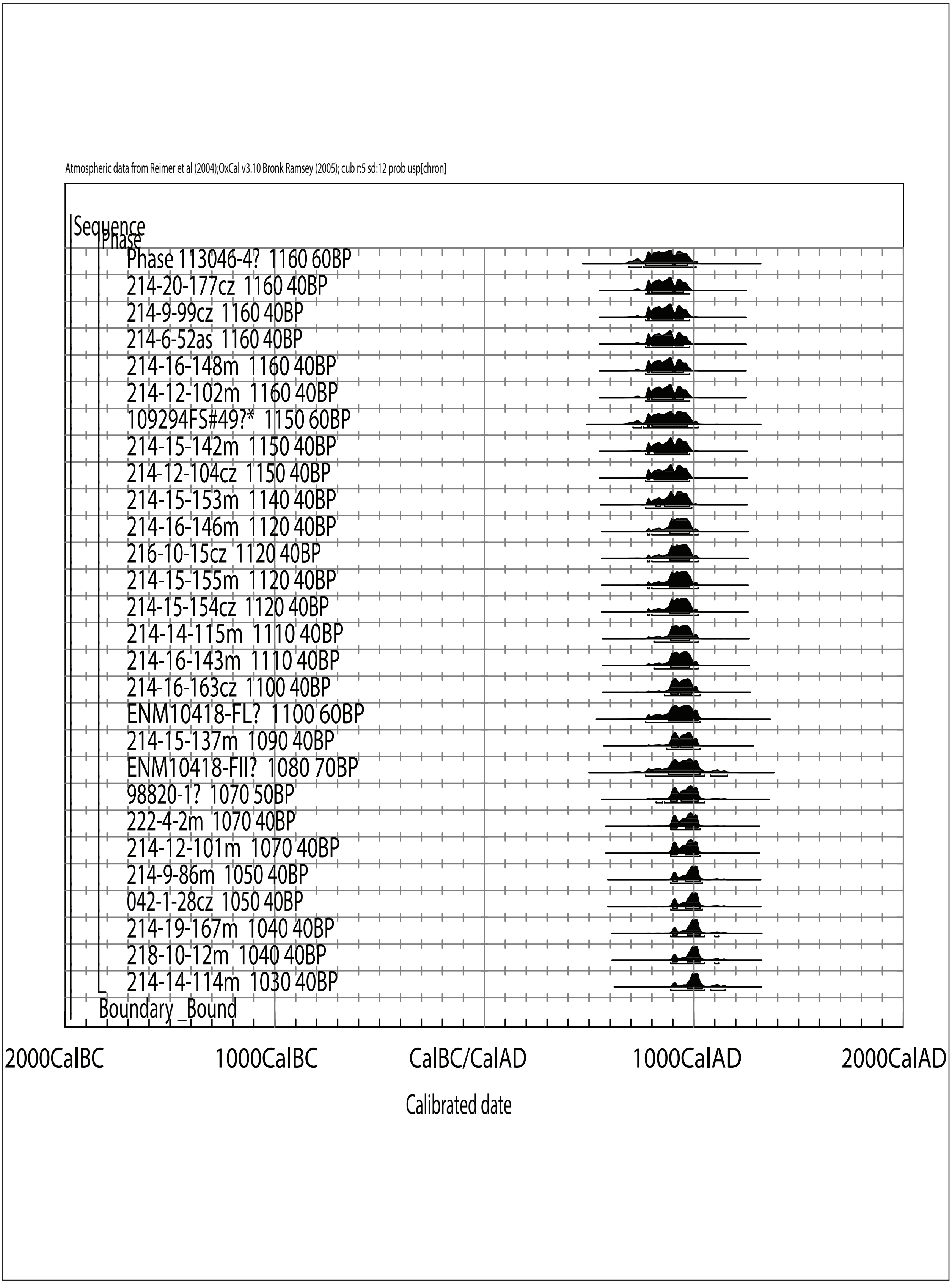

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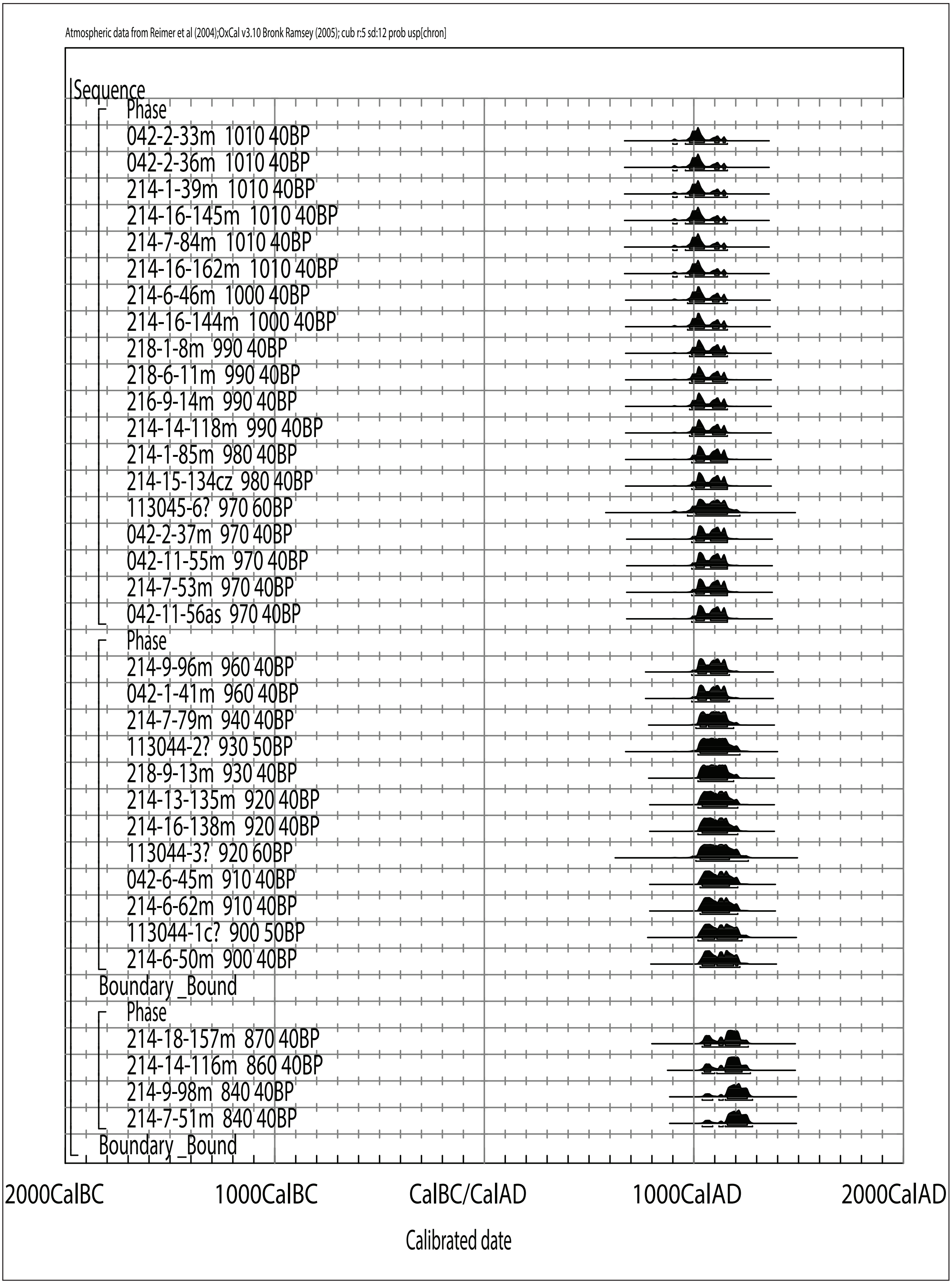

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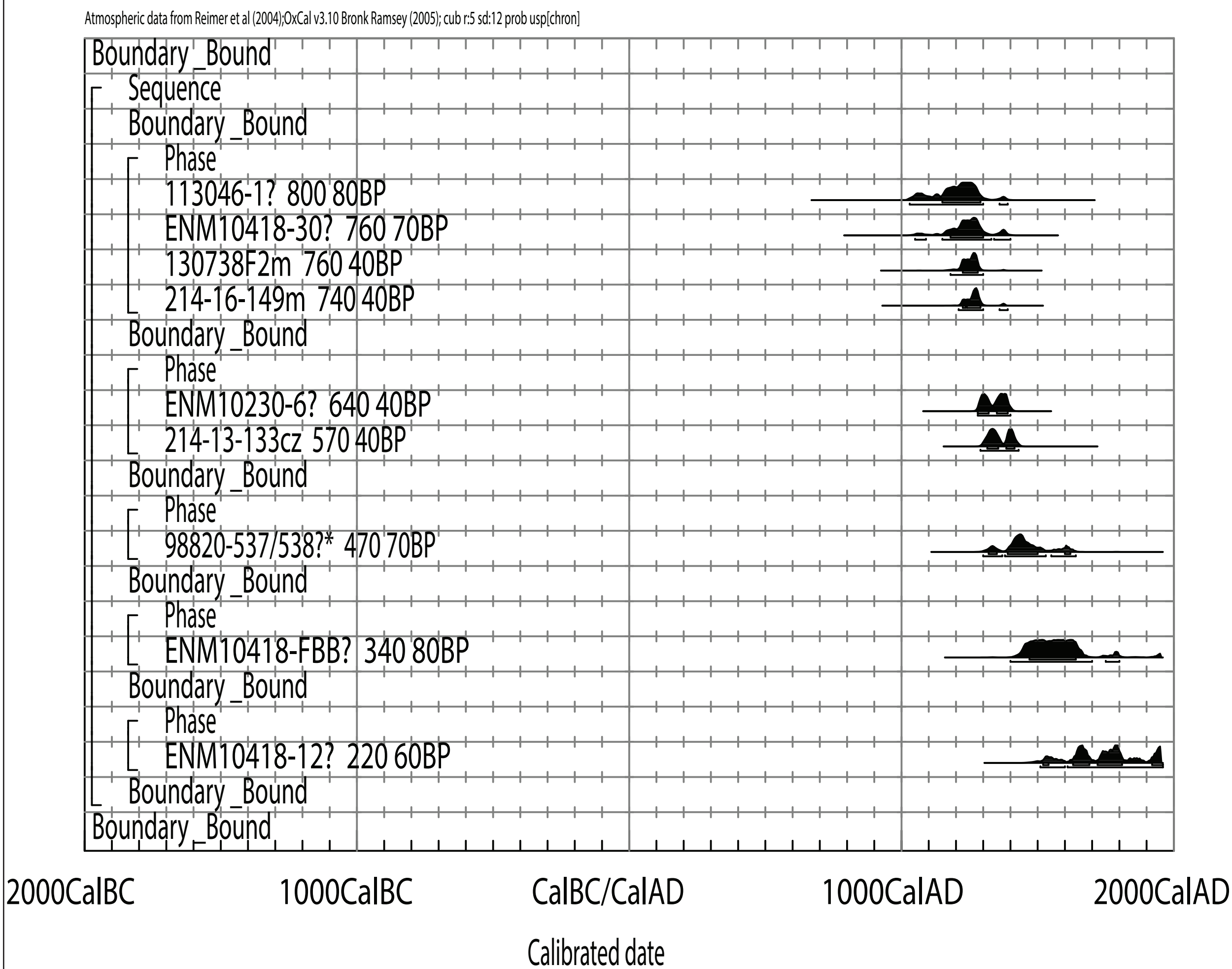

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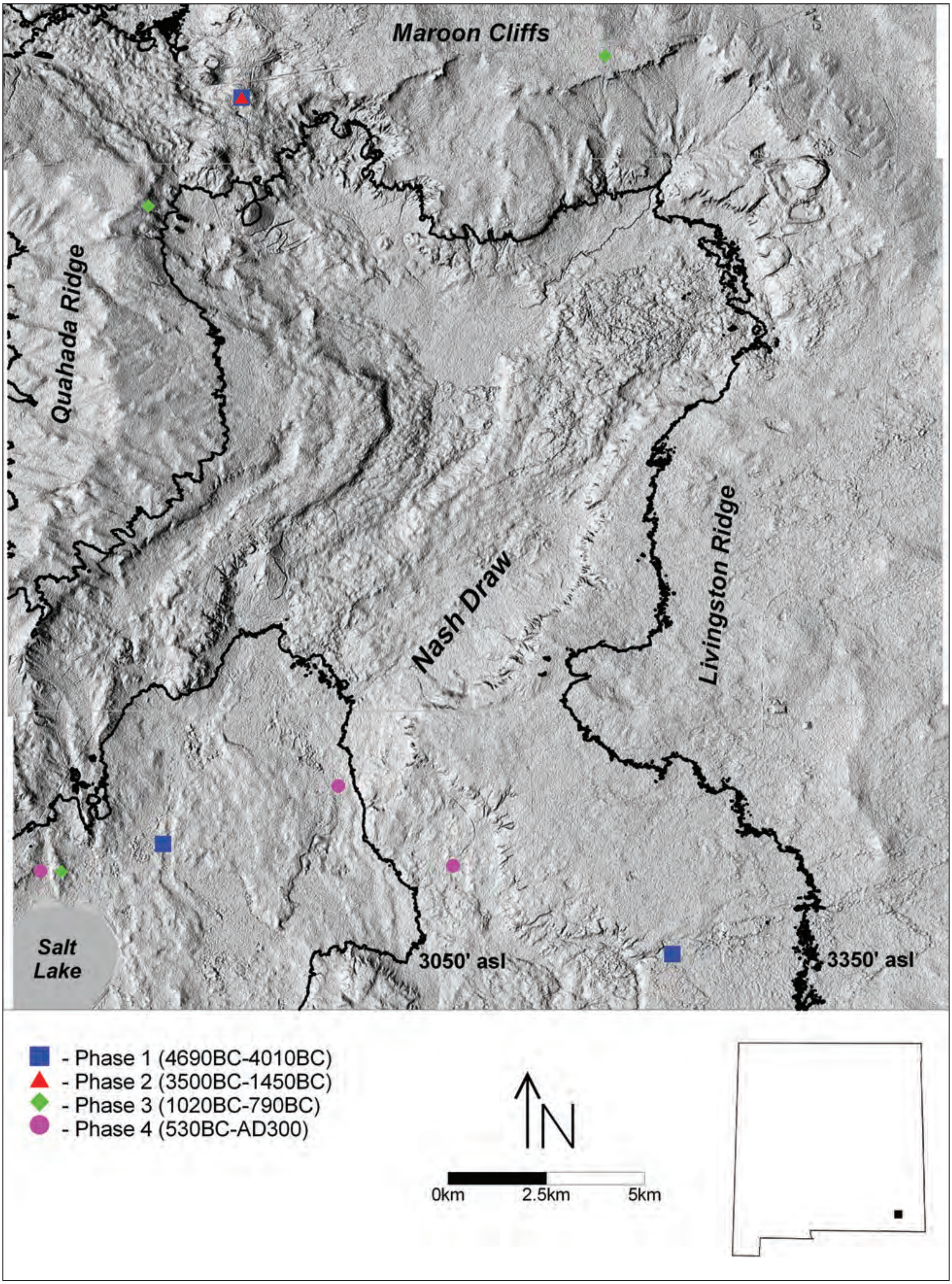

Figure 25.3a. Maps of occupation periods by site, Phases 1, 2, 3, and 4.

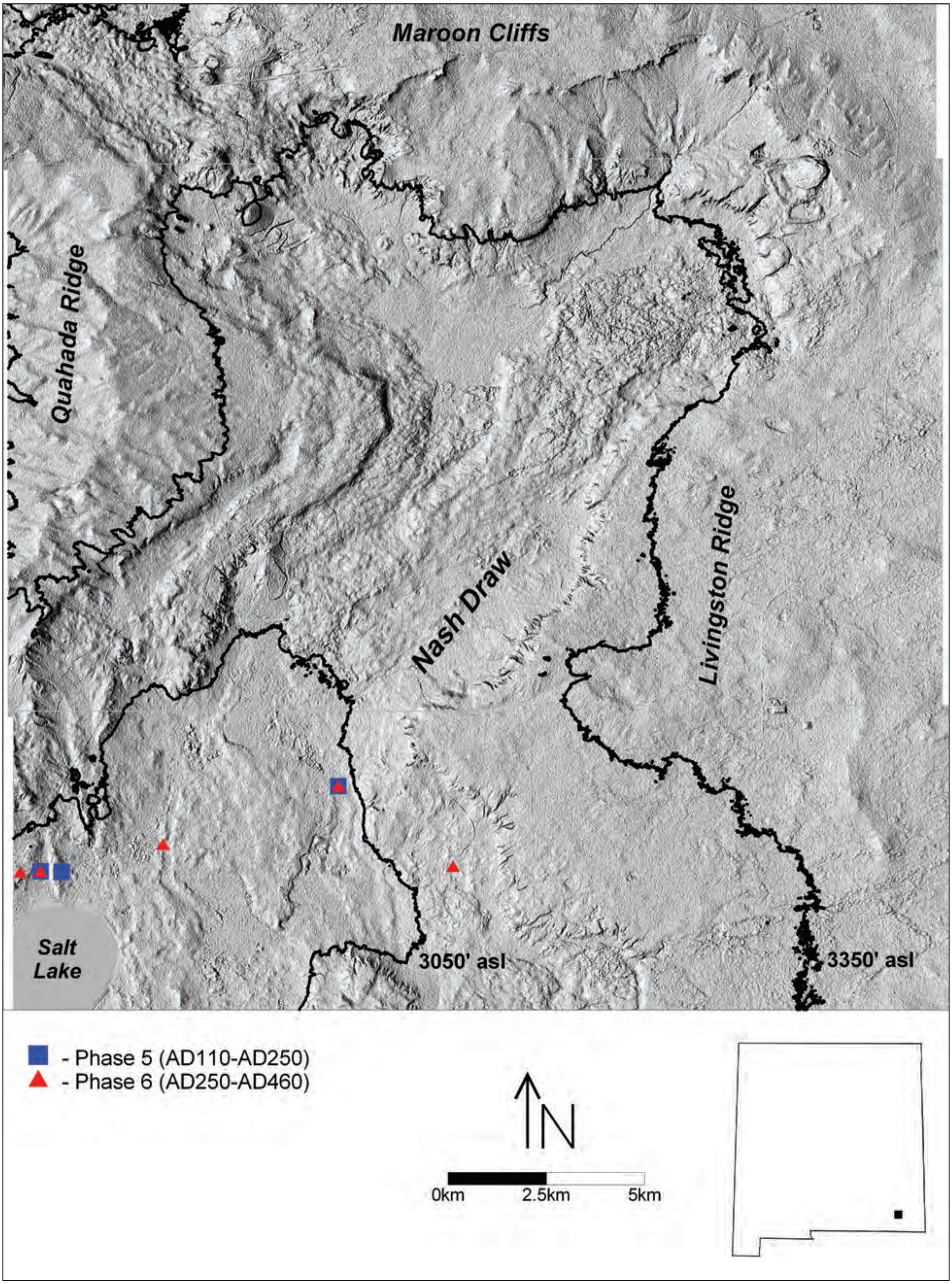

Figure 25.3b. Maps of occupation periods by site, Phases 5 and 6.

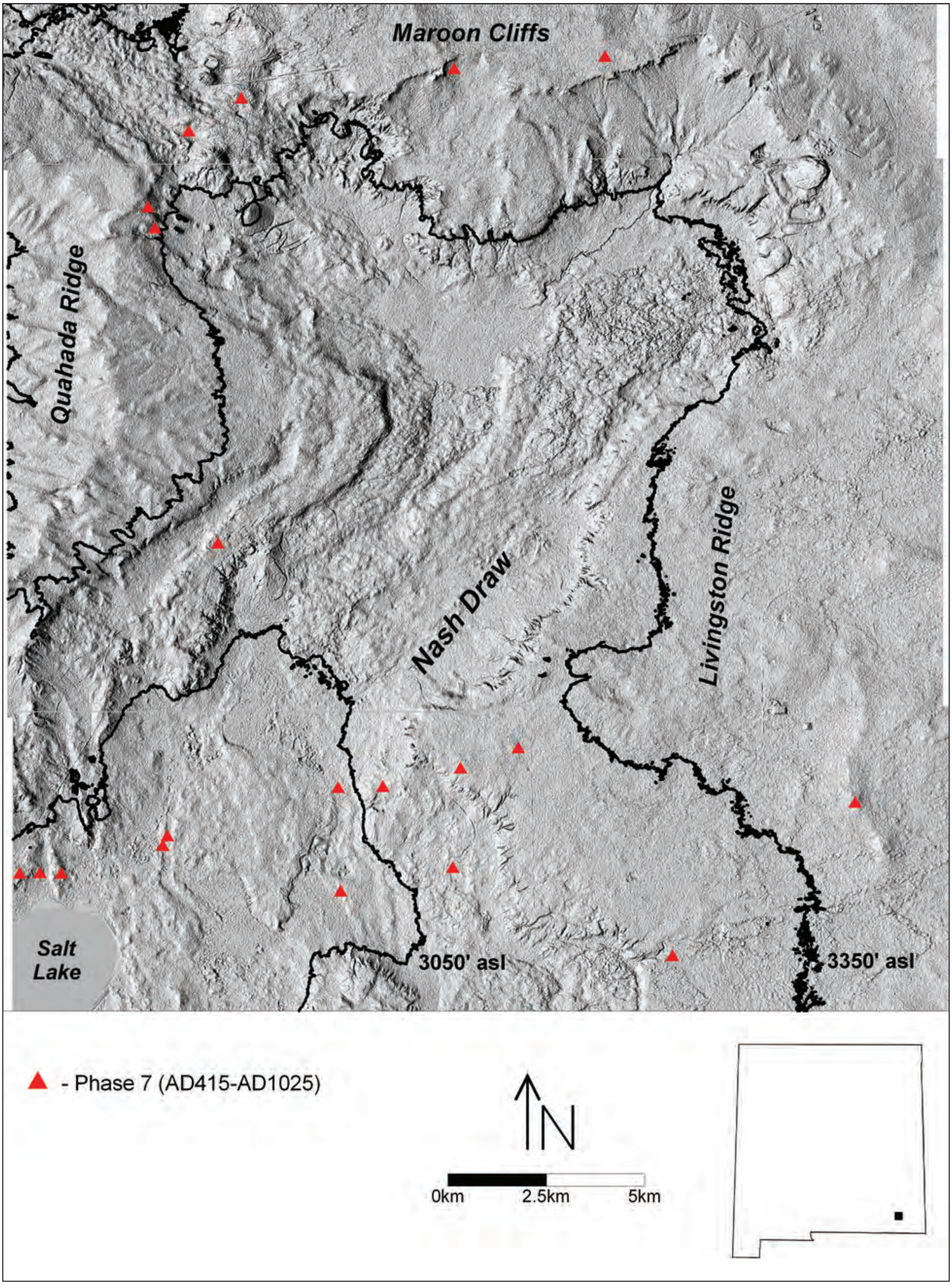

Figure 25.3c. Maps of occupation periods by site, Phase 7.

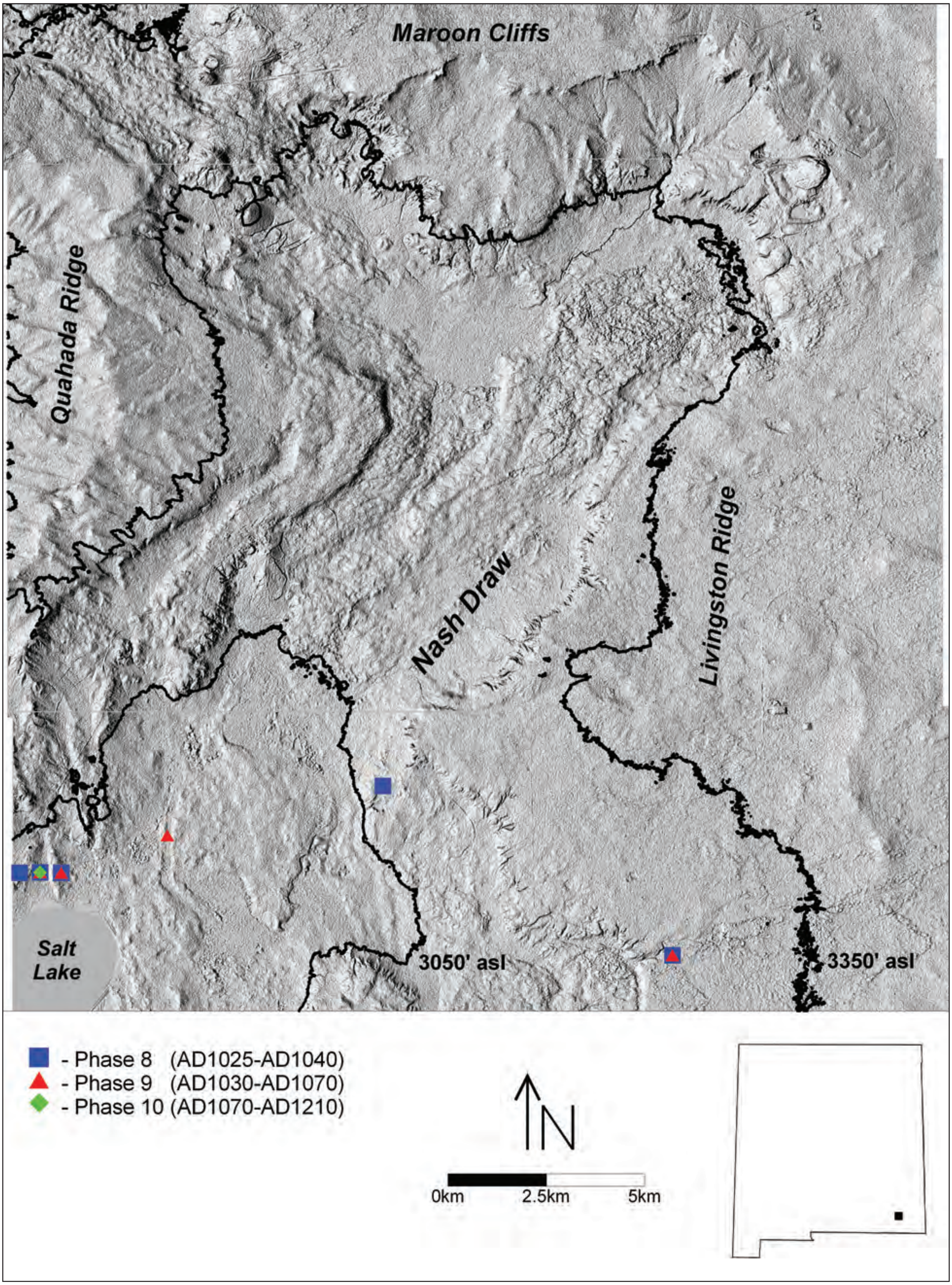

Figure 25.3d. Maps of occupation periods by site, Phases 8, 9, and 10.

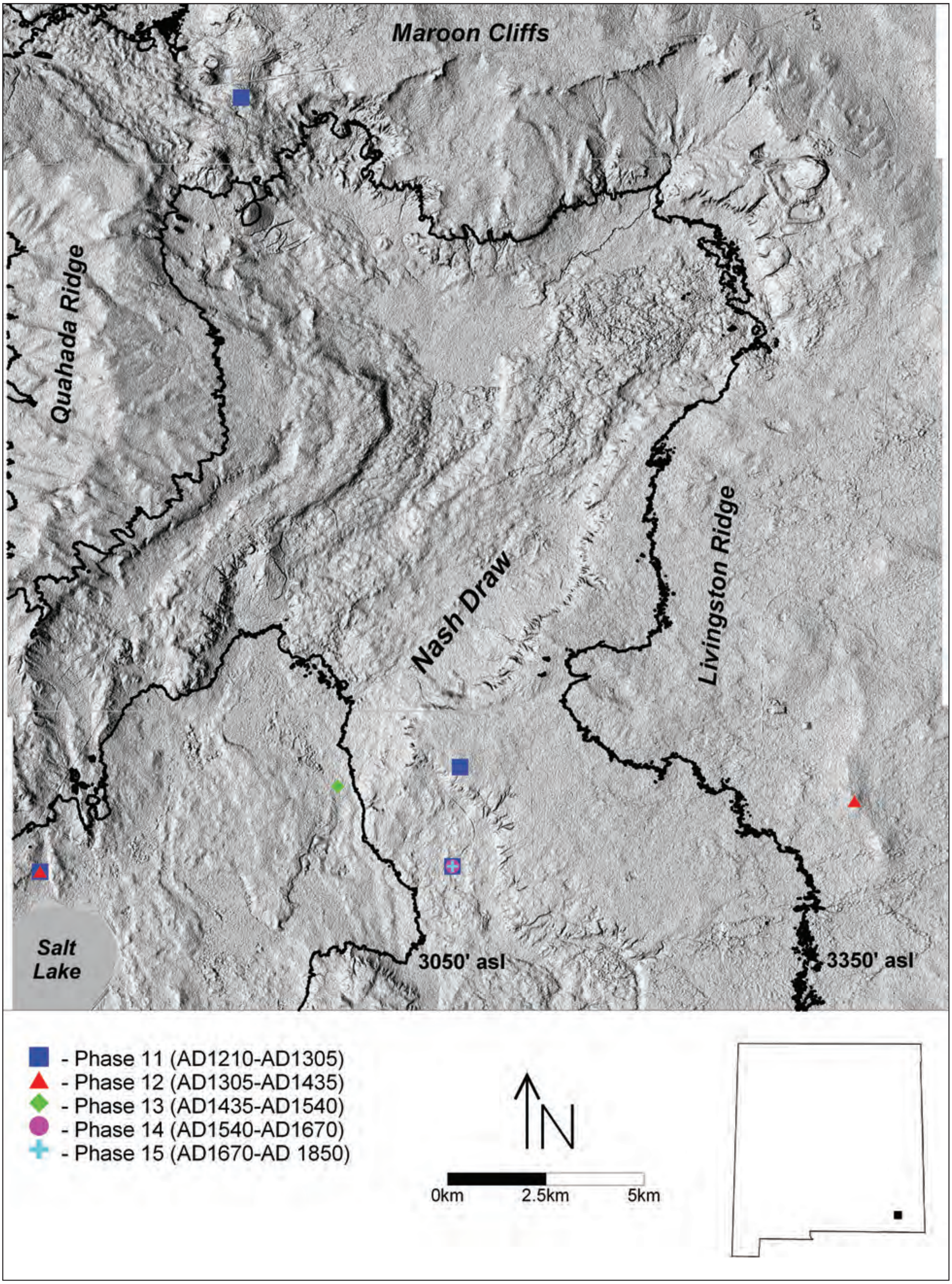

Figure 25.3e. Maps of occupation periods by site, Phases 11, 12, 13, 14, and 15.

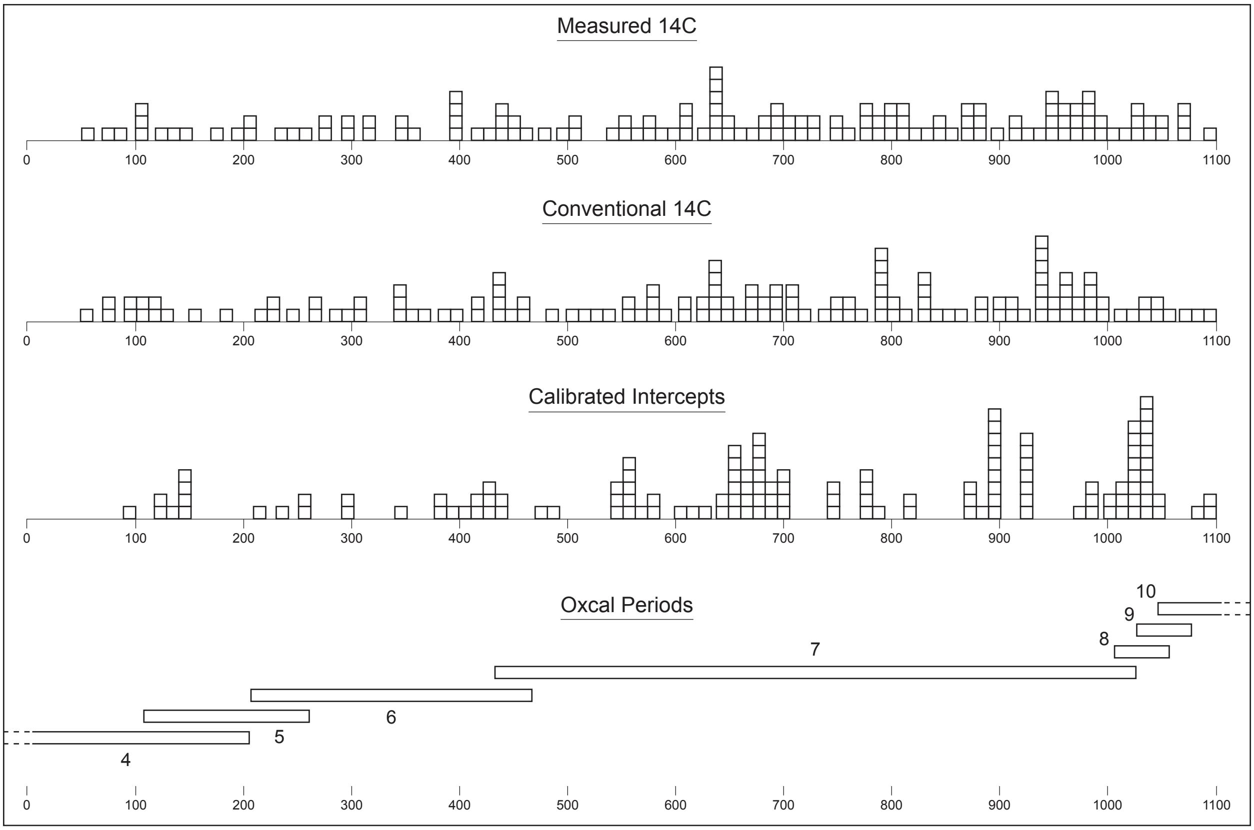

Figure 25.4. Comparison of measured 14C (a), conventional 14C (b), calibrated intercept (c), and OxCal (d) curves.

through Period 10 overlapped, suggesting repeated use of the study area for over 1000 years. Although the majority of dated contexts fall within the middle sequence, specifically between AD 200 and 1100 (n = 177/85.9 percent) representing a single continuous sequence, the grouping of determinations into six periods does suggest intermittent minimal activity. The youngest sequence is represented by five phases that demonstrate very limited use of the area after AD 1200.

26 ⸙ Special Biological Analyses

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Eight stone tools consisting of two tabular knives, a metate, and seven manos from sites LA 113042, LA 129214, LA 129216, LA 129217, and LA 129300 were submitted for combined pollen, starch, protein, and organic residue analysis. These combined analyses provide a thorough examination, allowing for the potential for multiple lines of evidence to support subsistence strategies and tool function interpretations. In addition, acorns from two locations in New Mexico were submitted for a thorough nutritional analysis.

Methods

A chemical extraction technique based on flotation is the standard preparation technique used in this laboratory for the removal of pollen from the large volume of sand, silt, and clay with which they were mixed. This particular process was developed for extraction of pollen from soils where preservation has been less than ideal and pollen density is lower than in peat. It is important to recognize that it is not the repetition of specific and individual steps in the laboratory, but rather mastery of the concepts of extraction and how the desired result is best achieved, given different sediment matrices, that results in successful recovery of pollen for analysis.

Pollen

Hydrochloric acid (10 percent) was used to remove calcium carbonates present in the soil, after which the samples were screened through 250 micron mesh. The samples were rinsed until neutral by adding water, letting the samples stand for 2 hours, and pouring off the supernatant. A small quantity of sodium hexametaphosphate was added to each sample once it reached neutrality, and then the samples were allowed to settle according to Stoke's Law in settling columns. This process was repeated with ethylenediaminetetraacetic acid (EDTA). These steps removed clay prior to heavy liquid separation. The samples then were freeze dried. Sodium polytungstate (SPT), with a density of 1.8, was used for the flotation process. The samples were mixed with SPT and centrifuged at 1500 rpm for 10 minutes to separate organic from inorganic remains. The supernatant containing pollen and organic remains was decanted. Sodium polytungstate again was added to the inorganic fraction to repeat the separation process. The supernatant was decanted into the same tube as the supernatant from the first separation. This supernatant was then centrifuged at 1500 rpm for 10 minutes to allow any silica remaining to be separated from the organics. Following this, the supernatant was decanted into a 50 ml conical tube and diluted with distilled water. These samples were centrifuged at 3000 rpm to concentrate the organic fraction in the bottom of the tube. After rinsing the pollen-rich organic fraction obtained by this separation, all samples receive a short (20 to 30 minute) treatment in hot hydrofluoric acid to remove any remaining inorganic particles. The samples then were acetolated for 3 to 5 minutes to remove any extraneous organic matter. A light microscope was used to count pollen at a magnification of 500X. Pollen preservation in these samples varied from good to poor. Comparative reference material collected at the Intermountain Herbarium at Utah State University and the University of Colorado Herbarium was used to identify the pollen to the family, genus, and species level, where possible.

Pollen aggregates were recorded during identification of the pollen. Aggregates are clumps of a single type of pollen and may be interpreted to represent pollen dispersal over short distances or the introduction of portions of the plant represented into an archaeological setting. Aggregates were included in the pollen counts as single grains, as is customary. The presence of aggregates is noted by an "A" next to the pollen frequency on the pollen diagram. A plus sign (+) on the pollen diagram indicates that the pollen or starch type was observed outside the regular count while scanning the remainder of the microscope slide (Samples 300 and 339) or that pollen and/or starch was observed, in spite of the fact that pollen was not present in a sufficient concentration to obtain a full count (Sample 470). Pollen diagrams are produced using Tilia 2.0 and TGView 2.0.2. Total pollen concentrations are calculated in Tilia using the quantity of sample processed in cubic centimeters (cc), the quantity of exotics (spores) added to the sample, the quantity of exotics counted, and the total pollen counted and expressed as pollen per cc of sediment.

Indeterminate pollen includes pollen grains that are folded, mutilated, and otherwise distorted beyond recognition. These grains are included in the total pollen count since they are part of the pollen record. The microscopic charcoal frequency registers the relationship between pollen and charcoal. The total number of microscopic charcoal fragments was divided by the pollen sum, resulting in a charcoal frequency that reflected the quantity of microscopic charcoal fragments observed, normalized per 100 pollen grains.

Pollen analysis also includes examination for and identification of starch granules to general categories, if they are present. Starch granules are a plant's mechanism for storing carbohydrates. Starches are found in numerous seeds, as well as in starchy roots and tubers. The primary categories of starches include the following: with or without visible hila; hilum centric or eccentric; hila patterns (dot, cracked, elongated); and shape of starch (angular, ellipse, circular, eccentric). Some of these starch categories are typical of specific plants, while others are more common and tend to occur in many different types of plants.

Protein Residue

Artifacts submitted for protein residue analysis were tested using an immunologically-based technique referred to as cross-over immunoelectrophoresis (CIEP). This method is based on an antigen-antibody reaction, where a known antibody (immunoglobulin) is used to detect an unknown antigen (Bog-Hansen 1990). Antigens are usually proteins or polysaccharides. The method for CIEP is based on forensic work by Culliford (1964, 1971) with changes made by Newman and Julig (1989) following the procedure used by the Royal Canadian Mounted Police Serology Laboratory in Ottawa, and the Centre of Forensic Sciences in Toronto. Further changes were made at the Paleo Research Institute following the advice of Dr. Richard Marlar of the Thrombosis Research Laboratory at the Denver VA Medical Center and the University of Colorado Health Sciences Center. Although several different protein-detection methods have been employed in archaeological analyses, including enzyme-linked immunosorbant assay (ELISA) and radioimmune assay (RIA), the CIEP test has been found to be extremely sensitive, with the detection of 10 to -8 g of protein possible Culliford (1964:1092). The specificity of CIEP is further strengthened by testing unknowns against non-immunized animal serum and the use of soil controls to eliminate the possibility of false positives due to non-specific protein interactions.

Ancient protein residues are preserved and have been detected on stone tools of considerable age using CIEP (Gerlach, et al. 1996; Hogberg et al. 2009; Kooyman et al. 2001; Seeman et al. 2008; Yost and Cummings 2008). In one of the largest samples of reactive protein residues from an archaeological site, Gerlach (1996) reports a total of 45 positive reactions obtained on 40 of the 130 stone tools tested from an early North American Paleoindian site, ca. 11,200 to 10,800 years BP.

In an archaeological context, an antigen is the unknown protein adhering to an artifact after its use. Ancient proteins undoubtedly break down into small fragments over time; however, antibodies can recognize small regions of antigens (Marlar et al. 1995). Studies by Loy (1983) and Gurfinkel and Franklin (1988) suggest that hemoglobin and other proteins bind to soil and clay particles through electrostatic interaction; this interaction protects the proteins from microbial attack and removal by groundwater. Sensabaugh et al. (1971) reported that dried blood proteins "covalently cross-linked to form a single proteinaceous mass with a high molecular weight, resulting in decreased solubility." Hyland (1990:105) suggests that protein molecules may be conjoined with fatty tissues, resulting in an insoluble complex that is secure against dissolution by water. These studies may explain, in part, mechanisms for prolonged protein preservation and adherence to stone surfaces; however, they also illustrate the challenges of recovery from artifact surfaces.

Artifacts were washed using a sonicating toothbrush with a new head and 10 ml of a 0.02M Tris hydrochloride, 0.5M sodium chloride, and 0.5 percent Triton X100 solution. The artifact and toothbrush head were rinsed with deionized water. Dirt was removed using centrifugation, and the resulting solution was concentrated down to approximately 1 ml using a Centriprep-10 centrifugal concentrator device with a 10,000 molecular weight cut-off membrane. Because soils contain compounds such as bacteria and animal feces that can cause false-positive results for artifacts buried in the soil, control samples also are typically tested; however, soil controls were not submitted with these artifacts.

The residues extracted from the artifacts and soil controls first were tested against pre-immune goat serum (serum from a non-immunized animal) to detect non-specific binding of proteins. Samples testing negative against pre-immune serum then were tested against prepared animal antisera obtained from ICN Pharmaceuticals, Inc. and Sigma Chemical Company, and against antisera raised under the direction of Robert Sargeant in Lompoc, California, and Dr. Richard Marlar. Appropriate positive and negative controls are run for each antisera. A positive control consists of the blood of an animal for which the antiserum is known to test positively, and a negative control consists of the serum/blood of the animal in which the antiserum was raised, either rabbit or goat.

CIEP is performed using agarose gel as the medium. Two holes were punched in the gel about 5 mm apart. The protein extract from the artifact was placed in the cathodic well and the antiserum was placed in the anodic well. The sample was electrophoresed in Barbital buffer (pH 8.6) for 45 minutes at a voltage of 130v to drive antigens and antibodies toward each other. Positive reactions appear as a line of precipitation between the two wells. Gels were stained with coomassie blue to make the precipitate line easier to see. Positive reactions were retested with dilute antisera to determine between true and false positives. Antisera were diluted to increase specificity of reactions, usually 1:10 or 1:20. Positive reactions obtained after this step were reported.

Identification of animals represented by positive results is usually made to the family level. All mammalian species have serum protein antigenic determinations in common; therefore, some cross reactions will occur between closely and sometimes distantly related animals (Gaensslen 1983:241). For example, bovine antiserum will react with bison blood, and deer antiserum will react with other members of the Cervidae (deer) family, such as elk and moose.

FTIR (Fourier Transform Infrared Spectroscopy)

A mixture of chloroform and methanol (CHM) was used as a solvent to remove lipids and other organic substances that had soaked into the surface of the ground stone and lithics. This mixture is represented in the FTIR graphics as CHM. The CHM solvent and sample were placed in a glass container and allowed to sit, covered, for several hours. After this period of time, the solvent was pipetted into an aluminum evaporation dish, where the CHM was allowed to evaporate. This process leaves the residue of any absorbed chemicals in the aluminum dishes. The residue remaining in the aluminum dishes was then placed on the FTIR crystal and the spectra were collected. The aluminum dishes were tilted during the process of evaporation to separate the lighter from the heavier fraction of the residue. The lighter and heavier fractions are designated upper (lighter fraction) and lower (heavier fraction), respectively, in the subsequent analysis.

FTIR is performed using a Nicolet 6700 optical bench with an ATR and a diamond crystal. The sample is placed in the path of a specially encoded infrared beam that passes through the sample and produces a signal called an "inferogram." The inferogram contains information about the frequencies of infrared that are absorbed and the strength of the absorptions, which is determined by the sample's chemical make-up. A computer reads the inferogram and uses Fourier transformation to decode the intensity information for each frequency (wave numbers) and presents a spectrum.

FTIR Review

Infrared spectroscopy (IR) is the study of how molecules absorb infrared radiation and ultimately convert it to heat, revealing how the infrared energy is absorbed, and the structure of specific organic molecules. Infrared spectroscopy has been experiencing a Renaissance for identifying organic substances during the past few decades. It is currently considered one of the more powerful tools in organic and analytical chemistry. One of the primary advantages to the FTIR is that it measures all wave lengths simultaneously. It has a relatively high signal-to-noise ratio and a short measurement time. Each peak in the spectrum represents either a chemical bond or a functional group.

Since molecular structures absorb the vibrational frequencies or wavelengths of infrared radiation, the bands of absorbance can then be used to identify the composition of the materials under study. In the case of the current research, the portion of the electromagnetic spectrum between 4000 to 400 wave numbers is used for identifying organic materials. Carbohydrates, lipids, proteins, and other organic molecules are associated with specific wave number bands (Isaksson 1999:36–39).

The infrared spectrum can be divided into two regions—the functional group region and the fingerprint region. These two groups are recognized by the effect that infrared radiation has on the respective molecules of these groups. The functional group region is located between 4000 and approximately 1500 wave numbers. The molecular bonds display specific characteristic vibrations that identify fats, lipids, waxes, lignins, proteins, carbohydrates, etc. The fingerprint region, located below 1500 wave numbers, is influenced by bending motions that further identify the molecules present.

Using the FTIR, it is possible to identify different types of organic compounds and eventually recognize different types of materials like plant or animal fats or lipids, plant waxes, esters, proteins, carbohydrates, and more. Specific regions of the spectrum are important in identifying these compounds.

The results of the identification of specific wavelengths can be compared with commercial or laboratory-created analytical standards to identify the specific types of bonds present in different materials. By combining the results of the analysis of individual samples with all of the reference materials in the PaleoResearch Institute (PRI) library, the percent match with individual reference items can be displayed. For instance, plant lipids or fats are identifiable between 3000 to 2800 wave numbers. A match might be obtained on this portion of the spectrum with nuts such as hickory, walnut, or acorn, or with animal fats or corn oil. Recovery of high-level matches with several types of nuts (in this example) indicates that nuts were processed. If the match with the PRI library is with meats, then the fats matched are more consistent with those produced by meat than plant parts, such as nuts.

Samples containing many compounds are more difficult to identify—and many archaeological samples are complex mixtures. Multipurpose artifacts, such as ground stone, that could have been used to crush or grind a variety of foodstuffs, or ceramic cooking vessels, that are expected to have been used to cook many different foods, might present a mixture problem. Mixtures sometimes have many absorption bands that overlap, yielding only broad envelopes of absorption and few distinctive features. FTIR analysis is expected to be particularly valuable in examining fire-cracked rock, for which few other means of analysis exist, since the fats, lipids, waxes, and other organic molecules contained in liquids that seep out of the food being processed are deposited on rocks during the baking process. Once again, these rocks might have been present in more than one cooking episode, thus having the potential to yield a complex signature. The PRI extraction method gently removes these organic molecules from the ground stone, ceramics, and/or rocks so that those molecules can be measured with the FTIR and subsequently identified.

Organic molecules from sediments can be extracted and the sediments then characterized. This has the potential to be very useful in identifying signatures of the remains responsible for a dark horizon. For instance, if a dark horizon is the result of decaying organic matter, either plant or animal, the FTIR will yield a signature of decaying organic remains. If the dark horizons are the result of blowing ash from cultural features, the FTIR signature will be considerably different. This is an affordable technique for making distinctions between horizons and identifying cultural horizons.

Carbohydrates

Carbohydrates are a product of photosynthesis in green plants. This group of compounds is the most abundant found on earth. The term carbohydrate encompasses three main groups of compounds: sugars; starches; and fibers. To elaborate, sugars include the simple carbohydrates found in table sugar, honey, natural fruit sugars, and molasses. Starches and complex carbohydrates are present in legumes, grains, vegetables, and fruits. Fibers, including cellulose, hemicellulose, and pectin, are present in whole grains, legumes, vegetables, and fruits (Garrison and Somer 1985:13). Dietary carbohydrates provide energy for bodily functions, including our ability to digest and absorb other foods. They are the body's preferred source of energy, although proteins and lipids also may be converted to energy. Carbohydrates are so important that an inadequate intake may result in nutritional deficiencies such as ketosis, energy loss, depression, and even loss of essential body protein. On the other hand, excess intake of carbohydrates causes obesity and dental decay.

To understand carbohydrates and their detection with the FTIR, it is important to know that they are formed of carbon atoms coupled to "hyrates," such as water, resulting in empirical formulas of $C_nH_{2n}O_n$ where "n" represents the number of atoms for C, H, and O, respectively. "Biochemically, carbohydrates are polyhydroxy alcohols with aldehyde or ketone groups that are potentially active" (Garrison and Somer 1985:13). Since carbohydrates are classified according to their structure and the FTIR detects the bonds between molecules, we will review the simple sugars (monosaccharides), multiple sugars (oligosaccharides), and complex molecules (polysaccharides) that are made up of simple sugars.

Polysaccharides

These complex starchy compounds follow the empirical formula: $C_6H_{10}O_5$. They are not sweet, do not crystallize, and are not water soluble. Simply defined, polysaccharides are complex carbohydrates found in plants as starch and cellulose, and in animals as glycogen. Because the FTIR detects the bonds between atoms in molecules, it is important to know that polysaccharides are formed of repeating units of mono- or disaccharides joined together by glycosidic bonds. Polysaccharides are often heterogeneous. Slight modifications of the repeating unit result in slightly different wave number signatures on the FTIR. Types of polysaccharides are descriptive and include storage (starches and glycogen), structural (cellulose and chitin), acidic (containing carboxyl groups, phosphate groups, and/or sulfuric ester groups), neutral (presumably without the acid features), bacterial (macromolecules that include peptidoglycan, lipipolysaccharides, capsules and exopolysaccharides), and more. The study of polysaccharides is an ever-growing field and industry, since polysaccharides are important to proper immune function, bowel health, and a host of other factors that are important in human health. At present there is no comprehensive study of which plants and animal parts contain which polysaccharides. Research into this field is currently growing at a rapid pace. Some highlights for the purpose of our discussions are presented below.

Storage Polysaccharides: Storage polysaccharides are digestible polysaccharides. Starch and glycogen are the two primary groups of these polysaccharides (Wardlaw and Insel 1996:80-81).

Starch is the primary digestible polysaccharide in the human diet, and the most important carbohydrate food source (Murray, et al. 2000:155; Wardlaw and Insel 1996:80). Starch is composed of long chains of glucose units. "Cooking increases the digestibility of...starches...making them more soluble in water and thus more available for attack by digestive enzymes" (Wardlaw and Insel 1996:80). Amorphous starch granules encased in cell walls burst free when cooked because the granules absorb water and expand. The two primary constituents of starch are amylose and amylopectin, both of which are a source of energy for plants and animals (Murray et al. 2000:155; Wardlaw and Insel 1996:80). When the glucose chains are long and straight, the starch is labeled amylose. If the chains are short and branched, they are amylopectin. Shorter chains of glucose (dextrin) are the intermediate product of the hydrolysis of starch. Glucan, which is often found in association with pectin, resides in the cell walls of plants and trees and many forms of bacteria and fungi (Stephen et al. 2006). Most people are familiar with beta glucans, which are a diverse group of molecules that occur commonly in the cellulose of plants, bran of cereals, cell walls of baker's yeast, and certain fungi, mushrooms, and bacteria. Some beta glucans may be useful as texturing agents and soluble fiber supplements. Beta glucans derived from yeast and medicinal mushrooms have been used for their ability to modulate the immune system.

Structural Polysaccharides: Structural polysaccharides, also known as dietary fiber, are indigestible by humans and other animals. Structural polysaccharides are primarily composed of cellulose, hemicellulose, pectin, gum, and mucilage (Wardlaw and Insel 1996:82). "The only noncarbohydrate components of dietary fiber are lignins, which are complex alcohol derivatives," (Wardlaw and Insel 1996:82). Lignins are complex alcohol derivatives that make up the non-carbohydrate components of insoluble plant fibers (Wardlaw and Insel 1996:82). As such, they cannot be digested by the enzymes animals produce (Carlile and Watkinson 1994). Lignin is found in all plants and is an important component of the secondary cell walls (Lebo et al. 2001; Martone et al. 2009; Wardlaw and Insel 1996:82). One of the important functions of lignin is to provide support through strengthening of the xylem cells of wood in trees (Arms and Camp 1995; Esau 1977; Wardrop 1969). In linking plant polysaccharides, lignin provides strength to cell walls and by extension to the entire plant (Chabannes et al. 2001). Because cellulose and chitin provide structural support to plants and animals they are not water soluble. Cellulose, hemicellulose, and pectin are all comprised of simple sugars, and their differences are defined by the various inclusions, exclusions, and combinations of these sugars, as well as how the sugars are bonded, and the molecular structure of the sugars of these polysaccharides.

Cellulose: Cellulose is comprised of a long linear chain of glucose, whereas hemicellulose consists of shorter branched chains of simple sugars in addition to glucose, including especially xylose, but also mannose, galactose, rhamnose, and arabinose (Crawford 1981; Updegraff 1969). Pectin, however, may be found in either a linear or branched form of simple sugars that is primarily composed of rhamnose.

Hemicellulose: Hemicellulose resides in the cell wall structures of many plants, particularly grain and vegetable plants, and is a component of both insoluble and soluble fibers (Wardlaw and Insel 1996:82). Some specific hemicelluloses include galactan, galactoglucomannan, glucomannan, glucuronoxylan (GX), and xyloglucan (Walker 2006; Wilkie 1985).

Galactan: Galactan is a structural polysaccharide, and hemicellulose, composed of polymerized galactose, or repeating sugar units linked in unbranched or branched chains (Biology online 2009b). Galactose is found predominantly in dairy products, but is also present in high quantities in sugar beets (a member of the Chenopodiaceae), and other gums and mucilages (Mayes 2000:149; McGee 1984:585; Mosby 2008).

Galactoglucomannan: Galactoglucomannan is a primary component of the woody tissue of coniferous plants (Gymnosperms) (Bochicchio and Reicher 2003).

Glucomannan: Glucomannan, which may be very concentrated in some roots or corms and in the wood of conifers and dicotyledons (dicots), is a soluble fiber used to treat constipation by decreasing fecal transit time (Bochicchio and Reicher 2003; Marzio 1989).

Pectin, Gums, and Mucilages

Pectin, gums, and mucilages are soluble fibers found inside and around plant cells that help "glue" them together (Wardlaw and Insel 1996:82). Pectin is a structural heteropolysaccharide and common substance found in many plants (apples, plums, gooseberries, and citrus) often used for its gelling or thickening action. Plant derived gums and mucilages such as gum arabic, guar gum, and locus bean gum are also used for this same purpose. Arabinan, arabinogalactan, arabinoglucuronoxylan, and rhamnogalacturonan are some examples of these types of polysaccharides (Wilkie 1985).

Arabinan: In plants, arabinan is essential for the function of guard cells that "play a key role in the ability of plants to survive on dry land, because their movements regulate the exchange of gases and water vapor between the external environment and the interior of the plant" (Jones et al. 2003:11783).

Arabinogalactan: Arabinogalactan is a sugar found in plant carbohydrate structures, particularly gums and hemicelluloses. One of arabinogalactan's many functions is to bond with proteins to repair damage when it occurs to a plant or its parts (Nothnagel et al. 2000).

Arabinoglucuronoxylan: Arabinoglucuronoxylan is found in the cell walls of softwoods and herbaceous plants (Sjostrom 1981).

Rhamnogalacturonan: Rhamnogalacturonans are specific pectic polysaccharides that reside in the cell walls of all land plants and result from the degradation of pectin (Willats et al. 2001). They are visible by the presence of peaks at 1150, 1122, 1070, 1043, 989, 951, 916, 902, 846, and 823 wave numbers.

Esters

Esters are an important functional group because they are present as flavoring agents in food and are components of biological compounds such as fats, oils, and lipids. In an ester, the basic unit of the molecule is known as a carbonyl. The presence of the double peak between 3000 and 2800 wave numbers identifies the presence of the aldehyde functional group that is present in fats, oils, lipids, and waxes.

There are two important groups of esters, saturated esters and aromatic esters. Aromatic esters take their name from their ability to produce distinctive odors and are present as flavoring agents in food. In contrast, saturated esters do not produce distinctive odors. Esters are expressed in the FTIR spectrum by three distinct peaks ("the rule of three") located at approximately 1700, 1200, and 1100 wave numbers, and a fourth peak in the region between 750 and 700 wave numbers that represent the CH_2 bend associated with aromatic esters. The first peak for saturated esters falls in the 1750 to 1735 range, the second peak lies between 1210 and 1160, and the third peak sits between 1100 and 1030. Saturated esters have a unique peak to acetates at 1240. This band can be very strong in the signature. The first peak for aromatic esters falls in the range between 1730 and 1715, the second peak between 1310 and 1250, and the third peak between 1130 and 1100 (Smith 1999:110–112). Distinguishing between saturated and aromatic esters, both components of foods, is easy if all three bands are present, since they occupy different wave number regions.

Lipids

Lipids that are solid at room temperature are called "fats," and those that are liquid at room temperature are referred to as "oils" (Wardlaw and Insel 1996:108). Both forms of lipids can be detrimental, as well as beneficial, to human health. Consumption of certain animal fats rich in saturated fatty acids can lead to heart disease, while ingesting omega-3 fatty acids such as EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) found in fish and plant sources are essential to good health.

Fatty Acids

Fatty acids are found in most lipids in the human and animal body, as well as in the lipids in foods (Wardlaw and Insel 1996:108). Long chains of carbons bonded together that are then bonded to hydrogens define the structure of fatty acids (Wardlaw and Insel 1996:109). A fatty acid is considered saturated if the carbons are connected by single bonds. Saturated fatty acids are high in animal fats. If the carbon chain has one double bond between two of the carbons, then the fatty acid is monounsaturated. If there are two or more double bonds between carbons, then the fatty acid is polyunsaturated.

Essential fatty acids are those lipids critical to human health, such as omega-3 and omega-6 fatty acids, alpha-lineolic acid, and linoleic acid that cannot be created within the body and must be obtained from dietary sources (Wardlaw and Insel 1996:110-111). These essential fatty acids are part of "vital body structures, perform vital roles in immune system function and vision, help form cell membranes, and produce hormone like compounds," and are necessary to maintain good health (Wardlaw and Insel 1996:111). Diets high in essential fatty acids, like omega-3 and omega-6, reduce the risk of heart attacks because they minimize the tendency for blood to clot (Wardlaw and Insel 1996:112). Fish oils contain high concentrations of omega-3 and omega-6 fatty acids and may be administered as a dietary supplement.

Proteins

The human body uses protein from dietary plant and animal sources to form body structures and other constituents (Wardlaw and Insel 1996:152). "Proteins contribute to key body functions, including blood clotting, fluid balance, production of hormones and enzymes, vision, and cell growth and repair" (Wardlaw and Insel 1996:152). This constant regulation and maintenance of the body requires thousands of different types of proteins that are not all available within the body (Wardlaw and Insel 1996:152). The majority of the building blocks for these proteins, which are also known as amino acids, are produced by plants.

Amino Acids

Within the body, amino acids are linked to form the necessary proteins, making them not only essential for life, but key to nutrition. Amino acids can be combined in a multitude of ways to create a vast variety of proteins. Differences between these proteins are distinguished by the unique arrangements of amino acids. Proteins are created through a process called translation, in which amino acids are added, one by one, to form short polymer chains called peptides, or longer chains called polypeptides or proteins (Rodnina and Wintermeyer 2007). The order in which the amino acids are added is determined by the genetic code of the mRNA template, which is a copy of an organism's genes (Creighton 1993). Amino acids are divided into standard and non-standard types.

Standard Amino Acids: There are 20 naturally occurring amino acids on earth called standard amino acids (Creighton 1993). These amino acids are encoded by the standard genetic code and are found in all forms of life (Creighton 1993). The standard amino acids are broken down into two different types, essential and nonessential.

Essential Amino Acids: Eight of the standard amino acids are considered "essential amino acids" because they are necessary for normal human growth and cannot be synthesized by the human body (Young 1994). Essential amino acids must be obtained from food sources, and include histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine (Furst and Stehle 2004; Reeds 2000; Wardlaw and Insel 1996:154).

Leucine: Leucine is used in the liver, adipose tissue, and muscle tissue. In adipose and muscle tissue, leucine aids in the formation of sterols and slows the degradation of muscle tissue by increasing the synthesis of muscle proteins (Combaret et al. 2005; Rosenthal et al. 1974). Common sources of leucine in the diet include beef, fish, shellfish, nuts and seeds, eggs, and legumes.

Lysine: Lysine is important for calcium absorption, building muscle, recovering from injuries or illnesses, and the production of hormones, enzymes, and antibodies (Nelson and Cox 2005). Plants that contain significant amounts of lysine include legumes, gourds/squash, spinach, amaranth, quinoa, and buckwheat (Wardlaw and Insel 1996:158). Other dietary sources of lysine include beef, poultry, pork, fish, eggs, and dairy.

Nonessential Amino Acids: The majority of the standard amino acids are considered "nonessential," meaning that under normal circumstances these amino acids can be manufactured by the human body and are not required in the diet. However, some amino acids that are normally nonessential may become an essential part of the diet for a person whose health has been compromised (Wardlaw and Insel 1996:155). Nonessential amino acids include alanine, arginine, asparagine, aspartate (aspartic acid), cysteine, glutamate (glutamic acid), glutamine, glycine, proline, serine, and tyrosine (Furst and Stehle 2004; Reeds 2000; Wardlaw and Insel 1996:154).

Alanine: Alanine plays an important role in the glucose-alanine cycle between tissues and liver (Nelson and Cox 2005). Common sources of alanine in the diet include meat, eggs, fish, legumes, nuts and seeds, and maize.

Asparagine: Asparagine is one of the most common of the 20 natural amino acids, and is most abundant in asparagus, from which its name is derived (Nelson and Cox 2005). Although the characteristic smell observed in the urine of individuals after their consumption of asparagus is often attributed to asparagine, specific studies on this correlation suggest the odor might instead be due to the metabolization and oxidation of asparagusic acid, also found in asparagus (Akers and Venkatasubramanian 1997; Vickery and Schmidt 1931; Waring et al. 1987). Common sources of asparagine include asparagus, potatoes, legumes, nuts and seeds, dairy, beef, poultry, eggs, fish, and seafood.

Serine: Serine is important in metabolic function (Nelson and Cox 2005). It serves as a neuronal signal by activating N-methyl-D-aspartate (NMDA) receptors in the brain and helps to build muscle tissue (Mothet et al. 2000). Common sources of serine in the diet are beef, eggs, nuts and seeds, legumes, and milk.

Nonstandard Amino Acids: Nonstandard amino acids are amino acids that are chemically altered after they have been incorporated into a protein and/or amino acids that exist in living organisms but are not found in proteins (Driscoll and Copeland 2003).

Nucleic Acids: Millions of proteins exist in all living organisms to assist with the daily functions of these complex systems. Proteins are produced and assembled locally to exact specifications, and a large amount of information is necessary to properly manage the system. This information is stored in a set of molecules called nucleic acids. Nucleic acids not only contain the genetic instructions for the proper development and functioning of living organisms, but also play a role in copying genetic information to protein (Saenger 1984). The most common examples of nucleic acids are DNA (deoxyribonucleic acid) and RNA (ribonucleic acid).

Ethnobotanic Review

It is a commonly accepted practice in archaeological studies to reference ethnographically documented plant uses as indicators of possible or even probable plant uses in prehistoric times. The ethnobotanic literature provides evidence for the exploitation of numerous plants in historic times, both by broad categories and by specific example. Evidence for exploitation from numerous sources can suggest widespread utilization and strengthens the possibility that the same or similar resources were used in prehistoric times. Ethnographic sources outside the study area have been consulted to permit a more exhaustive review of potential uses for each plant. Ethnographic sources document that, with some plants, historic use was developed and carried from the past. A plant with medicinal qualities very likely was discovered in prehistoric times and the usage persisted into historic times. There is, however, likely to have been a loss of knowledge concerning the utilization of plant resources as cultures moved from subsistence to agricultural economies and/or were introduced to European foods during the historic period. The ethnobotanic literature serves only as a guide, indicating that the potential for utilization existed in prehistoric times—not as conclusive evidence that the resources were used. Pollen and macrofloral remains, when compared with the material culture (artifacts and features) recovered by the archaeologists, can become indicators of use. Plants represented by pollen and organic residues will be discussed in the following paragraphs in order to provide an ethnobotanic background for discussing the remains.

Native Plants

Agavaceae: Agavaceae are perennial plants that are typically found in the foothills and lower mountain areas of the Southwest (Castetter et al. 1938:79). Members of the agave family were utilized in a variety of food and fiber applications by native peoples of the Southwest. The crowns of *Agave* (agave, century plant and mescal) species were commonly collected and roasted in pits. Roasted agave could be consumed immediately, or further prepared by boiling or pounding into a paste. Fermented agave beverages were a later introduction to the Southwest, by way of Mexico and Mesoamerica. Fibers from members of the Agavaceae family, particularly those of *Yucca* species, were used to make cloth, sandals, baskets, rope, and a variety of other utilitarian items. Roots of *Yucca* species have high saponin content, and were processed by groups throughout the Southwest to produce soap for washing. *Yucca* species were also a source for edible seeds and fleshy fruits (Bell and Castetter 1941; Castetter et al. 1938:78; Ebeling 1986:468–474; Luomala 1978).

Cheno-ams: Cheno-ams refer to a group representing the Chenopodiaceae (goosefoot) family and the genus *Amaranthus* (pigweed). These plants are weedy annuals or perennials, often growing in disturbed areas such as cultivated fields and site vicinities. Cheno-ams, including a variety of plants such as *Amaranthus, Atriplex, Chenopodium, Monolepis,* and *Suaeda*, are noted to have been used as food and for processing other foods. These plants were exploited for both their greens (cooked as potherbs) and seeds. The seeds were eaten raw or ground and used to make pinole and/or sometimes mixed with cornmeal to make a variety of mushes and cakes. The seeds usually are noted to have been parched prior to grinding. The greens are most tender when young, in the spring, but can be used at any time. The greens can be harvested and cooked either alone or with other foods. Various parts of the cheno-am plants are noted to have been gathered from early spring through the fall (Castetter and Bell 1942:61; Curtin 1984:47–71; Kearney and Peebles 1960; Kirk 1975).

Amaranthus: *Amaranthus* (amaranth, pigweed) leaves were an important source of iron. The greens are most tender when young, in the spring, but can be used at any time. The greens can be harvested and cooked either alone or with other foods. The leaves are noted to have been fried sometimes after being boiled. The plant also was used medicinally. *Amaranthus* poultices were used to reduce swellings and to soothe aching teeth. A leaf tea was used to stop bleeding, and to treat dysentery, ulcers, diarrhea, mouth sores, sore throats, and hoarseness (Angier 1978:33–35; Foster and Duke 1990:216;

Harris 1972:58; Kirk 1975:63; Krochmal and Krochmal 1973:34–35; Moore 1990:12; Muenscher 1987:192–195; Robbins et al. 1916:53).

Atriplex: *Atriplex* (saltbush) leaves and young shoots have a salty taste and were cooked as greens or added to meat and other vegetables for its salty flavor. The leaves also were boiled in water, then strained and fried in grease. Leaves were rubbed in water to produce lather for washing clothes and baskets. The dried tops of *A. canescens* (four-wing saltbush) were used to make a tea for treating nausea and vomiting from the flu. A hot tea was taken for breaking fevers, while a cold tea is used to treat stomachs (Moore 1990:29). The Hopi used ashes of *A. canescens* as a substitute for baking powder. The Tewa at Hano are noted to have used saltbush ashes to color cornmeal (Robbins et al. 1916:54). *Atriplex* ashes also were used to make hominy. *Atriplex* leaves, twigs, and blossoms yielded a bright yellow dye (Bryan and Young 1978:32). The wood was a source of firewood (Curtin 1984:66–69; Kearney and Peebles 1960:225; Whiting 1939:18, 22, 73). *Atriplex* are annual or perennial, herbaceous or shrubby plants found in arid, alkaline, or saline soil (Kirk 1975:59).

Chenopodium: The tiny flowers of *Chenopodium* (goosefoot, lamb's quarters) grow in clusters and can produce tens of thousands of seeds per plant. *Chenopodium* "seeds are about equal to corn in the number of calories they contain, but have significantly more protein and fat (Asch 1978:307). The cooked greens contain more than three times as much calcium as cooked spinach and also have more vitamin A and C (Watt and Merrill 1963:37, 59)" (Kindscher 1987:82). *Chenopodium* was used to season beans. *Chenopodium* also was used medicinally. Leaves were eaten to treat stomachaches and to prevent scurvy. Leaf poultices were applied to burns and swellings, and a tea made from the whole plant was used to treat diarrhea. A leaf decoction was used as a bath for rheumatism. Oil of *Chenopodium* is obtained from *C. ambrosioides* (wormseed goosefoot), which is a good cure for intestinal worms. *Chenopodium* is a weedy annual commonly found in ecologically disturbed habitats. It is an opportunistic weed, often establishing itself rapidly in disturbed areas (Angier 1978:33–35; Burlage 1968:29–31; Foster and Duke 1990:216; Harris 1972:58; Kindscher 1987:79–83; Kirk 1975:56, 63; Krochmal and Krochmal 1973:66–67; Moore 1990:42; Sweet 1976:48).

Cleome: *Cleome* (beeweed) is a weedy plant that grows in disturbed areas. This plant is noted to have been allowed to grow in gardens with cultivated plants. *Cleome* was used both as a food and pottery paint. The young plants were usually gathered and boiled as potherbs from spring until mid-summer. Large quantities of leaves were gathered and hung indoors to dry for winter use by the Zuni. The leaves were cooked with boiled corn and highly seasoned with chile. The seeds also can be gathered and ground into meal, although they require leaching. Utilization as a potherb appears to have been more common. The seeds ripen in the late summer and fall. Both the young and older plants can be gathered and the entire plant boiled until the water is thick and black. This thick fluid is then either used as a pottery paint or dried and made into cakes, which keep for an indefinite period. The cakes can be reconstituted by soaking them in water for use as pottery paint, or fried in grease to be eaten. *Cleome* is noted to yield a yellow-green dye. The Navajo used a cold infusion of leaves as a deodorant, and the leaves placed in shoes or moccasins. The Tewa are noted to have mixed finely ground plants in water and consumed this liquid for stomach disorders (Bryan and Young 1978:23; Clary 1983:55; Harrington 1967:72; Robbins et al. 1916:58–59; Stevenson 1915:69, 82; Vestal 1952:29; Whiting 1939:77–78).

Opuntia: *Opuntia* (prickly pear cactus) has broad, flattened joints and large, red to purple, juicy, pear-shaped fruits called "tunas". All species of prickly pear cactus produce edible fruit. The fruits were eaten raw, stewed, roasted, or dried for winter use. Dried fruits could be ground into a meal. Young stems or pads were peeled and eaten raw or roasted. Peeled stems also can be used as a dressing on wounds. The seeds were eaten in soups, or dried, parched, and ground into a meal to be used in gruel or cakes. The process of removing the spines from the cacti usually involves roasting or baking in a pit, and then rubbing the spines off. Prickly pear plants are noted to be the most widely distributed cacti in the Southwest and are found on arid, rocky, or sandy soils (Beaglehole 1937:70; Ebeling 1986:513–516; Harrington 1964:382–384; Kearney and Peebles 1960:581–586; Kirk 1975:50–52; Muenscher 1987:317; Nequatewa 1943:18–19; Robbins et al. 1916:62; Stevenson 1915:69; Whiting 1939:85–86).

Poaceae: Members of the Poaceae (grass) family have been widely used as a food resource, including

Agropyron (wheatgrass), *Hordeum* (little barley grass), *Elymus* (ryegrass), *Eragrostis* (lovegrass), *Achnatherum* syn. *Oryzopsis* (ricegrass), *Poa* (bluegrass), *Sporobolus* (dropseed), and others. Grass grains could be eaten raw but usually were parched and ground into a meal to make various mushes and cakes. Several species of grass contain hairs (awns) that were singed off by exposing the seeds to flame. Young shoots and leaves were cooked as greens. Roots were eaten raw, roasted, or dried and ground into flour. Grass also is reported to have been used as floor covering, tinder, basketry material, and for making brushes and brooms. Various grasses also were used in the manufacture or decoration of *pahos* (prayer sticks) and for various ceremonial purposes. Grass seeds ripen from spring to fall, depending on the species, providing a long-term available resource (Chamberlin 1964:372; Colton 1974:338, 365; Cushing 1920:219, 253–254; Elmore 1944:24–27; Harrington 1967:322; Kirk 1975:177–190; Robbins et al. 1916; Vestal 1952:15–18; Whiting 1939:65).

Quercus: *Quercus* (oak) are deciduous or evergreen shrubs and large trees; various species are widespread throughout the United States. All species of *Quercus* produce edible acorns, although the presence of tannin results in varying degrees of bitterness. White oak acorns are generally less bitter than black oak (including red oak) acorns. Shinnery oak (*Quercus havardii*), a member of the white oak group, is a common species of oak in this area, and may have been much more prominent in the past. The acorns of *Q. gambelii* (Gambel oak, Rocky Mountain white oak) are noted to be the least bitter of all; sometimes they are able to be eaten fresh. Gambel oak is the most common oak of the southern Rocky Mountain region. Other species of acorn are palatable only after the bitter taste has been removed. Acorns are noted to have been utilized by native peoples in the Southwest. Acorns were gathered, shelled, roasted, and ground into a meal. The ground meal most often was leached with water in various ways to remove the bitter taste. Wood ashes could be used like lye in the leaching process. The ground meal was used alone or mixed with cornmeal to make mush, thicken soup, or make breads and cakes. Acorn meal also could be mixed with meat or animal fat. Oak wood was used for a variety of utilitarian purposes including making bows, arrows, rabbit sticks, digging sticks, clubs, and other utensils. Oak wood is strong and hard, and it was valued as firewood because a large piece of oak would burn slowly all night long. Oak bark was the principal source of tanning materials. Oaks in the southwestern United States can be found in dry soils in canyons and foothills (Elmore 1944:23; Gallagher 1977:113; Harrington 1967:239–241; Kearney and Peebles 1960:216–217; Kirk 1975:104–106; Vines 1960:162; Whiting 1939:72).

Cultigens

Phaseolus: *Phaseolus* (bean) was largely cultivated in the Southwest. *Phaseolus* includes many varieties of domesticated beans, including *P. vulgaris* (common bean), *P. lunatus* (lima bean), *P. acutifolius* var. *latifolius* (tepary bean), and *P. coccineus* (runner bean). *Phaseolus* is noted to be a staple food of Tewa. Beans could be eaten when green and immature, but were often dried and stored for future use, both in the pod and shelled. Dried beans were most often boiled until soft and then eaten as is or fried. Crushed boiled beans can be mixed with mush and wrapped in corn husks, and beans can be added to meat stews (Gasser and Kwiatkowski 1991:430; Robbins et al. 1916:100; Stevenson 1915:69–70; Whiting 1939:80–82).

Zea mays: *Zea mays* (maize, corn) is an important New World cultigen, originating from a wild grass called "teosinte". Maize has long been a staple of the Southwest inhabitants, and charred maize is found in almost every cliffhouse in the Southwest (Stevenson 1915:73). Various colors of maize were grown, including white, yellow, blue, red, black, and a combination of these. Innumerable ways of preparing maize exist. Green corn was widely used, and ears were collected from the regular fields. Mature ears were eaten roasted or wrapped in corn husks and boiled. The kernels could be parched, soaked in water with juniper ash, and boiled to make hominy. Dried kernels could be ground into meal, which was used as a staple. Cornmeal could be colored with *Atriplex* ashes. Black corn was used as a dye for basketry and textiles and as body paint. Maize could be husked immediately upon harvesting, and clean husks were saved for smoking and other uses, such as wrapping food. Ears also could be allowed to dry on the roof, and ristras of maize could be hung inside from the roof. Whole ears and/or shelled kernels were stored for future use. Corn pollen was widely used in various rituals and ceremonies (Cushing 1920:264-267; Robbins et al. 1916:83-93; Stevenson 1915:73-76; Vestal 1952:18-19; Whiting 1939:67-70).

Discussion

A total of eight stone tools from sites LA 113042, LA 129214, LA 129216, LA 129217, and LA 129300 were submitted for combined pollen, starch, protein, and organic residue analysis. These combined analyses will provide a thorough examination, allowing for the potential for multiple lines of evidence to support subsistence strategies and tool function interpretations. Archaeologists commonly refer to the prehistoric remains from this part of southeastern New Mexico as the Eastern Extension of the Jornada Mogollon culture, and as such, an extension of a presumed farming society in prehistoric south-central New Mexico. However, the evidence to date suggests that the far southeastern part of the state was occupied by hunter-gatherers throughout prehistory and into the early historic period. The question of whether or not cultigens were grown east of the Pecos River is an area of ongoing research and debate (R. N. Wiseman, personal communication, 2010). The artifacts submitted for this analysis were recovered from sites discovered during the NM 128 Highway project. The cultural periods applied to these sites are Archaic 4 (pre-pottery, 500 BC to AD 500) and Neo-Archaic 1 (first pottery, AD 500 to 1000).

The environment for this area was significantly different during the time of prehistoric occupation than it is today. Many of the playas in the area would have been natural reservoirs holding monsoonal rainfall with water moving into them from drainages such as Nash Draw. Seeps and springs also may have been more numerous. Much of the vegetation has undergone significant changes, as well. Grasses were reported to have been much more common on the landscape, as well as nut and fruit bearing taxa such as shinnery oak (*Quercus havardii*), little walnut (*Juglans microcarpa*), and hackberry (*Celtis reticulata*). Today, the desert scrub community is the most common vegetation community in this area (McBride and Toll this report).

The results of the pollen, starch, protein, and organic residue analysis are discussed below by site number.

Nutritional analysis of two sets of acorns, collected near Loving and Roswell, provides information regarding these acorn populations. Full nutritional analysis, including analysis of the amino acid content of both populations, was performed and the results are presented in table format with accompanying discussion.

LA 113042

Two stone tools were submitted for pollen, starch, protein and FTIR analysis from this site (Table 26.1). Vegetation in this area today includes creosote bush (*Larrea tridentata*), snakeweed (*Gutierrezia sarothrae*), four-wing saltbush (*Atriplex canescens*), and acacia (*Acacia neovernicosa*). However, the vegetation during the time this site was occupied was likely much different.

Metate fragment (Sample 1032): Metate fragment 1032 was recovered from the fill of Feature 72, a large pit of unknown function. The temporal association of the metate is unknown, but probably dates to the past 2000 years (R. N. Wiseman, personal communication, 2010). The results are discussed by analysis type.

Pollen and starch: The pollen record yielded nearly equal quantities of High-spine Asteraceae, cheno-am, and indeterminate pollen (Fig. 26.1; Table 26.2), indicating that rabbitbrush and saltbush and/or related plants were abundant in the local vegetation community.

Recovery of small quantities of *Juniperus* and *Pinus* pollen indicate that juniper and pine trees grew sparsely in the area. The presence of small quantities of *Artemisia*, Low-spine Asteraceae, Brassicaceae, and Poaceae pollen represent sagebrush, ragweed/cocklebur, a member of the mustard family, and grasses growing locally.

This sample yielded a small quantity of *Zea mays* pollen, documenting the grinding of maize with this metate and providing evidence that the cultigen maize was available to and used by the occupants of this site. This sample yielded no starches. A large quantity of microscopic charcoal was observed, suggesting that Feature 72, the large pit, was a fire feature. Recovery of pollen that included *Zea mays* suggests that this metate was not severely burned. Pollen observed in this sample was, however, in much worse condition than that observed in most of the rest of the samples. Total pollen concentration

Table 26.1. Provenience data for samples, by site.

SAMPLE NO.	FEATURE	BLOCK	LEVEL	DEPTH (CMBS)	PROVENIENCE/ DESCRIPTION	ANALYSIS
LA 113042						
1032	72	12	lower fill	10	metate fragment from fill of large pit of unknown function, 371.97N/606.57E	pollen, starch, FTIR*, protein
1016	–	12	5	51	tabular knife, 375.20N/607.53E	pollen, starch, FTIR, protein
LA 129214						
300	–	2	surface	0	mano, 491.78N/401.45E	pollen, starch, FTIR, protein
339	41	1	2	10–20	mano fragment from a temporary shelter of unknown function, 504.99N/572.04 E	pollen, starch, FTIR, protein
1861	–	20	1	0–10	tabular knife, 426N/476E	pollen, starch, FTIR, protein
LA 129216						
903	–	–	surface	0	two broken pieces of a mano, 372N/604E	pollen, starch, FTIR, protein
LA 129217						
10	–	–	surface	0	mano fragment, 490.277N/537.455E	pollen, starch, FTIR, protein
LA 129300						
470	–	7	2	10–20	mano, 505.32N/549.34E	pollen, starch, FTIR, protein

* FTIR = Fourier Transform Infrared Spectroscopy

was approximately 100 pollen grains per square centimeter of metate surface washed.

Protein residue: Metate fragment 1032 was tested against the antisera listed in Table 26.3, yielding a positive result to deer antiserum (Table 26.4). This positive to deer antiserum indicates that remains from a member of the deer family (Cervidae) were processed using this metate. Dried meat, fat and/or bones might have been ground on this metate. These resources may have been combined with dried and ground plant-based foods. The most likely cervid represented by the positive reaction to deer antiserum is mule deer (*Odocoileus hemionus*). Mule deer, pronghorn, cottontail rabbits, and jackrabbits are noted as the most characteristic animals of the Southwest, and mule deer, pronghorn, and bighorn sheep were the three most common Southwestern game animals. Early Basketmaker Anasazi hunted deer and other large mammals with darts propelled by atlatls, while later Pueblo groups used bows and arrows. Hopi groups sometimes used a gourd horn to attract deer by imitating their call. Deer bones, skins, and flesh all were utilized. Meat was baked, roasted and/or eaten raw. Deer hides were tanned and made into mantles, blankets, clothing, and shoes. Bones also were used for a variety of purposes (Cordell 1984:32–34; Ebeling 1986:16; Euler and Dobyns 1971:3; Wormington 1956:31, 38, 45, 70).

Organic residue (FTIR): Organic residue analysis of the metate fragment from the pit identified as Feature 72 (Sample 1032) yielded peaks representing major categories (functional groups) of compounds (4000 to 1500 wave number), as well as specific compounds noted in the fingerprint region (1500 to 400 wave numbers) of the spectrum. The functional group peaks indicate the presence of absorbed water, amines, and fats/oils/lipids and/or plant waxes (Table 26.5). Peaks within the fingerprint region represent the presence of aromatic

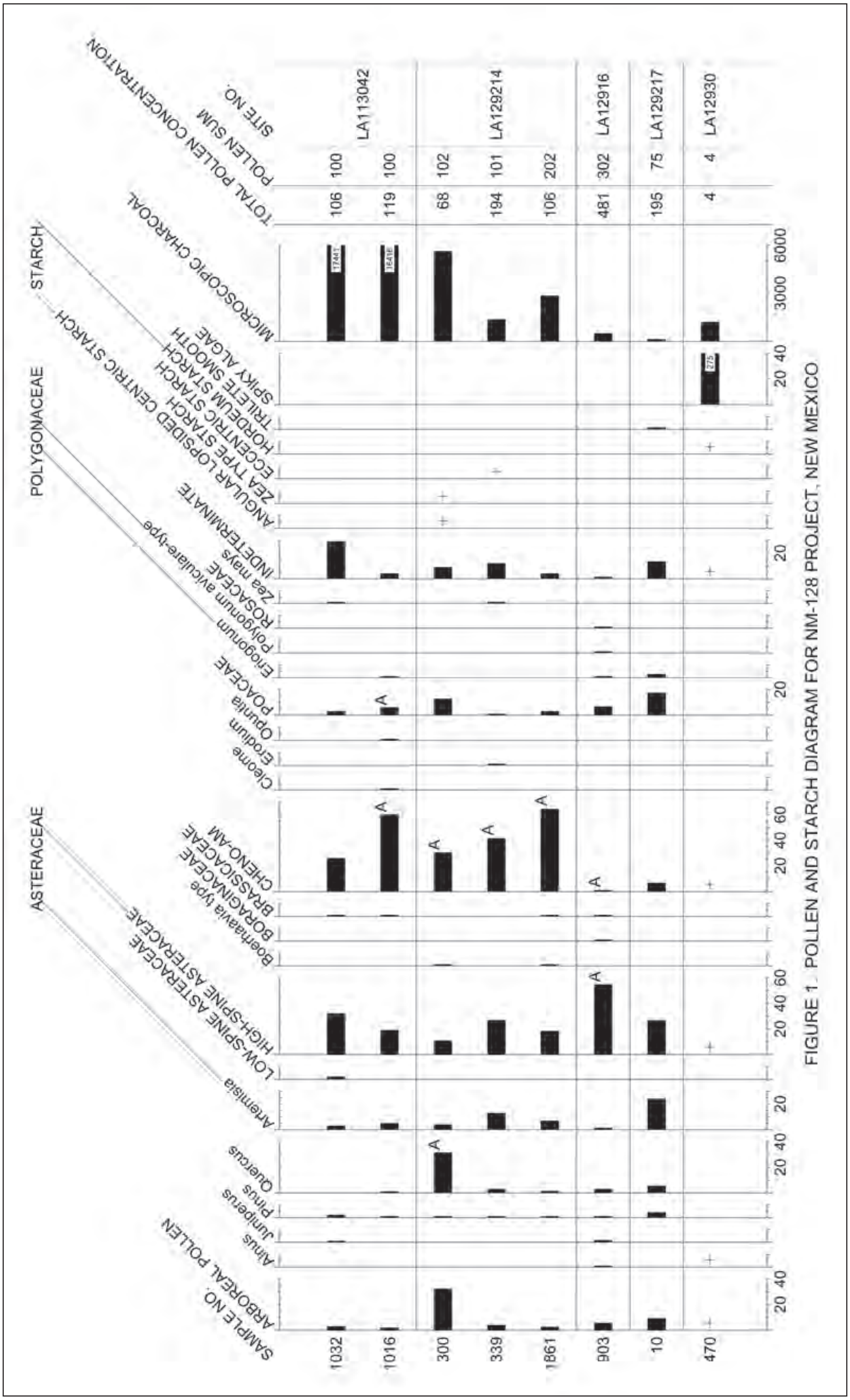

Figure 26.1. Pollen and starch diagram for NM 128 Project, New Mexico.

Table 26.2. Pollen types. Total pollen concentration = quantity of pollen per cubic centimeter (cc) of sediment.

SCIENTIFIC NAME	COMMON NAME
Arboreal Pollen	
Alnus	alder
Juniperus	juniper
Pinus	pine
Quercus	oak
Nonarboreal Pollen	
Asteraceae:	sunflower family
Artemisia	sagebrush
Low spine	includes ragweed, cocklebur, sumpweed
High spine	includes aster, rabbitbrush, snakeweed, sunflower, etc.
Boerhaavia type	spiderling
Boraginaceae	borage family
Brassicaceae	mustard or cabbage family
Cheno-am	includes the goosefoot family and amaranth
Cleome	beeweed
Erodium	storksbill, heron-bill, filaree
Opuntia	prickly pear cactus
Poaceae	grass family
Polygonaceae:	knotweed/smartweed family
Eriogonum	wild buckwheat
Polygonum aviculare type	smartweed
Rosaceae	rose family
Cultigens	
Zea mays	maize, corn
Indeterminate	too badly deteriorated to identify
Starches	
Angular lopsided centric starch	typical of starches from grass seeds such as those from bluestem (*Andropogon*) or ricegrass (*Achnatherum*)
Zea-type starch	typical of starches produced by maize
Hordeum starch	starch produced by wild rye
Eccentric starch	root starch
Spores	
Trilete, smooth	fern
Algae	
Spiky algae	algal body
Other	
Charcoal	microscopic charcoal

rings; aromatic and saturated esters; protein; the amino acids lysine, alanine, and leucine; calcium carbonate; calcium oxalates; pectin; starch; humates; cellulose and carbohydrates; and the polysaccharides galactoglucomannan and glucomannan.

Matches with peaks in portions of the spectrum representing proteins, saturated and aromatic esters, and lipids/triglycerides were made with *Quercus* (acorn) nutmeat, ground cheno-am seeds, parched and ground *Helianthus* (sunflower) seeds, *Helianthus* (sunflower) seed shells, charred *Xanthium* (cocklebur) seeds, and *Pinus* (pine) nut skins and shells (Table 26.6).

Cheno-am, sunflower, and cocklebur matched with multiple amino acids peaks representing lysine between 1550 and 1485 wave numbers. The amino

Table 26.3. Antisera used in artifact testing, by source.

ANTISERUM	SOURCE	POSSIBLE RESULTS
Animals		
Bear	ICN Pharmaceuticals, Incorporated	black bear, brown bear, grizzly, polar bear
Bison	prepared under the direction of Dr. Richard Marlar at the University of Colorado Health Sciences Center	bison, domestic bovids
Deer	ICN Pharmaceuticals, Incorporated	white tail deer, mule deer, elk, moose, caribou
Dog	Sigma Chemical Company	domestic dog, coyote, wolf, fox
Duck	Nordic Immunological Laboratories	duck, goose, pigeon, domestic turkey, wild turkey
Goat	Sigma Chemical Company	pronghorn, mountain goat, domestic goat
Grasshopper	prepared at PaleoResearch Institute	unknown specificity, but would likely cross-react with many insects in the order Orthoptera, which includes grasshoppers, crickets, and locusts
Guinea pig	Sigma Chemical Company	guinea pig, porcupine, beaver, squirrel family (squirrel, marmot, ground squirrel, chipmunk, etc.)
Human	ICN Pharmaceuticals, Incorporated	human
Mouse	Sigma Chemical Company	members of the New World rats and mice family, members of the Old World rats and mice family
Pig	ICN Pharmaceuticals, Incorporated	domestic pig, wild pig
Rabbit	Sigma Chemical Company	rabbit, jackrabbit (hare)
Rat	Sigma Chemical Company	members of the New World rats and mice family, members of the Old World rats and mice family, members of the Old World rats and mice family
Sheep	ICN Pharmaceuticals, Incorporated	domestic sheep, bighorn sheep
Turkey	Sigma Chemical Company	domestic turkey, wild turkey, ducks
Fish/Aquatic		
Catfish	Sigma Chemical Company	catfish, carp
Gizzard shad	Robert Sargeant	gizzard shad
Striped bass	Robert Sargeant	Perciformes order (spiny-rayed or percoid fish
Trout	Sigma Chemical Company	Salmonidae family (trout and salmon)
Plants		
Acorn	prepared at PaleoResearch Institute	acorn
Agave	prepared at PaleoResearch Institute	agave, yucca
Yucca	prepared at PaleoResearch Institute	yucca, agave

acid alanine also was represented in the sample by a peak at 1465 wave numbers, which matched with cocklebur and acorn. Acorn and pine matched with a third amino acid peak visible at 1376 wave numbers representing leucine. These matches suggest a variety of nuts and seeds possibly including acorn, cheno-am, sunflower, cocklebur, or pine were ground using the metate.

Cucurbita (gourd/pumpkin/squash) and dried and ground *Zea mays* (maize) kernels also were matched with a protein peak at 1460 wave numbers, as well as peaks in other portions of the spectrum representing lipids, cellulose, and aromatic esters. Matches with gourd/pumpkin/squash and maize suggest these cultigens also might have been processed with this artifact. Squash reference samples often match with archaeological samples, making confidence in this match somewhat shaky.

However, for this sample, the match with squash "flesh" was very good, suggesting that it might have been ground using this metate. Use of metates for this purpose is not common, at least in the literature or in most archaeobotanic reports. Therefore, it is recommended that further research

Table 26.4. Positive protein residue results, by site.

SITE	SAMPLE	DESCRIPTION	POSITIVE RESULT (ANTISERUM TYPE)	POSSIBLE ANIMAL(S) REPRESENTED
LA 113042	1032	metate fragment from fill of large pit of unknown function	deer	members of the Cervidae
	1016	tabular knife	acorn	–
LA 129214	300	mano	acorn	–
LA 129216	903	mano (two broken pieces)	acorn	–

be undertaken to confirm, through recovery of other evidence such as pollen, phytoliths, or starch, that ground stone was used for grinding squash/pumpkin in the past. The presence of maize in the sample is echoed by the pollen record.

Other peaks representing calcium oxalates are common for this project and their significance will not be restated for each sample. Calcium oxalates are present in many plants, often in the form of crystals, particularly in agave, yucca, and members of the Cactaceae (cactus) and Chenopodiaceae (goosefoot) families. Some edible plants containing calcium oxalates include legumes (leaves and pods), goosefoot (and spinach) greens (leaves), the fruits of saltbush, and cactus fruits and epidermal tissue. Recovery of a match to calcium oxalates on a metate fragment likely represents grinding seeds or fruits from one of the plants that contain these crystals. Matches with *Opuntia* (prickly pear cactus) buds for a calcium oxalate peak at 1630 wave numbers, as well as matches with raw *Agave* leaf pulp, ground *Yucca* pods, and *Phaseolus* (beans) in other portions of the spectrum suggest yucca and legume (possibly beans) might have been contributing to the calcium oxalate signature of this sample. The match with beans was good in several areas of the spectrum. Interpreting this match requires thinking about use of the metate for grinding or mixing foods not commonly associated with metates. For instance, no one has examined the possibility that once foods were cooked they might have been brought back to metates for further grinding or mixing with other foods. Exploration of this possibility makes sense in light of this rather strong match. The best confirming analysis to recover evidence of processing beans, if the pods were still retained, is phytolith analysis, which was not done for this metate or any of the ground stone examined in this project. Prickly pear cactus also was matched with protein and cellulose peaks.

Rosa (rose) leaves and raw, young *Typha* (cattail) root also matched with this signal; however, these matches occurred with paired peaks between approximately 1479 and 1335 wave numbers, representing protein and humates common in many cultural and environmental references. References that match only with these peaks for a sample are interpreted as environmental and may or may not be present in the sample.

Similarities with mammal blood for this signature were noted for protein peaks between 1658 and 1607 wave numbers. The positive result for deer from protein residue analysis of this artifact is a more reliable indicator for the presence of specific animal proteins because it is based on immunological techniques. FTIR matches with blood can only be interpreted at a general level, meaning specific species cannot be identified.

The recovery of peaks indicating calcium carbonate in samples from this project is consistent with alkaline sediments in the area. Peaks at approximately 1420, 873, and 712 wave numbers are characteristic of this compound's signature. The presence such peaks and matches with calcium carbonate are expected and indicate deposition of this compound on the artifacts. Due to the ubiquitous nature of these peaks and matches, complete restatement of their significance will not be reiterated for each sample.

No matches were made with a polysaccharide peak at 1034 wave numbers representing galactoglucomannan and glucomannan. Other galactoglucomannan peaks at 955 and 934 wave numbers also were not matched. Glucomannan and galactoglucomannan in the sample suggest woody and fibrous tissues from coniferous plants and dicotyledons (dicots) contributed to the signal. In the absence of matches with these peaks, the possible species present cannot be identified. The presence of these compounds is considered to be environmental.

Table 26.5. LA 113042 and LA 129214, FTIR peak range for samples.

		LA 113042		LA 129214		
PEAK RANGE	REPRESENTS	1032 METATE	1016 KNIFE	300 MANO	339 MANO	1861 KNIFE
3600–3200	absorbed water (O-H stretch)	3370	3341	3361	3382	3335
		3363	–	3336	3358	3354
		3362	–	–	–	3234
3500–3300 sharp	amines	3370	3341	3361	–	–
		3363	–	–	–	–
		3362	–	–	–	–
		3361	–	–	–	–
3000–2800	aldehydes: fats, oils, lipids, waxes	2954	2955	2924	2956	2954
		2953	2923–2922	2920	2954	2922
		2921	2919	2852	2923	2921
		2920	2852	2851	2920	2919
		2852–2850	2850	–	2854	2851
		–	–	–	2853	2850
2974	CH_3 asymmetric stretch	–	–	–	2956	–
2968		–	–	–	–	–
2965		–	–	–	–	–
2962		–	–	–	–	–
2956		–	–	–	–	–
2872		–	–	–	–	–
2959	CH_2 asymmetric stretch	–	2922	2924	–	2922
2938		–	–	–	–	–
2936		–	–	–	–	–
2934		–	–	–	–	–
2931		–	–	–	–	–
2930		–	–	–	–	–
2926		–	–	–	–	–
2924		–	–	–	–	–
2922		–	–	–	–	–
1750–1730	saturated esters (C=O stretch)	1743	1735	–	1735	1736
1742	lipids (triglycerides, C=O stretch)	1742	–	–	–	–
1737	lipids (phosphopilids, C=O stretch)	–	1735	–	1735	1736
1730–1705	aromatic esters (C=O stretch)	–	–	–	–	1711
		–	–	–	–	1710
1700–1500	protein, including 1650 protein	1637	1655	1655	1648	1665
		1578	1612	1543	1577	1648
		1541	1578	–	1536	1541
		1512	1541	–	1535	1513
		–	1511	–	1508	1512
		–	1508	–	–	–
1680–1600	pectin	1637	–	–	1648	1665
1260		955	–	–	1629	1648
955		–	–	–	–	–
		–	–	–	–	–
		–	–	–	–	–
1660–1655	proteins, nucleic acids	–	1655	1655	–	–
1640–1610,	lysine (amino acid) NH_3 + bending	1637	1612	1543	1536	1541
1550–1485		1541	1541	–	1535	1513
1541, 1511		1512	1511	–	1508	1512
		–	1508	–	–	–

(Table 26.5, continued)

		LA 113042		LA 129214		
PEAK RANGE	REPRESENTS	1032 METATE	1016 KNIFE	300 MANO	339 MANO	1861 KNIFE
1620	calcium oxalate	1630	1625	1629	1629	1605
		–	775	778	776	–
1500–1400	protein	1465	1461	1467	1459	1462
		1464	1458	1432	1420	1461
		1460	1421	1420	1407	1458
		–	–	–	–	1416
1465–1455	protein/lipids	1465	1461	–	1459	1462
		1464	1458	–	–	1461
		1460	–	–	–	1458
1465	alanine (amino acid) CH_2 + bending	1465	–	–	–	–
1490–1350	protein	1465	1461	1467	1459	1462
		1464	1458	1432	1420	1461
		1460	1421	1420	1407	1458
		1376	1377	1352	1358	1416
		1364	1364	–	–	1377
		–	–	–	–	1376
		–	–	–	–	1365
1384	split CH_3 umbrella mode, 1:1	1364	1364	–	–	1365
1364		–	–	–	–	–
1377	fats, oils, lipids, humates (CH_3, symmetric bending)	1376	1377	–	–	1377
1375	leucine (amino acid) CH_3, symmetric bending	1376	–	–	–	1376
	CH_3,umbrella mode	1376	–	–	–	1376
1350–1250	serine (amino acid), O-H bending	–	1249	–	1251	1250
1170–1150	cellulose	1160	1161	1162	1158	1164
1050		–	–	–	–	–
1030		–	–	–	–	–
1130–1100	aromatic esters	–	–	–	–	1112
		–	–	–	–	1111
1100–1030	saturated esters	1058	1088	1043	1052	1073
		1034	1052	–	–	1071
		1031	–	–	–	1033
		–	–	–	–	1031
1028–1000	cellulose carbohydrates	1027	1022	1028	1028	–
		–	1021	–	1020	–
		–	1008	–	–	–
1074	arabinogalactan	–	–	–	–	1073
1072	galactan	–	–	–	–	–
1070	rhamnogalacturonan, arabinan,	–	–	–	–	1071
	arabinoglucuronoxylan +	–	–	–	–	–
	galactoglucomannan	–	–	–	1071	–
1043	rhamnogalacturonan	–	–	1043	–	–
989		–	–	–	–	–
1043	arabinogalactan	–	–	1043	–	–
985		–	–	–	–	–
1034	galactoglucomannan	1034	–	–	–	–
960		955	–	–	–	–
1034	+glucomannan (9:1, w/w),	1034	–	–	–	1033
	glucomannan	–	–	–	–	–
1028	ester O-C-C stretch	1027	–	1028	1028	–
1026	starch	1027	–	–	–	–

(Table 26.5, continued)

		LA 113042		LA 129214		
PEAK RANGE	REPRESENTS	1032 METATE	1016 KNIFE	300 MANO	339 MANO	1861 KNIFE
1022	pectin	–	1022	–	–	–
972		–	–	–	–	–
1019	primary alcohol, CH_2-O stretch	–	–	–	1020	–
941	glucomannan	–	–	942	939	–
934	galactoglucomannan	934	–	–	935	934
931	starch	–	–	–	–	932
930	cellulose	–	–	–	–	930
881	arabinoglucuronoxylan + glactoglucomannan	–	881	–	–	–
879	arabinogalactan (Type II)	–	879	879	–	879
872	$CaCO_3$ (calcium carbonate)	873	–	–	872	–
750–700	aromatic esters	720	728	739	728	722
		–	–	727	712	721
		–	–	–	–	720
722–719	CH_2 Rock (methylene)	720	–	–	–	722
		–	–	–	–	721
		–	–	–	–	720
699–697	aromatic ring bend	–	–	–	–	700
692	aromatic ring bend (phenyl ether)	692	693	–	–	–
660, 648	O-H out-of-plane bend	–	–	648	–	–

FTIR = Fourier Transform Infrared Spectography

Other peaks between 3500 and 3300 wave numbers represent amines that are produced by the breakdown of amino acids through plant and animal decomposition (Guch and Wayman 2007:176). Amines in the sample probably are attributable to the cultural and environmental signal, as these compounds are not unique to either natural processes or cultural activities.

Tabular Knife (Sample 1016). A tabular knife, sample 1016, was also submitted for analysis. This tool, recovered from a depth of 51 cm below surface, was not recovered from a feature, and its temporal association is unknown.

Pollen and starch: Pollen analysis yielded a signature dominated by cheno-am pollen, probably representing local vegetation dominated by saltbush and/or other members of the goosefoot family and perhaps also amaranth. Recovery of a moderate quantity of High-spine Asteraceae pollen indicates that rabbitbrush and/or related plants were fairly common in the local vegetation. The presence of small quantities of *Pinus* and *Quercus* pollen indicates that both pines and oak trees grew locally. Recovery of small quantities of *Artemisia*, Brassicaceae, *Cleome*, *Opuntia*, Poaceae, and *Eriogonum* pollen represents local growth of sagebrush, a member of the mustard family, beeweed, prickly pear cactus, grasses, and wild buckwheat. It is possible this tabular knife was used to cut prickly pear cactus or beeweed. The other pollen types do not appear to represent plants likely to have been cut. Only a small quantity of the pollen was poorly preserved. Again, microscopic charcoal was very abundant. Total pollen concentration on this knife was slightly more than 100 pollen per square centimeter of the washed area. No starches were observed in this sample.

Protein residue: The tabular knife was tested against the antisera listed in Table 26.3, yielding a positive result acorn antiserum. A positive to acorn antiserum indicates that acorns from a species of oak (*Quercus*) were processed using this tool. This reaction was noted to be particularly strong, and may indicate intense utilization of this tool for some aspect of acorn processing. Although *Quercus* pollen was observed from the surface wash of the tool, it is unlikely that it represents processing. Organic residue analysis obtained a match with *Quercus* nutmeat (discussed in the next section), which probably is the result of processing. All species of *Quercus* produce edible acorns, although the presence of tannin results in varying degrees of bitterness. White oak acorns are generally less bitter than black oak (including red oak) acorns.

Table 26.6. LA 113042 and LA 129214, matches for FTIR results.

			LA 113042		LA 129214		
MATCH (SCIENTIFIC NAME)	MATCH (COMMON NAME)	PART	1032 METATE (RANGE)	1016 KNIFE (RANGE)	300 MANO (RANGE)	339 MANO (RANGE)	1861 KNIFE (RANGE)
Cultural							
Agave	agave	leaf pulp (raw)	1490–1401	–	–	–	–
			1389–1338	–	–	–	–
		leaf skin (raw)	–	–	1174–1153	–	–
			–	–	1060–980	–	–
Cheno-Am	goosefoot family and amaranth	seed (ground)	1762–1715	–	–	–	–
			1481–1434	–	–	–	–
			1174–1150	–	–	–	–
			735–705	–	–	–	–
Cucurbita	gourd/ pumpkin/ squash	flesh (raw)	1762–1732	–	1568–1514	965–901	–
			1481–1434	–	968–914	–	–
			1174–1150	–	–	–	–
			735–705	–	–	–	–
Helianthus	sunflower	seed (parched, ground)	1762–1732	–	–	–	–
			1490–1398	–	–	–	–
			1174–1150	–	–	–	–
			735–705	–	–	–	–
		shell	1762–1715	–	–	–	–
			1479–1425	–	–	–	–
Opuntia	prickly pear cactus	bud	1658–1607	–	–	–	–
			1392–1335	–	–	–	–
			1099–1042	–	–	–	–
Phaseolus	bean	bean	1762–1715	–	–	–	–
			1479–1425	–	–	–	–
Pinus	pine	nut skin	1762–1732	–	–	–	–
			1481–1434	–	–	–	–
			1392–1335	–	–	–	–
		nutshell	1762–1732	–	–	–	–
			1479–1425	–	–	–	–
			1392–1335	–	–	–	–
Quercus	acorn	nutmeat	1762–1732	–	977–884	–	–
			1481–1440	–	779–759	–	–
			1395–1332	–	–	–	–
			953–899	–	–	–	–
Xanthium	cocklebur	seed (charred)	1556–1529	–	–	–	–
			1481–1434	–	–	–	–
Yucca	yucca	pod (ground)	1762–1732	–	–	–	–
			1174–1150	–	–	–	–
Zea mays	maize	kernel (dried, ground)	1762–1732	–	–	–	–
			1481–1434	–	–	–	–
			1392–1335	–	–	–	–
			1174–1150	–	–	–	–
Mammalia	mammal	blood	1658–1607	–	–	–	–
Environmental							
Agave	agave	leaf pulp (raw)	–	–	1750–1694	–	–
			–	–	1481–1419	–	–
			–	–	738–711	–	–

(Table 26.6, continued)

			LA 113042		LA 129214		
MATCH (SCIENTIFIC NAME)	MATCH (COMMON NAME)	PART	1032 METATE (RANGE)	1016 KNIFE (RANGE)	300 MANO (RANGE)	339 MANO (RANGE)	1861 KNIFE (RANGE)
Calcium carbonate	calcium carbonate	–	–	–	–	1431–1386	–
		–	–	–	–	890–854	–
		–	–	–	–	720–702	–
Cheno-am	goosefoot family and seed	seed (ground)	–	–	–	–	1476–1440
	amaranth		–	–	–	–	1389–1353
			–	–	–	–	735–705
Cleome	beeweed	leaf	–	–	–	–	1750–1694
			–	–	–	–	1398–1353
			–	–	–	–	1180–1150
			–	–	–	–	1048–1012
		stem	–	–	–	–	1750–1688
Cucurbita	gourd/ pumpkin/ squash	flesh (raw)	–	1765–1697	–	–	1476–1440
			–	1479–1397	–	–	1398–1353
			–	785–761	–	–	–
Deteriorated cellulose	deteriorated cellulose		–	1039–971	803–788	–	–
Phaseolus	bean	beanpod	–	1765–1688	–	–	–
Quercus	acorn	nutmeat	–	1479–1397	–	–	1476–1410
			–	785–761	–	–	1389–1362
			–	–	–	–	980–902
			–	–	–	–	738–711
Rosa	rose	leaf	1392–1335	–	–	–	–
Typha	cattail	young root (raw)	1479–1425	–	–	–	–
Zea mays	maize	kernel (dried, ground)	–	1479–1425	–	–	–
			–	–	–	–	1565–1523
			–	–	–	–	1476–1434
			–	–	–	–	1398–1368
			–	–	–	–	1045–1000
			–	–	–	–	738–708
		cupule (raw, dried)	–	–	–	–	–
			–	–	–	–	1676–1616
			–	–	–	–	1553–1523
			–	–	–	–	1476–1440
			–	–	–	–	1180–1150
			–	–	–	–	735–705

FTIR = Fourier Transform Infrared Spectography

Shinnery oak (*Quercus havardii*), a member of the white oak group, is a common species of oak in this area, and may have been much more prominent in the past. The acorns of *Q. gambelii* (Gambel oak, Rocky Mountain white oak) are noted to be the least bitter of all; sometimes they can be eaten fresh. Gambel oak is the most common oak of the southern Rocky Mountain region. Other species of acorn are palatable only after the bitter taste has been removed. Acorns are noted to have been utilized by native peoples in the Southwest. Acorns were gathered, shelled, roasted, and ground into a meal. The ground meal most often was leached with water in various ways to remove the bitter taste. Wood ashes could be used like lye in the leaching process. The ground meal was used alone or mixed with cornmeal to make mush, thicken soup, or make breads and cakes. Acorn meal also could be mixed with meat or animal fat. Oak wood was used for a variety of utilitarian purposes including making bows, arrows, rabbit sticks, digging sticks, clubs, and other utensils (Elmore 1944:23; Gallagher

1977:113; Harrington 1967:239–241; Kearney and Peebles 1960:216–217; Kirk 1975:104–106; Vines 1960:162; Whiting 1939:72).

Organic residue (FTIR): The tabular knife also was examined for organic residues. Sample 1016 yielded functional group peaks indicating the presence of absorbed water, amines, and fats/oils/lipids and/or plant waxes. Peaks in the fingerprint region represent aromatic rings; aromatic and saturated esters; proteins including nucleic acids; the amino acids lysine and serine; calcium oxalates; humates; pectin; cellulose and carbohydrates; and the polysaccharides arabinoglucuronxylan, arabinogalactan, and galactoglucomannan.

Matches with *Quercus* (acorn) nutmeat were made with peaks at 1458 and 775 wave numbers, representing protein and esters, respectively. Raw *Cucurbita* (gourd/pumpkin/squash) flesh and *Phaseolus* (bean) pods—probably representing legumes in general—were matched with portions of the spectrum that represented proteins and lipids/phospholipids. This match with squash/pumpkin flesh was not as good as that noted for sample 1032, making any interpretation of using this tabular knife to cut squash/pumpkin suspect. A protein and lipids peak at 1458 wave numbers also was matched with dried, ground *Zea mays* (maize) kernels.

The presence of peaks matching acorn, maize, beans (legumes), and gourd/pumpkin/squash probably represent the presence of these plants in sediments processed at the site. These signatures might have been imparted onto the knife as a result of storing the knife with food or discarding the knife in an area which contained discarded food remains. Other that with deteriorated cellulose in the cellulose and carbohydrate portion of the spectrum represent the local environmental signal and the natural breakdown of plant matter in the sediments from which the knife was recovered.

No matches were made with peaks representing the amino acids lysine and serine; however, lysine is common in gourds and squash, and legumes contain large amounts of serine. The presence of gourds or squash and legumes in the sample could be contributing to these amino acid peaks.

Contributions to calcium oxalate peaks at 1625 and 775 wave numbers could be attributable to legumes in the sample or sediments, although no matches were made with these peaks.

Peaks representing the polysaccharides arabinoglucuronoxylan, galactoglucomannan, and arabinogalactan probably are attributable to the environmental signature. Arabinoglucuronoxylan and galactoglucomannan indicate that fibrous tissues from softwoods and herbaceous plants are present in the sediments, while arabinogalactan suggests the presence of non-specific plant gums and hemicelluloses.

The natural breakdown of amino acids from plant and animal materials at the site are probably the source of the amine peak visible in the sample at 3341 wave numbers.

LA 129214

The area around this site is comprised primarily of coppice dunes stabilized by mesquite, little-leaf sumac, and four-winged saltbush. Two manos and one tabular knife were submitted for pollen, starch, protein, and organic residue analysis from this site. The results are discussed by tool and analysis type.

Mano (Sample 300). A mano, represented as Sample 300, was recovered from the surface of the site and is not associated with a feature.

Pollen and starch: Pollen analysis of the mano yielded a very large quantity of *Quercus* pollen, indicating that oaks were growing locally and suggesting the possibility that this mano was last used in the spring when oaks pollinate. Given the fact that acorns must be split open to release the nutmeat for processing and the fact that *Quercus* pollen is not transported in large quantities on acorns, it is unlikely that this elevated *Quercus* pollen frequency represents the processing of acorns. Cheno-am pollen was observed in a quantity nearly equal to that of *Quercus* pollen, indicating that saltbush and related plants were abundant in the local vegetation community. Recovery of small quantities of *Pinus*, *Artemisia*, High-spine Asteraceae, *Boerhaavia*-type, and Poaceae pollen represent pines, sagebrush, various members of the sunflower family such as rabbitbrush, spiderling, and grasses growing in the local vegetation community. It is possible that a portion of the cheno-am pollen noted on this mano is present through grinding cheno-am seeds. The only starches recovered are typical of those produced in maize kernels (Fig. 26.2[a] and [b]), suggesting grinding maize with this mano. A relatively large quantity of microscopic charcoal also was observed in this wash, that probably is associated

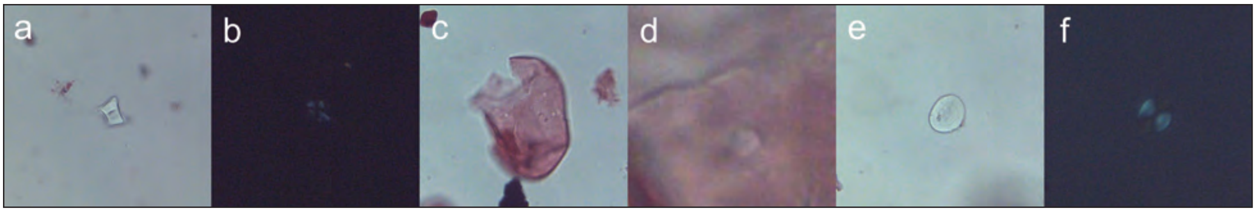

Figure 26.2[a-f]. Images of starches and pollen recovered from LA 129216, LA 129217, and LA 129300.

with the period of use, suggesting placement near a hearth. Total pollen concentration of more than 60 pollen per square centimeter of washed surface is relatively low.

Protein residue: Protein residue analysis of the mano (Sample 300) yielded a positive result to acorn antiserum. A positive to acorn antiserum indicates that acorns from a species of oak (*Quercus*) were processed using this tool unless this positive is a false positive due to deterioration of acorns in the sediments adjacent to the mano or the presence of bacteria that produce false positives. As previously discussed, *Quercus* pollen was extremely abundant on the grinding surface of the tool, providing strong supporting evidence of the availability of acorns.

Organic residue (FTIR): FTIR analysis of the mano (Sample 300) recovered from the surface of the site, yielded peaks representing functional group compounds including absorbed water, amines, and fats/oils/lipids and/or plant waxes. Other peaks identified in the fingerprint range indicate the presence of aromatic and saturated esters; proteins including nucleic acids; the amino acid lysine; calcium oxalates; cellulose and carbohydrates; and the polysaccharides rhamnogalacturonan, arabinogalactan, and glucomannan.

Matches for *Quercus* (acorn) nutmeat were made with peaks representing esters and the polysaccharide glucomannan. Glucomannan is found in fibrous tissues from dicots, of which oak is a member. These matches suggest nuts that might have included acorn were ground using the mano.

Raw *Cucurbita* (gourd/pumpkin/squash) flesh also was matched with the glucomannan peak at 942 wave numbers, suggesting the possibility that this cultigen also contributed to the glucomannan in the sample. Gourd, pumpkin, and/or squash also matched with a peak at 1543 wave numbers representing the amino acid lysine. This amino acid is common in members of the Cucurbitaceae, such as gourd, pumpkin, and squash, as well as in other plants. This match also was not as strong as that reported for sample 1032, a metate. Therefore, interpretation that this mano was used to grind squash/pumpkin flesh is considered weak.

Other matches were made with raw *Agave* leaf skin for peaks at 1162 and 1028 representing cellulose and carbohydrates. This match suggests agave might be part of the deteriorated cellulose signature present in the sample. Agave processing might have occurred with this artifact; however, agave matches also might represent plants growing in the local environment.

Deteriorated cellulose matched only with peaks in a portion of the spectrum representing aromatic esters. The presence of cellulose probably indicates the local environmental signal and the natural breakdown of plant materials in the sediments at the site; however, cellulose in the sample also might represent processed plants that have deteriorated to a point where they are only visible by their general cellulose signature.

Other polysaccharides in the sample including rhamnogalacturonan and arabinogalactan, which are found in many plants (Nothnagel et al. 2000; Willats et al. 2001), are probably contributing to both the cultural and environmental components of the signature. Likewise, the presence of amines, organic compounds produced naturally by the breakdown of amino acids as plant and animal materials decompose (Guch and Wayman 2007:176), could also represent a combination of cultural activities and natural processes that have imparted their signature on the artifact.

Mano Fragment (Sample 339): A mano fragment, Sample 339, was recovered from Feature 42 at 10 to 20 cm below surface, a temporary shelter lacking specific indications of a use-surface or floor. Temporal association of the mano is uncertain, other than the probability that it dates to the last 2000 years.

Pollen and starch: Pollen analysis of the mano fragment yielded a signature co-dominated by High-spine Asteraceae and cheno-am pollen, reflecting local vegetation including both rabbitbrush and related plants and saltbush and related plants. It is possible that cheno-am seeds also were ground using this mano. Recovery of small quantities of *Pinus*, *Quercus*, *Artemisia*, *Erodium*, and Poaceae represent plants growing at the site either during the prehistoric time period or more recently. These plants included pine, oak, sagebrush, filaree, and grasses. A small quantity of *Zea mays* pollen was recovered from this sample indicating that maize was ground using this mano. The fact that the *Zea mays* pollen was torn (Fig. 26.2[c] and [d]) indicates that it was present when the mano was used. An eccentric starch also was observed in this sample. At present, this starch has not been identified further than as that of a root or tuber. This mano fragment exhibited a much smaller quantity of microscopic charcoal than did other samples from this site and a larger total pollen concentration of nearly 200 pollen per square centimeter of washed surface.

Protein Residue: Protein residue analysis of the mano yielded no positive results. It is possible that this mano was not used to grind meat and plant material, the ground material is not represented by antisera in our reference collection, or insufficient amounts of protein residues were retained on the mano surface for recovery and identification.

Organic residue (FTIR): Analysis of the organic residues from the mano (Sample 339) found in the temporary shelter (Feature 41) yielded functional group peaks indicating the presence of absorbed water and fats/oils/lipids and/or plant waxes. Peaks within the fingerprint range of the spectrum represent aromatic and saturated esters; protein; the amino acids lysine and serine; calcium carbonate; calcium oxalates; pectin; cellulose and carbohydrates; and the polysaccharides galactoglucomannan and glucomannan.

The best match for these peaks was with calcium carbonate suggesting the sample is dominated by an environmental signal. All three peaks at 1407, 872, and 712 wave numbers characteristic of calcium carbonate were visible and matched with this compound.

A weak match with raw *Cucurbita* (gourd/pumpkin/squash) flesh for a peak at 939 wave numbers representing glucomannan, a polysaccharide found in dicots such as gourd, pumpkin, and squash, was not interpreted to represent processing squash/pumpkin.

Portions of the spectrum representing the amino acids lysine and serine were not matched with any references in the PaleoResearch libraries. Contributions to the lysine peaks might be attributable to members of the Cucurbitaceae in the sample, while serine peaks suggests the presence of nuts, seeds, and/or meat. In the absence of matches with these peaks, it is difficult to determine the specific floral and/or faunal species contributing to the signal.

No matches were made with polysaccharide peaks at 935 wave numbers representing galactoglucomannan. This compound is common in the fibrous tissues of conifers and suggests these plants are contributing to the signature. The presence of galactoglucomannan probably is attributable to plants growing in the local environment.

Tabular Knife (Sample 1861). A tabular knife, represented by Sample 1861, was recovered between 0 and 10 cm below surface, and is not associated with a feature.

Pollen and starch: Pollen analysis of the tabular knife yielded a record heavily dominated by cheno-am pollen, representing local vegetation that included saltbush or closely related plants. In addition, a moderately small quantity of High-spine Asteraceae pollen indicates that members of the sunflower family also grew in the area. Recovery of small quantities of *Pinus*, *Quercus*, *Artemisia*, *Boerhaavia*-type, Brassicaceae, and Poaceae pollen indicate that local vegetation also included pines, oak, sagebrush, spiderling, a member of the mustard family, and grasses. No starches were observed in this sample. This sample contained a moderate quantity of microscopic charcoal and a total pollen concentration of slightly more than 100 pollen per square centimeter of washed surface.

Protein residue. Protein residue analysis of the tabular knife (Sample 1861) yielded no positive results. It is possible that this tool was not used for processing animal and plant resources or that it had not been used since its last edge shaping/re-sharpening episode. It is also possible that it was used to process animals and plants other than those represented by the available antisera or that an insufficient amount of protein residues were retained on the tools surface.

Organic residue (FTIR): The tabular knife also was examined for organic residues. Sample 1861 yielded peaks representing several functional group compounds including: absorbed water, fats/oils/lipids, or plant waxes. Other peaks in the fingerprint range including aromatic rings; aromatic and saturated esters; protein; the amino acids lysine, leucine, and serine; calcium oxalates; pectin; humates; starch; cellulose; and the polysaccharides arabinogalactan, galactan, rhamnogalacturonan, arabinan, arabinoglucuronoxylan, galactoglucomannan, and glucomannan also were identified.

Peaks representing proteins, the amino acid leucine, and aromatic esters matched with *Quercus* (acorn) nutmeat, ground cheno-am seeds, and raw *Agave* leaf pulp. Leucine contributions from nuts and seeds, such as acorn and cheno-am, probably account for the protein peak at 1376 wave numbers. Matches with acorn, cheno-am, and agave probably indicate plants part of the local environment.

The amino acid serine also was identified by a peak at 1250 wave numbers. This compound indicates nuts, seeds, and/or meat are present in the sample. Although no matches were made with this peak, serine in acorns and cheno-am seeds could be contributing to this peak.

Dried *Zea mays* (maize) cupules and kernels matched with several peaks between 1680 and 1435 wave numbers, a portion of the spectrum representing proteins. Cellulose and ester peaks also were matched with maize. These matches detect the presence of maize in the sediments at the site. Although maize pollen and *Zea*-type starch were not present in this sample, they were found in other samples (300 and 339) from this site.

Raw *Cucurbita* (gourd/pumpkin/squash) flesh also matched with this signal at paired peaks between approximately 1479 and 1335 wave numbers, representing protein and humates. These peaks are common in many cultural and environmental references. References that match only with these peaks for a sample are interpreted as environmental, and may or may not be present in the sample. Therefore, any interpretation that this knife was used to cut squash/pumpkin is tentative and premature.

Other matches with *Cleome* (beeweed) leaves and stems for portions of the spectrum representing cellulose, humates, and aromatic and saturated esters probably also represent the environmental signal. *Cleome* is absent from the pollen record for this sample; however, cleome pollen was visible in the environmental component of Sample 1016 from another site (LA 113042) in this project.

A peak at 1071 wave numbers indicates the presence of several polysaccharides including rhamnogalacturonan and arabinan. These polysaccharides are present in many plants (Jones et al. 2003:11783) and cannot be associated either with the cultural or the environmental components of the signature due to their ubiquitous occurrence in the plant kingdom. Also represented by this peak, arabinoglucuronoxylan and galactoglucomannan suggest fibrous tissues from softwoods and herbaceous plats are contributing to the signal. The fifth polysaccharide indicated by this peak is galactan. This compound suggests the presence of members of the Chenopodiaceae, perhaps *Atriplex* (saltbush) and/or *Chenopodium* (goosefoot). Cheno-am in the sample might be a source of galactan indicated by this peak.

Arabinogalactan in the sample suggests the general presence of plant matter; however, without matches to this peak, the specific plant species contributing to the signature cannot be identified.

The polysaccharide glucomannan is indicated by a peak at 1033 wave numbers. This compound suggests woody and fibrous tissue from dicots is present in the sample. Contributions from specific floral species cannot be determined without matches.

LA 129216

Mano (Sample 903). The area around this site is described as consisting primarily of coppice dunes stabilized by mesquite, little-leaf sumac, and four-winged saltbush. A mano (Sample 903) comprised of two broken pieces was submitted for pollen, starch, protein, and organic residue (FTIR) analysis. This tool was recovered from the surface of the site.

Pollen and starch: Pollen analysis of the mano yielded a record heavily dominated by High-spine Asteraceae pollen, probably reflecting local growth of rabbitbrush and perhaps other members of the sunflower family. The cheno-am frequency was moderate, recording the presence of saltbush in the local vegetation community, as well as the possibility that cheno-am seeds were ground. Recovery of small quantities of *Alnus*, *Juniperus*, *Artemisia*, Boraginaceae, Brassicaceae, Poaceae, *Eriogonum*, *Polygonum aviculare*-type, and Rosaceae reflect local growth of alder, juniper, sagebrush, members of the borage and mustard families, grasses, wild buckwheat, knotweed, and a member of the rose family. This sample exhibited only a small quantity of microscopic charcoal, and total pollen concentration was much higher at approximately 480 pollen per square centimeter of ground surface washed. No starches were observed in this sample.

Protein residue: Protein residue analysis of mano Sample 903 yielded a positive to acorn antiserum. A positive to acorn antiserum indicates that acorns from a species of oak (*Quercus*) were processed using this tool. This finding is supported by the results of the organic residue analysis (discussed below) with a match to acorn (*Quercus*) nutmeat residue.

Organic residue (FTIR): Organic residue analysis of mano Sample 903 yielded functional group peaks indicating the presence of absorbed water and fats/oils/lipids and/or plant waxes (Table 26.7). Peaks within the fingerprint range of the spectrum represent aromatic rings; aromatic and saturated esters; protein; the amino acids lysine and serine; calcium carbonate; calcium oxalates; humates; starch; and the polysaccharides galactan, rhamnogalacturonan, arabinan, arabinoglucuronoxylan, galactoglucomannan, and glucomannan.

Matches with the mano fragment were made with *Quercus* (acorn) nutmeat and shells for portions of the spectrum representing protein, as well as a peak at 940 wave numbers representing the polysaccharide glucomannan, a compound common in dicots, such as acorn (Table 26.8). These matches suggest nuts, including acorns, were ground with this mano.

Other matches with peaks representing proteins between 1700 and 1450 wave numbers also were made with parched and ground *Helianthus* (sunflower) seeds; raw, dried *Zea mays* (maize) cupules; and *Cucurbita* (gourd/pumpkin/squash) flesh suggesting gourds, pumpkins, or squash, maize, and seeds, such as sunflower, also might have been processed using the artifact. Gourd/pumpkin/squash also was matched with the glucomannan peak at 940 wave numbers. Matches with several plants and plant parts for the peaks between 1700 and 1450 wave numbers indicates that these peaks might be too general to substantiate use or processing of a single plant. Likewise, the glucomannan peak at 940 wave numbers cannot be associated only with squash/pumpkin. Therefore, any interpretation that this mano was used to grind squash/pumpkin is very tentative.

Contributions to unmatched lysine peaks visible in the protein range of the spectrum could be attributable to members of the Cucurbitaceae, such as gourd, pumpkin, or squash in the sample. Likewise, peaks representing the amino acid serine might be detecting acorn and sunflower, even though these peaks also were not matched.

Boiled *Yucca* pods and baked *Opuntia* (prickly pear cactus) buds were matched with peaks at 1633 and 1630 wave numbers representing calcium oxalates. Matches to calcium oxalates indicate plants rich in these crystals, such as yucca and prickly pear cactus, are contributing to the signal. The presence of calcium oxalates also could be attributable to other calcium oxalate rich plants such as *Agave*, *Atriplex* (saltbush), *Chenopodium* (goosefoot), and other cactus species.

Pinus (pine) nut shells, *Allium* (wild onion) bulbs, *Cleome* (beeweed) flowers, and *Rosa* (rose) leaves also matched with this signal; however, these matches occurred with paired peaks between approximately 1479 and 1335 wave numbers, representing protein and humates common in many cultural and environmental references. References that match only with these peaks for a sample are interpreted as environmental, and may or may not be present in the sample.

Other matches with *Rhus* (skunkbush) wood represent plants growing in the local environment.

Several polysaccharides are indicated by a single peak at 1071 wave numbers. Rhamnogalacturonan and arabinan are found in many plants and suggest only the general presence of plant materials in the sample. The presence of fibrous tissues from softwoods and herbaceous plants are indicated by the polysaccharides arabinoglucuronoxylan and galactoglucomannan, while galactan in the sample suggests members of the Chenopodiaceae, perhaps *Atriplex* (saltbush) and/or *Chenopodium* (goosefoot), are contributing to the signal. Cheno-am pollen was observed in this sample, which is consistent with this signal. Without matches for these peaks, it is best to interpret these polysaccharides as representing compounds in the environmental signal.

LA 129217

Mano fragment (Sample 10). This site is situated on top of Livingston Ridge, the landform that defines the eastern limit of Nash Draw and its valley. Parabolic dunes and coppice dunes occur in this area, with shinnery oak (*Quercus havardii*) and mesquite

Table 26.7. LA 129216, LA 129217, and LA 129300, FTIR peak range for samples.

PEAK RANGE	WHAT PEAK RANGE REPRESENTS	LA 129216 903 MANO	LA 129217 10 MANO	LA 129300 470 MANO
3600–3200	absorbed water (O-H stretch)	3374	3394	–
		2265	3385	–
		3351	3335	–
3500–3300 sharp	amines	–	3385	–
3000–2800	aldehydes (fats, oils, lipids, waxes)	2952	2924	–
		2922	2923	–
		2921	2853	–
		2853	2852	–
		2851	–	–
2959	CH_2 asymmetric stretch	2922	2924	–
2938		–	–	–
2936		–	–	–
2934		–	–	–
2932		–	–	–
2930		–	–	–
2926		–	–	–
2924		–	–	–
2922		–	–	–
1750–1730	saturated esters (C=O stretch)	1742	–	–
		1736	–	–
1742	lipids (triglycerides, C=O stretch)	1742	–	–
1737	lipids (phosphopilids, C=O stretch)	1736	–	–
1700–1500	protein, including 1650 protein	1636	1648	–
		1582	1637	–
		1578	–	–
		1541	–	–
		1512	–	–
1650	proteins (asparagine, C=O stretch)	–	1648	–
1640–1610	lysine (amino acid) NH_3+ bending	1636	1637	–
1550–1485		1541	–	–
		1512	–	–
1100	lysine (amino acid) NH_3+ rocking	1100	–	–
1620	calcium oxalate	1633	1636	–
1315		1630	776	–
780		1610	–	–
		777	–	–
1500–1400	protein	1459	1458	1416
		1413	1438	1414
		–	1425	–
1465–1455	protein/lipids	1459	1458	–
1490–1350	protein	1459	1458	1416
		1413	1438	1414
		1377	1425	–
		1364	1350	–
1377	fats, oils, lipids, humates	1377	–	–
	CH_3, symmetric bend			
1350–1250	serine (amino acid) O-H bending	1349	1350	–
		1288	1344	–
		1287	1343	–
		–	1249	–

(Table 26.7, continued)

PEAK RANGE	WHAT PEAK RANGE REPRESENTS	LA 129216 903 MANO	LA 129217 10 MANO	LA 129300 470 MANO
1188	saturated ester C-C-O	1185	–	–
1170–1150	cellulose	–	1161	–
1050		–	–	–
1030		–	–	–
1161	arabinoglucuronoxylan	–	1161	–
1151	galactoglucomannan			
1130–1100	aromatic esters	1110	–	–
1110	starch	1110	–	–
1100–1030	saturated esters	1071	1044	1040
		1069	–	1034
		1031	–	–
1028–1000	cellulose carbohydrates	–	1003	–
1072	galactan	1071	–	–
1070	rhamnogalacturonan, arabinan	1071	–	–
	arabinoglucuronoxylan + galactoglucomannan	–	–	–
1040	arabinogalactan (Type II)	–	–	1040
1034	galactoglucomannan	–	–	1034
960		–	–	–
993	alkene out-of-plane C-H	–	993	–
910		–	–	–
718		–	–	–
640		–	–	–
941	glucomannan	940	942	–
872	$CaCO_3$ (calcium carbonate)	874	–	875
850	starch	–	–	852
830	symmetric C-C-O stretch	830	–	–
750–700	aromatic esters	722	743	728
		712	–	–
		700	–	–
722–719	CH_2 Rock (methylene)	722	–	–
699–697	aromatic ring bend	700	–	–
692	aromatic ring bend (phenyl ether)	–	693	–

FTIR = Fourier Transform Infrared Spectography

being the dominant vegetation. Snakeweed (*Gutierrezia sarothrae*) is also fairly common. Other plants growing in the vicinity of this site include sandsage (*Artemisia filifolia*), crown-of-thorns (*Koeberlinia spinosa*), javelinabush (*Condalia ericoides*), various cacti (Cactaceae), and grasses (Poaceae) such as *Sporobolus*, *Aristida*, and *Cenchrus*. A mano fragment (Sample 10) was recovered from the surface of the site, and submitted for pollen, starch, protein, and organic residue analysis.

Pollen and starch: Pollen analysis of the mano fragment (Sample 10) yielded nearly equal quantities of *Artemisia* and High-spine Asteraceae pollen, with slightly lower frequencies of Poaceae and indeterminate pollen. This record indicates that sagebrush and other members of the sunflower family such as rabbitbrush and other plants grew locally. In addition, recovery of small quantities of *Pinus*, *Quercus*, cheno-am, and *Eriogonum* pollen reflect local growth of pines, oaks, saltbush and related plants, and wild buckwheat. No starches were noted in this sample. A single fern spore was observed and the quantity of microscopic charcoal was very small. Total pollen concentration was nearly 200 pollen per square centimeter of ground surface washed.

Protein residue: Protein residue analysis of the mano fragment yielded no positive results. It is possible that this tool was not used for processing animal and plant resources, that it was used to process animals and plants other than those represented by the available antisera, or that insufficient

Table 26.8. LA 129216, LA 129217, and LA 129300, matched for FTIR results.

MATCH (SCIENTIFIC NAME)	MATCH (COMMON NAME)	PART	LA 129216 903 MANO (RANGE)	LA 129217 10 MANO (RANGE)	LA 129300 470 MANO (RANGE)
Cultural					
Cucurbita	gourd/ pumpkin/ squash	flesh	1756–1721	–	–
			1484–1425	–	–
			1377–1350	–	–
			959–917	–	–
Helianthus	sunflower	seed (parched, ground)	1756–1721	–	–
			1484–1428	–	–
			1386–1371	–	–
Opuntia	prickly pear cactus	bud (baked)	1652–1613	1670–1601	–
Quercus	acorn	nutmeat	1762–1720	962–896	–
			1484–1425	–	–
			962–908	–	–
		shell	1479–1425	–	–
			1386–1371	–	–
Yucca	yucca	pod (boiled)	1756–1721	1670–1601	–
			1652–1613	–	–
Zea mays	maize	cupule (raw, dried)	1756–1721	–	–
			1484–1425	–	–
Environmental					
Allium	wild onion	bulb	1386–1371	–	–
Calcium carbonate	calcium carbonate	–	–	–	1464–1356
			–	–	887–863
			–	–	744–711
Cleome	beeweed	flowers	1386–1371	–	–
Deteriorated cellulose	deteriorated cellulose	–	–	1093–908	–
				809–782	–
Pinus	pine	nut shell	1484–1428	–	–
			1386–1371	–	–
Rhus	skunkbush	wood	1762–1709	–	–
			1484–1428	–	–
Rosa	rose	leaf	1386–1371	–	–

FTIR = Fourier Transform Infrared Spectography

amounts of protein residues were retained on the tool surface.

Organic residue (FTIR): FTIR analysis of Sample 10 yielded peaks representing functional group compounds including absorbed water, amines, and fats/oils/lipids and/or plant waxes. Other peaks identified in the fingerprint range indicate the presence of aromatic rings; aromatic and saturated esters; protein; the amino acids asparagine, lysine, and serine; calcium oxalates; cellulose and carbohydrates; and the polysaccharides arabinoglucuronoxylan, galactoglucomannan, and glucomannan.

The best match for these peaks was with deteriorated cellulose. This match probably represents the local environmental signal and the natural breakdown of plant matter in the sediments from which the mano was recovered. Alternatively, the presence of cellulose could indicate that plants processed with this artifact have deteriorated to the point where they are no longer visible beyond their general cellulose signature.

No matches were made with peaks in the protein portion of the spectrum representing the amino acids asparagine, lysine, and serine. Asparagine and serine in the sample suggest nuts, seed, and/or animal materials are contributing to the signal. Meat also is indicated by lysine peaks; however, this compound is more concentrated in gourds, squash, and legumes suggesting the possibility that these plants might be contributing to the signal. Any interpretation of their processing should, however, rest on more substantial evidence such as pollen, phytoliths, or starches.

A calcium oxalate peak at 1636 wave numbers was matched with baked *Opuntia* (prickly pear cactus) buds and boiled *Yucca* pods; however, the remainder of the spectrum was not a good match for these references. These matches suggest calcium oxalate rich plants, perhaps prickly pear cactus and yucca, are contributing to this peak.

Woody and fibrous tissues from coniferous and/or dicotyledonous plants are indicated in the sample by a peak at 942 wave numbers representing the polysaccharide glucomannan. A weak match with *Quercus* (acorn) nutmeat for this peak suggests glucomannan in acorns might be contributing to this range of the spectrum.

Other polysaccharides in the sample including arabinoglucuronoxylan and galactoglucomannan suggest softwoods and herbaceous plants are contributing to the signal. In the absence of matches with these peaks, the presence of these compounds was interpreted as representing plants growing in the local environment.

The natural breakdown of amino acids in the local environment was probably the source of amines that are represented by a peak at 3385 wave numbers.

LA 129300

Mano (Sample 470). Specific site info was not provided; however, the common vegetation is expected to be similar to that described for the previously discussed site LA 129217. A mano (Sample 470) was recovered from a depth of 10 to 20 cm below the surface and submitted for pollen, starch, protein, and organic residue analysis.

Pollen and starch: Pollen analysis of the mano yielded little pollen—only approximately four pollen per square centimeters of surface washed. Microscopic charcoal was not abundant in this sample, indicating that the paucity of pollen is probably not the result of burning. A *Hordeum*-type starch was noted (**Fig**ure 26.2[e] and [f]), indicating that little barley grass or wild barley grass seeds were ground using this mano. A very large quantity of algal bodies was recovered from this sample, suggesting the presence of a wetland resource. It is likely that the algal bodies were transported along with either water or a wetland resource that was ground using this mano.

Protein residue: Protein residue analysis of the mano (sample 470) yielded no positive results. It is possible that this tool was not used for processing animal and plant resources, that it was used to process animals and plants other than those represented by the available antisera, or that insufficient amounts of protein residues were retained on the tool surface.

Organic residue (FTIR): Analysis of the organic residues extracted from the mano sample 470 yielded no functional group peaks. Peaks in the fingerprint region represent aromatic and saturated esters; protein; starch; and the polysaccharides arabinogalactan and galactoglucomannan.

The signature obtained from this mano is almost completely identical to the signature characteristic of calcium carbonate. The three primary peaks of the calcium carbonate signature at approximately 1416, 875, and 728 wave numbers were visible and matched with this reference, suggesting the sample representing the mano is dominated by an environmental signal. As previously mentioned, the presence of calcium carbonate is expected, and matches with this compound probably indicate deposition of this compound on the mano.

Two smaller polysaccharide peaks at 1040 and 1034 wave numbers, representing arabinogalactan and galactoglucomannan, were not matched. The presence of these compounds suggests softwoods and herbaceous plants also are contributing to the signal. Arabinogalactan and galactoglucomannan in the sample probably represent these compounds found in plants growing in the local environment.

Nutritional Analysis Of Acorns

Two bags of acorns collected near Loving and Roswell, New Mexico, were submitted for nutritional analysis. These acorns were collected a little over a year prior to the analysis. We submitted these acorns to NutriData in California for that analysis, then have combined those results with the published nutritional information on acorns available through the USDA (USDA Natural Resources Conservation Service 2011) (Table 26.9). The percent difference in nutritional information between the populations of acorns collected near Loving and Roswell is also calculated and presented on this table.

Table 26.9. Nutritional data for various acorns, per 100 grams.

NUTRIENTS	USDA-PUBLISHED DATA	LOVING ACORNS	ROSWELL ACORNS	RATIO OF ROSWELL TO LOVING
Calories (kcal)	507.14	370.00	377.00	1.018919
Calories from fat (kcal)	262.86	28.17	35.10	1.246006
Fat (g)	31.43	3.13	3.90	1.246006
Saturated fat (g)	3.93	0.61	0.73	1.196721
Trans fatty acid (g)	not reported	–	–	–
Cholesterol (mg)	not reported	–	–	–
Carbohydrates (g)	53.57	81.16	80.12	0.987186
Dietary fiber (g)	not reported	17.42	16.73	0.960390
Total sugars (g)	not reported	9.67	7.93	0.820062
Protein (g)	28.21	4.27	5.33	1.248244
Water (g)	5.00	8.50	7.96	0.936471
Ash (g)	1.79	2.93	2.70	0.921502
Mono fat (g)	20.00	1.31	1.86	1.419847
Poly fat (g)	6.07	1.21	1.32	1.090909
Vitamins:				
Vitamin A - (IU)	0.00	1047.00	1423.00	1.359121
Vitamin C (mg)	0.00	20.13	18.10	0.899155
Niacin (mg)	2.50	–	–	–
Vitamin B6 (mg)	0.71	–	–	–
Folate (mcg)	115.00	–	–	–
Pantothenic acid (mg)	1.07	–	–	–
Minerals:				
Sodium (mg)	0.00	24.00	22.00	0.916667
Calcium (mg)	53.93	79.97	52.96	0.662248
Iron (mg)	1.07	0.95	0.99	1.042105
Potassium (mg)	710.71	920.00	879.00	0.955435
Magnesium (mg)	42.86	–	–	–
Phosphorous (mg)	102.86	–	–	–
Zinc (mg)	0.71	–	–	–
Copper (mg)	0.71	–	–	–
Manganese (mg)	1.43	–	–	–

It is interesting to note that the values for approximately half of the nutritional elements is higher for the acorns collected near Roswell than for those collected near Loving. The reverse is true for the other half of the nutrients.

This split—accompanied by the fact that the difference between the nutritional values for these two populations of acorns is less than the difference between either one of these groups of nuts and the published data—suggests that acorns probably differ significantly in their nutritional content. Some of this difference might be related to the substrate (sediment) in which the oak trees grow. Other differences might be related to the quantity of water received by each population. The USDA site does not specify which species of acorns is represented in their study. All USDA data has been converted from the published amount for 1 ounce (28 g) to an amount for 100 g, since the nutritional data for the Loving and Roswell acorns is reported per 100 g of acorn meat. It is interesting, however, that the USDA published data for acorns indicates a higher calorie count both for total calories and especially for calories from fat than do either the Loving or Roswell acorns.

As expected, nutritional analysis from different sources is not uniform, meaning that the same nutrients were not evaluated for the USDA published data and by NutriData. It is possible that the very low quantities of nutrients reported for calories, protein, and fats in the Loving and Roswell acorns, compared to the USDA published data, result from the fact that fresh acorns were not available for analysis. These acorns were dried out and although they could have been ground, it is unlikely that they would have been consumed when they were this old.

Table 26.10. Amino acids for various acorns.

AMINO ACIDS	USDA-PUBLISHED DATA	LOVING ACORNS	ROSWELL ACORNS	RATIO OF ROSWELL TO LOVING
Total protein (N x 6.25, g/100g)	8.21	4.27	5.33	1.248244
Tryptophan	97.86	50.9	63.5	1.247544
Threonine	312.14	162.4	202.5	1.246921
Isoleucine	375	195.1	243.3	1.247053
Leucine	642.86	340	417.1	1.226765
Lysine	503.57	262	326.8	1.247328
Methionine	136.07	70.8	88.3	1.247175
Cysteine	143.93	76	93.4	1.228947
Phenylalanine	353.93	184.2	229.7	1.247014
Tyrosine	246.07	128	159.7	1.247656
Valine	453.57	238	294.3	1.236555
Histidine	223.93	122	145.3	1.190984
Arginine	621.43	323.3	403.2	1.247139
Alanine	460.71	239.7	298.9	1.246975
Aspartic acid	835.71	434.8	542.3	1.24724
Glutamic acid	1300	676.4	843.5	1.247043
Glycine	375	195.1	243.3	1.247053
Proline	323.93	177.2	210.2	1.18623
Serine	343.93	181.3	223.2	1.231109

In general, acorns appear to provide a good source of fats and the fat soluble Vitamin A. Published USDA values for nutrients suggest that acorns also are a good source of protein, Vitamin B6, and the minerals copper, phosphorous, potassium, and manganese (USDA Natural Resources Conservation Service 2011).

In addition, because amino acid peaks are visible in FTIR analysis and their presence has become very important in our interpretations, we also ran an amino acid assay for each of the groups of acorns, with the results presented in Table 26.10. It is interesting to note that all of the values for amino acids were higher in the acorns collected near Roswell and lower in the Loving acorns. Both of these populations yielded lower amino acid quantities than the published USDA data indicates. Once again, storage of the acorns might have degraded amino acids prior to analysis, since these acorns had been collected more than a year prior to the analysis.

Summary and Conclusions

Eight artifacts from five different sites were submitted for pollen, starch, protein, and organic residue analysis. A summary table (Table 26.11) presents the evidence for use of these tools for processing acorns and other plants or meat. Briefly, six of the eight artifacts yielded either FTIR or protein residue, or both, evidence for processing acorns. No starches typical of those produced by acorns were recovered from any of the artifacts. Pollen representing maize was noted on two of the artifacts (Samples 1032 and 339, representing a metate and mano, respectively). In addition, maize starch was noted in Sample 330, representing a mano. Starch evidence for grinding wild barley grass seeds was noted in Sample 470, representing a mano. This sample also contained a large quantity of algal bodies, suggesting either use of water or perhaps grinding roots from a wetland habitat with this mano. A more detailed review of evidence from the protein and FTIR analyses is presented below.

Protein residue analysis yielded positive results on four of the eight tools tested. From site LA 113042, a metate (Sample 1032) tested positive to deer antiserum, suggesting that dried meat or bones from a member of the Cervidae were processed. A tabular knife (Sample 1016) from the same site yielded a strong positive to acorn antiserum, suggesting that it was used to process acorns. From LA 129214, a mano (Sample 300) yielded a very strong positive to acorn antiserum, suggesting that it was used to process acorns. This strong positive result is

Table 26.11. Acorn and cultigen evidence by site.

SITE	SAMPLE NO.	DESCRIPTION	ACORN	MAIZE	OTHER
LA 113042	1032	metate	FTIR*	pollen	deer (protein)
	1016	tabular knife	protein	–	–
			FTIR	–	–
LA 129214	300	mano	protein (strong)	starch	–
			FTIR (weak)	–	–
	339	mano	–	pollen	eccentric (root) starch
	1861	tabular knife	FTIR	–	–
LA 129216	903	mano	protein	–	–
			FTIR	–	–
LA 129217	10	mano	FTIR (weak)	–	–
LA 129300	470	mano	–	–	*Hordeum* starch

* FTIR = Fourier Transform Infrared Spectroscopy

consistent with the unusually high percent relative abundance of *Quercus* pollen on this same artifact. From LA 129216, a mano (Sample 903) tested positive to acorn antiserum, suggesting that it was used to process acorns.

The FTIR record for the ground stone from sites LA 113042, LA 129214, LA 129216, and LA 129217 suggests processing a variety of native and cultivated plants including agave, yucca, cheno-am, sunflower, cocklebur, pine, acorn, prickly pear cactus, maize, legumes (possibly beans), and less probable gourd, pumpkin, or squash. In fact, the matches with gourd/pumpkin/squash are interesting, but not necessarily at a level indicative of processing. The only ground stone sample that did not show evidence of food processing was the mano (Sample 470) from LA 129300. This sample yielded a signature identical to calcium carbonate that probably resulted from the deposition of this compound on the artifact by the alkaline sediments in which it was buried. Calcium carbonate also appeared to strongly influence the signature representing the mano (Sample 339) from LA 129214.

Organic residue analysis of the knives from sites LA 113042 and LA 129214 revealed only an environmental signal. Matches for these samples reflected plant materials found in the sediments at the site from the natural breakdown of plant materials, and probably plant processing. The knife (Sample 1016) recovered from site LA 113042 yielded matches with deteriorated cellulose, acorn, maize, legumes (possibly beans), and far less probable gourd, pumpkin, or squash. FTIR evidence for processing these plants was also found on a metate (Sample 1032) recovered from this site. Agave, cheno-am, beeweed, acorn, and maize were matched with the knife (Sample 1861) from site LA 129214. Organic residue analysis of one of two manos (Sample 300) from this site also suggested agave and acorn were ground. Although a match with gourd, pumpkin, or squash was obtained, processing squash could not be interpreted with confidence for the other mano (Sample 339) from the site. Cheno-am and maize probably were processed at this site using tools not submitted for analysis, while beeweed likely reflects plants growing in the local environment.

The presence of calcium oxalates in all but one of the samples (Sample 470) might suggest more widespread processing of agave, yucca, prickly pear cactus, and plants in the Chenopodiaceae family, including saltbush, and perhaps goosefoot and others, at the site, although the possibility that calcium oxalates are present and detectable might also reflect deterioration of plant matter from the local vegetation. Recovery of calcium oxalate peaks in samples that matched with any of these plants provides a clear association of the calcium oxalate peaks with plants that contain calcium oxalates. Samples that exhibit one or more peaks associated with calcium oxalates, but no matches to specific plants, probably have suffered a higher degree of degradation of compounds that has obscured enough of the signature to make matching with modern references difficult. It is possible that samples that exhibit matches with any of these plants, but no peaks associated with calcium oxalates, have suffered deterioration that has removed this compound. Calcium oxalates are easily dissolved and rarely observed, as crystals, in sediment samples, even if those samples were collected beneath legumes or other calcium oxalate producing plants. Therefore, recovery of an FTIR signature for calcium oxalates is considered to be a very valuable means of tracking the presence of this compound.

Acorn matches obtained for the ground stone and knife samples from this project were made in portions of the spectrum representing proteins, the amino acids alanine and leucine, lipids/triglycerides, glucomannan, and saturated and aromatic esters. Matching in so many areas of the spectrum, and to so many compounds, strengthens the interpretation of processing acorns. Matches with the acorn references for Samples 903, 1016, 1032, and 1861 were very obvious, while others (Samples 10 and 300) only suggested possible contributions to select peaks. Acorn matches in protein portions of the spectrum, including the two amino acid peaks, also were matched with other nut and/or seed references, such as cheno-am, sunflower, cocklebur, and pine, suggesting these compounds are common in these foods. Although acorn can be included in the interpretation, it is not the only possibility due to the commonality of these peaks.

Peaks representing lipids/triglycerides and esters that matched with acorn also were matched with nuts and seeds, as well as yucca and maize references. Again, acorn may be contributing to the signature, but the plant is probably not present.

Acorn matches with glucomannan peaks representing a polysaccharide compound found in dicots were often, but not always, shared with matches for members of the Cucurbitaceae, also a dicot. Although the glucomannan peak can suggest the presence of dicots, some different plant species within this group—such as acorn and gourd, pumpkin, and squash—appear to share similar FTIR signature peaks representing this compound. As a result, matches with acorn suggest acorn is a possible contributor to the signature, but members of the squash family cannot be ruled out. Conversely, the matches with gourd, pumpkin, and/or squash were not sufficiently specific to provide conclusive evidence of processing this cultigen.

Although there are differences between the reference signatures for acorn and other plants matched in this project, the signatures produced by the samples only revealed peaks shared by several references, making it difficult to single out specific plants as the primary contributors. Since the samples in the project represent a collection of plants, not all peaks for each reference are visible. As a result, important peaks that could make identification more certain for specific plants, such as acorn, are not present.

Nutritional analysis of two groups of acorns, collected near Loving and Roswell, New Mexico, allowed comparison of the nutrients in these acorns to each other. This comparison seems to indicate a natural variation in nutrient content, rather than any preferential nutritional content for acorns growing in one area or another. In addition, although these values were relatively consistent between the two groups of acorns, they were not very similar to quantities reported by the USDA, even though the data from the USDA was calculated to a sample size of acorns of 100 g, which is similar to that reported by NutriData on these two groups of acorns. Based on these results, estimating nutritional content through nutritive analysis appears to be highly variable, requiring a study of nutrient depletion as a result of storage by comparing fresh acorns and stored acorns. This is the most obvious source of differences between the published USDA data and the data obtained from acorns collected near Loving and Roswell. It is likely, however, that this single factor is not responsible for all of the differences in reported nutrient contents.

27 ⩡ Addressing the Research Design

Reggie N. Wiseman

This section addresses the research questions posed in the Data Recovery Plan reproduced as Chapter 5 in this document. Each question will be visited in turn, presenting summations and discussions of pertinent findings.

At the time of the preparation of the Data Recovery Plan (OAS Staff 2006) our database on the NM 128 sites consisted solely of observations made of the undisturbed surfaces of the archaeological sites. No testing or excavation had been undertaken, resulting in the promulgation of an excavation plan based solely on field observations; our understanding of the archaeological literature concerning prior surveys, excavations, and synthetical treatments; our perceived data needs and interpretative avenues regarding continued research in the region; and the potential for the NM 128 sites to contribute to those needs and answers.

In the discussions that follow, emphasis is placed on the fact that southeastern New Mexico is comprised of two fairly distinct subregions demarcated by the Pecos River. To the west lies the south-central mountain chain of the Jicarillas, Capitans, Sierra Blanca, Sacramentos, and Guadalupes and their foothills and outwash plains (a.k.a. the Sacramento Plain). East of the river lay the Southern High Plains or Llano Estacado and the broken land (or Mescalero Plain) that extends from the edge of the llano and the river.

Although archaeologists have long followed Corley's (1965) interpretation that the prehistoric cultural remains east of the Pecos are an eastern extension of the Jornada Mogollon culture, I have serious reservations about the validity of this proposition. In my view, west of the Pecos (including the mountain chain, the Roswell "oasis," and the Pecos Valley between Roswell and Fort Sumner, <u>but not</u> the Guadalupe Mountains) we had true farmers and perhaps some interstitial/peripheral hunter-gatherers. The Sacramento Plain between the mountains and the Pecos Valley is too poorly inventoried archaeologically to be able to characterize with certainty; my impression is that prehistoric use probably was a mix by farmers and hunter-gatherers, either locally based and/or traveling between the river and the mountains. East of the Pecos were hunter-gatherers, perhaps with a few farmers (i.e., the "Ochoa phase") late in prehistoric times in what we now call southern Lea County. Consequently, the question about the presence and importance of cultigens, and especially corn, in the prehistoric human diet east of the Pecos is critical to our understanding of the prehistory of the region and will surface time and time again until our perspective clarifies in the matter.

Research Question 1: Regarding the Nature of the Occupations

The best and simplest way to characterize the occupations of the NM 128 Native American sites is to say that they were camps, probably used primarily for collecting and at least some processing and consumption of food resources from the surrounding terrain. The most common facilities documented at the sites are thermal features for roasting and baking foods, and/or for providing warmth and light for night activities. These features occur singly and in clusters, but intensive radiocarbon dating, buttressed by OxCal analysis to estimate contemporaneity, shows that multiple time periods are usually represented within the clusters and among the solitary thermal pits in most excavation blocks.

A few pits of two general sizes were also found. The larger ones are comparatively shallow for their size and are similar in many ways to pits used for the burial of deceased individuals. However, no bones or other direct evidence of this type of use were recovered from the fills to confirm this possibility. Given the porosity of the site sediments and generally poor preservation of animal bone, the absence of human bone cannot be automatically taken as evidence that the pits were not used for human burial. The smaller pits are of a size commonly believed to have been used for caching items for future use. However, all pits but one was empty. Feature 44 at LA 113042 contained carefully arranged rocks that appear to have been intended for later retrieval/removal and use as heating elements in a thermal feature.

A number of very small pits believed to be postholes and possible postholes were found in some of the blocks at some of the larger sites. These holes are believed to have held vertical or semi-vertical timbers, probably for a variety of purposes such as supporting shelters, drying racks, and the like. In situations such as these, archaeologists like to see symmetrical arrangements of postholes that provide convincing evidence for these kinds of features (shelters, etc.), but such is not the case for the NM 128 sites. It is interesting to note that the floor plans of the two shelters shown in the Australian Alyawara camp (Fig. 16.1) are both triangular, not rectangular.

At least one structure and possibly two others are identified at LA 129214. According to Lewis Binford (1990:121–122), hunter-gatherers planning to sleep overnight at a location, "regardless of the expected occupational duration," only rarely opted to not build shelters. Thus, it seems highly probable that our excavations at the NM 128 sites missed the remains of a number of shelters/structures. Some of the reasons undoubtedly have to do with the facts that not all structures necessarily leave archaeological traces or traces of sufficient coherence to permit ready identification as to their significance. Another, perhaps more important reason, is that excavations typically focus on readily discernible features such as thermal pits and refuse accumulations, for they usually involve discolorations of the soil. As demonstrated by the camp footprint model employed here, structure remnants can be quite subtle and are generally found in areas peripheral to burn features.

In the section on activity area analysis, I present a generalized model of a camp footprint based on the Alyawara, a modern Australian Aborigine group studied in detail by James O'Connell (1987). This model presents a more or less linear pattern formed of the shelter(s), living space, fire pits, baking facilities, small-item refuse dumps, and large-item disposal areas developed by members of a residential group. Residential groups normally consist mainly of families, but other compositions of individuals (such as men's groups in the case of the Alyawara) may also be represented. I used this pattern to search the NM 128 excavation records for correlations and found three possible examples.

The first example, in Block 1 at LA 129214 (Fig. 16.5), consists of a pair of probable windbreak features (Features 40 and 41, natural features augmented to serve as a single shelter?), a space "in front" that was essentially artifact free (i.e., living space), groupings of thermal features, and parts of a refuse scatter, all of which reasonably reflect the camp footprint of the Alyawara model.

The second example, at the west end of Block 5/7/14 at LA 129214 (Fig. 16.8), is less certain as a camp footprint. Arranged west to east, it consists of an ill-defined, compacted, use-surface about 2 sq m in size (possible shelter "floor," Feature 301); a nearly artifact-free zone to the east; two possible postholes and a thermal feature (47) a few meters to the east; and a concentration of lithic debitage east of those. The lithics also partly covered a cluster of thermal features. One problem with the interpretation of the lithic debitage as a refuse area belonging to the possible camp is the fact that Thermal Feature 47 predates the thermal pit cluster. That means that the cluster of thermal pits was developed and used after the abandonment of the camp, which would have had the users of those features walking, squatting, sitting, and perhaps lying on the lithics. As expressed elsewhere in this report, there is reason to believe that people generally avoided this type of situation because of the discomfort that the lithics could have inflicted on the people.

The third example of a possible camp footprint is located at the east end of Blocks 5/7/14 at LA 129214 (Fig. 16.8). Feature 300 is a probable structure but not a camp footprint per se. If a camp footprint is associated with this structure, it probably lay to the east outside of the excavation limits. The structure itself appears to have been a circular brush shelter with an entrance on its east side.

As discussed below in reference to other research questions, the NM 128 sites were probably occupied in order to exploit local food resources. These activities are attested by the recovery of remnants of both plant and animal foods and the facilities and artifacts used to procure, process, and prepare them for consumption.

Table 27.1. Activities inferred from recovered artifacts.

ARTIFACT TYPE	INFERRED ACTIVITIES
Manos and metates	Plant food processing.
Pottery	Cooking; food service; temporary storage, especially for dry materials; wet materials would quickly deteriorate brown ware vessel walls. Plant food processing (mainly yucca stems?) and unknown use involving red pigment.
Projectile points	Hunting; possibly defense/offense against humans; and processing fibers and/or animal hides to make basketry, cordage, netting, etc., and clothing (see Chapter 1).
Choppers	Processing game for food and/or plant materials for consumption and/or making fiber items.
Hammerstones	Mano and metate production and maintenance; chipped lithic artifact manufacture including raw material (core) reduction; and general pounding.
Ornaments	Personal adornment.
Flake tools	Vegetal processing; meat processing; chopping/hammering; wood/bone working; leatherworking; arrow/dart shaft refurbishing; bifacial tool refurbishing; projectile point manufacture; and one small biface and large biface reduction/manufacture (see Chapter 17).
Lithic debris	Chipped lithic tool production and refurbishment.
Pigments	Ornamentation, and possible ritual use.
Pecos Diamonds	Possible use as toys or for ritual purposes.

Research Question 2: Regarding Artifact Assemblages and Occupational Activities

Among the NM 128 project sites, artifact numbers are low, but their diversity is moderate. The primary artifact types include manos and metates, projectile points, tabular knives, pottery vessels, and chipped lithic manufacture debris (broken bifaces, flakes, cores, and shatter). Less common artifacts include hammerstones, scrapers, possible choppers, ornaments, and a variety of flake tools. Table 27.1 presents our inferences regarding the activities represented by these artifact types.

An assortment of numerous small pieces (less than 1 cm at the longest dimension) of earthy materials and minerals might have been collected by the site occupants for use as colorants. The red, yellow, white, and blue-green colors are known or strongly suspected of being locally available. Without specific indications for use, such as grinding facets, we cannot be certain whether these materials are natural or manuports. A few pieces of hematite have striations indicating use by humans, presumably as pigment. A number of grinding stones and tabular knives have red coloration of them, indicating grinding, processing, and application of this material.

The doubly-terminated quartz crystals known locally as Pecos Diamonds or Pecos Valley Diamonds (PVDs) were also very common at the western NM 128 sites. Although PVDs are geologically available in the Nash Draw Valley, archaeological recovery contexts indicate that at least some of them had been collected by the prehistoric peoples. Their use or uses, however, are conjectural.

In summary, for the sites as a whole, the items of material culture enumerated in Table 27.1 imply the wide variety of activities one would expect in a base camp or general habitation situation. However, the overall numbers of each type of artifact are few, and not every block in every NM 128 project site produced examples of each artifact type. We cannot unequivocally state that all of these activities took place in every block at every site, nor can we assume that they did not. The overall low artifact numbers in general indicate relatively short occupations (a few weeks at most) that are generally characterized by intermittent deposition of fragments of tools as determined by tool use-life durations (Schlanger 1990). For more information, see Chapter End Notes: Note 1 at the end of this chapter.

If our inferences about short-term occupations involving a wide variety of activities are correct, then it follows that the sites' occupants were probably engaged in what Binford (1980) refers to as "forager" behavior. That is, at least during that part of the year during which the NM 128 project sites were used, the people were moving their families to the food resources. If these people were also moving their camps from one resource patch to another, then they were engaged in what Binford (1980) and Sebastian and Larralde (1989) refer to as "serial foraging." Tainter (1979) predicts precisely this type of behavior for this part of New Mexico during prehistoric times.

Research Question 3: Regarding Subsistence

No direct subsistence data were recovered from any of the Paleoindian 4 or the Archaic 2 proveniences at the NM 128 sites. The two Paleoindian 4 features at site LA 129216 are somewhat anomalous in that they are mainly identified because they contrast with the surrounding natural sediments. The Archaic 4 features at sites LA 129218 and LA 129300 are thermal pits that do not seem to differ significantly from later-dating thermal features. The fuelwood recovered from the Archaic features are mesquite and creosote charcoal, the presence of which suggests that the environment at the time was similar to that of later periods. If true, then the plant and animal species available for exploitation, especially during the Archaic period, were probably pretty much the same as during later periods. The only real evidence for subsistence pursuits that represent these two early periods (Paleoindian 4 and Archaic 2) are large dart points that presumably refer to the hunting of large animals.

The discussions that follow refer to remains recovered from contexts dating to the Archaic 4 through the early Neo-Archaic 3 periods at the NM 128 sites.

The Question of Gardening/Farming in the Project Area

Whether the peoples living east of the Pecos River in New Mexico grew cultigens such as corn is integral to the prevailing view that they were an eastern extension of the Jornada Mogollon culture and, by implication, were culturally related to the farmers of the greater El Paso region. However, corn remains are rare from excavations in the region. It is not only important to validate this "requirement for inclusion" in the Jornada Mogollon concept, but it is absolutely necessary for proper perception of the prehistory of the region. There seems to be little doubt that the people of the central Jornada Mogollon of the El Paso region were serious farmers, especially after AD 1000 or 1100 (Miller and Kenmotsu 2004).

But the peoples living east of the Pecos River in southeastern New Mexico are an entirely different matter on several grounds (Wiseman in prep). As discussed in the following paragraphs, the subsistence situation of the peoples east of the Pecos appears on present evidence to conform more with one or the other of the following options: either hunter-gatherers who obtained small amounts of corn from farmers of the Sierra Blanca country (Lincoln and Otero counties NM) and/or the El Paso region or with what Bruce Smith (2001, 2005) calls "low level food production." Neither of these options fits with what we know of the Jornada Mogollon, casting serious doubt as to the efficacy of calling these people and their culture Jornada Mogollon.

Six lines of evidence are examined here with regard to this question: plant macro-remains collected during fieldwork; small botanical remains recovered from soil samples using the flotation technique; pollen sampling; residue analysis of artifacts; the nature of the manos; and Steve Hall's geomorphology study of a small plot of alluvium next to one of the sites. It is pertinent to note that the pollen samples selected for analysis from the archaeological excavations came from a variety of protected proveniences, including from beneath rocks and artifacts (especially manos) and at the bottoms of pits.

Four of the six lines of evidence produced short, simple answers. No macroremains of corn, beans, or squash were found in any of the samples taken from the seven prehistoric sites investigated by this project. Similarly, no microremains of these same species were recovered from any of the 381 bags of sediment from 135 features that were processed by flotation and examined for plant remains (McBride and Toll this report). Nor did pollen of corn, beans, or squash appear among the 22 soil samples processed specifically for these remains (Davis this report). Hall's study (this report) of an alluvial micro-niche next to LA 113042, specifically with regard to its suitability for gardening, failed to find evidence of cultigens.

The sixth line of evidence, residue analysis (especially washes of mano and metate grinding surfaces) produced the only evidence for cultigens recovered from the NM 128 sites. A metate fragment from Pit Feature 72 in Block 12 at LA 113042 and a mano fragment from the shelter (Feature 42) in Block 1 at LA 129214 produced fragmented corn pollen grains. A mano from the surface of Block 2 at LA 129214 produced corn starch granule(s) (Cummings et al. this report: Table 26.11). These remains, especially the pollen, are generally believed to be good indicators of the cultivation of corn at or near the find spot. However, because the NM 128 examples are from washes of grinding-stone surfaces and not sediment samples, per se, this assumption may not hold and may reflect pollen manuported from other locations. But, at a minimum, these pollen grains and starch granule(s) indicate that corn was processed and presumably consumed at LA 113042 and LA 129214. Whether or not corn was grown at or near the sites is still an open question because all other indicators obtained by other methods from the NM 128 sites suggest not. Further research is required.

Regarding mano size, 23 complete specimens from the four sites that produced manos have a mean grinding surface area of 76.0 sq cm. If the three largest specimens are removed, this figure drops to less than 70.0 sq cm. Mean grinding surface areas this small indicate little to no reliance on corn as a subsistence item (Hard et al. 1996:Fig. 2) either way.

As just related, though, two manos from LA 129214 produced corn residues, one of starch and the other of pollen. The specimen producing the starch grain, FS 300, is a complete, oval, one-hand mano that is 11.7 cm by 8.7 cm in overall size, with an oval grinding surface measurement of 10.5 by 6.5 cm. These figures, expressed as areas of ovals (ellipses) in square centimeters, are 74.94 and 53.60, respectively. The pollen producer, FS 339, is an end fragment of what appears from its contours to be a little over one-half of an oval, one-hand mano; total artifact size is 7.0+ cm by 9.8 cm; total estimated original length is 10.0 to 11.0 cm. Thus, the total lengths of both manos are near the critical length of 11 cm, the dividing point between two "agricultural dependence" categories (Hard et al. 1996:Table 10.4, p. 148). Mano lengths of less than 11 cm indicate "none to low" dependence on farming, while those between 11 and 15 cm long indicate "none to moderate" dependence on farming. Similarly, the grinding area figure of 53.60 sq cm. for mano FS 300 falls within the "none or low" category of farming dependency (Hard et al. 1996: Fig. 2, p. 259).

The NM 128 data can now be added to recent reports of corn residues from sites along Bear Grass Draw (Cummings and Varney 2008), Quahada ridge (Cummings and Yost 2009a, 2009b), and Tower Hill (Cummings et al. 2010). The Quahada Ridge and Tower Hill residues involve interpretation of complex data based on the combined analyses of FTIR (Fourier Transform Infrared Spectroscopy), phytolith, starch, and pollen remains. The pollen and starch data seem fairly secure. But, in considering the rather detailed explanation of the FTIR technique and disagreements regarding the efficacy of phytolith analysis (Charles Frederick, personal communication, 2010), I can only conclude that the results obtained by these two techniques should be considered tentative for now and may be subject to elaboration, reinterpretation, or rejection at some future date.

Much of my caution regarding reports of corn from prehistoric sites east of the Pecos River is due to two facts. First, on two different occasions between 1979 and 1981, Robert H. "Bus" Leslie told me that, in all the digging in which he participated with members of the Lea County Archaeological Society (LCAS), neither he nor any of the other members reported seeing identifiable remnants of corn. Since the LCAS did all the work leading up to Corley's 1965 formulation of the Eastern Extension of the Jornada Mogollon "hypothesis," the apparent absence of corn in southeastern New Mexico sites east of the Pecos River is of singular note. From then until now, I have discovered only one report of actual corn macro-remains from that same region. A single cupule fragment is reported from a small thermal feature at LA 104607 (Puseman 1995). This site, located along Bear Grass draw about 52 km (31 miles) due north of the NM 128 sites, is believed to have been occupied between AD 1000 and 1100. However, the limited excavation and minimal corn remains at this site preclude an informed evaluation of just how corn fit into the subsistence regimen of the occupants. Given the questions raised earlier regarding the results of some of the newer techniques (FTIR, etc.), recovery of more corn macro-remains would strengthen confidence in their results.

Assuming for the moment that the data currently on hand from all sources are accurate, it is important to keep in mind that the total of quantity of corn is minimal. Their presence does not necessarily mean that corn was grown at or near the sites in question or even at some location east of the Pecos River. Nor can we infer for the moment that the importance of corn to the human diet east of the Pecos was more than minimal or even incidental. In fact, corn residues extracted from sherds and identified through FTIR might mean nothing more than that corn had been cooked in the vessels before they were traded east of the Pecos. It has long been known that the farmers in the Sierra Blanca and El Paso regions were also the makers of most of the pottery that ultimately made its way to the hunter-gatherers east of the Pecos. It would probably be a mistake to assume that only new, unused (i.e., uncontaminated) vessels were traded. So, we have many, many details to work out before we can gain the correct perspective on the question of cultigens, especially corn, at sites in southeastern New Mexico east of the Pecos.

Exploitation of Wild Plant Species

Flotation, pollen, protein, and FTIR analyses of sediments and residues from 135 features and seven artifacts at the NM 128 sites yielded evidence of human use of eight annual taxa and seven perennial taxa. The remains date from the Late Archaic 4 period through the early Neo-Archaic 3 period, or roughly from AD 100 to 1400. No data were obtained from the pre-Christian (i.e., dates BC) features at these sites.

The annual taxa include remains of amaranth, goosefoot, purslane, carpetweed, flame flower, sunflower, little barley grass, and high-spine asteraceae. The perennials include mesquite, yucca, acorns, unidentified root/tuber, hedgehog, horse crippler, and prickly pear cacti. All of these taxa produce edible parts, and most have parts that are useful for other purposes as well.

It is interesting to note with regard to the use of little barley grass that, in south-central Arizona, barley may have been a domesticate (Adams 1987). However, this was almost certainly not the case at the NM 128 sites.

One of the more fascinating materials recovered from the project sites is the woody exterior covering or epidermis of the trunk-like lower portion (or stem or "crown") of the yucca. The stem is that part of the plant between the ground and the base of the leaves. Numerous small fragments of the epidermis of the stem were recovered from many thermal features at NM 128 sites. The stem can be baked and consumed by humans in much the same way that agave and sotol crowns or "hearts" are prepared (McBride and Toll this report; Church and Sale 2003:124-127). The presence of so many fragments of yucca epidermis in NM 128 thermal features means, at a minimum, that this woody material was useful as fuel.

But, were the stems or crowns of yuccas used for food as well? After all, the finding of a baked yucca "heart" in an "earth oven" at site 41EP5281 on the Orogrande Range in the Tularosa basin south of Alamogordo, NM, confirms that at least some prehistoric peoples ate yucca stems (Miller and Burt 2009:Fig. 4.2). I suspect that the answer for the NM 128 project area is "yes," as well. I also suspect on the basis of the frequency of yucca stem epidermal fragments recovered from NM 128 sites that yucca was a major food for the occupants while they inhabited these particular sites.

After all, the evidence presented elsewhere in this report suggests that one of the major local vegetative communities is/was the desert grassland. Several species of yucca, including *Y. baccata*, *Y. elata*, *Y. glauca*, *Y. schottii*, and *Y. torreyi*, are members of this community (Dick-Peddie 1993:Table 7.4, pp. 116 ff). And, three species of yucca — *glauca*, *torreyi*, and *campestris* — have been recently documented in the immediate vicinity of our sites (Marron and Associates 2005, 2006).

Prior to flowering, the young flower stalks of yucca and perhaps the leaves themselves can be used for food. Yucca is useable for food year round. However, it is best during the late spring and early summer (Church and Sale 2003:125), possibly indicating its use at the NM 128 sites during that season. This is precisely the season when foods are generally scarce for all pre-industrial peoples and therefore when all possible foods could have and would have been used. This possibility of seasonality could also explain why so few other species of edible plants are represented among the NM 128 samples, even though charred plant remains (e.g., fuel) in general are quite common.

The possibility that the NM 128 project peoples were processing yucca for food brings up another important question. If they were baking the yucca in the manner that agave and sotol are prepared for human consumption, where are the communal baking facilities (a.k.a. ring middens, midden rings, midden circles, mescal pits, agave roasters, sotol pits, annular thermal features, communal baking facilities, etc.) normally believed to have been associated with this activity. Certainly nothing of the sort was encountered at any of the NM 128 sites. However, 14 sites purportedly bearing one or more ring middens have been recorded east of the Pecos River in southeastern New Mexico. Importantly, none have been excavated, nor have their identifications as ring middens been confirmed by more recent examinations.

As part of an evaluation study of ring middens east of the Pecos River, I queried the Archaeological Records Management (ARMS) file at the Laboratory of Anthropology, Santa Fe, for a list of these 14 sites. I then examined the paper files, with the following results. While a study of this sort (a records check) cannot be considered final, many of the site records have sufficient description and/or illustration (feature maps) to eliminate most from further consideration.

In this way, I found insufficient evidence to conclude that the following 12 sites have ring middens: LA numbers 16402, 25668, 44574, 108783, 109378, 111236, 117806, 122416, 129303, 131353, 131460, and 149998. Reasons for eliminating these sites from further consideration include: burned-rock features that are too small (3 by 3 m and smaller, half the size of normal ring middens); rings that are probably stone enclosure type houses (Katz and Katz 2002; Wiseman 2002b) (sites LA 129303 and LA 149998); and concentrations of burned rocks and darkly-stained soils that represent a number of things ranging from individual small thermal features to large anthrosols and associated cultural materials. Two sites, LA 21092 (18 km, or 11 miles, north-northwest of the NM 128 project sites) and LA 147389 (16 km, or 10 miles, due south of the NM 128 project sites), have features that require further field examination, evaluation, and possibly excavation to determine whether or not they are ring middens.

It is important to keep in mind, however, thermal features smaller than ring middens can also be used to cook agave, sotol, and yucca. Examples include those discussed in point (1) in the preceding paragraph (examples at sites LA 16402 [Feature 1], LA 108783, LA 111236, LA 131353 [Feature 3], and LA 138460 [Feature 4] (ARMS site files, Laboratory of Anthropology, Santa Fe). After all, it may well be a matter of scale in which the size of the consuming group is the most important factor. The amount of food to be prepared in a specific instance may determine the size of the facility used, especially if the facility is to be used only once. At the NM 128 sites, probably most of the thermal features, but especially the larger, deeper ones, were an appropriate size for the task, since many of the occupation groups appear to have been small (nuclear families? small extended families?). Some of the thermal features showed only light use in the form of light-colored fills, but none of them had large accumulations of burned-rocks like those at the sites just mentioned. The same is true of features at two of the Seven Rivers sites (LA 38264 and LA 113249) that I call "small pit-baking facilities" (Wiseman 2010).

Regarding ethnographic data, historic examples clearly illustrate that sotol can be prepared and served as a meal for two individuals while in transit. In this example, for breakfast two "Mexican" men baked the crown of a single plant in the coals of a surface hearth during the time that it took a pioneer family to prepare, consume, and clean up after their breakfast (Langford 1973:17-18). This raises another important point, whether the food is prepared for immediate consumption, for storage for later use, or for transport elsewhere.

And finally, as Wening discusses (this report), tabular knives (a.k.a. "agave knives"), would have been useful for processing (removing the epidermis and cutting into pieces) the yucca trunks/stems for baking. Nineteen complete and fragmentary examples were recovered from four of the NM 128 sites, LA numbers 113042, 129214, 129218, and 129222. Wening's suggestions have been reinforced by the results of residue analyses of two of the NM 128 tabular knives. Cummings et al. (this report) detected remnants of prickly pear, acorn, gourd/pumpkin/squash, legume and mesquite and also suggested the outside possibility of cultivated beans (*Phaseolus*) on these items.

Other plant taxa of economic use to humans have been recorded for sites near the NM 128 project area. In addition to those taxa already mentioned for NM 128, these include grass family (Poaceae), saltbush, ryegrass, plantain, agave, and arrow root family (Cummings and Varney 2008; Cummings and Yost 2009a, 2009b; Cummings et al. 2010). Also, mustard, spectacle pod, jackass clover, mint, cat's claw, cholla cactus, and walnut may have been used, especially at sites located on the Guadalupe Ridge Pediment west of the Pecos River (Jones et al. 2010a:756–758). Acorns are discussed further under Research Question 6.

The identification of agave remains and its use by prehistoric peoples living west of the Pecos River is to be anticipated because at least two species growabundantly in the Guadalupe mountains and their foothills. However, reports of probable agave use east of the Pecos are another matter, for no agave grows there today (Martin Stein, Carlsbad F.O., U.S.D.I. Bureau of Land Management, personal communication, 2010). Nor would we expect it to have grown there in the past. It may be significant that the few botanical reports of agave from archaeological contexts east of the Pecos were recovered from the results of FTIR analysis of ground stone artifacts and pottery (Cummings and Varney 2008; Cummings and Yost 2009a, 2009b; Cummings et al. this report).

One of the more interesting reports of an economic plant recovered from sites east of the Pecos River in southeastern New Mexico is that of Marantaceae, or the arrow root family (Cummings and Varney 2008; Cummings and Yost 2009a, 2009b; Cummings et al. 2010). Genera within this family include *Maranta*, *Calathea*, and *Thalia*. Marantaceae genera and species generally favor tropical and some subtropical climates, with only two species of *Thalia* occurring within the United States. More recent research on the FTIR and other signatures have now demonstrated that the identification of Marantaceae is in error and that the substances in question probably belong instead to the Commelinaceae or spiderwort family. Two species in particular—*Tradescantia occidentalis* and *T. o. virginica*—have been recorded for the Hopi as being useful for their greens in the late spring and summer (Hough 1898; Swank 1932). A couple of species of spiderwort, including *T. occidentalis*, growin the general vicinity of the NM 128 project sites (Martin and Hutchins 1980).

Exploitation of Animal Species

The following indented section, with minor revisions, is taken from the Data Recovery Plan (OAS Staff 2006:114-115). Also, two of the sites, the Fox Place and the Henderson site, are omitted here because they are 100 km (62 miles) from our area of concern. Otherwise, the section is repeated here to present comparative data regarding prehistoric faunal remains from southeastern New Mexico sites.

Faunal Assemblages in the Area

Nancy J. Akins (2006)

> Many of the sites in this region are short-term, repeatedly occupied sites, suggesting exploitation of similar resources over time. These small camp sites generally represent but one aspect of broader subsistence strategies that transcend time. For example, the general concept of Archaic adaptation is one of small-mammal utilization (e.g., Sebastian and Larralde 1989:52), yet particular sites were used for large-animal exploitation regardless of time period. Roney's excavations at Hooper Canyon Cave [in the Guadalupe Mountains] found that almost 84 percent of the Archaic bone was from large mammals and only 11 percent from small mammals. The same was true of his ceramic-level faunal assemblage (Roney 1995:72).
>
> More typical is the assemblage from Macho Dunes (LA 29363), a seasonal camp dating from the period AD 610-950 just east of Carlsbad (Zamora 2000:147–148). A small but diverse faunal assemblage, mostly small mammals (squirrel, kangaroo rat, small mouse, wood rat, porcupine, cottontail, jackrabbit, canid, badger, bison, bird, and turtle), was recovered. Almost all of the bone was from the Formative [Neo-Archaic in the terminology used for the NM 128 project] component, but the few attributed to the Archaic component are mice and cottontail (Moga 2000:119, 122).
>
> At Punto de los Muertos (LA 116471), on the north edge of Carlsbad, an unusually large assemblage of animal bone (n = 8,053) and human bone was recovered from a rock circle dating from the Late Archaic to after AD. 1000 (Wiseman 2003c:101). Excavation recovered a fairly small number of species for the sample size—at least 26 that

> are mostly rodents, small mammals, and birds—but the assemblage also includes appreciable amounts or medium-sized artiodactyls such as deer and pronghorn. Much of the bone is burned and broken into small pieces (Akins 2003:118–119).
>
> Late Prehistoric sites in the Carlsbad area generally produce faunal assemblages dominated by small mammals and mussels. In the Brantley Reservoir area, northwest of Carlsbad, the Champion Site, consisting of a ring midden, a number of hearths, and scattered lithic and ceramic artifacts, had a small but varied faunal assemblage. In addition to an abundance of freshwater mussels, there were small numbers of jackrabbit, cottontail, squirrel, prairie dog, wood rat, turtle, and carnivore bones (Gallagher and Bearden 1980:119–120). Later excavations at a range of sites, including ring middens and stone enclosures, recovered freshwater mussel, cottontail, jackrabbit, wood rat, pocket gopher, deer, bird, and fish remains (Robertson 1985:A19–A20).
>
> Just north of the [NM 128] project area, sites excavated in conjunction with WIPP produced little fauna. One [hearth site] and lithic and ceramic artifact scatter (ENM 10418) contained cottontail, deer, bison, and freshwater mussel (Lord and Clary 1985:183–188).
>
> Little fauna was recovered from sites excavated along a transmission line in Eddy and Lea counties. With the exception of a bison kill (LA 22107) dating between AD 1445 and 1625, very little bone was found, and most was not identifiable. In addition to the bison, probable pronghorn, rodent, jackrabbit, and bird were recovered (Staley et al. 1996b:195–197, 204).

Since the time that the above projects were summarized, other reports for the region have appeared. True to form, most of the excavated sites failed to produce faunal remains. For those few sites that did produce faunal materials, the analysts generally conclude that most bones are probably the result of post-occupational intrusion. The exceptions are as follows:

1. Several sites investigated for the NexGen/Core Project yielded faunal information. LA 8055 (north end of Quahada ridge) produced 41 bones and bone fragments. Species represented include roadrunner, perching bird, ground squirrel, wood rat, cottontail, deer-size or larger, dog- to deer-size, mouse- to hare-size, and freshwater mussel. The discussion intimates that few if any of these remains are the result of human activity. However, several mussel shell fragments display evidence of human intervention, probably for food, tool, and/or ornament use (Jones et al. 2010a:292–293).

2. LA 132518 (on the Guadalupe Ridge pediment [GRP] west of Pecos River), an annular thermal feature or ring midden site, produced 1 complete valve and 238 fragments of *Cyrtonaias tampicoensis* mussels, some burned and others with modified edges as a result of tool and/or ornament use (Jones et al. 2010a:428).

3. LA 130730, another annular thermal feature site situated on the GRP west of the Pecos River, yielded 16 sun-bleached mouse- to hare-size bones, 1 of which is burned. One rabbit- to hare-size bone and a jackrabbit bone are also sun-bleached and believed to be noncultural in origin. Four of 116 freshwater mussel shell fragments, on the other hand, display cut edges, suggesting use for making ornaments. The mere presence of the shells may also indicate use for food, though none are burned (Jones et al. 2010a:456).

4. LA 130727 is a large site with annular thermal features situated on the GRP west of the Pecos River. Its faunal assemblage is quite large, with 5,814 fragments representing 17 categories — collard lizard and collard lizard-size, rattlesnake, snake, small bird, bird, small mammal, mouse or rat, rice rat, wood rat, rodent, rabbit or hare, cottontail, jackrabbit, medium mammal, carnivore, and large mammal. Ninety percent (5,257 of 5,814) of the bones belong to the small-mammal (mouse- to hare-size) category, more than one-third of which are burned. Other categories with burned specimens include medium mammal (dog- to deer-size, 20 percent), rabbit or hare (9 percent), jackrabbit (17 percent), cottontail (14 percent), rodent (11 percent), and carnivore (100 percent, n = 1) (Jones et al. 2010a:543-548).

5. One complete valve and 88 fragments of *Cyrtonaias tampicoensis* mussel were also recovered from LA 130727. One broken pendant and several edge-modified fragments indicate use for ornaments. However, the authors question the use of this species for food because of the distance from its source, and, presumably, potential problems with spoilage because of that distance, 30 km (19 miles) to Pecos River, or 5 to 6 km (3 to 4 miles) to the Black River, if they were available there). The shell fragments had not been burned (Jones et al. 2010a:548–549).

It seems that the Native Americans would have been well aware of the problems of easy spoilage of mussels, particularly during the warm season. In order to use the mussel meats and to avoid potential spoilage during the long trek back to their camps, they could have consumed the meats at or near the gathering spot and then carried the shells back to the sites for use as tools and/or ornaments. This would permit realization of total use of the mussels, assuming that the people did not have taboos against mussels as food. Since we currently have no way of knowing whether our subjects had taboos against consumption of mussels, it is more appropriate to assume that they did eat mussels until such time as we actually acquire knowledge to the contrary.

Four other sites, all multicomponent Archaic and Neo-Archaic camps on the GRP west of the Pecos River, also produced faunal materials. Sites LA 132520, 132521, and 132522 yielded a total of 62 mussel shell fragments (all *Cyrtonaias tampicoensis*?); few of the fragments were modified, and none were burned. However, as just discussed, their very presence in the sites indicates use for food, tools, and/or ornaments. Additionally, LA 132520 produced one burned small-mammal bone; and LA 132521 produced three unburned artiodactyl pelvic bone fragments and three rib and one long-bone fragments from a medium mammal. The fourth site, LA 130723, yielded five bone fragments, three from a small mammal (all calcined), one from a cottontail, and one from a medium mammal (Jones et al. 2010a:608–609, 635, 679, 756).

The NM 128 faunal assemblages fit right in with the assemblages from other sites in the region. That is, the NM 128 assemblages are generally small, are from scattered proveniences, are not comprehensive in their distribution across the sites, and are difficult to date with certainty. While this makes definitive interpretation difficult, it is the nature of the database. Archaeologists simply need to be patient and methodical in the incremental accumulation of these data. With perseverance, we will one day be able to make full sense of this aspect of the human subsistence quest.

For now, it appears as though small-bodied animals and freshwater mussels formed the core of the animal nutrient contribution to the human diet in the study region. Taxa/categories of fauna that can be said to have been used with a fair degree of certainty by the occupants of the sites (as attested by burned elements) include cottontail, jackrabbit, kangaroo rat, wood rat, rodent, small mammal (up to fox size; Akins personal communication 2010), and two species of freshwater mussel. Medium artiodactyl, large artiodactyl, and medium and large mammals are also represented. In addition, deer was identified through protein residue analysis of a metate fragment from LA 113042 (Cummings et al. this report). However, burned small-mammal bones are specifically mentioned in numerous places in Akins' report, and burned small-mammal bones figure prominently in the large assemblage from LA 130727 (as mentioned earlier).

This prominence of small mammals in the diet is important to recognize. The normal interpretive tendency is to focus on the contributions of larger-bodied animals to the prehistoric diet, usually noting that each antelope, deer, and bison provides very large quantities of meat as the result of a single kill. True as this may be, other factors ameliorate the general effects of this contribution. For instance, ethnographic studies of many groups, hunter-gatherers and farmers alike, emphasize the role of culturally required food-sharing and available preservation technology —mainly drying of the meat. The net effect in most instances is that the per capita portions of meat from the larger animals were probably small on average and may have been consumed over shorter periods of time than one might expect. Gray (1977) may well be correct in his suggestion that, at Laguna Plata, and therefore along Nash Draw, the small numbers of medium (deer, sheep, antelope) and large (bison) mammal bones in prehistoric sites may "indicate more an opportunistic, or chance, procurement of those species."

In spite of the windfall of meat supplied by large animal kills, I suspect that the periodic killing and consumption of small animals provided a more constant, albeit small supply of meat on a short interval basis (day-to-day, week-to-week) throughout the year. These aspects are discussed in greater detail elsewhere (OAS Staff 2006:175–178; Wiseman 2004:136–140). While those discussions emanate from the interpretation of fauna from the Fox Place and Los Molinos sites, I consider the arguments to be equally applicable to the NM 128 project sites.

Discussion of Subsistence at NM 128 Sites

The food remains recovered from the project sites represent primary occupations during the Archaic 4 through the early Neo-Archaic 3 periods. These remains include wild plants and animals and the cultigen corn. Gourd/pumpkin/squash may also have been used but this possibility is less likely according to the analysts (Cummings et al. this report). However, no clear evidence of actual growing of corn was found, even though some effort was expended in searching for it. Thus far, minimal evidence of farm products has been found at a few locations in the general area lying east of the Pecos River. Only one report includes corn macro-remains, a cupule fragment from a site on Bear Grass Draw. Corn pollen grains and one example of corn starch were identified from washes of NM 128 metate and mano grinding surfaces. All other reports of corn involve detection using relatively new scientific techniques, the full implications of which still require thorough evaluation and clarification. The accumulation of a track record for these techniques will be important in confirming credibility.

The wild plant-food remains and inferred food remains identified for the NM 128 sites include both annuals and perennials. The annuals are amaranth, goosefoot, purslane, carpetweed, flame flower, sunflower, little barley grass, and high-spine asteraceae. The perennials are yucca, mesquite, acorns, hedgehog cactus, horse-crippler cactus, prickly pear cactus, and unidentified root/tuber. Yucca is proposed as having been a major subsistence target of the occupants of the NM 128 sites. These plants are commonly reported for other sites in the region and appear to represent mainstay food items for the prehistoric peoples living east of the Pecos River. Agave and Marantacaea remains have been reported through newly utilized scientific techniques from a couple of sites situated north of the NM 128 sites. However, like the reports of corn, the status of agave in the archaeological record needs to be clarified. Recent reconsideration of Marantacaea suggests that the remains are now referable to the spiderwort family.

One of the more surprising aspects of the ethnobotanical record of the NM 128 project sites and the archaeological record for the region in general is the near absence of shin-oak, *Quercus havardii*. Leslie (1965a) reports having recovered acorns from the Merchant site. Lord and Reynolds (1985) state that unspecified charred *Q. havardii* remnants and pollen were recovered from a thermal feature at ENM 10230 in the WIPP project. And now, acorn residues have been identified on manos, a metate and a tabular knife from four of the NM 128 project sites. Although several authors have suggested that this plant was a major food item of the prehistoric peoples in the region, we still need to find more evidence to support this idea. It should be noted in this regard that it was many years before botanists were able to confirm that agave remains can be found with some certainty and frequency in the large thermal features variously called ring middens, agave roasters, etc. Yet, prior to that time, virtually everyone was "certain" that these features were used primarily to cook the products of these plants.

Animal food and possible animal food remains are dominated by small mammals (mice, rats, rabbits, wood rats, squirrels), with small numbers of mussels, birds, deer, bison, and possibly frogs, toads, snakes, and lizards. These animals are commonly reported from other sites in the region and appear to represent mainstay food items for the prehistoric peoples living east of the Pecos River. The mussels would have been gathered from the Pecos and perhaps its western tributaries such as the Black and Delaware Rivers.

Regarding the season or seasons of availability of these plant and animal foods, we need to consider two periods during the year. The annual plants and the seeds and fruits of the perennial plants are available from the mid-summer to the early fall (McBride and Toll this report). Regarding the perennial species yucca and prickly pear, if the people were eating the pads of the latter, both *are available year round* but are best during the spring and early summer. The spring is a typically difficult time for virtually all hunter-gatherers and many farmers in temperate climates. Plant foods (except for greens) are generally scarce, and stored-foods are running low or are exhausted. Depending on the degree of harshness of the winter, animal foods may be in short supply as well. Thus, all foods that are available during the spring and early summer are of special importance for human survival and overall health. It seems probable that the NM 128 sites were used to varying degrees from late spring into the early fall and perhaps in other seasons as well, especially if yucca and perhaps prickly pear pads were used at times other than their optimum. Regarding prickly pear pads, archaeological coprolites and written documents from the south, Lower Pecos, and west regions of Texas (and therefore probably southeastern New Mexico?) demonstrate that they were a much-used foodstuff during both prehistoric and early historic times (e.g., Sobolik 1996b:207 and Covey 1997:105).

This brings up the question of food storage and the apparent lack of evidence for it at the NM 128 sites. As mentioned elsewhere in this report, very few pits that could have been used for storage of foodstuffs were found, in spite of the fact that dozens of thermal features were excavated. Did a focus on excavating easily discovered features (thermal features with their burned sediments and rocks) and darkly-stained anthrosols prevent us from finding storage pits that might have been located away from these features? This possibility has already been raised with respect to the seeming (near) absence of structures.

One way of evaluating the situation is to look at several factors regarding the nature of the occupations of the sites. The fairly ubiquitous presence of grinding equipment—manos and mutates—at most of the sites and in many of the excavation blocks indicates that a certain amount of food was prepared and probably consumed at all of the locations. But other criteria, in the form of short occupations (low artifact densities), the possibility of a lifestyle of tethered nomadism (associated with springs and evidenced by the development of anthrosols from the accumulation of thermal feature carbon, but not from animal and human waste [i.e., phosphorus-producers]?), and certain climatic factors, provide other clues. Studies by Lewis Binford and his students have investigated a useful measure of environmental variability known as "effective temperature" or ET. He explains that effective temperature,

> [Effective temperature] simultaneously describes both the total amount and yearly distribution of solar radiation...a measure of both the length of the growing season and the intensity of solar energy available during the growing season. Since biotic production is primarily a result of solar radiation coupled with sufficient water to sustain photosynthesis, we can expect a general relationship to obtain between ET value and global patterns of biotic activity and hence production. Other things being equal, the higher the ET value, the greater the production of new cells within the plant and producer component of the habitat. This means that in a very simplistic sense we might expect "food rich" environments when ET is high and "food poor" environments when ET is low (Binford 1980:13–14).

The importance of ET here is that it can provide a crude index as to when and why hunter-gatherers do or do not use storage as a means of extending the availability of certain foodstuffs. In general, Binford's cross-cultural studies illustrate that the occurrence of food storage is inversely proportional to ET. That is, the lower the ET value, the higher the dependency on food storage. Peoples living in tropical climates, with ETs of 15/16 or more, use little or no storage (Binford 1980:Fig. 4). The ET of the NM 128 project area is 14.9 (Cordell 1979:Map 2), and an ET of 15 (the highest ET value in New Mexico) is approximately 30 km (20 miles) to the south at the New Mexico/Texas state line. Thus, the NM 128 project sites are on the "cusp" whereby food storage may or may not be useful and therefore may or may not be expected to occur. From this, we might infer that, in this far corner of New Mexico and extending into Texas and beyond, food would generally have been available and therefore procurable year round. The most pertinent question relative to our project area would then be how much food would be available under these circumstances. This question is underscored by the general dryness of the NM 128 region, as opposed to Binford's sample in which the study groups lacking storage primarily inhabit non-temperate regions (i.e., the tropics, subtropics, and boreal forests).

So the question remains. Should we expect to find evidence of food storage (i.e., storage pits) in prehistoric sites in this part of New Mexico? We basically did not find unambiguous examples of storage pits at our sites, but we also did not excavate extensively enough in areas away from thermal features (fire pits and baking facilities) in order to be certain. Future excavations in the region should strive to locate and identify storage features or eliminate the possibilities that they have been overlooked. This can only be done by conducting excavations well away from the thermal features and other dark deposits (anthrosols and trash deposits) that are readily observed and normally targeted for excavation. Extensive excavations should be conducted in light-colored sediments within sites where storage pits (and structures, too) might be found. Techniques should be geared toward identifying subtle features having poorly defined edges and interior fills lacking strong coloration.

Returning to the question of seasons of occupation, if the occupations at the NM 128 sites were seasonal (and all data indicate that they were), we cannot account for the over-wintering companion sites (i.e., sites occupied during the late fall through early spring). Although we have no explicit data pointing us to these sites, it is worth noting that the nearest ones displaying evidence of heavy, perhaps winter-related habitation are those at the group of playas dominated by Laguna Plata (Runyan 1972; Haskell 1977; Laumbach 1979; Brown 2010). These lakes are located only a few kilometers northeast of the head of Nash Draw. For that matter, the large group of sites in the Nash Draw Valley just below (southwest of) the Maroon Cliffs could also be the home or winter quarters of the occupants of the NM 128 sites. This location is topographically low and therefore protected to a degree from the frigid north winds that occasionally sweep the Southern Plains during winter.

And finally, one of the more important questions about subsistence is what the general climate was like at the time of the occupations. We are fortunate that the project area is close to the Guadalupe Mountains, the source of an important series of caves, their stalagmites, and several studies of past climate derived from them (see Tatum's paleoclimate section, this report). The speleothem-derived climatic reconstruction (Fig. 2.3) for the period starting about the beginning of the Christian era and ending about AD 1200 shows that the climate was somewhat moister than at the present time (as denoted by the -4.0 mesic/xeric line in the figure). This period equates closely with the primary period of use of the NM 128 sites, AD 90 to 1100. Although this period experienced occasional dry episodes (values -3.7 to – 4.0 in Fig. 2.3), the overall climate was better for plant growth than during the twentieth century.

The one surprise in all this is that, starting about 1000 BC and lasting until about AD 300, the climate produced "significantly greater effective annual moisture" (Polyak and Asmerom 2001:150) than at present. Yet, we obtained only one occupation date (ca. 920 BC) pertaining to this period other than the beginning date at AD 90 of our main series of dates.

After AD 1200, the overall climate dried somewhat until the present day, though a brief upswing in moisture and coolness did occur during the period known as the Little Ice Age, AD 1540 to 1710.

Research Question 4: Regarding Exchange and Mobility

Normally speaking, three kinds of items are useful as indicators of exchange and mobility. These are distinctive artifact types, lithic raw materials, and pottery.

Formal Artifacts

In this part of New Mexico, distinctive, non-local artifact types are often made of non-local raw materials, thereby reinforcing the fact that the artifacts were imported from other regions. An excellent example is a Harahey knife made of Alibates material that was found by a local collector on the west side of the Nash Draw Valley a few kilometers north of the NM 128 project sites. This roughly diamond-shaped, four-bevel knife with alternately-beveled edges is characteristic of the Late Prehistoric bison-hunting cultures of the Plains. The source area of the material, Alibates silicified dolomite, is the Canadian River Valley north of the city of Amarillo, Texas (Banks 1990:91–92). Obviously, this item and/or the material from which it was made was carried a minimum of 400 km (250 miles) prior to its loss in this part of southeastern New Mexico.

The NM 128 project sites produced three formal artifacts made of materials from far-off sources:

Corner-notched dart point 154-1 (Fig. 17.5b), from LA 129214, Block 2, Square 510N/532E, Level 1, is made of Alibates material from the northern Texas Panhandle (Banks 1990:91–92). Its style is closest to the Martindale type in the Texas system (Turner and Hester 1993), but the likeness is not strong.

Stemmed dart point 1320-1 (Fig. 17.6g), from LA 129214, Block 13, Square 469N/424E, Level 2, is made of Edwards chert, a material from central or west-central Texas. The nearest known geologic source of Edwards chert is 240 km (150 miles) east of the NM 128 project sites (Banks 1990:60–61). Because this point is only a stem fragment, its type is uncertain. It could be a Dalton type but with exaggerated basal corners, or, it could be a Fairland (Turner and Hester 1993). Unfortunately, the cultural meaning and temporal parameters of these two types are disparate (late Paleoindian versus Transitional Archaic), and preclude effective interpretation of the significance of this particular specimen. The most significant factor is that the material type indicates that the point ultimately came from central or west-central Texas.

The third projectile point, a stemmed dart point 849-1 (Fig. 17.6d) from LA 113042, Block 10, Square 502N/604E, Level 1, is made of Edwards chert. This fragment of the stem and lower blade most closely resembles a Bajada point (late Paleoindian or Early Archaic) in the Oshara sequence of northwestern New Mexico (Irwin-Williams 1973). However, since this point is made of Edwards chert, a Bajada type assignment is questionable.

Chipped Lithic Toolstones

Four imported tool stones are represented among the chipped lithic debitage from NM 128. These are Edwards chert, Tecovas chert, Pedernal "chert," and obsidian. In many cases, identifications are quite certain, but in others, the matches are less certain (see Hamilton's section, this report). Examples of the latter are referred to as "possible Edwards" and "possible Tecovas."

Edwards chert (n = 45) and possible Edwards chert (n = 48) are by far the most common imported tool stones in the NM 128 collections. They were recovered from six sites, with none being recovered from LA 129216. The distributions of these items by site are provided in Table 27.2. As mentioned earlier, this material comes from central and west-central Texas (Banks 1990:60–61) some 240 km (149 miles) to the east of the NM 128 project sites.

Only two (conjoinable) pieces of Tecovas chert (a.k.a. Quitaque chert) and one piece of possible Tecovas were recovered. The two conjoinable pieces were recovered from Square 469N/513E, Level 2, and from a backdirt pile, both in Block 1 of LA 113042. The piece of possible Tecovas came from Block 16 (square and level unknown) of LA 129214. At least two general source areas are known for Tecovas, the Quitaque region in the upper reaches of the Pease and Red rivers in the Texas Panhandle (east of Plainview) and along the Canadian river in Oldham and Potter counties north of Amarillo (Banks 1990:92-94).

The single piece of Pedernal "chert" (in this case the chalcedonic form; Banks 1990:69) is essentially confirmed by its characteristic apple green reaction to stimulation by short-wave ultraviolet light. The main source area for this material is on the northwest side of the Jemez Mountains in north-central New Mexico, but cobbles of it can be found a long distance down the Rio Grande through the central and south-central parts of the state. Our specimen comes from the surface at grid unit 534.94N/507.69E in Block 1 at LA 129300.

Only two pieces of obsidian were recovered by the project, and both came from LA 129214. The core-flake from Block 6, Square 465N/536E, was retrieved from Level 1, while the biface-thinning flake came from the surface of Square 466N/426E in Block 13. At one-tenth gram and six-tenths gram, respectively, both are quite small and were not submitted for sourcing analysis. However, both are slightly black and nearly clear, suggesting a Jemez Mountains source in north-central New Mexico or, less likely, a gravel source somewhere down the Rio Grande from there.

Pottery

Four basic types of pottery were recovered from five of the NM 128 sites, most of it from LA sites 129214 (79.8 percent) and 113042 (17.3 percent) (see Wilson's report in this volume). Roughly speaking, major contributors to these figures are site size and amount of excavation conducted at each. All of the pottery, as far as we can currently ascertain, was made in areas west of the Pecos River and well away from the project area (Hill 2009). Thus, all of the vessels represented by the 1001 pottery sherds were carried to the NM 128 sites from distances as close as the Sierra Blanca country (150 km, or 95 miles) to as far as the El Paso region (200 km, or 130 miles).

The four pottery types, in order of abundance at the NM 128 sites, are El Paso Brown, South Pecos Brown, Jornada Brown, and Chupadero Black-on-white.

Table 27.2. Distribution of Edwards Chert and Possible Edwards Chert debitage by site.

NUMBER	BLOCK	SQUARE	LEVEL
LA 113042 - Edwards Chert			
1	1	465N/515E	2
1	1	469N/517E	1
2	1	469N/519E	1
1	2	456N/518E	2
1	2	456N/518E	3
1	6	540N/600E	1
1	8	486N/600E	4
1	10	500N/606E	1
1	11	491N/616E	2
LA 113042 - Possible Edwards Chert			
1	1	465N/513E	3
1	2	460N/520E	1
1	2	461–462N/518–519E	F33
2	8	486N/600E	4
2	11	493N/614E	1
LA 129214 - Edwards Chert			
1	5	484N/536E	2
1	8	490N/496E	1
1	8	491N/501E	1
1	8	486N/495E	1
1	8	493N/504E	1
1	12	490N/433E	1
1	12	489N/433E	1
1	12	489N/435E	1
1	12	486N/437E	1
1	12	489N/431E	2
1	12	incomplete data	–
1	13	471N/417E	1
1	13	472N/419E	1
1	13	470N/421E	2
1	13	472N/415E	1
1	16	434N/473E	4
1	18	472N/388E	2
LA 129214 - Possible Edwards Chert			
1	6	470N/536E	2
1	8	488N/498E	1
1	8	488N/501E	1
2	12	486N/433E	2
1	12	486N/433E	1
1	12	490N/429E	1
1	13	468N/421E	2
1	13	469N/421E	2
1	13	469N/419E	1
1	13	471N/415E	1
1	13	472N/416E	1
1	13	471N/412E	2
1	16	467N/447E	2
1	16	434N/475E	1
1	16	435N/475E	1

The El Paso Brown was most likely made somewhere in the greater El Paso region, probably the Hueco Bolson, southern Tularosa Basin, and/or along the Rio Grande.

South Pecos Brown, being one of the varieties or off-shoots of Jornada Brown, would have been made in or about Sierra Blanca Peak in south-central Lincoln County or north-central Otero County (the "Ruidoso country") of south-central New Mexico. The distinctive solid gray feldspar syenite temper (sometimes referred to as Sierra Blanca gray syenite) is known to exist geologically in that massif, but the full extent of its occurrence and use by prehistoric potters has not yet been established. I (RNW) have seen it outcropping in roadcuts of the switchbacks of NM 532 between the village of Alto and the Sierra Blanca ski area. However, I have also seen pottery containing this rock at sites along the south and west sides of Sierra Blanca as well as along the east and north sides, suggesting that it crops out all around the mountain. If my suspicions are accurate, then this rock would have been available over a vast area to potters who cared to use it.

The Jornada Brown sherds contain one or more monzonites common to the Sierra Blanca and the Capitan mountains. These mountains contain a variety of syenitic and monzonitic compositions bearing subtle variations in colors of feldspars, minor mafic constituents, and presence or absence of quartz. Some of the variation, particularly in colors, is induced by greater or lesser proximity to the heat caused by the intrusion of dikes and other igneous bodies. The presence of these materials in the NM 128 Jornada Brown sherds indicates manufacture in some part or parts of that rather large, geologically-complex region.

And finally, the Chupadero Black-on-white, with its sherd and dark rock temper in a white paste presents a problem, for we do not as yet know for certain where it was made. This combination of clay and rock are suggestive of some place in central New Mexico and especially west of the Rio Grande. Very white clays are characteristic of pottery from Acoma Pueblo, but the full extent of the geologic availability of this clay remains to be discovered.

Summary of Exchange/Trade

As far as can now be ascertained, pottery vessels, tool stones, and formal artifacts of exotic tool stones

(*Table 27.2, continued*)

NUMBER	BLOCK	SQUARE	LEVEL
1	16	no data	–
1	16	434N/472E	1
1	16	436N/480E	1
1	16	436N/483E	1
1	16	no data	–
1	19	487N/394E	2
LA 129217 - Edwards Chert			
1	1	488N/492E	2
1	2	496N/490E	1
1	3	528N/501E	s*
1	3	529N/501E	s
1	4	470N/541E	3
1	5	488N/480E	2
1	5	486N/482E	3
1	5	488N/480E	5
LA 129217 - Possible Edwards Chert			
1	1	488N/492E	2
1	2	488N/490E	1
1	3	528N/500E	3
1	3	528N/501E	s
1	5	488N/482E	5
1	5	486N/482E	3
1	5	488N/480E	6
LA 129218 - Edwards Chert			
1	1	534N/461E	1
2	2	508N/502E	1
1	2	506N/500E	1
1	4	530N/504E	1
1	4	528N/504E	1
1	7	502N/486E	2
1	10	538N/467E	1
LA 129218 - Possible Edwards Chert			
1	2	508N/500E	1
1	3	516N/502E	1
1	3	518N/502E	1
1	6	510N/480E	2
LA 129222 - Edwards Chert			
–	–	none	–
LA 129222 - Possible Edwards Chert			
1	1	456N/521E	1
1	2	460N/511E	1
1	6	463N/494E	2
1	6	463N/492E	1
1	–	529N/516E	s
LA 129300 - Edwards Chert			
1	3	509N/457E	s
1	4	458N/511E	1
LA 129300 - Possible Edwards Chert			
1	6	456N517E	1
1	6	463N/494E	1
1	13	456N/517E	2

* s = surface

recovered from the NM 128 sites were traded in from potentially as far away as the northern Texas Panhandle to the northeast; central or west-central Texas to the east and southeast; the El Paso area to the west; and south-central and perhaps central New Mexico to the northwest. This vast region of approximately 362,500 sq km (139,962 square miles) measures roughly 500 km (300 miles) north–south by 725 km (450 miles) east–west.

Especially given the facts that, items from these exchange sources are commonly represented in southeastern New Mexico sites of all types and the overall distances are so vast, I suspect that these items moved about through down-the-line exchange, either by active trading or scavenging from abandoned sites. Direct procurement by the inhabitants of the NM 128 sites seems unlikely except under the most exceptional circumstances (see Kelley 1955 for one example).

Research Question 5: Regarding the Dating of the Occupations

One of the primary goals of this project, and a major contribution to the study of southeastern New Mexico was the large number of radiocarbon dates, 145 in total, obtained mostly from thermal features at six of the seven prehistoric sites. Unfortunately, no dates were obtained from LA 129217. The NM 128 dates increase the number of radiocarbon dates from southeastern New Mexico sites by nearly 75 percent (Railey et al. 2009).

Four major advantages accrue to the acquisition of large numbers of radiocarbon dates:

1. The more dates obtained, the greater the likelihood that the earliest and latest occupations of the sites will be identified;

2. In the case of sites that experienced more than one occupation (this applies to virtually all sites in southeastern New Mexico), more of those occupations can be identified and dated in a given site;

3. With a sufficient number of dates for a given site or area, we can get an idea as to what periods of occupation have greater representation, versus those that are less well represented or are not represented at all;

4. For most purposes, radiocarbon dates supplant the need to use diagnostic artifacts (in particular, projectile points and pottery) as temporal indicators. Thus, all problems attendant with the potential for spurious associations, poorly dated artifact types, the viability of extending dates of exotic artifact types to new regions, etc., are eliminated.

The 145 radiocarbon dates from the NM 128 project sites highlight several important aspects of the prehistoric use of the lower reaches of Nash Draw.

The dates referred to in the following points are the calibrated intercept dates. Readers desiring the date ranges are referred to the original radiocarbon sheets presented in Appendix 4.

The earliest cultural dates for the project were obtained by the Optically Stimulated Luminescence technique (OSL) on sediment units in connection with the geomorphology study (Hall this report).

1 .The earliest occupation concerns two cultural rock features at LA 129216 that are bracketed by (interpolated from) OSL dates on sediments (Hall this report). The dates belong to the Paleoindian 4 period, or between 8,600 and 6,970 BC. Neither rock feature was dated directly (no associated carbon), and no associated use-surfaces or individual artifacts were noted in or around them. Three projectile points typed as Golondrina were recovered from LA sites 129217 and 300, but two were surface finds and the one buried example, dated by OSL to 3710 ± 300 years ago, is *not* in original context, indicating either redeposition or reuse by later site occupants.

2. The next occupations belong to the last part of the Archaic 1 and the early part of the Archaic 2, in this case between about 4540 BC and 4250 BC. Of the five dates belonging to this period, three are from LA 129218, and two are from LA 129300.

3. No dates represent the next 3300 years, or from 4250 to 920 BC

4. The next date, about 920 BC, is an isolate at LA 113042. It represents the latter part of the Archaic 3 or Late Archaic period.

5. A date of about AD 90 is the first in the long series that encompasses the rest, or 96 percent, of the dates from the project. The last date in the series is about AD 1400. It starts with the last of the Archaic 4 period and ends with the early Neo-Archaic 3. The series, which is 1300 years long, coincides well with Railey et al. (2009:42-51) finding that prehistoric use of southeastern New Mexico between the Pecos River and the western escarpment of the Llano Estacado was heaviest at this time.

6. Most or all of the Neo-Archaic 3 through the Neo-Archaic 4 periods (about AD 1400 to AD 1700) are not represented among the NM 128 project dates.

7. To accurately bracket the occupation periods of large sites in southeastern New Mexico requires dozens of radiocarbon dates. Many, if not most, of the larger sites experienced fairly frequent reoccupations over very long periods of time. And because of the problems associated with dating of projectile point styles, long-lived pottery types, and the portability of these items, their usefulness in dating occupations is always highly questionable in the absence of absolute dating techniques such as radiocarbon analysis.

Several aspects of the period of primary use of the NM 128 sites (about AD 90 to AD 1400) require discussion. The OxCal analysis suggests that this 1300-year-long period had only six breaks in occupation, and that each period overlaps the adjacent ones. This seems to imply that one or more year-round occupations took place at specific locations in one or more of the sites. However, I consider this proposition to be suspect simply because all other indicators suggest that site visits were relatively short, probably on the order of a few days to a few weeks in duration and that the groups then moved on to other locations to continue their subsistence rounds.

One of the more interesting aspects of the prehistoric use of the NM 128 sites is that some occupations might have involved only a single group of people but that the members of that group occupied loci at two or more of the sites. LA sites 129216, 129214, and 113042, which are all located very close to one another, have produced the exact same ^{14}C dates that illustrate this possibility. Data supporting an interpretation of short occupations include low artifact counts, evidence of brief use of most thermal features (light-colored fills bearing small amounts of charcoal dust and few, if any, pieces of charcoal), and the seeming absence of substantial habitation remains. I can only conclude that the OxCal analysis provides a skewed perception of the degree, number, and duration of the occupations at the sites.

Given the above considerations, I believe that the number and duration of the occupations at the NM 128 sites are more accurately portrayed by a simple graphing of the calibrated intercept dates

(Fig. 25.4c). This is not to say that the dates in themselves are necessarily accurate with regard to their positions in the Christian calendar as currently presented. After all, each new calibration routine adjusts many of the dates to either earlier or later positions, thereby adjusting their calendric implications. The value of the figure lies in its portrayal of numerous breaks in occupation, more commensurate with the other indicators as mentioned above. This is especially true when the dates are broken down by site. We cannot claim that the occupations of all of our sites are appropriately represented because most are not as thoroughly investigated as is LA 129214. But the graph for LA 129214 does illustrate a staccato occupation history that again is more in accord with the other excavation data from the project as well as expectations normally believed characteristic of hunter-gatherer adaptations and mobility patterns.

Continuing with the graph of intercept dates, it is probably most appropriate to think of the seven major occupation periods as probably dating to the early to mid-AD 100s, about AD 400, the mid to late 500s, the middle 600s into the early 700s, about 800, about 900, and around 1000. Shorter, less intensive uses of the NM 128 sites occurred between these major episodes. If these approximations are accurate, they mean that major use of the NM 128 area took place at intervals of every 50 to 100 years. I particularly like this "scenario" because it suggests what I consider to be highly probable—that the uses of the project sites and area were on a periodic basis, and that the major periods of use were probably separated by comparatively long periods of non-use because of the need for the floral and faunal species to recover/replenish from exploitation by humans in combination with the regenerative problems caused by the occasional periods of drought that characterize the region.

While I generally prefer to use the calibration intercept dates for looking at the question of dating features, sites, and occupations of regions, not everyone agrees that these values are the best or most appropriate ones to use. For instance, personnel at Beta-Analytic recommend that only the two standard deviation ranges be used when discussing dating of sites and events, because there is a 92 percent chance that the true date of that site or event occurred at some point within that period. Other people prefer using the conventional radiocarbon dates as derived from the measured radiocarbon dates. Consequently, I constructed Figure 25.4 to permit comparison of these values as well as the OxCal periods. In order to simplify the data to some degree, I have plotted the central values rather than the standard deviations and have grouped them into 10-year increments. As already explained for the plot of the calibrated intercepts, the specific decadal associations should be viewed as approximations, not absolutes. This is particularly true with the measured 14C dates because they are expressed in radiocarbon years. Since radiocarbon years are not of uniform duration at each point in the scale, they are not directly comparable to the calendar. Nevertheless, the main idea in this exercise is to gain a sense of the distributions of the dates for each series and, roughly speaking, to be able to compare one series against the other.

If we look at each distribution or graph with respect to the heights of individual decadal increments (i.e., the number of cases per decade) and the number of breaks in the horizontal distribution, we see some interesting changes from the top graph (measured ^{14}C) to the second one (conventional ^{14}C) to the third one (calibrated intercepts). The trend, barely evident between the first and second graphs, is a slight tendency toward greater representation in some decades (more and slightly higher peaks) and a few more breaks in the horizontal distributions (i.e., "empty decades").

The third graph, calibrated intercepts, accentuates the groupings and the lengths of the breaks (empty decades). While fewer breaks occur in the third graph, the average length of the breaks is greater (2.8 decades versus 1.3 in Graph 2). Of all the graphs, and as stated earlier, I believe the third one has the greatest potential for defining the general number of major and minor occupation episodes and the intensities/numbers of occupations per period. However, as mentioned earlier, these data can only be used as approximations as to actual calendar years because the calibration routine currently in use is itself an approximation technique.

And finally, the fourth graph, the OxCal periods, combines the dates into the fewest groups. As shown in the graph, each period overlaps both the preceding and the following periods to small degrees. Interestingly, the OxCal routine actually uses dates from the No. 7 group in Graph 3 (the one dated about AD 1000) to compose OxCal periods 7, 8, 9, and 10. While I had initially hoped that the

OxCal technique would identify those dates that, while not numerically the same, are statistically one in the same and therefore potentially represent concurrent dates and occupations. That is, the groups might identify cultural features used by members of the same camping group. If these groupings could be relied upon to some level of possibility, then we could start to think and hypothesize in terms of the sizes of camping and cooperating groups (read family groups, local groups, even band-size groups). But, most of the OxCal groups clearly encompass time spans that are much too long to be interpreted as concurrent occupations. As a result, I decided to group only those dates that are literally the same and to use them as proxy indications of contemporaneous features and therefore of family and/or local-group size units (see earlier discussion).

Research Question 6: Regarding the Shin-Oak Study and Acorns as a Prehistoric Resouce in Southeastern New Mexico

It should be noted at the outset that the term "shin oak" in this report *refers solely* to the species *Quercus havardii*. At least two other species/subspecies of oak in Texas are also occasionally called shin oak, the Mohr Shin Oak (*Q. Mohriana*) and the Vasey Shin Oak (*Q. Pungens* var. *vaseyana*) (Powell 1997; Stanley 2004).

As related in an earlier section, acorns from the shin oak, *Quercus havardii,* have long been suspected of being a primary food resource for the prehistoric inhabitants of southeastern New Mexico lying east of the Pecos River. Today, nearly 1.5 million acres of this productive species lie within New Mexico, but authorities disagree as to its prehistoric (pre-Euro-American) distribution and quantity (Peterson and Boyd 1998:2). Today, shin oak also covers about 3.5 million acres in adjacent parts of Texas (west-central and the panhandle), and another 1 million acres in far western Oklahoma. The single largest concentration of shin oak occurs in southeastern New Mexico and across the line into the first one or two counties of Texas. All totaled, this New Mexico/Texas "patch" appears to cover approximately 3 million acres. A resource "patch" of this size is highly significant and represents an extremely important resource for all species that use it, including man.

The individual acorns of *Q. havardii* vary somewhat in size. Acorn meats that we collected from three separate localities in 2009 ranged from 15 to 25 mm long and 10 to 20 mm in diameter. At a given location, acorn production does not occur every year. Rather, according to Peterson and Boyd (1998:9–10), production occurs as infrequently as 1 out of every 10 years and as often as 4 in every 10 years. However, limited experience in the summers of 2008 and 2009 suggests that availability of acorns can be on a plant-by-plant basis (with one plant producing and adjacent ones not producing), as well as on a patch by patch basis. A given plant may have just a few acorns, or it may have a few dozen. Age and situation of individual plants and availability of moisture to specific plants may be keys to acorn availability. Our observations and collections were made at three locations in July of 2009: one in the vicinity of NM 128 project sites LA 129217 and LA 129218 located south of the WIPP site; another 8 km (5 miles) due south of Maljamar, NM; and the third 65 km (40 miles) east of Roswell along US 380 (i.e., just west of Caprock, NM). The two batches of acorns analyzed and reported in Cummings et al. (this report) are from the WIPP ("Loving") and Caprock ("Roswell") locales.

One aspect of acorns always elicits questions and comments from archaeologists who are familiar with aboriginal California cultures. Apparently, all California tribes, whose territories contained one or more species of oak, used acorns as a dietary mainstay. The fact that, in order to render the various California acorns edible by humans, the acorns first had to be processed by rather elaborate means to remove the chemicals called tanins or tanic acid (Heizer and Elsasser 1980). Tanins are compounds so bitter that humans cannot tolerate their presence in food.

Thus, people knowledgeable of the tannin problem always want to know about the acorns of Southwestern species and what has to be done to make them edible by humans. Mindful of this situation, and having been told by ethnobotanists such as Richard I. Ford that acorns of New Mexico species generally have little to no tannins, I tasted a number of acorns while I collected from the shin oaks in the WIPP, Maljamar, and Caprock areas as a part of my NM 128 studies. For the most part, I could not detect the presence of tannins in most of the acorns I ate, but I did encounter the occasional one that had small amounts. Although I did not test on a routine or statistically valid basis, I suspect that the percentage of shin oak acorns that do have tannins will, on average, be rendered unobjectionable when mixed with those that do not. If true, then preparation of large batches of *Q. havardii* acorns at a time will probably not require any form of treatment to remove the tanins of the occasional acorns that contain this chemical.

The nutritional analysis of acorns from the NM 128/WIPP/Loving and the Roswell/Caprock localities had two interesting surprises. First, the results from each locality were slightly different from one another. And, the NM 128/Roswell results also differ from those obtained by the USDA for acorns of unidentified species (Table 26.9; compare also with Table 27.3). Cummings et al. (this report) suggest that part of these differences may be due to at least three factors—differences in growing medium (soil substrate), moisture availability, and deterioration of our modern acorns caused by storage (and drying) over the year between harvest and analysis. This raises an important question. How soon does the food value of acorns begin to deteriorate during storage? We currently have no answer.

During their discussion, Cummings et al. (this report) address nutrients such as fat content and calories from fat but do not discuss the carbohydrate content. Yet, it seems very likely that the carbohydrate content of acorns would have been the most important nutrient to the prehistoric inhabitants of the region. Why? The availability of a major carbohydrate source would have been crucial to human life in the region. An important part of the answer to this question is whether corn, another excellent source of carbohydrate was, or was not, grown east of the Pecos River in southeastern New Mexico.

In the recent past, some researchers discussed at length the protein contribution made to the human diet by corn and beans. Among other things, this focus caused some people to overlook the fact that the overwhelming dietary value of corn, by volume, is its carbohydrate content. This and other considerations encouraged the continuing emphasis on looking for evidence of horticulture, whether in the form of gardening (low level production of food) or of farming (higher level production of food), in practically all areas of the Southwest. In some cases, questionable evidence was used to propose (and defend) interpretations of prehistoric farming in regions that are poorly, or not at all, suited for growing crops under conditions of low ("primitive") technology. Southeastern New Mexico, east of the Pecos River is one such case simply because of the mean low annual precipitation in those parts of the region between the Pecos Valley and the Llano Estacado. Since this situation is discussed in detail in a forthcoming monograph (Wiseman in prep.), it will not be discussed here.

Here, we focus on the question of why the growing of corn east of the Pecos would not have been necessary. As mentioned earlier the climate of this part of southeastern New Mexico would have been marginal for growing corn. The growing or frost-free season of approximately 220 days is certainly long enough, and the mean annual temperature of 62 degrees Fahrenheit (Carlsbad station; Gabin and Lesperance 1977) is warm enough. However, natural rainfall is both highly variable from year to year and generally too low overall in most years for dry farming (mean of 20 cm or 7.9 inches during the growing season).

Today, all farming in the nearby Pecos valley requires irrigation, and no farming is done between the Pecos valley and the edge of the Llano Estacado. Thus, it seems improbable that the growing of corn east of the Pecos in southeastern New Mexico would have been possible on a sustained basis during prehistoric times. Nor would it have been necessary, for the presence of the vast shin-oak communities starting a few miles to the east of the river should have been able to supply large amounts of carbohydrate in the form of acorns on a regular and sustained basis. All that would be required is that the prehistoric people were free to move about as the acorns became available in different places each year. As mentioned earlier, individual shin-oak plants do not produce acorns each and every year.

This brings us to the fact that we now have a growing body of evidence, including Cummings et al. (this report), that at least some corn was being processed and consumed (presumably) at an unknown number of sites east of the Pecos. On the basis of the current evidence, we believe that the corn residue retrieved from the fabric of potsherds and from the surfaces of some metates and manos was from corn obtained by the hunter-gatherers of our sites from the farming villages in the Sierra Blanca/Roswell regions to the west. This evidence includes corn pollen grains recovered from NM 128 artifacts. Normally, corn pollen in a site is interpreted as evidence that corn was grown close to the

Table 27.3. Comparison of Quercus havardii *nutritional data with data on seven California oak species and "Indian Corn" (percent by weight).*

COMMON NAME	GENUS/ SPECIES	WATER (%)	PROTEIN (%)	FATS (%)	FIBER (%)	CARBOHYDRATES (%)
Coast live oak	*Quercus agrifolia*	29.10	4.88	13.01	9.04	42.52
Canyon oak	*Quercus chrysolepsis*	42.10	2.63	5.50	8.10	40.42
Blue oak	*Quercus douglasii*	33.60	4.00	5.90	7.15	47.80
Oregon oak	*Quercus garryana*	30.70	3.00	3.40	9.10	52.45
California black oak	*Quercus kellogii*	31.40	3.44	13.55	8.60	41.81
Valley oak	*Quercus lobata*	40.80	3.19	3.60	6.15	44.91
Tanbark oak	*Lithocarpus densiflora*	36.00	2.06	8.50	14.15	38.29
Average for California oak species	–	34.81	3.31	7.64	8.90	44.03
Shin oak	*Quercus havardii* at Caprock, NM	6.70	4.50	7.80	14.20	68.00
Shin oak	*Quercus havardii* at Loving/WIPP NM	7.20	3.60	4.80	14.80	69.00
Average for shin oak samples	–	7.00	4.10	6.30	14.30	69.00
"Indian Corn"	–	12.50	9.20	1.90	1.00	74.40

Data from Cummings et al. (this report), and Heizer and Elsasser 1980:Table 4.

find location. However, regarding the corn pollen from the NM 128 artifacts, I assume that the pollen came to the sites with the substances ground on the metate and mano, but I could be wrong. Other samples collected by the NM 128 project and discussed elsewhere in this report lack corn remains even though the analyses (pollen samples from loci protected by artifacts, pollen samples taken from potential garden spots, etc.) were conducted specifically to find evidence of actual plots where corn or other cultigens were grown in the past.

This brings up another question. Why would people, who had to walk everywhere they went, go to the trouble of carrying even small quantities of corn over distances on the order of 130 km (80 miles) before consuming it? This seems especially nonsensical when, as we have seen, they had sufficient supplies of readily available carbohydrates in the form of acorns. The answer may have been simple. Corn would have been exotic to non-farming people who had access to it, particularly because it is sweet compared to acorns. Although the sweetness presumably would have been an "acquired" taste for the hunter-gatherers of NM 128, occasional contact with farmers, as attested by trade pottery, could have provided opportunities for familiarization.

Another question raised by the Data Recovery Plan concerns the appearance of the shin oak in southeastern New Mexico and adjacent west Texas. When did the shin-oak communities form, and from whence did they come? Today, the NM 128 project area lies at the southwestern edge of the modern distribution of *Quercus havardii*.

Peterson and Boyd (1998) in a recent literature review of the shin-oak *Quercus havardii* show its modern distribution in New Mexico, Texas, and Oklahoma to be fairly impressive (Fig. 27.1). Although this oak occurs on several types of substrates (soils), the common denominator is fairly deep to deep sand and sand dunes.

The predilection of *Q. havardii* for deep sand is a limiting factor. In New Mexico and Texas, extensive and intensive grazing of livestock by Spaniards and Americans has resulted in the generation and deposition of large amounts of eolian sediments ("sand") on the landscape. While scientists are in disagreement about many of the details, all agree that the modern ground surface has changed greatly in many parts of this vast region. For instance, Hall (this report) has determined that Los Medanos (Spanish for sand dunes) that support the shin-oak growth nearest to the NM 128 sites, formed only about 2000 years ago. Thus, the spread of shin oak to the vicinity of the NM 128 sites is fairly recent, perhaps providing a clue as

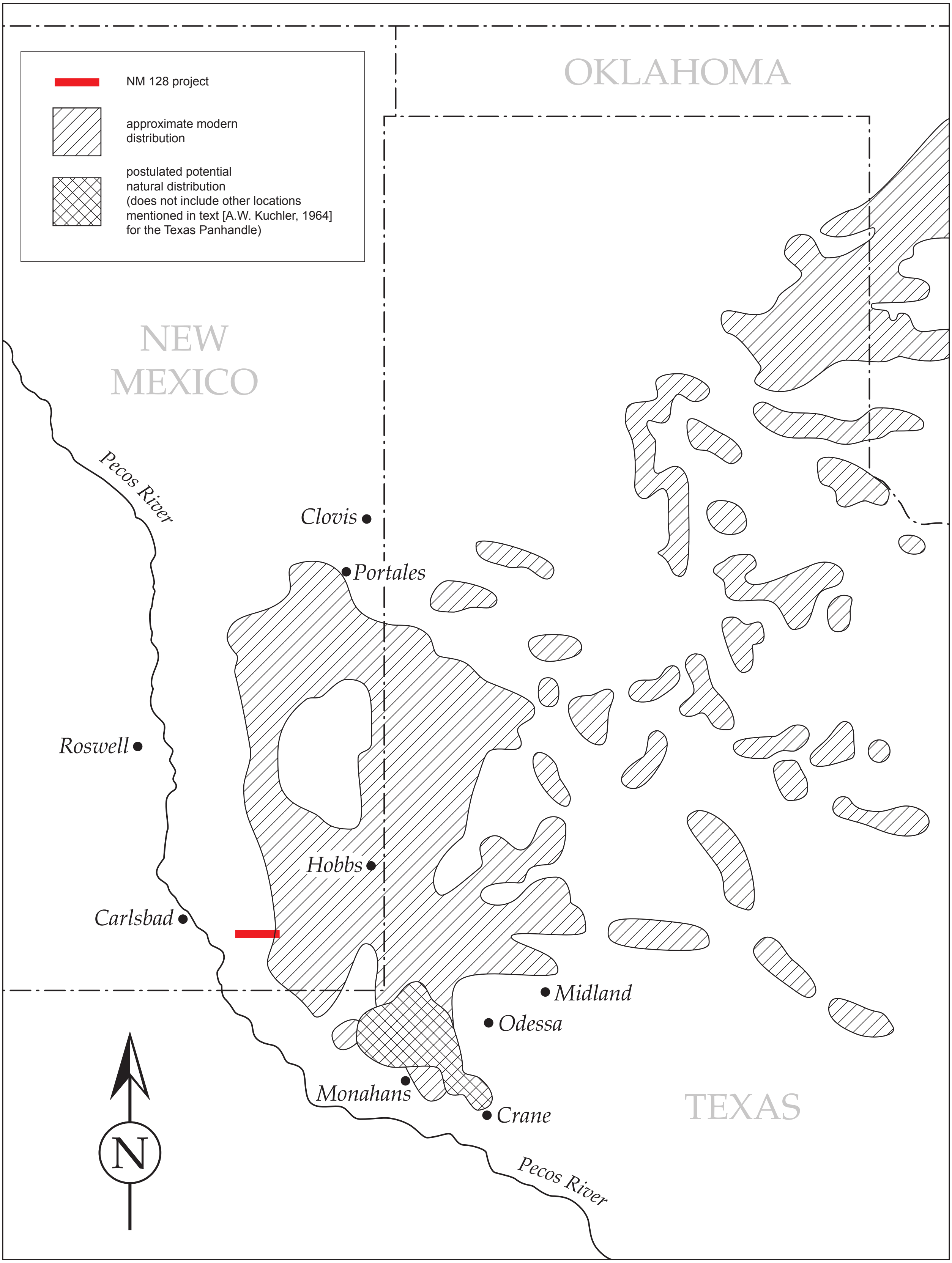

Figure 27.1. Approximate ancient and modern distributions of shin oak (Quercus havardii) in New Mexico, Texas, and Oklahoma.

to why the most intensive use of the NM 128 sites started when it did.

Modern studies (see Peterson and Boyd 1998) emphasize the fact that scientists have found very few examples of *Q. havardii* that started from acorns. Rather, shin-oak shrubs seem to spread most reliably by extension of rhyzomes, a slow method indeed when one is talking about millions of acres of eventual coverage. If Kuchler (1964) is correct in postulating a very limited original source area for *Q. havardii* (Fig. 27.1, dark crosshatched area in Texas, south and east of the southeast corner of New Mexico, for more information, see Chapter End Notes: Note 2 at the end of this chapter), then other methods of propagation of *Q. havardii,* such as human intervention, can be considered.

One of the factors that raised concern about the use of terms like "hunter-gatherers" especially when juxtaposed with the term "farmers" is that the distinction is no longer clear cut. Many instances have now been documented world-wide whereby some supposed non-farming hunter-gatherer groups have been found to manipulate the natural environment by encouraging the propagation of certain plants without actually sowing seeds and tending the plants prior to harvesting the crops. Is it possible that prehistoric Native Americans in southeastern New Mexico had a hand in extending the distribution of *Q. havardii* in some manner, such as cutting segments of roots (with or without "sprouts"?), transporting them to other areas of deep sand, and sticking them into the ground to see if they would grow? Apparently, in this manner, many early American pioneers stuck cottonwood twigs in suitable places to grow trees (J. P. Wilson, personal communication to R. N. Wiseman 1968).

Apparently, several species of oaks in the hill country of central Texas can be propagated in this manner, especially if "tree sprouts" are used (Stanley 2004). Tree sprouts are the beginnings of trees that have sprouted from a root and grown to and above the ground surface.

Research Question 7: Regarding the Geomorphology Study

The geomorphology and soil stratigraphic study by Hall (this report) is a major addition to our knowledge about and understanding of the formation of the late Pleistocene and Holocene sediment units in this part of the Mescalero Plain. The new information and insights gained from this study also constitute a major addition to Hall's (2002) seminal study of the regional geomorphology and paleoclimate.

My comments here address those aspects pertaining directly to the Native American experience in the project area. For aspects pertaining to the purely geologic and geomorphologic realms, the reader is referred to Hall's report and especially to the bullet point summary at the end of that chapter.

Evidence for a Paleoindian Presence

Scant evidence of potential Paleoindian presence was found at three NM 128 sites, LA 129216, LA 129217, and LA 129300. The best example is found in Backhoe Trench 1 at LA 129216. Follow-up work by hand excavation exposed two rock concentrations that are geologically anomalous and probably cultural.

Feature 11 lacked convincing evidence that it is cultural other than the possibility that the rocks may have marked the bottom of a very large, shallow pit. Hall (this volume) interpolates an OSL date of 8970 BP for this feature, placing it within the Paleoindian 4 period (Plainview/Golondrina) of this study. Feature 12, located 5 m horizontally from and 15 cm deeper than Feature 11, appears to be a lightly used, very large thermal pit.

An interpolated OSL date of 10,600 BP places it in the Paleoindian 3 period (Folsom/Midland) of this study. Both Features 11 and 12 "floated" in sand and lacked readily definable associated use-surfaces. Nor were any artifacts found in, around, or near the features.

The rest of the Paleoindian evidence consists of three Golondrina points recovered from LA 129217 and LA 129300. In good context, these artifacts would signal occupation during the Paleoindian 4 period, ca. 8000 to 6200 BC.

However, two specimens come from surface contexts, one at LA 129217 and the other at LA 129300. The third, also from LA 129300, was buried 18 cm below the modern surface. Hall (this volume) obtained an OSL date of 1710 ± 300 BC from sediments a few centimeters to one side of the point. This date is much too recent for the projectile point style and indicates that it was probably picked up and then dropped by later occupants of the site. In

Texas, Golondrina points have been dated to the period ca. 7080 to 6830 BC (Turner and Hester 1993) and about 8000 BC (Hester 2011).

Sediment Associations of Human Occupations

Dating estimates and sediment unit associations at the NM 128 sites confirm that prehistoric archaeological sites in this part of New Mexico are to be found within and on top of Hall's Unit 1 Sand (this report; also 2002). This unit, OSL-dated to the period 14,000 to 3000 years BP, generally can be found to contain archaeological remains dating to the Paleoindian 2 through 4 and Archaic 1 through 3 periods. Late Archaic 3 and 4 sites, plus all Neo-Archaic sites can be expected to lie stratigraphically either on top of the Unit 1 sands or somewhere within the overlying Los Medanos unit. According to Hall, Los Medanos sand apparently started to form as recently as about the beginning of the Christian era.

Late Prehistoric Period Anthrosols

One of the more fascinating aspects of the sediments encountered at three of the NM 128 (LA 113042, 129214, and 129216) is the presence of anthrosols, units generated in large part by the activities and refuse of humans. Many cultural features, especially thermal ones, occurred throughout the anthrosols at LA 113042 and 129214.

Perhaps the biggest surprise is that the anthrosols, where tested, contain lower concentrations of total phosphorous than expected. This suggests to me (RNW) that the anthrosols derive primarily from finely powdered charcoal associated with thermal feature use rather than from decomposition of plant, animal, and human residues left by the Native Americans. Frederick et al. (2011) refers to a similar appearing dark deposit at the Boot Hill site as a "biochar" and provides some discussion and references for useful follow-up.

Alluvium in Drainage Next to LA 113042

Hall's examination (this report) of a well-defined accumulation of alluvium in the drainage immediately east of LA 113042 adds yet another important dimension to the question as to whether the Native Americans engaged in gardening at the NM 128 project sites. Carefully detailed documentation of this unit, plus pollen sampling for the remains of cultigens (especially corn), provided negative results.

Radiocarbon assays from the bottom and the top of the alluvium date the unit from about 1000 BC to AD 1350/1400. Thus, the alluvium was available throughout the primary occupation of LA sites 129214 and 113042 (ca. AD 100 to 1100) but was not used for growing corn or other plant foods for humans.

Chapter End Notes

Note 1: No perishable artifacts—basketry, sandals, or cordage—were recovered from any of the NM 128 sites. However, Granado Cave, located in the Rustler Hills of west Texas, lies only 84 km (52 miles) due south of the NM 128 sites (Hamilton 2001).

Excavations at Granado Cave recovered a comparative wealth of perishable artifacts that very likely duplicate many of the items that would have been found at the NM 128 sites had conditions of preservation been much better. Eighteen of 20 radiocarbon dates from Granado Cave fall between AD 1 and 1500, precisely the period represented by most of the NM 128 site occupations.

Note 2: Kuchler (1964:3) states that any map purporting to reconstruct potential vegetation of a region should be dated. However, he adds that the date of his map is 1964—the date of publication—and not the time at which vegetation distributions were supposedly extant.

I can only suggest that the limited distribution of his Vegetation Type 71 (which includes *Q. havardii*) shown in Figure 27.1 pertains, perhaps, to the end of the Pleistocene or some undetermined time subsequent to that event. The area Kuchler attributes to Vegetation Type 71 is so small compared to the modern distribution that, surely, the date of validity must be at least a few thousand years ago.

Kuchler also mentions, but does not map, one or more other loci in Texas that he thinks supported Vegetation Type 71. Thus, one must assume that the one major locus he depicts probably gave rise to part or all of the modern distribution of the species in adjacent southeastern New Mexico. The other Texas loci evidently are too small for the scale selected for his map.

It is important to mention that modern scientists have not formed a consensus as to what degree the modern distribution of shin oak reflects past distributions; some believe earlier distributions were about the same as today; others think such distributions were more restricted (Peterson and Boyd 1998). Again, specific time periods under consideration are not mentioned.

28 ⊻ Summary and Conclusions

Reggie N. Wiseman

Seven prehistoric sites and one recent historic site were investigated for the NM 128 project. NM 128 crosses the lower end of Nash Draw, a relatively short but archaeologically rich intermittent drainage lying more-or-less parallel to and about 5 km (3 miles) east of the edge of the Pecos River Valley. Nash Draw empties southward into a natural depression called Salt Lake that has been vastly expanded through disposal of waste water from nearby potash mines. Formerly, and to some extent today, surface water in Nash Draw is available mainly from small seeps and springs that flow mostly during wet weather. Three larger, more permanent springs are on record, but two of them, when tested, had exceedingly high loads of dissolved minerals; if they were that way during prehistoric times, their water should have been unpotable to humans. However, the density of archaeological sites along the Nash Draw Valley suggests that sufficient potable water was available for serious human use of the valley and its environs.

The historic site, LA 129220, is a dismantled livestock facility belonging to the former James Ranch. Remnants of drinkers, feeders, water storage tanks, and a windmill (components disassembled and stockpiled on site at an unknown time) lay within the project area south of the existing NM 128 and were documented. A railroad-tie-and-wire corral lying immediately north of the highway right-of-way was not recorded beyond the survey stage and presumably remains intact to this day. LA 129220 dates to the early/mid-twentieth century.

The prehistoric occupations represented among the NM 128 sites include the Paleoindian 4, Early Archaic 2, Late Archaic 3, and Late Archaic 4 through early Neo-Archaic 3 periods. Only negligible information is available for the first three of these periods. Far and away the bulk of the information gained by this project comes from the Late Archaic 4 through the early Neo-Archaic (especially between AD 1 and 1100) uses of the sites.

Of the seven prehistoric sites, only one (LA 129214) received a large amount of excavation because the site area was encompassed by the new right-of-way. All other sites were "clipped" by the new construction, resulting in the investigation of relatively small percentages of the total areas of each. All of the sites are surface to shallow in depth. They are "dune" sites exposed mainly in blowouts (deflation depressions) in the sand sheet. LA 129222 is the one exception in that most of the site surface has little to no sand overlying the gypsum substratum on the valley bottom. Excavation has shown that features and deposits are stratified to varying degrees in some places within most of the sites, especially those with deeper sand accumulations. The sites are situated on the valley margins both west (LA 113042, LA 129214, LA 129216) and east (LA 129217, LA 129218) of the Nash Draw Valley and on low rises on the valley bottom (LA 129222, LA 129300).

Excavations by hand and mechanical trenching and scraping uncovered a total of 266 cultural features at the seven sites. By far, the majority of these features were thermal pits, but temporary shelters/structures, postholes, possible human burial pits, and cache pits were also found in small numbers. Three footprints of individual camps—a camp includes a shelter, an outdoor living space, thermal and other features, and artifact discard areas—were identified. Had larger areas been excavated in each excavation block, a larger, more meaningful sample of individual camp footprints would have been exposed and investigated.

The three westernmost sites also had very distinctive, dark, human-caused layers (anthrosols) of sediment of varying extent, depth, and color intensity developed in the areas of most intense use. In most instances where sufficient excavation was conducted, these sediments were found to contain closely spaced fire pits, both horizontally and vertically. Surprisingly, these sediments lacked the elevated total phosphorus values that would ordinarily be expected, supporting an inference that they might be best characterized as "biochars."

Partly as a result of the NM 128 project, a revised system of cultural phases for the region is introduced in this document. Aside from slight revisions to the dates for some of the phases, the primary change is in the use of the term Neo-Archaic (instead of the misleading word "Formative") to signal the growing body of evidence that most of the prehistoric occupation east of the Pecos River in southeastern New Mexico was by hunter-gatherers living in ways very similar to their Archaic ancestors/predecessors. The prior *suggestion* of widespread farming east of the river has always been *assumed* to be true because of the presence of pottery and a few poorly described structures in sites excavated 50 or more years ago. *This assumption has been taken on faith but never proven, in spite of the mounting evidence to the contrary!*

One hundred and forty-five of the features were dated by radiocarbon and several OSL dates, providing not only an excellent sense of the occupation periods represented but also of the intensities of use during each period. The occupation periods represented among the NM 128 sites include: Paleoindian 4 (late Paleoindian, 8000 to 6200 BC, minimal use detected); Early Archaic 2 (4500 to 4200 BC, at two sites); Late Archaic 3 (ca. 820 BC, only one component); and Late Archaic 4 through early Neo-Archaic 3 (time of Christ to about AD 1400). On the strength of present evidence, far and away the most intensive use of the sites occurred between AD 100 and 1100. But, how many more occupation periods would be identified, and how would our perception of occupation intensity change if all features, both discovered and not discovered, were dated?

Fewer than 8000 artifacts, including lithic chipping debris and pottery sherds, were recovered from the surfaces and excavations in all sites. Including evidence for only slight use of many features and light discoloration of sediments outside of the anthrosol areas, this figure indicates that occupations were generally of fairly short duration, probably on the order of a few days or a few weeks. The overall variety of artifact types, however, suggests that a fairly wide range of activities was performed at some (or many or most?) loci within the sites. If true, it is further postulated that the occupations probably constituted base-camp activities associated with a serial foraging lifestyle (*sensu* Binford 1980:16–17, but applied to warm climate region; Sebastian and Larralde 1989:55–56; see Data Recovery Plan, this report). It is further postulated that at least some of the NM 128 site occupants wintered over in camps located as close as the Maroon Cliffs at the head of Nash Draw 15 km (9 miles) to the north and at the many sites associated with the four huge playas dominated by Laguna Plata 20 to 25 km (12 to 15 miles) to the northeast).

This brings up the critical aspect of food resources that nourished the occupants of the NM 128 sites. The combination of studies undertaken during this project includes geomorphology, macro and micro plant and animal remains, and residues from artifacts. The plant remains revealed that numerous annual and perennial species were exploited.

Yucca stems and probably acorns may have been important components of the diet. Animal exploitation focused mostly on smaller species (rabbits, rats, mice, etc.), with larger species (antelope, deer) probably taken when encountered.

Corn residues from manos and metates suggest use of farmed products; however, pollen studies of sediments taken from numerous protected locations (under rocks, etc.) and from an excellent alluvial plot next to LA 113042 found no evidence of corn cultivation.

It is possible that the corn remains from the NM 128 samples and from residue analyses of potsherds and other artifacts at other sites *east* of the Pecos River may represent foodstuffs brought into these sites from farming villages located *west* of the Pecos River in the Sierra Blanca country and the Roswell oasis. Obviously, much more work will be required before we can be certain about these matters.

And finally, a number of items indicating long-distance exchange were recovered from the NM 128 sites. The most common connections are with central/west-central Texas (Edwards chert tool stone) and the El Paso region (El Paso Brown pottery). Tecovas (Quitaque) chert tool stone (but *not* Alibates silicified dolomite!) represents the Texas Panhandle. The Chupadero Black-on-white pottery almost certainly came from the Sierra Blanca/Capitan region of southeastern New Mexico. The couple of items of obsidian and Pedernal chalcedony tool stones might have come from either their original geologic source areas in north-central New Mexico (Jemez country) or from some point down the Rio Grande (Las Cruces? El Paso?). Given the distances to most of these sources, down-the-line exchange, rather than direct procurement, is the most likely mechanism by which these items reached the NM 128 sites.

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Appendix 1 ⚶ Feature Plans and Profiles

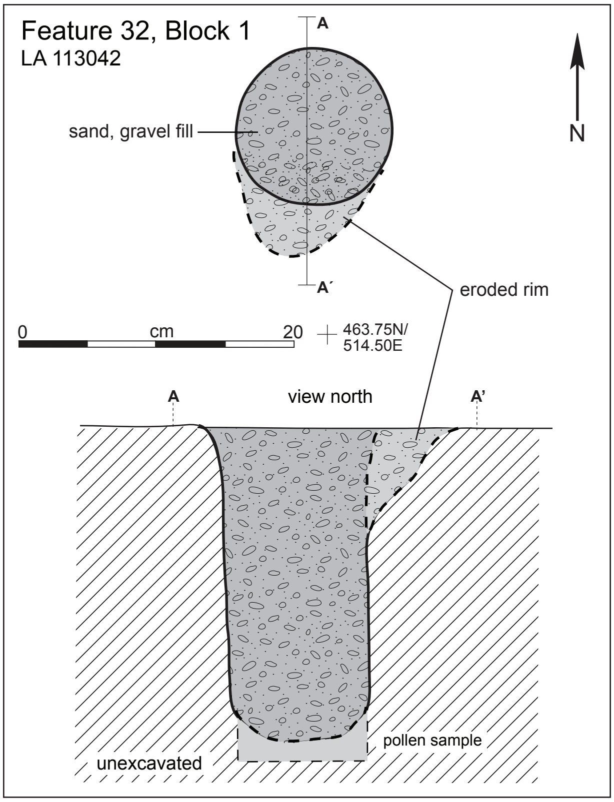
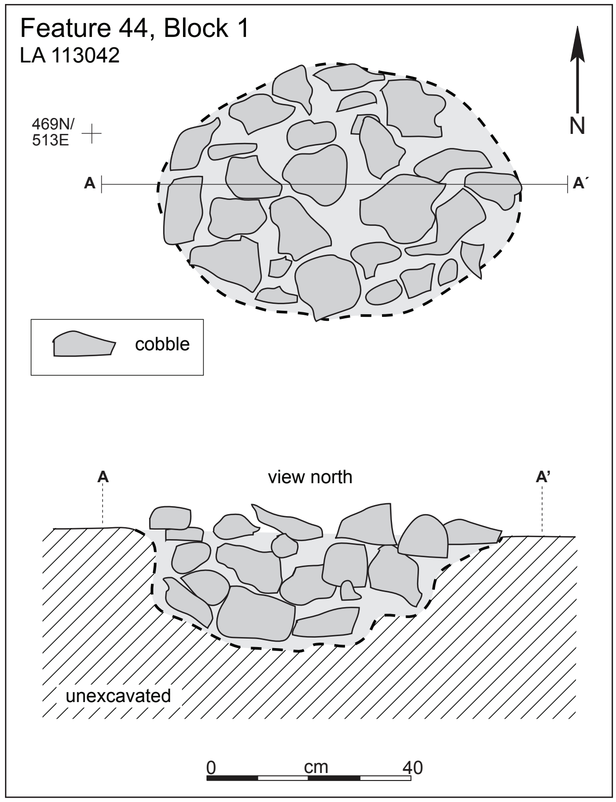


Figure App1.1. LA 113042, Feature 32, Block 1.



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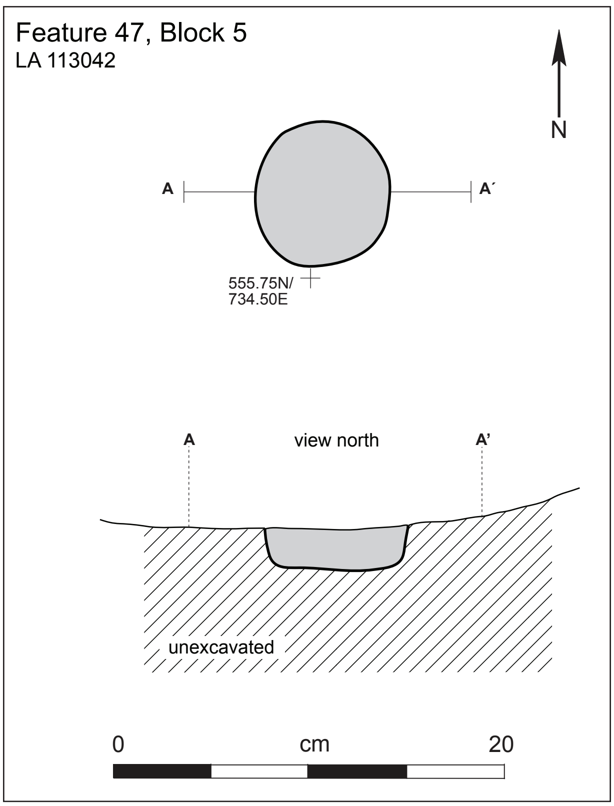

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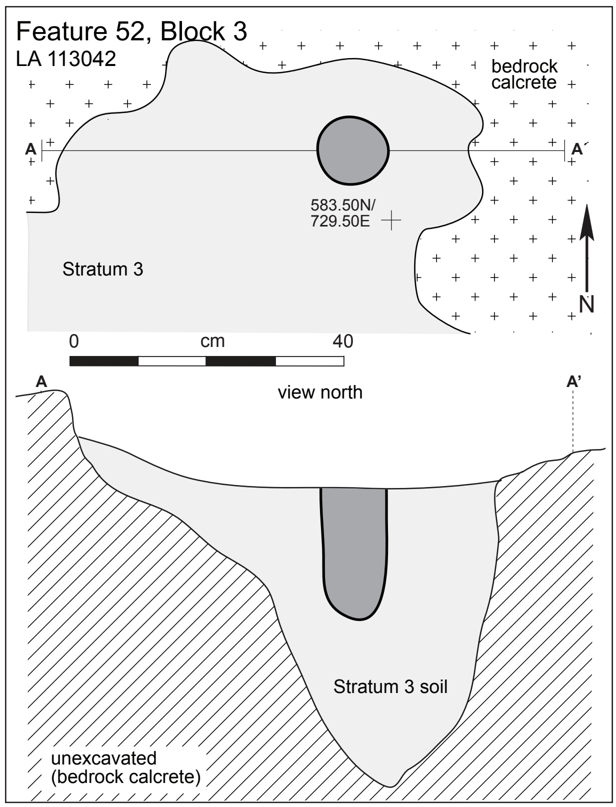

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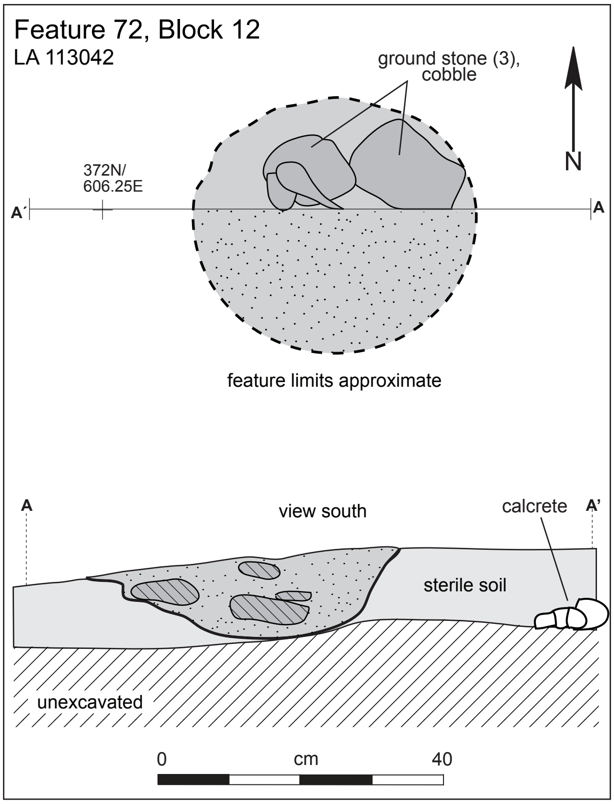

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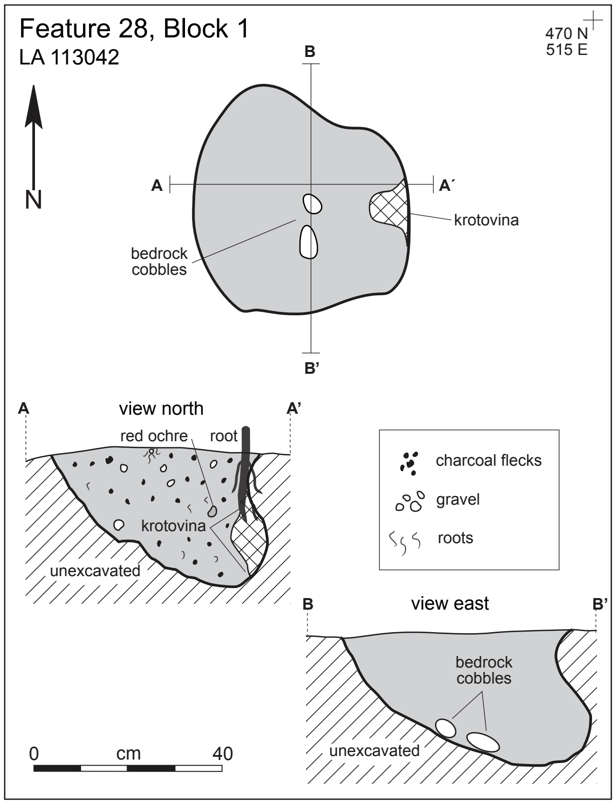

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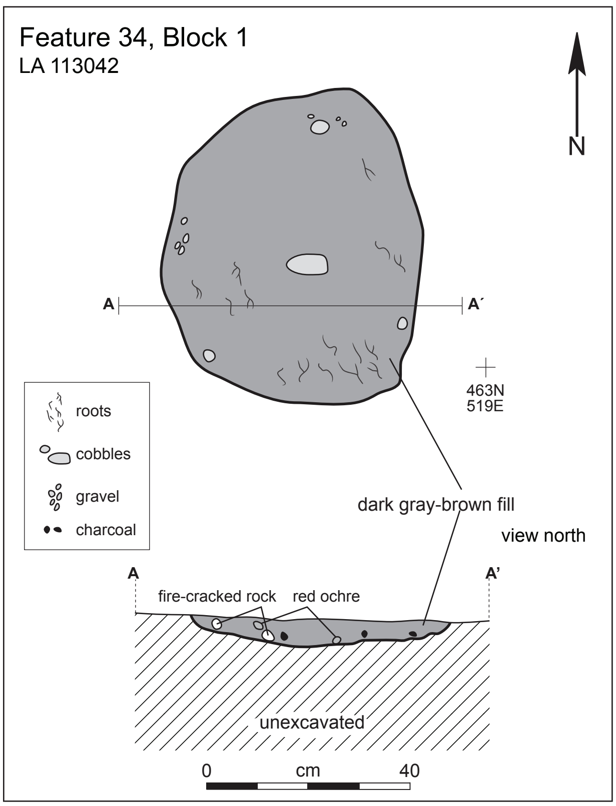

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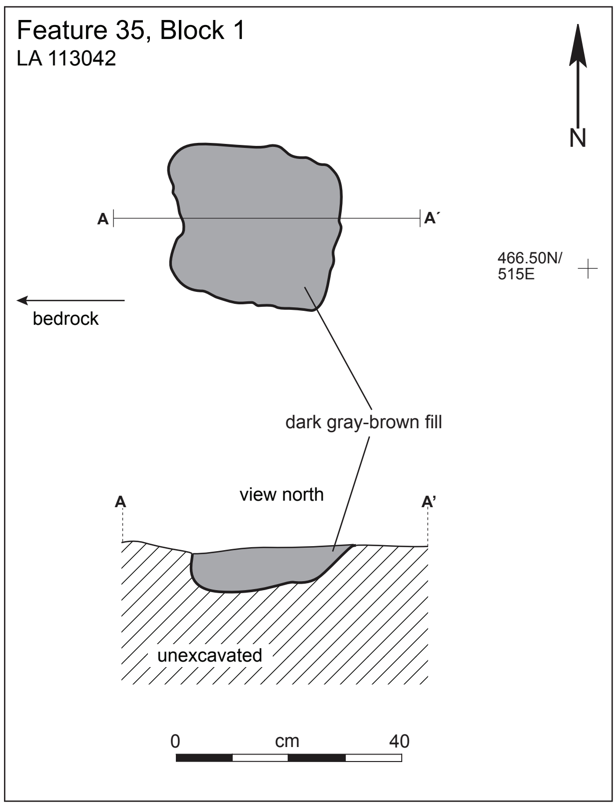

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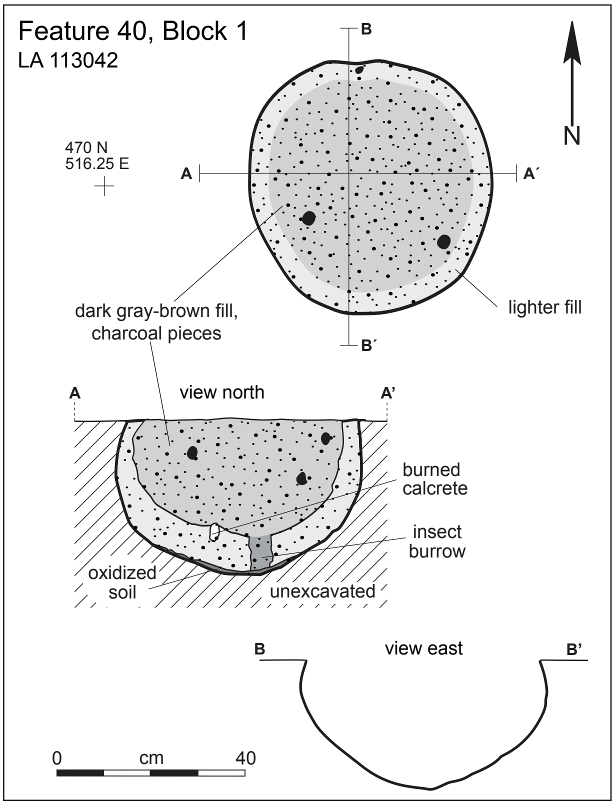

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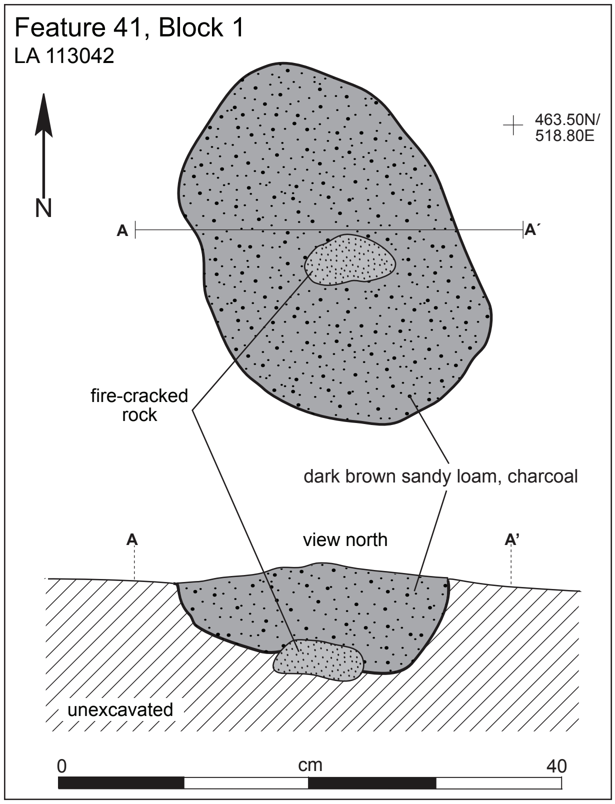

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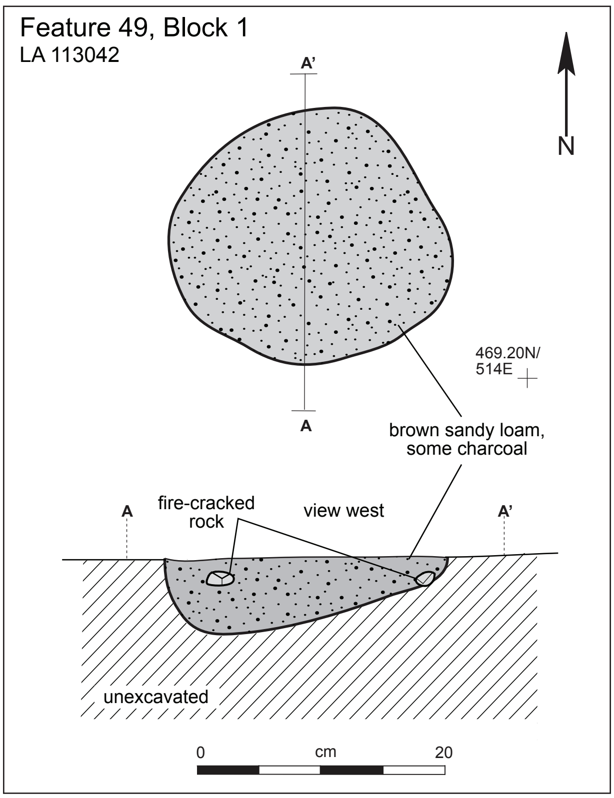

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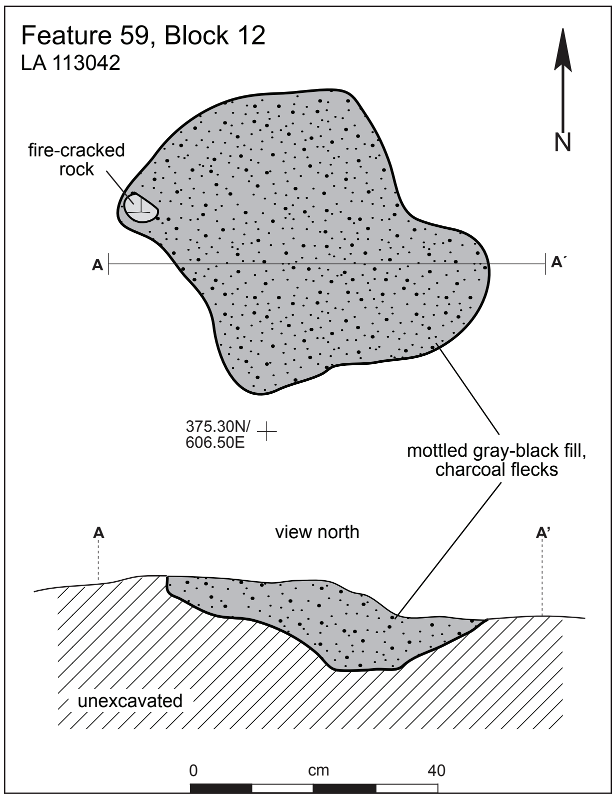

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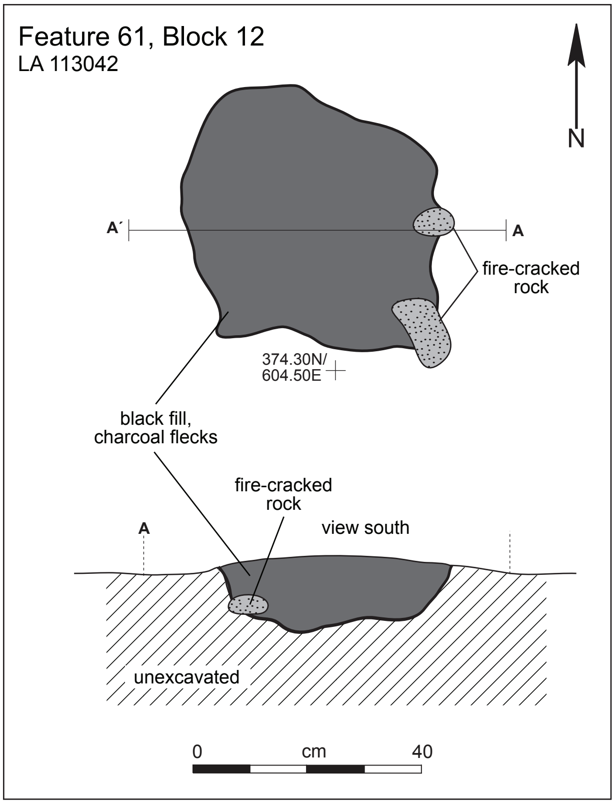

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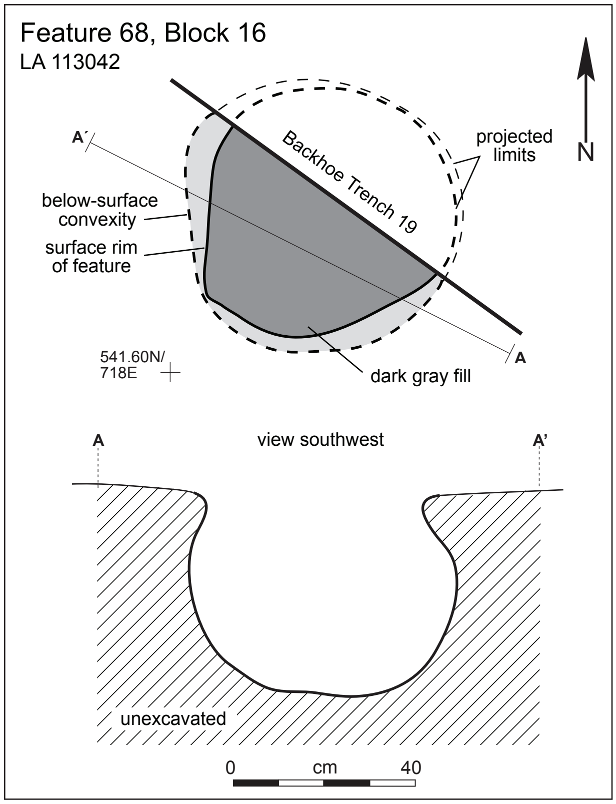

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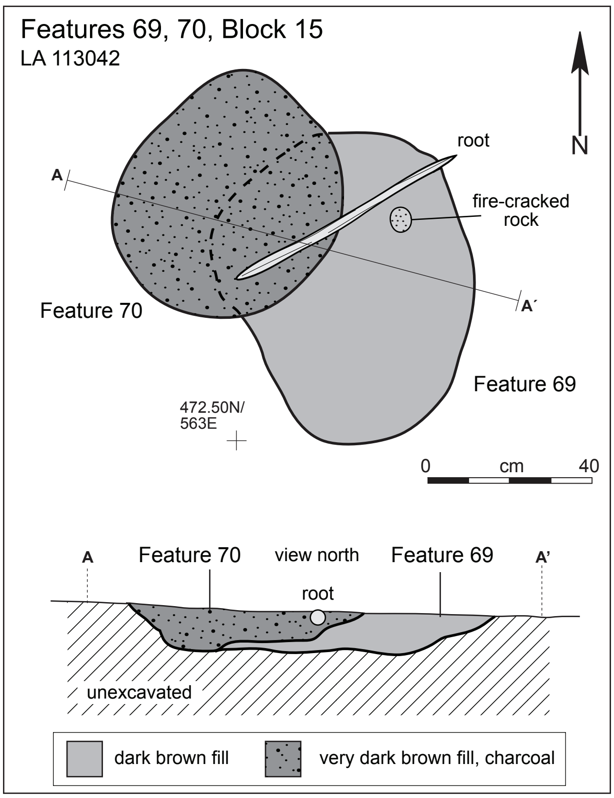

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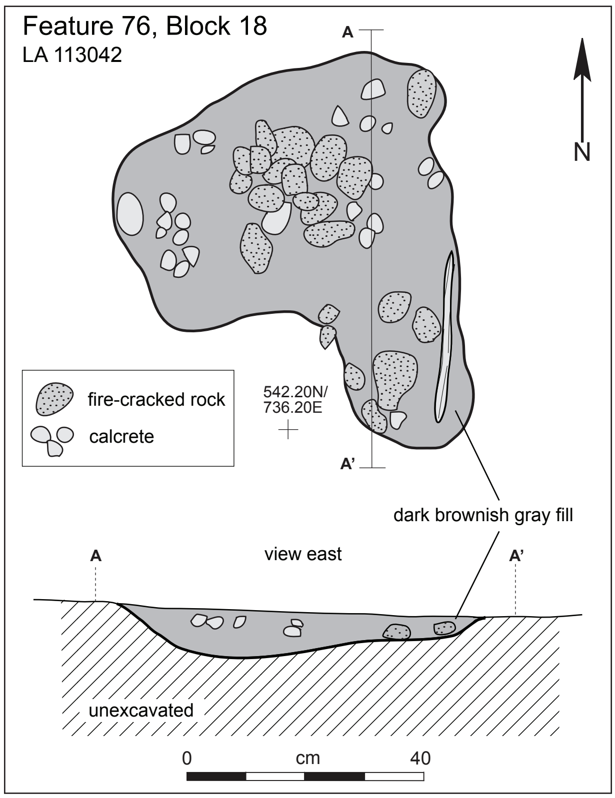


Figure App1.16. LA 113042, Feature 76, Block 18, non-rock.

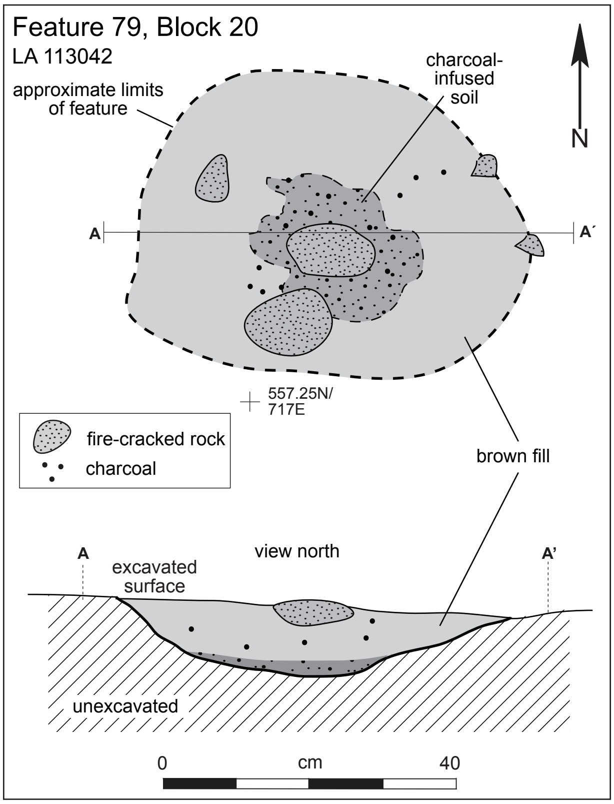


Figure App1.17. LA 113042, Feature 79, Block 20, non-rock.

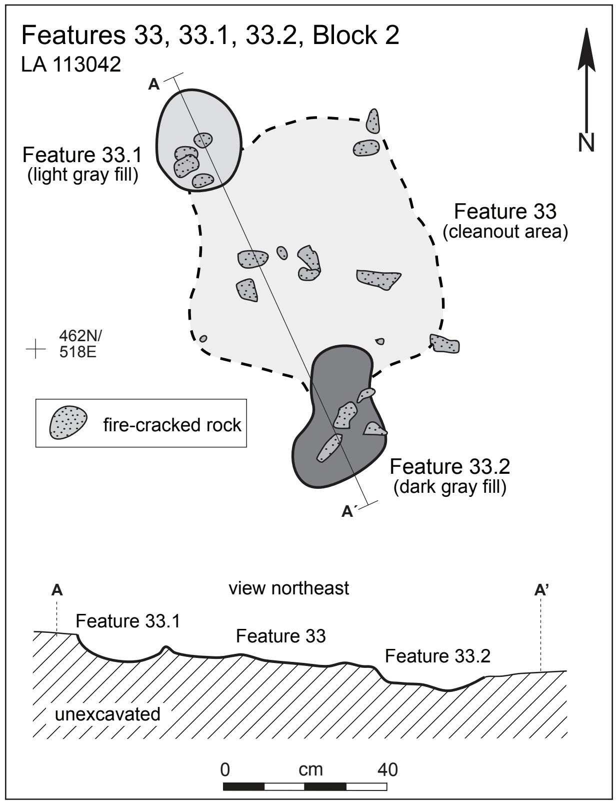


Figure App1.18. LA 113042; Features 33, 33.1, 33.2; Block 2, rock.

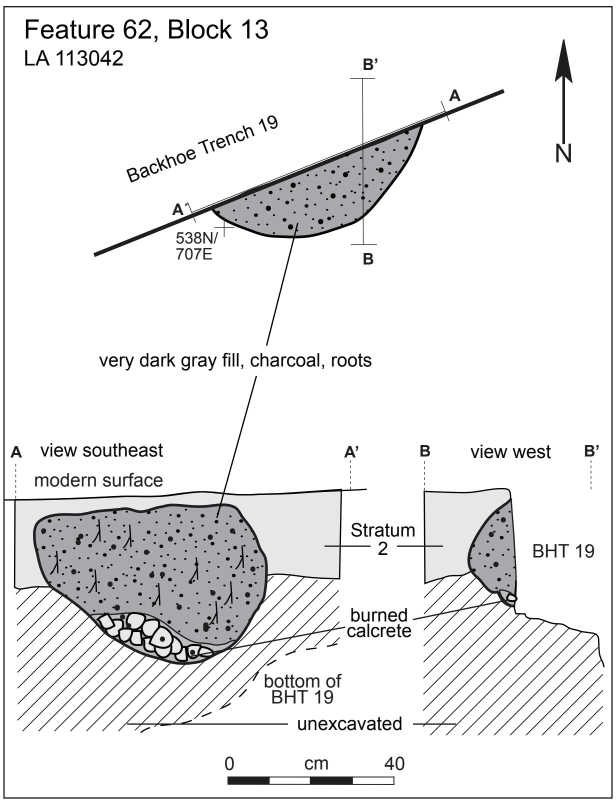


Figure App1.19. LA 113042, Feature 62, Block 13, rock.

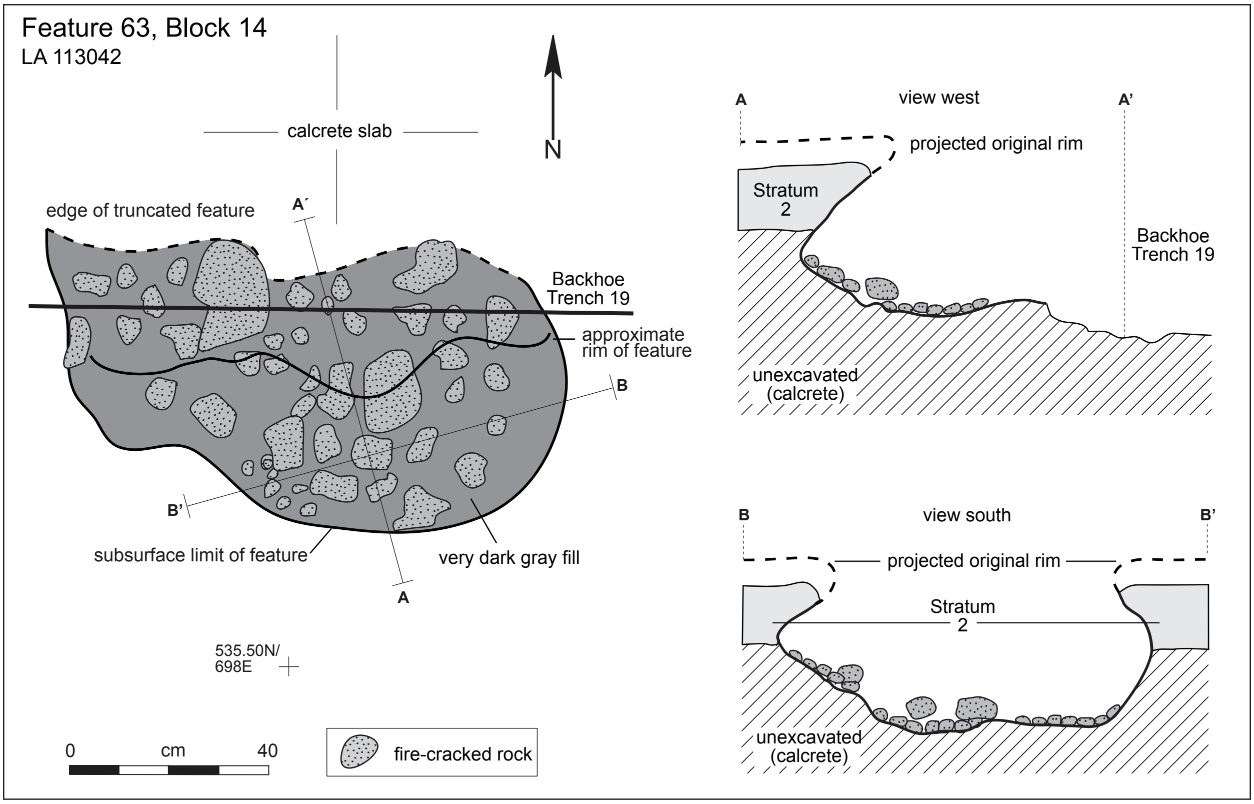


Figure App1.20. LA 113042, Feature 63, Block 14, rock.

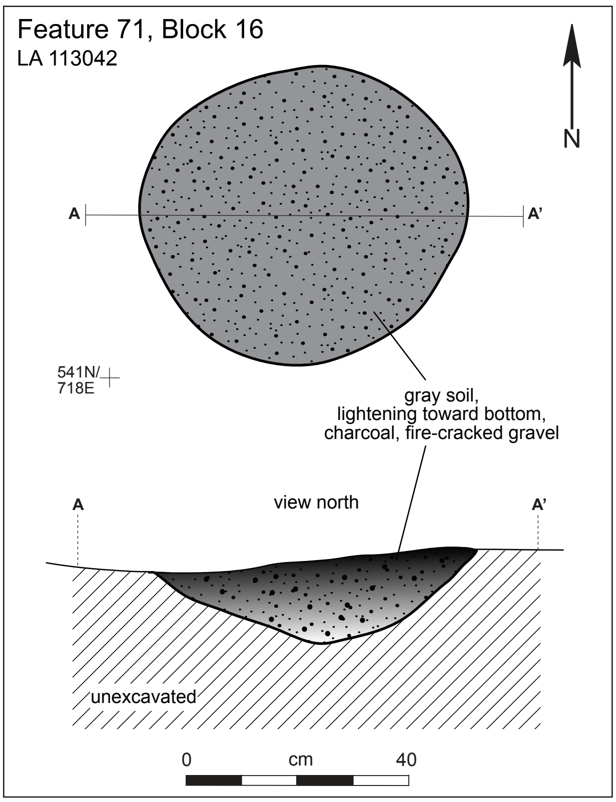


Figure App1.21. LA 113042, Feature 71, Block 16, rock.

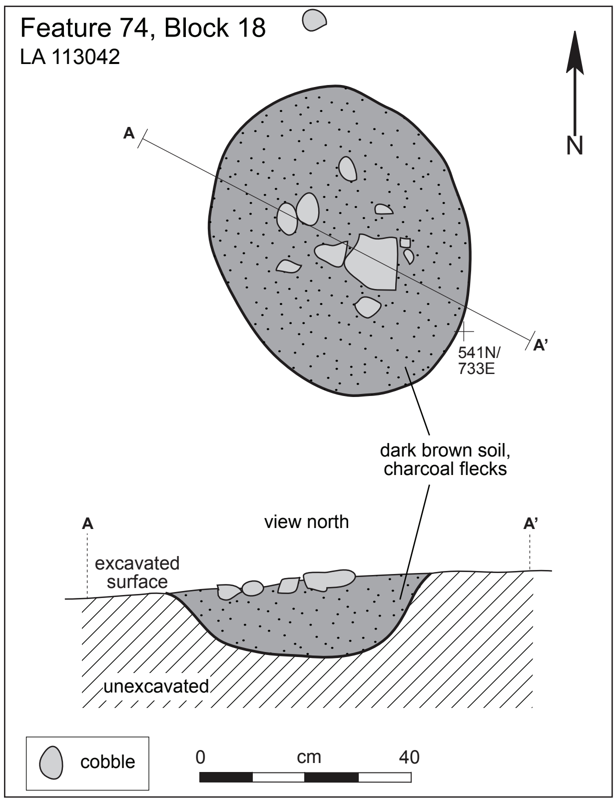


Figure App1.22. LA 113042, Feature 74, Block 18, rock.

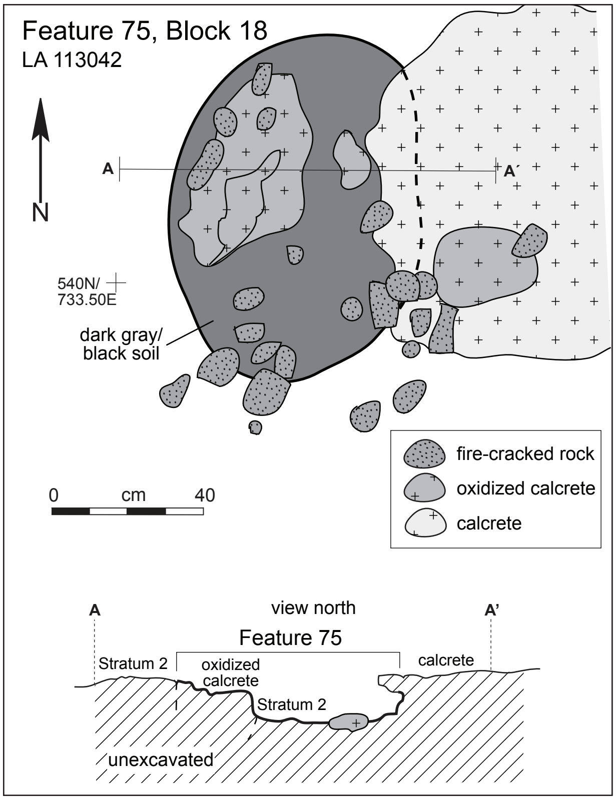


Figure App1.23. LA 113042, Feature 75, Block 18, rock.

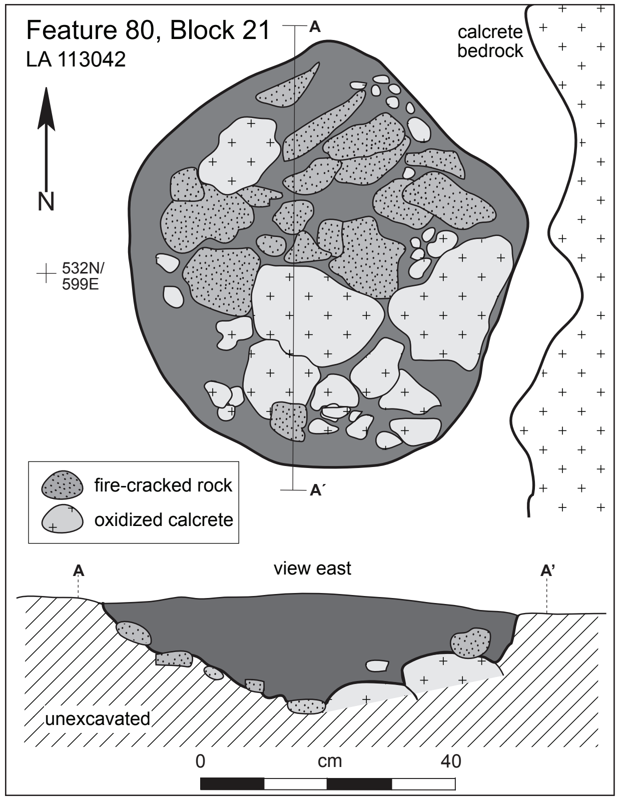


Figure App1.24. LA 113042, Feature 80, Block 21, rock.

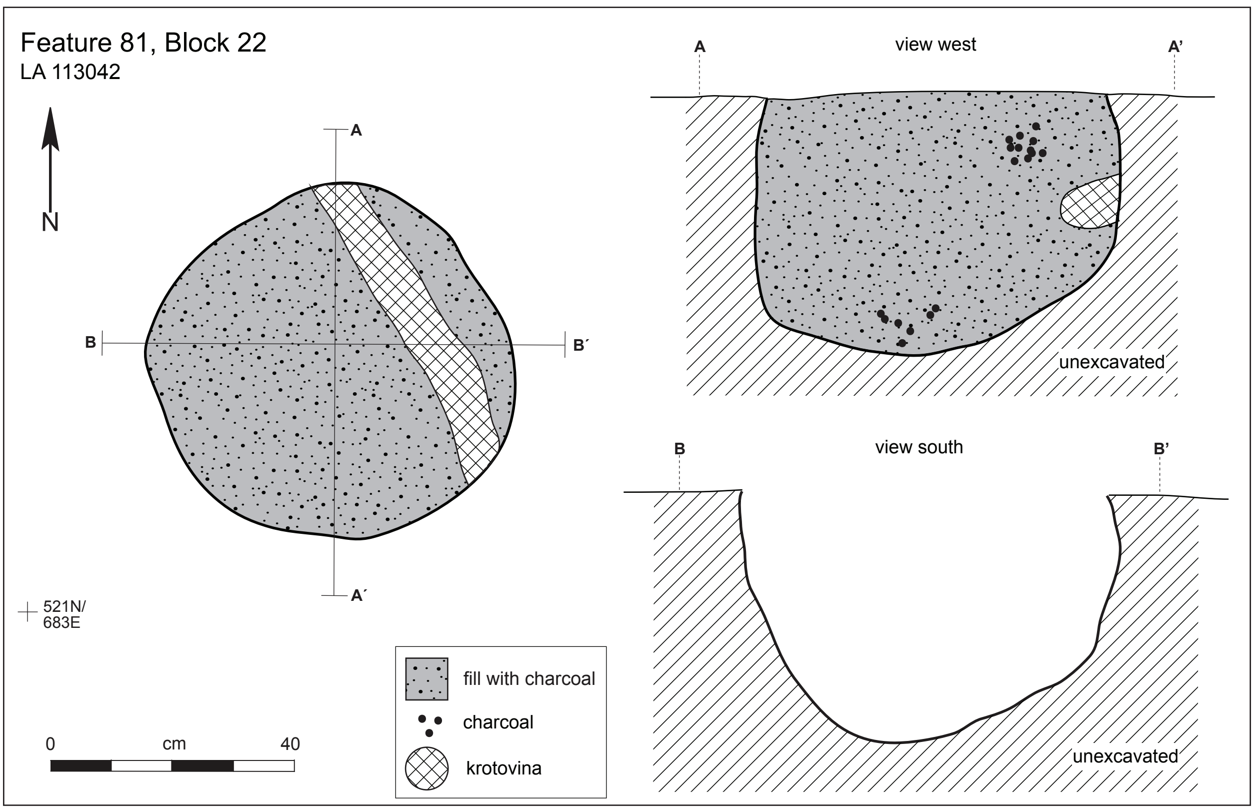


Figure App1.25. LA 113042, Feature 81, Block 22, rock.

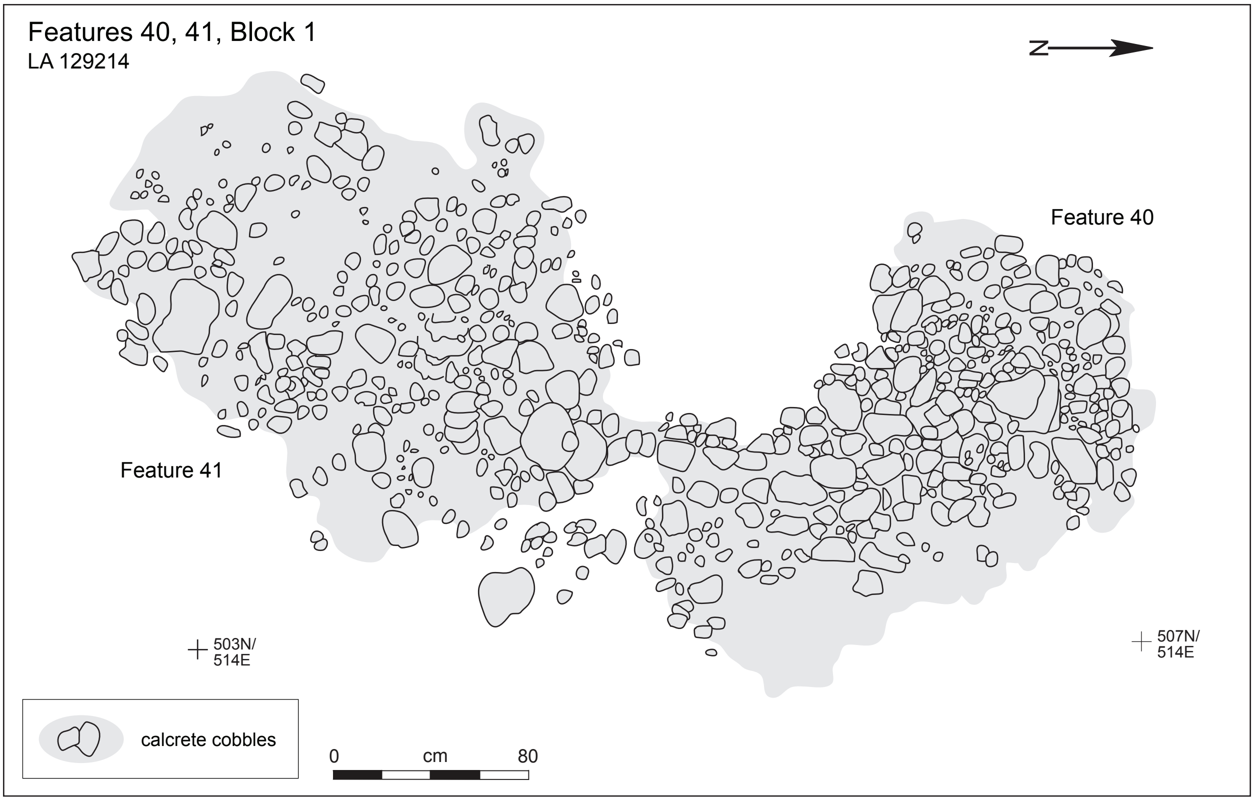


Figure App1.26. LA 129214; Features 40, 41; Block 1.

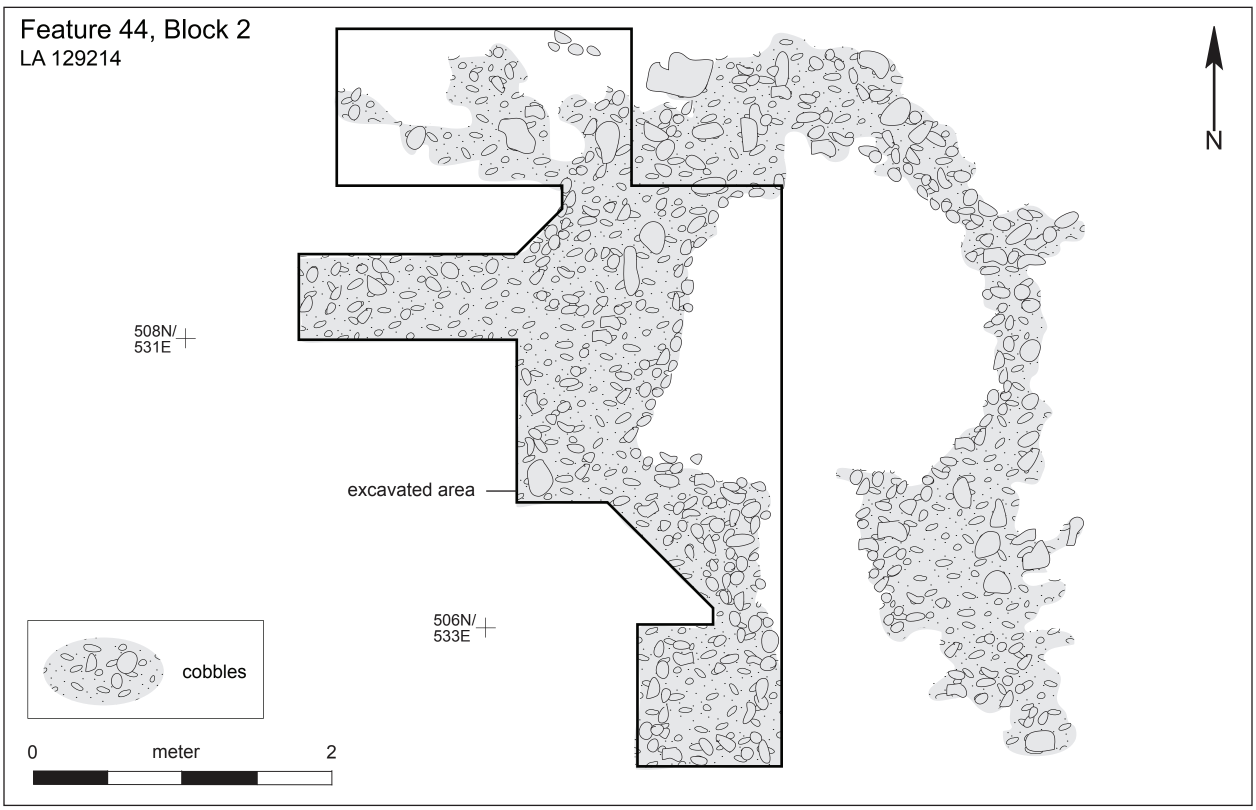


Figure App1.27. LA 129214; Feature 44, Block 2.

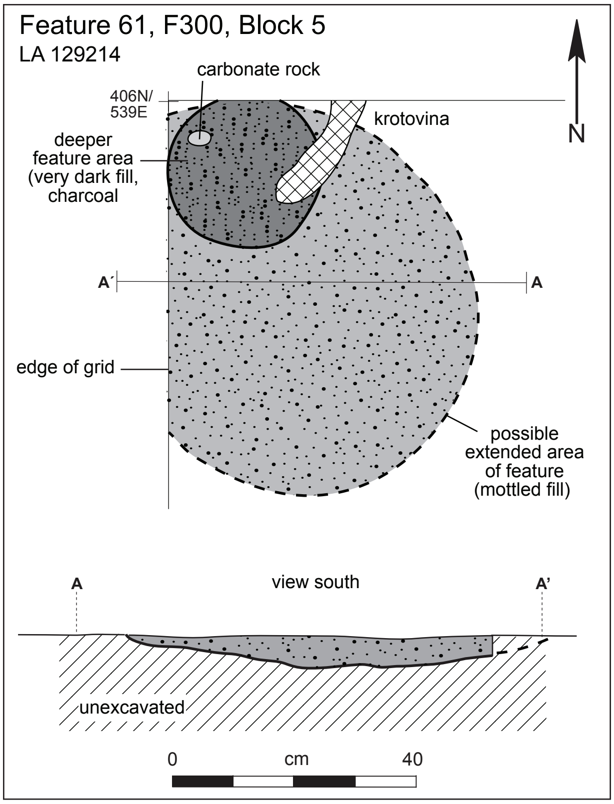


Figure App1.28. LA 129214, Feature 61, F300, Block 5.

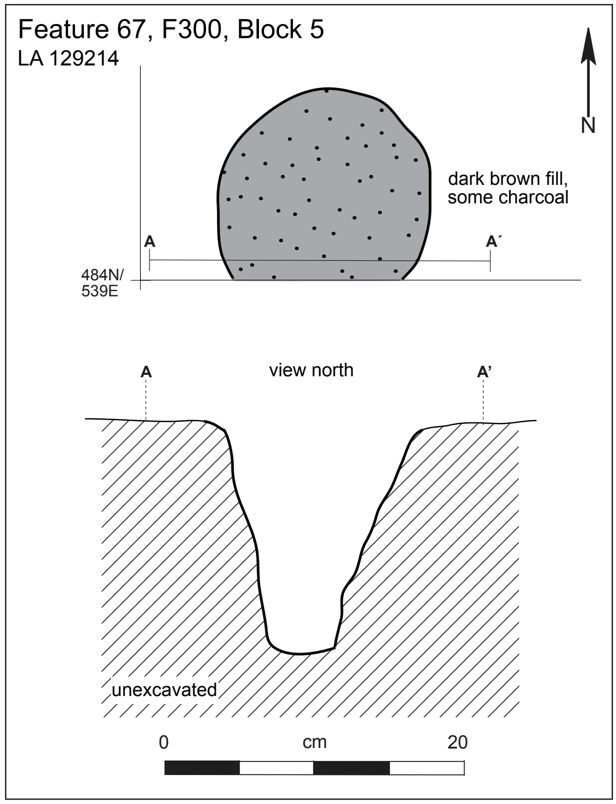


Figure App1.29. LA 129214, Feature 67, F300, Block 5.

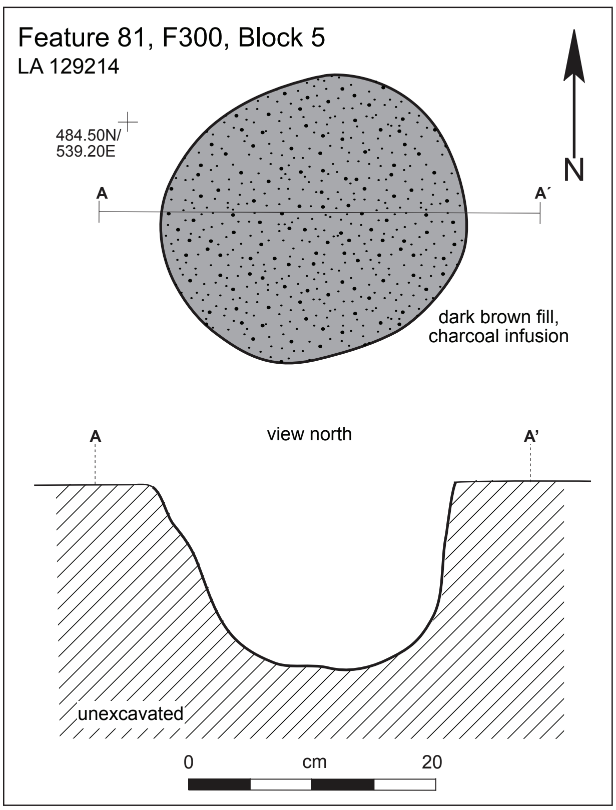


Figure App1.30. LA 129214, Feature 81, F300, Block 5.

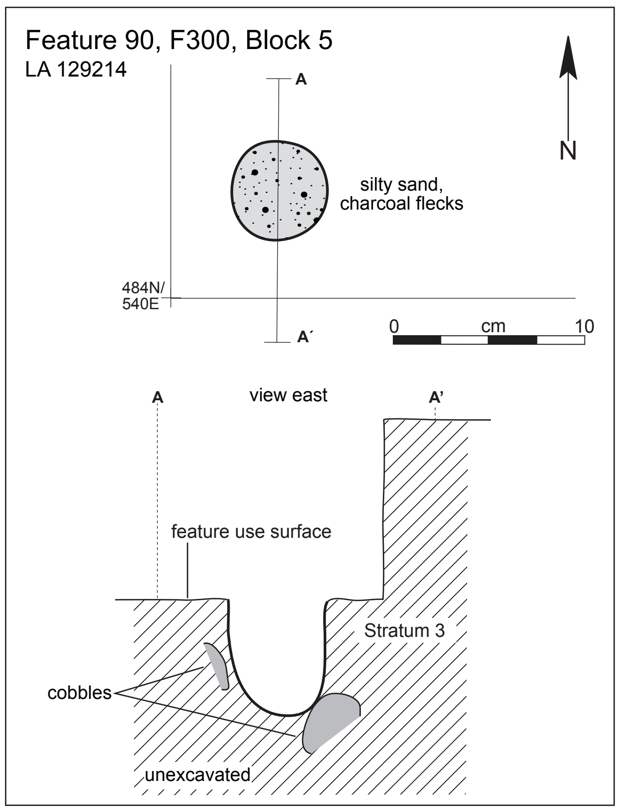


Figure App1.31. LA 129214, Feature 90, F300, Block 5.

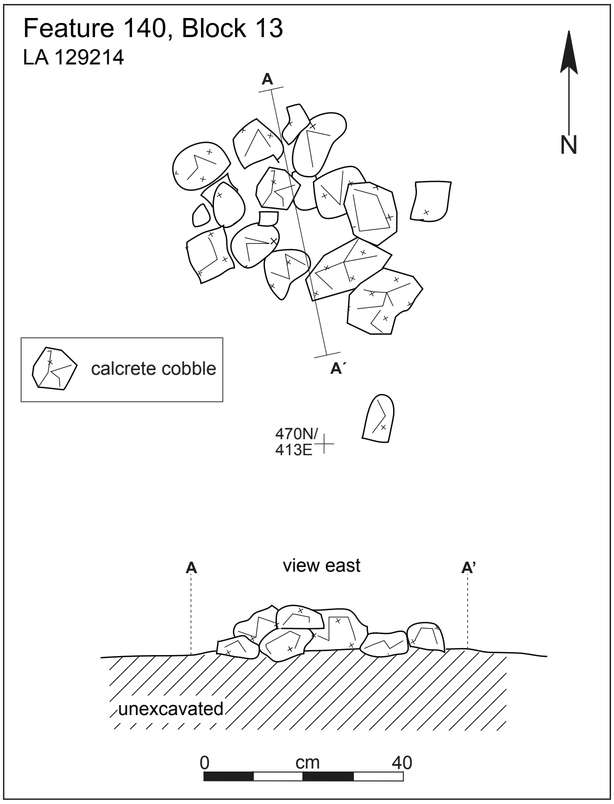


Figure App1.32. LA 129214,Feature 140, Block 13.

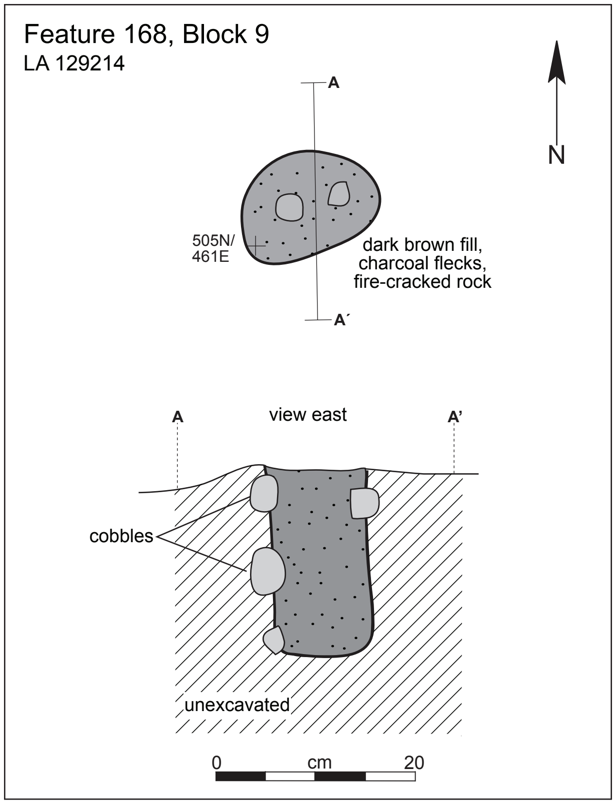


Figure App1.33. LA 129214, Feature 168, Block 9.

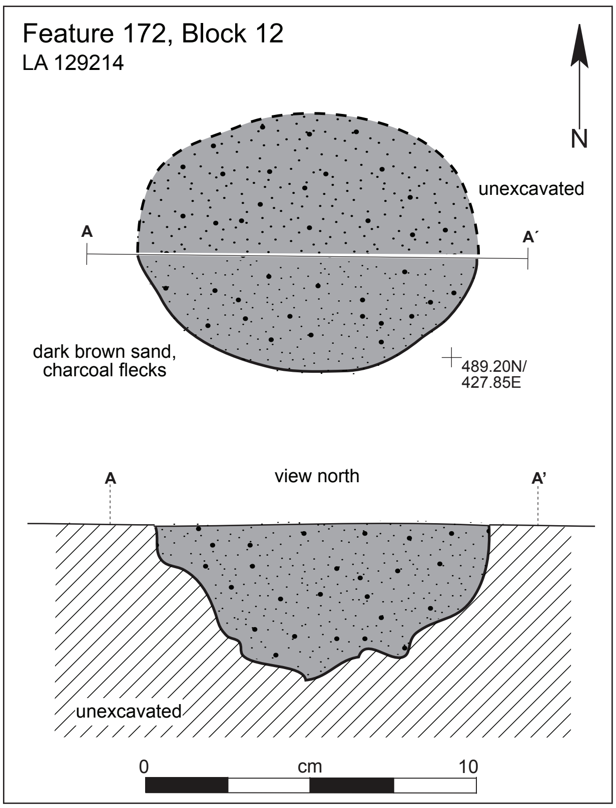


Figure App1.34. LA 129214, Feature 172, Block 12.

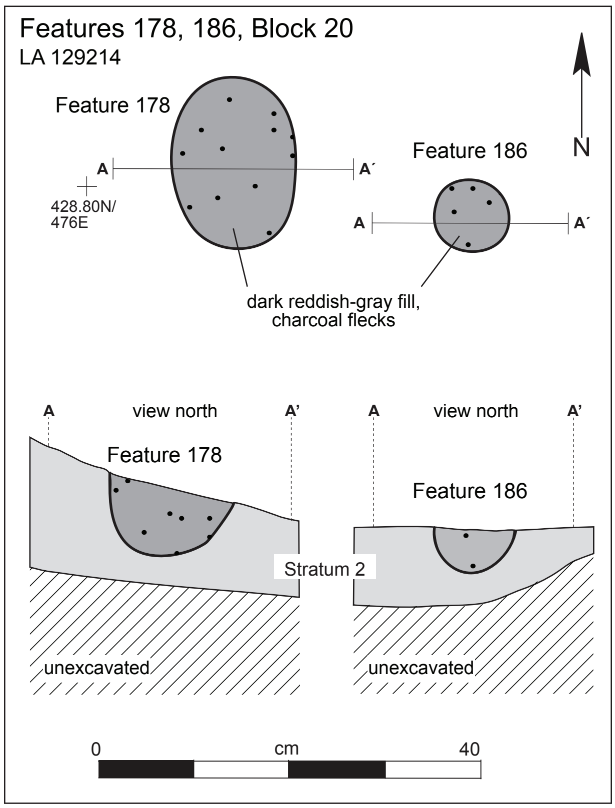


Figure App1.35. LA 129214; Features 178, 186; Block 20.

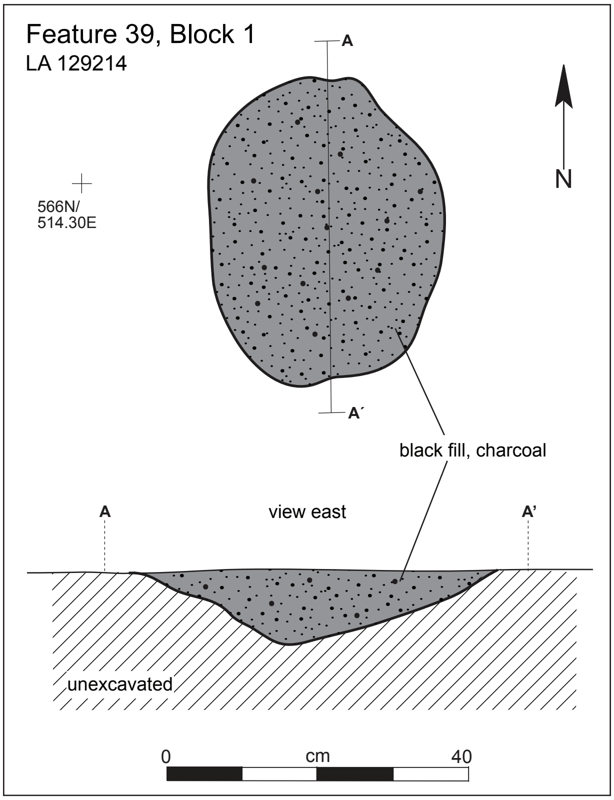


Figure App1.36. LA 129214, Feature 39, Block 1, non-rock.

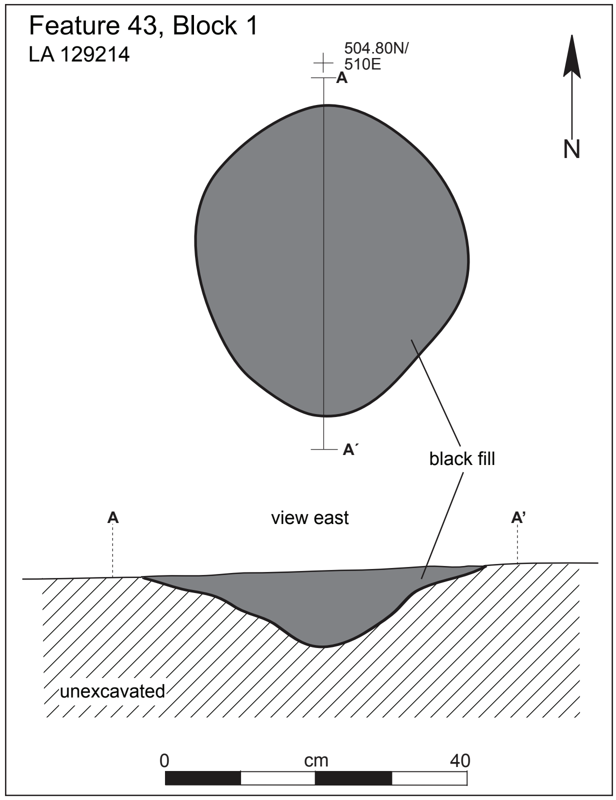


Figure App1.37. LA 129214, Feature 43, Block 1, non-rock.

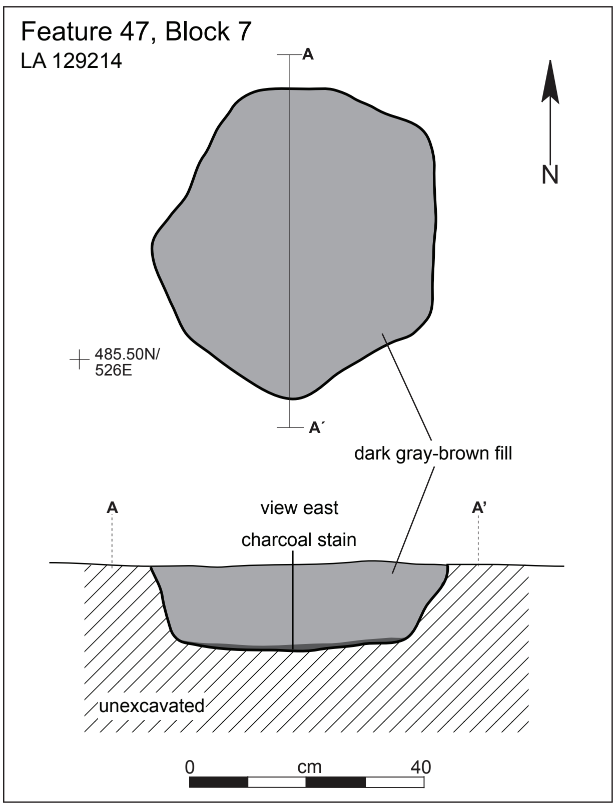


Figure App1.38. LA 129214, Feature 47, Block 7, non-rock.

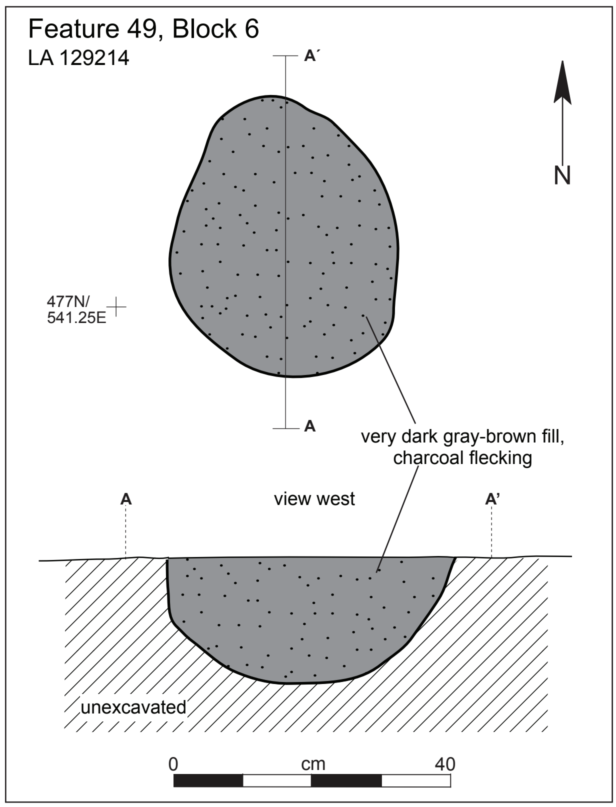


Figure App1.39. LA 129214, Feature 49, Block 6, non-rock.

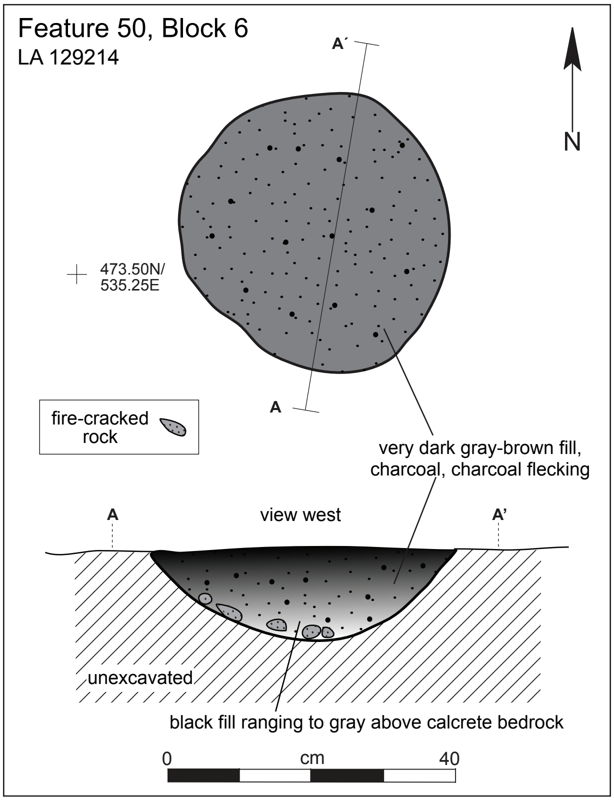


Figure App1.40. LA 129214, Feature 50, Block 6, non-rock.

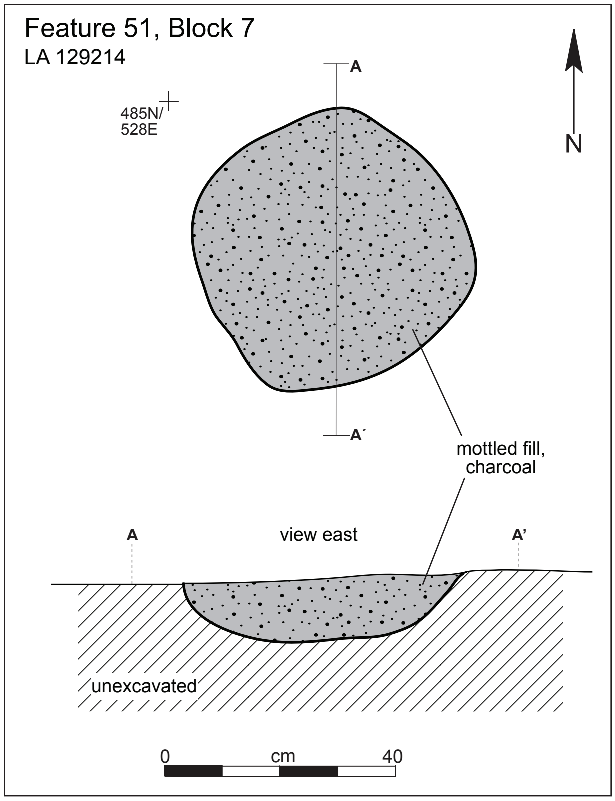


Figure App1.41. LA 129214, Feature 51, Block 7, non-rock.

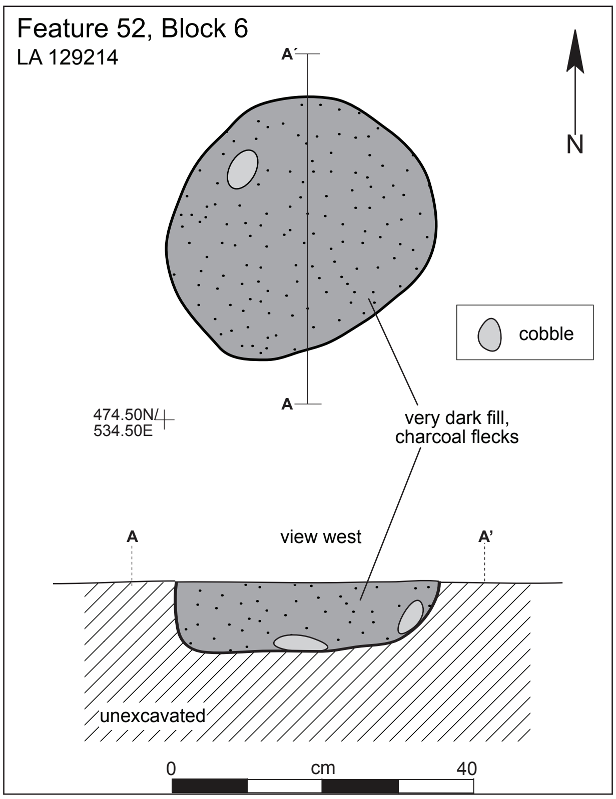


Figure App1.42. LA 129214, Feature 52, Block 6, non-rock.

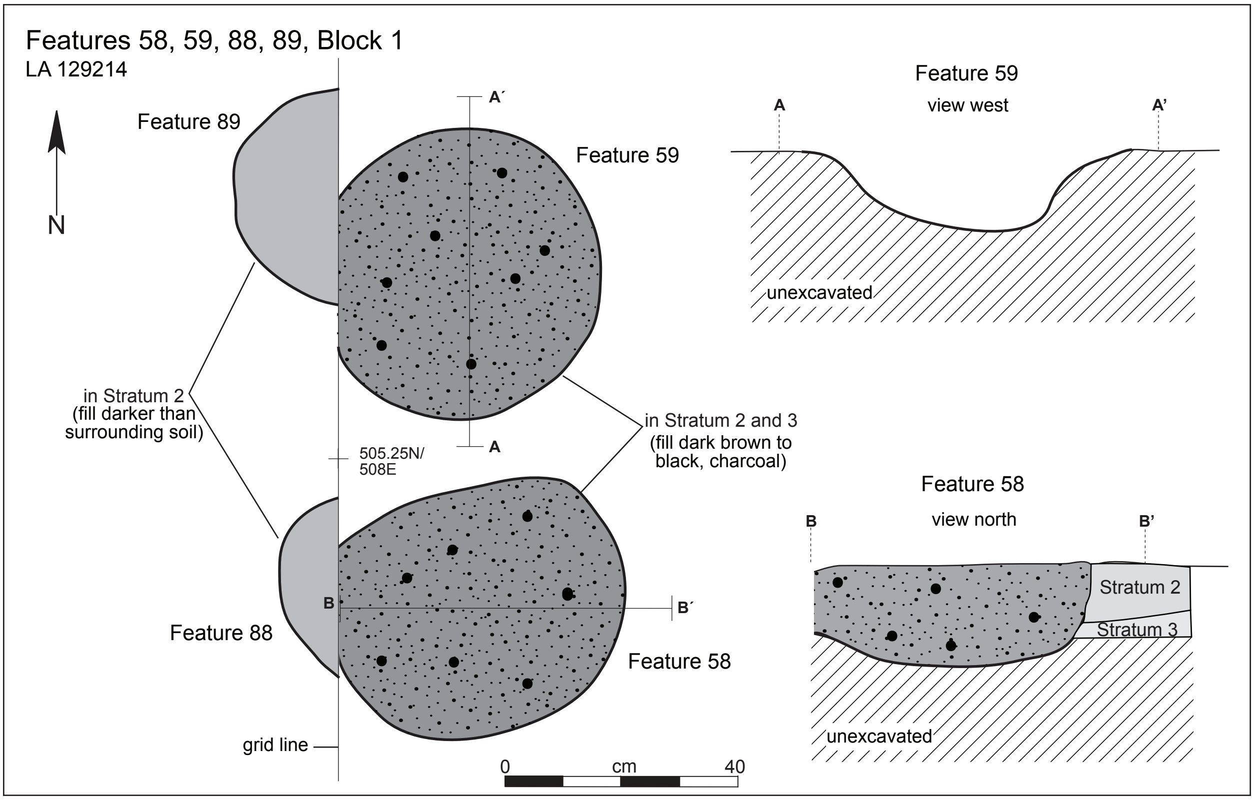


Figure App1.43. LA 129214; Features 58, 59, 88, and 89; Block 1; non-rock.

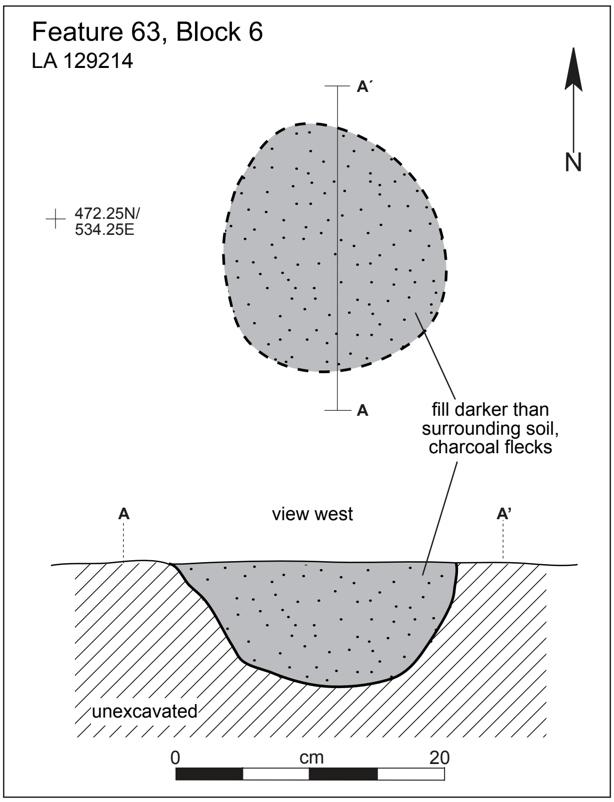


Figure App1.44. LA 129214, Feature 63, Block 6, non-rock.

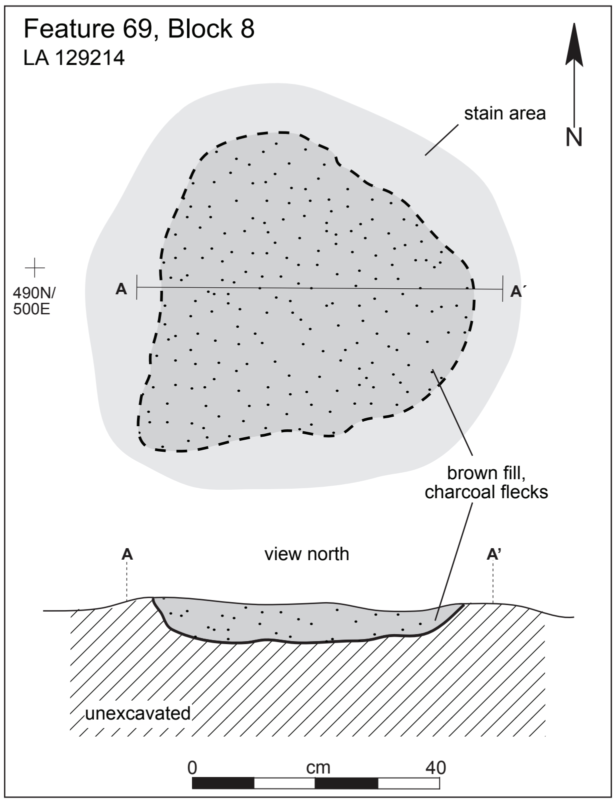


Figure App1.45. LA 129214, Feature 69, Block 8, non-rock.

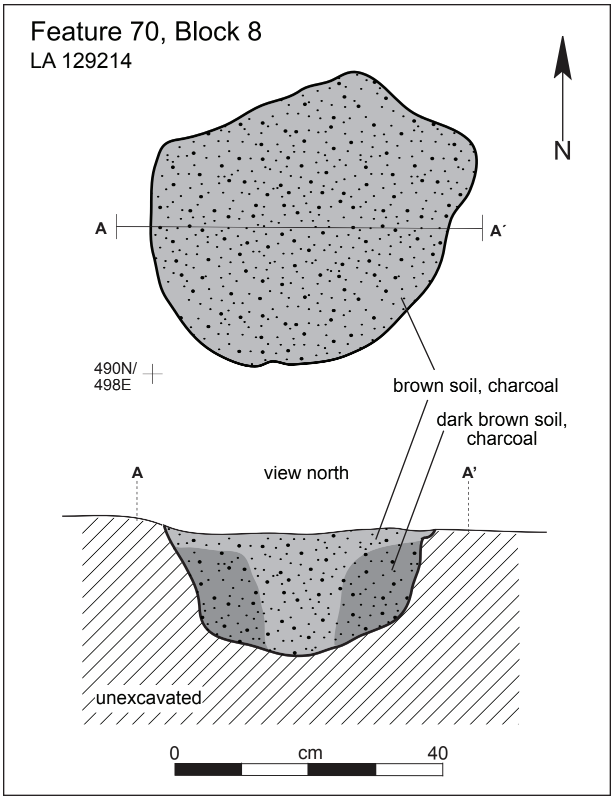


Figure App1.46. LA 129214, Feature 70, Block 8, non-rock.

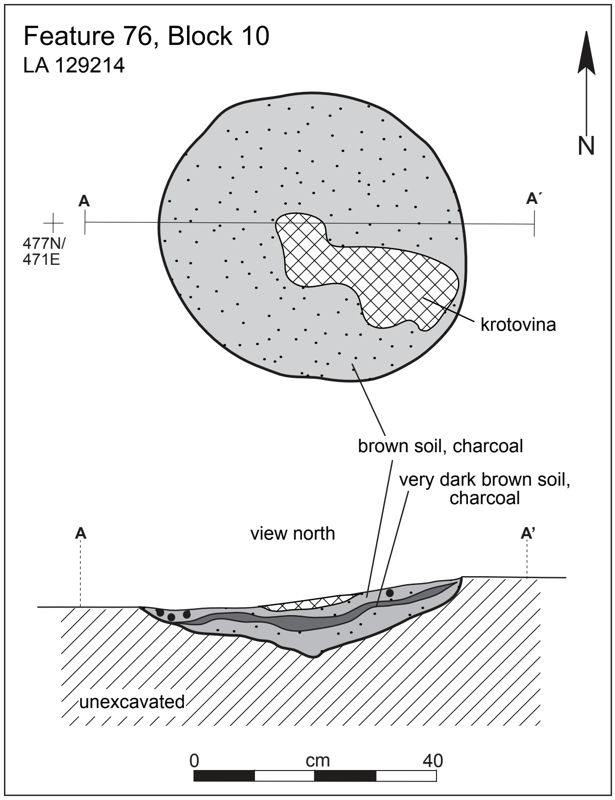


Figure App1.47. LA 129214, Feature 76, Block 10, non-rock.

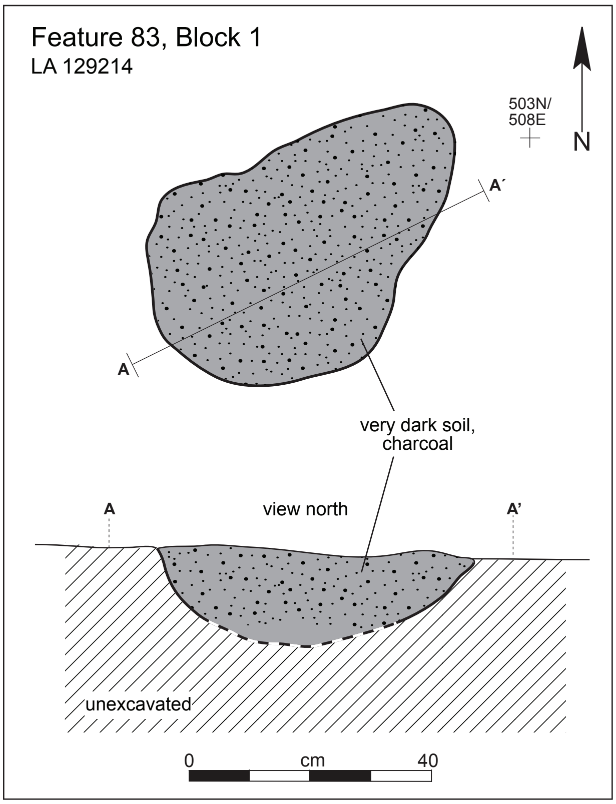


Figure App1.48. LA 129214, Feature 83, Block 1, non-rock.

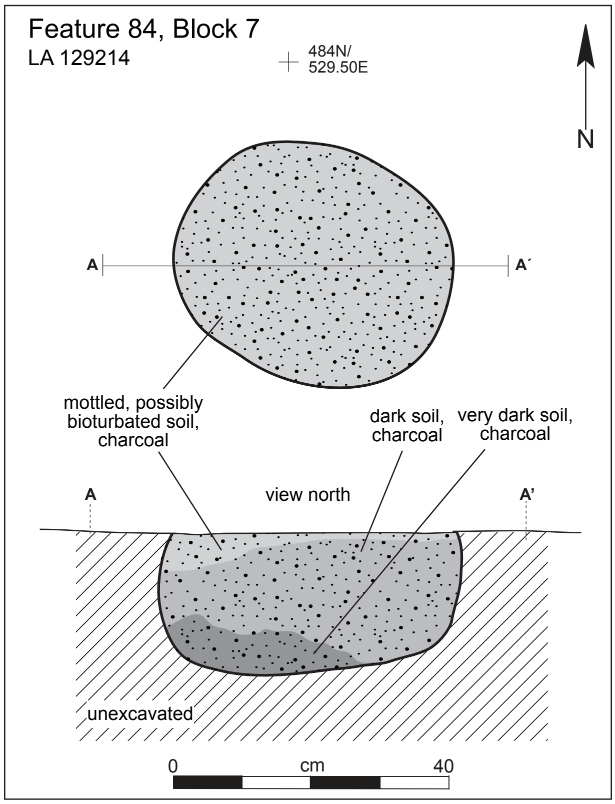


Figure App1.49. LA 129214, Feature 84, Block 7, non-rock.

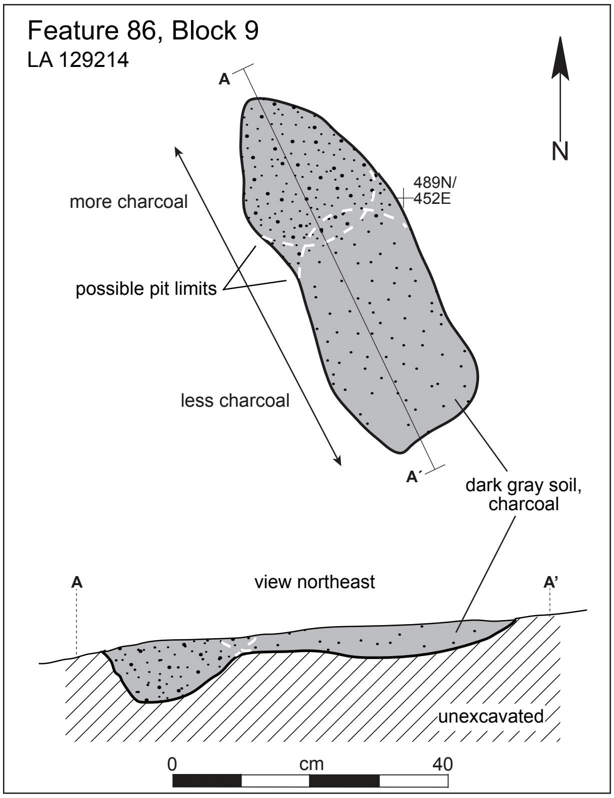


Figure App1.50. LA 129214, Feature 86, Block 9, non-rock.

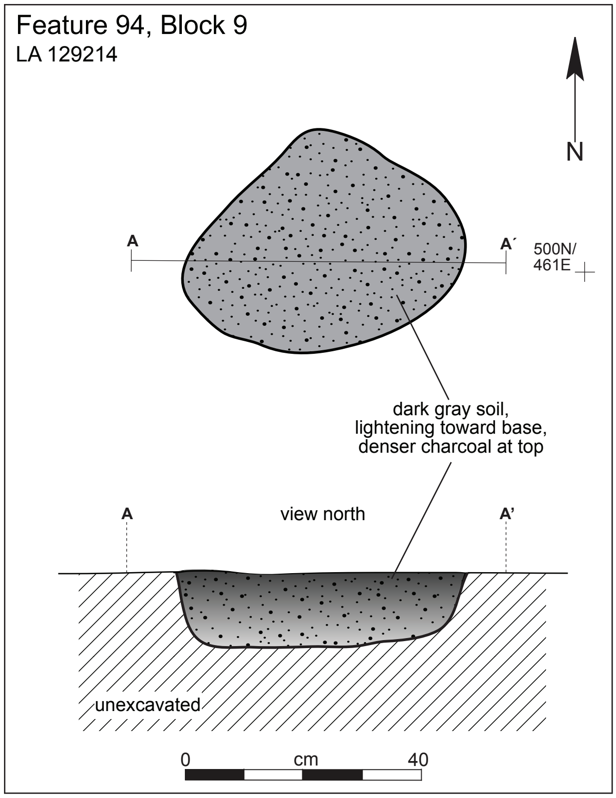


Figure App1.51. LA 129214 ,Feature 94, Block 9, non-rock.

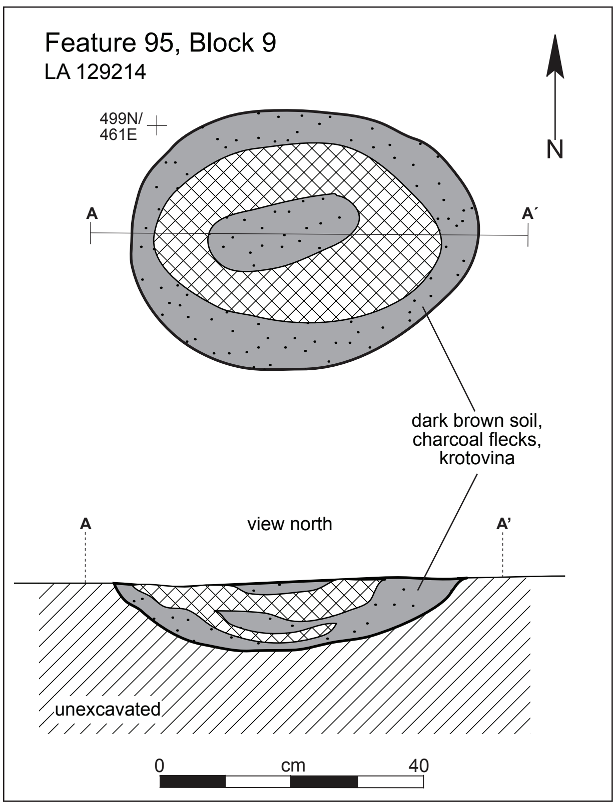


Figure App1.52. LA 129214, Feature 95, Block 9, non-rock.

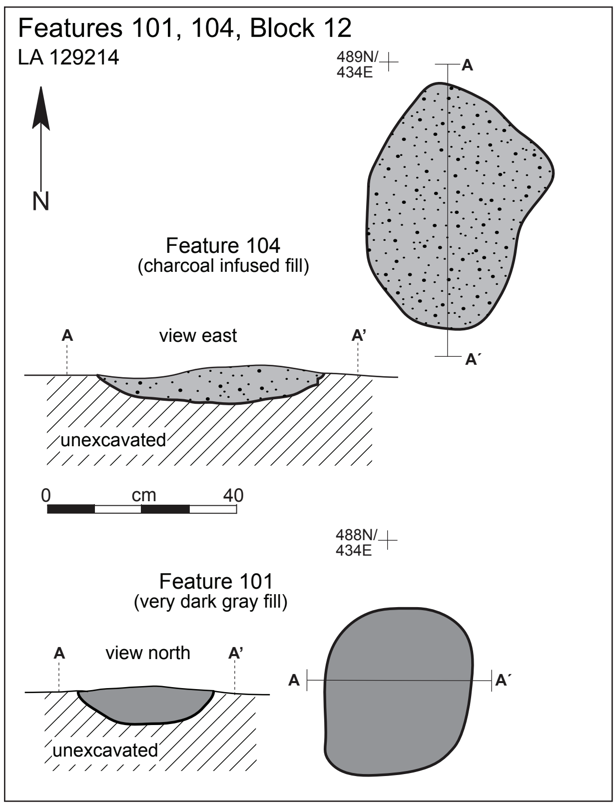


Figure App1.53. LA 129214; Features 101, 104; Block 12; non-rock.

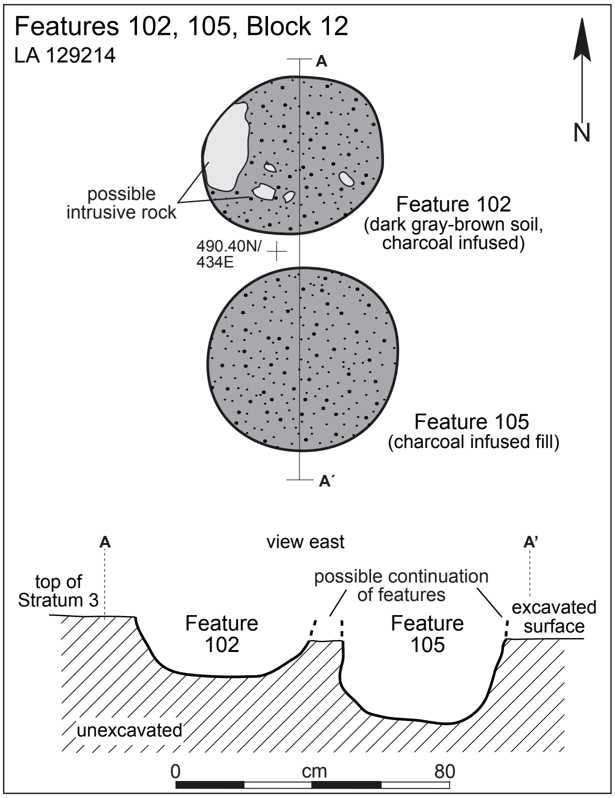


Figure App1.54. LA 129214; Features 102, 105; Block 12; non-rock.

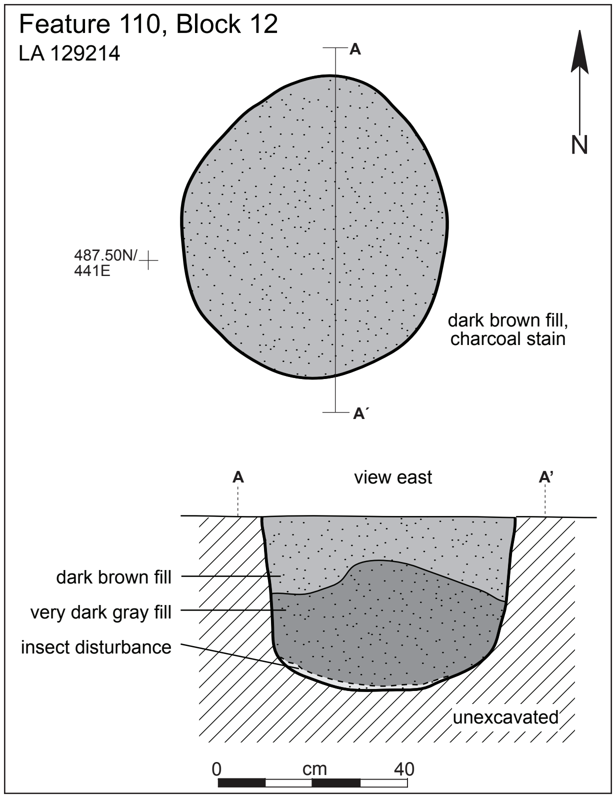


Figure App1.55. LA 129214, Feature 110, Block 12, non-rock.

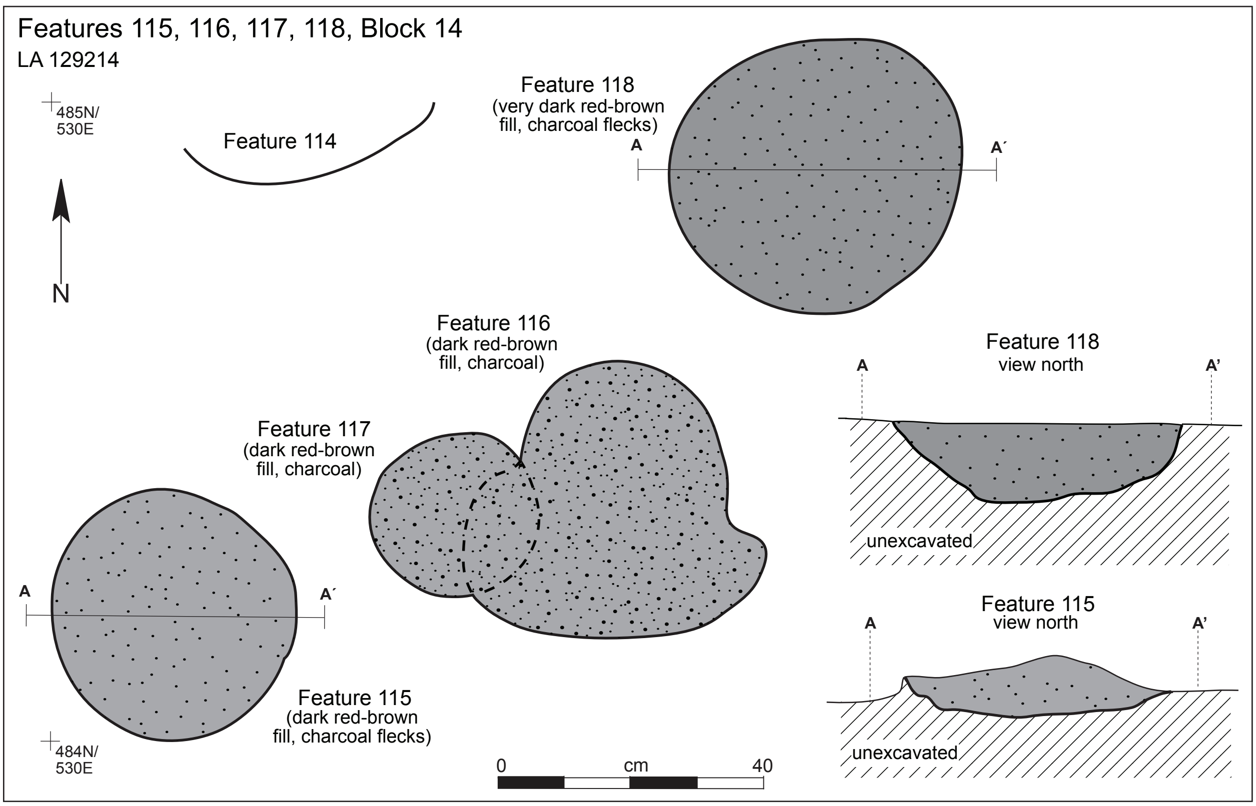


Figure App1.56. LA 129214; Features 115, 116, 117, and 118; Block 14; non-rock.

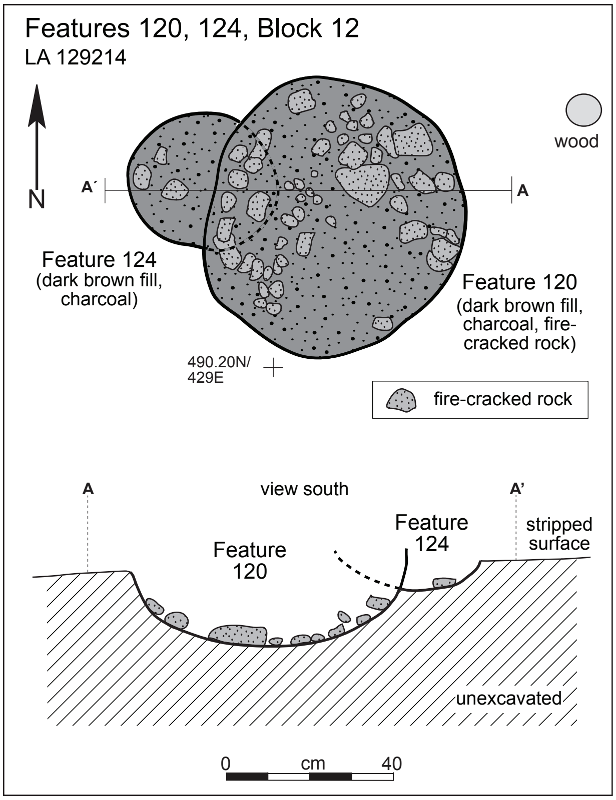


Figure App1.57. LA 129214; Features 120, 124; Block 12; non-rock.

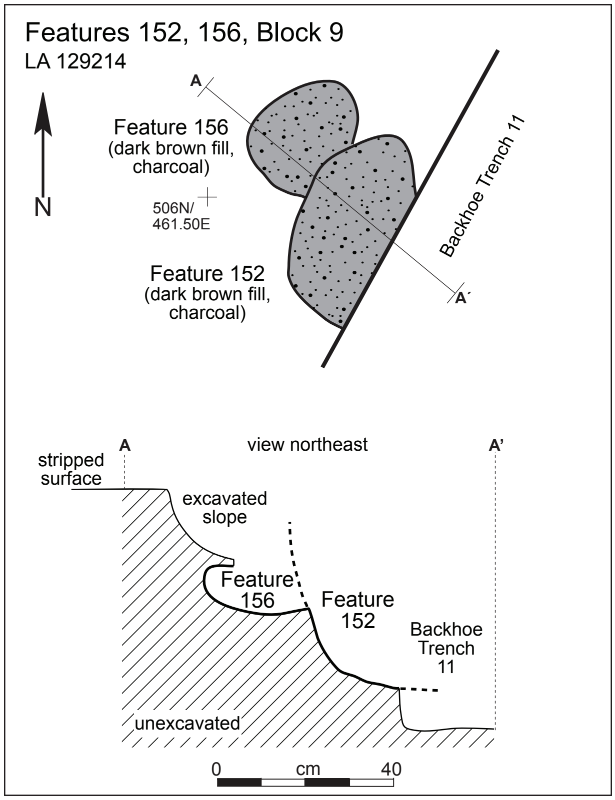


Figure App1.58. LA 129214; Features 152, 156; Block 9; non-rock.

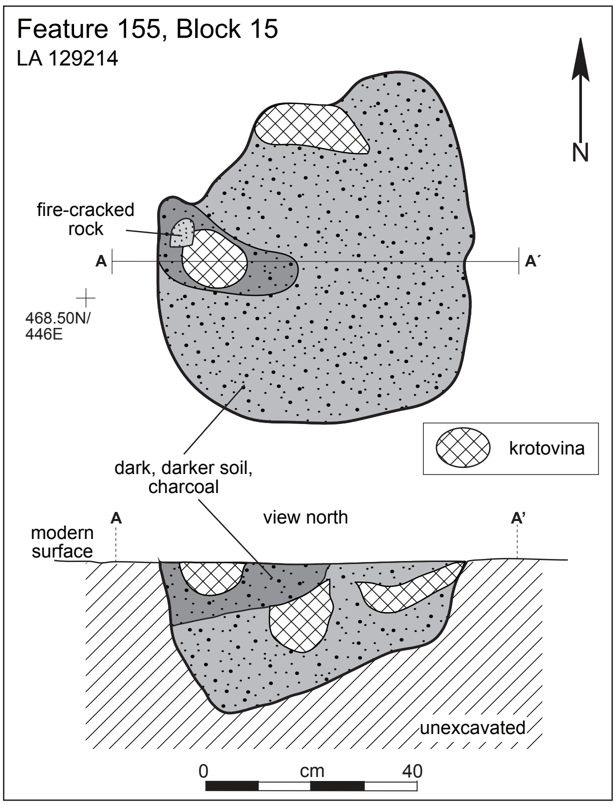


Figure App1.59. LA 129214, Feature 155, Block 15, non-rock.

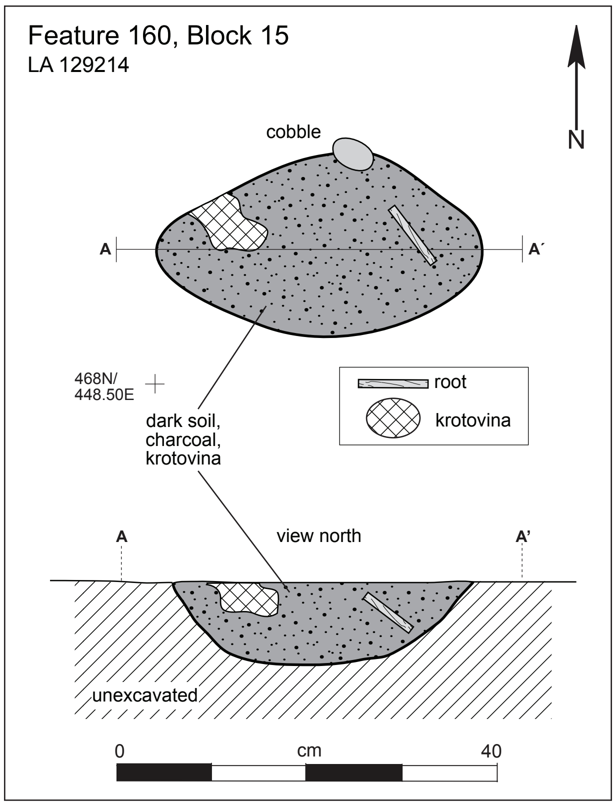


Figure App1.60. LA 129214, Feature 160, Block 15, non-rock.

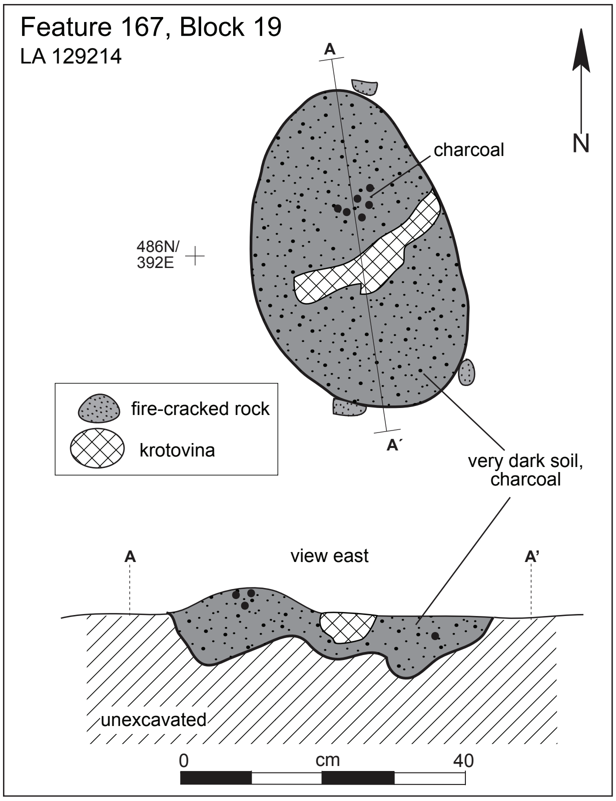


Figure App1.61. LA 129214, Feature 167, Block 19, non-rock.

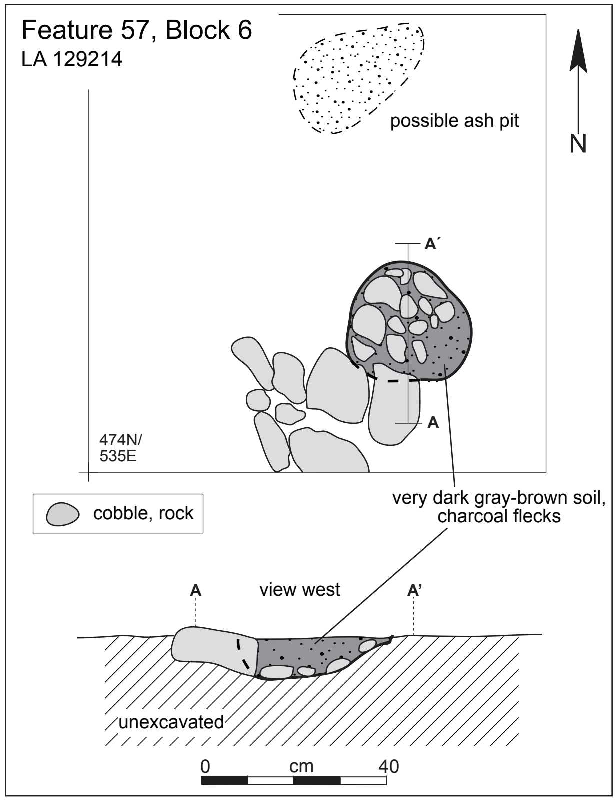


Figure App1.62. LA 129214, Feature 57, Block 6, rock.

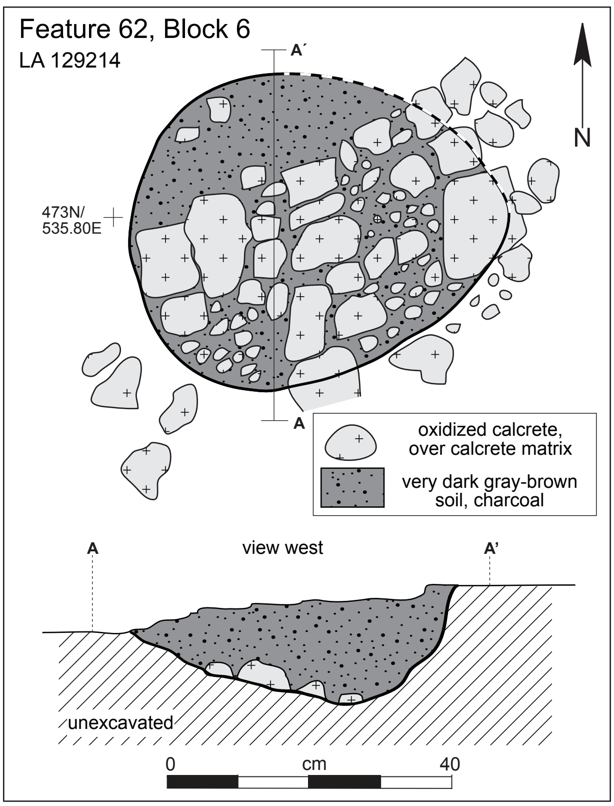


Figure App1.63. LA 129214, Feature 62, Block 6, rock.

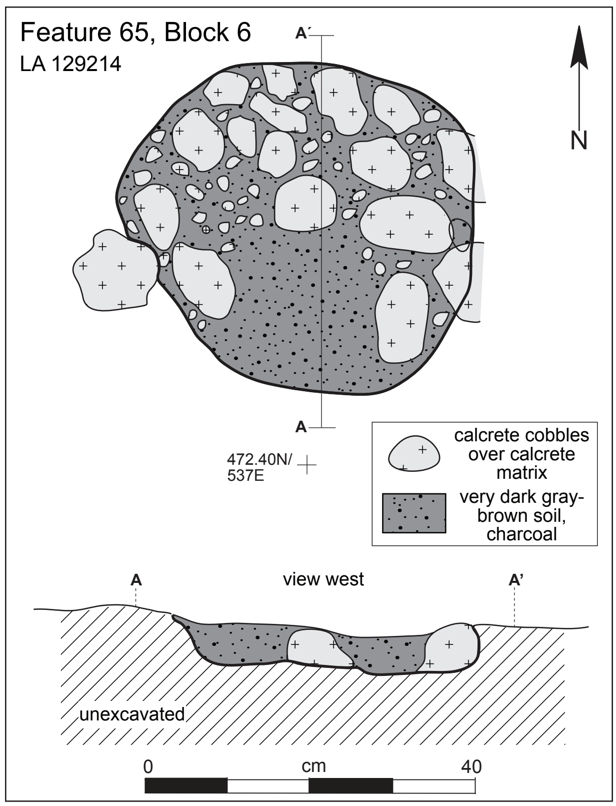


Figure App1.64. LA 129214, Feature 65, Block 6, rock.

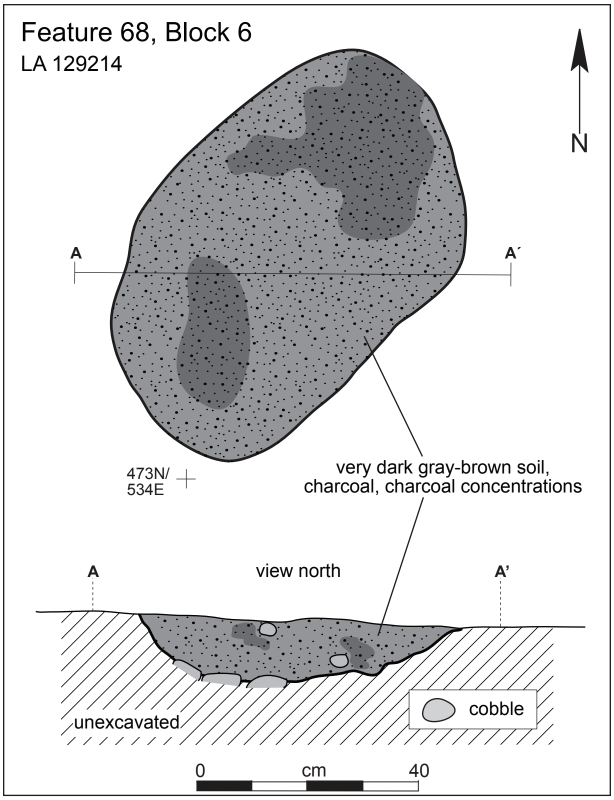


Figure App1.65. LA 129214, Feature 68, Block 6, rock.

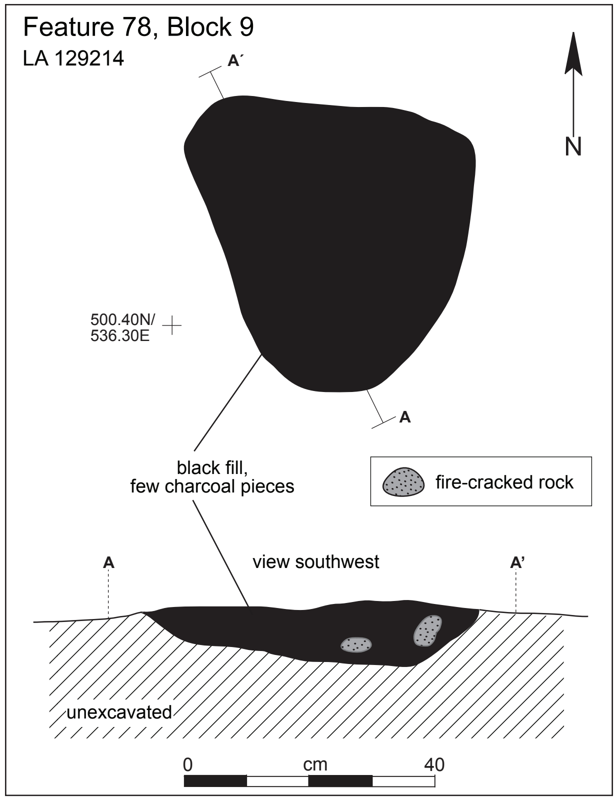


Figure App1.66. LA 129214, Feature 78, Block 9, rock.

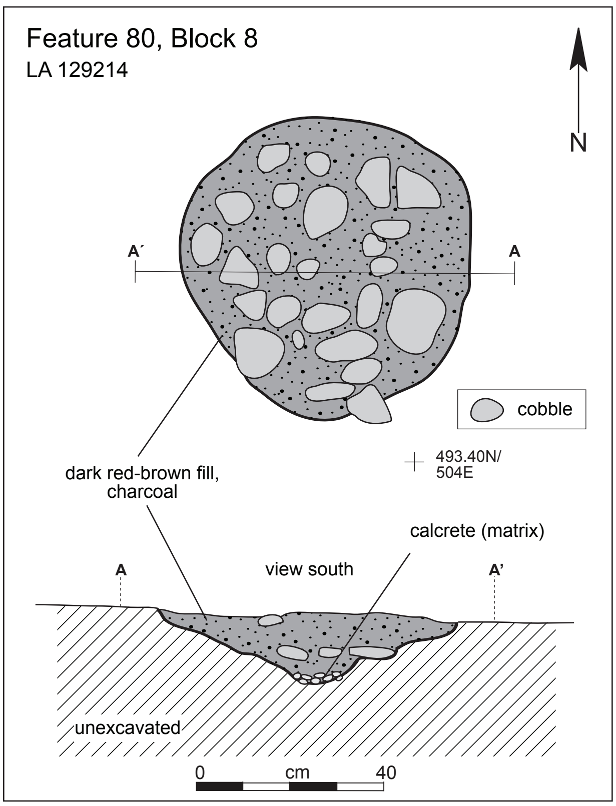


Figure App1.67. LA 129214, Feature 80, Block 8, rock.

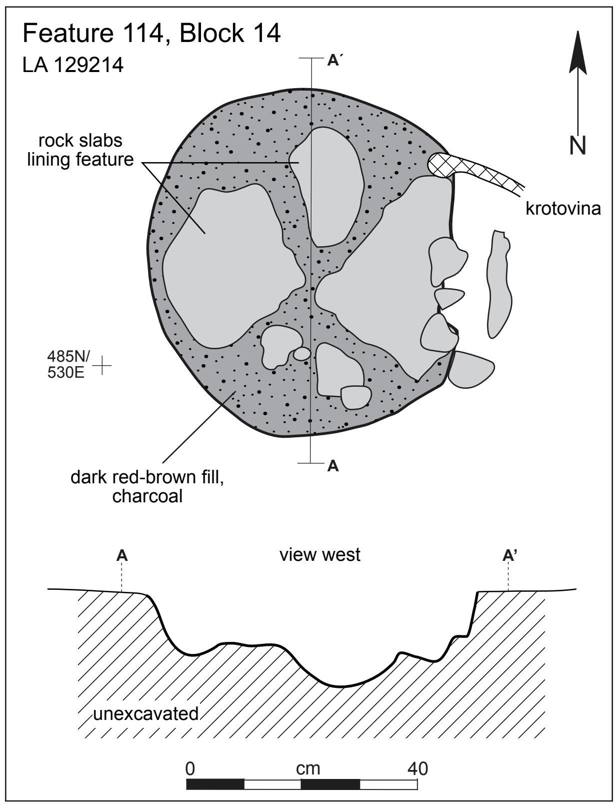


Figure App1.68. LA 129214, Feature 114, Block 14, rock.

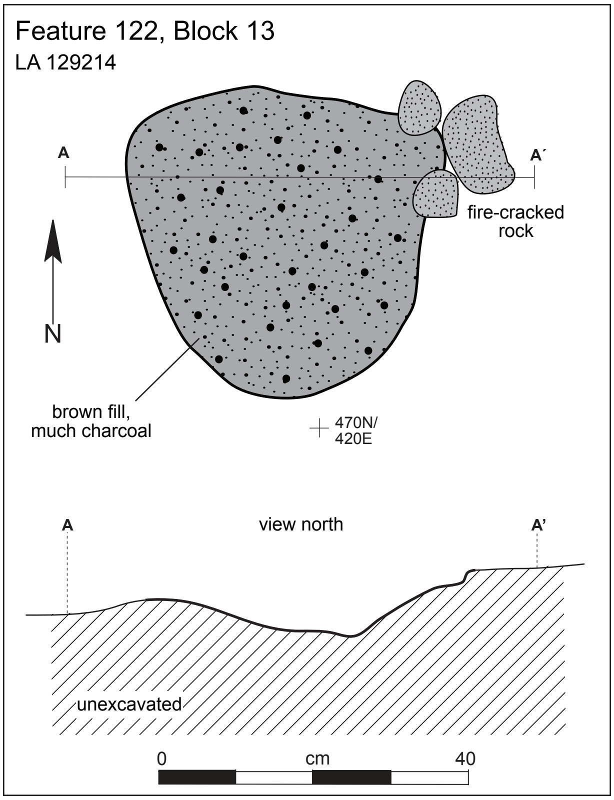


Figure App1.69. LA 129214, Feature 122, Block 13, rock.

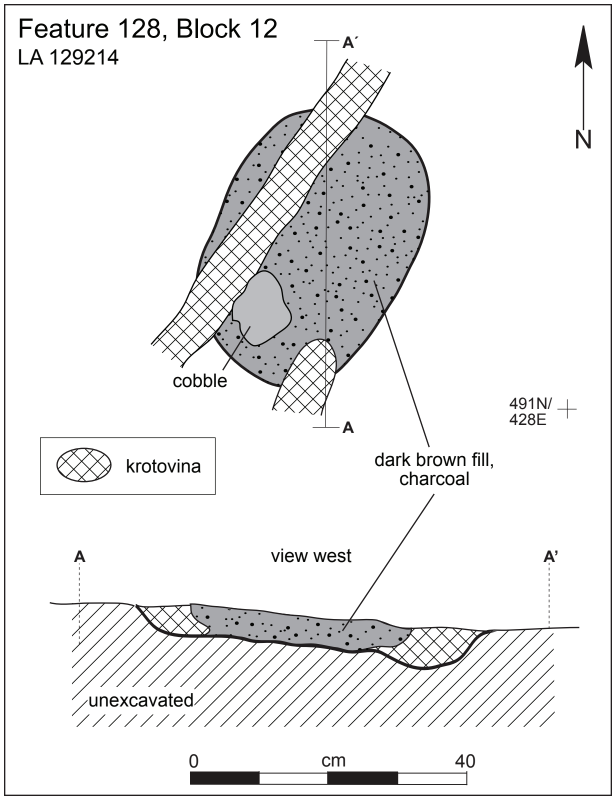


Figure App1.70. LA 129214, Feature 128, Block 12, rock.

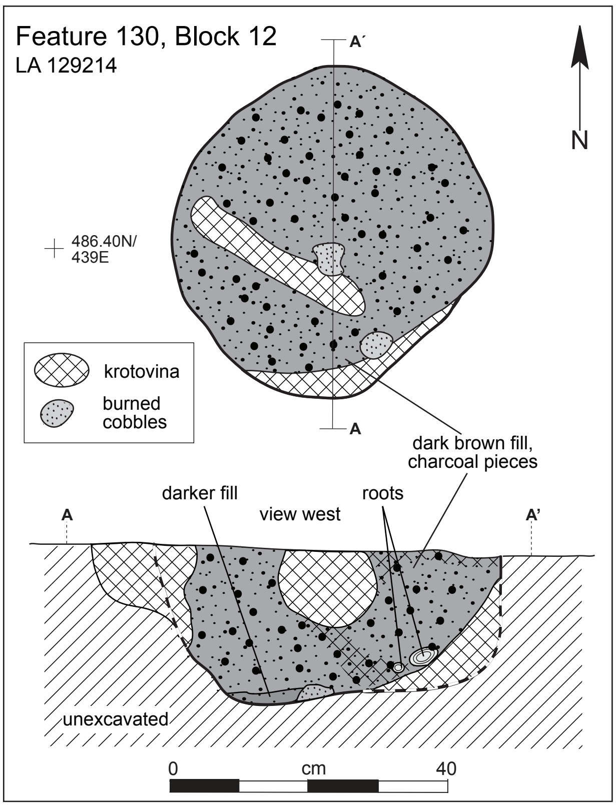


Figure App1.71. LA 129214, Feature 130, Block 12, rock.

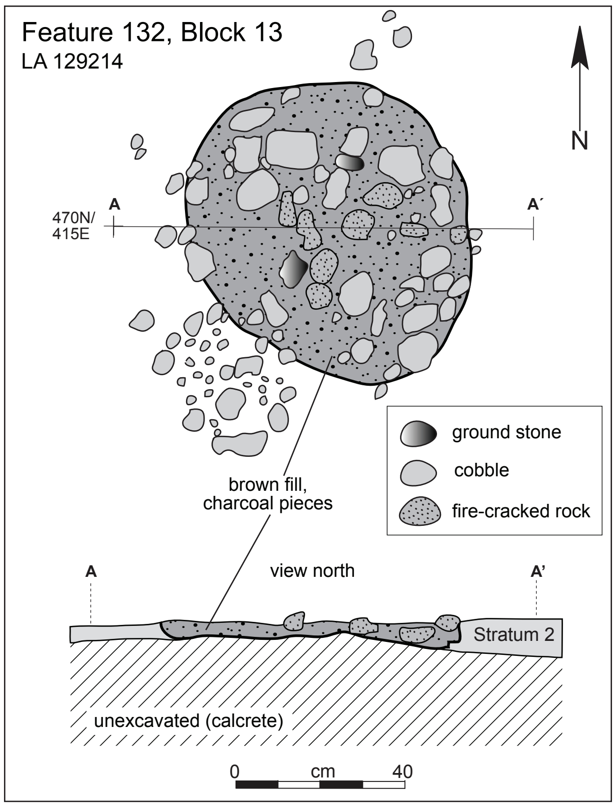


Figure App1.72. LA 129214, Feature 132, Block 13, rock.

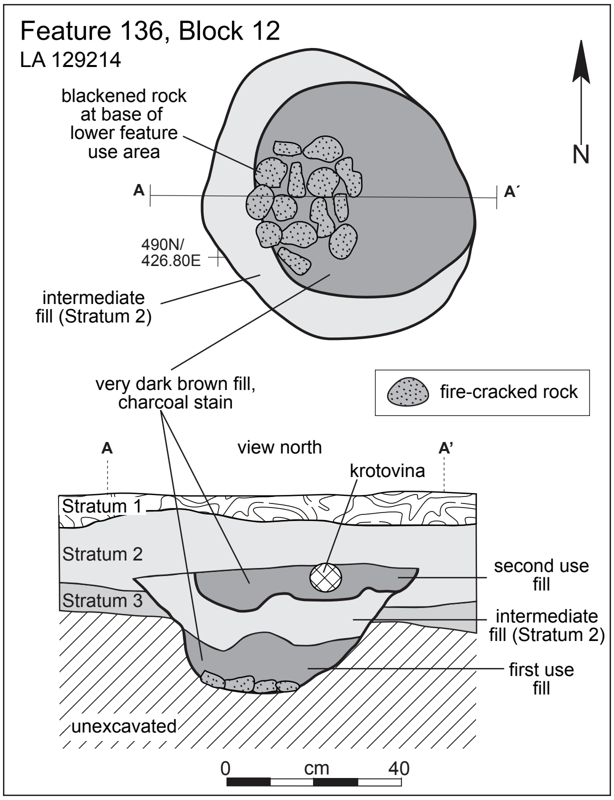


Figure App1.73. LA 129214, Feature 136, Block 12, rock.

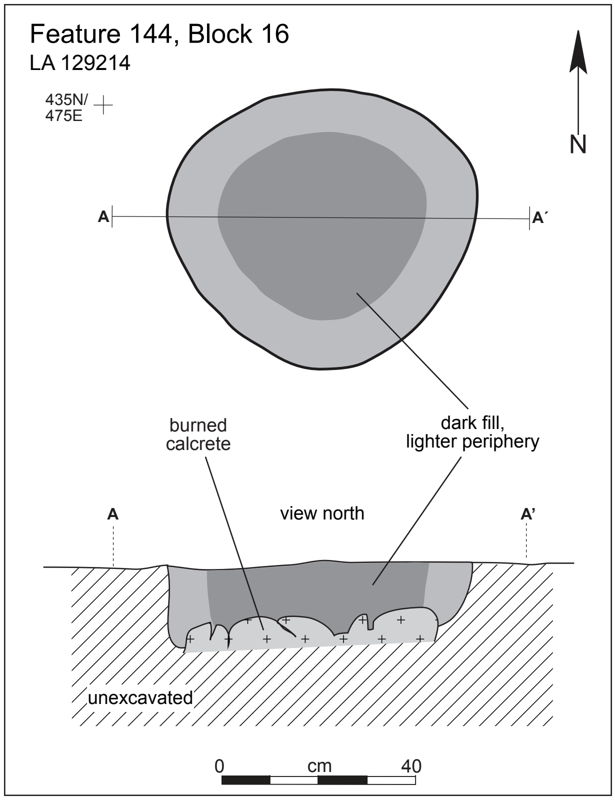


Figure App1.74. LA 129214, Feature 144, Block 16, rock.

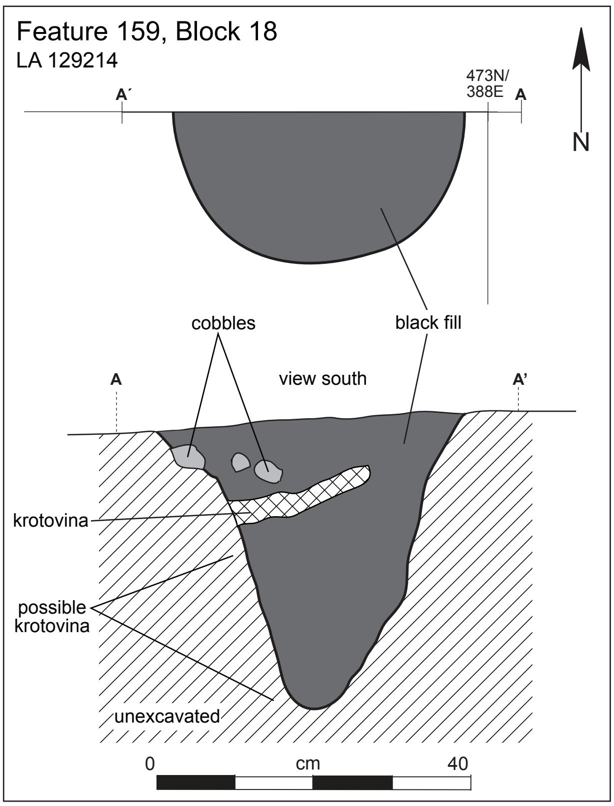


Figure App1.75. LA 129214, Feature 159, Block 18, rock.

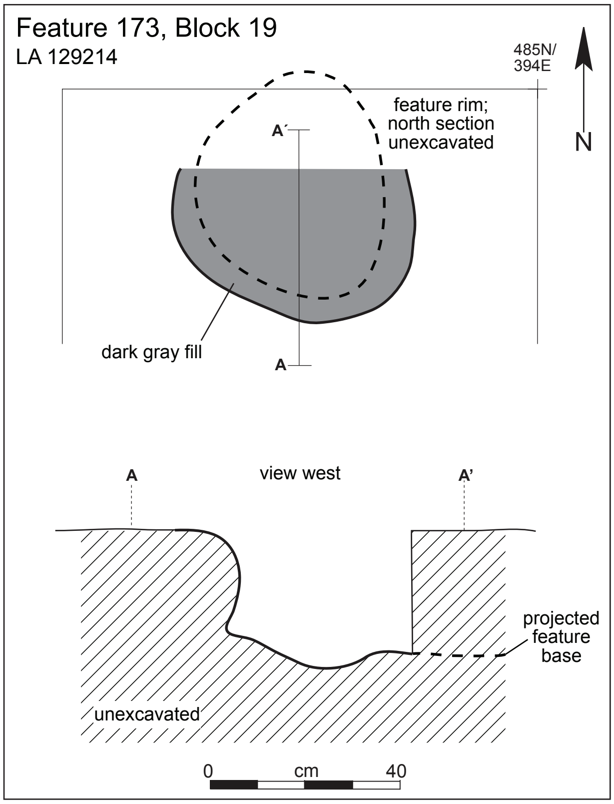


Figure App1.76. LA 129214, Feature 173, Block 19, rock.

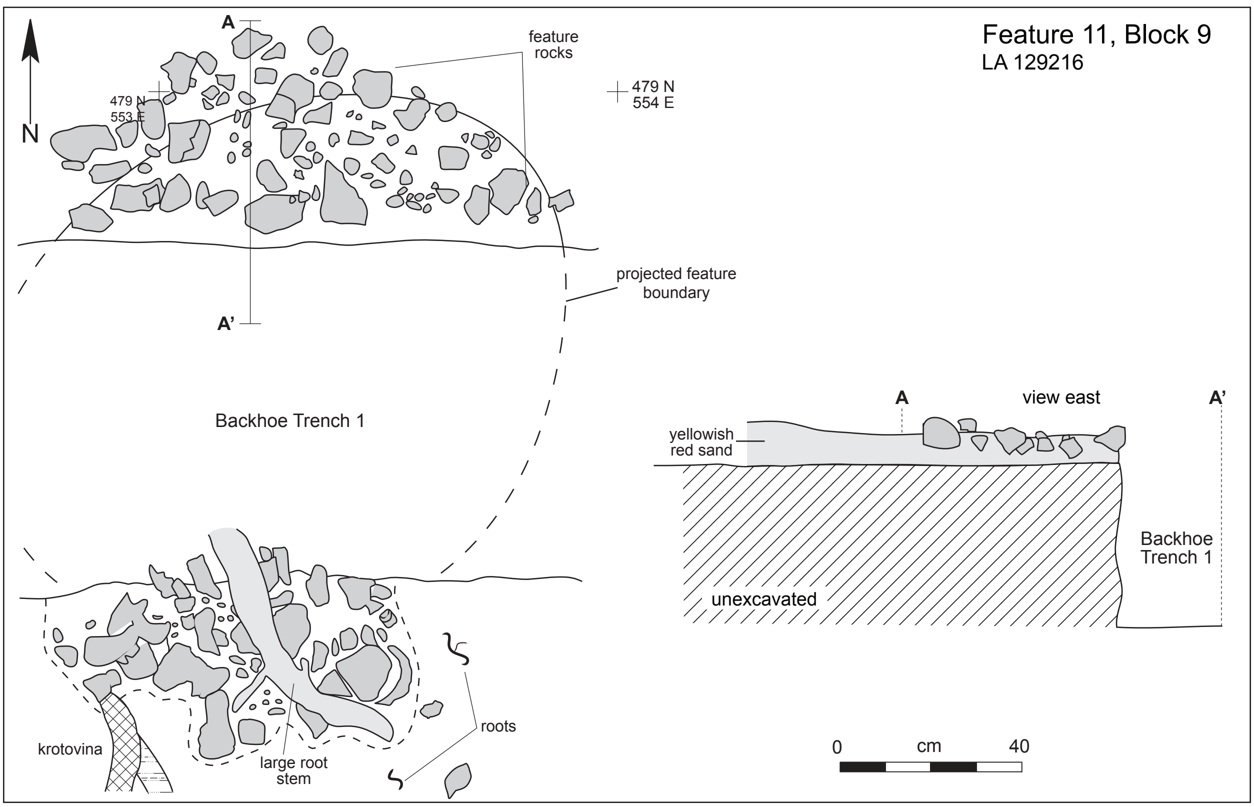


Figure App1.77. LA 129216, Feature 11, Block 9.

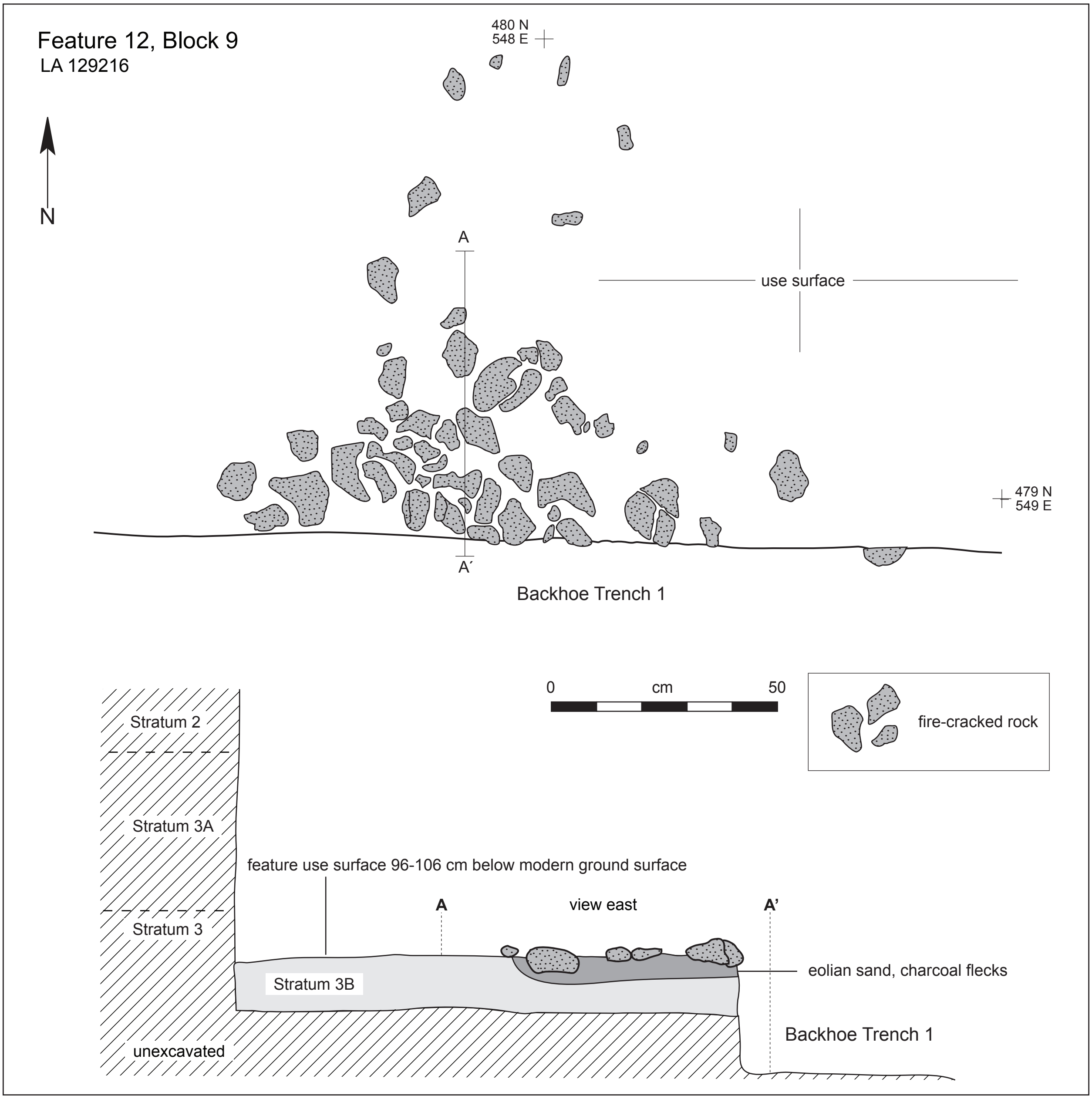


Figure App1.78. LA 129216, Feature 12, Block 9.

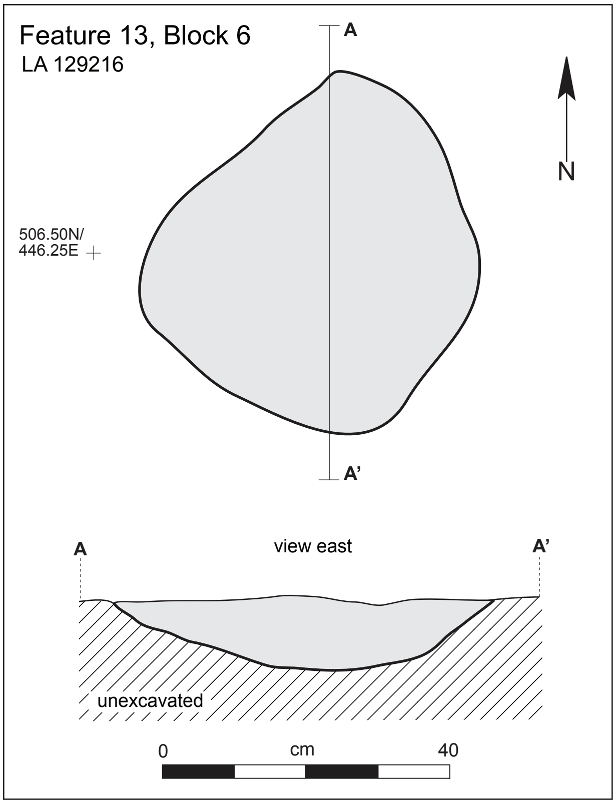


Figure App1.79. LA 129216, Feature 13, Block 6.

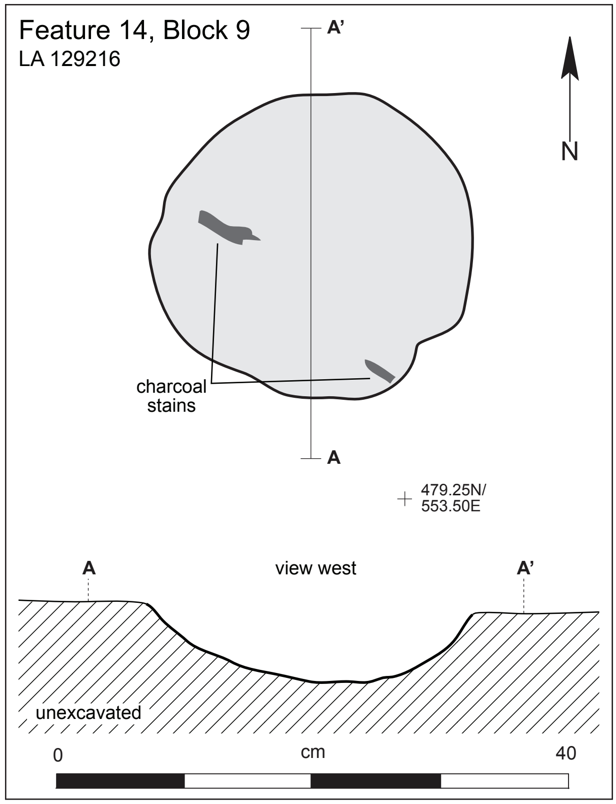
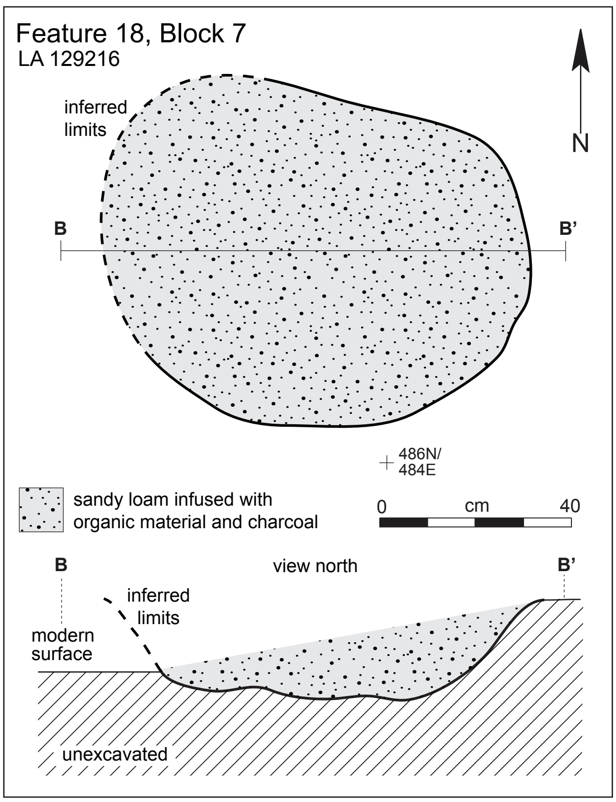


Figure App1.80. LA 129216, Feature 14, Block 9.



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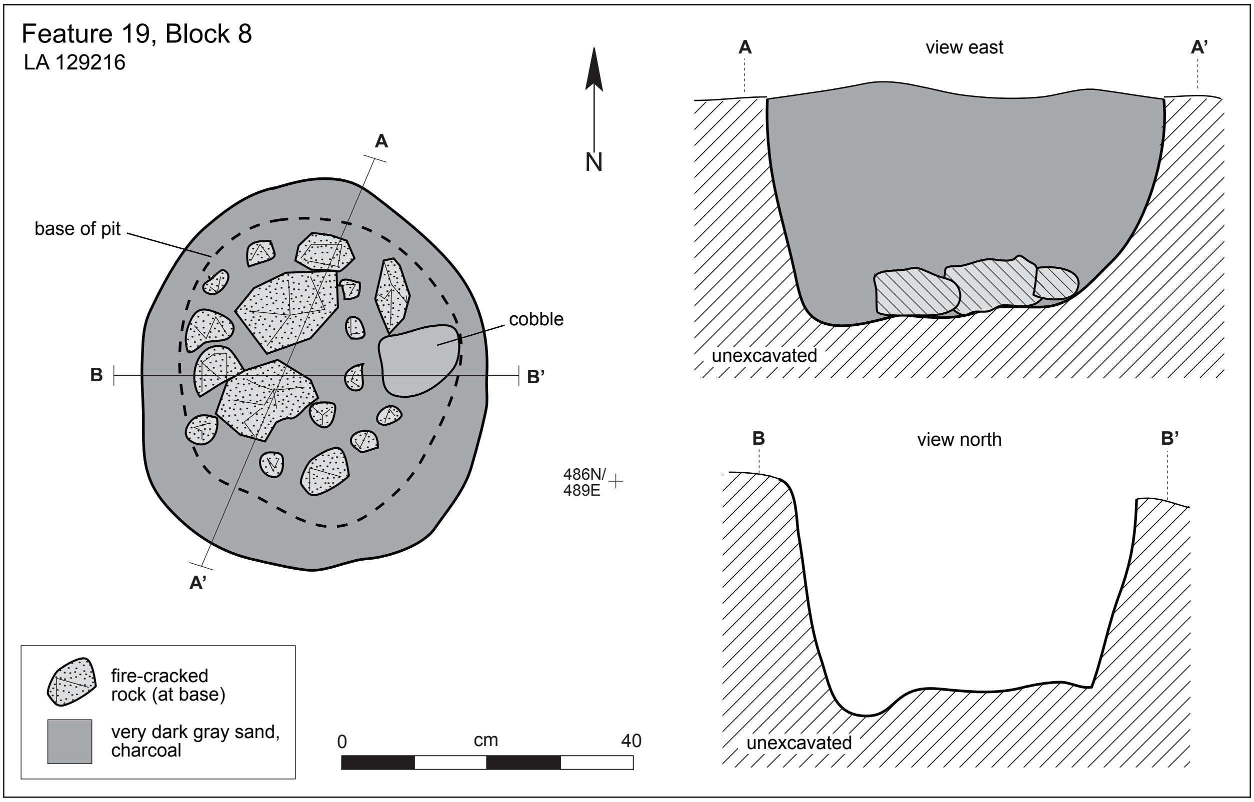

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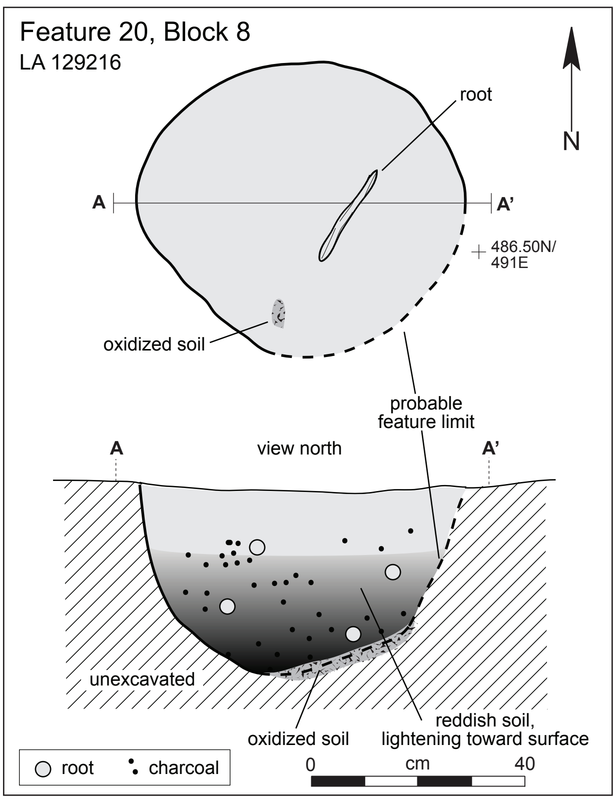
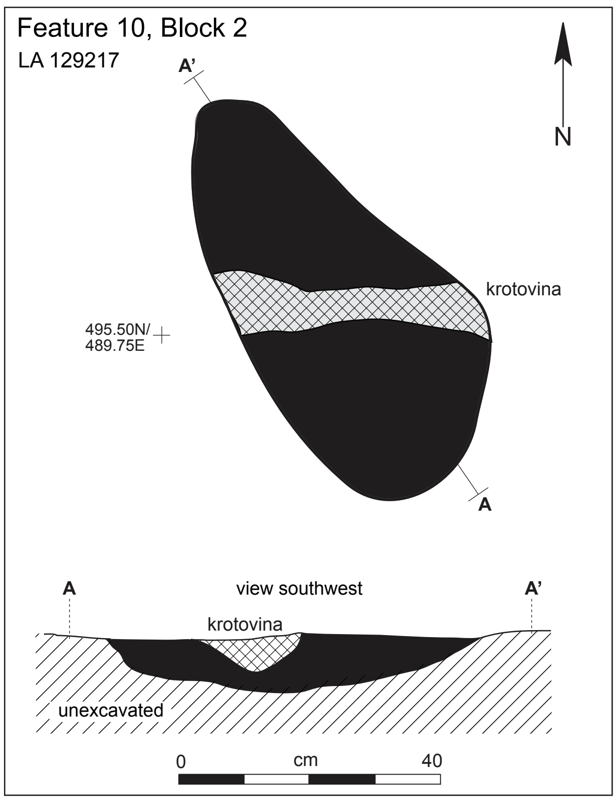


Figure App1.83. LA 129216, Feature 20, Block 8.



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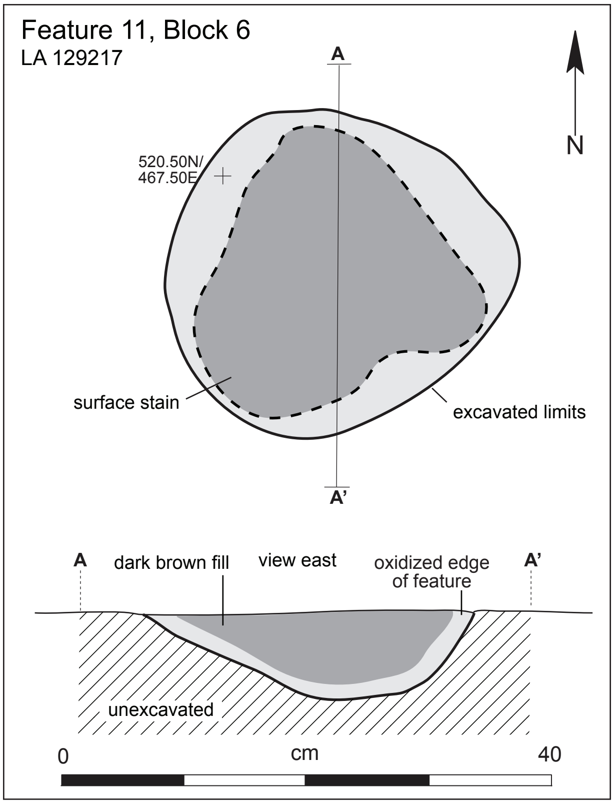


Figure App1.85. LA 129217, Feature 11, Block 6.

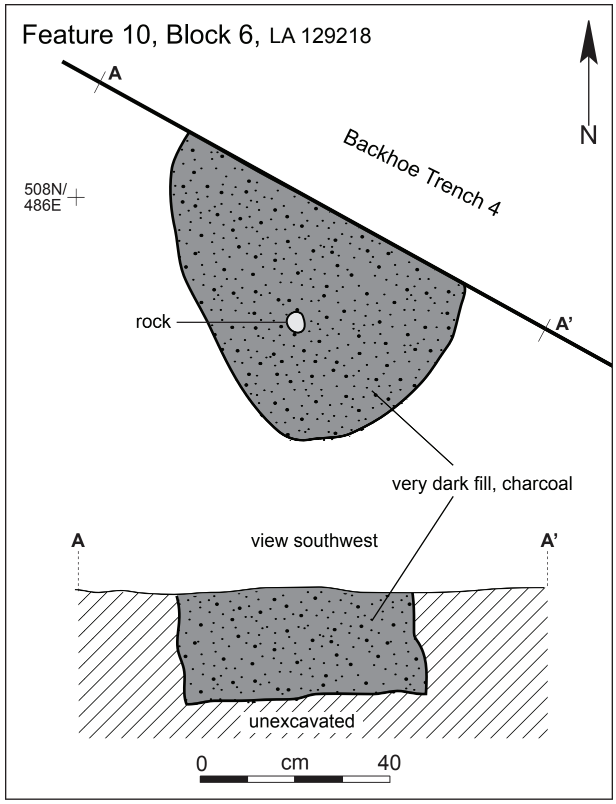


Figure App1.86. LA 129218, Feature 10, Block 6.

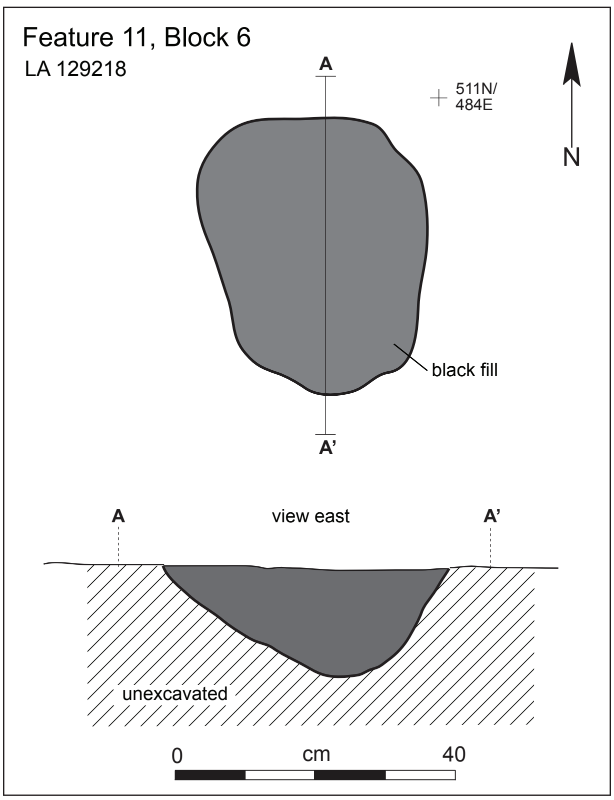


Figure App1.87. LA 129218, Feature 11, Block 6, non-rock.

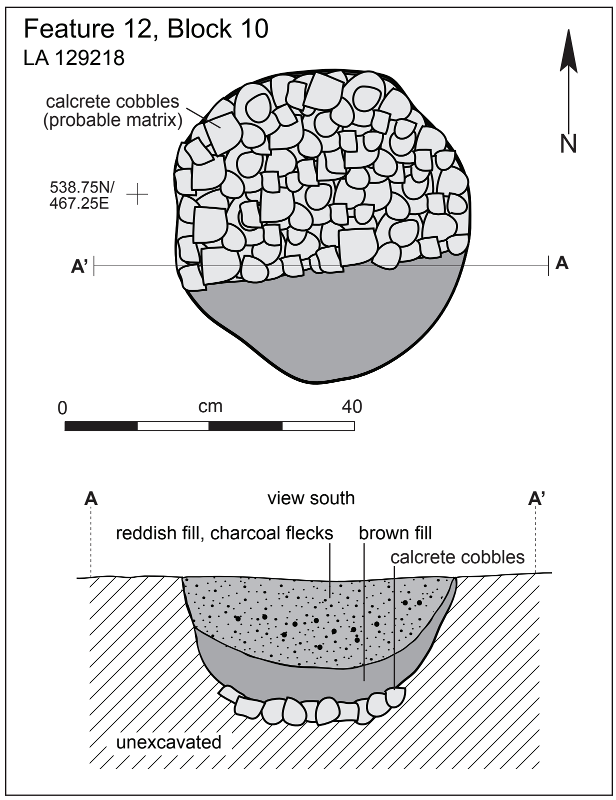


Figure App1.88. LA 129218, Feature 12, Block 10, non-rock.

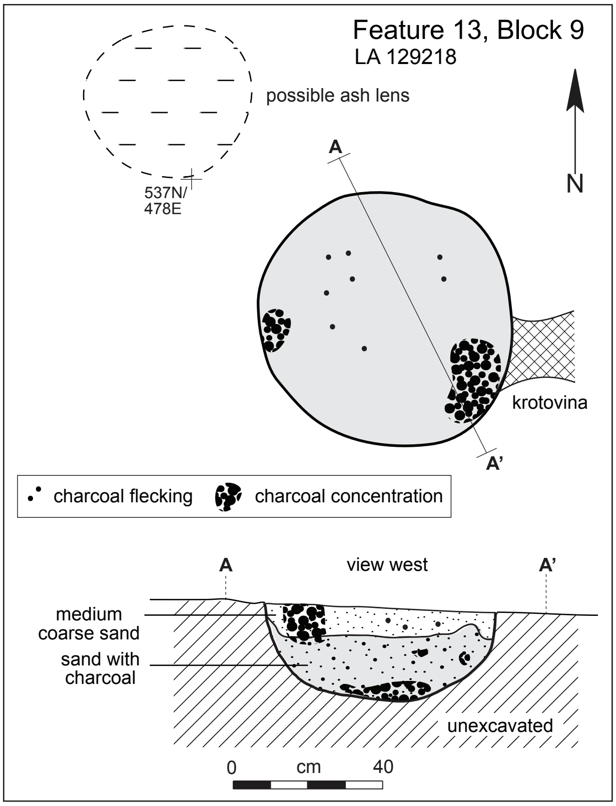


Figure App1.89. LA 129218, Feature 13, Block 9, non-rock.

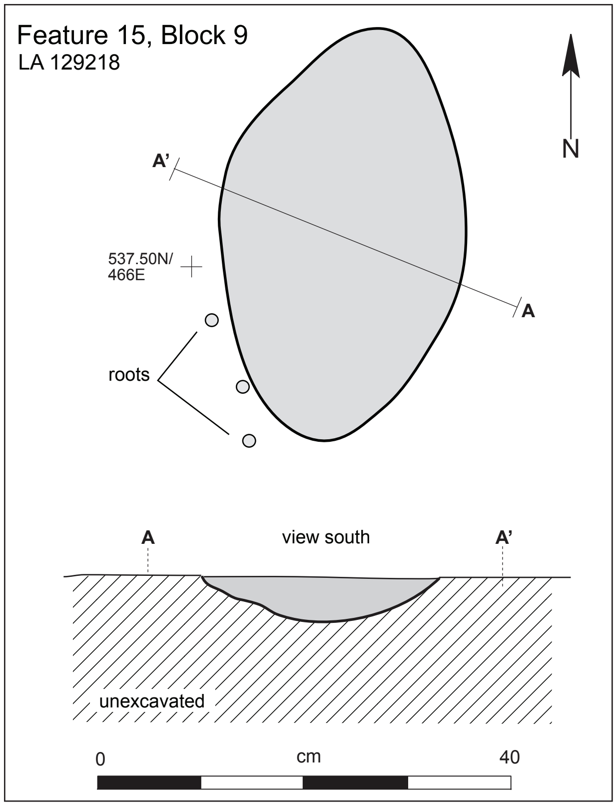


Figure App1.90. LA 129218, Feature 15, Block 9, non-rock.

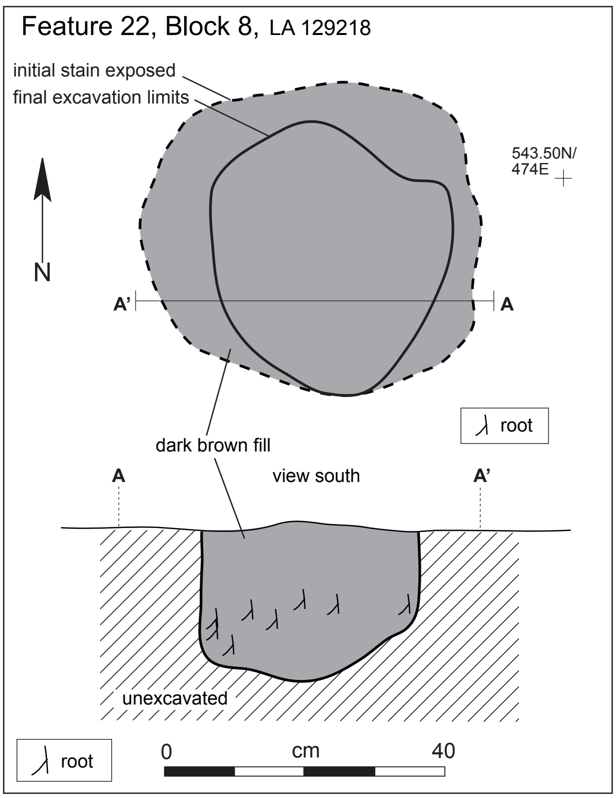


Figure App1.91. LA 129218, Feature 22, Block 8, non-rock.

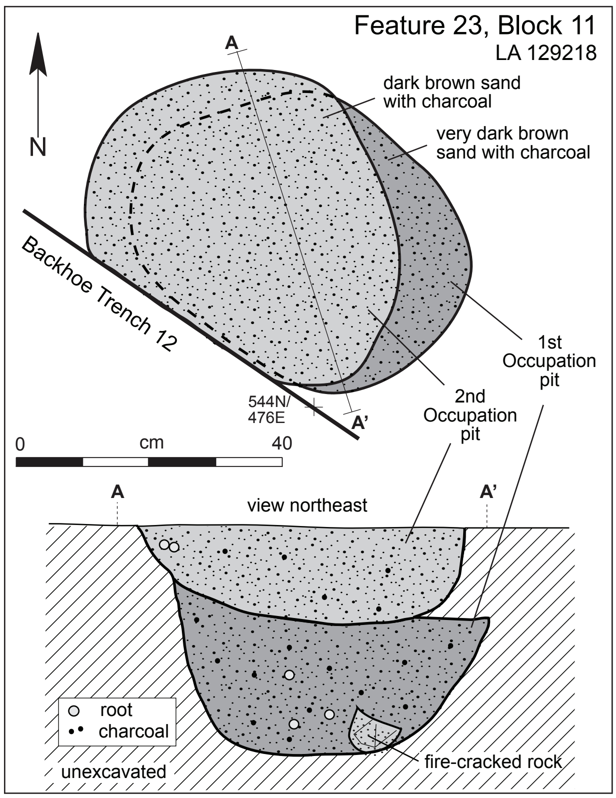


Figure App1.92. LA 129218, Feature 23, Block 11, non-rock.

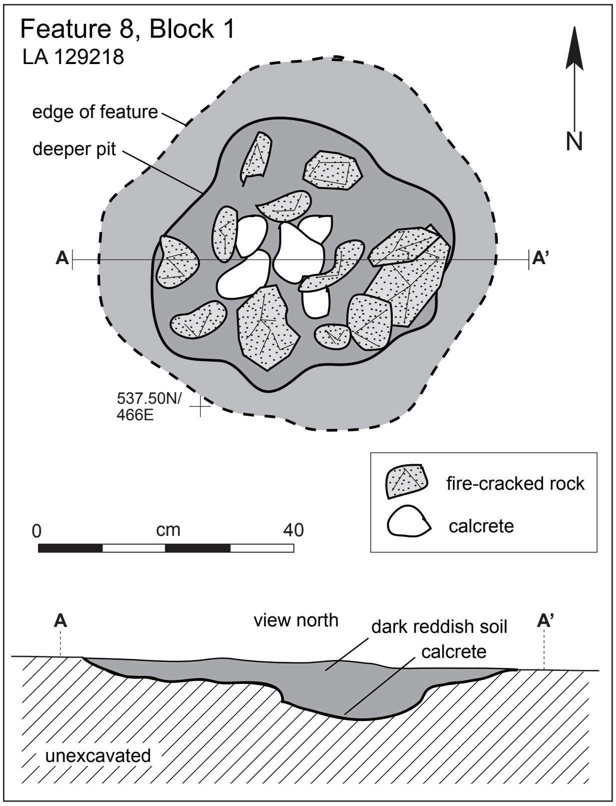
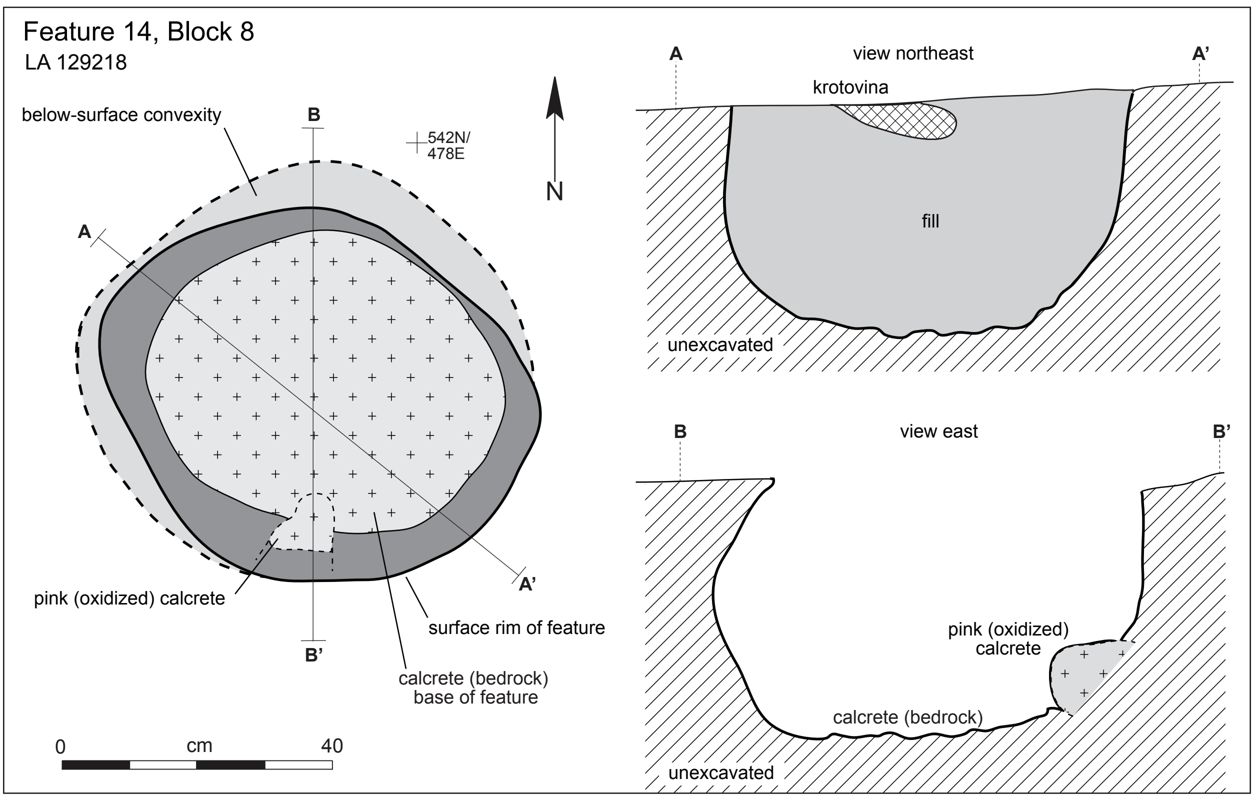


Figure App1.93. LA 129218, Feature 8, Block 1, rock.



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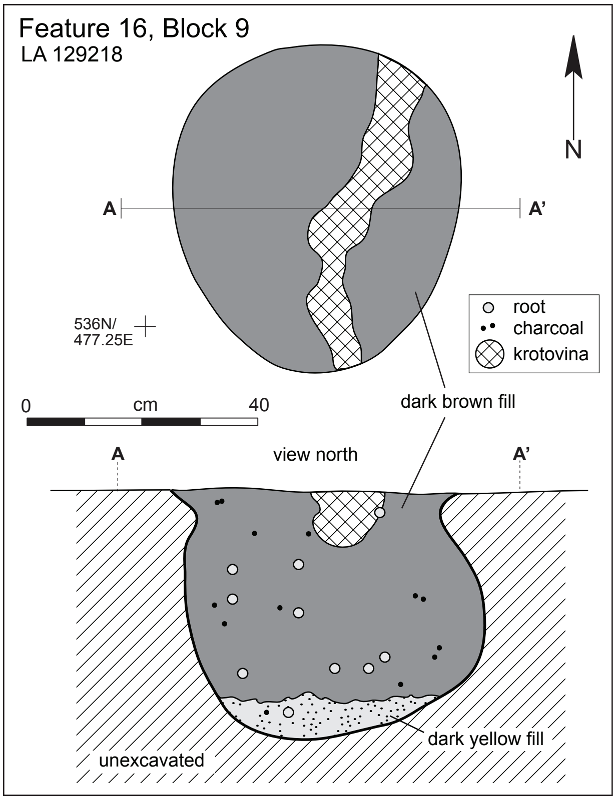

Figure App1.95. LA 129218, Feature 16, Block 9, rock.

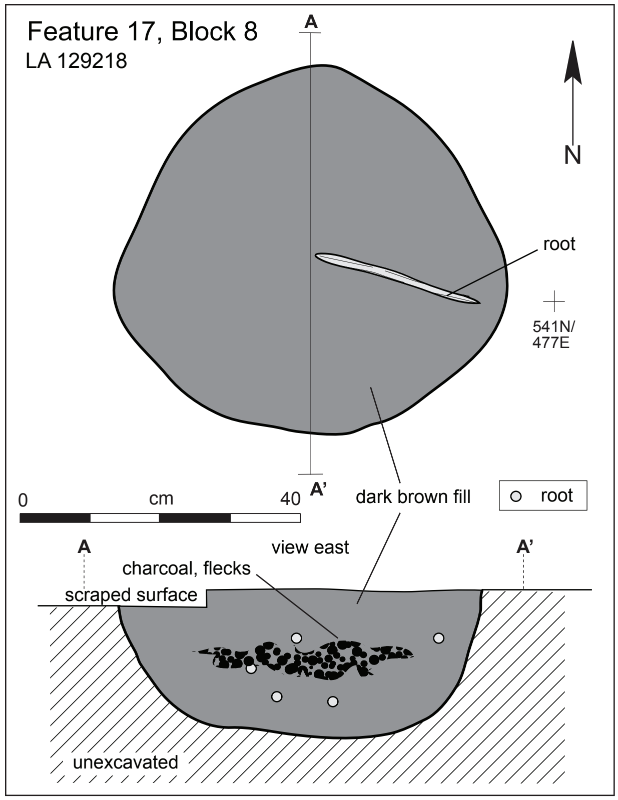

Figure App1.96. LA 129218, Feature 17, Block 8, rock.

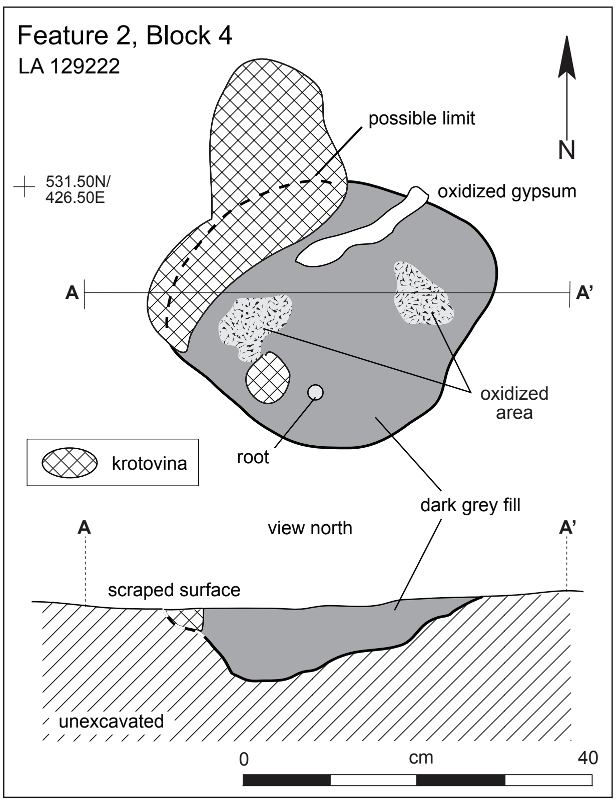

Figure App1.97. LA 129222, Feature 2, Block 4.

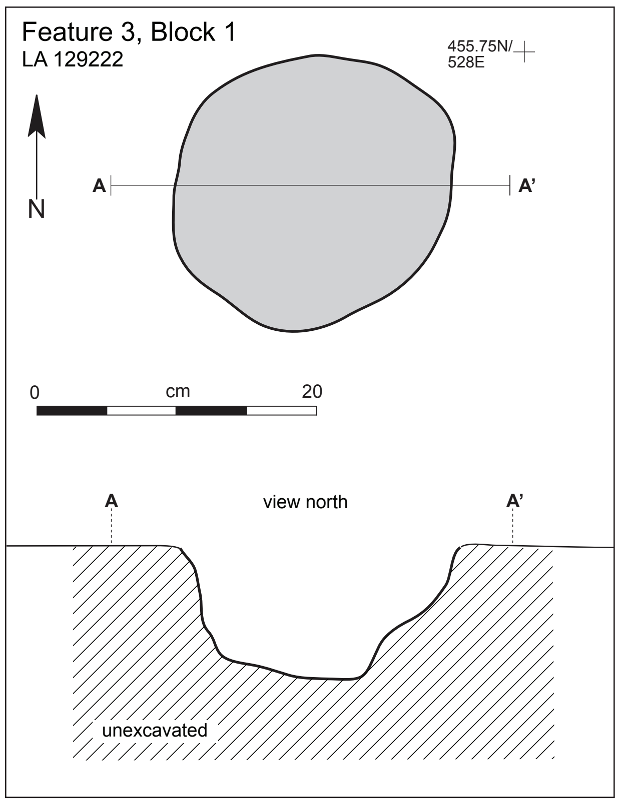

Figure App1.98. LA 129222, Feature 3, Block 1.

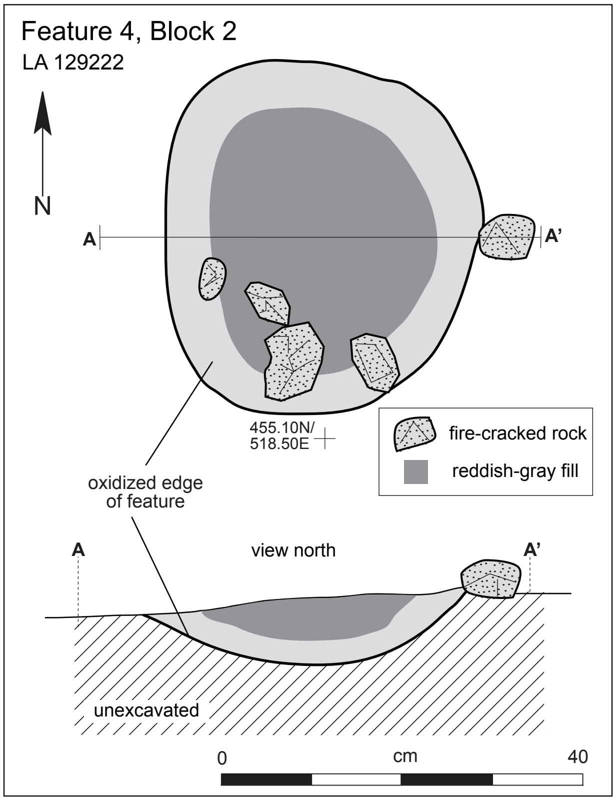

Figure App1.99. LA 129222, Feature 4, Block 2.

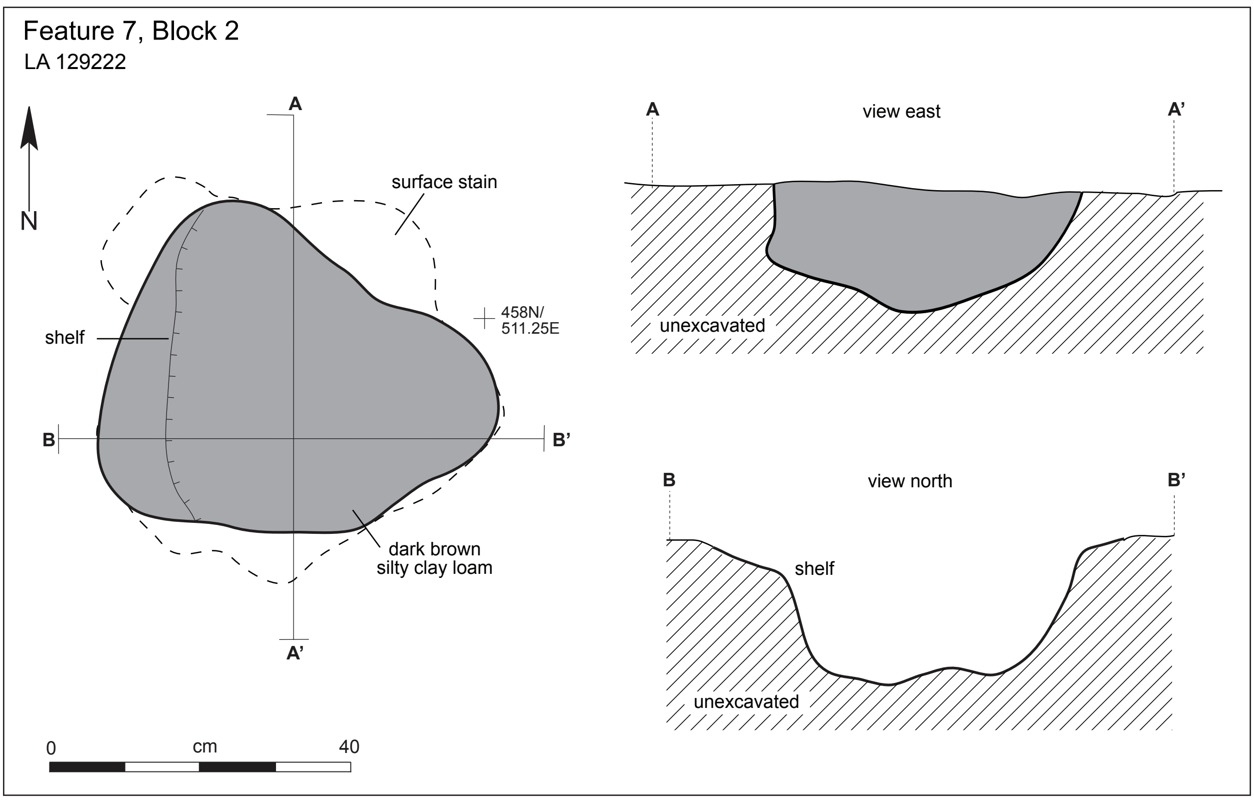

Figure App1.100. LA 129222, Feature 7, Block 2.

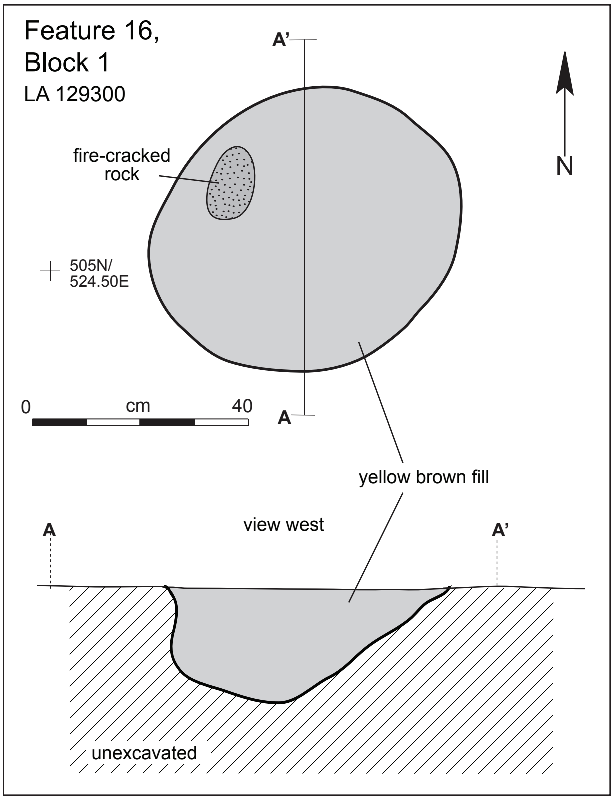

Figure App1.101. LA 129300, Feature 16, Block 1.

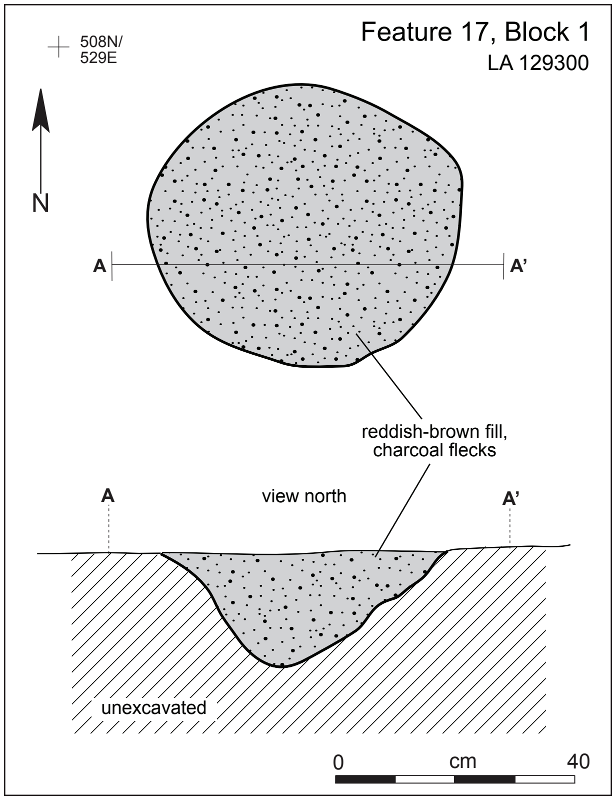

Figure App1.102. LA 129300, Feature 17, Block 1.

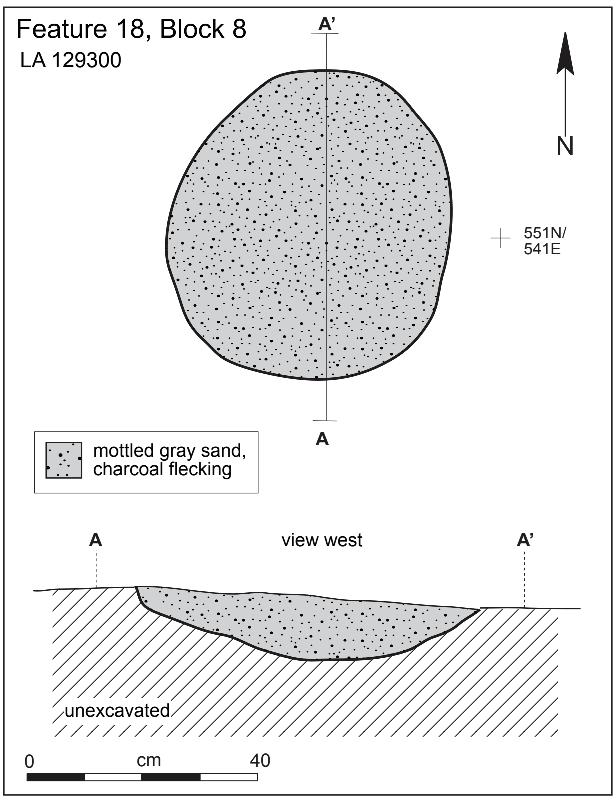

Figure App1.103. LA 129300, Feature 18, Block 8.

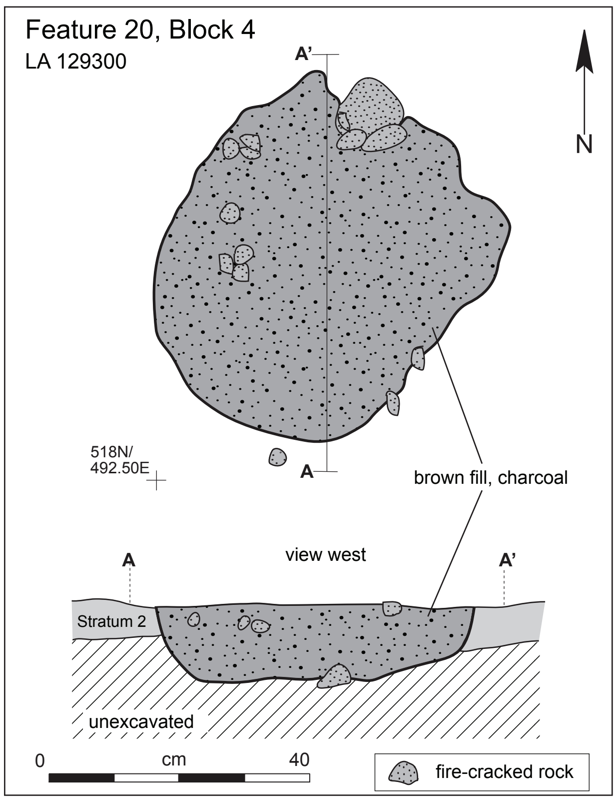

Figure App1.104. LA 129300, Feature 20, Block 4.

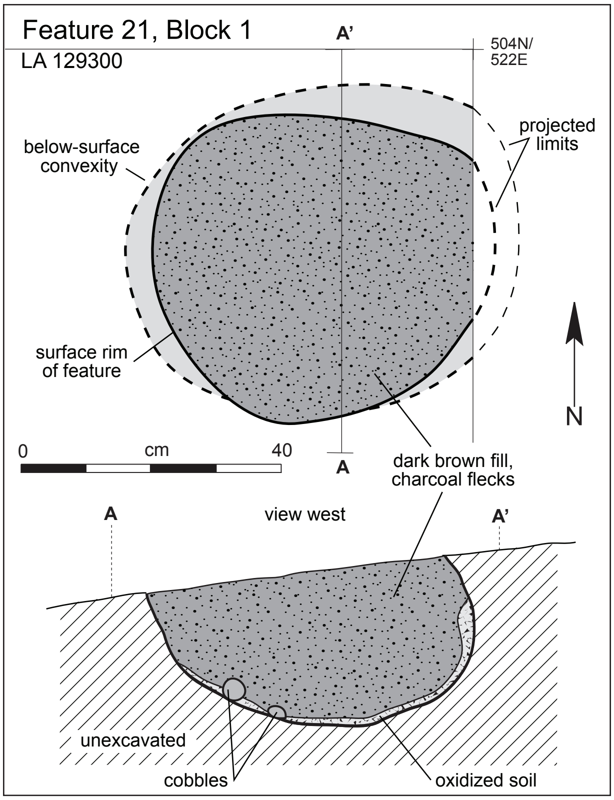

Figure App1.105. LA 129300, Feature 21, Block 1.

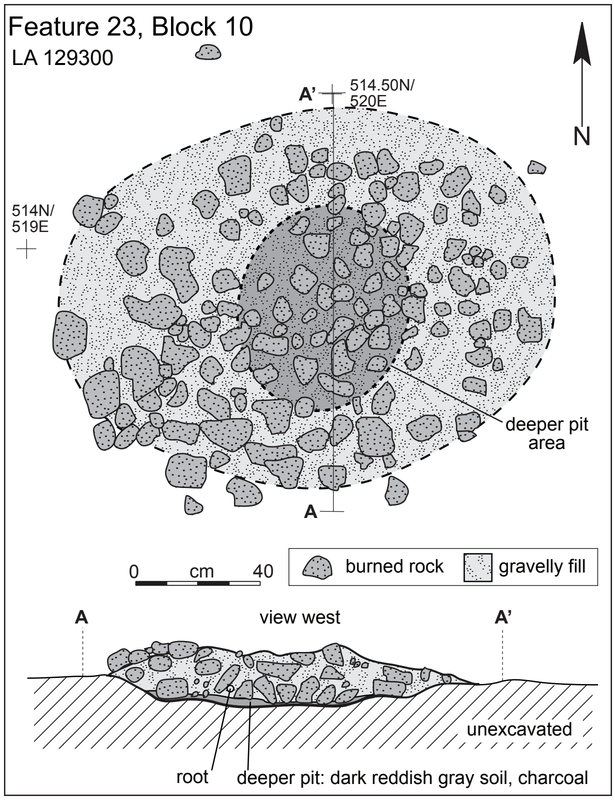

Figure App1.106. LA 129300, Feature 23, Block 10.

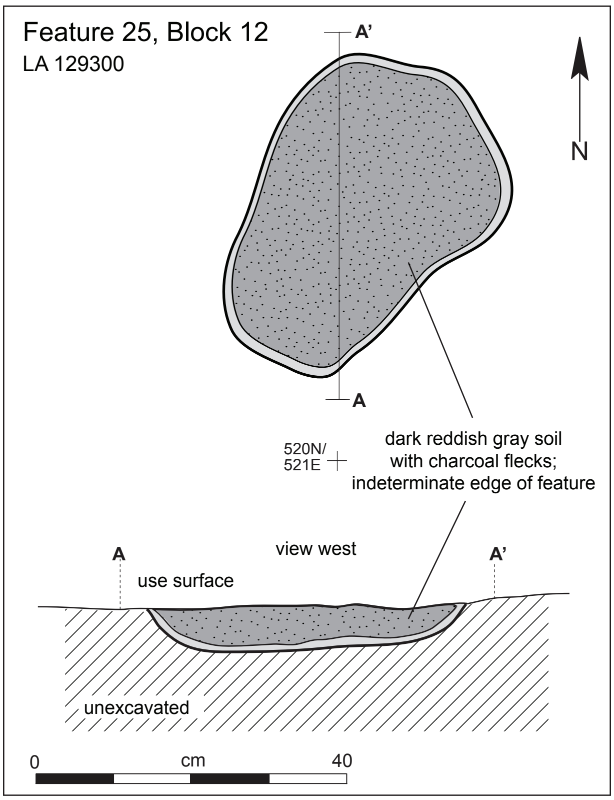

Figure App1.107. LA 129300, Feature 25, Block 12.

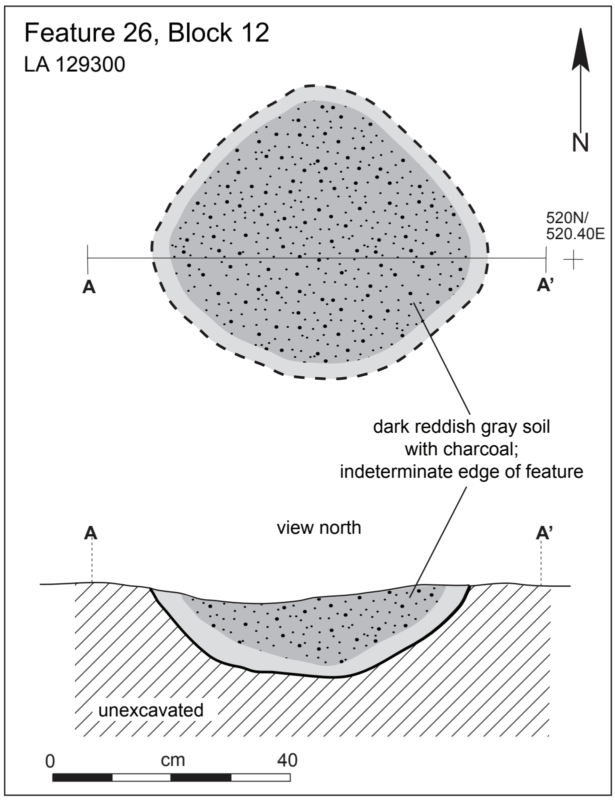

Figure App1.108. LA 129300, Feature 26, Block 12.

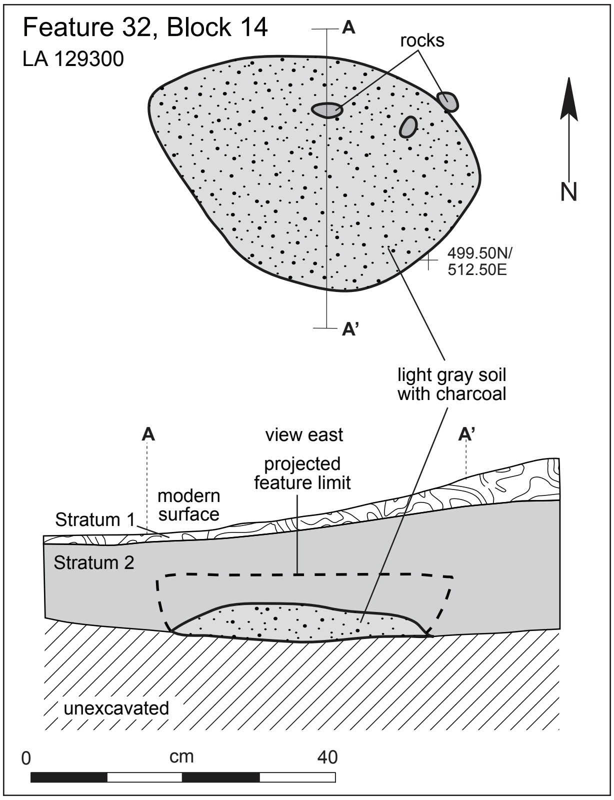

Figure App1.109. LA 129300, Feature 32, Block 14.

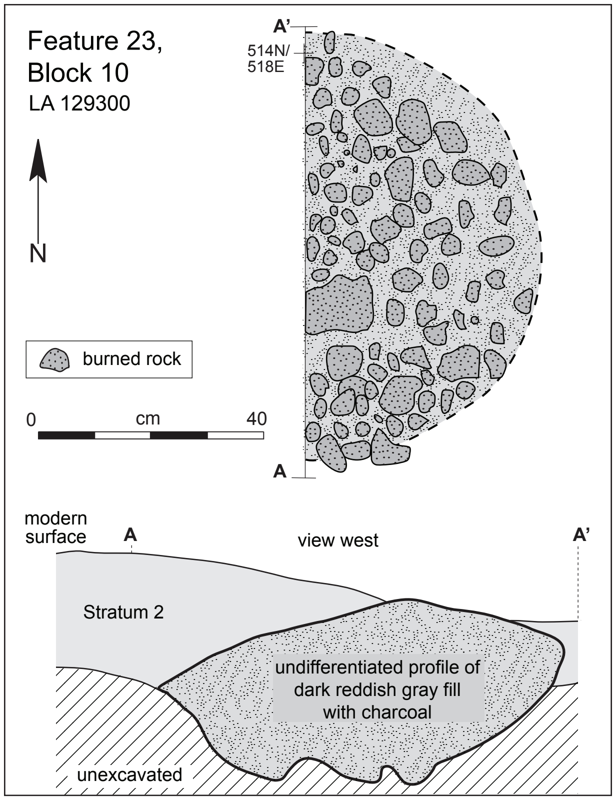

Figure App1.110. LA 129300, Feature 23, Block 10.

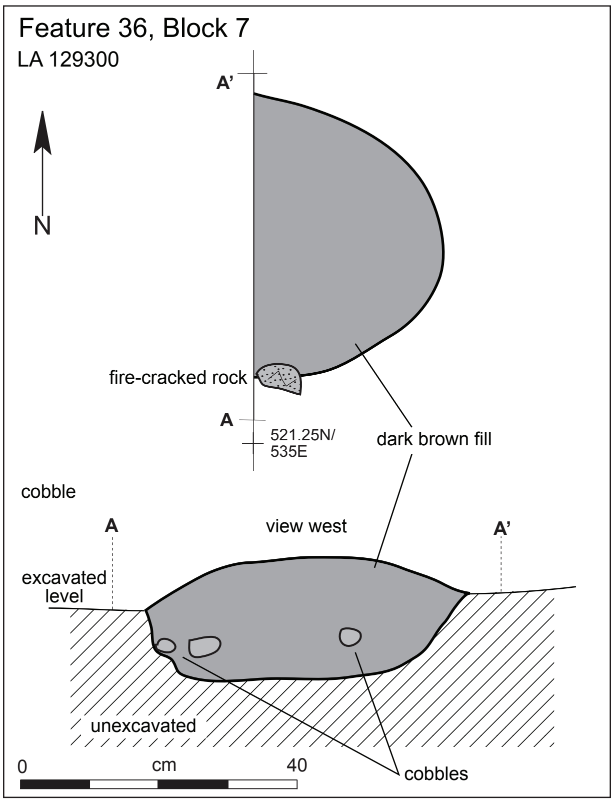

Figure App1.111. LA 129300, Feature 36, Block 7.

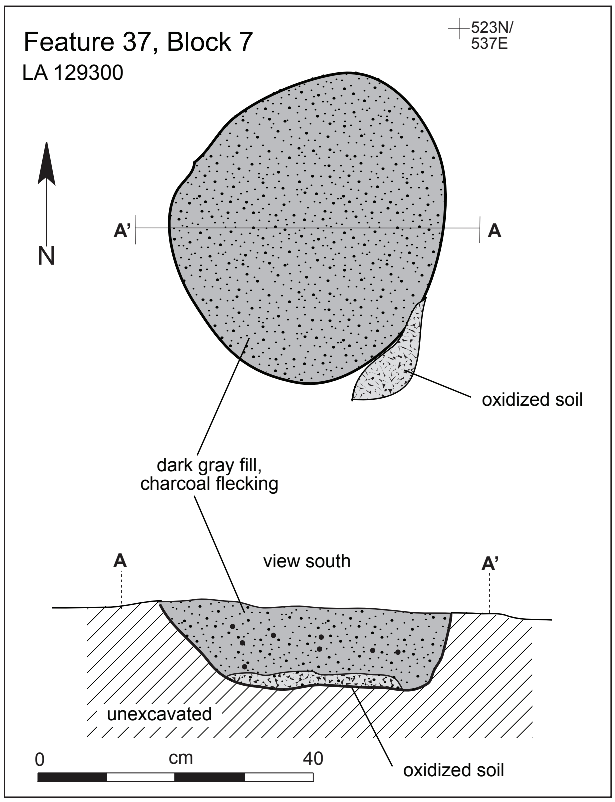

Figure App1.112. LA 129300, Feature 37, Block 7.

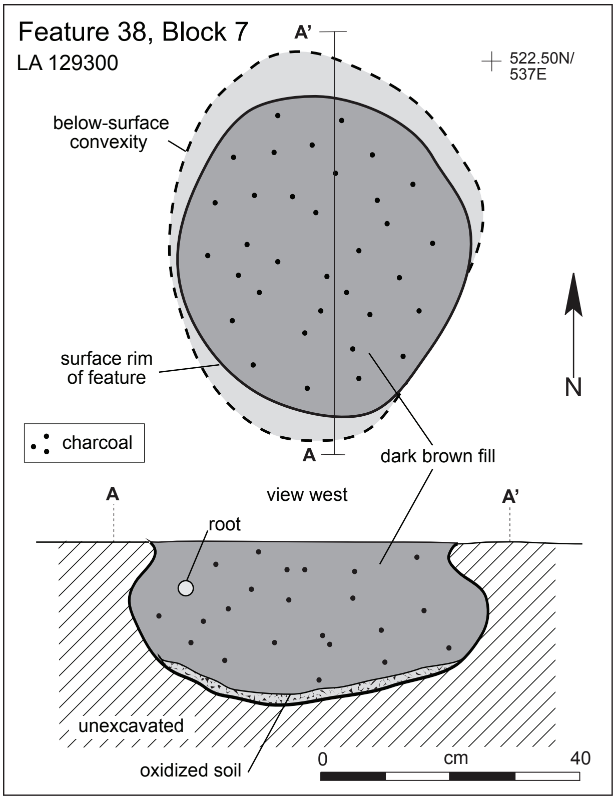

Figure App1.113. LA 129300, Feature 38, Block 7.

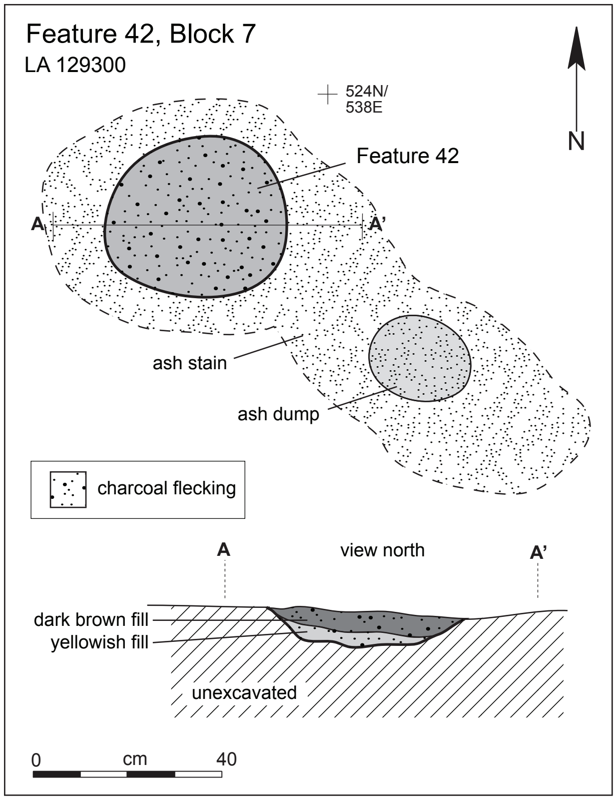

Figure App1.114. LA 129300, Feature 42, Block 7.

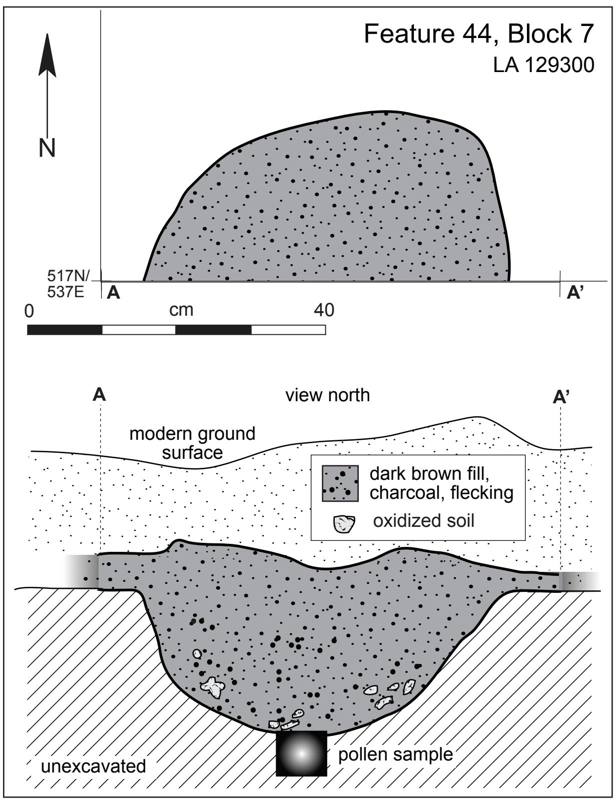

Figure App1.115. LA 129300, Feature 44, Block 7.

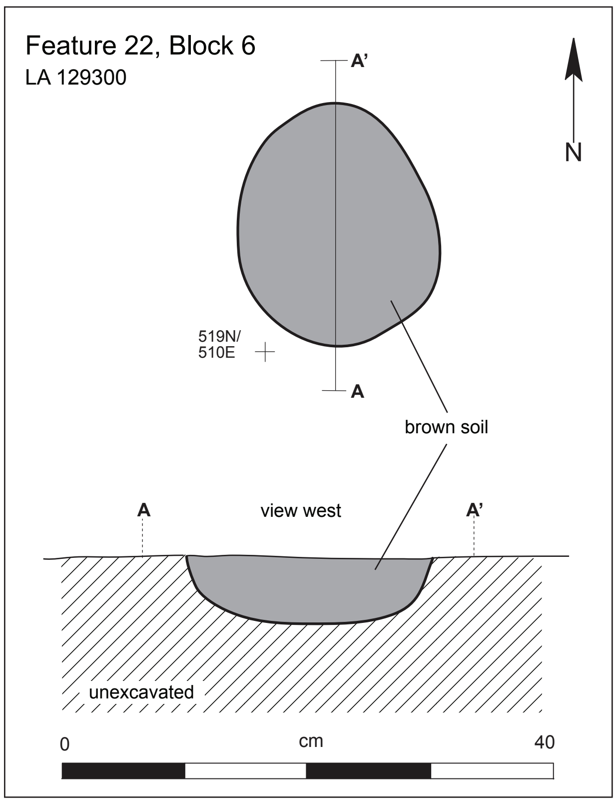

Figure App1.116. LA 129300, Feature 22, Block 6, pithouse.

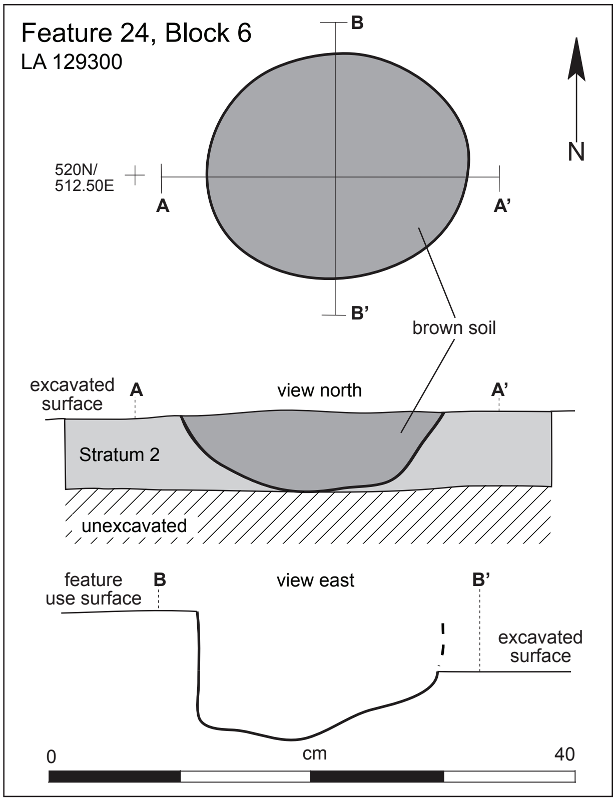

Figure App1.117. LA 129300, Feature 24, Block 6, pit.

Appendix 2 ⸸ Ground Stone Artifacts

Complete, Nearly Complete, and Unique Artifact Descriptions

Karen Wening

Manos

One Hand Mano/Core/Hammerstone (LA 129214, FS 699): This unmodified, oval, limestone cobble is ground on two opposing convex surfaces. One of the use-surfaces is heavily ground and randomly striated, the other is moderately ground. Approximately three-fourths of the perimeter displays flaking. Flake scars at the narrower ends of the cobble appear to result from hammerstone use. Battering, crushing, and grinding wear obscure some of the flake-scar edges. Two flake scars removed from the lateral cobble edge may be due to core reduction or shaping. These scars are also obscured by grinding wear (4.7 by 3.7 by 2.6 cm, 73 grams).

One Hand Mano (LA 113042, FS 563): This complete, unmodified, tan quartzite cobble displays grinding and polish wear on a single surface. The use-surface displays a flat TXC and a convex LXC. It is roughly oval in plan and may exhibit battering wear on the perimeter of the ground surface (8.3 by 7.0 by 5.0 cm, 405 grams).

One Hand Mano (LA 129300, FS 515): This unmodified, wedge-shaped, red sandstone cobble is lightly ground on the the irregular "ventral" surface. The dorsal surface displays a heavy caliche deposit and is unused.

Mano/Hammerstone/Pigment Grinder (LA 113042, FS 1081): This complete, round, gray chert cobble displays extensive battering wear over half of its spherical surface. Numerous small flakes have spalled off as a result of this hammerstone wear. These flakes do not appear to result from core reduction, as the material contains numerous impurities and fractures; there is no evidence of platform creation. Four small, cortical facets have been ground nearly to a polish and display multidirectional striations. These facets are approximately 2 by 2 cm each and are flat or slightly convex. Three facets display multidirectional striations, and one facet exhibits unidirectional striations. A small portion of the cortical surface is stained with reddish brown pigment, but it is not clear if this material was being processed by this artifact. The flaked and battered portion of the cobble also has numerous projections that have been ground as well (7.8 by 7.2 by 6.2 cm, 511 grams).

Mano/Pigment Grinder (LA 129214, FS 1424): This complete, unmodified cobble appears to be gray chert. The cortical surface displays numerous impact fractures, but no flakes have been removed. Red pigment stains adhere to approximately 30 percent of the surface. Most of this pigment resides on one surface, which shows little evidence of grinding. The opposite surface is ground to a polish, with small amounts of red pigment displayed. Both surfaces are slightly convex on both axes (8.0 by 5.8 by 4.9 cm, 263 grams).

One Hand Cobble Mano (LA 129214, FS 1522): This is a complete, unmodified, red quartzite cobble that appears to have been ground on two cortical facets, both of which are convex on both axes. It is slightly sooted over approximately half of the surface. Only portions of the ground surfaces are visible through the caliche deposit, which covers about 70 percent of the surface. The largest ground surface is also pitted, possibly from crushing. This pitting wear is not the result of hammerstone use (7.3 by 5.7 by 5.6 cm, 397 grams).

Mano/Hammerstone/Core (LA 129214, FS 1860-5): This is a complete, purple quartzite cobble with three smoothly ground cortical facets. Approximately seven flake scars occupy about half of the surface area, the perimeters of which are heavily ground. It appears that this cobble initially served as a core and was subsequently used in grinding and crushing activities. There is also battering wear from hammerstone use, which appears to be mostly overlain by grinding. One ground surface is flat on both axes, the other is markedly convex on both axes. Both are smoothly ground but not striated. The cobble is roughly dome-shaped in cross section and oval in plan. It measures 7.0 by 5.7 by 5.2 cm and weighs 252 grams.

Mano/Edge Abrader (LA 113042, FS 202): This is also a multifunctional tool. It appears to have been used concomitantly as a handstone and abrading stone. It is an unshaped, small, fine-grained sandstone cobble that is round in plan. It displays a single, flat ground facet. The markedly convex cobble perimeter displays deep multidirectional striations, apparently from use as an abrading tool. The artifact is complete, refit from seven pieces, all of which appear to be frost spalls (7.5 by 6.7 by 3.8 cm, 270 grams).

Mano/Hammerstone (LA 129214, FS 337): This is a combination mano/hammerstone tool. The primary use is as a hammerstone, and the secondary use is a mano, or handstone, as the battering wear is overlain by grinding in several locations. It is an unshaped, small, brown quartzite cobble, oval in plan shape and displaying two perpendicularly oriented ground surfaces, one of which is flat; the other is convex. Both surfaces are ground smooth and have been lightly polished. The mano is also extensively battered around a single edge, which also forms the edge of the convex use surface (7.4 by 6.0 by 5.5 cm, 340 grams).

Mano/Hammerstone (LA 129214, FS 1557): This complete, brown quartzite cobble may have functioned as both a hammerstone and a mano. It is oval in plan and displays facets that are moderately ground, which displays polish on the high points. The wear surfaces are slightly pitted; this may be the result of crushing. Crushing or hammerstone wear is present on nearly every projecting edge and is overlain by areas of light grinding. Hammerstone use appears to be confined to half of the perimeter. Both ground facets are slightly convex on both axes. Wear striations are not visible on these facets (6.6 by 5.9 by 5.5 cm, 290 grams).

Mano or Abrader (LA 129214, FS 1858): This is a complete, unmodified, flattened cobble of yellow-brown sandstone. It is teardrop-shaped and is plano-convex in TXS. It is lightly ground on the flat surface. Both the teardrop plan shape and the thin cross section are atypical of the mano assemblage (11.4 by 7.5 by 2.7 cm, 225 grams). It displays light grinding only and may have had a limited use-life.

Mano Reshaped from a Metate Fragment (LA 129214, FS 585): This small, one-hand mano displays the metate surface on the dorsal surface and is heavily ground on the ventral side. Both axes of the ventral surface are convex. It is light-brown sandstone. The mano is flaked into a roughly triangular shape (6.1 by 3.9 by 1.5 cm, 32 grams).

Mano Reshaped from a Metate Fragment (LA 113042, FS 1015): This mano has been reshaped from a basin metate fragment. Of the four artifacts of this type in the assemblage, this is the single complete specimen. It may also have been used with two hands overlain, based on its length (14.8 by 10.4 by 4.6 cm, 854 grams). It is of gray, fine-grained sandstone and is fully shaped by pecking into an oval plan shape. The dorsal surface retains portions of the original basin metate border and concave use surface. This metate source material creates a wedge shaped TXC and LXC. The ventral mano use-surface is convex both in TXC and LXC. This is the largest mano from the project, with the possible exception of LA 129214, FS 321, below. The dorsal metate surface does not display secondary wear as a mano.

Mano Reshaped from a Bifacial Metate Fragment (LA 129214, FS 1176): This artifact is a brown sandstone slab originally used as a bifacial metate. Following breakage, the wedge-shaped fragment formed by the metate edge and the use surface was bimarginally flaked around the entire perimeter into an oval. As the mano was not used after shaping, both metate use-surfaces remain. The distal edge of the mano is well shaped by pecking. It cannot be determined if this pecking was done as part of the mano's shaping or as the original metate edge (15.6 by 12.5 by 4.8 cm, 1250 grams).

One Hand Mano Reshaped from a Metate Fragment (LA 129214, FS 722): This brown-sandstone metate fragment is shaped by flaking, pecking, and grinding into a subrectangular shape. The concave metate surface is evident on the dorsal side, and the ventral side is heavily ground. The distal side of the mano is also heavily ground, whether from use, shaping, or the original metate edge is indeterminate. This distal edge is also unusual in that it slopes away from the user toward the ventral surface (Fig. 19.14). This one-hand mano is reshaped from metate fragment with unusual distal edge shape. In addition to grinding wear on the ventral surface, the distal edge is rounded and polished from use. This edge also appears to have been maintained by bimarginal flaking. It measures 12.6 by 9.1 by 4.1 cm and weighs 730 grams. The proximal edge thickness is 1.2 cm.

One Hand Mano with Angled Striations (LA 129214, FS 1347): This heavily used, red-sandstone mano is shaped by flaking and pecking into an oval shape. It displays two use-surfaces, both of which are convex on both axes. It is wedge-shaped in transverse and longitudinal cross sections. The most interesting characteristic of this mano is the presence of multidirectional striations on both use-surfaces, which is unusual for manos with this cross section shape. It measures 14.2 by 9.8 by 3 cm and weighs 547 grams.

One Hand Mano with deep striations (LA 129214, FS 524): This artifact is formed from an unmodified, oval, limestone cobble. It is biconvex in cross section and ground on two opposing surfaces. Interestingly, one use-surface displays deep multidirectional scratches and the other, bidirectional striations. It is burned and sooted (6.5 by 5.4 by 4.7 cm, 270 grams).

One Hand Mano (LA 129216, FS 903): This artifact is of fine-grained, red hematitic sandstone. It is somewhat roughly shaped by flaking and pecking into an oval plan shape. Both the ventral and dorsal surfaces are slightly convex. The TXS is also wedge shaped. The ventral surface displays moderate use and is not resharpened. The dorsal surface displays very light grinding, which appears to be for shaping only. The mano measures 12.4 by 8.8 by 4.3 cm and weighs 511 grams. It is refit from two pieces, with one small corner missing. Nearly the entire surface is burned and sooted.

One Hand Mano with Angled Facets (LA 113042, FS 674): This is a very well shaped, one-hand mano displaying atypical wear facets. These facets appear to be the result of moving the mano at an angle to the user (Fig. 19.15). It is formed from well-cemented, fine-grained red sandstone into a subrectangular form. Both the dorsal and ventral surfaces exhibit a flat LXC. The heavily worn, atypical wear facets are visible on both the ventral and dorsal surfaces, oriented at an angle to the long axis of the mano. As a result of these angled facets, the TXS differs on both ends. One end displays a wedge TXS, the other a sinuous facet from the proximal to the ventral edge. The proximal edge of the mano is worn to a thin 4 mm edge. The mano measures 11 by 8.1 by 3.8 cm and weighs 450 grams.

Two Hand Loaf Mano/Pigment Grinder (LA 129214, FS 321): This large, unshaped sandstone cobble may have been used to grind red pigment or was painted with red pigment. The material color is indeterminate due to the caliche covering the entire artifact. It is lightly ground on one convex TXC, flat LXC surface only. The ground surface displays red pigment over most of the use area as well as one lengthwise side. The tool is unique in its thick, loaf-shaped, biconvex TXS and high weight. It is also unusual for the project in that it would require two hands to manipulate. Because it is very large and heavy and displays little wear, it may have been painted with pigment and did not function as a mano. Both the grinding wear and the red pigment occur on the cortical surface. The tool measures 23.2 by 11 by 8.1 cm and weighs 350 grams. One small corner is missing.

Small Oval Sandstone Mano (LA 129214, FS 300): This is a one-hand mano of red sandstone. It is similar to FS 1015 in that it is wedge shaped in both TXS and LXS. The mano is pecked and flaked into an oval plan shape. The most heavily worn surface is convex both in TXC and LXC, and the dorsal surface is flat in TXC and LXC. The mano is worn quite thin, to 6 cm, around approximately half of the perimeter. The distal edge is considerably thicker at 3.10 cm. The longitudinal asymmetry of this mano and FS 1015 suggest that pressure was applied unevenly to the dorsal surface, possibly with the hand placed off-center at the thinnest edge (10.7 by 8.7 by 3.1 cm, 378 grams).

Airfoil Cross Section Mano (FS 129214, FS 339): This lateral fragment is worthy of inclusion here due to its atypical "airfoil" cross section. The heavily ground ventral and dorsal use-surfaces bisect, forming a well defined facet. This facet is parallel to the length for about half of the perimeter, curving up toward the dorsal surface near the proximal edge, creating a sinuous line. (Fig. 19.16). This sinuous facet may result from a semicircular stroke in a basin metate. The upward curve of the facet indicates that it was not used on a flat surface. A rocking stroke may have created the bisected use-surfaces. It may have been formed from a cobble; however, use obscures most of the raw material form (red sandstone, 9.7 [incomplete] by 7.0 by 4.6 cm, 372 grams).

Metates

Dolomite Cobble Metate (LA 129214, FS 1774): This artifact is formed from a flattened, unmodified dolomite cobble that is shaped by pecking around most of the perimeter. One surface is naturally convex and serves as the metate base; the opposing surface is concave and is very lightly ground. It measures 21.5 by 15.0 by 2.6 cm and weighs 260 grams. It was recovered from Level 3, Strat 2, Square 406.91, 349.90E, Block 19.

Triangular Hand-held Metate (LA 113042, FS 591): This is a small, triangular metate that displays a narrow, deeply concave wear surface, which is open at the triangle base and closed at the apex, resembling a small trough. It appears to be complete. It is formed from white sandstone and is mostly covered with caliche, obscuring most of the wear surface. Its small size probably indicates that it was hand-held, and the narrow basin was probably ground reciprocally (13.5 by 11.5 by 3.3 cm, 540 grams). It is ground to a depth of 1.5 cm and was recovered from Level 2, Stratum 2 of Square 457.16N, 518.16E, Block 2.

Sandstone Cobble Metate Preform (LA 113042, FS 540): This is an unutilized, complete metate preform modified by shaping around the sides only. It is an oval, red sandstone cobble pecked to shape around the sides. The naturally concave surface has not been utilized, but caliche may obscure wear patterns. The convex base and concave potential working surface are natural cobble contours. It measures 22.7 by 12.3 by 7.3 cm and weighs 3400 grams. It was recovered from Level 1, Strat 1, Block 1, Square 463N, 515E.

Limestone Metate Preform (FS 129214, FS 1720): This complete metate, formed from a limestone slab, is roughly flaked into an oval shape. The entire perimeter, base, and working surface are flaked to shape. The concave surface is not ground but is slightly pitted. It measures 22 by 18.5 by 6.5 cm and weighs 3400 grams. It was recovered from the fill of F.156, Block 12, Square 506.84N, 461.76E.

Small Bifacial Basin Metate (LA 113042, FS 1032-1): This fragmentary basin metate is made of well cemented, red hematitic sandstone. Its most remarkable characteristic is that it displays two opposing ground basins. It is pecked and flaked around the perimeter to a roughly oval shape. This metate was used first as a basin. It broke and was then flipped over and reused on the reverse side as a basin. Apparently, the item broke again, and ceased its life as a tool. Its final condition is in two refit pieces, with neither basin metate in complete form. Only a corner of the first basin metate is present and appears to have been quite large. The basin on this side is fairly well defined, bordered by a 9 cm pecked shelf, and deeply ground to a 3 cm depth. Although the original basin is incomplete, it may have been wider than the reverse basin, ground with a circular or semicircular stroke. No resharpening of the first basin is evident. The complete dimensions of the metate and the basin are not obtainable. When this first metate broke, one fragment was flipped over and another basin was ground. This basin is very well defined, (10 by 26 cm), deeply ground to a 1.8 cm depth, and is bordered by a 3 to 5 cm shelf. It appears to have been ground reciprocally, as the basin is long and narrow. The second breakage left this basin fragmentary as well, though the basin dimensions listed earlier appear to be nearly complete. The thickness between the two basins at the most deeply worn point is 0.67 cm. The outside dimensions measure 33 (complete for the second basin) by 17 (incomplete for both basins) by 4.7 cm (possibly complete for both basins).

Limestone Basin Metate (LA 129214, FS 1633): This limestone slab has been shaped by flaking and pecking into a circular shape. It is mostly complete, with about one-third missing from the edge. A small, shallow, circular basin has been shaped in the center of one surface. It is lightly ground, with pitting wear also present inside the basin. The convex base is lightly ground to shape. It measures 18.8 by 12.5 by 4.0 cm and weighs 1.95 kg.

Appendix 3 ⚶ OxCal Data Tables

Table App3.1. Calibrated probabilities for Nash Draw radiometric determinations.

Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 68.2% probability	MCMC sampled calibrated age 95.4% probability
(Sequence)					
Boundary				4690BC (68.2%) 4520BC	4850BC (95.4%) 4490BC
(Phase)					
218-8-14m : 5720±40BP	Beta-258926	4620BC (68.2%) 4490BC	4690BC (95.4%) 4460BC	4585BC (68.2%) 4485BC	4660BC (95.4%) 4450BC
300-4-20m : 5710±40BP	Beta-258931	4610BC (68.2%) 4490BC	4690BC (10.7%) 4630BC 4620BC (84.7%) 4450BC	4580BC (68.2%) 4460BC	4660BC (95.4%) 4450BC
130738F19m : 5590±40BP	Beta-245413	4455BC (68.2%) 4365BC	4500BC (95.4%) 4340BC	4455BC (68.2%) 4365BC	4500BC (95.4%) 4340BC
218-11-23m : 5520±40BP	Beta-258928	4450BC (18.7%) 4420BC 4400BC (49.5%) 4330BC	4460BC (93.1%) 4320BC 4290BC (2.3%) 4270BC	4450BC (18.7%) 4420BC 4400BC (49.5%) 4330BC	4460BC (93.3%) 4320BC 4290BC (2.1%) 4270BC
218-9-16m : 5480±40BP	Beta-258927	4365BC (47.3%) 4320BC 4295BC (20.9%) 4265BC	4450BC (5.5%) 4410BC 4400BC (89.9%) 4240BC	4365BC (47.4%) 4320BC 4295BC (20.8%) 4265BC	4450BC (5.6%) 4410BC 4400BC (89.8%) 4240BC
300-10-23c : 5390±40BP	Beta-258932	4330BC (65.6%) 4230BC 4190BC (2.6%) 4180BC	4340BC (70.6%) 4220BC 4210BC (13.7%) 4150BC 4140BC (11.0%) 4060BC	4330BC (68.2%) 4230BC	4350BC (78.4%) 4220BC 4210BC (12.9%) 4150BC 4130BC (1.7%) 4110BC 4100BC (2.4%) 4070BC
130738F11m : 5260±40BP	Beta-245412	4230BC (9.8%) 4200BC 4170BC (20.9%) 4100BC 4080BC (37.5%) 3990BC	4230BC (14.2%) 4190BC 4180BC (81.2%) 3970BC	4240BC (40.7%) 4190BC 4180BC (27.5%) 4100BC	4240BC (95.4%) 3990BC
(Phase)					
Boundary				4220BC (68.2%) 4010BC	4240BC (95.4%) 3770BC
Boundary				3500BC (68.2%) 2300BC	4100BC (95.4%) 2300BC
(Phase)					
130738F10m : 3930±40BP	Beta-212702	2480BC (68.2%) 2340BC	2570BC (7.2%) 2520BC 2500BC (88.2%) 2290BC	2480BC (68.2%) 2340BC	2570BC (7.3%) 2520BC 2500BC (88.1%) 2290BC
(Phase)					
Boundary				2500BC (68.2%) 1450BC	2500BC (95.4%) 1000BC
Boundary				1020BC (68.2%) 870BC	1180BC (95.4%) 840BC
(Phase)					
042-1-40m : 2780±40BP	Beta-258898	1000BC (64.6%) 890BC 870BC (3.6%) 850BC	1020BC (95.4%) 820BC	940BC (68.2%) 845BC	1000BC (95.4%) 830BC
132494F3f : 2770±40BP	Beta-212706	980BC (48.0%) 890BC 880BC (20.2%) 840BC	1010BC (95.4%) 820BC	935BC (68.2%) 845BC	990BC (95.4%) 820BC
132494F12m : 2720±50BP	Beta-212712	910BC (68.2%) 815BC	980BC (95.4%) 790BC	920BC (68.2%) 840BC	980BC (95.4%) 800BC
109291FS#36?* : 2710±80BP	Beta-88645	970BC (2.1%) 960BC 940BC (66.1%) 790BC	1120BC (95.4%) 760BC	925BC (68.2%) 835BC	1000BC (95.4%) 800BC
(Phase)					
Boundary				810BC (68.2%) 790BC	970BC (95.4%) 630BC
Boundary				530BC (68.2%) 180BC	750BC (95.4%) 50BC
(Phase)					
ENM10418-R2? : 2270±80BP	TX-5026	410BC (23.7%) 340BC 330BC (44.5%) 200BC	550BC (95.4%) 50BC	400BC (9.5%) 350BC 320BC (58.7%) 170BC	420BC (95.4%) 40BC
98820-539/5407* : 2040±80BP	Beta-139029	170BC (68.2%) 50AD	360BC (4.4%) 290BC 230BC (91.0%) 130AD	170BC (8.2%) 130BC 120BC (60.0%) 50AD	350BC (1.5%) 310BC 230BC (93.9%) 130AD
98820-5447* : 1940±70BP	Beta-139032	40BC (68.2%) 130AD	110BC (95.4%) 240AD	40BC (68.2%) 130AD	110BC (95.4%) 220AD

Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 68.2% probability	MCMC sampled calibrated age 95.4% probability
(Sequence)					
Boundary				4690BC (68.2%) 4520BC	4850BC (95.4%) 4490BC
(Phase)					
218-8-14m : 5720±40BP	Beta-258926	4620BC (68.2%) 4490BC	4690BC (95.4%) 4460BC	4585BC (68.2%) 4485BC	4660BC (95.4%) 4450BC
300-4-20m : 5710±40BP	Beta-258931	4610BC (68.2%) 4490BC	4690BC (10.7%) 4630BC 4620BC (84.7%) 4450BC	4580BC (68.2%) 4460BC	4660BC (95.4%) 4450BC
130738F19m : 5590±40BP	Beta-245413	4455BC (68.2%) 4365BC	4500BC (95.4%) 4340BC	4455BC (68.2%) 4365BC	4500BC (95.4%) 4340BC
218-11-23m : 5520±40BP	Beta-258928	4450BC (18.7%) 4420BC 4400BC (49.5%) 4330BC	4460BC (93.1%) 4320BC 4290BC (2.3%) 4270BC	4450BC (18.7%) 4420BC 4400BC (49.5%) 4330BC	4460BC (93.3%) 4320BC 4290BC (2.1%) 4270BC
218-9-16m : 5480±40BP	Beta-258927	4365BC (47.3%) 4320BC 4295BC (20.9%) 4265BC	4450BC (5.5%) 4410BC 4400BC (89.9%) 4240BC	4365BC (47.4%) 4320BC 4295BC (20.8%) 4265BC	4450BC (5.6%) 4410BC 4400BC (89.8%) 4240BC
300-10-23c : 5390±40BP	Beta-258932	4330BC (65.6%) 4230BC 4190BC (2.6%) 4180BC	4340BC (70.6%) 4220BC 4210BC (13.7%) 4150BC 4140BC (11.0%) 4060BC	4330BC (68.2%) 4230BC	4350BC (78.4%) 4220BC 4210BC (12.9%) 4150BC 4130BC (1.7%) 4110BC 4100BC (2.4%) 4070BC
130738F11m : 5260±40BP	Beta-245412	4230BC (9.8%) 4200BC 4170BC (20.9%) 4100BC 4080BC (37.5%) 3990BC	4230BC (14.2%) 4190BC 4180BC (81.2%) 3970BC	4240BC (40.7%) 4190BC 4180BC (27.5%) 4100BC	4240BC (95.4%) 3990BC
(Phase)					
Boundary				4220BC (68.2%) 4010BC	4240BC (95.4%) 3770BC
Boundary				3500BC (68.2%) 2300BC	4100BC (95.4%) 2300BC
(Phase)					
130738F10m : 3930±40BP	Beta-212702	2480BC (68.2%) 2340BC	2570BC (7.2%) 2520BC 2500BC (88.2%) 2290BC	2480BC (68.2%) 2340BC	2570BC (7.3%) 2520BC 2500BC (88.1%) 2290BC
(Phase)					
Boundary				2500BC (68.2%) 1450BC	2500BC (95.4%) 1000BC
Boundary				1020BC (68.2%) 870BC	1180BC (95.4%) 840BC
(Phase)					
042-1-40m : 2780±40BP	Beta-258898	1000BC (64.6%) 890BC 870BC (3.6%) 850BC	1020BC (95.4%) 820BC	940BC (68.2%) 845BC	1000BC (95.4%) 830BC
132494F3f : 2770±40BP	Beta-212706	980BC (48.0%) 890BC 880BC (20.2%) 840BC	1010BC (95.4%) 820BC	935BC (68.2%) 845BC	990BC (95.4%) 820BC
132494F12m : 2720±50BP	Beta-212712	910BC (68.2%) 815BC	980BC (95.4%) 790BC	920BC (68.2%) 840BC	980BC (95.4%) 800BC
109291FS#36?* : 2710±80BP	Beta-88645	970BC (2.1%) 960BC 940BC (66.1%) 790BC	1120BC (95.4%) 760BC	925BC (68.2%) 835BC	1000BC (95.4%) 800BC
(Phase)					
Boundary				810BC (68.2%) 790BC	970BC (95.4%) 630BC
Boundary				530BC (68.2%) 180BC	750BC (95.4%) 50BC
(Phase)					
ENM10418-R2? : 2270±80BP	TX-5026	410BC (23.7%) 340BC 330BC (44.5%) 200BC	550BC (95.4%) 50BC	400BC (9.5%) 350BC 320BC (58.7%) 170BC	420BC (95.4%) 40BC
98820-539/5407* : 2040±80BP	Beta-139029	170BC (68.2%) 50AD	360BC (4.4%) 290BC 230BC (91.0%) 130AD	170BC (8.2%) 130BC 120BC (60.0%) 50AD	350BC (1.5%) 310BC 230BC (93.9%) 130AD
98820-5447* : 1940±70BP	Beta-139032	40BC (68.2%) 130AD	110BC (95.4%) 240AD	40BC (68.2%) 130AD	110BC (95.4%) 220AD

(Table App3.1, continued)

Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 68.2% probability	MCMC sampled calibrated age 95.4% probability
		320AD (57.7%) 410AD		320AD (60.6%) 410AD	
216-7-17m : 1670±40BP	Beta-258921	260AD (3.3%) 280AD 330AD (64.9%) 430AD	250AD (90.8%) 440AD 480AD (4.6%) 530AD	335AD (68.2%) 420AD	250AD (95.4%) 430AD
214-6-64m : 1660±40BP	Beta-258479	260AD (2.0%) 280AD 330AD (66.2%) 430AD	250AD (86.3%) 470AD 480AD (9.1%) 540AD	340AD (68.2%) 425AD	250AD (11.2%) 300AD 310AD (84.2%) 440AD
214-8-71m : 1650±40BP	Beta-258480	330AD (65.1%) 440AD 490AD (3.1%) 510AD	250AD (5.1%) 290AD 320AD (90.3%) 540AD	345AD (68.2%) 430AD	250AD (8.0%) 300AD 320AD (87.4%) 440AD
214-10-76m : 1650±40BP	Beta-258484	330AD (65.1%) 440AD 490AD (3.1%) 510AD	250AD (5.1%) 290AD 320AD (90.3%) 540AD	345AD (68.2%) 430AD	250AD (8.3%) 300AD 320AD (87.1%) 440AD
98820-27 : 1650±60BP	Beta-101477	260AD (3.7%) 280AD 330AD (50.3%) 440AD 480AD (14.3%) 530AD	250AD (95.4%) 540AD	260AD (1.1%) 280AD 330AD (67.1%) 430AD	250AD (95.4%) 450AD
(Phase) Boundary (Phase)				415AD (68.2%) 460AD	405AD (95.4%) 485AD
ENM10418-FU? : 1610±60BP	Beta-10470	390AD (68.2%) 540AD	250AD (2.4%) 290AD 320AD (93.0%) 590AD	455AD (68.2%) 540AD	420AD (95.4%) 580AD
216-6-13m : 1610±40BP	Beta-258916	400AD (34.8%) 470AD 480AD (33.4%) 540AD	340AD (95.4%) 550AD	460AD (1.4%) 470AD 475AD (66.8%) 540AD	420AD (95.4%) 550AD
214-8-80m : 1610±40BP	Beta-258486	400AD (34.8%) 470AD 480AD (33.4%) 540AD	340AD (95.4%) 550AD	475AD (68.2%) 535AD	420AD (95.4%) 550AD
214-12-109m : 1610±40BP	Beta-232980	400AD (34.8%) 470AD 480AD (33.4%) 540AD	340AD (95.4%) 550AD	460AD (1.1%) 470AD 475AD (67.1%) 535AD	420AD (95.4%) 550AD
300-00-44? : 1600±40BP	Beta-258941	410AD (31.3%) 470AD 480AD (36.9%) 540AD	380AD (95.4%) 560AD	465AD (68.2%) 540AD	420AD (95.4%) 560AD
ENM10418-9? : 1590±50BP	TX-5010	420AD (68.2%) 540AD	340AD (95.4%) 590AD	455AD (68.2%) 540AD	420AD (95.4%) 580AD
214-12-110m : 1590±40BP	Beta-258503	420AD (68.2%) 540AD	390AD (95.4%) 570AD	465AD (68.2%) 540AD	420AD (95.4%) 560AD
216-8-20m : 1580±40BP	Beta-232995	430AD (68.2%) 540AD	400AD (95.4%) 570AD	460AD (68.2%) 540AD	430AD (95.4%) 570AD
214-6-82m : 1570±40BP	Beta-258487	430AD (68.2%) 540AD	400AD (95.4%) 580AD	460AD (68.2%) 545AD	430AD (95.4%) 580AD
214-12-129m : 1560±40BP	Beta-258510	430AD (68.2%) 550AD	410AD (95.4%) 590AD	455AD (68.2%) 550AD	430AD (95.4%) 590AD
130738F4m : 1560±40BP	Beta-212701	430AD (68.2%) 550AD	410AD (95.4%) 590AD	455AD (68.2%) 550AD	430AD (95.4%) 590AD
216-8-19m : 1560±40BP	Beta-232994	430AD (68.2%) 550AD	410AD (95.4%) 590AD	455AD (68.2%) 550AD	430AD (95.4%) 590AD
98820-525/526?* : 1550±60BP	Beta-139023	430AD (68.2%) 570AD	390AD (95.4%) 640AD	450AD (68.2%) 570AD	430AD (95.4%) 620AD
300-7-38u : 1540±40BP	Beta-258936	430AD (68.2%) 570AD	420AD (95.4%) 610AD	450AD (68.2%) 580AD	430AD (95.4%) 610AD
132494F1m : 1540±50BP	Beta-212705	430AD (68.2%) 580AD	410AD (95.4%) 620AD	460AD (68.2%) 580AD	430AD (95.4%) 620AD
042-2-64as : 1540±40BP	Beta-258905	430AD (68.2%) 570AD	420AD (95.4%) 610AD	450AD (68.2%) 580AD	430AD (95.4%) 610AD
113044-4? : 1530±60BP	Beta-101475	430AD (27.7%) 490AD 500AD (40.5%) 600AD	410AD (95.4%) 640AD	460AD (68.2%) 600AD	430AD (95.4%) 640AD
214-6-68m : 1520±40BP	Beta-232974	440AD (18.0%) 490AD 530AD (50.2%) 610AD	420AD (95.4%) 620AD	460AD (11.5%) 490AD 530AD (56.7%) 610AD	430AD (95.4%) 620AD
ENM10418-FQ? : 1520±60BP	Beta-10469	430AD (24.0%) 490AD 500AD (44.2%) 610AD	420AD (95.4%) 650AD	460AD (68.2%) 610AD	430AD (95.4%) 640AD
300-7-41m : 1520±40BP	Beta-258938	440AD (18.0%) 490AD 530AD (50.2%) 610AD	420AD (95.4%) 620AD	460AD (11.1%) 490AD 530AD (57.1%) 610AD	430AD (95.4%) 620AD
300-00-43? : 1520±40BP	Beta-258940	440AD (18.0%) 490AD	420AD (95.4%) 620AD	460AD (11.7%) 490AD	430AD (95.4%) 620AD
Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 68.2% probability	MCMC sampled calibrated age 95.4% probability
		530AD (50.2%) 610AD		530AD (56.5%) 610AD	
214-16-180m : 1520±40BP	Beta-258534	440AD (18.0%) 490AD 530AD (50.2%) 610AD	420AD (95.4%) 620AD	460AD (11.1%) 490AD 530AD (57.1%) 610AD	430AD (95.4%) 620AD
214-18-159m : 1510±40BP	Beta-258528	460AD (7.0%) 490AD 530AD (61.2%) 610AD	430AD (95.4%) 640AD	460AD (3.9%) 480AD 530AD (64.3%) 610AD	440AD (95.4%) 640AD
214-6-63m : 1500±40BP	Beta-258478	535AD (68.2%) 620AD	430AD (95.4%) 650AD	535AD (68.2%) 615AD	440AD (95.4%) 650AD
042-12-58m : 1500±40BP	Beta-275121	535AD (68.2%) 620AD	430AD (95.4%) 650AD	535AD (68.2%) 615AD	440AD (95.4%) 650AD
98820-524?* : 1480±60BP	Beta-139022	530AD (68.2%) 650AD	430AD (95.4%) 660AD	540AD (68.2%) 640AD	440AD (95.4%) 660AD
216-10-16m : 1470±40BP	Beta-258917	565AD (68.2%) 635AD	460AD (1.1%) 480AD 530AD (94.3%) 660AD	560AD (68.2%) 635AD	530AD (95.4%) 660AD
98820-527/528? : 1460±40BP	Beta-139024	570AD (68.2%) 640AD	530AD (95.4%) 660AD	575AD (68.2%) 640AD	530AD (95.4%) 660AD
042-18-77m : 1450±40BP	Beta-275122	580AD (68.2%) 645AD	540AD (95.4%) 660AD	580AD (68.2%) 645AD	540AD (95.4%) 660AD
132494F5f : 1450±40BP	Beta-212708	580AD (68.2%) 645AD	540AD (95.4%) 660AD	580AD (68.2%) 645AD	540AD (95.4%) 660AD
132494F9f : 1450±40BP	Beta-212710	580AD (68.2%) 645AD	540AD (95.4%) 660AD	580AD (68.2%) 645AD	540AD (95.4%) 660AD
43276-2? : 1440±80BP	Beta-101482	540AD (68.2%) 670AD	420AD (93.4%) 720AD 740AD (2.0%) 770AD	540AD (68.2%) 660AD	440AD (93.3%) 710AD 740AD (2.1%) 770AD
214-6-55m : 1440±40BP	Beta-232972	585AD (68.2%) 650AD	550AD (95.4%) 660AD	590AD (68.2%) 650AD	550AD (95.4%) 660AD
ENM10418-35? : 1430±80BP	TX-5021	540AD (68.2%) 670AD	420AD (92.3%) 720AD 740AD (3.1%) 770AD	540AD (68.2%) 670AD	440AD (92.2%) 720AD 740AD (3.2%) 770AD
042-12-67m : 1430±40BP	Beta-258907	595AD (68.2%) 655AD	550AD (95.4%) 670AD	595AD (68.2%) 655AD	550AD (95.4%) 670AD
132494F4m : 1420±50BP	Beta-212707	590AD (68.2%) 660AD	540AD (95.4%) 680AD	590AD (68.2%) 660AD	540AD (95.4%) 680AD
214-12-105m : 1420±40BP	Beta-258501	600AD (68.2%) 655AD	560AD (95.4%) 670AD	600AD (68.2%) 655AD	560AD (95.4%) 670AD
300-12-25m : 1400±40BP	Beta-258933	610AD (68.2%) 660AD	570AD (95.4%) 680AD	610AD (68.2%) 660AD	560AD (95.4%) 680AD
214-15-151m : 1400±40BP	Beta-258524	610AD (68.2%) 660AD	570AD (95.4%) 680AD	610AD (68.2%) 660AD	570AD (95.4%) 680AD
214-9-152m : 1390±40BP	Beta-232987	615AD (68.2%) 665AD	570AD (95.4%) 690AD	610AD (68.2%) 665AD	570AD (95.4%) 690AD
130740F10wl : 1390±40BP	Beta-212703	615AD (68.2%) 665AD	570AD (95.4%) 690AD	615AD (68.2%) 665AD	570AD (95.4%) 690AD
214-5-300/67m : 1380±40BP	Beta-232973	620AD (68.2%) 675AD	580AD (92.7%) 710AD 740AD (2.7%) 770AD	620AD (68.2%) 675AD	570AD (92.4%) 700AD 740AD (3.0%) 770AD
042-17-73m : 1380±40BP	Beta-258909	620AD (68.2%) 675AD	580AD (92.7%) 710AD 740AD (2.7%) 770AD	615AD (68.2%) 670AD	570AD (92.6%) 710AD 740AD (2.8%) 770AD
214-5-300/61m : 1380±40BP	Beta-258476	620AD (68.2%) 675AD	580AD (92.7%) 710AD 740AD (2.7%) 770AD	620AD (68.2%) 675AD	570AD (92.9%) 700AD 740AD (2.5%) 770AD
ENM10230-1a? : 1370±60BP	TX-5031	600AD (63.0%) 690AD 750AD (5.2%) 770AD	560AD (95.4%) 780AD	600AD (63.1%) 700AD 750AD (5.1%) 770AD	560AD (95.4%) 780AD
300-7-37m : 1370±40BP	Beta-258937	630AD (68.2%) 685AD	590AD (90.1%) 720AD 740AD (5.3%) 770AD	625AD (68.2%) 685AD	590AD (90.2%) 720AD 740AD (5.2%) 770AD
214-12-119m : 1370±40BP	Beta-258509	630AD (68.2%) 685AD	590AD (90.1%) 720AD 740AD (5.3%) 770AD	620AD (68.2%) 685AD	590AD (90.1%) 720AD 740AD (5.3%) 770AD
109920FS#33* : 1360±70BP	Beta-88639	600AD (58.4%) 720AD 740AD (9.8%) 770AD	540AD (94.2%) 820AD 840AD (1.2%) 860AD	600AD (58.5%) 720AD 740AD (9.7%) 770AD	540AD (94.3%) 820AD 840AD (1.1%) 860AD
ENM10418-25? : 1350±60BP	TX-5014	630AD (55.2%) 720AD 740AD (13.0%) 770AD	560AD (95.4%) 810AD	630AD (55.8%) 720AD 740AD (12.4%) 770AD	560AD (95.4%) 810AD
042-1-49cz : 1350±40BP	Beta-258902	640AD (61.8%) 690AD 750AD (6.4%) 770AD	610AD (95.4%) 770AD	640AD (63.0%) 690AD 750AD (5.2%) 770AD	610AD (95.4%) 780AD
042-15-82m : 1350±40BP	Beta-258911	640AD (61.8%) 690AD	610AD (95.4%) 770AD	640AD (62.9%) 690AD	610AD (95.4%) 780AD

(Table App3.1, continued)

Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 68.2% probability	MCMC sampled calibrated age 95.4% probability
		750AD (6.4%) 770AD		750AD (5.3%) 770AD	
109294FS#797* : 1350±60BP	Beta-88651	630AD (55.2%) 720AD 740AD (13.0%) 770AD	560AD (95.4%) 810AD	630AD (55.9%) 720AD 740AD (12.3%) 770AD	560AD (95.4%) 810AD
042-22-81m : 1330±40BP	Beta-258914	650AD (53.7%) 710AD 740AD (14.5%) 770AD	640AD (95.4%) 780AD	650AD (54.1%) 710AD 740AD (14.1%) 770AD	640AD (95.4%) 780AD
214-20-178m : 1330±40BP	Beta-258533	650AD (53.7%) 710AD 740AD (14.5%) 770AD	640AD (95.4%) 780AD	650AD (54.1%) 710AD 740AD (14.1%) 770AD	640AD (95.4%) 780AD
214-9-94m : 1320±40BP	Beta-232977	650AD (51.7%) 710AD 740AD (16.5%) 770AD	640AD (95.4%) 780AD	650AD (51.4%) 710AD 740AD (16.8%) 770AD	640AD (95.4%) 780AD
214-16-182m : 1320±40BP	Beta-258536	650AD (51.7%) 710AD 740AD (16.5%) 770AD	640AD (95.4%) 780AD	650AD (51.8%) 710AD 740AD (16.4%) 770AD	640AD (95.4%) 780AD
300-12-26m : 1320±40BP	Beta-258934	650AD (51.7%) 710AD 740AD (16.5%) 770AD	640AD (95.4%) 780AD	650AD (51.8%) 710AD 740AD (16.4%) 770AD	640AD (95.4%) 780AD
214-13-141m : 1320±40BP	Beta-232986	650AD (51.7%) 710AD 740AD (16.5%) 770AD	640AD (95.4%) 780AD	650AD (51.6%) 710AD 740AD (16.6%) 770AD	640AD (95.4%) 780AD
214-9-156m : 1320±40BP	Beta-258527	650AD (51.7%) 710AD 740AD (16.5%) 770AD	640AD (95.4%) 780AD	650AD (50.6%) 710AD 740AD (17.6%) 770AD	640AD (95.4%) 780AD
214-12-120m : 1310±40BP	Beta-232984	660AD (48.6%) 720AD 740AD (19.6%) 770AD	640AD (95.4%) 780AD	660AD (49.0%) 720AD 740AD (19.2%) 770AD	640AD (95.4%) 780AD
214-5-57m : 1310±40BP	Beta-258473	660AD (48.6%) 720AD 740AD (19.6%) 770AD	640AD (95.4%) 780AD	660AD (48.5%) 720AD 740AD (19.7%) 770AD	640AD (95.4%) 780AD
214-5-74m : 1300±40BP	Beta-232975	660AD (45.7%) 720AD 740AD (22.5%) 770AD	640AD (95.4%) 810AD	660AD (46.7%) 720AD 740AD (21.5%) 770AD	640AD (95.4%) 810AD
ENM10418-317 : 1290±70BP	TX-5018	650AD (64.0%) 780AD 790AD (4.2%) 810AD	620AD (95.4%) 900AD	650AD (63.4%) 780AD 790AD (4.8%) 810AD	620AD (95.4%) 900AD
214-12-103cz : 1290±40BP	Beta-232979	660AD (42.9%) 730AD 740AD (25.3%) 770AD	650AD (94.3%) 820AD 840AD (1.1%) 860AD	665AD (42.8%) 720AD 735AD (25.4%) 770AD	650AD (95.4%) 820AD
042-6-46m : 1290±40BP	Beta-258901	660AD (42.9%) 730AD 740AD (25.3%) 770AD	650AD (94.3%) 820AD 840AD (1.1%) 860AD	670AD (42.5%) 720AD 740AD (25.7%) 770AD	650AD (94.1%) 820AD 840AD (1.3%) 860AD
214-12-136m : 1290±40BP	Beta-258515	660AD (42.9%) 730AD 740AD (25.3%) 770AD	650AD (94.3%) 820AD 840AD (1.1%) 860AD	665AD (44.5%) 725AD 740AD (23.7%) 770AD	650AD (94.2%) 820AD 840AD (1.2%) 860AD
130740F9m : 1290±40BP	Beta-220855	660AD (42.9%) 730AD 740AD (25.3%) 770AD	650AD (94.3%) 820AD 840AD (1.1%) 860AD	670AD (42.5%) 725AD 735AD (25.7%) 770AD	650AD (95.4%) 820AD
ENM10230-1b? : 1280±60BP	TX-5030	660AD (66.6%) 780AD 790AD (1.6%) 800AD	650AD (95.4%) 890AD	660AD (66.4%) 780AD 790AD (1.8%) 800AD	650AD (95.4%) 890AD
042-18-75m : 1280±40BP	Beta-258912	675AD (40.5%) 730AD 735AD (27.7%) 775AD	650AD (92.5%) 830AD 840AD (2.9%) 870AD	675AD (41.1%) 730AD 735AD (27.1%) 770AD	650AD (95.4%) 870AD
214-19-171m : 1280±40BP	Beta-232992	675AD (40.5%) 730AD 735AD (27.7%) 775AD	650AD (92.5%) 830AD 840AD (2.9%) 870AD	675AD (39.6%) 730AD 735AD (28.6%) 775AD	650AD (92.6%) 830AD 840AD (2.8%) 870AD
109294FS#63?* : 1270±70BP	Beta-88650	660AD (65.6%) 810AD 840AD (2.6%) 860AD	640AD (94.1%) 900AD 920AD (1.3%) 940AD	660AD (66.6%) 820AD 840AD (1.6%) 860AD	640AD (94.3%) 900AD 920AD (1.1%) 940AD
214-9-72m : 1270±40BP	Beta-258461	680AD (68.2%) 775AD	660AD (95.4%) 870AD	680AD (68.2%) 775AD	660AD (95.4%) 870AD
214-14-111m : 1270±40BP	Beta-232981	680AD (68.2%) 775AD	660AD (95.4%) 870AD	680AD (68.2%) 775AD	660AD (95.4%) 870AD
214-6-54as : 1270±40BP	Beta-258472	680AD (68.2%) 775AD	660AD (95.4%) 870AD	680AD (68.2%) 775AD	660AD (95.4%) 870AD
214-9-158m : 1250±40BP	Beta-232990	680AD (68.2%) 810AD	670AD (95.4%) 880AD	680AD (60.7%) 780AD	670AD (95.4%) 880AD

Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 68.2% probability	MCMC sampled calibrated age 95.4% probability
				790AD (7.5%) 810AD	
214-9-93m : 1250±40BP	Beta-258493	680AD (68.2%) 810AD	670AD (95.4%) 880AD	680AD (68.2%) 810AD	670AD (95.4%) 880AD
214-16-161m : 1250±40BP	Beta-258535	680AD (68.2%) 810AD	670AD (95.4%) 880AD	680AD (68.2%) 810AD	670AD (95.4%) 880AD
109291FS#407* : 1240±60BP	Beta-88646	680AD (68.2%) 870AD	660AD (93.4%) 900AD 920AD (2.0%) 940AD	680AD (60.9%) 830AD 840AD (7.3%) 870AD	660AD (93.4%) 900AD 920AD (2.0%) 950AD
214-7-87m : 1240±40BP	Beta-232978	680AD (61.6%) 820AD 840AD (6.6%) 860AD	670AD (95.4%) 890AD	680AD (34.9%) 750AD 760AD (29.1%) 820AD 840AD (4.2%) 860AD	670AD (95.4%) 890AD
ENM10418-387 : 1230±80BP	TX-5024	690AD (22.8%) 750AD 760AD (45.4%) 880AD	650AD (95.4%) 980AD	690AD (21.8%) 750AD 760AD (46.4%) 890AD	650AD (95.4%) 970AD
113045-2? : 1230±50BP	Beta-101478	710AD (17.9%) 750AD 760AD (50.3%) 880AD	660AD (95.4%) 900AD	710AD (18.4%) 750AD 760AD (49.8%) 870AD	660AD (95.4%) 900AD
132494F11m : 1220±40BP	Beta-212711	720AD (8.4%) 740AD 770AD (59.8%) 880AD	680AD (95.4%) 900AD	720AD (8.3%) 740AD 770AD (59.9%) 880AD	680AD (95.4%) 900AD
300-14-32m : 1210±40BP	Beta-258935	720AD (2.3%) 740AD 770AD (65.9%) 890AD	680AD (93.8%) 900AD 920AD (1.6%) 940AD	770AD (68.2%) 890AD	680AD (93.9%) 900AD 920AD (1.5%) 940AD
109292FS#677* : 1200±60BP	Beta-88647	710AD (9.4%) 750AD 760AD (58.8%) 900AD	680AD (95.4%) 960AD	710AD (8.9%) 750AD 760AD (59.3%) 900AD	680AD (95.4%) 970AD
132494F6m : 1200±60BP	Beta-212709	710AD (9.4%) 750AD 760AD (58.8%) 900AD	680AD (95.4%) 960AD	710AD (9.0%) 750AD 760AD (57.8%) 900AD 920AD (1.5%) 940AD	680AD (95.4%) 970AD
214-12-131m : 1200±40BP	Beta-258511	770AD (68.2%) 890AD	680AD (91.1%) 900AD 910AD (4.3%) 950AD	770AD (68.2%) 890AD	680AD (90.9%) 900AD 920AD (4.5%) 950AD
214-9-95m : 1200±40BP	Beta-258494	770AD (68.2%) 890AD	680AD (91.1%) 900AD 910AD (4.3%) 950AD	770AD (68.2%) 890AD	680AD (90.9%) 900AD 910AD (4.5%) 950AD
214-9-106cz : 1190±40BP	Beta-258502	770AD (68.2%) 890AD	690AD (7.8%) 750AD 760AD (87.6%) 970AD	770AD (68.2%) 890AD	690AD (8.0%) 750AD 760AD (87.4%) 970AD
214-10-77m : 1190±40BP	Beta-258485	770AD (68.2%) 890AD	690AD (7.8%) 750AD 760AD (87.6%) 970AD	780AD (68.2%) 890AD	690AD (7.4%) 750AD 760AD (88.0%) 970AD
214-15-161m : 1180±40BP	Beta-258529	770AD (68.2%) 900AD	710AD (4.0%) 750AD 760AD (91.4%) 980AD	770AD (68.2%) 900AD	710AD (3.6%) 750AD 760AD (91.8%) 980AD
113042-1a? : 1180±50BP	Beta-101471	770AD (63.6%) 900AD 920AD (4.6%) 940AD	690AD (8.5%) 750AD 760AD (86.9%) 960AD	770AD (63.2%) 900AD 920AD (5.0%) 940AD	690AD (8.4%) 750AD 760AD (87.0%) 980AD
300-12-40m : 1160±40BP	Beta-258939	780AD (4.1%) 790AD 800AD (49.8%) 900AD 910AD (14.3%) 950AD	770AD (95.4%) 980AD	780AD (3.9%) 790AD 800AD (50.0%) 900AD 910AD (14.3%) 950AD	770AD (95.4%) 980AD
113046-4? : 1160±60BP	Beta-101481	770AD (48.3%) 900AD 910AD (19.9%) 970AD	690AD (7.0%) 750AD 760AD (88.4%) 1010AD	780AD (48.0%) 900AD 910AD (20.2%) 970AD	690AD (6.4%) 750AD 760AD (89.0%) 1000AD
214-20-177cz : 1160±40BP	Beta-258532	780AD (4.1%) 790AD 800AD (49.8%) 900AD 910AD (14.3%) 950AD	770AD (95.4%) 980AD	780AD (4.0%) 790AD 810AD (49.4%) 900AD 910AD (14.8%) 960AD	770AD (95.4%) 980AD
214-9-99cz : 1160±40BP	Beta-258497	780AD (4.1%) 790AD 800AD (49.8%) 900AD 910AD (14.3%) 950AD	770AD (95.4%) 980AD	780AD (3.7%) 790AD 800AD (49.6%) 900AD 910AD (14.9%) 950AD	770AD (95.4%) 980AD
214-6-52as : 1160±40BP	Beta-258471	780AD (4.1%) 790AD	770AD (95.4%) 980AD	780AD (3.9%) 790AD	770AD (95.4%) 980AD

(Table App3.1, continued)

Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 68.2% probability	MCMC sampled calibrated age 95.4% probability
		800AD (49.8%) 900AD 910AD (14.3%) 950AD		800AD (49.8%) 900AD 920AD (14.6%) 950AD	
214-16-148m : 1160±40BP	Beta-258522	780AD (4.1%) 790AD 800AD (49.8%) 900AD 910AD (14.3%) 950AD	770AD (95.4%) 980AD	780AD (3.7%) 790AD 800AD (49.6%) 900AD 910AD (14.7%) 950AD	770AD (95.4%) 980AD
214-12-102m : 1160±40BP	Beta-258499	780AD (4.1%) 790AD 800AD (49.8%) 900AD 910AD (14.3%) 950AD	770AD (95.4%) 980AD	780AD (4.1%) 790AD 800AD (46.9%) 900AD 910AD (17.2%) 960AD	770AD (95.4%) 980AD
109294FS#49?* : 1150±60BP	Beta-88649	780AD (3.0%) 790AD 800AD (65.2%) 970AD	710AD (3.5%) 750AD 760AD (91.9%) 1020AD	780AD (3.5%) 790AD 810AD (64.7%) 970AD	710AD (3.5%) 750AD 760AD (91.9%) 1010AD
214-15-142m : 1150±40BP	Beta-258518	780AD (1.8%) 790AD 810AD (66.4%) 970AD	770AD (95.4%) 980AD	780AD (1.3%) 790AD 810AD (12.2%) 850AD 860AD (54.8%) 970AD	770AD (95.4%) 990AD
214-12-104cz : 1150±40BP	Beta-258500	780AD (1.8%) 790AD 810AD (66.4%) 970AD	770AD (95.4%) 980AD	780AD (1.3%) 790AD 810AD (10.6%) 850AD 860AD (56.3%) 970AD	770AD (95.4%) 980AD
214-15-153m : 1140±40BP	Beta-232991	820AD (2.5%) 840AD 860AD (65.7%) 980AD	770AD (95.4%) 990AD	860AD (68.2%) 980AD	770AD (95.4%) 990AD
214-16-146m : 1120±40BP	Beta-232988	885AD (68.2%) 980AD	780AD (1.3%) 790AD 800AD (94.1%) 1020AD	885AD (68.2%) 980AD	780AD (1.2%) 790AD
216-10-15cz : 1120±40BP	Beta-258917	885AD (68.2%) 980AD	780AD (1.3%) 790AD 800AD (94.1%) 1020AD	885AD (68.2%) 980AD	780AD (95.4%) 1000AD
214-15-155m : 1120±40BP	Beta-258526	885AD (68.2%) 980AD	780AD (1.3%) 790AD 800AD (94.1%) 1020AD	885AD (68.2%) 980AD	780AD (1.3%) 790AD 800AD (94.1%) 1000AD
214-15-154cz : 1120±40BP	Beta-258525	885AD (68.2%) 980AD	780AD (1.3%) 790AD 800AD (94.1%) 1020AD	885AD (68.2%) 980AD	780AD (1.3%) 790AD 800AD (94.1%) 1010AD
214-14-115m : 1110±40BP	Beta-258506	890AD (68.2%) 980AD	810AD (95.4%) 1020AD	890AD (68.2%) 980AD	810AD (95.4%) 1020AD
214-16-143m : 1110±40BP	Beta-258519	890AD (68.2%) 980AD	810AD (95.4%) 1020AD	890AD (68.2%) 980AD	810AD (95.4%) 1020AD
214-16-163cz : 1100±40BP	Beta-258531	890AD (26.0%) 925AD 935AD (42.2%) 990AD	860AD (95.4%) 1030AD	895AD (24.8%) 930AD 935AD (43.4%) 990AD	820AD (1.2%) 840AD 860AD (94.2%) 1020AD
ENM10418-FL? : 1100±60BP	Beta-10468	880AD (68.2%) 1020AD	770AD (95.4%) 1030AD	880AD (68.2%) 1000AD	770AD (95.4%) 1020AD
214-15-137m : 1090±40BP	Beta-258516	895AD (23.6%) 925AD 935AD (44.6%) 995AD	870AD (95.4%) 1030AD	895AD (24.4%) 925AD 940AD (43.8%) 995AD	870AD (95.4%) 1020AD
ENM10418-FII? : 1080±70BP	Beta-10467	880AD (68.2%) 1030AD	770AD (90.6%) 1050AD 1080AD (4.8%) 1160AD	890AD (68.2%) 1010AD	780AD (95.4%) 1020AD
98820-1? : 1070±50BP	Beta-101476	890AD (15.1%) 920AD 940AD (53.1%) 1020AD	820AD (1.1%) 850AD 860AD (94.3%) 1050AD	890AD (18.4%) 920AD 940AD (49.8%) 1010AD	870AD (95.4%) 1030AD
222-4-2m : 1070±40BP	Beta-258929	890AD (16.0%) 920AD 960AD (52.2%) 1020AD	890AD (95.4%) 1030AD	890AD (17.1%) 920AD 950AD (51.1%) 1010AD	890AD (95.4%) 1020AD
214-12-101m : 1070±40BP	Beta-258498	890AD (16.0%) 920AD 960AD (52.2%) 1020AD	890AD (95.4%) 1030AD	890AD (17.1%) 920AD 940AD (51.1%) 1010AD	890AD (95.4%) 1020AD
214-9-86m : 1050±40BP	Beta-258490	900AD (7.3%) 920AD 960AD (60.9%) 1030AD	890AD (95.4%) 1040AD	900AD (10.0%) 920AD 960AD (58.2%) 1020AD	890AD (95.4%) 1020AD
042-1-28cz ; 1050±40BP	Beta-258894	900AD (7.3%) 920AD 960AD (60.9%) 1030AD	890AD (95.4%) 1040AD	900AD (10.6%) 920AD 960AD (57.6%) 1020AD	890AD (95.4%) 1020AD

Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 68.2% probability	MCMC sampled calibrated age 95.4% probability
214-19-167m : 1040±40BP	Beta-232993	900AD (3.5%) 920AD 970AD (64.7%) 1030AD	890AD (93.7%) 1050AD 1100AD (1.7%) 1120AD	900AD (5.5%) 920AD 970AD (62.7%) 1020AD	890AD (95.4%) 1020AD
218-10-12m : 1040±40BP	Beta-258924	900AD (3.5%) 920AD 970AD (64.7%) 1030AD	890AD (93.7%) 1050AD 1100AD (1.7%) 1120AD	900AD (3.4%) 920AD 960AD (64.8%) 1020AD	890AD (95.4%) 1030AD
214-14-114m : 1030±40BP	Beta-258505	970AD (68.2%) 1040AD	890AD (87.5%) 1050AD 1080AD (7.9%) 1150AD	970AD (68.2%) 1020AD	890AD (12.6%) 930AD 940AD (82.6%) 1030AD
(Phase)				1005AD (68.2%) 1025AD	990AD (95.4%) 1030AD
042-2-33m : 1010±40BP	Beta-258895	980AD (60.1%) 1050AD 1100AD (7.0%) 1120AD 1140AD (1.1%) 1150AD	900AD (2.6%) 920AD 960AD (92.8%) 1160AD	1015AD (68.2%) 1035AD	1000AD (95.4%) 1045AD
042-2-36m : 1010±40BP	Beta-258896	980AD (60.1%) 1050AD 1100AD (7.0%) 1120AD 1140AD (1.1%) 1150AD	900AD (2.6%) 920AD 960AD (92.8%) 1160AD	1015AD (68.2%) 1035AD	1000AD (95.4%) 1045AD
214-1-39m : 1010±40BP	Beta-258469	980AD (60.1%) 1050AD 1100AD (7.0%) 1120AD 1140AD (1.1%) 1150AD	900AD (2.6%) 920AD 960AD (92.8%) 1160AD	1015AD (68.2%) 1035AD	1000AD (95.4%) 1045AD
214-16-145m : 1010±40BP	Beta-258521	980AD (60.1%) 1050AD 1100AD (7.0%) 1120AD 1140AD (1.1%) 1150AD	900AD (2.6%) 920AD 960AD (92.8%) 1160AD	1015AD (68.2%) 1035AD	1005AD (95.4%) 1045AD
214-7-84m : 1010±40BP	Beta-258488	960AD (60.1%) 1050AD 1100AD (7.0%) 1120AD 1140AD (1.1%) 1150AD	900AD (2.6%) 920AD 960AD (92.8%) 1160AD	1015AD (68.2%) 1035AD	1000AD (95.4%) 1045AD
214-16-162m : 1010±40BP	Beta-258531	960AD (60.1%) 1050AD 1100AD (7.0%) 1120AD 1140AD (1.1%) 1150AD	900AD (2.6%) 920AD 960AD (92.8%) 1160AD	1015AD (68.2%) 1035AD	1000AD (95.4%) 1045AD
214-6-46m : 1000±40BP	Beta-232969	960AD (50.5%) 1050AD 1090AD (14.5%) 1120AD 1140AD (3.2%) 1150AD	970AD (95.4%) 1160AD	1015AD (68.2%) 1035AD	1005AD (95.4%) 1045AD
214-16-144m : 1000±40BP	Beta-258520	980AD (50.5%) 1050AD 1090AD (14.5%) 1120AD 1140AD (3.2%) 1150AD	970AD (95.4%) 1160AD	1015AD (68.2%) 1035AD	1005AD (95.4%) 1045AD
218-1-8m : 990±40BP	Beta-258922	990AD (40.8%) 1050AD 1090AD (27.4%) 1150AD	980AD (95.4%) 1160AD	1015AD (68.2%) 1035AD	1005AD (95.4%) 1045AD
216-6-11m : 990±40BP	Beta-258923	990AD (40.8%) 1050AD 1090AD (27.4%) 1150AD	980AD (95.4%) 1160AD	1015AD (68.2%) 1035AD	1005AD (95.4%) 1045AD
216-9-14m : 990±40BP	Beta-258918	990AD (40.8%) 1050AD 1090AD (27.4%) 1150AD	980AD (95.4%) 1160AD	1015AD (68.2%) 1035AD	1005AD (95.4%) 1045AD
214-14-118m : 990±40BP	Beta-258508	990AD (40.8%) 1050AD 1090AD (27.4%) 1150AD	980AD (95.4%) 1160AD	1015AD (68.2%) 1035AD	1005AD (95.4%) 1045AD
214-1-85m : 980±40BP	Beta-258469	1010AD (29.2%) 1050AD 1080AD (39.0%) 1160AD	990AD (95.4%) 1160AD	1020AD (68.2%) 1040AD	1010AD (95.4%) 1050AD
214-15-134cz : 980±40BP	Beta-258514	1010AD (29.2%) 1050AD 1080AD (39.0%) 1160AD	990AD (95.4%) 1160AD	1020AD (68.2%) 1040AD	1010AD (95.4%) 1050AD
113045-67 : 970±60BP	Beta-101479	1010AD (68.2%) 1160AD	970AD (95.4%) 1220AD	1015AD (68.2%) 1040AD	1005AD (95.4%) 1050AD
042-2-37m : 970±40BP	Beta-258897	1010AD (25.6%) 1050AD	990AD (95.4%) 1160AD	1020AD (68.2%) 1040AD	1010AD (95.4%) 1050AD

(Table App3.1, continued)

Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 68.2% probability	MCMC sampled calibrated age 95.4% probability
		1080AD (42.6%) 1160AD			
042-11-55m : 970±40BP	Beta-258903	1010AD (25.6%) 1050AD 1080AD (42.6%) 1160AD	990AD (95.4%) 1160AD	1020AD (68.2%) 1040AD	1010AD (95.4%) 1050AD
214-7-53m : 970±40BP	Beta-232970	1010AD (25.6%) 1050AD 1080AD (42.6%) 1160AD	990AD (95.4%) 1160AD	1020AD (68.2%) 1040AD	1010AD (95.4%) 1050AD
042-11-56as : 970±40BP	Beta-258904	1010AD (25.6%) 1050AD 1080AD (42.6%) 1160AD	990AD (95.4%) 1160AD	1020AD (68.2%) 1040AD	1010AD (95.4%) 1050AD
(Phase)					
(Phase)					
214-9-96m : 960±40BP	Beta-258495	1020AD (22.2%) 1060AD 1080AD (46.0%) 1160AD	990AD (95.4%) 1170AD	1030AD (68.2%) 1055AD	1025AD (95.4%) 1080AD
042-1-41m : 960±40BP	Beta-258899	1020AD (22.2%) 1060AD 1080AD (46.0%) 1160AD	990AD (95.4%) 1170AD	1030AD (68.2%) 1055AD	1025AD (95.4%) 1080AD
214-7-79m : 940±40BP	Beta-232976	1030AD (15.7%) 1060AD 1070AD (52.5%) 1160AD	1010AD (95.4%) 1180AD	1035AD (68.2%) 1060AD	1025AD (95.4%) 1080AD
113044-2? : 930±50BP	Beta-101473	1030AD (68.2%) 1160AD	1020AD (95.4%) 1220AD	1035AD (68.2%) 1060AD	1025AD (95.4%) 1080AD
218-9-13m : 930±40BP	Beta-258925	1030AD (68.2%) 1160AD	1020AD (95.4%) 1190AD	1035AD (68.2%) 1060AD	1030AD (95.4%) 1080AD
214-13-135m : 920±40BP	Beta-232985	1040AD (68.2%) 1160AD	1020AD (95.4%) 1210AD	1035AD (68.2%) 1060AD	1030AD (95.4%) 1080AD
214-16-138m : 920±40BP	Beta-258517	1040AD (68.2%) 1160AD	1020AD (95.4%) 1210AD	1035AD (68.2%) 1060AD	1030AD (95.4%) 1080AD
113044-3? : 920±60BP	Beta-101474	1030AD (68.2%) 1170AD	1010AD (95.4%) 1260AD	1035AD (68.2%) 1060AD	1030AD (95.4%) 1080AD
042-6-45m : 910±40BP	Beta-258900	1040AD (68.2%) 1170AD	1030AD (95.4%) 1210AD	1035AD (68.2%) 1060AD	1030AD (95.4%) 1080AD
214-6-62m : 910±40BP	Beta-258477	1040AD (68.2%) 1170AD	1030AD (95.4%) 1210AD	1035AD (68.2%) 1060AD	1030AD (95.4%) 1080AD
113044-1c? : 900±50BP	Beta-101472	1040AD (29.9%) 1100AD 1110AD (38.3%) 1210AD	1020AD (95.4%) 1230AD	1035AD (68.2%) 1060AD	1030AD (95.4%) 1080AD
214-6-50m : 900±40BP	Beta-232971	1040AD (30.5%) 1100AD 1110AD (35.0%) 1190AD 1200AD (2.6%) 1210AD	1030AD (95.4%) 1220AD	1035AD (68.2%) 1060AD	1030AD (95.4%) 1080AD
(Phase)					
Boundary				1040AD (68.2%) 1070AD	1035AD (95.4%) 1105AD
(Phase)					
214-18-157m : 870±40BP	Beta-232989	1050AD (14.1%) 1060AD 1120AD (1.9%) 1140AD 1150AD (52.2%) 1220AD	1040AD (95.4%) 1260AD	1050AD (17.6%) 1090AD 1150AD (50.6%) 1220AD	1040AD (95.4%) 1230AD
214-14-116m : 860±40BP	Beta-258507	1050AD (9.7%) 1080AD 1150AD (58.5%) 1230AD	1040AD (17.0%) 1100AD 1110AD (78.4%) 1270AD	1050AD (14.2%) 1080AD 1150AD (54.0%) 1220AD	1040AD (95.4%) 1260AD
214-9-98m : 840±40BP	Beta-258496	1160AD (68.2%) 1255AD	1040AD (7.4%) 1090AD 1120AD (2.1%) 1140AD 1150AD (85.8%) 1280AD	1050AD (7.4%) 1080AD 1150AD (60.8%) 1230AD	1040AD (16.4%) 1090AD 1120AD (79.0%) 1270AD
214-7-51m : 840±40BP	Beta-258470	1160AD (68.2%) 1255AD	1040AD (7.4%) 1090AD 1120AD (2.1%) 1140AD 1150AD (85.8%) 1280AD	1050AD (7.4%) 1080AD 1150AD (60.8%) 1230AD	1040AD (16.2%) 1090AD 1120AD (79.2%) 1270AD
(Phase)					
Boundary				1180AD (68.2%) 1310AD	1050AD (8.8%) 1120AD 1160AD (86.6%) 1420AD
(Sequence)					
Provenience dated material : Conventional radiocarbon age	Laboratory Sample Number	Calibrated age 68.2% probability	Calibrated age 95.4% probability	MCMC sampled calibrated age 88.2% probability	MCMC sampled calibrated age 95.4% probability
Boundary				1210AD (68.2%) 1270AD	1150AD (95.4%) 1290AD
(Phase)					
113046-1? : 800±80BP	Beta-101480	1150AD (68.2%) 1290AD	1030AD (93.9%) 1300AD 1360AD (1.5%) 1390AD	1240AD (68.2%) 1285AD	1200AD (95.4%) 1300AD
ENM10418-30? : 760±70BP	TX-5017	1180AD (68.2%) 1300AD	1050AD (2.9%) 1090AD 1150AD (84.6%) 1330AD 1340AD (8.0%) 1400AD	1240AD (68.2%) 1285AD	1205AD (95.4%) 1300AD
130736F2m : 760±40BP	Beta-212700	1225AD (68.2%) 1280AD	1180AD (95.4%) 1300AD	1245AD (68.2%) 1285AD	1220AD (95.4%) 1290AD
214-16-149m : 740±40BP	Beta-258523	1225AD (2.5%) 1235AD 1240AD (65.7%) 1290AD	1210AD (92.4%) 1300AD 1360AD (3.0%) 1390AD	1250AD (68.2%) 1285AD	1220AD (95.4%) 1290AD
(Phase)					
Boundary				1260AD (68.2%) 1305AD	1230AD (95.4%) 1350AD
(Phase)					
ENM10230-6? : 640±40BP	TX-5037	1280AD (29.2%) 1320AD 1350AD (39.0%) 1390AD	1280AD (95.4%) 1400AD	1290AD (40.1%) 1325AD 1345AD (28.1%) 1385AD	1280AD (95.4%) 1400AD
214-13-133cz : 570±40BP	Beta-258513	1315AD (41.1%) 1355AD 1385AD (27.1%) 1415AD	1290AD (95.4%) 1430AD	1300AD (68.2%) 1360AD	1290AD (78.6%) 1370AD 1380AD (16.8%) 1420AD
(Phase)					
Boundary				1340AD (68.2%) 1435AD	1300AD (95.4%) 1470AD
(Phase)					
98820-537/538?* : 470±70BP	Beta-139028	1320AD (4.2%) 1350AD 1390AD (60.8%) 1500AD 1600AD (3.2%) 1620AD	1300AD (11.5%) 1370AD 1380AD (69.7%) 1530AD 1550AD (14.2%) 1640AD	1400AD (68.2%) 1470AD	1320AD (4.4%) 1370AD 1380AD (91.0%) 1530AD
(Phase)					
Boundary				1420AD (68.2%) 1540AD	1390AD (95.4%) 1640AD
(Phase)					
ENM10418-FBB? : 340±80BP	Beta-10465	1470AD (68.2%) 1640AD	1400AD (92.4%) 1700AD 1750AD (3.0%) 1800AD	1470AD (68.2%) 1610AD	1440AD (95.4%) 1660AD
(Phase)					
Boundary				1500AD (68.2%) 1670AD	1450AD (95.4%) 1780AD
(Phase)					
ENM10418-12? : 220±60BP	TX-5012	1520AD (1.9%) 1540AD 1630AD (23.1%) 1690AD 1720AD (32.6%) 1810AD 1920AD (10.7%) 1960AD	1510AD (11.4%) 1600AD 1610AD (84.0%) 1960AD	1520AD (11.1%) 1560AD 1630AD (38.0%) 1700AD 1730AD (19.2%) 1800AD	1480AD (95.4%) 1820AD
(Phase)					
Boundary				1530AD (7.7%) 1580AD 1640AD (60.5%) 1850AD	1520AD (95.4%) 1970AD
(Sequence)					
Boundary					

References - Atmospheric data from Reimer et al (2004);OxCal v3.10 Bronk Ramsey (2005); cub r:5 sd:12 prob usp[chron]

Appendix 4 ⊻ Radiocarbon Analysis Data

Table App4.1. Concordance list of feature numbers, Beta Analytic radiocarbon samples, and OAS laboratory sample numbers.

FEATURE NO.	BETA ANALYTIC NO.	OAS SAMPLE NO.
LA 113042		
28	258894	042-541-28
33	258895	042-1034/6-33
35	258896	042-713-36
37	258897	042-710-37
40	258898	042-739-40
41	258899	042-737-41
45	258900	042-786-45
46	258901	042-810-46
49	258902	042-842-49
55	258903	042-971-55
56	258904	042-972-56
63	258906	042-1013-63
64	258905	042-1003-64
67	258907	042-1019-67
68	258908	042-1031-68
73	258909	042-1041-73
75	258912	042-1071-75
78	258910	042-1069-78
80	258913	042-1072-80
81	258914	042-1077-81
82	258911	042-1070-82
58	275121	042-12-58
77	275122	042-18-77
LA 129214		
46	232969	214-524
47	232968	214-509
50	232971	214-578
53	232970	214-574
55	232972	214-597
67	232973	214-698
68	232974	214-729
74	232975	214-841
79	232976	214-895
87	232978	214-1064
94	232977	214-1057
103	232979	214-1185
109	232980	214-1304
111	232981	214-1334
120	232984	214-1433
122	232982	214-1394
123	232983	214-1401
135	232985	214-1542
141	232986	214-1664
146	232988	214-1745
152	232987	214-1715
153	232991	214-1867
157	232989	214-1747
158	232990	214-1769
167	232993	214-1874
171	232992	214-1873a
39	258469	214-431-39

(Table App4.1, continued)

FEATURE NO.	BETA ANALYTIC NO.	OAS SAMPLE NO.
51	258470	214-573-51
52	258471	214-586-52
54	258472	214-593-54
57	258473	214-623-57
58	258474	214-622-58
59	258475	214-658-59
61	258476	214-657-61
62	258477	214-697-62
63	258478	214-663-63
64	258479	214-682-64
71	258480	214-755-71
72	258481	214-766-72
73	258482	214-774-73
75	258483	214-850-75
76	258484	214-876-76
77	258485	214-886-77
80	258486	214-908-80
82	258487	214-909-82
84	258488	214-994-84
85	258489	214-943-85
86	258490	214-961-86
88	258491	214-1003-88
89	258492	214-1004-89
93	258493	214-1065-93
95	258494	214-1106-95
96	258495	214-1366-96
98	258496	214-1135-98
99	258497	214-1157-99
101	258498	214-1189-101
102	258499	214-1237-102
104	258500	214-1190-104
105	258501	214-1239-105
106	258502	214-1188-106
110	258503	214-1343-110
112	258504	214-1329-112
114	258505	214-1469-114
115	258506	214-1397-115
116	258507	214-1470-116
118	258508	214-1376-118
119	258509	214-1346-119
129	258510	214-1497-129
131	258511	214-1522-131
132	258512	214-1536-132
133	258513	214-1615-133
134	258514	214-1555-134
136	258515	214-1605-136
137	258516	214-1556-137
138	258517	214-1606-138
142	258518	214-1660-142
143	258519	214-1678-143
144	258520	214-1662-144
145	258521	214-1677-145
148	258522	214-1691-148
149	258523	214-1748-149
151	258524	214-1666-151

(Table App4.1, continued)

FEATURE NO.	BETA ANALYTIC NO.	OAS SAMPLE NO.
154	258525	214-1868-154
155	258526	214-1866-155
156	258527	2141718-156-
159	258528	214-1751-159
161	258529	214-1864-161
162	258530	214-1953-162
163	258531	214-1901-163
177	258532	214-1813-177
178	258533	214-1912-178
180	258534	214-1810-180
181	258535	214-1811-181
182	258536	214-1812-182
LA 129216		
19	232994	216-89
20	232995	216-91a
10	258915	216-37-10
13	258916	216-53-13
14	258918	216-66-14
15	258919	216-69-15
16	258917	216-65-16
17	258921	216-77-17
18	258920	216-76-18
LA 129218		
8	258922	218-19-8
11	258923	218-85-11
12	258924	218-100-12
13	258925	218-101-13
14	258926	218-135-14
16	258927	218-140-16
23	258928	218-155-23
LA 129222		
2	258929	222-275-2
LA 129300		
20	258931	300-347-20
21	258930	300-252-21
23	258932	300-390-23
25	258933	300-391-25
26	258934	300-392-26
32	258935	300-428-32
37	258937	300-435-37
38	258936	300433-38
40	258939	300-465-40
41	258938	300-457-41
43	258940	300-480-43
44	258941	300-481-44

FROM: Darden Hood, Director (mailto:mailto:dhood@radiocarbon.com)
(This is a copy of the letter being mailed. Invoices/receipts follow only by mail.)

August 21, 2007

Mr. Eric Blinman
Museum of New Mexico
Office of Archaeological Studies
P.O. Box 2087
Santa Fe, NM 87504-2087
USA

RE: Radiocarbon Dating Results For Samples 214-509, 214-524, 214-574, 214-578, 214-597, 214-698, 214-729, 214-841, 214-895, 214-1057, 214-1064, 214-1185, 214-1304, 214-1334, 214-1394, 214-1401, 214-1433, 214-1542, 214-1664, 214-1715, 214-1745, 214-1747, 214-1769, 214-1867, 214-1873a, 214-1874, 216-89, 216-91a

Dear Mr. Blinman:

Enclosed are the radiocarbon dating results for 28 samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses proceeded normally. The report sheet contains the dating result, method used, material type, applied pretreatment and two-sigma calendar calibration result (where applicable) for each sample.

This report has been both mailed and sent electronically, along with a separate publication quality calendar calibration page. This is useful for incorporating directly into your reports. It is also digitally available in Windows metafile (.wmf) format upon request. Calibrations are calculated using the newest (2004) calibration database. References are quoted on the bottom of each calibration page. Multiple probability ranges may appear in some cases, due to short-term variations in the atmospheric 14C contents at certain time periods. Examining the calibration graphs will help you understand this phenomenon. Calibrations may not be included with all analyses. The upper limit is about 20,000 years, the lower limit is about 250 years and some material types are not suitable for calibration (e.g. water).

We analyzed these samples on a sole priority basis. No students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

Information pages are enclosed with the mailed copy of this report. They should answer most of questions you may have. If they do not, or if you have specific questions about the analyses, please do not hesitate to contact us. Someone is always available to answer your questions.

Our invoice is enclosed. Please, forward it to the appropriate officer or send VISA charge authorization. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood

Mr. Eric Blinman | Report Date: 8/21/2007

Museum of New Mexico | Material Received: 7/24/2007

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 232968 SAMPLE : 214-509 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 120 to 330 (Cal BP 1830 to 1620)	1790 +/- 40 BP	-24.4 o/oo	1800 +/- 40 BP
Beta - 232969 SAMPLE : 214-524 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 980 to 1060 (Cal BP 970 to 900) AND Cal AD 1080 to 1150 (Cal BP 870 to 800)	1000 +/- 40 BP	-25.0 o/oo	1000 +/- 40 BP
Beta - 232970 SAMPLE : 214-574 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1000 to 1160 (Cal BP 950 to 790)	970 +/- 40 BP	-24.8 o/oo	970 +/- 40 BP
Beta - 232971 SAMPLE : 214-578 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1030 to 1220 (Cal BP 920 to 730)	900 +/- 40 BP	-24.9 o/oo	900 +/- 40 BP
Beta - 232972 SAMPLE : 214-597 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 550 to 660 (Cal BP 1400 to 1290)	1450 +/- 40 BP	-25.7 o/oo	1440 +/- 40 BP

Mr. Eric Blinman

Report Date: 8/21/2007

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 232973 SAMPLE : 214-698 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 610 to 680 (Cal BP 1340 to 1270)	1380 +/- 40 BP	-24.7 o/oo	1380 +/- 40 BP
Beta - 232974 SAMPLE : 214-729 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 430 to 620 (Cal BP 1520 to 1330)	1520 +/- 40 BP	-24.9 o/oo	1520 +/- 40 BP
Beta - 232975 SAMPLE : 214-841 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 650 to 780 (Cal BP 1300 to 1170)	1280 +/- 40 BP	-23.9 o/oo	1300 +/- 40 BP
Beta - 232976 SAMPLE : 214-895 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1020 to 1200 (Cal BP 930 to 750)	940 +/- 40 BP	-25.0 o/oo	940 +/- 40 BP
Beta - 232977 SAMPLE : 214-1057 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 650 to 770 (Cal BP 1300 to 1180)	1320 +/- 40 BP	-24.7 o/oo	1320 +/- 40 BP

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 232978 SAMPLE : 214-1064 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 670 to 890 (Cal BP 1280 to 1060)	1240 +/- 40 BP	-24.7 o/oo	1240 +/- 40 BP
Beta - 232979 SAMPLE : 214-1185 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 660 to 780 (Cal BP 1290 to 1160)	1250 +/- 40 BP	-22.8 o/oo	1290 +/- 40 BP
Beta - 232980 SAMPLE : 214-1304 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 380 to 550 (Cal BP 1570 to 1400)	1610 +/- 40 BP	-24.8 o/oo	1610 +/- 40 BP
Beta - 232981 SAMPLE : 214-1334 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 660 to 870 (Cal BP 1290 to 1080)	1270 +/- 40 BP	-25.3 o/oo	1270 +/- 40 BP
Beta - 232982 SAMPLE : 214-1394 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 140 to 390 (Cal BP 1810 to 1560)	1760 +/- 40 BP	-24.9 o/oo	1760 +/- 40 BP

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 232983 SAMPLE : 214-1401 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 220 to 400 (Cal BP 1730 to 1550)	1750 +/- 40 BP	-25.8 o/oo	1740 +/- 40 BP
Beta - 232984 SAMPLE : 214-1433 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 650 to 780 (Cal BP 1300 to 1170)	1310 +/- 40 BP	-24.8 o/oo	1310 +/- 40 BP
Beta - 232985 SAMPLE : 214-1542 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1020 to 1210 (Cal BP 930 to 740)	930 +/- 40 BP	-25.7 o/oo	920 +/- 40 BP
Beta - 232986 SAMPLE : 214-1664 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 650 to 770 (Cal BP 1300 to 1180)	1320 +/- 40 BP	-25.1 o/oo	1320 +/- 40 BP
Beta - 232987 SAMPLE : 214-1715 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 600 to 680 (Cal BP 1350 to 1270)	1400 +/- 40 BP	-25.4 o/oo	1390 +/- 40 BP

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 232988 SAMPLE : 214-1745 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 810 to 1010 (Cal BP 1140 to 940)	1120 +/- 40 BP	-25.1 o/oo	1120 +/- 40 BP
Beta - 232989 SAMPLE : 214-1747 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1040 to 1260 (Cal BP 910 to 700)	860 +/- 40 BP	-24.3 o/oo	870 +/- 40 BP
Beta - 232990 SAMPLE : 214-1769 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 670 to 880 (Cal BP 1280 to 1070)	1260 +/- 40 BP	-25.8 o/oo	1250 +/- 40 BP
Beta - 232991 SAMPLE : 214-1867 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 780 to 990 (Cal BP 1170 to 960)	1150 +/- 40 BP	-25.7 o/oo	1140 +/- 40 BP
Beta - 232992 SAMPLE : 214-1873a ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 660 to 810 (Cal BP 1290 to 1140)	1300 +/- 40 BP	-26.2 o/oo	1280 +/- 40 BP

Mr. Eric Blinman

Report Date: 8/21/2007

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 232993	1040 +/- 40 BP	-24.8 o/oo	1040 +/- 40 BP

SAMPLE : 214-1874
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 900 to 920 (Cal BP 1050 to 1030) AND Cal AD 950 to 1040 (Cal BP 1000 to 920)

Beta - 232994	1530 +/- 40 BP	-23.2 o/oo	1560 +/- 40 BP

SAMPLE : 216-89
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 410 to 590 (Cal BP 1540 to 1360)

Beta - 232995	1580 +/- 40 BP	-24.9 o/oo	1580 +/- 40 BP

SAMPLE : 216-91a
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 400 to 570 (Cal BP 1550 to 1380)

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.4:lab. mult=1)

Laboratory number: **Beta-232968**

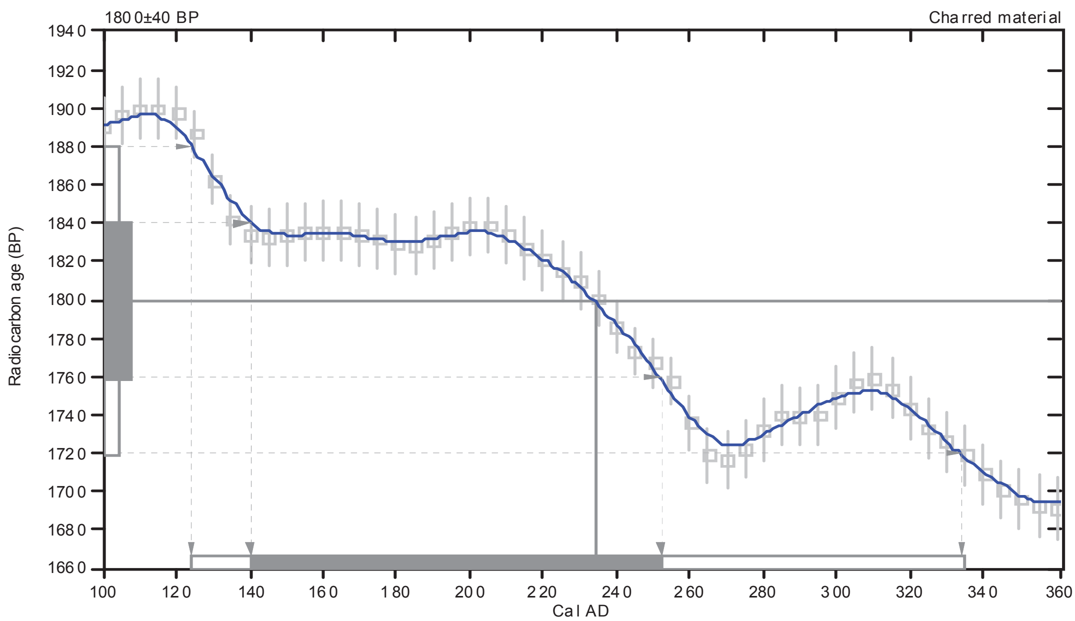
Conventional radiocarbon age: **1800±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 120 to 330 (Cal BP 1830 to 1620)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 230 (Cal BP 1720)

1 Sigma calibrated result: (68% probability) Cal AD 140 to 250 (Cal BP 1810 to 1700)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25:lab. mult=1)

Laboratory number: **Beta-232969**

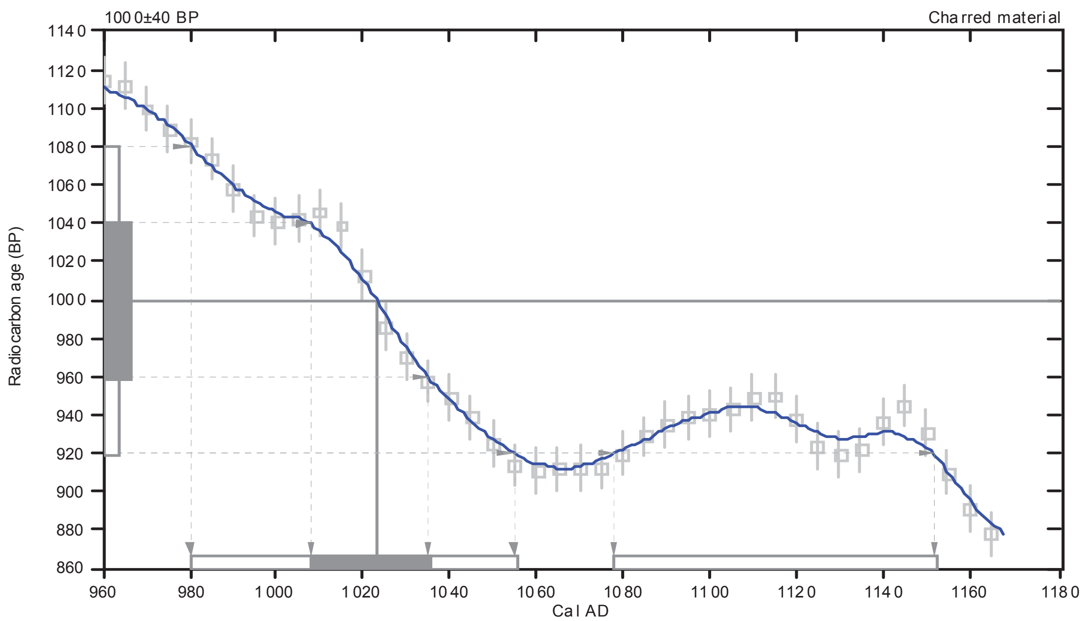
Conventional radiocarbon age: **1000±40 BP**

2 Sigma calibrated results: (95% probability) **Cal AD 980 to 1060 (Cal BP 970 to 900) and Cal AD 1080 to 1150 (Cal BP 870 to 800)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1020 (Cal BP 930)

1 Sigma calibrated result: (68% probability) Cal AD 1010 to 1040 (Cal BP 940 to 920)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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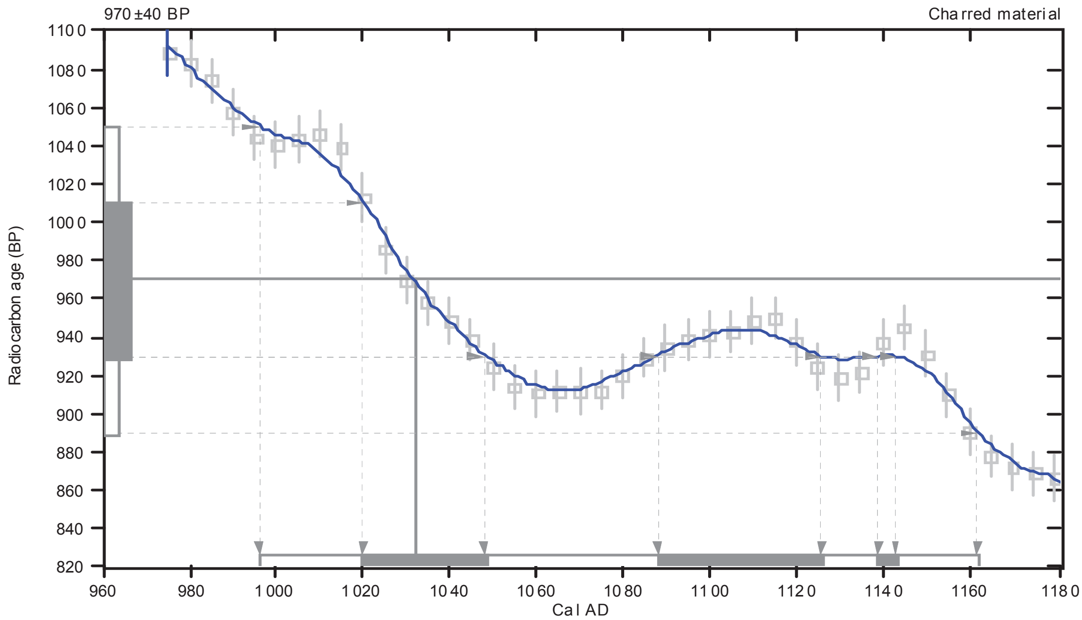
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number:	**Beta-232970**
Conventional radiocarbon age:	**970±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 1000 to 1160 (Cal BP 950 to 790)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1030 (Cal BP 920)
1 Sigma calibrated results: (68% probability)	Cal AD 1020 to 1050 (Cal BP 930 to 900) and Cal AD 1090 to 1130 (Cal BP 860 to 820) and Cal AD 1140 to 1140 (Cal BP 810 to 810)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.9:lab. mult=1)

Laboratory number: **Beta-232971**

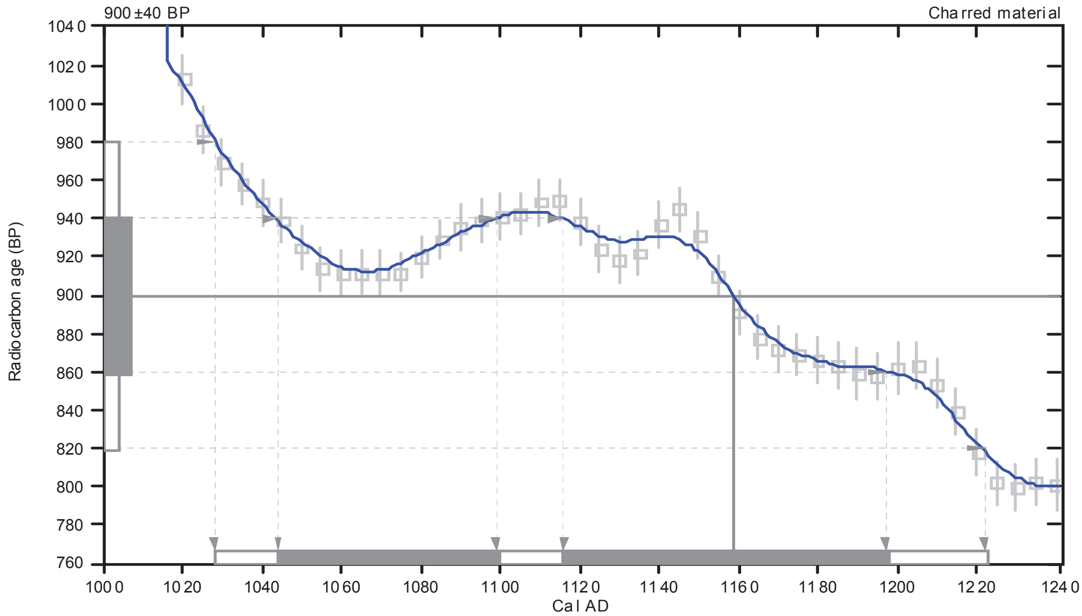
Conventional radiocarbon age: **900±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1030 to 1220 (Cal BP 920 to 730)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1160 (Cal BP 790)

1 Sigma calibrated results: (68% probability) Cal AD 1040 to 1100 (Cal BP 910 to 850) and Cal AD 1120 to 1200 (Cal BP 830 to 750)



References:

Database used
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Calibration Database
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.7:lab. mult=1)

Laboratory number: **232972**

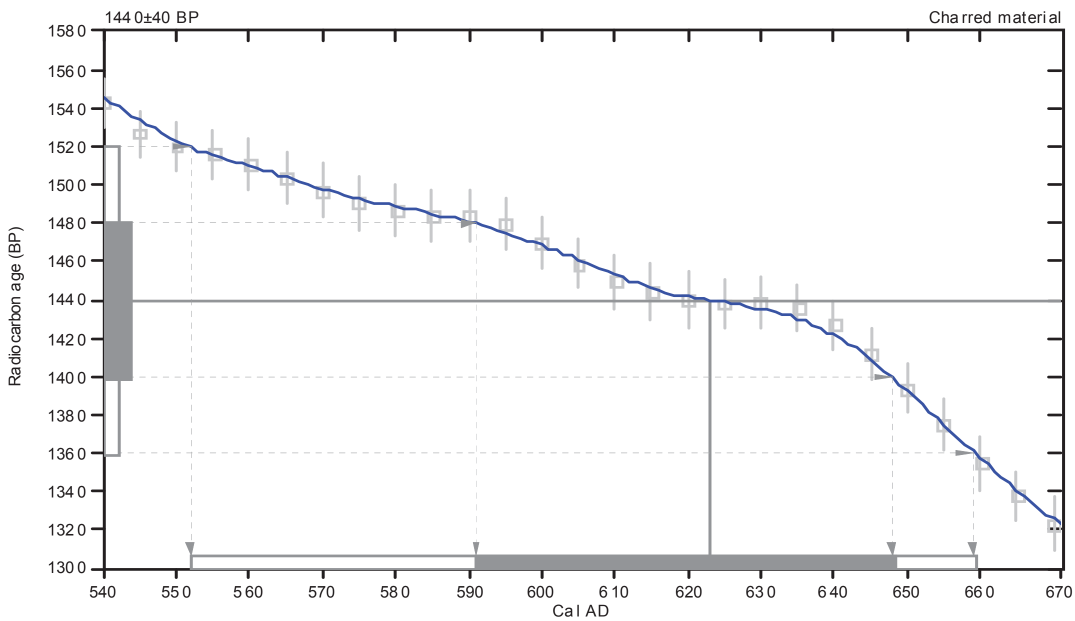
Conventional radiocarbon age: **1440±40 BP**

2 Sigma calibrated result: **Cal AD 550 to 660 (Cal BP 1400 to 1290)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 620 (Cal BP 1330)

1 Sigma calibrated result: Cal AD 590 to 650 (Cal BP 1360 to 1300)
(68% probability)



References:
Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number: **232973**

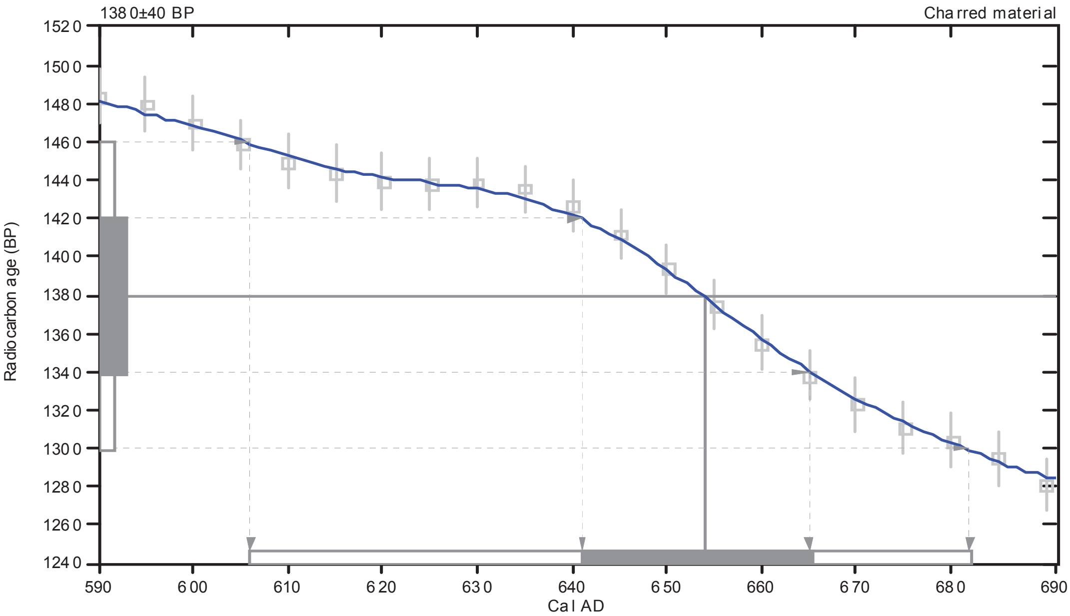
Conventional radiocarbon age: **1380±40 BP**

2 Sigma calibrated result: **Cal AD 610 to 680 (Cal BP 1340 to 1270)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 650 (Cal BP 1300)

1 Sigma calibrated result: Cal AD 640 to 660 (Cal BP 1310 to 1280)
(68% probability)



References:

Database used
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Calibration Database
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.9:lab. mult=1)

Laboratory number: **232974**

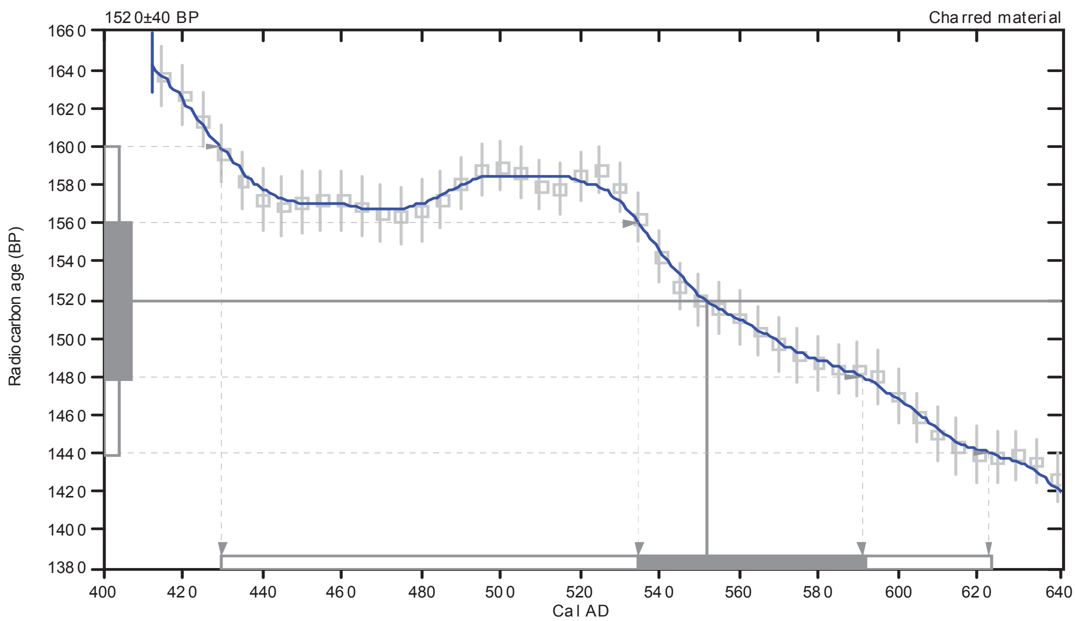
Conventional radiocarbon age: **1520±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 430 to 620 (Cal BP 1520 to 1330)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 550 (Cal BP 1400)

1 Sigma calibrated result: (68% probability) Cal AD 540 to 590 (Cal BP 1420 to 1360)



References:

Database used

INTCAL04

Calibration Database

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.9:lab. mult=1)

Laboratory number: **232975**

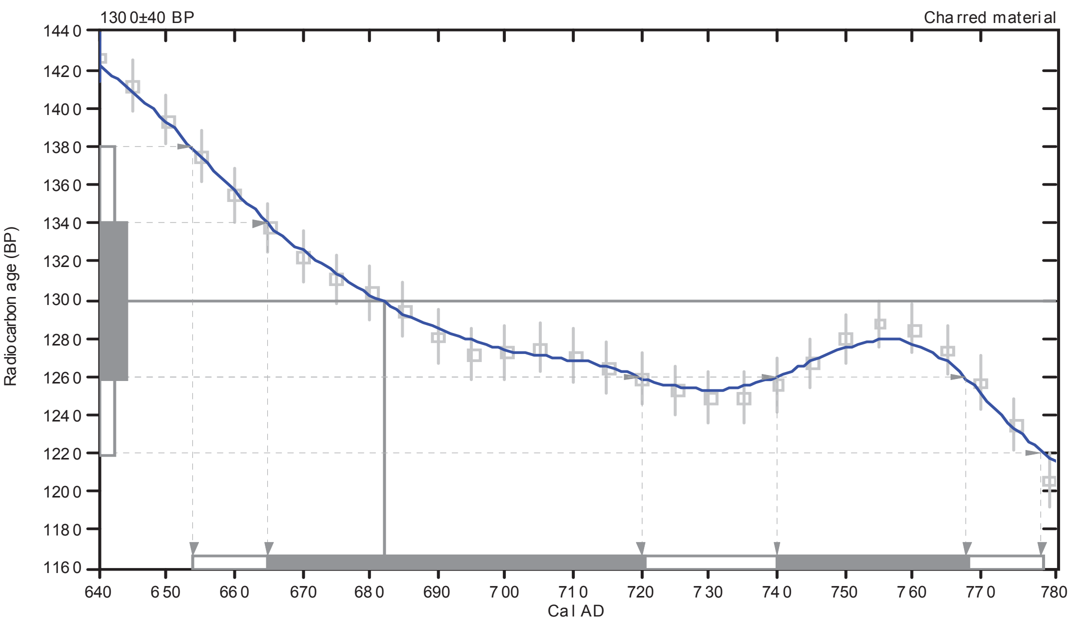
Conventional radiocarbon age: **1300±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 650 to 780 (Cal BP 1300 to 1170)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 680 (Cal BP 1270)

1 Sigma calibrated results: (68% probability) Cal AD 660 to 720 (Cal BP 1280 to 1230) and Cal AD 740 to 770 (Cal BP 1210 to 1180)



References:

Database used
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25:lab. mult=1)

Laboratory number: **232976**

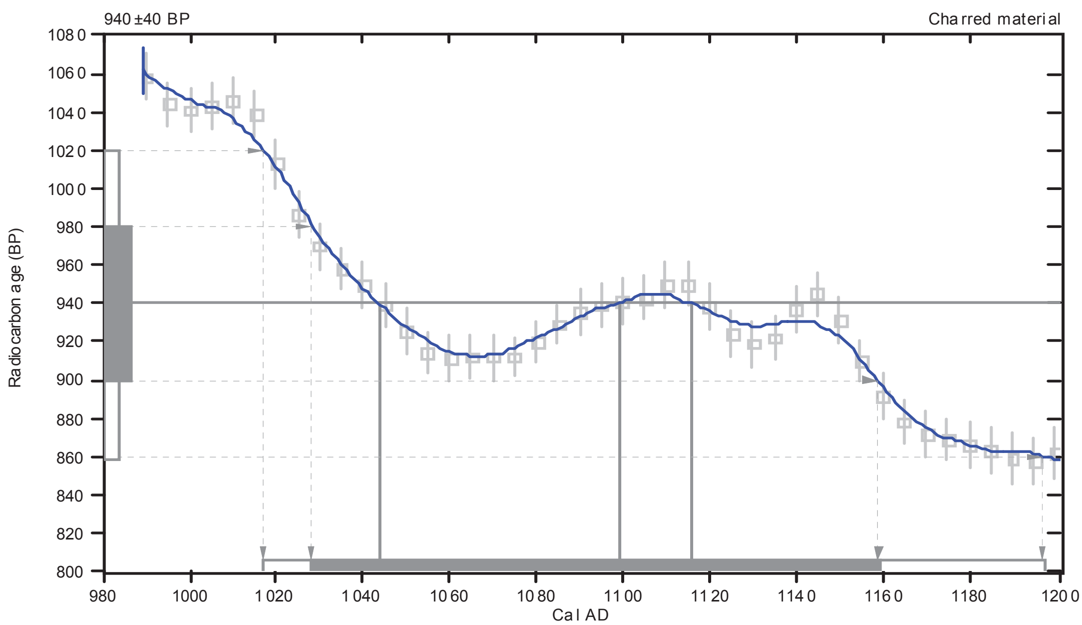
Conventional radiocarbon age: **940±40 BP**

2 Sigma calibrated result: **Cal AD 1020 to 1200 (Cal BP 930 to 750)**
(95% probability)

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 1040 (Cal BP 910) and Cal AD 1100 (Cal BP 850) and Cal AD 1120 (Cal BP 830)

1 Sigma calibrated result: Cal AD 1030 to 1160 (Cal BP 920 to 790)
(68% probability)



References:

Database used
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number: **232977**

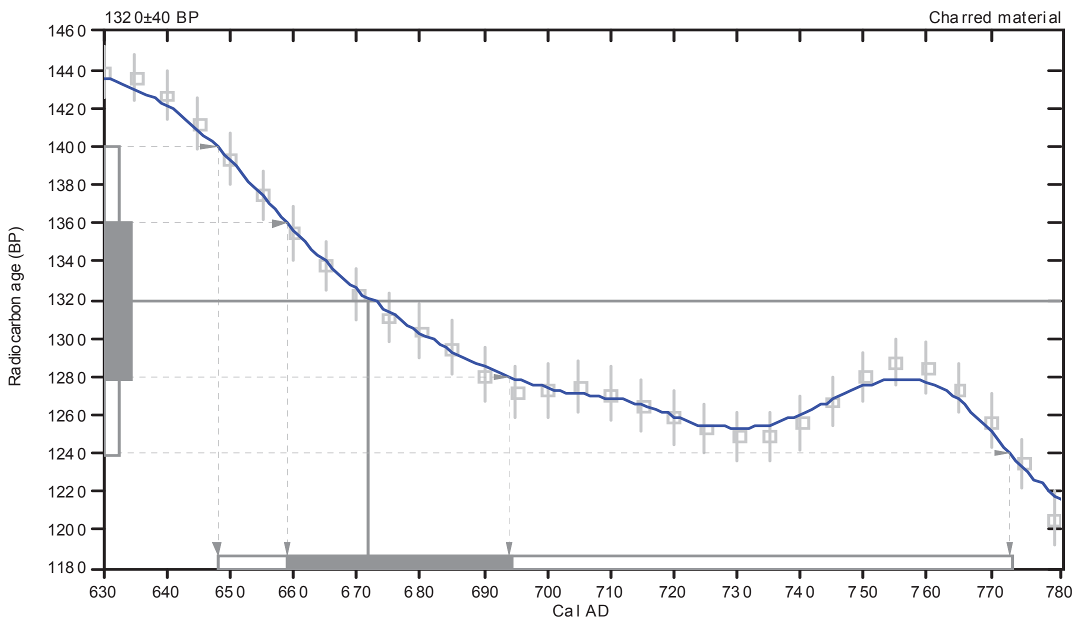
Conventional radiocarbon age: **1320±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 650 to 770 (Cal BP 1300 to 1180)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 670 (Cal BP 1280)

1 Sigma calibrated result: (68% probability) Cal AD 660 to 690 (Cal BP 1290 to 1260)



References:

Database used
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number: **232978**

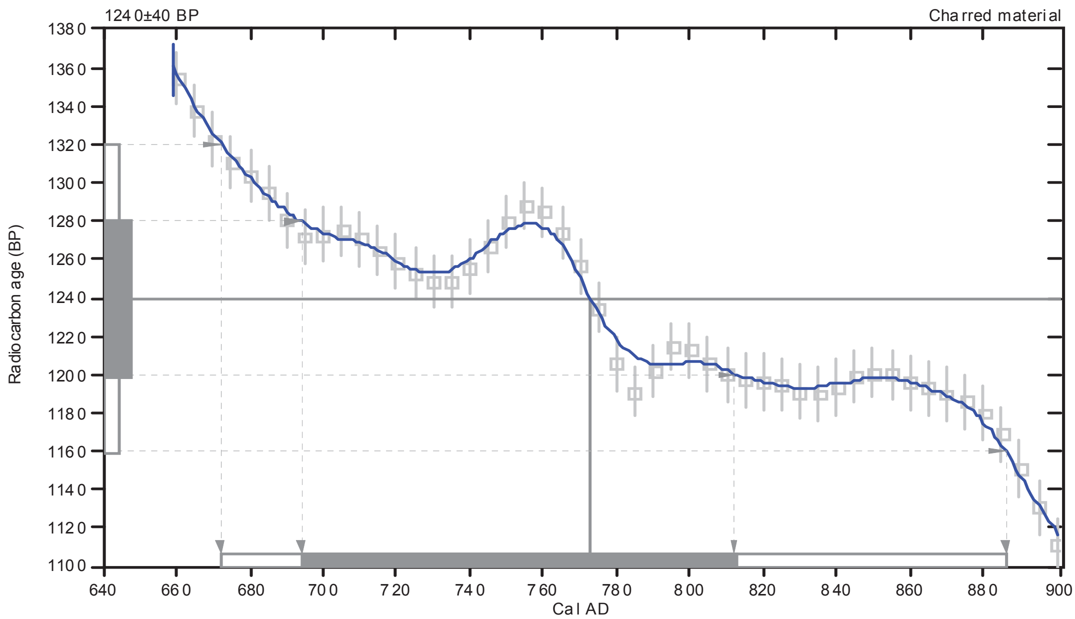
Conventional radiocarbon age: **1240±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 670 to 890 (Cal BP 1280 to 1060)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 770 (Cal BP 1180)

1 Sigma calibrated result: (68% probability) Cal AD 690 to 810 (Cal BP 1260 to 1140)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.8:lab. mult=1)

Laboratory number: **232979**

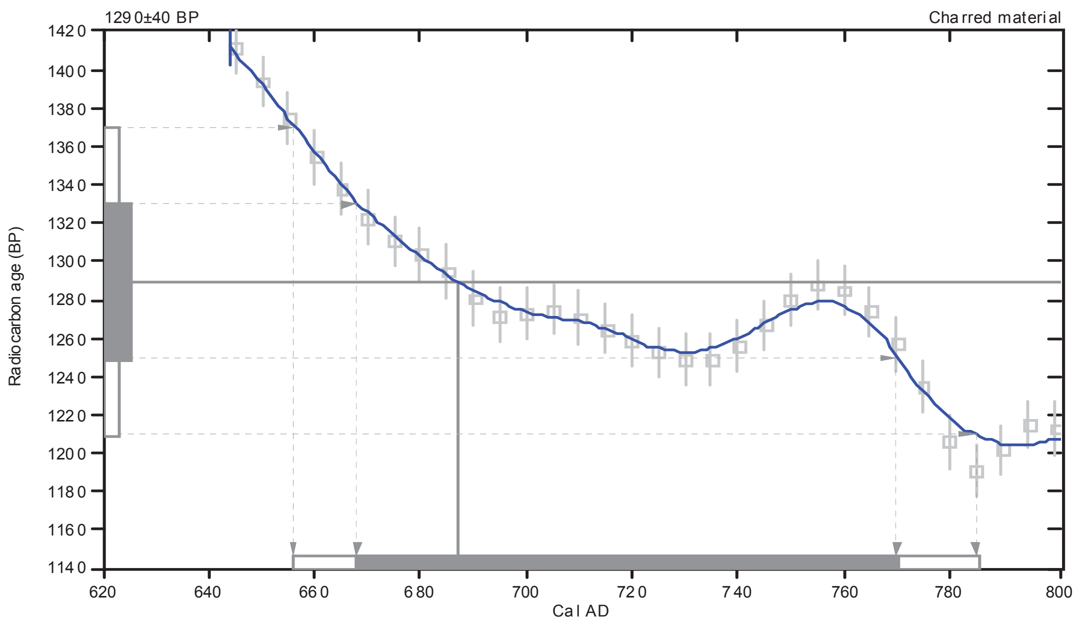
Conventional radiocarbon age: **1290±40 BP**

2 Sigma calibrated result: **Cal AD 660 to 780 (Cal BP 1290 to 1160)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 690 (Cal BP 1260)

1 Sigma calibrated result: Cal AD 670 to 770 (Cal BP 1280 to 1180)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number: **232980**

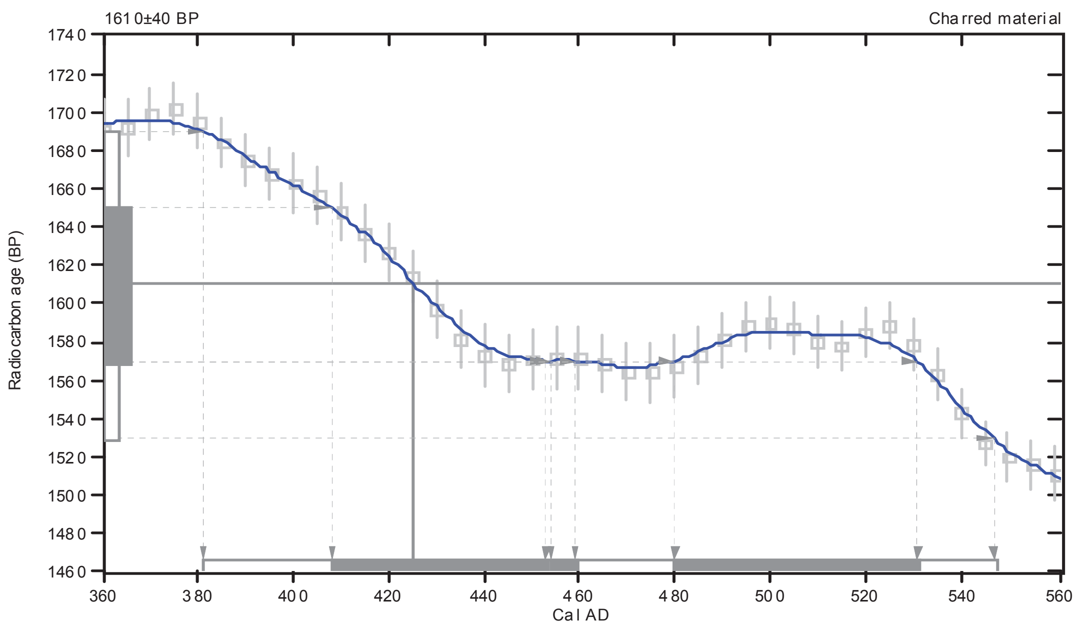
Conventional radiocarbon age: **1610±40 BP**

2 Sigma calibrated result: **Cal AD 380 to 550 (Cal BP 1570 to 1400)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 420 (Cal BP 1520)

1 Sigma calibrated results: Cal AD 410 to 450 (Cal BP 1540 to 1500) and
(68% probability) Cal AD 450 to 460 (Cal BP 1500 to 1490) and
Cal AD 480 to 530 (Cal BP 1470 to 1420)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.3:lab. mult=1)

Laboratory number: **232981**

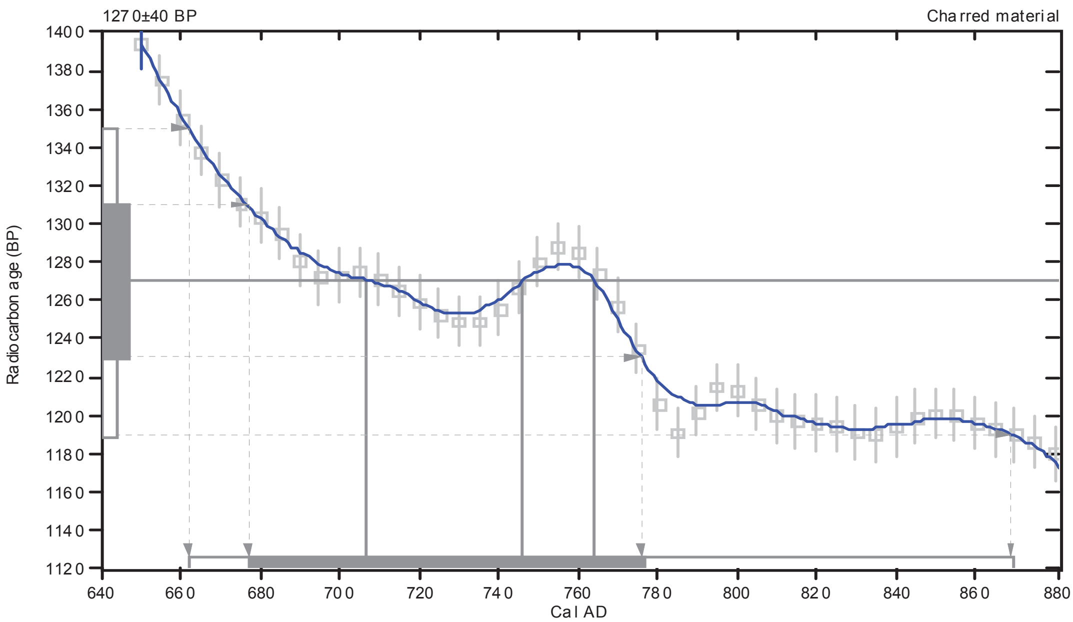
Conventional radiocarbon age: **1270±40 BP**

2 Sigma calibrated result: **Cal AD 660 to 870 (Cal BP 1290 to 1080)**
(95% probability)

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 710 (Cal BP 1240) and
Cal AD 750 (Cal BP 1200) and
Cal AD 760 (Cal BP 1190)

1 Sigma calibrated result: Cal AD 680 to 780 (Cal BP 1270 to 1170)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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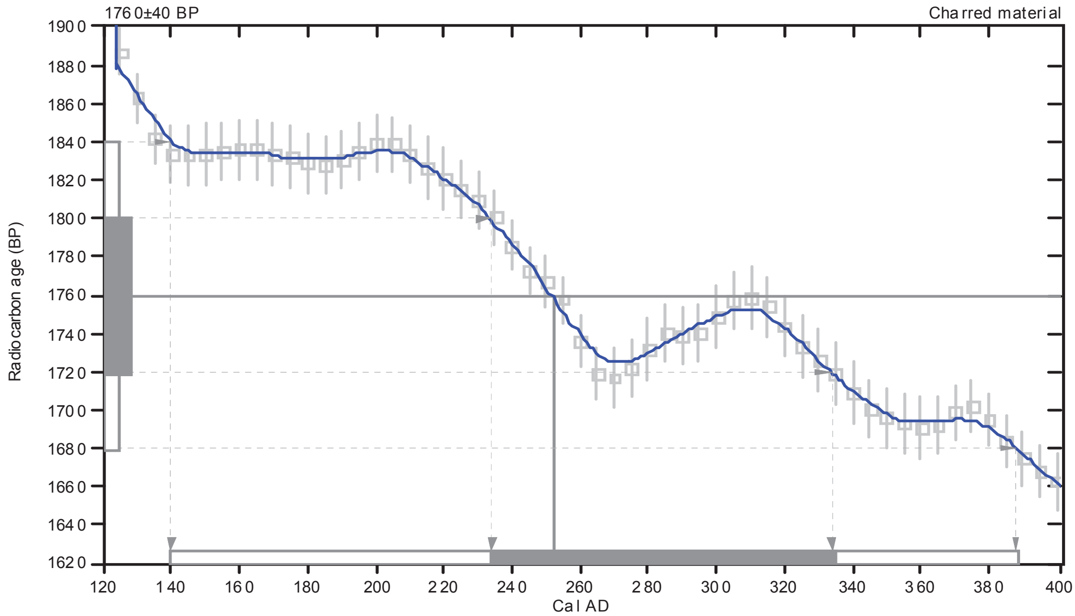
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.9:lab. mult=1)

Laboratory number:	**232982**
Conventional radiocarbon age:	**1760±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 140 to 390 (Cal BP 1810 to 1560)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 250 (Cal BP 1700)
1 Sigma calibrated result: (68% probability)	Cal AD 230 to 330 (Cal BP 1720 to 1620)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.8:lab. mult=1)

Laboratory number: **232983**

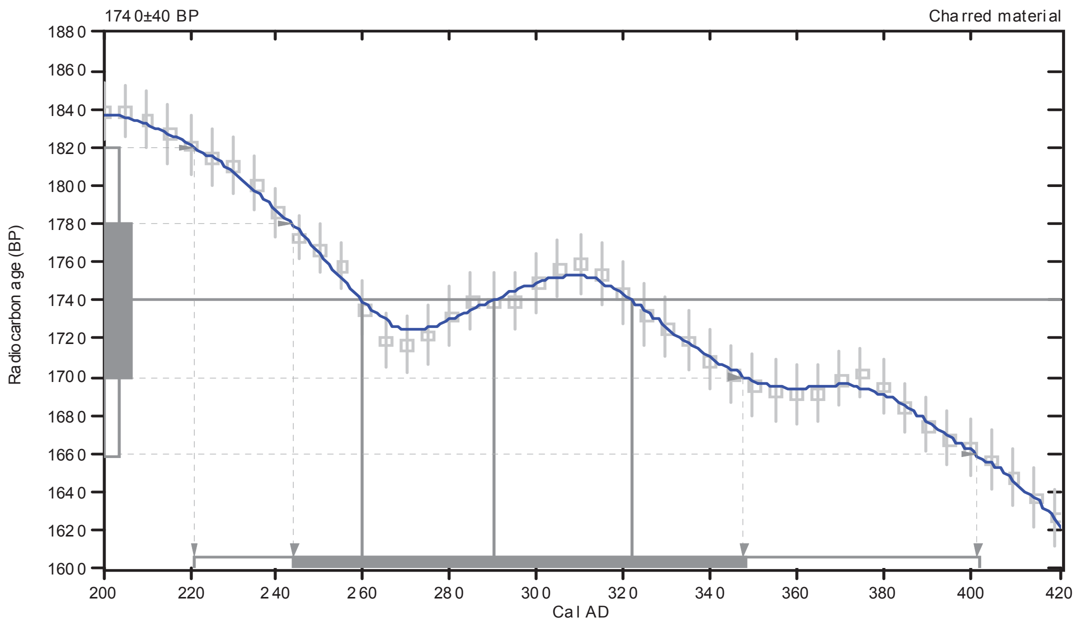
Conventional radiocarbon age: **1740±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 220 to 400 (Cal BP 1730 to 1550)**

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 260 (Cal BP 1690) and
Cal AD 290 (Cal BP 1660) and
Cal AD 320 (Cal BP 1630)

1 Sigma calibrated result: (68% probability) Cal AD 240 to 350 (Cal BP 1710 to 1600)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number: **232984**

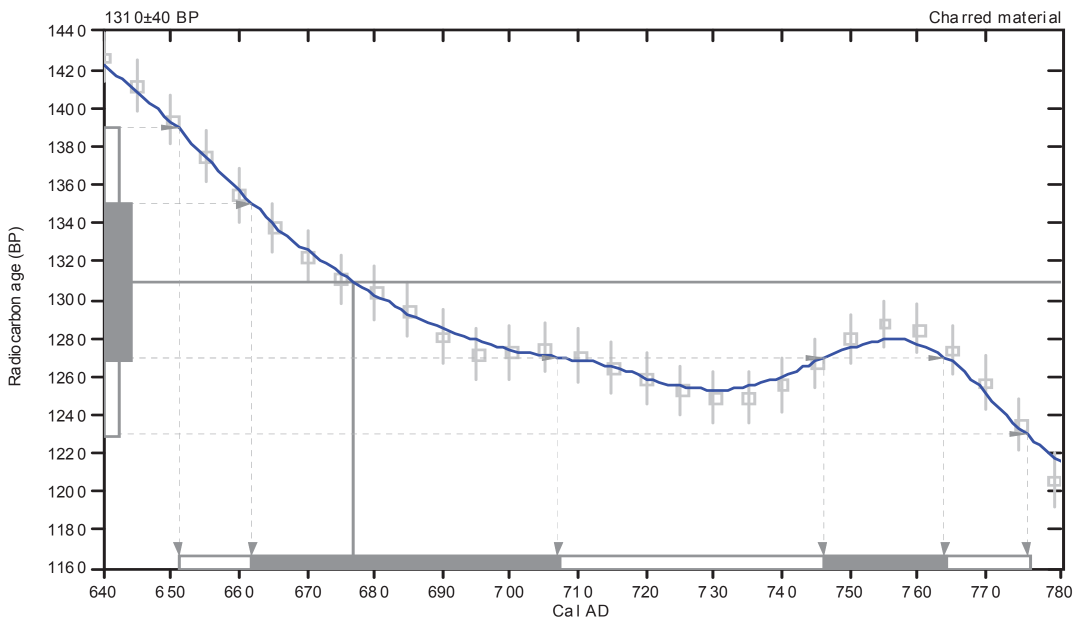
Conventional radiocarbon age: **1310±40 BP**

2 Sigma calibrated result: **Cal AD 650 to 780 (Cal BP 1300 to 1170)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 680 (Cal BP 1270)

1 Sigma calibrated results: Cal AD 660 to 710 (Cal BP 1290 to 1240) and
(68% probability) Cal AD 750 to 760 (Cal BP 1200 to 1190)



References:

Database used
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Calibration Database
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.7:lab. mult=1)

Laboratory number: **232985**

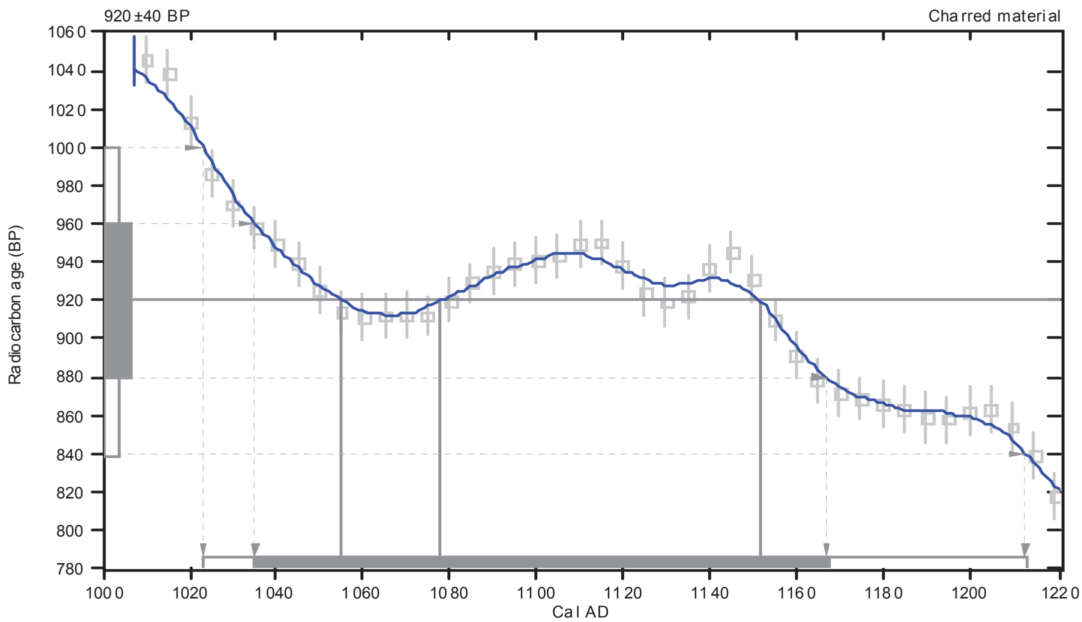
Conventional radiocarbon age: **920±40 BP**

2 Sigma calibrated result: **Cal AD 1020 to 1210 (Cal BP 930 to 740)**
(95% probability)

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 1060 (Cal BP 900) and
Cal AD 1080 (Cal BP 870) and
Cal AD 1150 (Cal BP 800)

1 Sigma calibrated result: Cal AD 1040 to 1170 (Cal BP 920 to 780)
(68% probability)



References:
Database used
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **232986**

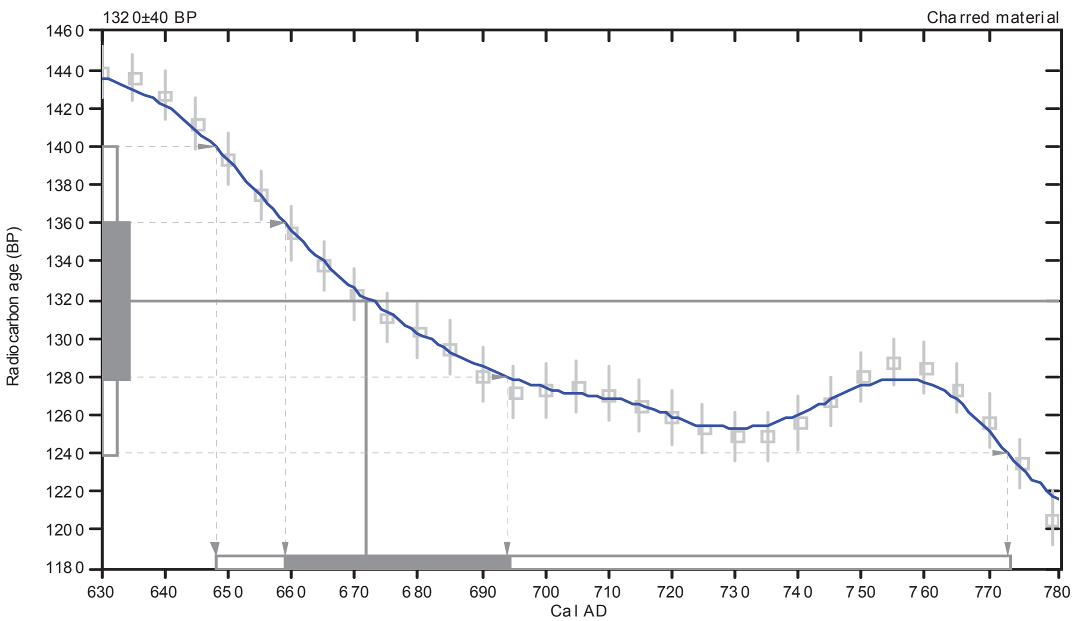
Conventional radiocarbon age: **1320±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 650 to 770 (Cal BP 1300 to 1180)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 670 (Cal BP 1280)

1 Sigma calibrated result: (68% probability) Cal AD 660 to 690 (Cal BP 1290 to 1260)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.4:lab. mult=1)

Laboratory number: **232987**

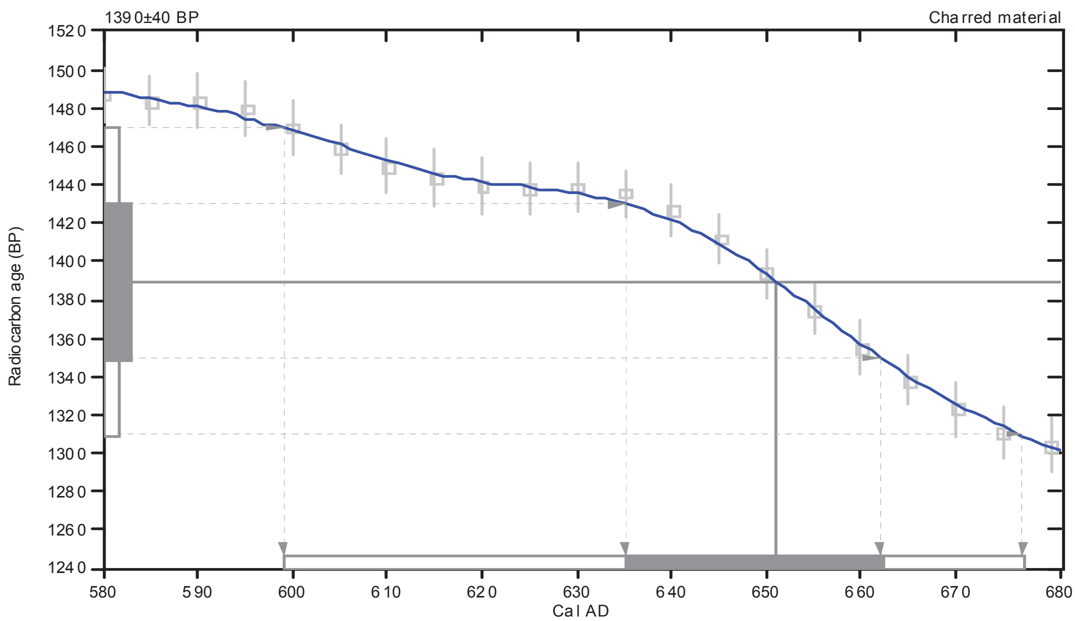
Conventional radiocarbon age: **1390±40 BP**

2 Sigma calibrated result: **Cal AD 600 to 680 (Cal BP 1350 to 1270)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 650 (Cal BP 1300)

1 Sigma calibrated result: Cal AD 640 to 660 (Cal BP 1320 to 1290)
(68% probability)



References:

Database used
INTCAL04

Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **232988**

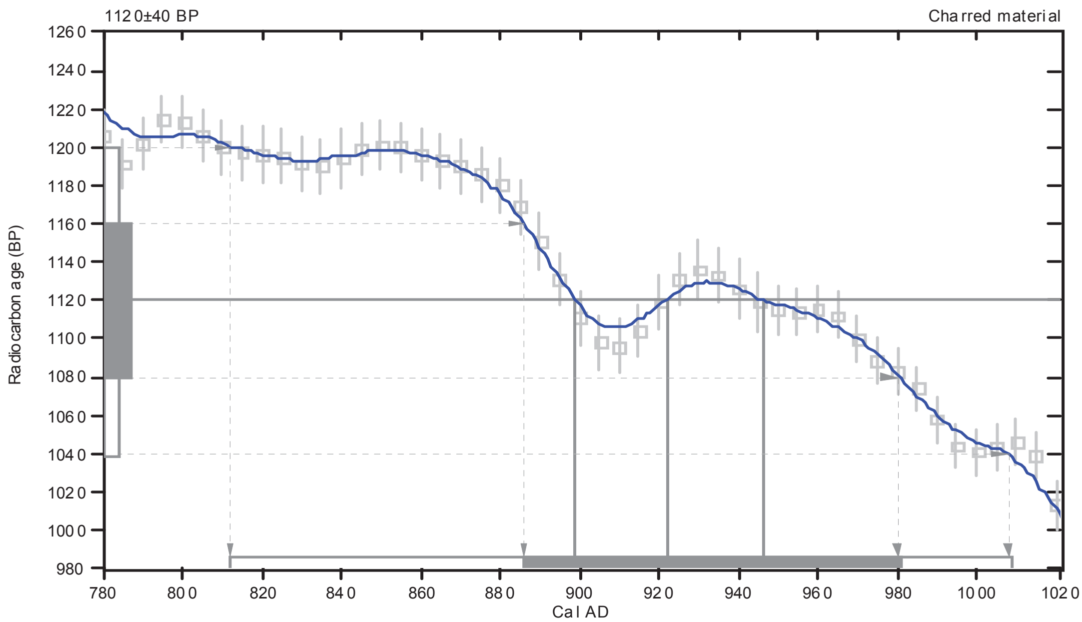
Conventional radiocarbon age: **1120±40 BP**

2 Sigma calibrated result: **Cal AD 810 to 1010 (Cal BP 1140 to 940)**
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve: Cal AD 900 (Cal BP 1050) and
Cal AD 920 (Cal BP 1030) and
Cal AD 950 (Cal BP 1000)

1 Sigma calibrated result: Cal AD 890 to 980 (Cal BP 1060 to 970)
(68% probability)



References:

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number: **232989**

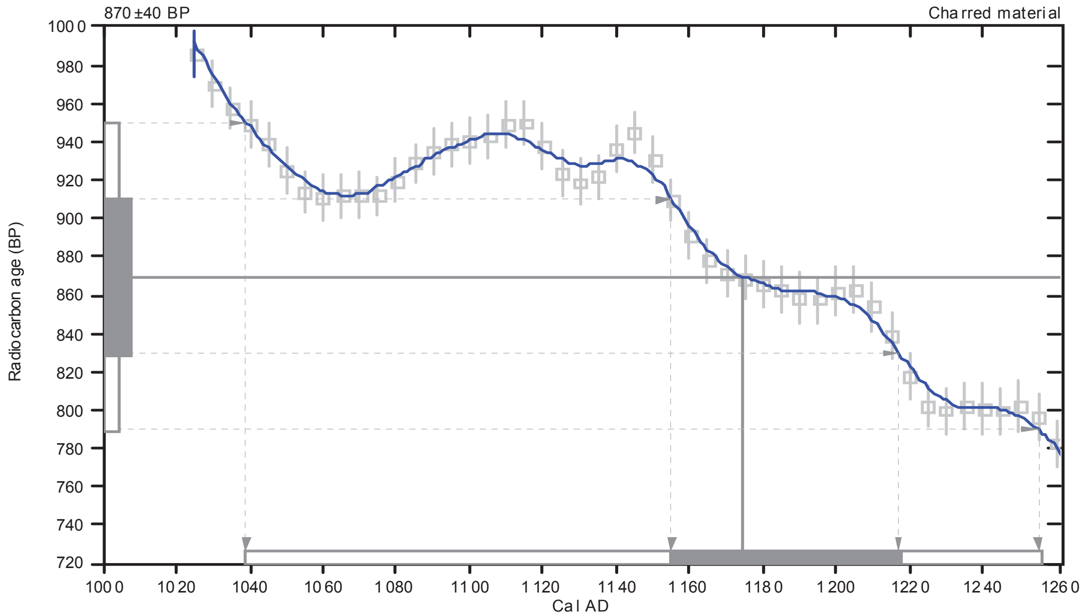
Conventional radiocarbon age: **870±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1040 to 1260 (Cal BP 910 to 700)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1170 (Cal BP 780)

1 Sigma calibrated result: (68% probability) Cal AD 1160 to 1220 (Cal BP 800 to 730)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.8:lab. mult=1)

Laboratory number: **232990**

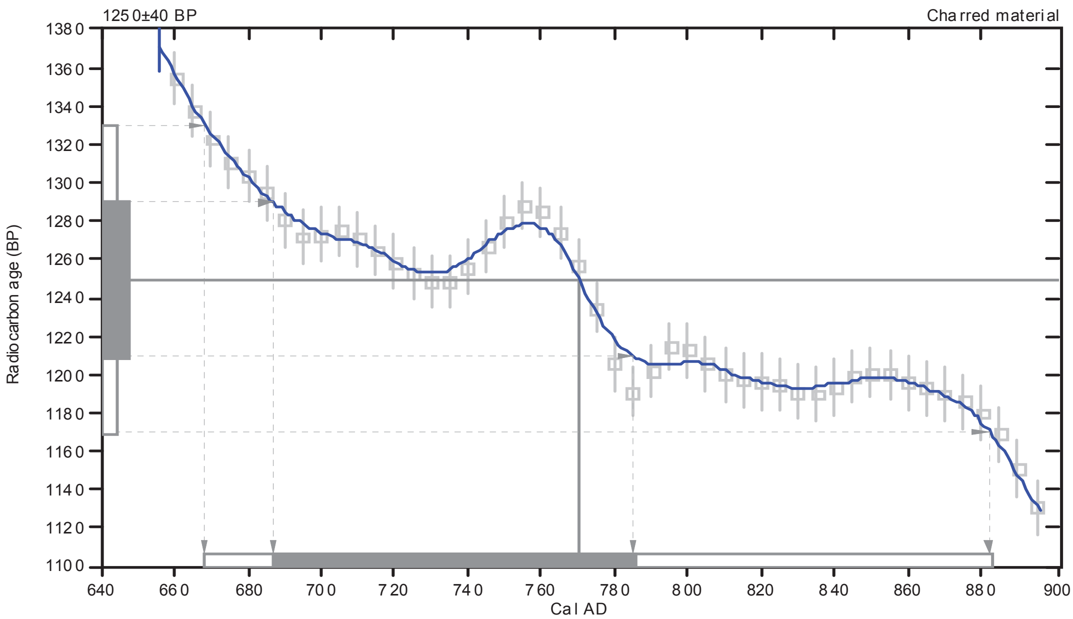
Conventional radiocarbon age: **1250±40 BP**

2 Sigma calibrated result: **Cal AD 670 to 880 (Cal BP 1280 to 1070)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 770 (Cal BP 1180)

1 Sigma calibrated result: Cal AD 690 to 780 (Cal BP 1260 to 1160)
(68% probability)



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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.7:lab. mult=1)

Laboratory number: **232991**

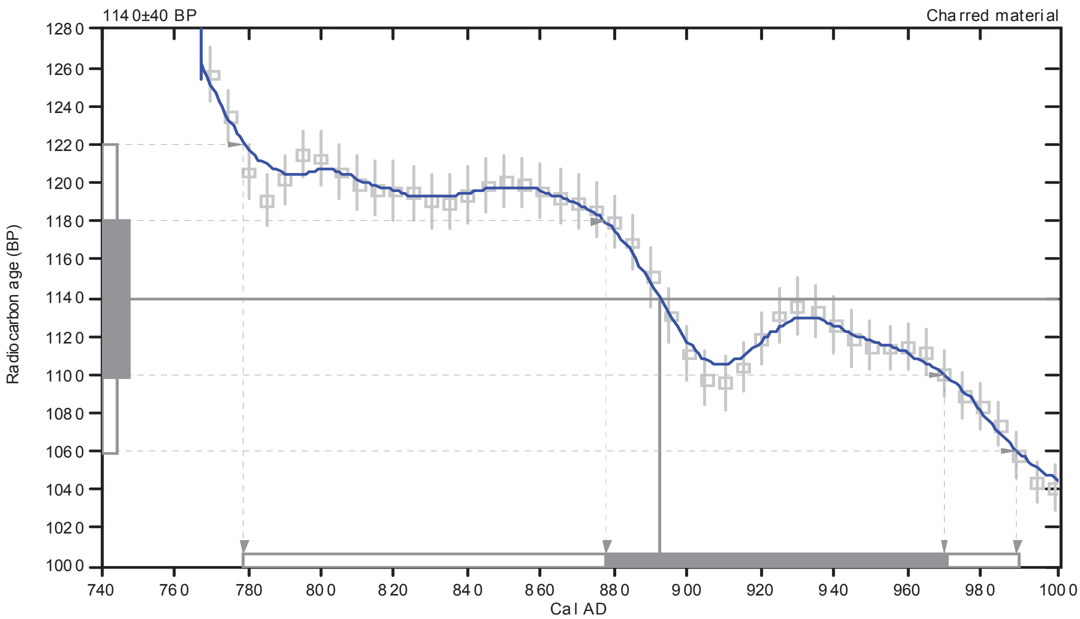
Conventional radiocarbon age: **1140±40 BP**

2 Sigma calibrated result: **Cal AD 780 to 990 (Cal BP 1170 to 960)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 890 (Cal BP 1060)

1 Sigma calibrated result: Cal AD 880 to 970 (Cal BP 1070 to 980)
(68% probability)



References:

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-26.2:lab. mult=1)

Laboratory number: **232992**

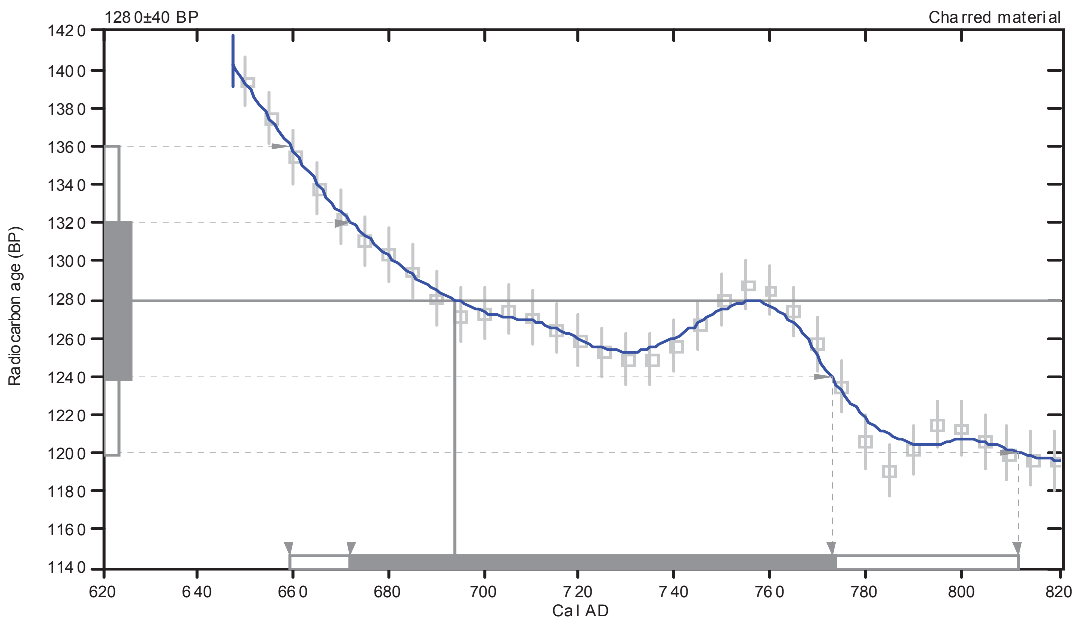
Conventional radiocarbon age: **1280±40 BP**

2 Sigma calibrated result: **Cal AD 660 to 810 (Cal BP 1290 to 1140)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 690 (Cal BP 1260)

1 Sigma calibrated result: Cal AD 670 to 770 (Cal BP 1280 to 1180)
(68% probability)



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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number: **232993**

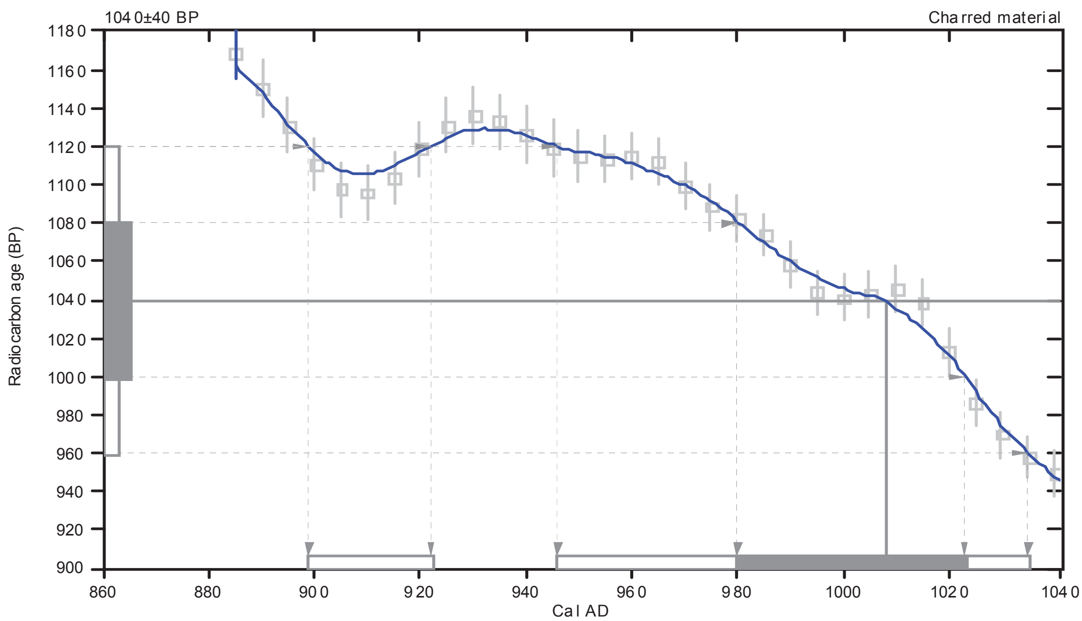
Conventional radiocarbon age: **1040±40 BP**

2 Sigma calibrated results: (95% probability) **Cal AD 900 to 920 (Cal BP 1050 to 1030) and Cal AD 950 to 1040 (Cal BP 1000 to 920)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1010 (Cal BP 940)

1 Sigma calibrated result: (68% probability) Cal AD 980 to 1020 (Cal BP 970 to 930)



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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.2:lab. mult=1)

Laboratory number: **232994**

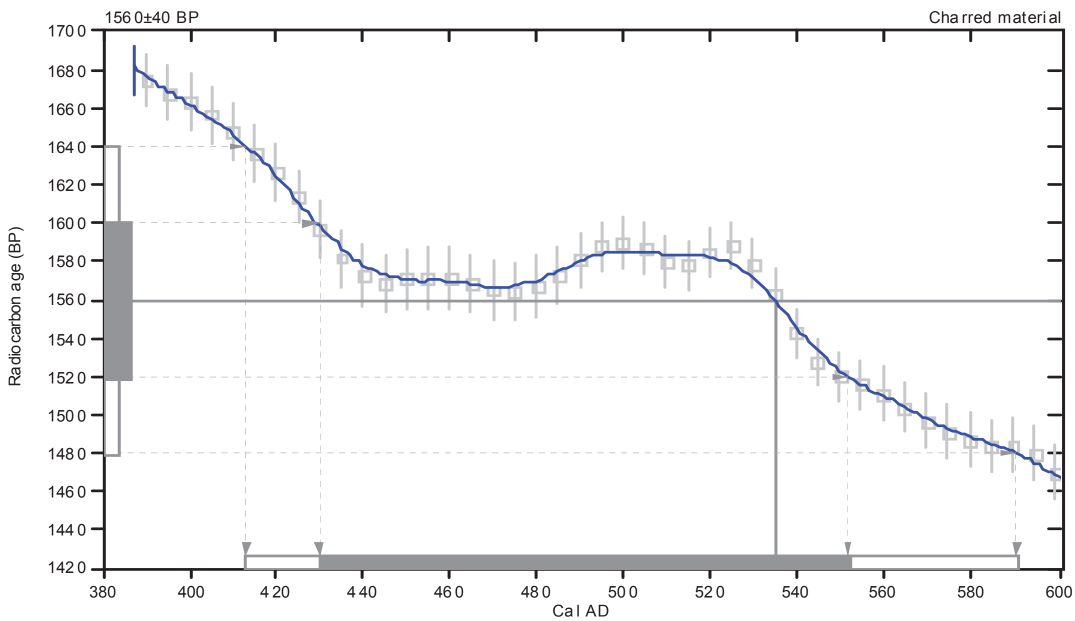
Conventional radiocarbon age: **1560±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 410 to 590 (Cal BP 1540 to 1360)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 540 (Cal BP 1420)

1 Sigma calibrated result: (68% probability) Cal AD 430 to 550 (Cal BP 1520 to 1400)



References:

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.9:lab. mult=1)

Laboratory number: **232995**

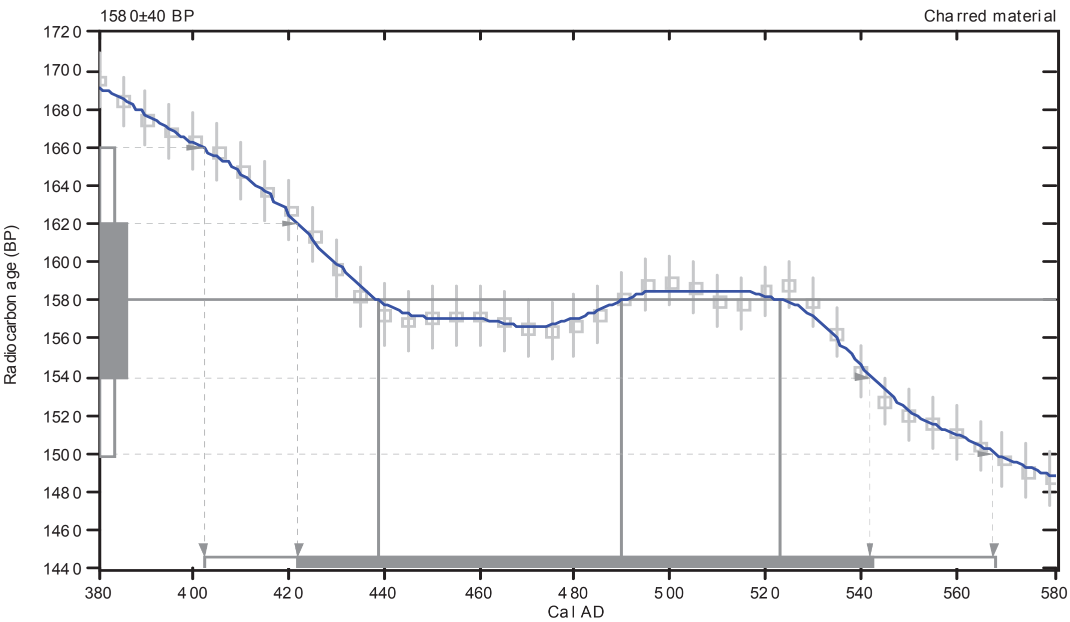
Conventional radiocarbon age: **1580±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 400 to 570 (Cal BP 1550 to 1380)**

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 440 (Cal BP 1510) and
Cal AD 490 (Cal BP 1460) and
Cal AD 520 (Cal BP 1430)

1 Sigma calibrated result: (68% probability) Cal AD 420 to 540 (Cal BP 1530 to 1410)



References:

Database used
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Calibration Database
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Darden Hood
President

Ronald Hatfield
Christopher Patrick
Deputy Directors

May 4, 2009

Dr. Eric Blinman
Office of Archaeological Studies
P.O. Box 2087
Santa Fe, NM 87504-2087
USA

RE: Radiocarbon Dating Results For Samples 214-341-39, 214-573-51, 214-586-52, 214-593-54, 214-623-57, 214-622-58, 214-658-59, 214-657-61, 214-697-62, 214-663-63, 214-682-64, 214-755-71, 214-766-72, 214-774-73, 214-850-75, 214-876-76, 214-886-77, 214-908-80, 214-909-82, 214-994-84, 214-943-85, 214-961-86, 214-1003-88, 214-1004-89, 214-1065-93, 214-1106-95, 214-1366-96, 214-1135-98, 214-1157-99, 214-1189-101, 214-1237-102, 214-1190-104, 214-1239-105, 214-1188-106, 214-1343-110, 214-1329-112, 214-1469-114, 214-1397-115, 214-1470-116, 214-1367-118, 214-1346-119, 214-1497-129, 214-1522-131, 214-1536-132, 214-1615-133, 214-1555-134, 214-1605-136, 214-1556-137, 214-1606-138, 214-1660-142, 214-1678-143, 214-1662-144, 214-1677-145, 214-1691-148, 214-1748-149, 214-1666-151, 214-1868-154, 214-1866-155, 214-1718-156, 214-1751-159, 214-1864-161, 214-1953-162, 214-1901-163, 214-1813-177, 214-1912-178, 214-1810-180, 214-1811-181, 214-1812-182

Dear Dr. Blinman:

Enclosed are the radiocarbon dating results for 68 samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses proceeded normally. As usual, the method of analysis is listed on the report with the results and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Our invoice has been sent electronically. Thank you for your prior efforts in arranging payment. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood
Digital signature on file

BETA ANALYTIC INC.
DR. M.A. TAMERS and MR. D.G. HOOD
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman — Report Date: 5/4/2009

Office of Archaeological Studies — Material Received: 4/17/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258469	1010 +/- 40 BP	-24.8 o/oo	1010 +/- 40 BP
Beta - 258470	850 +/- 40 BP	-25.4 o/oo	840 +/- 40 BP
Beta - 258471	990 +/- 40 BP	-14.4 o/oo	1160 +/- 40 BP
Beta - 258472	1250 +/- 40 BP	-24.0 o/oo	1270 +/- 40 BP
Beta - 258473	1290 +/- 40 BP	-23.7 o/oo	1310 +/- 40 BP

Beta - 258469 — 1010 +/- 40 BP — -24.8 o/oo — 1010 +/- 40 BP
SAMPLE : 214-341-39
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 980 to 1050 (Cal BP 970 to 900) AND Cal AD 1090 to 1130 (Cal BP 860 to 820)
Cal AD 1140 to 1140 (Cal BP 810 to 810)

Beta - 258470 — 850 +/- 40 BP — -25.4 o/oo — 840 +/- 40 BP
SAMPLE : 214-573-51
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1060 to 1080 (Cal BP 900 to 870) AND Cal AD 1150 to 1270 (Cal BP 800 to 680)

Beta - 258471 — 990 +/- 40 BP — -14.4 o/oo — 1160 +/- 40 BP
SAMPLE : 214-586-52
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 770 to 980 (Cal BP 1180 to 970)

Beta - 258472 — 1250 +/- 40 BP — -24.0 o/oo — 1270 +/- 40 BP
SAMPLE : 214-593-54
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 660 to 870 (Cal BP 1290 to 1080)

Beta - 258473 — 1290 +/- 40 BP — -23.7 o/oo — 1310 +/- 40 BP
SAMPLE : 214-623-57
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 650 to 780 (Cal BP 1300 to 1170)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

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beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman

Report Date: 5/4/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258474 SAMPLE : 214-622-58 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 20 to 220 (Cal BP 1930 to 1730)	1900 +/- 40 BP	-24.9 o/oo	1900 +/- 40 BP
Beta - 258475 SAMPLE : 214-658-59 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 140 to 380 (Cal BP 1810 to 1570)	1750 +/- 40 BP	-23.5 o/oo	1770 +/- 40 BP
Beta - 258476 SAMPLE : 214-657-61 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 610 to 680 (Cal BP 1340 to 1270)	1370 +/- 40 BP	-24.5 o/oo	1380 +/- 40 BP
Beta - 258477 SAMPLE : 214-697-62 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1030 to 1220 (Cal BP 920 to 730)	900 +/- 40 BP	-24.6 o/oo	910 +/- 40 BP
Beta - 258478 SAMPLE : 214-663-63 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 440 to 490 (Cal BP 1510 to 1460) AND Cal AD 520 to 640 (Cal BP 1430 to 1310)	1480 +/- 40 BP	-23.6 o/oo	1500 +/- 40 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman

Report Date: 5/4/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258479	1660 +/- 40 BP	-25.2 o/oo	1660 +/- 40 BP

SAMPLE : 214-682-64
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 260 to 290 (Cal BP 1690 to 1660) AND Cal AD 320 to 440 (Cal BP 1630 to 1510)
Cal AD 490 to 520 (Cal BP 1460 to 1430)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258480	1640 +/- 40 BP	-24.4 o/oo	1650 +/- 40 BP

SAMPLE : 214-755-71
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 260 to 280 (Cal BP 1680 to 1670) AND Cal AD 330 to 450 (Cal BP 1620 to 1500)
Cal AD 450 to 460 (Cal BP 1500 to 1490) AND Cal AD 480 to 530 (Cal BP 1470 to 1420)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258481	1260 +/- 40 BP	-24.1 o/oo	1270 +/- 40 BP

SAMPLE : 214-766-72
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 660 to 870 (Cal BP 1290 to 1080)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258482	1680 +/- 40 BP	-24.4 o/oo	1690 +/- 40 BP

SAMPLE : 214-774-73
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 250 to 420 (Cal BP 1700 to 1520)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258483	1850 +/- 40 BP	-24.8 o/oo	1850 +/- 40 BP

SAMPLE : 214-850-75
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 70 to 250 (Cal BP 1880 to 1700)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

BETA ANALYTIC INC.

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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman — Report Date: 5/4/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258484	1640 +/- 40 BP	-24.3 o/oo	1650 +/- 40 BP

SAMPLE : 214-876-76
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 260 to 280 (Cal BP 1680 to 1670) AND Cal AD 330 to 450 (Cal BP 1620 to 1500)
Cal AD 450 to 460 (Cal BP 1500 to 1490) AND Cal AD 480 to 530 (Cal BP 1470 to 1420)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258485	1180 +/- 40 BP	-24.5 o/oo	1190 +/- 40 BP

SAMPLE : 214-886-77
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 710 to 750 (Cal BP 1240 to 1200) AND Cal AD 760 to 900 (Cal BP 1190 to 1050)
Cal AD 920 to 960 (Cal BP 1040 to 990)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258486	1600 +/- 40 BP	-24.2 o/oo	1610 +/- 40 BP

SAMPLE : 214-908-80
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 380 to 550 (Cal BP 1570 to 1400)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258487	1560 +/- 40 BP	-24.1 o/oo	1570 +/- 40 BP

SAMPLE : 214-909-82
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 410 to 580 (Cal BP 1540 to 1370)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258488	1010 +/- 40 BP	-25.1 o/oo	1010 +/- 40 BP

SAMPLE : 214-994-84
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 980 to 1050 (Cal BP 970 to 900) AND Cal AD 1090 to 1130 (Cal BP 860 to 820)
Cal AD 1140 to 1140 (Cal BP 810 to 810)

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258489 SAMPLE : 214-943-85 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 990 to 1160 (Cal BP 960 to 790)	960 +/- 40 BP	-23.6 o/oo	980 +/- 40 BP
Beta - 258490 SAMPLE : 214-961-86 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 900 to 1030 (Cal BP 1050 to 920)	1040 +/- 40 BP	-24.4 o/oo	1050 +/- 40 BP
Beta - 258491 SAMPLE : 214-1003-88 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 70 to 250 (Cal BP 1880 to 1700)	1850 +/- 40 BP	-25.0 o/oo	1850 +/- 40 BP
Beta - 258492 SAMPLE : 214-1004-89 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 50 to 230 (Cal BP 1900 to 1720)	1870 +/- 40 BP	-24.3 o/oo	1880 +/- 40 BP
Beta - 258493 SAMPLE : 214-1065-93 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 670 to 880 (Cal BP 1280 to 1070)	1220 +/- 40 BP	-22.9 o/oo	1250 +/- 40 BP

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258494	1210 +/- 40 BP	-25.5 o/oo	1200 +/- 40 BP

SAMPLE : 214-1106-95
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 690 to 900 (Cal BP 1260 to 1050) AND Cal AD 920 to 950 (Cal BP 1030 to 1000)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258495	950 +/- 40 BP	-24.5 o/oo	960 +/- 40 BP

SAMPLE : 214-1366-96
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1010 to 1170 (Cal BP 940 to 780)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258496	840 +/- 40 BP	-24.7 o/oo	840 +/- 40 BP

SAMPLE : 214-1135-98
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1060 to 1080 (Cal BP 900 to 870) AND Cal AD 1150 to 1270 (Cal BP 800 to 680)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258497	1140 +/- 40 BP	-23.7 o/oo	1160 +/- 40 BP

SAMPLE : 214-1157-99
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 770 to 980 (Cal BP 1180 to 970)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258498	1060 +/- 40 BP	-24.5 o/oo	1070 +/- 40 BP

SAMPLE : 214-1189-101
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 890 to 1030 (Cal BP 1060 to 920)

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258499 SAMPLE : 214-1237-102 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 770 to 980 (Cal BP 1180 to 970)	1150 +/- 40 BP	-24.3 o/oo	1160 +/- 40 BP
Beta - 258500 SAMPLE : 214-1190-104 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 780 to 980 (Cal BP 1170 to 960)	1150 +/- 40 BP	-25.1 o/oo	1150 +/- 40 BP
Beta - 258501 SAMPLE : 214-1239-105 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 570 to 660 (Cal BP 1380 to 1280)	1410 +/- 40 BP	-24.3 o/oo	1420 +/- 40 BP
Beta - 258502 SAMPLE : 214-1188-106 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 710 to 750 (Cal BP 1240 to 1200) AND Cal AD 760 to 900 (Cal BP 1190 to 1050) Cal AD 920 to 960 (Cal BP 1040 to 990)	1180 +/- 40 BP	-24.5 o/oo	1190 +/- 40 BP
Beta - 258503 SAMPLE : 214-1343-110 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 390 to 560 (Cal BP 1560 to 1390)	1560 +/- 40 BP	-23.4 o/oo	1590 +/- 40 BP

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258504	1880 +/- 40 BP	-24.7 o/oo	1880 +/- 40 BP

SAMPLE : 214-1329-112
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 50 to 230 (Cal BP 1900 to 1720)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258505	1010 +/- 40 BP	-23.9 o/oo	1030 +/- 40 BP

SAMPLE : 214-1469-114
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 900 to 920 (Cal BP 1050 to 1040) AND Cal AD 960 to 1040 (Cal BP 990 to 910)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258506	1110 +/- 40 BP	-24.9 o/oo	1110 +/- 40 BP

SAMPLE : 214-1397-115
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 870 to 1010 (Cal BP 1080 to 940)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258507	850 +/- 40 BP	-24.4 o/oo	860 +/- 40 BP

SAMPLE : 214-1470-116
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1040 to 1100 (Cal BP 910 to 850) AND Cal AD 1120 to 1260 (Cal BP 830 to 690)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258508	990 +/- 40 BP	-25.0 o/oo	990 +/- 40 BP

SAMPLE : 214-1367-118
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 980 to 1160 (Cal BP 960 to 800)

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258509 SAMPLE : 214-1346-119 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 610 to 690 (Cal BP 1340 to 1260)	1350 +/- 40 BP	-23.7 o/oo	1370 +/- 40 BP
Beta - 258510 SAMPLE : 214-1497-129 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 410 to 590 (Cal BP 1540 to 1360)	1560 +/- 40 BP	-24.7 o/oo	1560 +/- 40 BP
Beta - 258511 SAMPLE : 214-1522-131 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 690 to 900 (Cal BP 1260 to 1050) AND Cal AD 920 to 950 (Cal BP 1030 to 1000)	1170 +/- 40 BP	-23.3 o/oo	1200 +/- 40 BP
Beta - 258512 SAMPLE : 214-1536-132 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 230 to 410 (Cal BP 1720 to 1540)	1700 +/- 40 BP	-23.0 o/oo	1730 +/- 40 BP
Beta - 258513 SAMPLE : 214-1615-133 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1300 to 1430 (Cal BP 650 to 520)	520 +/- 40 BP	-22.2 o/oo	570 +/- 40 BP

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Beta - 258514 SAMPLE : 214-1555-134 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 990 to 1160 (Cal BP 960 to 790)	930 +/- 40 BP	-21.7 o/oo	980 +/- 40 BP
Beta - 258515 SAMPLE : 214-1605-136 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 660 to 780 (Cal BP 1290 to 1160)	1270 +/- 40 BP	-23.7 o/oo	1290 +/- 40 BP
Beta - 258516 SAMPLE : 214-1556-137 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 880 to 1020 (Cal BP 1070 to 930)	1080 +/- 40 BP	-24.2 o/oo	1090 +/- 40 BP
Beta - 258517 SAMPLE : 214-1606-138 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1020 to 1210 (Cal BP 930 to 740)	920 +/- 40 BP	-24.7 o/oo	920 +/- 40 BP
Beta - 258518 SAMPLE : 214-1660-142 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 780 to 980 (Cal BP 1170 to 960)	1130 +/- 40 BP	-23.5 o/oo	1150 +/- 40 BP

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Beta - 258519	1090 +/- 40 BP	-23.7 o/oo	1110 +/- 40 BP
SAMPLE : 214-1678-143			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 870 to 1010 (Cal BP 1080 to 940)			
Beta - 258520	1000 +/- 40 BP	-25.1 o/oo	1000 +/- 40 BP
SAMPLE : 214-1662-144			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 980 to 1060 (Cal BP 970 to 900) AND Cal AD 1080 to 1150 (Cal BP 870 to 800)			
Beta - 258521	980 +/- 40 BP	-23.1 o/oo	1010 +/- 40 BP
SAMPLE : 214-1677-145			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 980 to 1050 (Cal BP 970 to 900) AND Cal AD 1090 to 1130 (Cal BP 860 to 820) Cal AD 1140 to 1140 (Cal BP 810 to 810)			
Beta - 258522	1160 +/- 40 BP	-25.2 o/oo	1160 +/- 40 BP
SAMPLE : 214-1691-148			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 770 to 980 (Cal BP 1180 to 970)			
Beta - 258523	730 +/- 40 BP	-24.3 o/oo	740 +/- 40 BP
SAMPLE : 214-1748-149			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 1220 to 1300 (Cal BP 730 to 660)			

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Report Date: 5/4/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258524 SAMPLE : 214-1666-151 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 590 to 670 (Cal BP 1360 to 1280)	1400 +/- 40 BP	-24.7 o/oo	1400 +/- 40 BP
Beta - 258525 SAMPLE : 214-1868-154 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 810 to 1010 (Cal BP 1140 to 940)	1080 +/- 40 BP	-22.4 o/oo	1120 +/- 40 BP
Beta - 258526 SAMPLE : 214-1866-155 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 810 to 1010 (Cal BP 1140 to 940)	1120 +/- 40 BP	-25.1 o/oo	1120 +/- 40 BP
Beta - 258527 SAMPLE : 214-1718-156 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 650 to 770 (Cal BP 1300 to 1180)	1310 +/- 40 BP	-24.6 o/oo	1320 +/- 40 BP
Beta - 258528 SAMPLE : 214-1751-159 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 430 to 640 (Cal BP 1520 to 1320)	1500 +/- 40 BP	-24.4 o/oo	1510 +/- 40 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

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beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman

Report Date: 5/4/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258529	1170 +/- 40 BP	-24.2 o/oo	1180 +/- 40 BP

SAMPLE : 214-1864-161
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 720 to 740 (Cal BP 1230 to 1210) AND Cal AD 770 to 970 (Cal BP 1180 to 980)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258530	1010 +/- 40 BP	-24.9 o/oo	1010 +/- 40 BP

SAMPLE : 214-1953-162
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 980 to 1050 (Cal BP 970 to 900) AND Cal AD 1090 to 1130 (Cal BP 860 to 820)
Cal AD 1140 to 1140 (Cal BP 810 to 810)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258531	1090 +/- 40 BP	-24.2 o/oo	1100 +/- 40 BP

SAMPLE : 214-1901-163
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 880 to 1020 (Cal BP 1070 to 930)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258532	1160 +/- 40 BP	-25.1 o/oo	1160 +/- 40 BP

SAMPLE : 214-1813-177
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 770 to 980 (Cal BP 1180 to 970)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258533	1320 +/- 40 BP	-24.2 o/oo	1330 +/- 40 BP

SAMPLE : 214-1912-178
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 640 to 770 (Cal BP 1300 to 1180)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman

Report Date: 5/4/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258534 SAMPLE : 214-1810-180 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 430 to 620 (Cal BP 1520 to 1330)	1520 +/- 40 BP	-25.1 o/oo	1520 +/- 40 BP
Beta - 258535 SAMPLE : 214-1811-181 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 670 to 880 (Cal BP 1280 to 1070)	1240 +/- 40 BP	-24.5 o/oo	1250 +/- 40 BP
Beta - 258536 SAMPLE : 214-1812-182 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 650 to 770 (Cal BP 1300 to 1180)	1310 +/- 40 BP	-24.5 o/oo	1320 +/- 40 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

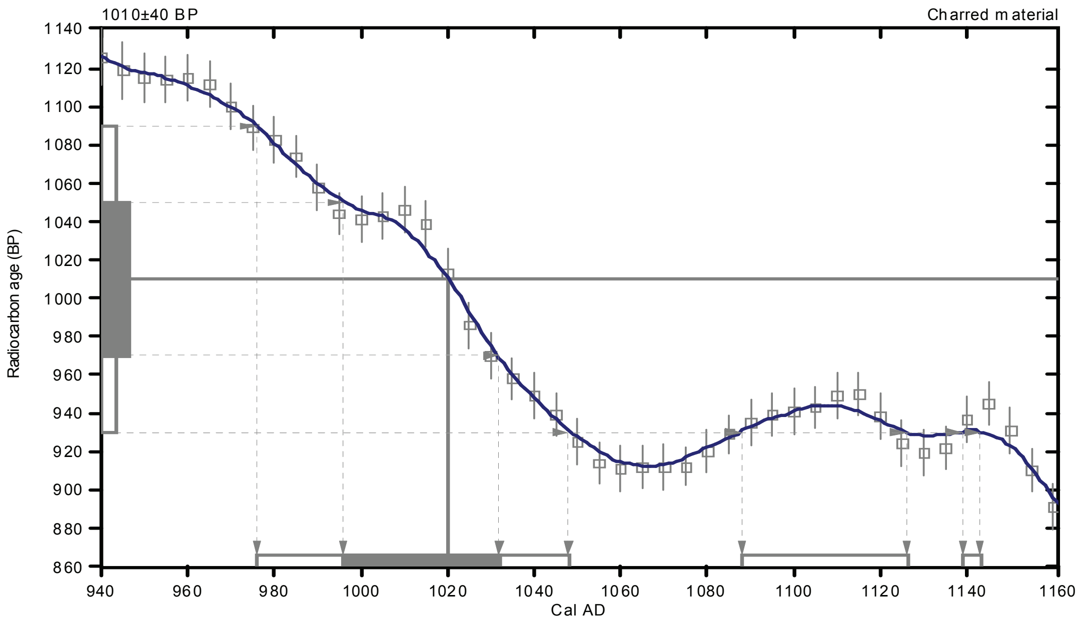
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number:	**Beta-258469**
Conventional radiocarbon age:	**1010±40 BP**
2 Sigma calibrated results: (95% probability)	**Cal AD 980 to 1050 (Cal BP 970 to 900) and Cal AD 1090 to 1130 (Cal BP 860 to 820) and Cal AD 1140 to 1140 (Cal BP 810 to 810)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1020 (Cal BP 930)
1 Sigma calibrated result: (68% probability)	Cal AD 1000 to 1030 (Cal BP 950 to 920)



References:

Database used
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.4:lab. mult=1)

Laboratory number: **Beta-258470**

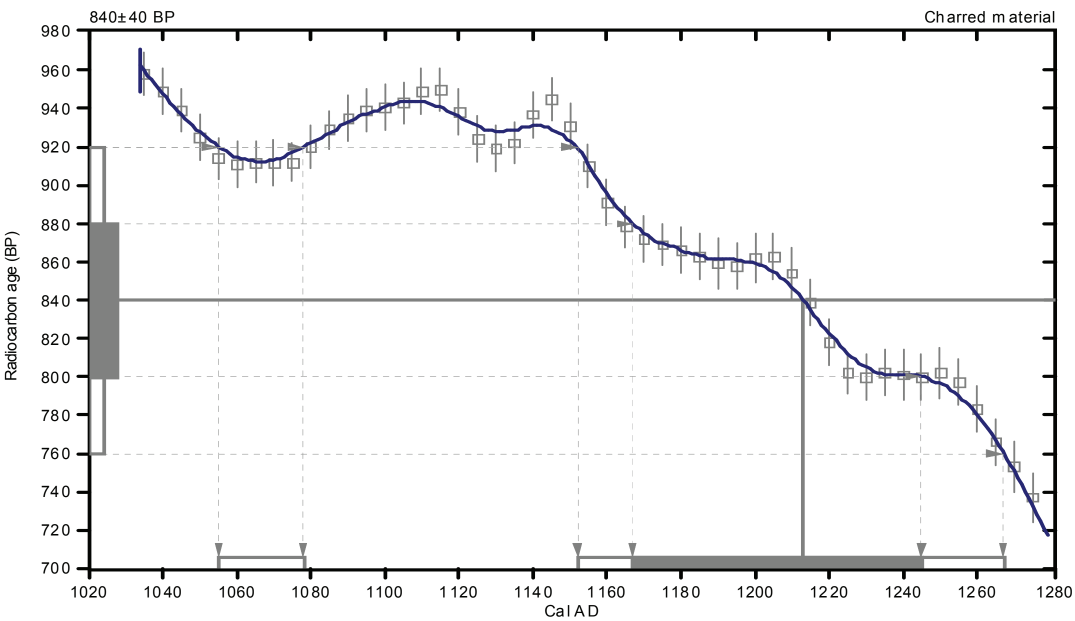
Conventional radiocarbon age: **840±40 BP**

2 Sigma calibrated results: **Cal AD 1060 to 1080 (Cal BP 900 to 870) and**
(95% probability) **Cal AD 1150 to 1270 (Cal BP 800 to 680)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1210 (Cal BP 740)

1 Sigma calibrated result: Cal AD 1170 to 1240 (Cal BP 780 to 700)
(68% probability)



References:

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-14.4:lab. mult=1)

Laboratory number: **Beta-258471**

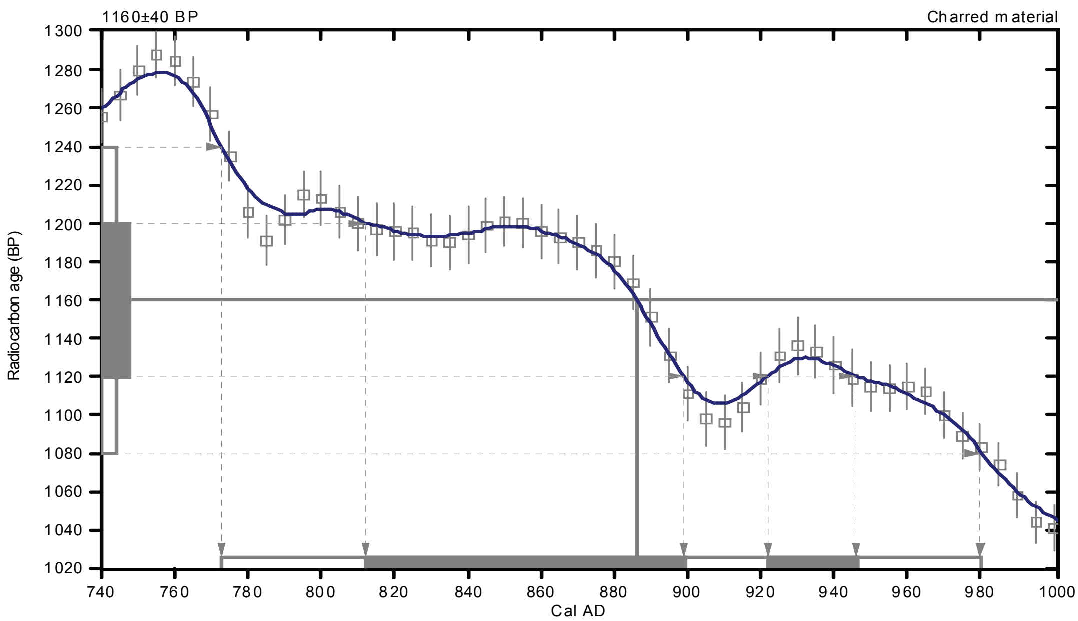
Conventional radiocarbon age: **1160±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 770 to 980 (Cal BP 1180 to 970)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 890 (Cal BP 1060)

1 Sigma calibrated results: (68% probability) Cal AD 810 to 900 (Cal BP 1140 to 1050) and Cal AD 920 to 950 (Cal BP 1030 to 1000)



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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24:lab. mult=1)

Laboratory number: **Beta-258472**

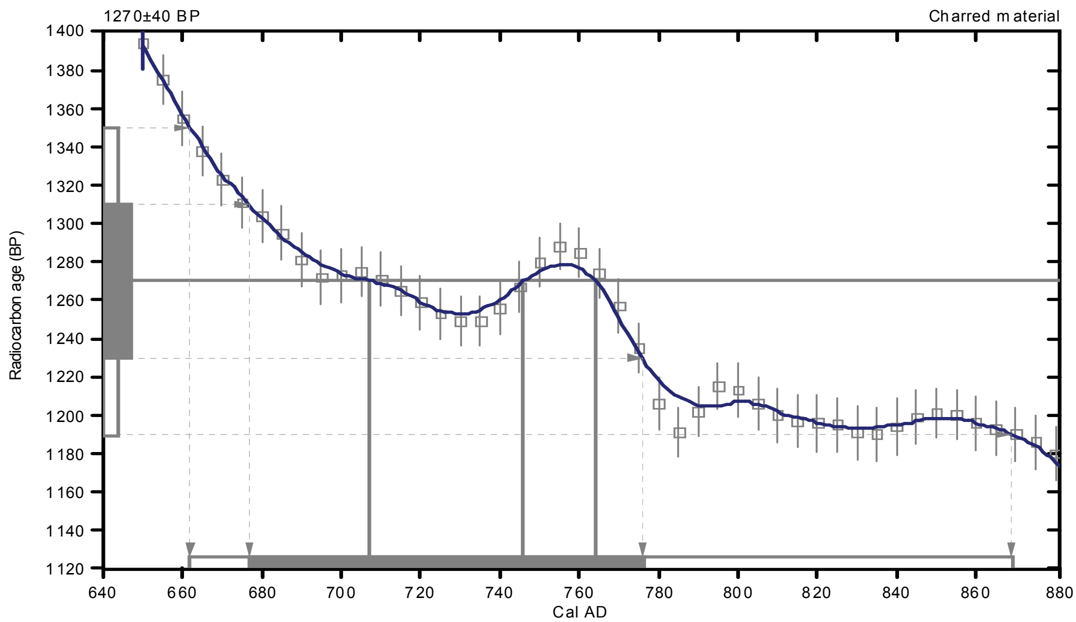
Conventional radiocarbon age: **1270±40 BP**

2 Sigma calibrated result: **Cal AD 660 to 870 (Cal BP 1290 to 1080)**
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve: Cal AD 710 (Cal BP 1240) and
Cal AD 750 (Cal BP 1200) and
Cal AD 760 (Cal BP 1190)

1 Sigma calibrated result: Cal AD 680 to 780 (Cal BP 1270 to 1170)
(68% probability)



References:
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7:lab. mult=1)

Laboratory number: **Beta-258473**

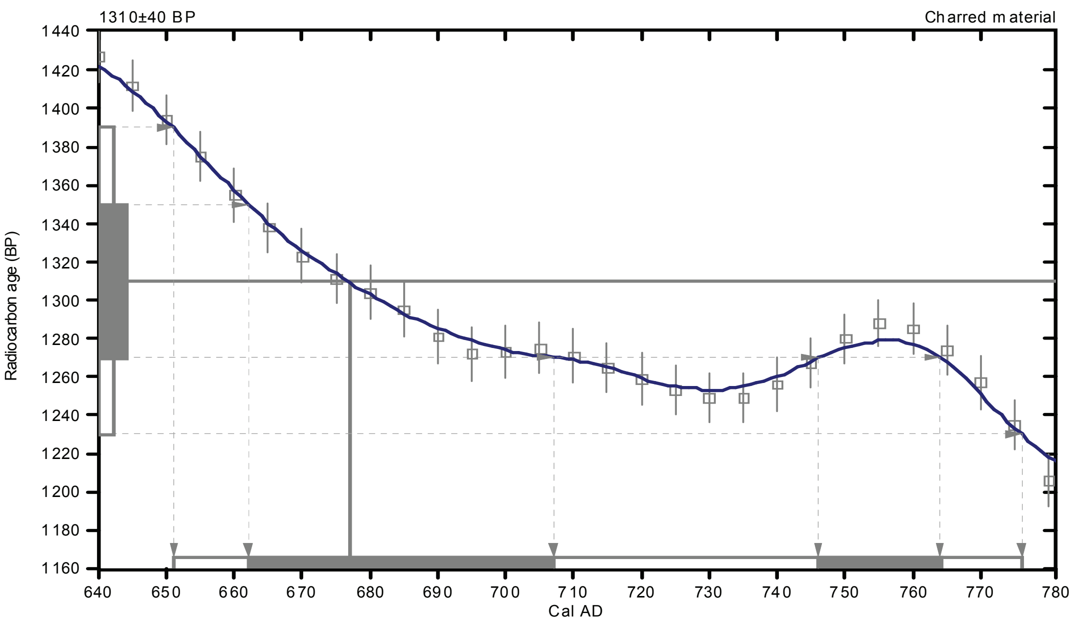
Conventional radiocarbon age: **1310±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 650 to 780 (Cal BP 1300 to 1170)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 680 (Cal BP 1270)

1 Sigma calibrated results: (68% probability) Cal AD 660 to 710 (Cal BP 1290 to 1240) and Cal AD 750 to 760 (Cal BP 1200 to 1190)



References:

Database used

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.9:lab. mult=1)

Laboratory number: **Beta-258474**

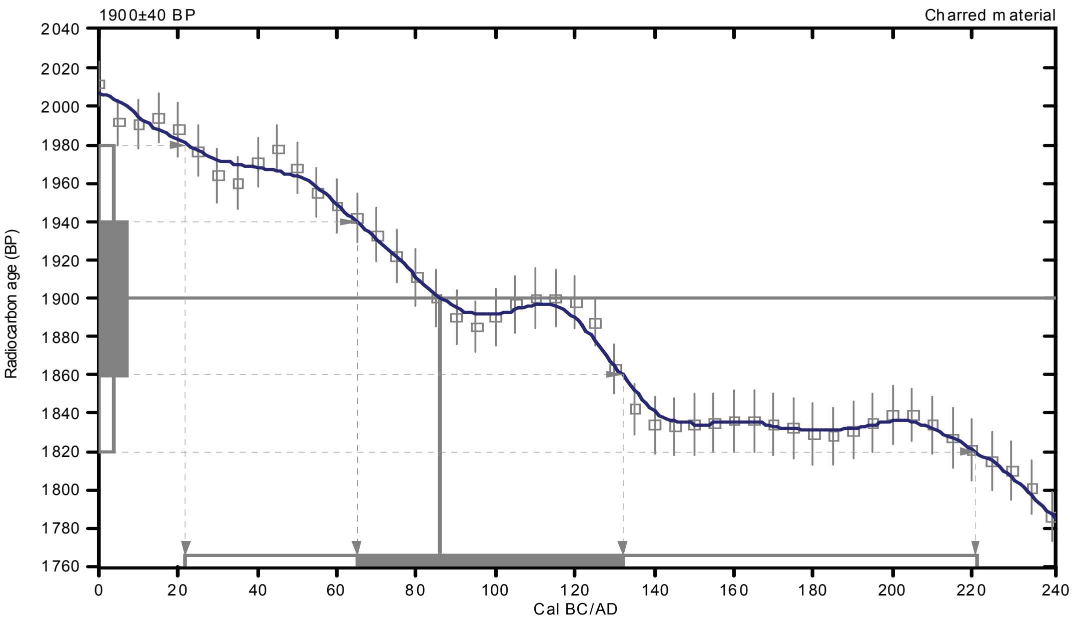
Conventional radiocarbon age: **1900±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 20 to 220 (Cal BP 1930 to 1730)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 90 (Cal BP 1860)

1 Sigma calibrated result: (68% probability) Cal AD 60 to 130 (Cal BP 1880 to 1820)



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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.5:lab. mult=1)

Laboratory number: **Beta-258475**

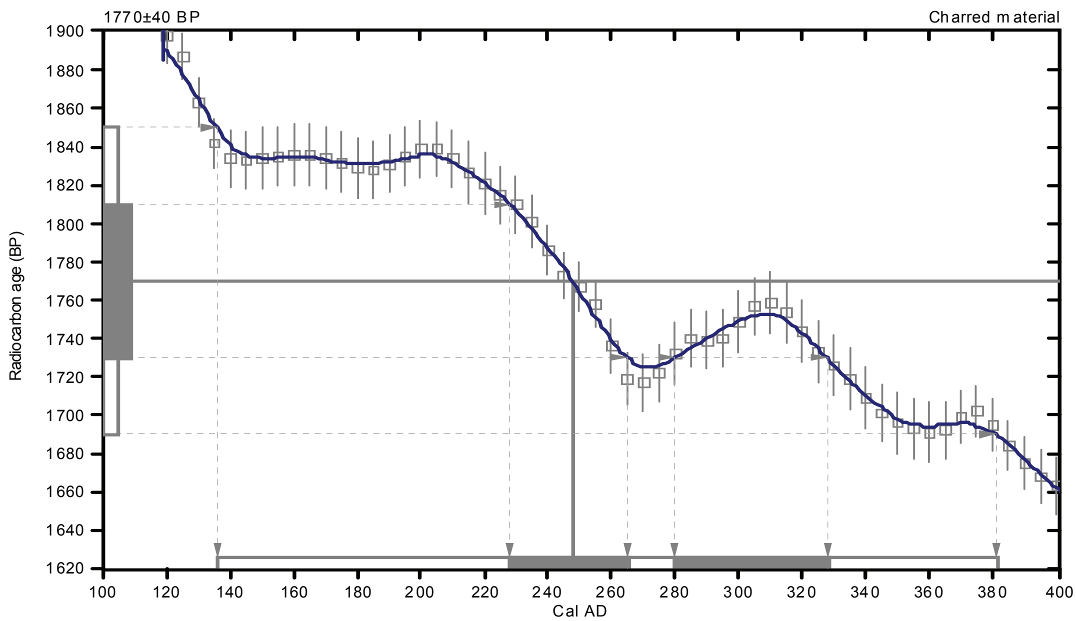
Conventional radiocarbon age: **1770±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 140 to 380 (Cal BP 1810 to 1570)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 250 (Cal BP 1700)

1 Sigma calibrated results: (68% probability) Cal AD 230 to 260 (Cal BP 1720 to 1680) and Cal AD 280 to 330 (Cal BP 1670 to 1620)



References:

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258476**

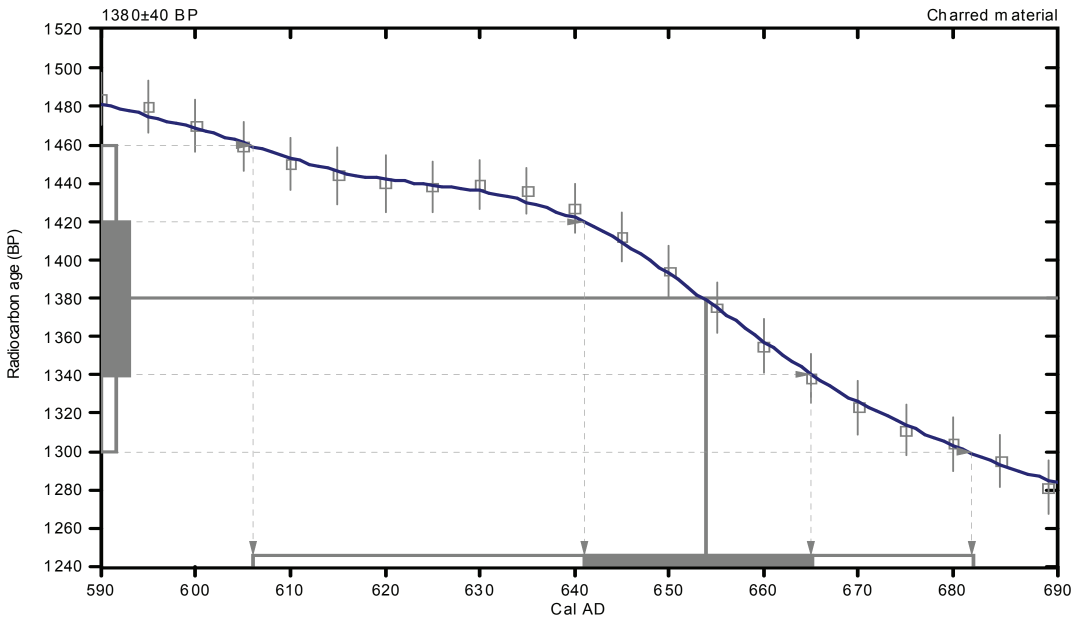
Conventional radiocarbon age: **1380±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 610 to 680 (Cal BP 1340 to 1270)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 650 (Cal BP 1300)

1 Sigma calibrated result: (68% probability) Cal AD 640 to 660 (Cal BP 1310 to 1280)



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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.6:lab. mult=1)

Laboratory number: **Beta-258477**

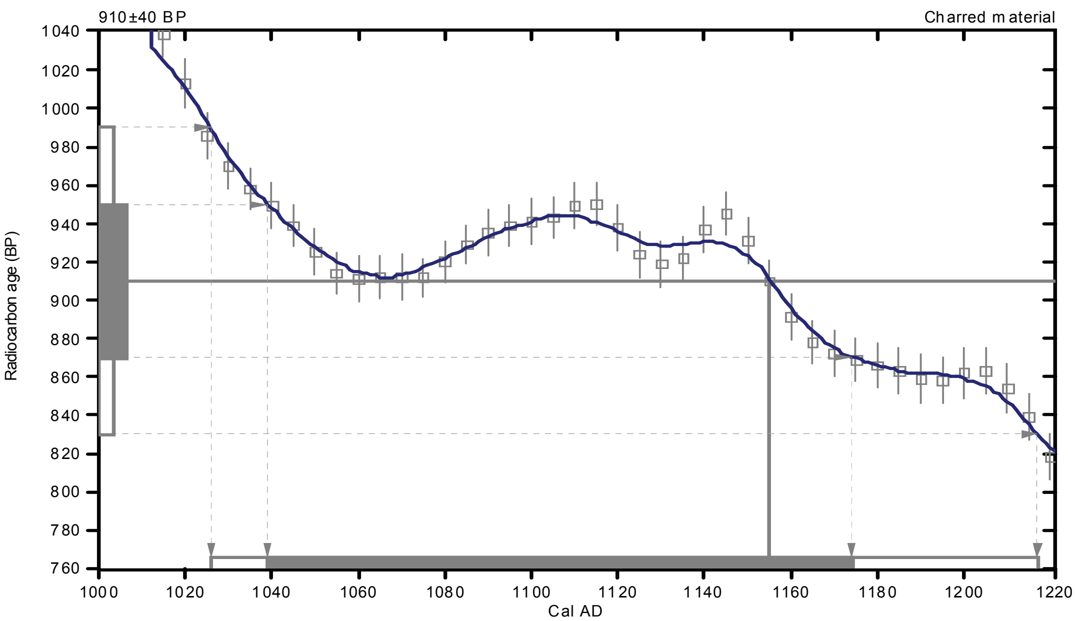
Conventional radiocarbon age: **910±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1030 to 1220 (Cal BP 920 to 730)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1160 (Cal BP 800)

1 Sigma calibrated result: (68% probability) Cal AD 1040 to 1170 (Cal BP 910 to 780)



References:

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.6:lab. mult=1)

Laboratory number: **Beta-258478**

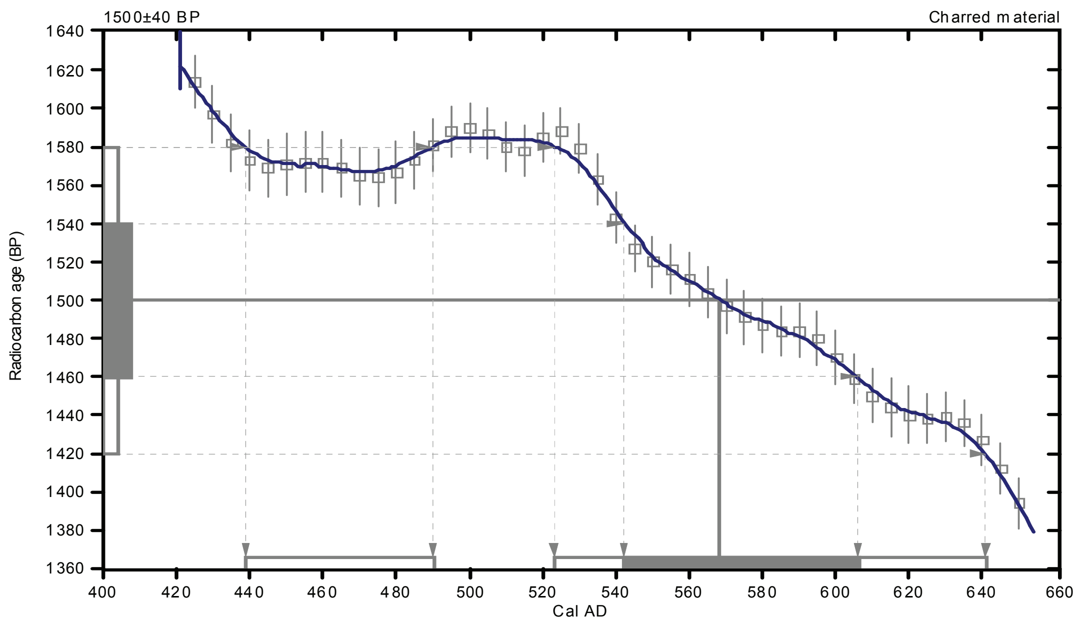
Conventional radiocarbon age: **1500±40 BP**

2 Sigma calibrated results: **Cal AD 440 to 490 (Cal BP 1510 to 1460) and**
(95% probability) **Cal AD 520 to 640 (Cal BP 1430 to 1310)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 570 (Cal BP 1380)

1 Sigma calibrated result: Cal AD 540 to 610 (Cal BP 1410 to 1340)
(68% probability)



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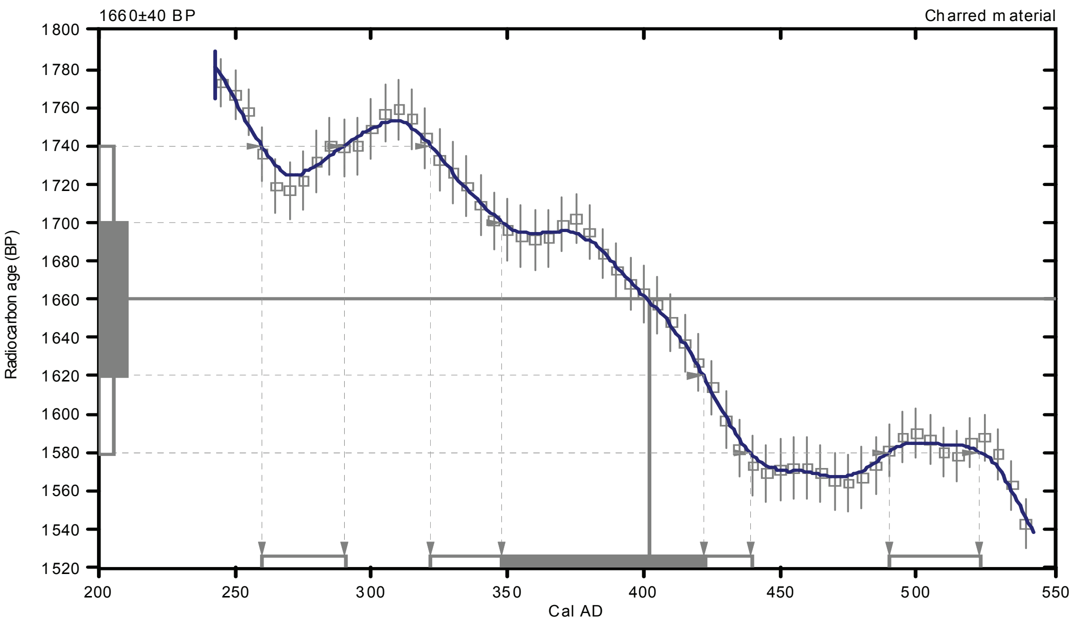
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.2:lab. mult=1)

Laboratory number:	**Beta-258479**
Conventional radiocarbon age:	**1660±40 BP**
2 Sigma calibrated results: (95% probability)	**Cal AD 260 to 290 (Cal BP 1690 to 1660) and Cal AD 320 to 440 (Cal BP 1630 to 1510) and Cal AD 490 to 520 (Cal BP 1460 to 1430)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 400 (Cal BP 1550)
1 Sigma calibrated result: (68% probability)	Cal AD 350 to 420 (Cal BP 1600 to 1530)



References:

Database used
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Calibration Database
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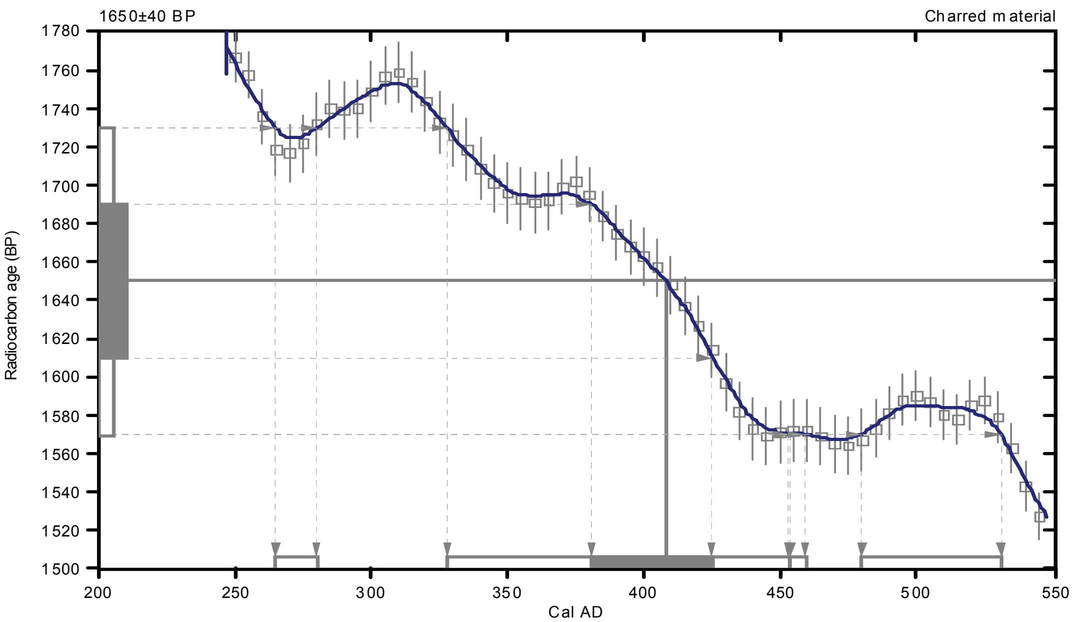
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.4:lab. mult=1)

Laboratory number:	**Beta-258480**
Conventional radiocarbon age:	**1650±40 BP**
2 Sigma calibrated results: (95% probability)	**Cal AD 260 to 280 (Cal BP 1680 to 1670) and Cal AD 330 to 450 (Cal BP 1620 to 1500) and Cal AD 450 to 460 (Cal BP 1500 to 1490) and Cal AD 480 to 530 (Cal BP 1470 to 1420)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 410 (Cal BP 1540)
1 Sigma calibrated result: (68% probability)	Cal AD 380 to 420 (Cal BP 1570 to 1520)



References:

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.1:lab. mult=1)

Laboratory number: **Beta-258481**

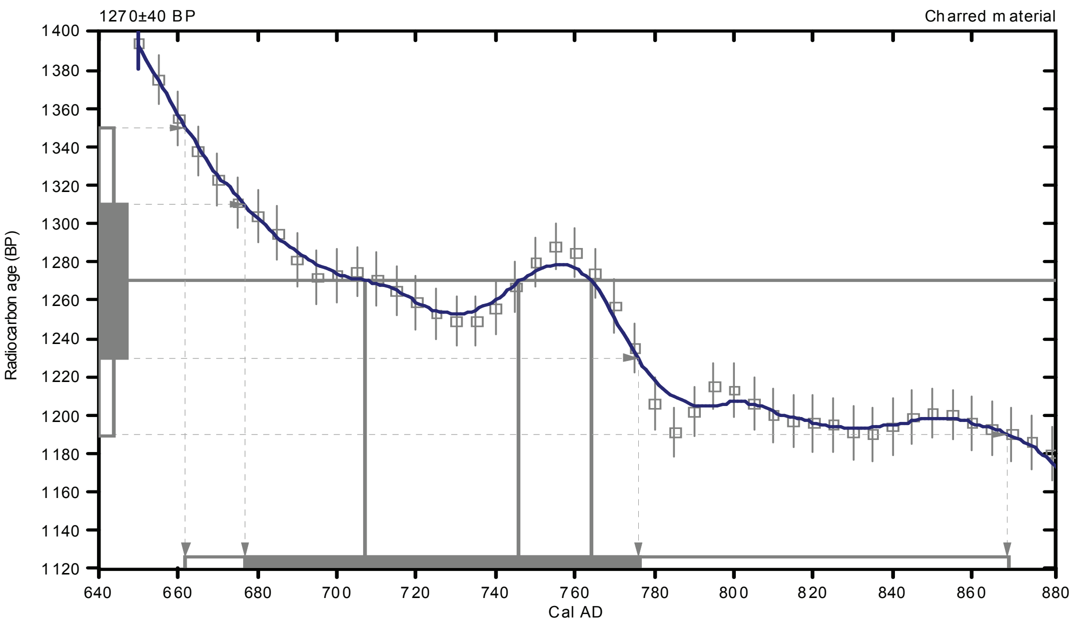
Conventional radiocarbon age: **1270±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 660 to 870 (Cal BP 1290 to 1080)**

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 710 (Cal BP 1240) and
Cal AD 750 (Cal BP 1200) and
Cal AD 760 (Cal BP 1190)

1 Sigma calibrated result: (68% probability) Cal AD 680 to 780 (Cal BP 1270 to 1170)



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4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

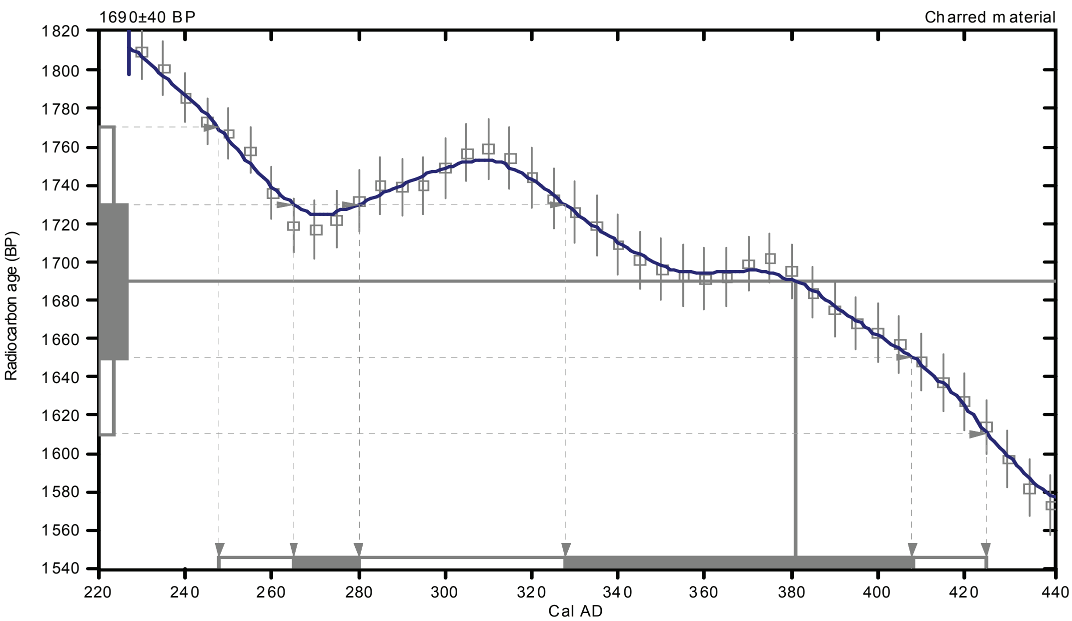
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.4:lab. mult=1)

Laboratory number:	**Beta-258482**
Conventional radiocarbon age:	**1690±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 250 to 420 (Cal BP 1700 to 1520)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 380 (Cal BP 1570)
1 Sigma calibrated results: (68% probability)	Cal AD 260 to 280 (Cal BP 1680 to 1670) and Cal AD 330 to 410 (Cal BP 1620 to 1540)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number: **Beta-258483**

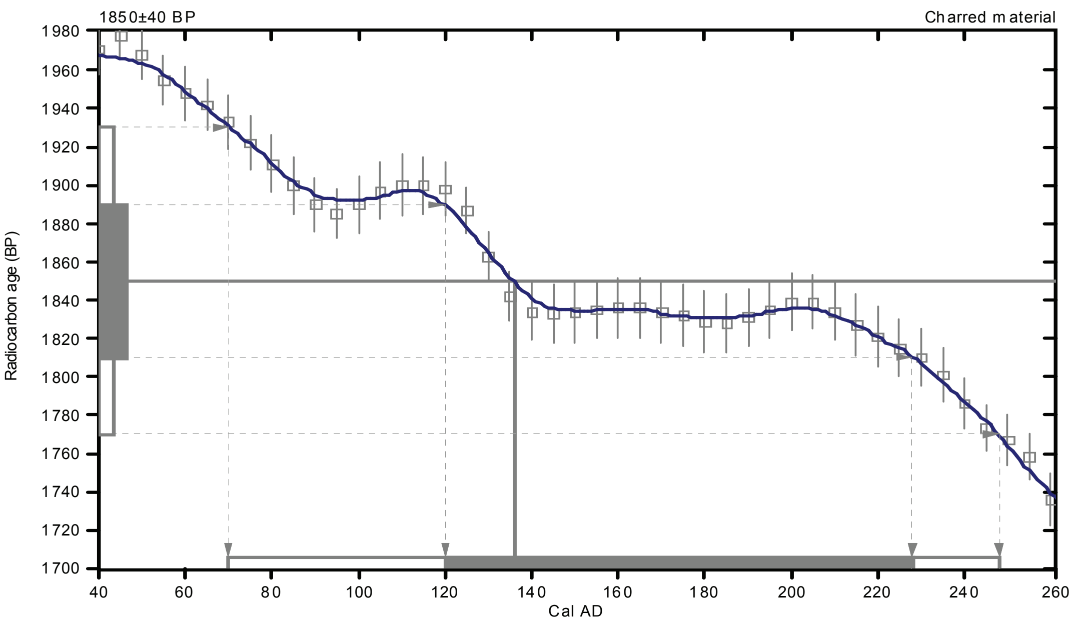
Conventional radiocarbon age: **1850±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 70 to 250 (Cal BP 1880 to 1700)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 140 (Cal BP 1810)

1 Sigma calibrated result: (68% probability) Cal AD 120 to 230 (Cal BP 1830 to 1720)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number: **Beta-258484**

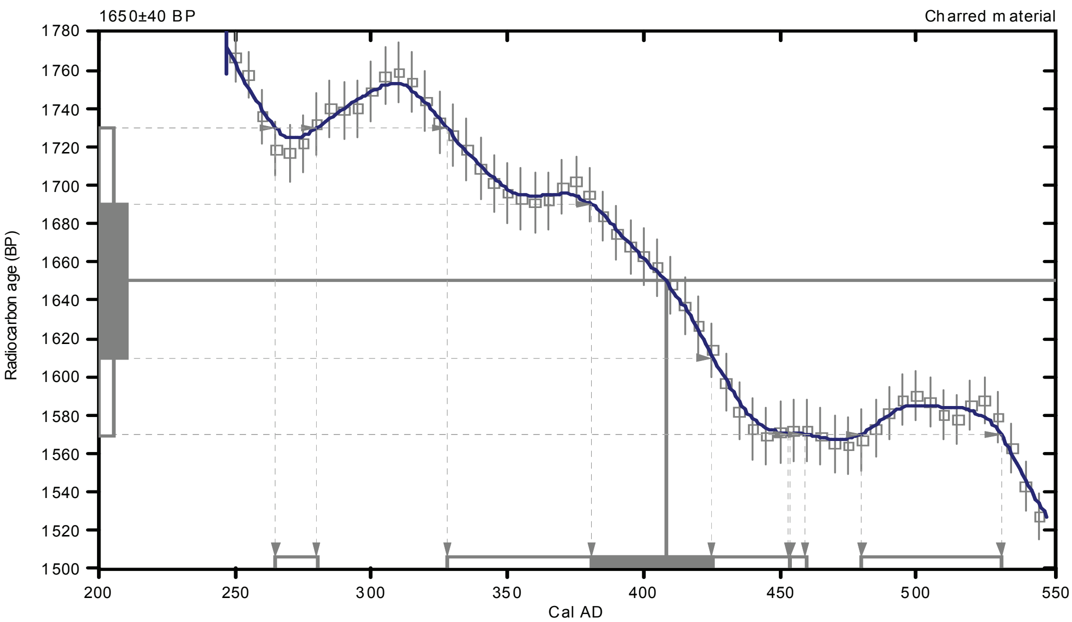
Conventional radiocarbon age: **1650±40 BP**

2 Sigma calibrated results: **Cal AD 260 to 280 (Cal BP 1680 to 1670) and**
(95% probability) **Cal AD 330 to 450 (Cal BP 1620 to 1500) and**
Cal AD 450 to 460 (Cal BP 1500 to 1490) and
Cal AD 480 to 530 (Cal BP 1470 to 1420)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 410 (Cal BP 1540)

1 Sigma calibrated result: Cal AD 380 to 420 (Cal BP 1570 to 1520)
(68% probability)



References:

Database used
INTCAL04
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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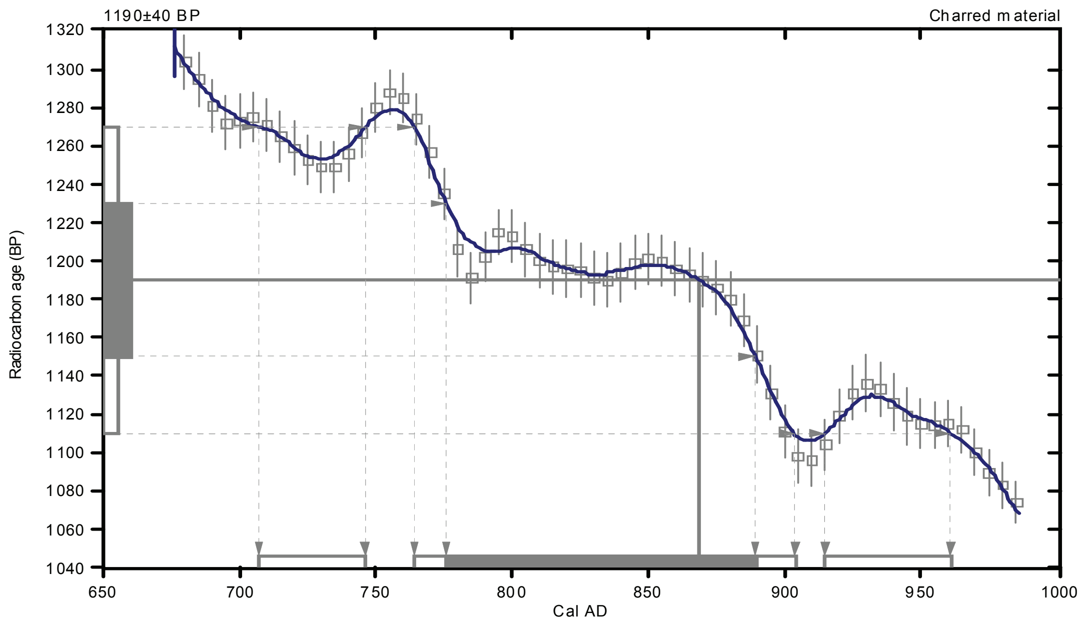
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number:	**Beta-258485**
Conventional radiocarbon age:	**1190±40 BP**
2 Sigma calibrated results: (95% probability)	**Cal AD 710 to 750 (Cal BP 1240 to 1200) and Cal AD 760 to 900 (Cal BP 1190 to 1050) and Cal AD 920 to 960 (Cal BP 1040 to 990)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 870 (Cal BP 1080)
1 Sigma calibrated result: (68% probability)	Cal AD 780 to 890 (Cal BP 1170 to 1060)



References:

Database used

INTCAL04

Calibration Database

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

Laboratory number: **Beta-258486**

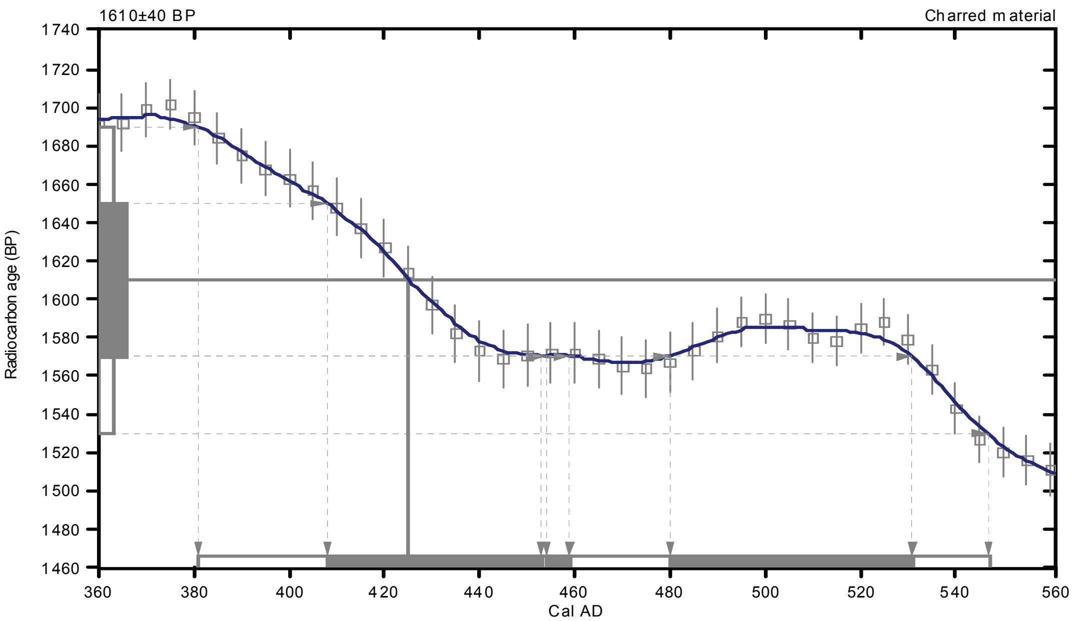
Conventional radiocarbon age: **1610±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 380 to 550 (Cal BP 1570 to 1400)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 420 (Cal BP 1520)

1 Sigma calibrated results: (68% probability)
Cal AD 410 to 450 (Cal BP 1540 to 1500) and
Cal AD 450 to 460 (Cal BP 1500 to 1490) and
Cal AD 480 to 530 (Cal BP 1470 to 1420)



References:

Database used
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.1:lab. mult=1)

Laboratory number: **Beta-258487**

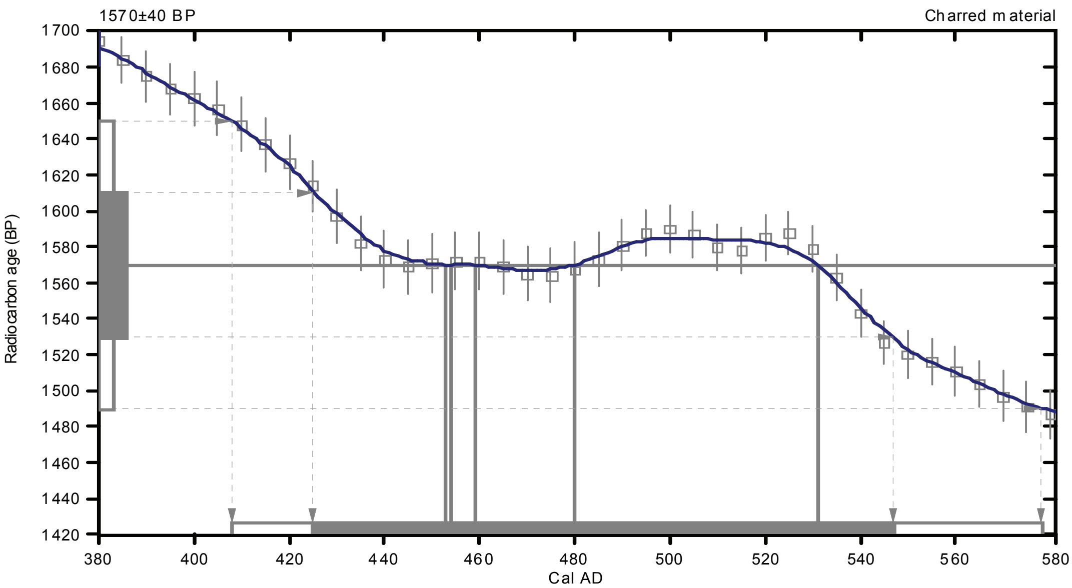
Conventional radiocarbon age: **1570±40 BP**

2 Sigma calibrated result: **Cal AD 410 to 580 (Cal BP 1540 to 1370)**
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve: Cal AD 450 (Cal BP 1500) and
Cal AD 450 (Cal BP 1500) and
Cal AD 460 (Cal BP 1490) and
Cal AD 480 (Cal BP 1470) and
Cal AD 530 (Cal BP 1420)

1 Sigma calibrated result: Cal AD 420 to 550 (Cal BP 1520 to 1400)
(68% probability)



References:

Database used
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **Beta-258488**

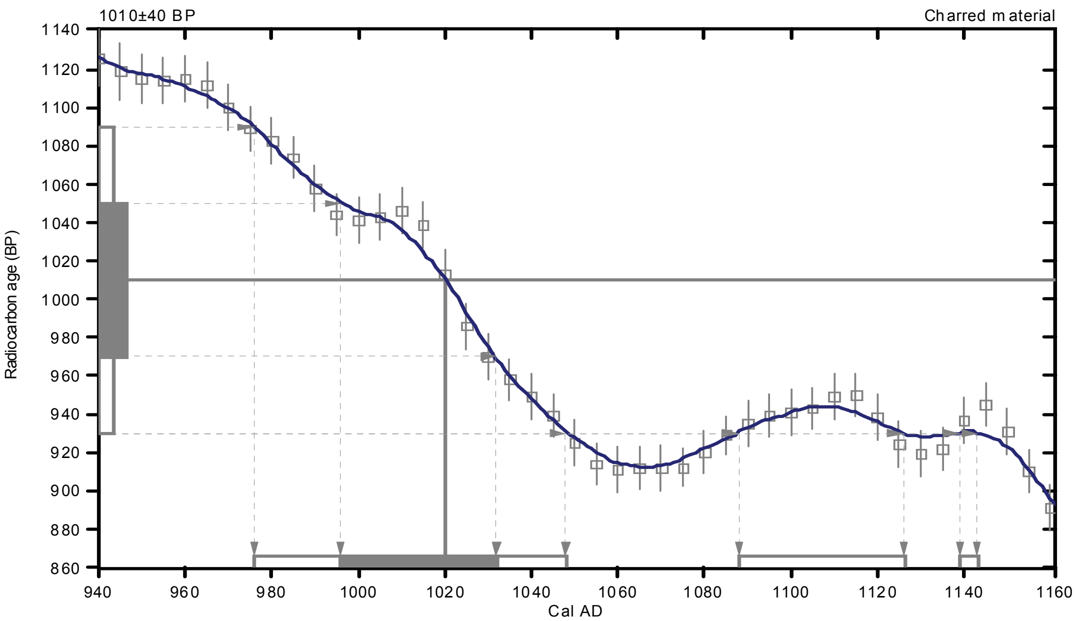
Conventional radiocarbon age: **1010±40 BP**

2 Sigma calibrated results: **Cal AD 980 to 1050 (Cal BP 970 to 900) and**
(95% probability) **Cal AD 1090 to 1130 (Cal BP 860 to 820) and**
Cal AD 1140 to 1140 (Cal BP 810 to 810)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1020 (Cal BP 930)

1 Sigma calibrated result: Cal AD 1000 to 1030 (Cal BP 950 to 920)
(68% probability)



References:
Database used
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Calibration Database
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.6:lab. mult=1)

Laboratory number: **Beta-258489**

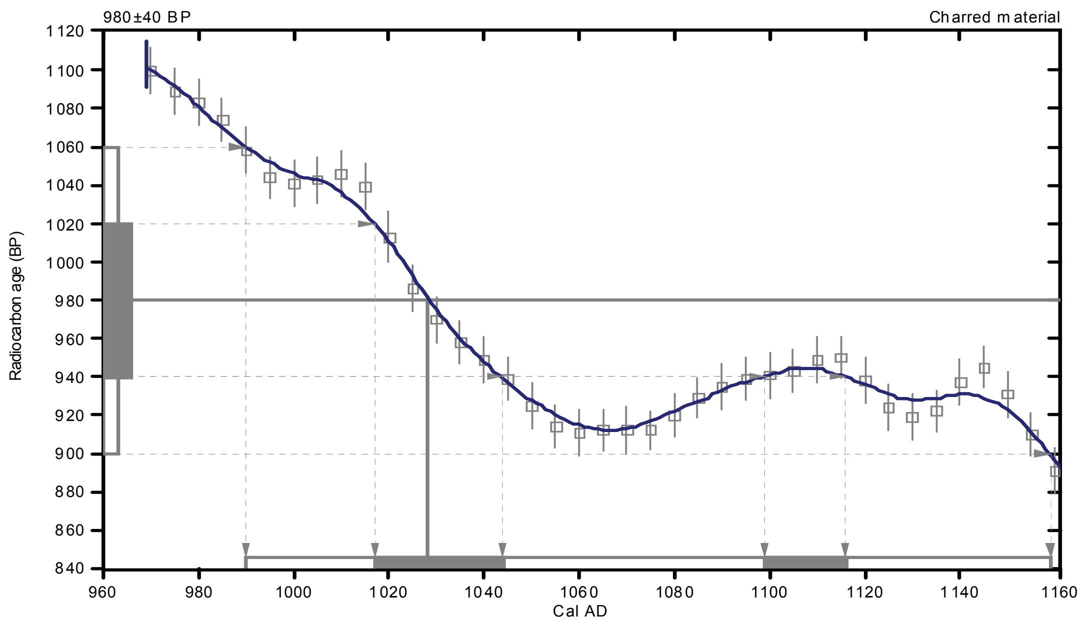
Conventional radiocarbon age: **980±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 990 to 1160 (Cal BP 960 to 790)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1030 (Cal BP 920)

1 Sigma calibrated results: (68% probability) Cal AD 1020 to 1040 (Cal BP 930 to 910) and Cal AD 1100 to 1120 (Cal BP 850 to 830)



References:

Database used
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.4:lab. mult=1)

Laboratory number: **Beta-258490**

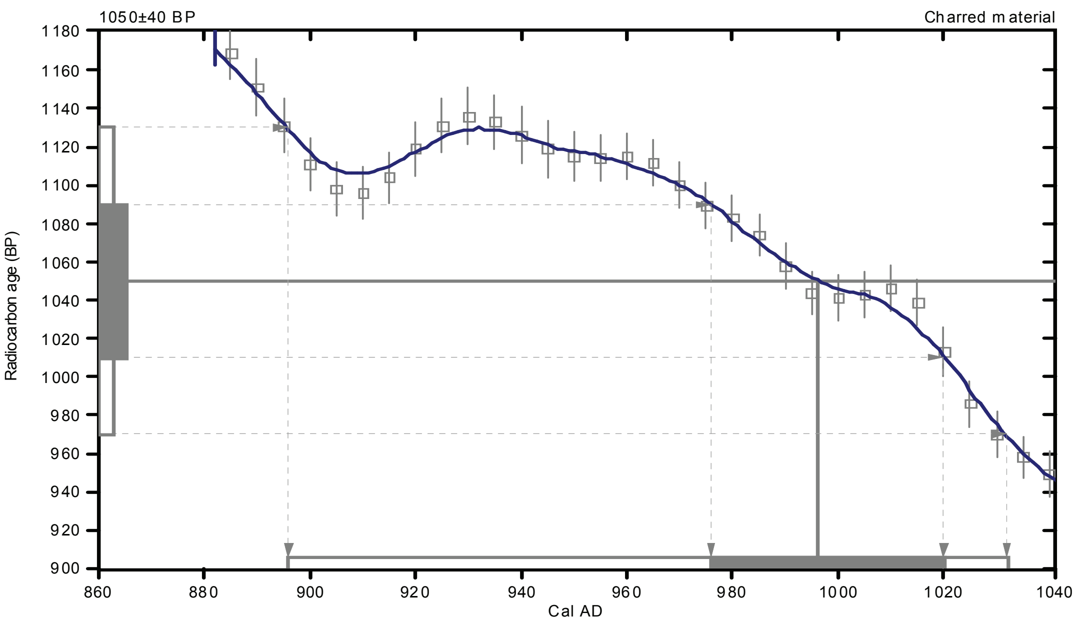
Conventional radiocarbon age: **1050±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 900 to 1030 (Cal BP 1050 to 920)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1000 (Cal BP 950)

1 Sigma calibrated result: (68% probability) Cal AD 980 to 1020 (Cal BP 970 to 930)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25:lab. mult=1)

Laboratory number: **Beta-258491**

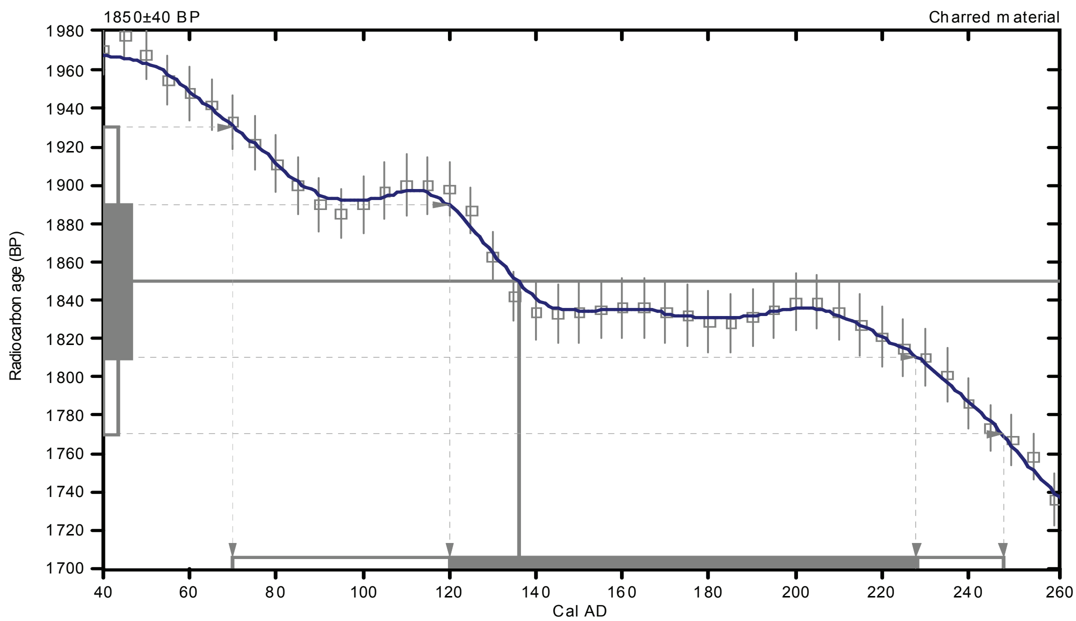
Conventional radiocarbon age: **1850±40 BP**

2 Sigma calibrated result: **Cal AD 70 to 250 (Cal BP 1880 to 1700)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 140 (Cal BP 1810)

1 Sigma calibrated result: Cal AD 120 to 230 (Cal BP 1830 to 1720)
(68% probability)



References:

Database used
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number: **Beta-258492**

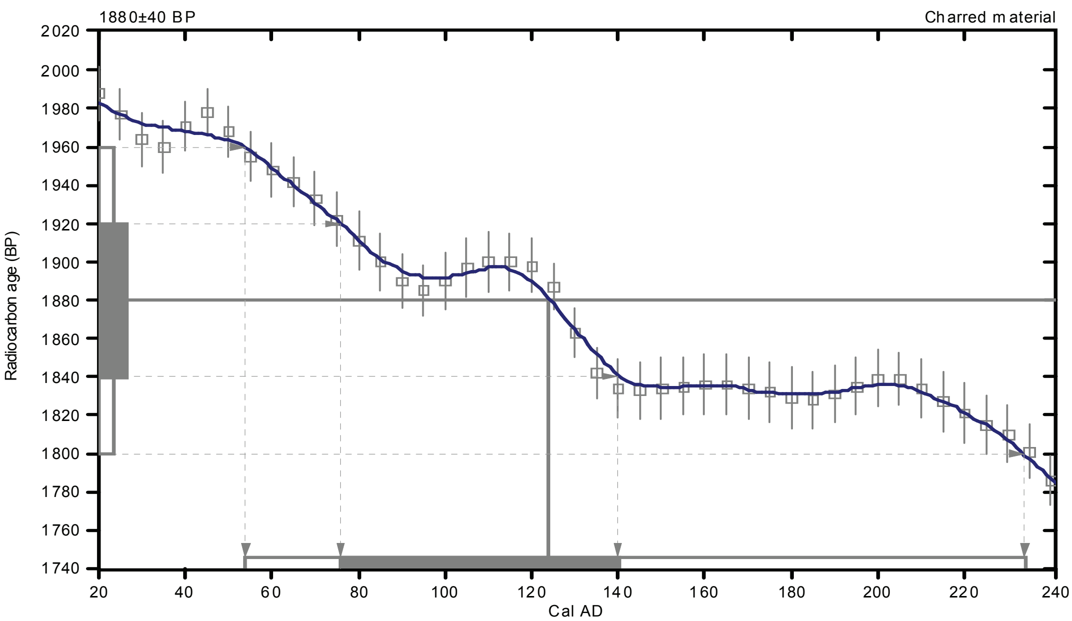
Conventional radiocarbon age: **1880±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 50 to 230 (Cal BP 1900 to 1720)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 120 (Cal BP 1830)

1 Sigma calibrated result: (68% probability) Cal AD 80 to 140 (Cal BP 1870 to 1810)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

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Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.9:lab. mult=1)

Laboratory number: **Beta-258493**

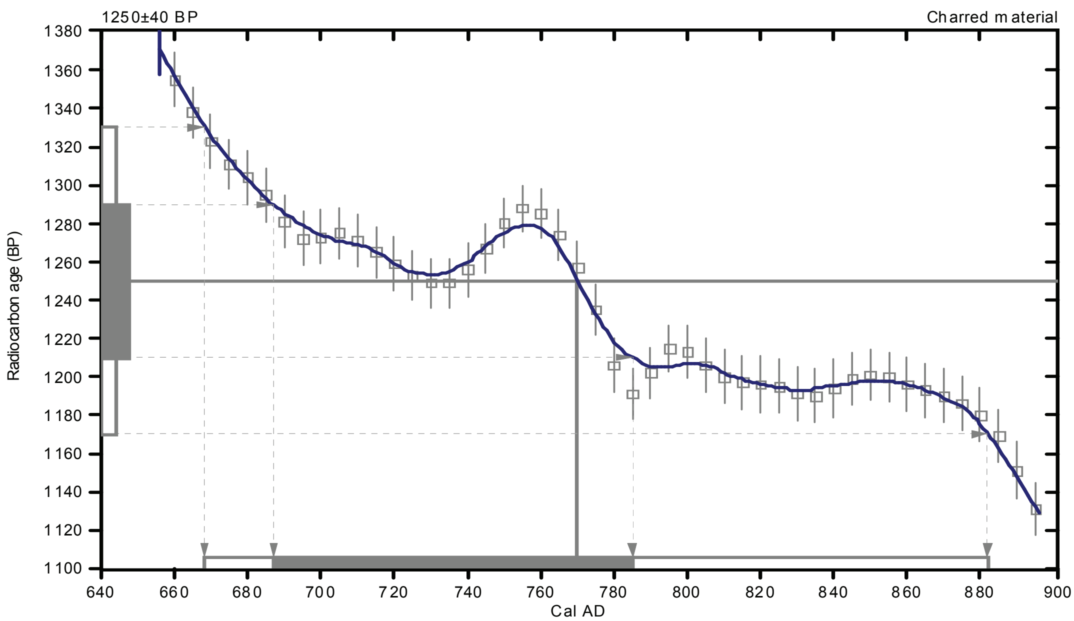
Conventional radiocarbon age: **1250±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 670 to 880 (Cal BP 1280 to 1070)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 770 (Cal BP 1180)

1 Sigma calibrated result: (68% probability) Cal AD 690 to 780 (Cal BP 1260 to 1160)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.5:lab. mult=1)

Laboratory number: **Beta-258494**

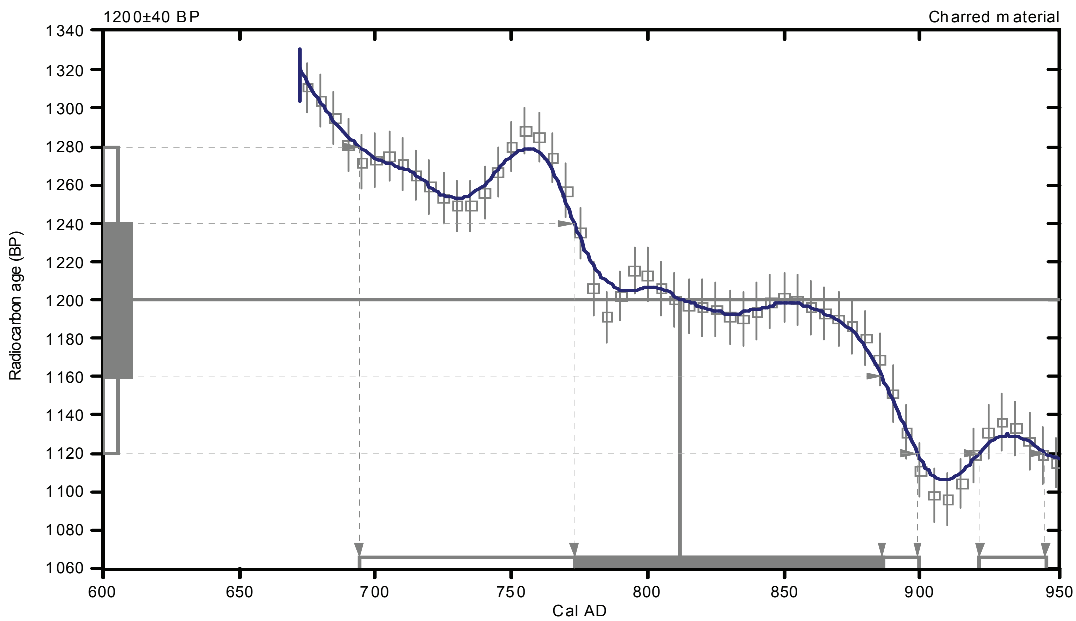
Conventional radiocarbon age: **1200±40 BP**

2 Sigma calibrated results: **Cal AD 690 to 900 (Cal BP 1260 to 1050) and**
(95% probability) **Cal AD 920 to 950 (Cal BP 1030 to 1000)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 810 (Cal BP 1140)

1 Sigma calibrated result: Cal AD 770 to 890 (Cal BP 1180 to 1060)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258495**

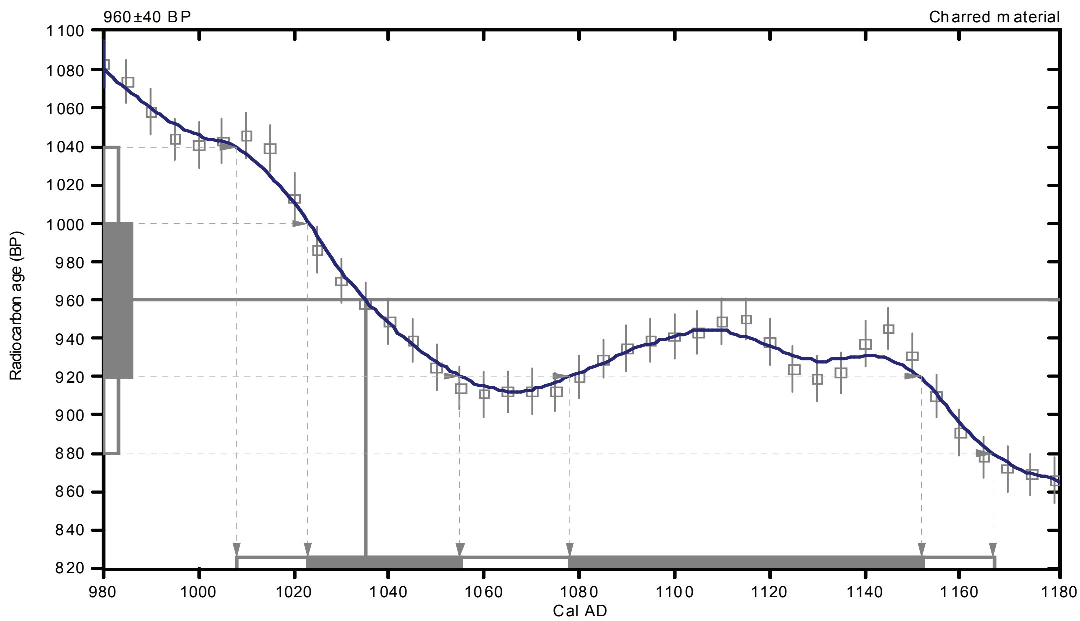
Conventional radiocarbon age: **960±40 BP**

2 Sigma calibrated result: **Cal AD 1010 to 1170 (Cal BP 940 to 780)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1040 (Cal BP 920)

1 Sigma calibrated results: Cal AD 1020 to 1060 (Cal BP 930 to 900) and
(68% probability) Cal AD 1080 to 1150 (Cal BP 870 to 800)



References:
Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number: **Beta-258496**

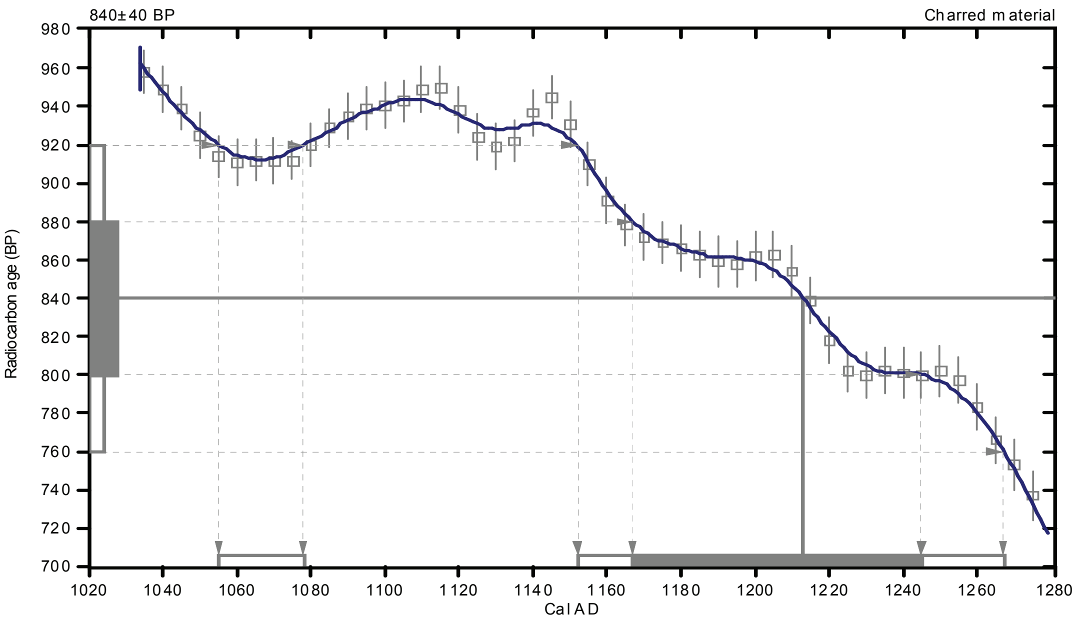
Conventional radiocarbon age: **840±40 BP**

2 Sigma calibrated results: **Cal AD 1060 to 1080 (Cal BP 900 to 870) and**
(95% probability) **Cal AD 1150 to 1270 (Cal BP 800 to 680)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1210 (Cal BP 740)

1 Sigma calibrated result: Cal AD 1170 to 1240 (Cal BP 780 to 700)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7:lab. mult=1)

Laboratory number: **Beta-258497**

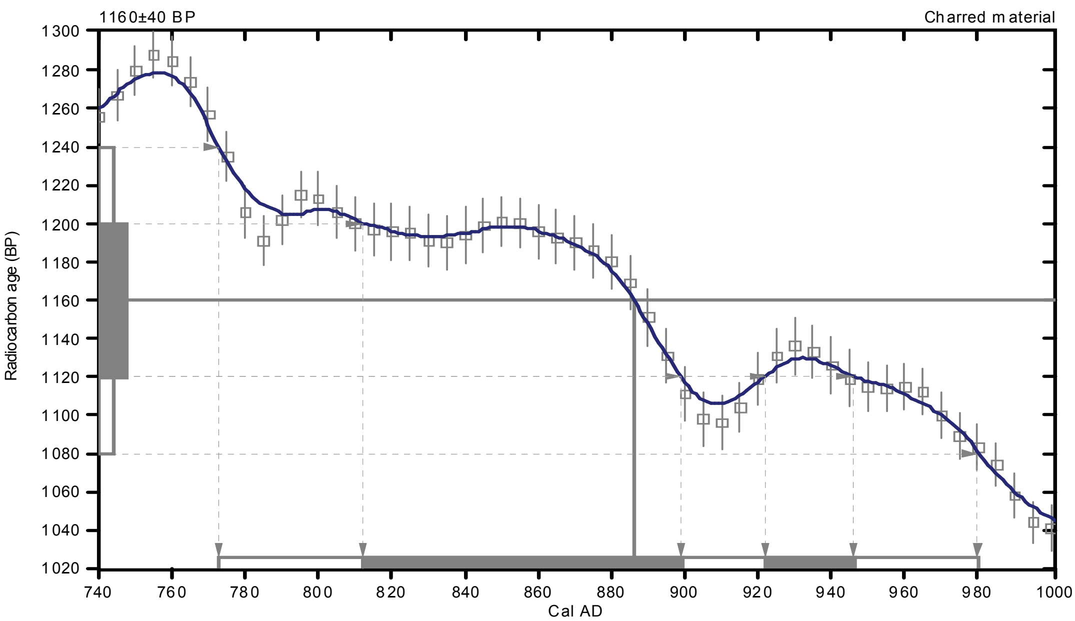
Conventional radiocarbon age: **1160±40 BP**

2 Sigma calibrated result: **Cal AD 770 to 980 (Cal BP 1180 to 970)**
(95% probability)

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 890 (Cal BP 1060)

1 Sigma calibrated results: Cal AD 810 to 900 (Cal BP 1140 to 1050) and
(68% probability) Cal AD 920 to 950 (Cal BP 1030 to 1000)



References:

Database used
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INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258498**

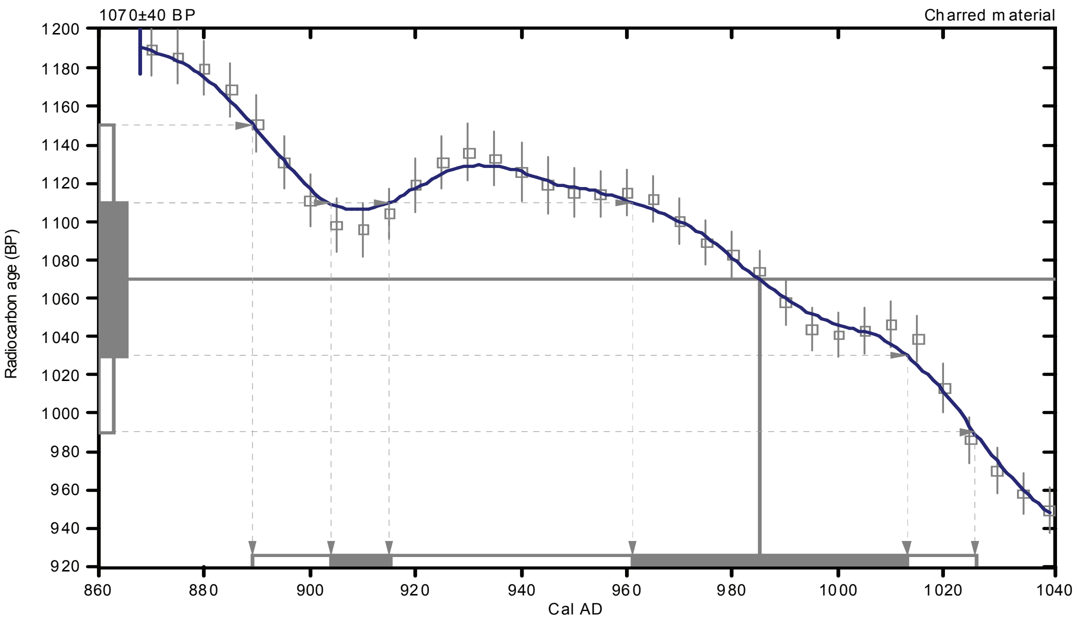
Conventional radiocarbon age: **1070±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 890 to 1030 (Cal BP 1060 to 920)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 980 (Cal BP 960)

1 Sigma calibrated results: (68% probability) Cal AD 900 to 920 (Cal BP 1050 to 1040) and Cal AD 960 to 1010 (Cal BP 990 to 940)



References:

Database used
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Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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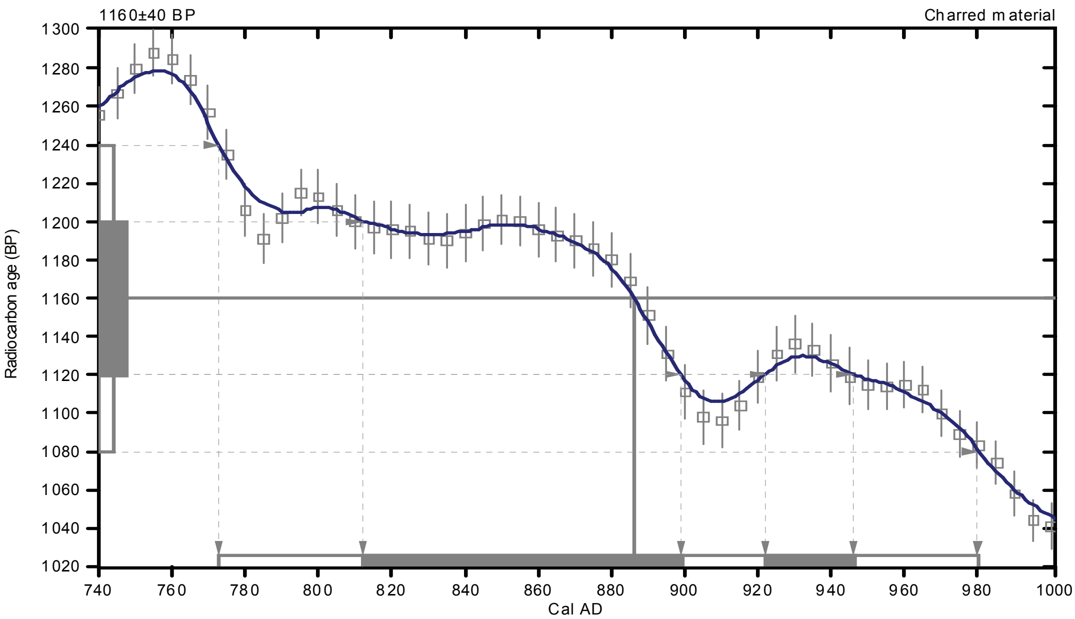
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number:	**Beta-258499**
Conventional radiocarbon age:	**1160±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 770 to 980 (Cal BP 1180 to 970)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 890 (Cal BP 1060)
1 Sigma calibrated results: (68% probability)	Cal AD 810 to 900 (Cal BP 1140 to 1050) and Cal AD 920 to 950 (Cal BP 1030 to 1000)



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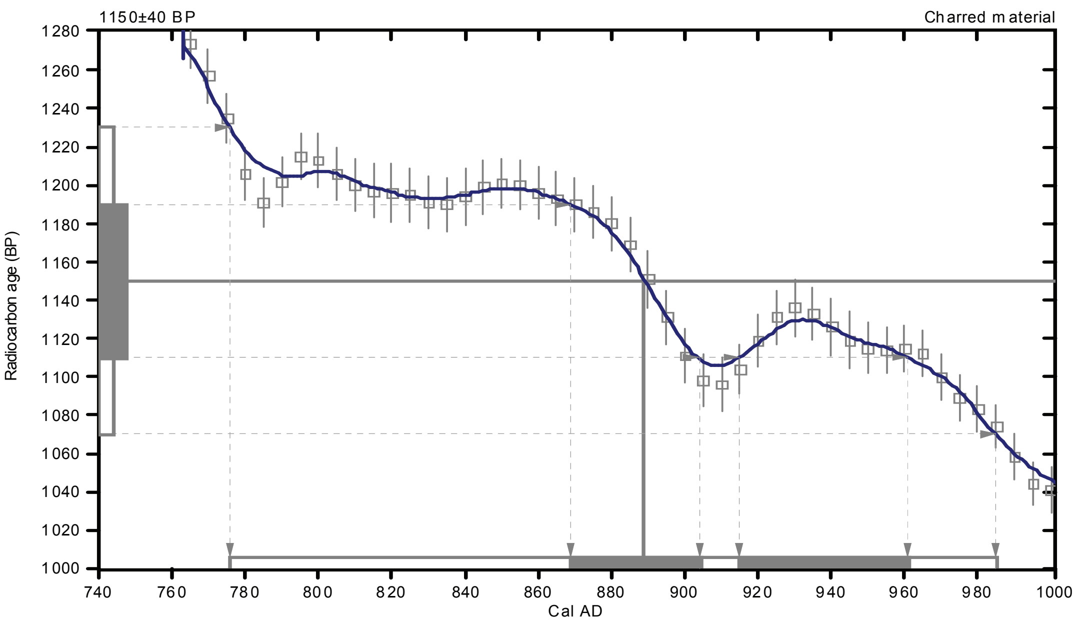
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number:	**Beta-258500**
Conventional radiocarbon age:	**1150±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 780 to 980 (Cal BP 1170 to 960)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 890 (Cal BP 1060)
1 Sigma calibrated results: (68% probability)	Cal AD 870 to 900 (Cal BP 1080 to 1050) and Cal AD 920 to 960 (Cal BP 1040 to 990)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number: **Beta-258501**

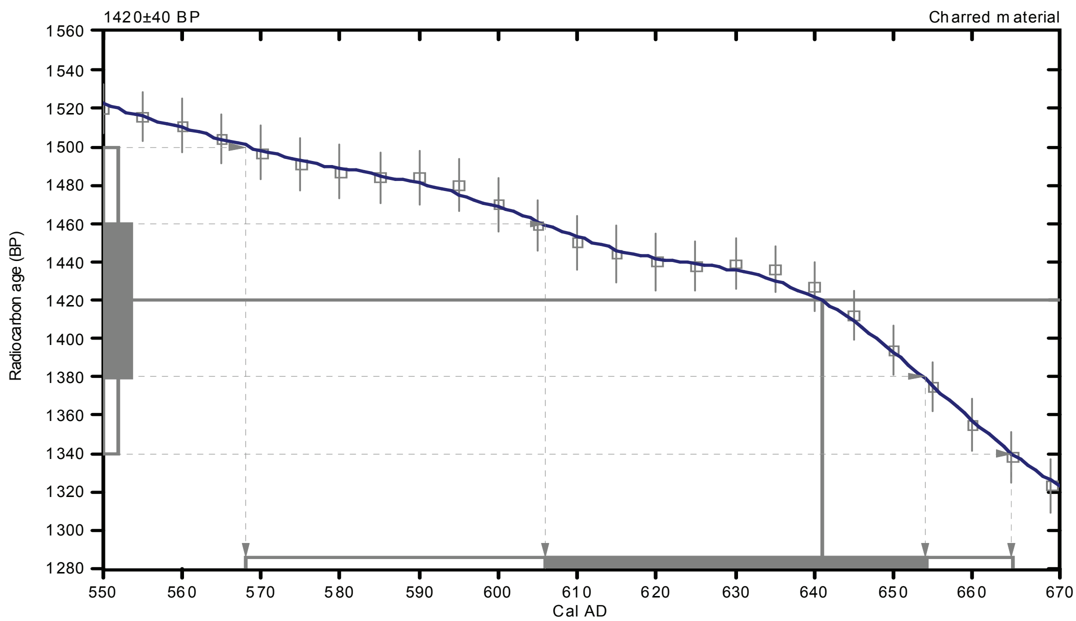
Conventional radiocarbon age: **1420±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 570 to 660 (Cal BP 1380 to 1280)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 640 (Cal BP 1310)

1 Sigma calibrated result: (68% probability) Cal AD 610 to 650 (Cal BP 1340 to 1300)



References:
Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258502**

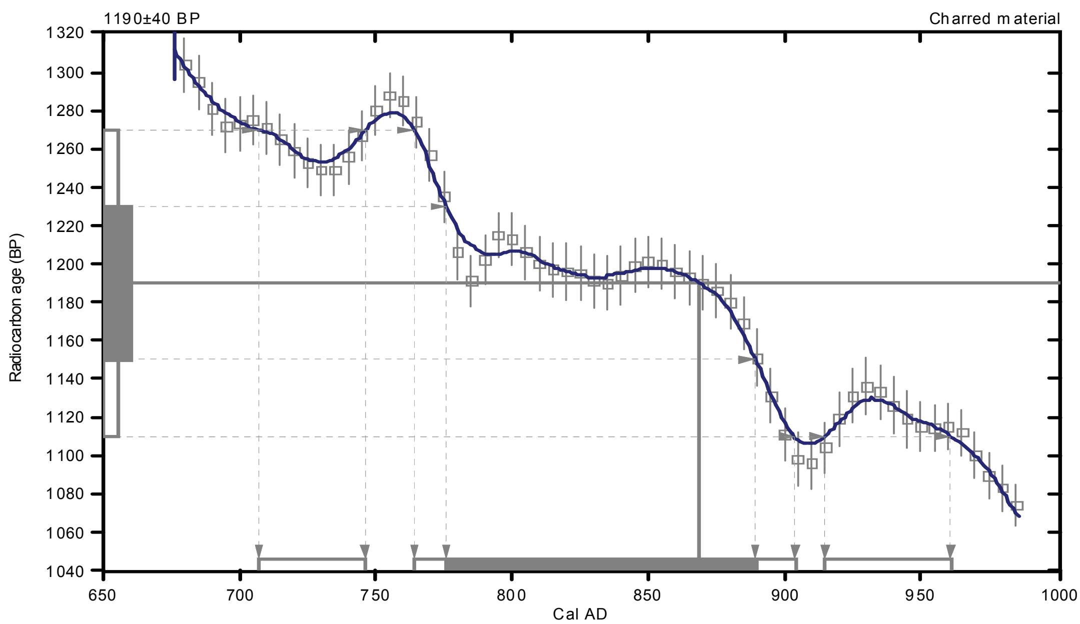
Conventional radiocarbon age: **1190±40 BP**

2 Sigma calibrated results: (95% probability) **Cal AD 710 to 750 (Cal BP 1240 to 1200) and Cal AD 760 to 900 (Cal BP 1190 to 1050) and Cal AD 920 to 960 (Cal BP 1040 to 990)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 870 (Cal BP 1080)

1 Sigma calibrated result: (68% probability) Cal AD 780 to 890 (Cal BP 1170 to 1060)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.4:lab. mult=1)

Laboratory number: **Beta-258503**

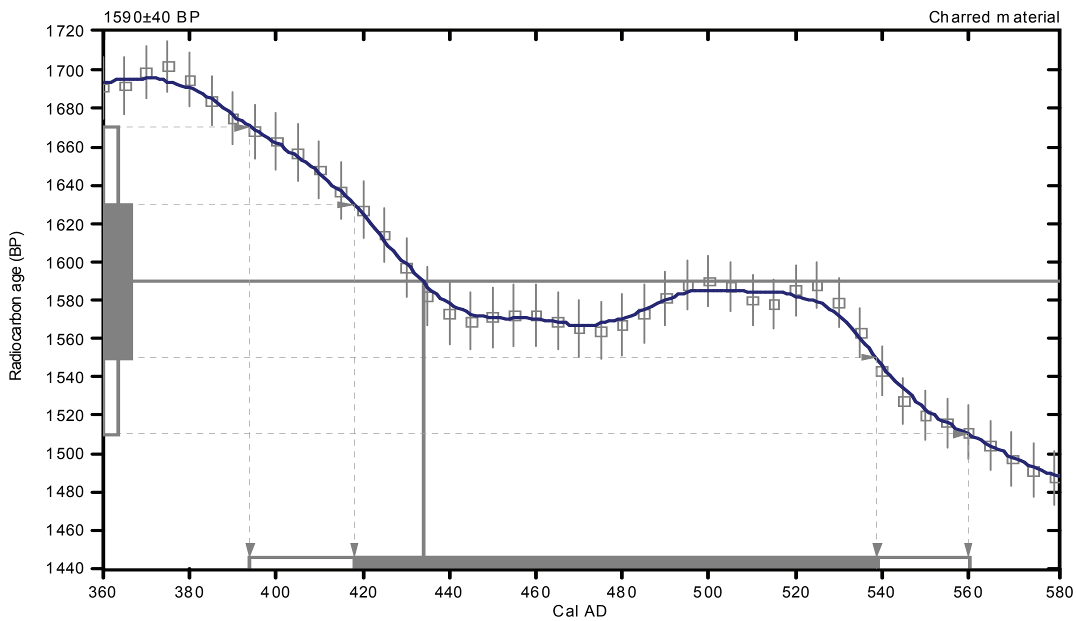
Conventional radiocarbon age: **1590±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 390 to 560 (Cal BP 1560 to 1390)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 430 (Cal BP 1520)

1 Sigma calibrated result: (68% probability) Cal AD 420 to 540 (Cal BP 1530 to 1410)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number: **Beta-258504**

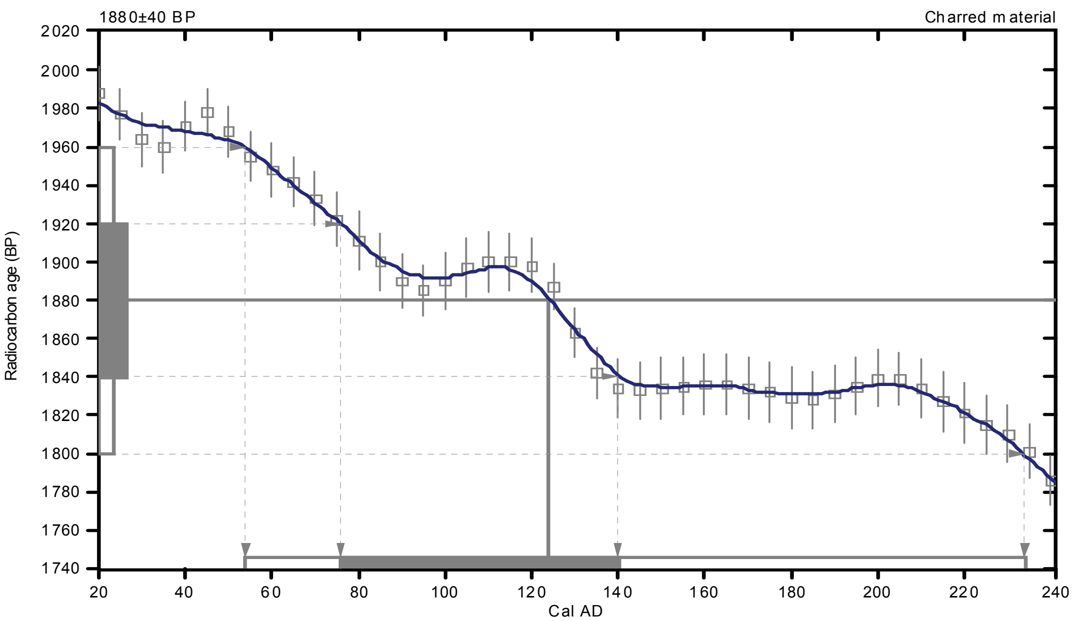
Conventional radiocarbon age: **1880±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 50 to 230 (Cal BP 1900 to 1720)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 120 (Cal BP 1830)

1 Sigma calibrated result: (68% probability) Cal AD 80 to 140 (Cal BP 1870 to 1810)



References:

Database used

INTCAL04

Calibration Database

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.9:lab. mult=1)

Laboratory number: **Beta-258505**

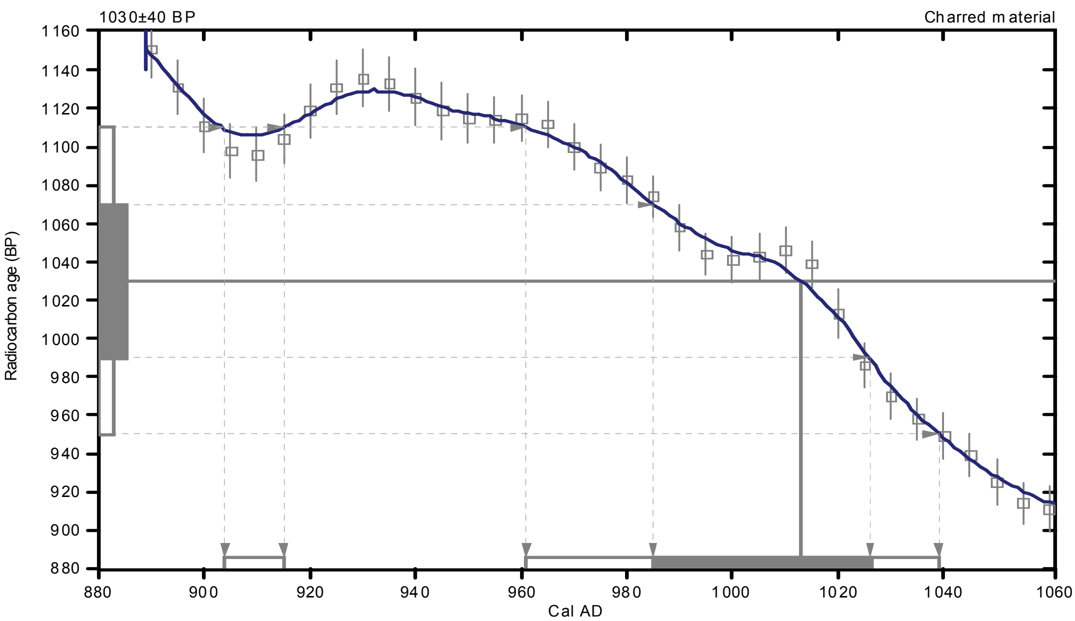
Conventional radiocarbon age: **1030±40 BP**

2 Sigma calibrated results: **Cal AD 900 to 920 (Cal BP 1050 to 1040) and**
(95% probability) **Cal AD 960 to 1040 (Cal BP 990 to 910)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1010 (Cal BP 940)

1 Sigma calibrated result: Cal AD 980 to 1030 (Cal BP 960 to 920)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.9:lab. mult=1)

Laboratory number: **Beta-258506**

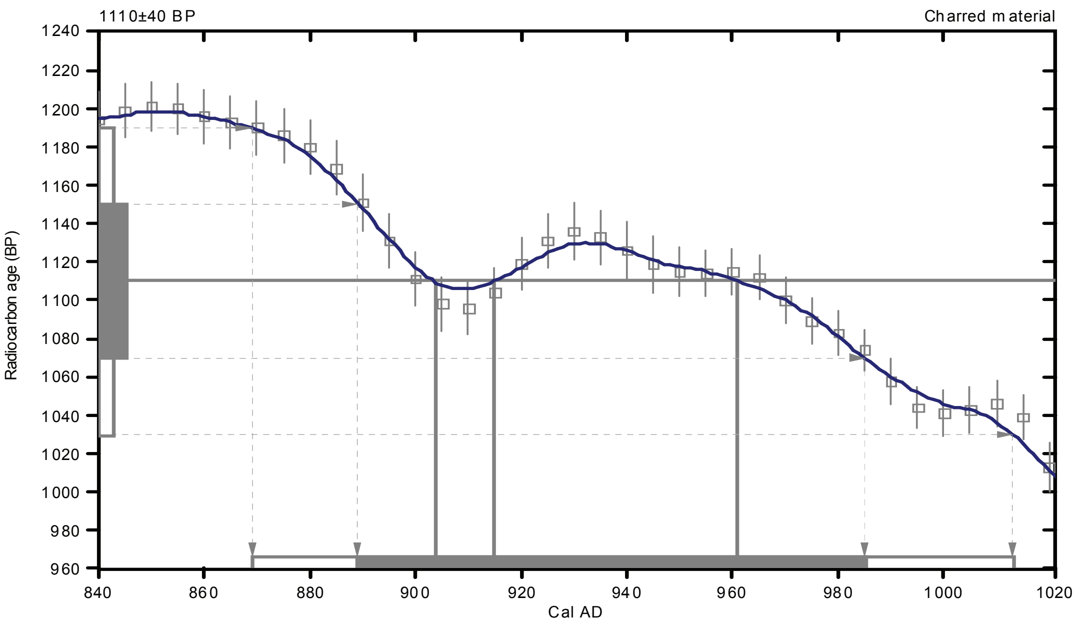
Conventional radiocarbon age: **1110±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 870 to 1010 (Cal BP 1080 to 940)**

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 900 (Cal BP 1050) and Cal AD 920 (Cal BP 1040) and Cal AD 960 (Cal BP 990)

1 Sigma calibrated result: (68% probability) Cal AD 890 to 980 (Cal BP 1060 to 960)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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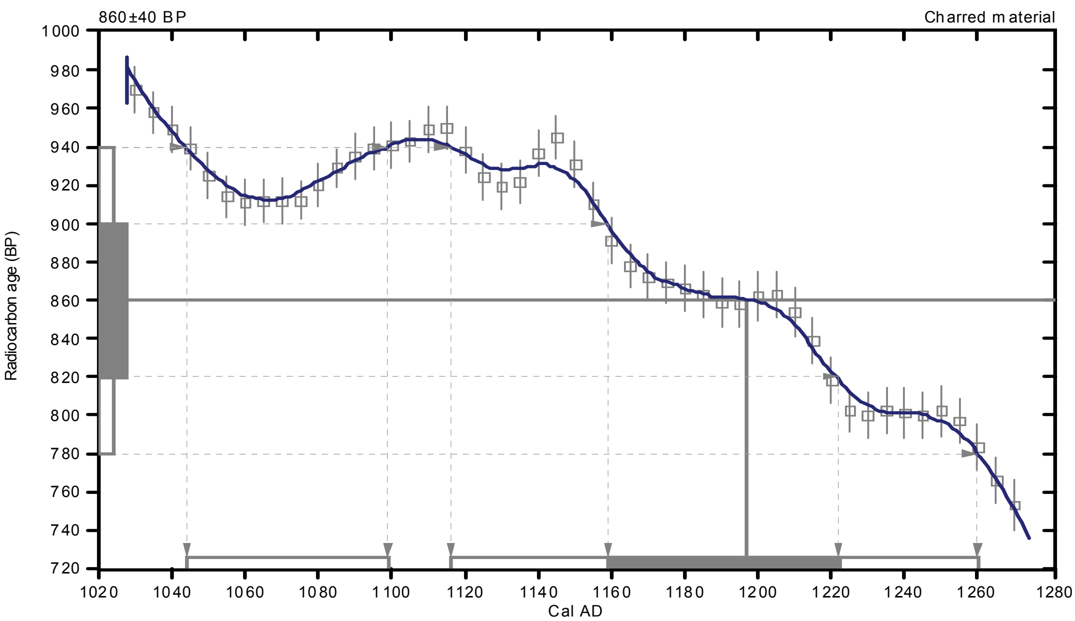
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.4:lab. mult=1)

Laboratory number:	**Beta-258507**
Conventional radiocarbon age:	**860±40 BP**
2 Sigma calibrated results: (95% probability)	**Cal AD 1040 to 1100 (Cal BP 910 to 850) and Cal AD 1120 to 1260 (Cal BP 830 to 690)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1200 (Cal BP 750)
1 Sigma calibrated result: (68% probability)	Cal AD 1160 to 1220 (Cal BP 790 to 730)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25:lab. mult=1)

Laboratory number: **Beta-258508**

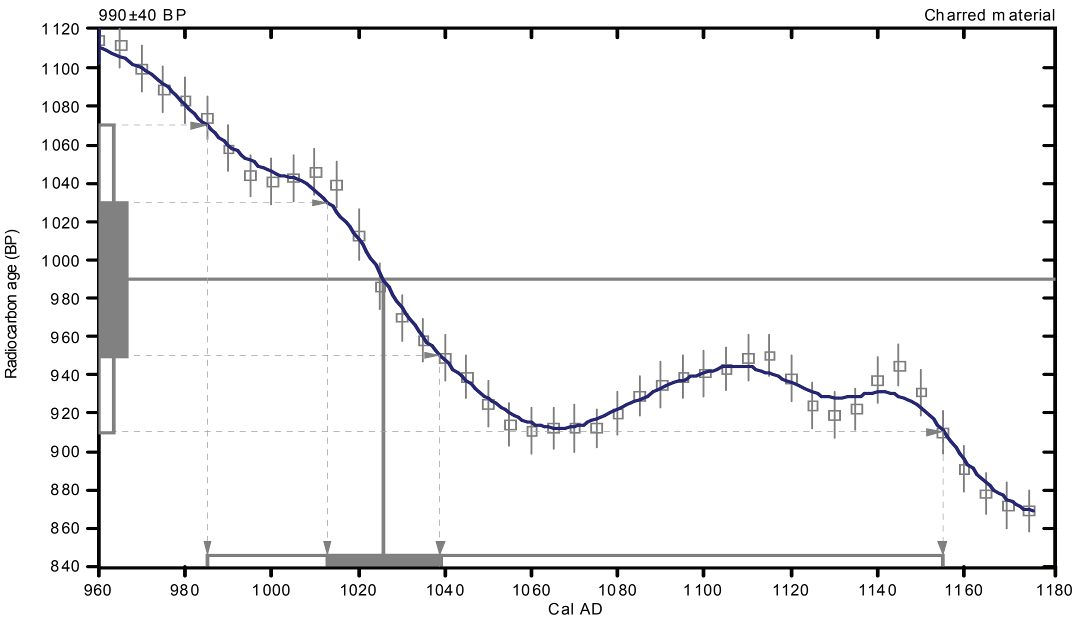
Conventional radiocarbon age: **990±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 980 to 1160 (Cal BP 960 to 800)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1030 (Cal BP 920)

1 Sigma calibrated result: (68% probability) Cal AD 1010 to 1040 (Cal BP 940 to 910)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7:lab. mult=1)

Laboratory number: **Beta-258509**

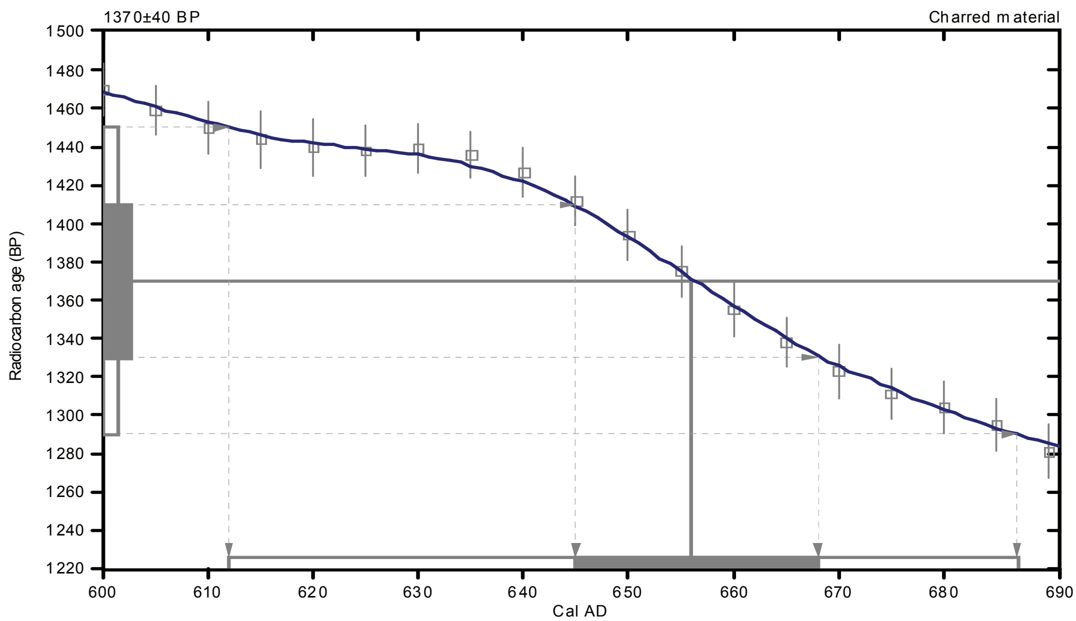
Conventional radiocarbon age: **1370±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 610 to 690 (Cal BP 1340 to 1260)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 660 (Cal BP 1290)

1 Sigma calibrated result: (68% probability) Cal AD 640 to 670 (Cal BP 1300 to 1280)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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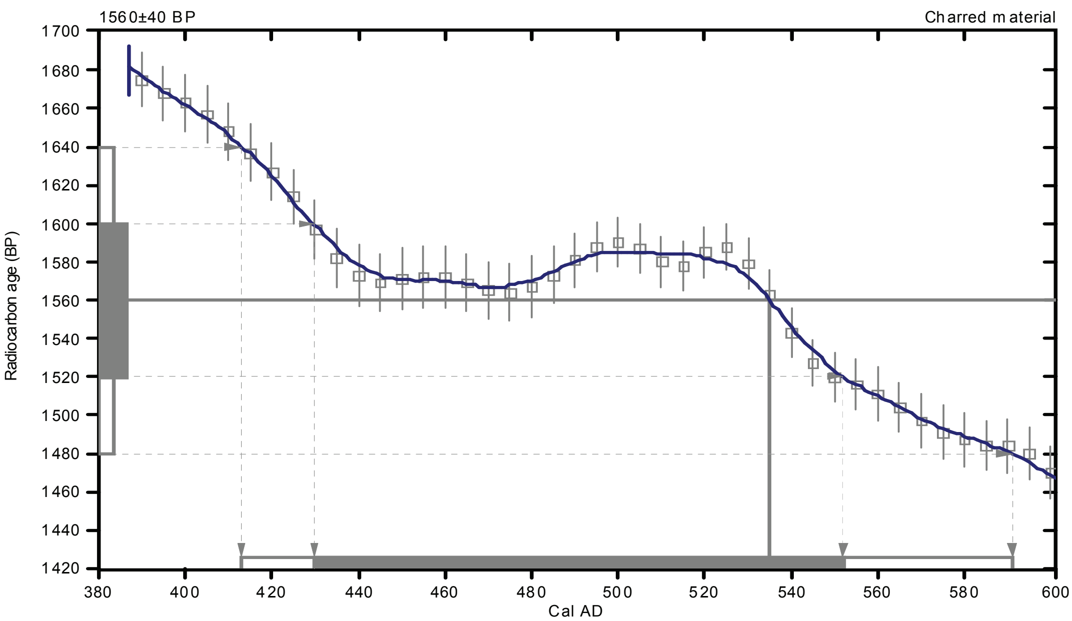
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number:	**Beta-258510**
Conventional radiocarbon age:	**1560±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 410 to 590 (Cal BP 1540 to 1360)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 540 (Cal BP 1420)
1 Sigma calibrated result: (68% probability)	Cal AD 430 to 550 (Cal BP 1520 to 1400)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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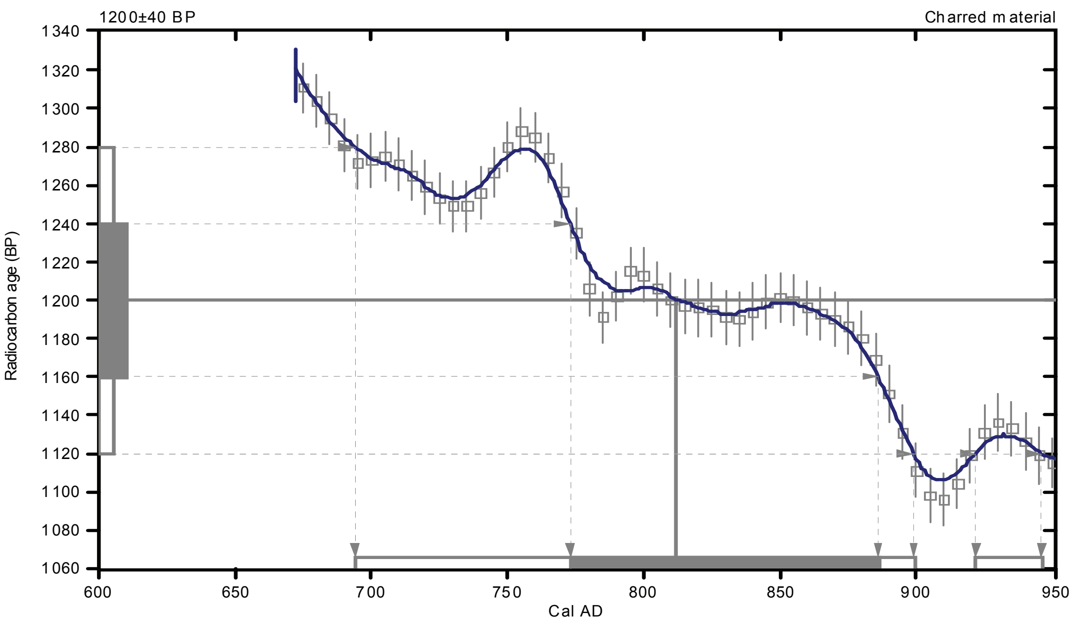
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.3:lab. mult=1)

Laboratory number:	**Beta-258511**
Conventional radiocarbon age:	**1200±40 BP**
2 Sigma calibrated results: (95% probability)	**Cal AD 690 to 900 (Cal BP 1260 to 1050) and Cal AD 920 to 950 (Cal BP 1030 to 1000)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 810 (Cal BP 1140)
1 Sigma calibrated result: (68% probability)	Cal AD 770 to 890 (Cal BP 1180 to 1060)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23:lab. mult=1)

Laboratory number: **Beta-258512**

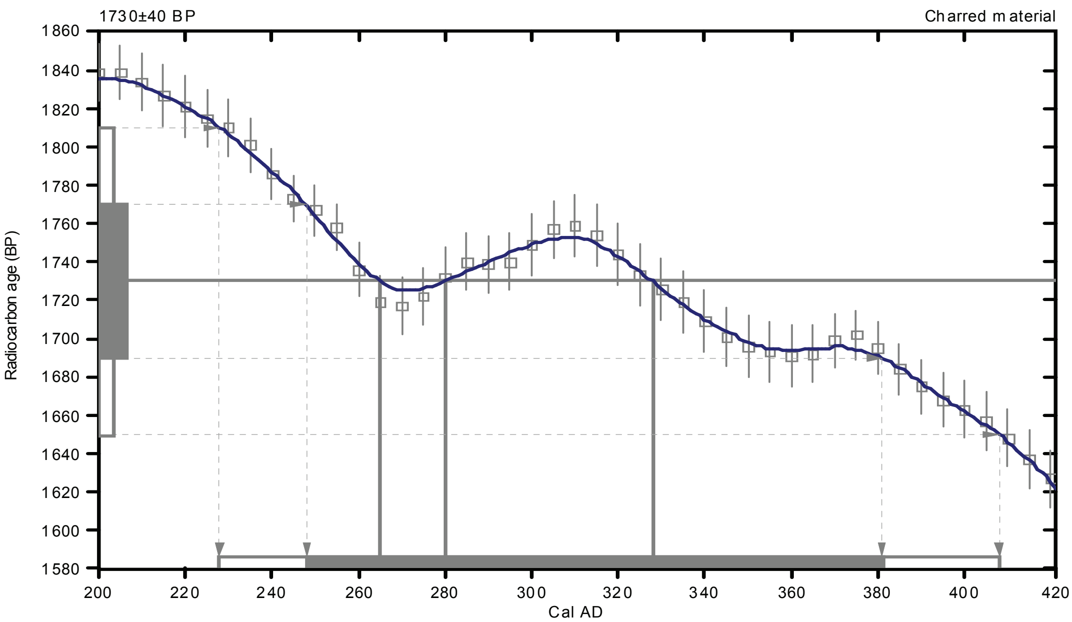
Conventional radiocarbon age: **1730±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 230 to 410 (Cal BP 1720 to 1540)**

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 260 (Cal BP 1680) and
Cal AD 280 (Cal BP 1670) and
Cal AD 330 (Cal BP 1620)

1 Sigma calibrated result: (68% probability) Cal AD 250 to 380 (Cal BP 1700 to 1570)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.2:lab. mult=1)

Laboratory number: **Beta-258513**

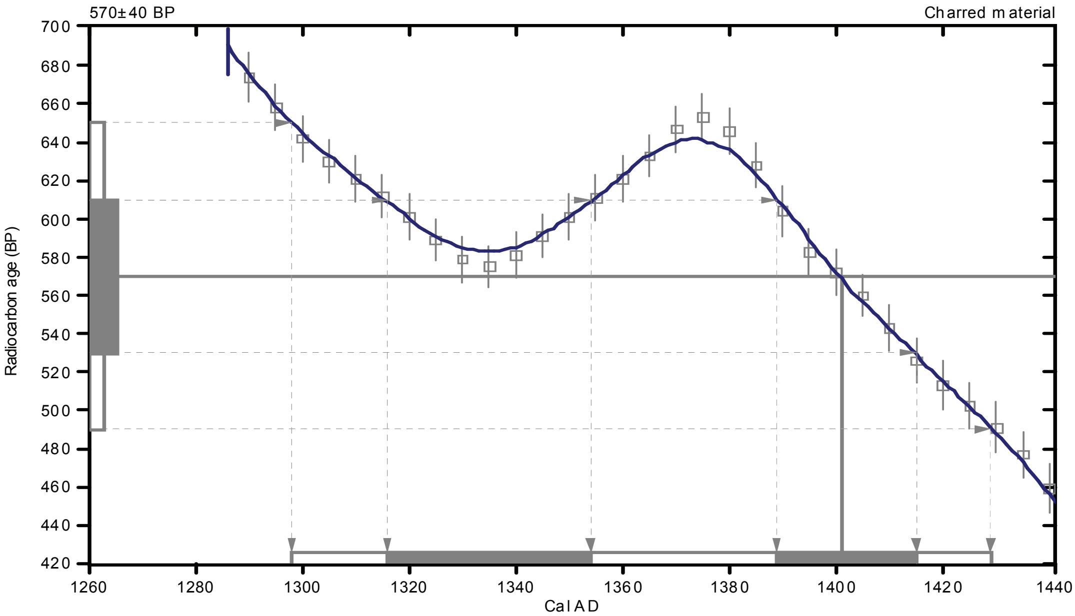
Conventional radiocarbon age: **570±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1300 to 1430 (Cal BP 650 to 520)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1400 (Cal BP 550)

1 Sigma calibrated results: (68% probability) Cal AD 1320 to 1350 (Cal BP 630 to 600) and Cal AD 1390 to 1420 (Cal BP 560 to 540)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-21.7:lab. mult=1)

Laboratory number: **Beta-258514**

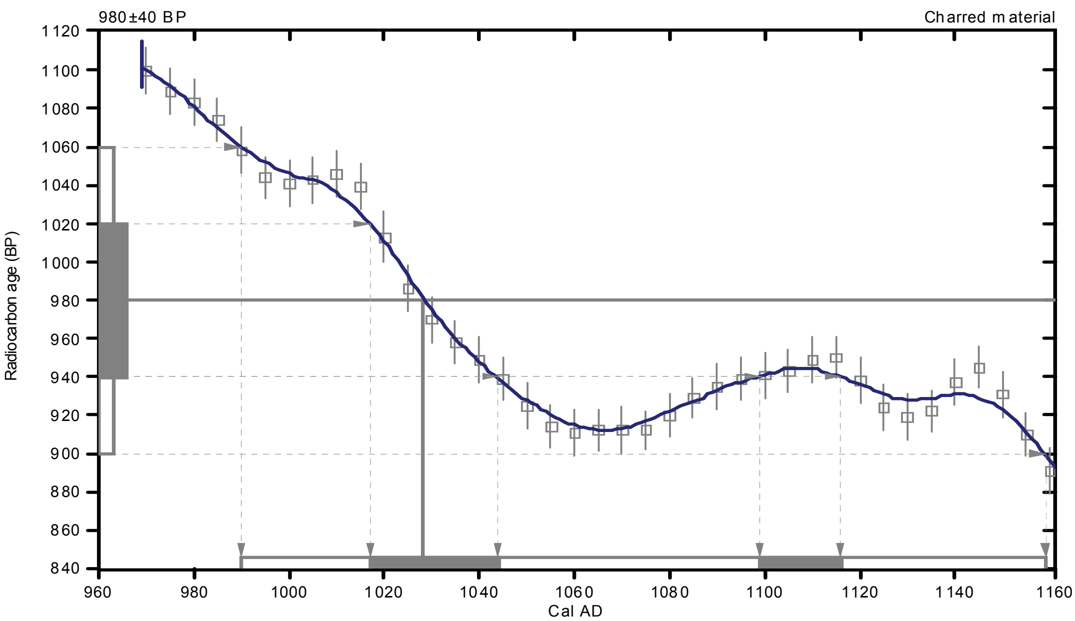
Conventional radiocarbon age: **980±40 BP**

2 Sigma calibrated result: **Cal AD 990 to 1160 (Cal BP 960 to 790)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1030 (Cal BP 920)

1 Sigma calibrated results: Cal AD 1020 to 1040 (Cal BP 930 to 910) and
(68% probability) Cal AD 1100 to 1120 (Cal BP 850 to 830)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7:lab. mult=1)

Laboratory number: **Beta-258515**

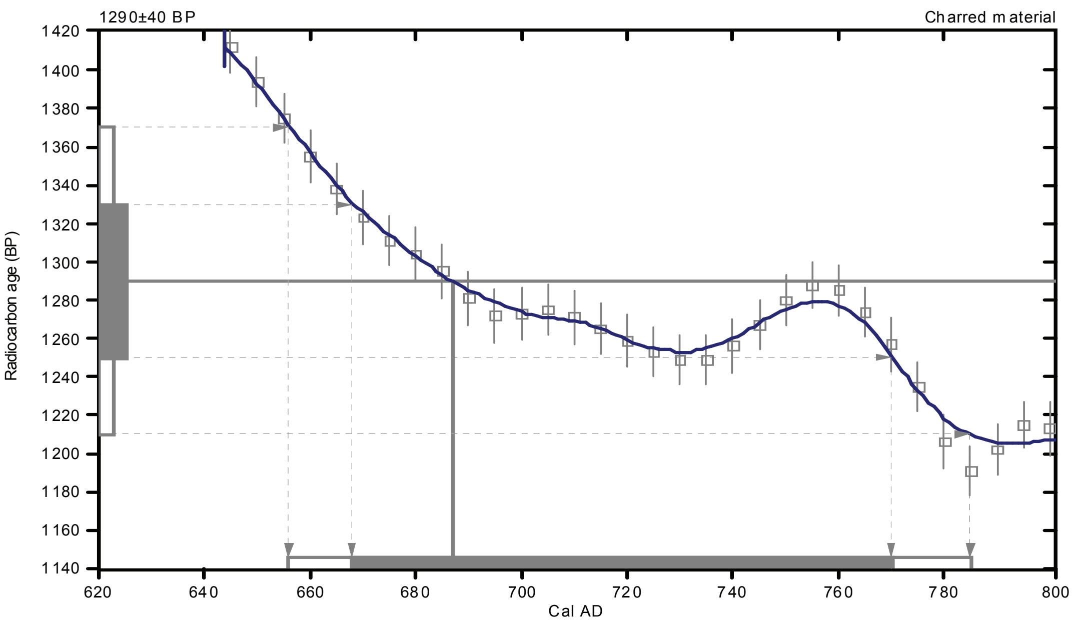
Conventional radiocarbon age: **1290±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 660 to 780 (Cal BP 1290 to 1160)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 690 (Cal BP 1260)

1 Sigma calibrated result: (68% probability) Cal AD 670 to 770 (Cal BP 1280 to 1180)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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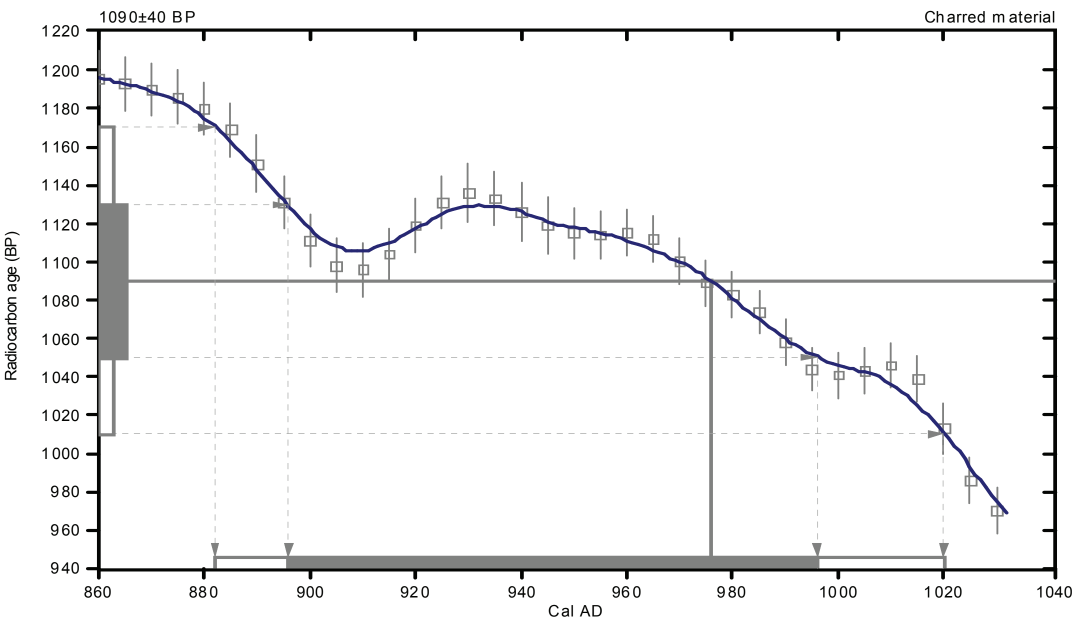
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

Laboratory number:	**Beta-258516**
Conventional radiocarbon age:	**1090±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 880 to 1020 (Cal BP 1070 to 930)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 980 (Cal BP 970)
1 Sigma calibrated result: (68% probability)	Cal AD 900 to 1000 (Cal BP 1050 to 950)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number: **Beta-258517**

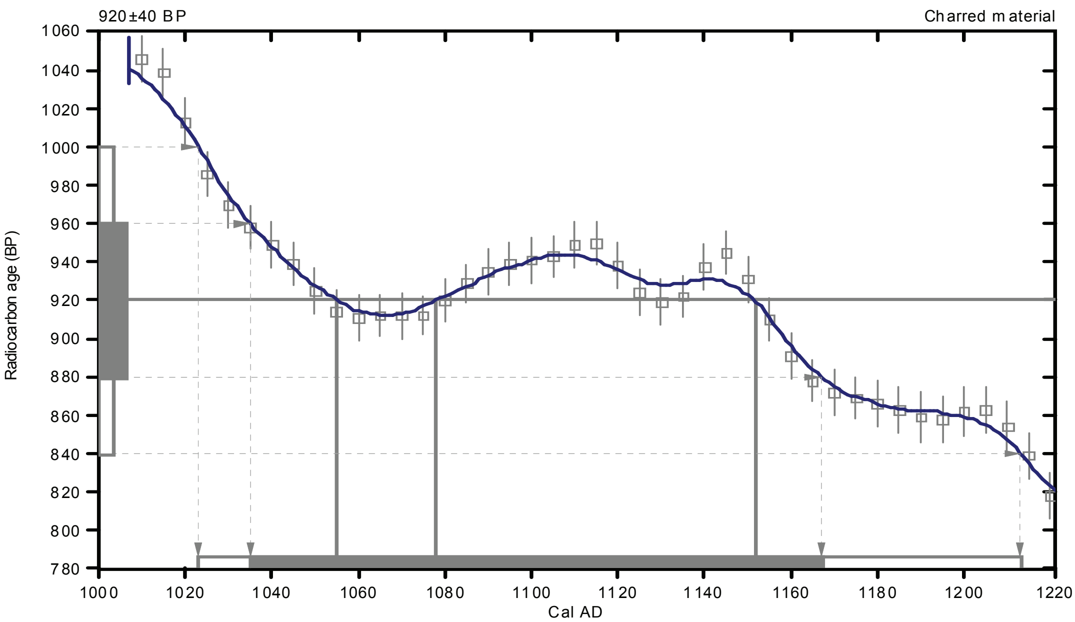
Conventional radiocarbon age: **920±40 BP**

2 Sigma calibrated result: **Cal AD 1020 to 1210 (Cal BP 930 to 740)**
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve: Cal AD 1060 (Cal BP 900) and
Cal AD 1080 (Cal BP 870) and
Cal AD 1150 (Cal BP 800)

1 Sigma calibrated result: Cal AD 1040 to 1170 (Cal BP 920 to 780)
(68% probability)



References:
Database used
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Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.5:lab. mult=1)

Laboratory number: **Beta-258518**

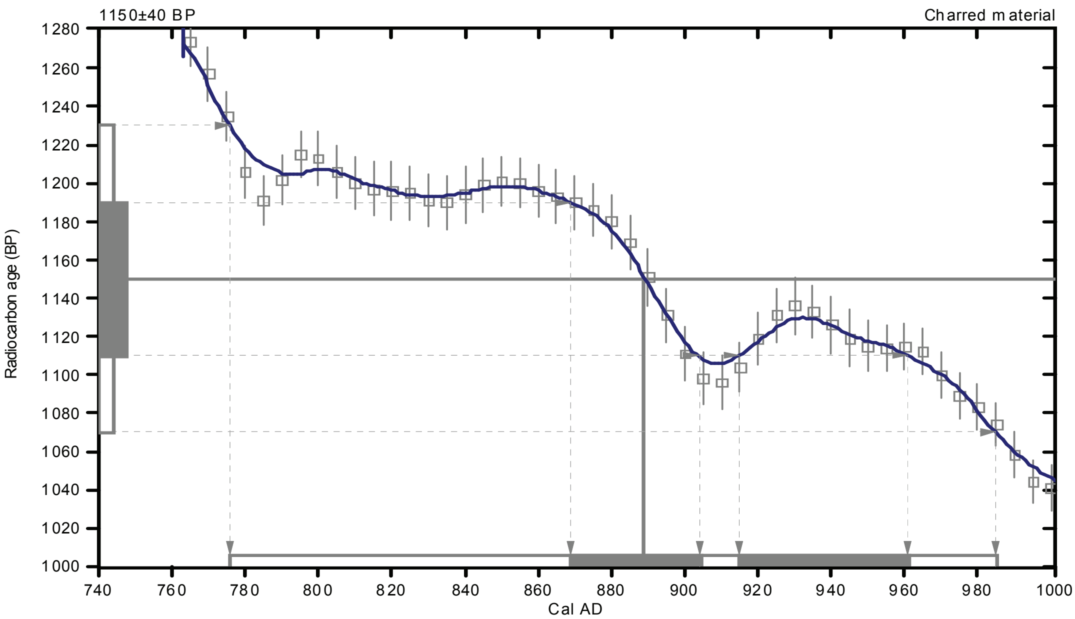
Conventional radiocarbon age: **1150±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 780 to 980 (Cal BP 1170 to 960)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 890 (Cal BP 1060)

1 Sigma calibrated results: (68% probability) Cal AD 870 to 900 (Cal BP 1080 to 1050) and Cal AD 920 to 960 (Cal BP 1040 to 990)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7:lab. mult=1)

Laboratory number: **Beta-258519**

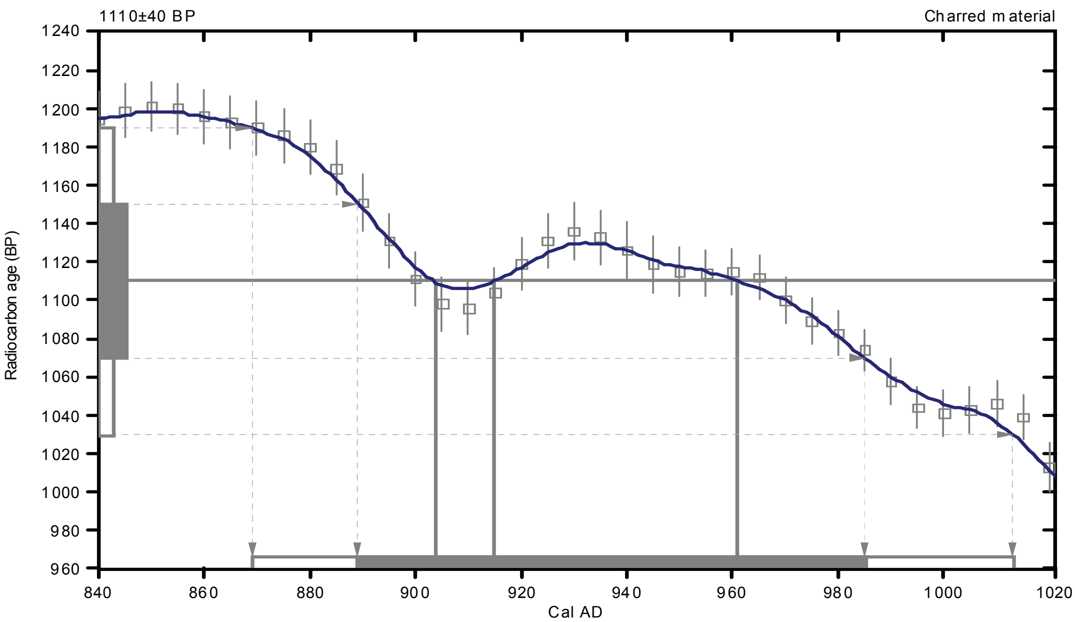
Conventional radiocarbon age: **1110±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 870 to 1010 (Cal BP 1080 to 940)**

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 900 (Cal BP 1050) and
Cal AD 920 (Cal BP 1040) and
Cal AD 960 (Cal BP 990)

1 Sigma calibrated result: (68% probability) Cal AD 890 to 980 (Cal BP 1060 to 960)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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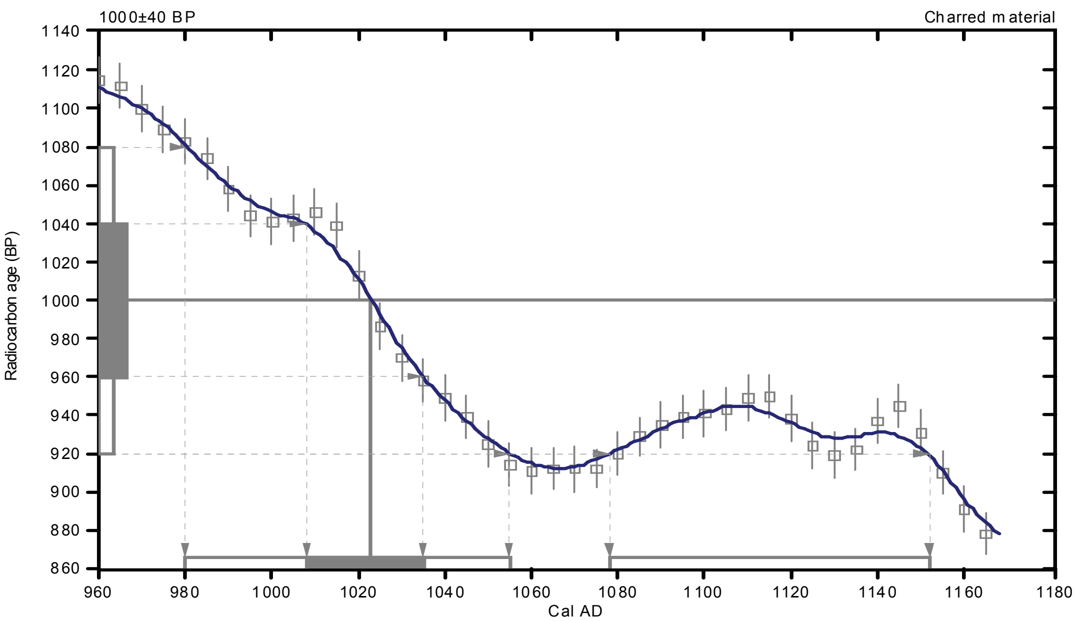
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number:	**Beta-258520**
Conventional radiocarbon age:	**1000±40 BP**
2 Sigma calibrated results: (95% probability)	**Cal AD 980 to 1060 (Cal BP 970 to 900) and Cal AD 1080 to 1150 (Cal BP 870 to 800)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1020 (Cal BP 930)
1 Sigma calibrated result: (68% probability)	Cal AD 1010 to 1040 (Cal BP 940 to 920)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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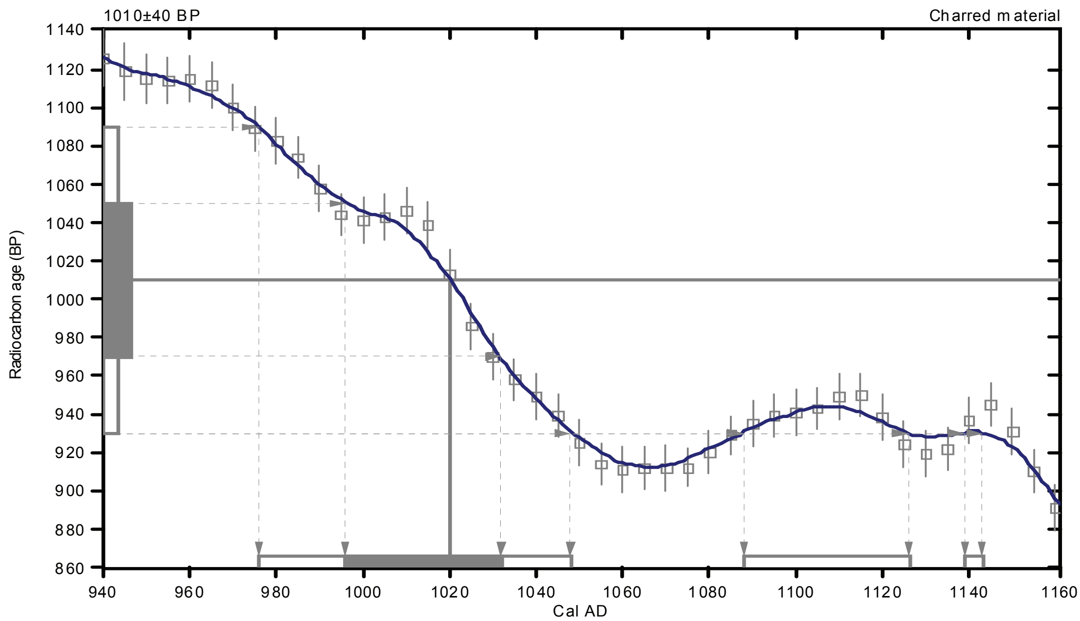
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.1:lab. mult=1)

Laboratory number:	**Beta-258521**
Conventional radiocarbon age:	**1010±40 BP**
2 Sigma calibrated results: **(95% probability)**	**Cal AD 980 to 1050 (Cal BP 970 to 900) and** **Cal AD 1090 to 1130 (Cal BP 860 to 820) and** **Cal AD 1140 to 1140 (Cal BP 810 to 810)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1020 (Cal BP 930)
1 Sigma calibrated result: (68% probability)	Cal AD 1000 to 1030 (Cal BP 950 to 920)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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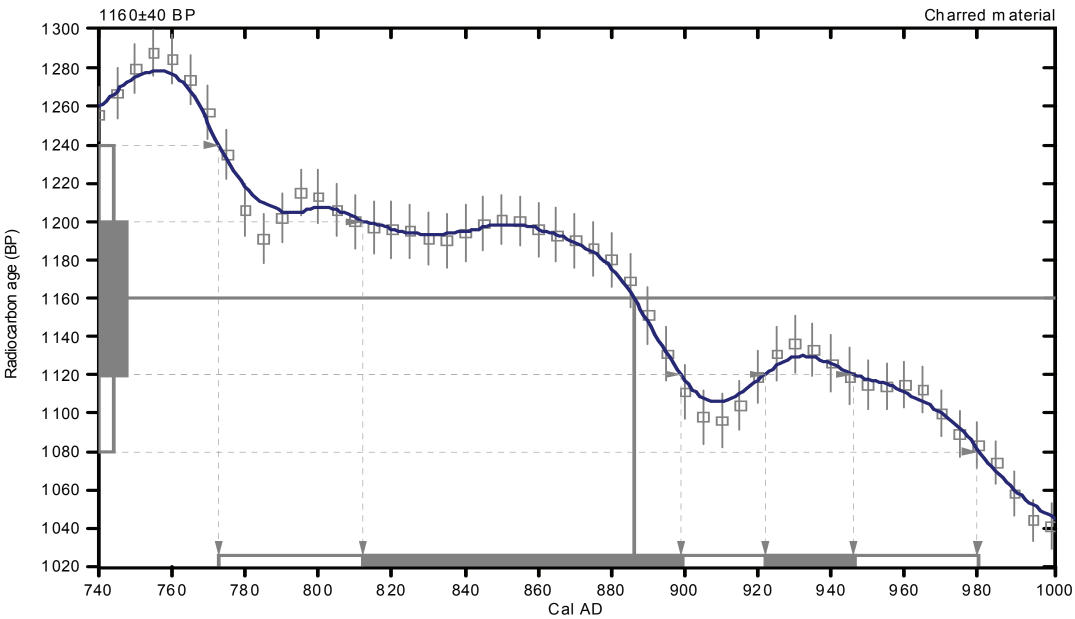
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.2:lab. mult=1)

Laboratory number:	**Beta-258522**
Conventional radiocarbon age:	**1160±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 770 to 980 (Cal BP 1180 to 970)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 890 (Cal BP 1060)
1 Sigma calibrated results: (68% probability)	Cal AD 810 to 900 (Cal BP 1140 to 1050) and Cal AD 920 to 950 (Cal BP 1030 to 1000)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number: **Beta-258523**

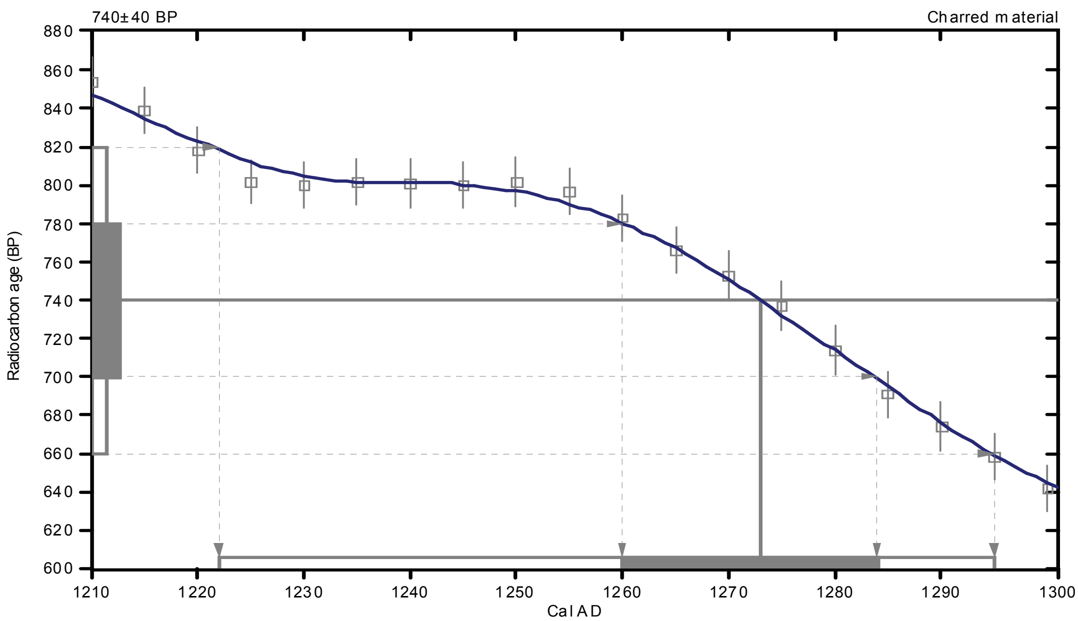
Conventional radiocarbon age: **740±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1220 to 1300 (Cal BP 730 to 660)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1270 (Cal BP 680)

1 Sigma calibrated result: (68% probability) Cal AD 1260 to 1280 (Cal BP 690 to 670)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number: **Beta-258524**

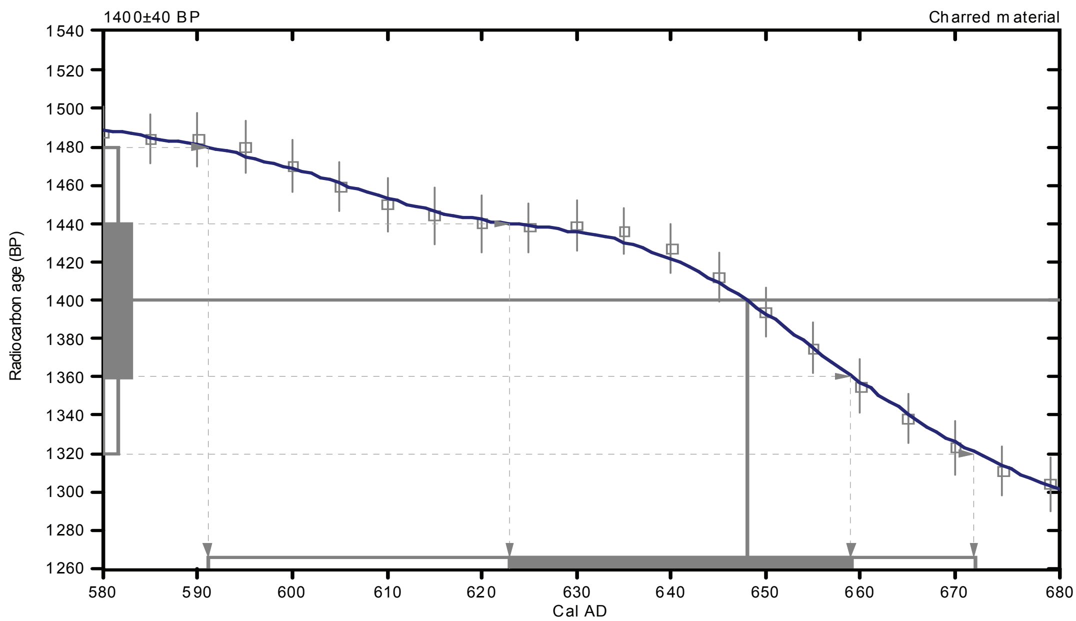
Conventional radiocarbon age: **1400±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 590 to 670 (Cal BP 1360 to 1280)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 650 (Cal BP 1300)

1 Sigma calibrated result: (68% probability) Cal AD 620 to 660 (Cal BP 1330 to 1290)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.4:lab. mult=1)

Laboratory number: **Beta-258525**

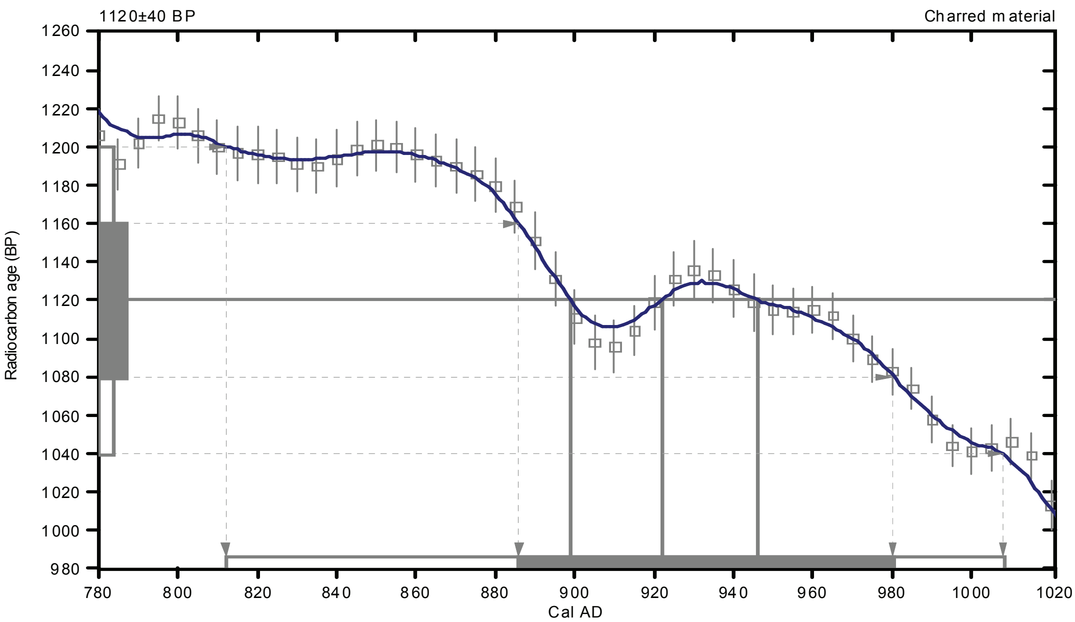
Conventional radiocarbon age: **1120±40 BP**

2 Sigma calibrated result: **Cal AD 810 to 1010 (Cal BP 1140 to 940)**
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve: Cal AD 900 (Cal BP 1050) and
Cal AD 920 (Cal BP 1030) and
Cal AD 950 (Cal BP 1000)

1 Sigma calibrated result: Cal AD 890 to 980 (Cal BP 1060 to 970)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **Beta-258526**

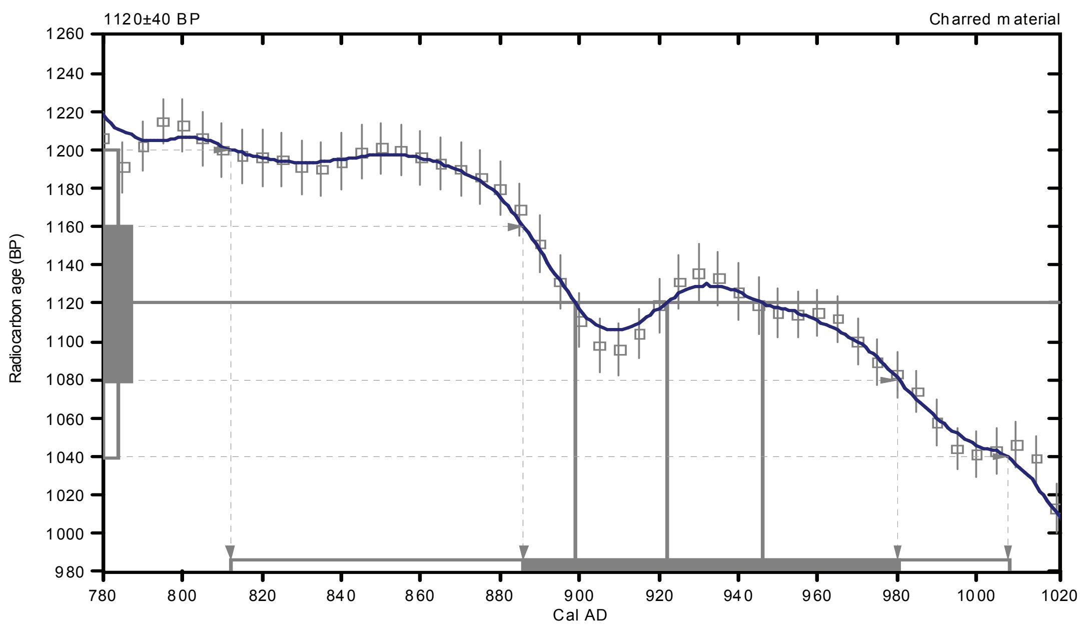
Conventional radiocarbon age: **1120±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 810 to 1010 (Cal BP 1140 to 940)**

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 900 (Cal BP 1050) and Cal AD 920 (Cal BP 1030) and Cal AD 950 (Cal BP 1000)

1 Sigma calibrated result: (68% probability) Cal AD 890 to 980 (Cal BP 1060 to 970)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.6:lab. mult=1)

Laboratory number: **Beta-258527**

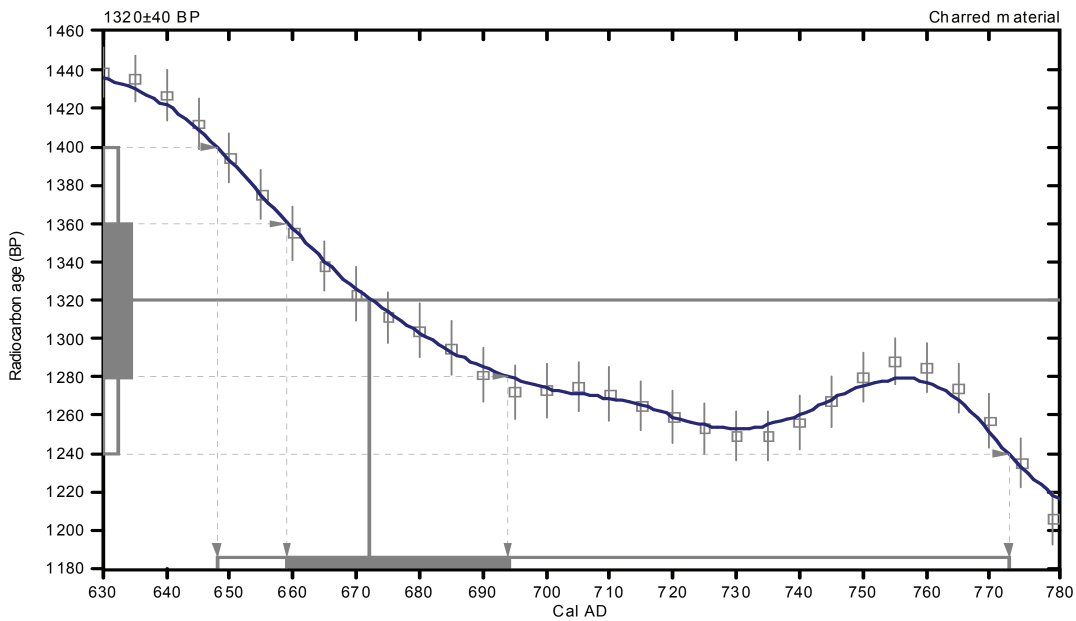
Conventional radiocarbon age: **1320±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 650 to 770 (Cal BP 1300 to 1180)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 670 (Cal BP 1280)

1 Sigma calibrated result: (68% probability) Cal AD 660 to 690 (Cal BP 1290 to 1260)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.4:lab. mult=1)

Laboratory number: **Beta-258528**

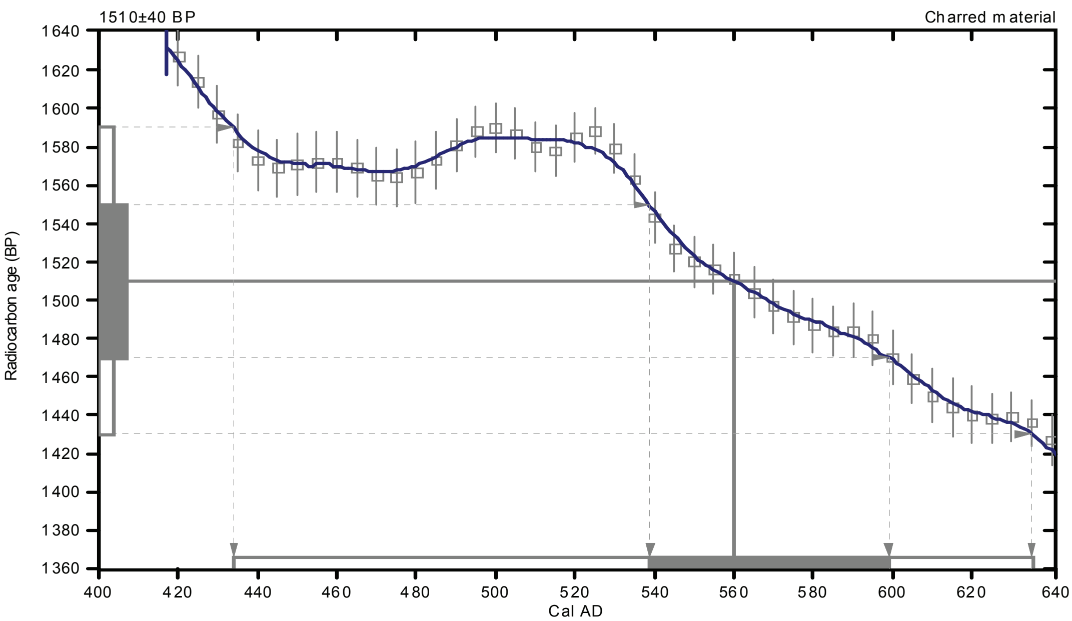
Conventional radiocarbon age: **1510±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 430 to 640 (Cal BP 1520 to 1320)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 560 (Cal BP 1390)

1 Sigma calibrated result: (68% probability) Cal AD 540 to 600 (Cal BP 1410 to 1350)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

Laboratory number: **Beta-258529**

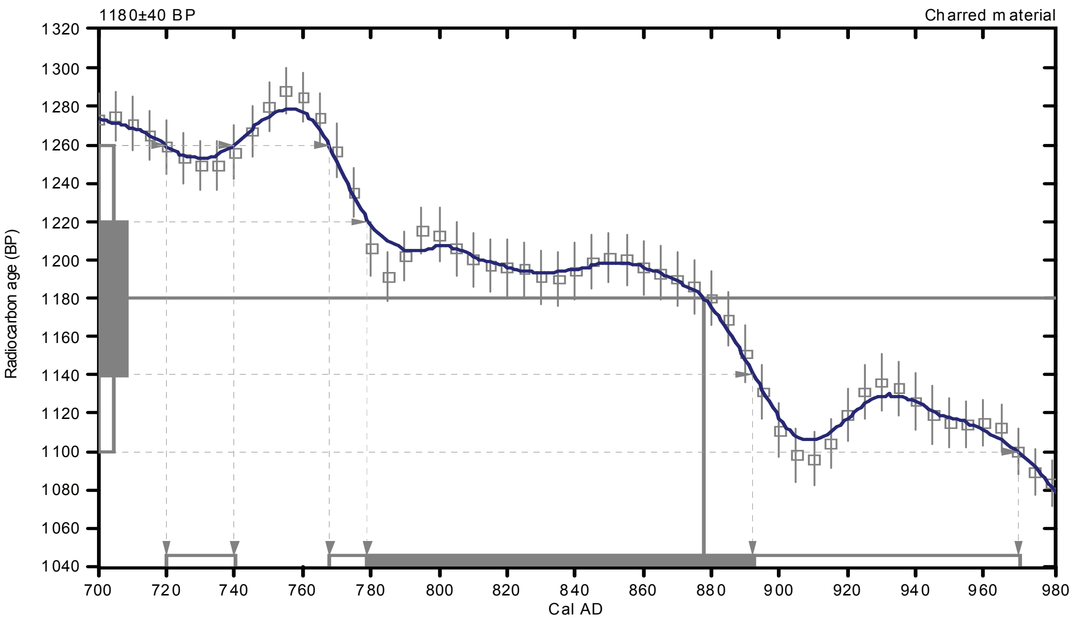
Conventional radiocarbon age: **1180±40 BP**

2 Sigma calibrated results: **Cal AD 720 to 740 (Cal BP 1230 to 1210) and**
(95% probability) **Cal AD 770 to 970 (Cal BP 1180 to 980)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 880 (Cal BP 1070)

1 Sigma calibrated result: Cal AD 780 to 890 (Cal BP 1170 to 1060)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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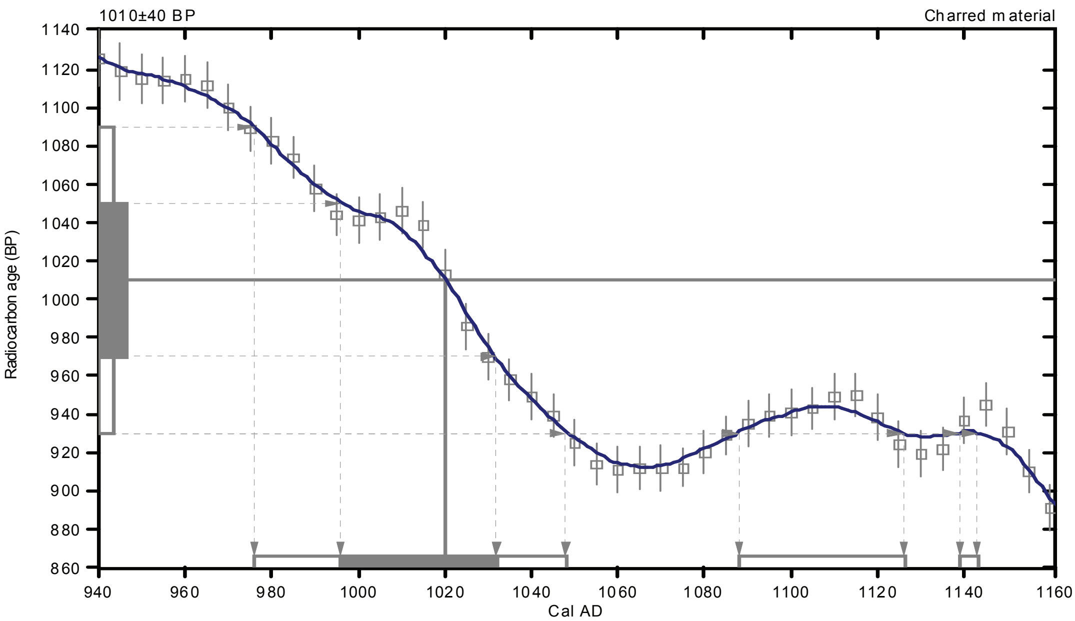
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.9:lab. mult=1)

Laboratory number:	**Beta-258530**
Conventional radiocarbon age:	**1010±40 BP**
2 Sigma calibrated results: **(95% probability)**	**Cal AD 980 to 1050 (Cal BP 970 to 900) and** **Cal AD 1090 to 1130 (Cal BP 860 to 820) and** **Cal AD 1140 to 1140 (Cal BP 810 to 810)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1020 (Cal BP 930)
1 Sigma calibrated result: (68% probability)	Cal AD 1000 to 1030 (Cal BP 950 to 920)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

Laboratory number: **Beta-258531**

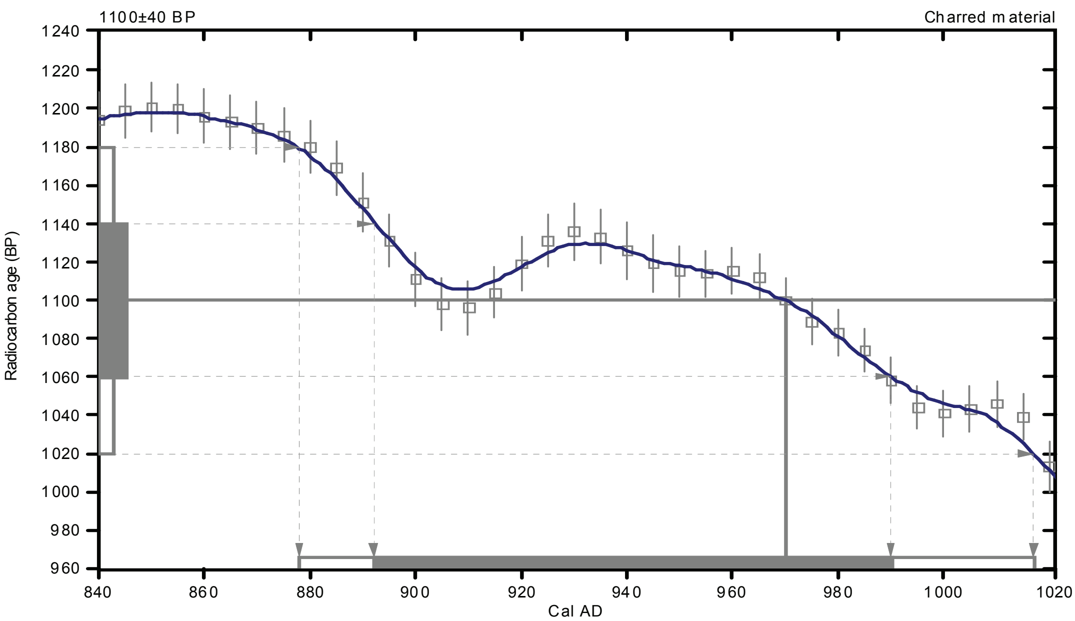
Conventional radiocarbon age: **1100±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 880 to 1020 (Cal BP 1070 to 930)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 970 (Cal BP 980)

1 Sigma calibrated result: (68% probability) Cal AD 890 to 990 (Cal BP 1060 to 960)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **Beta-258532**

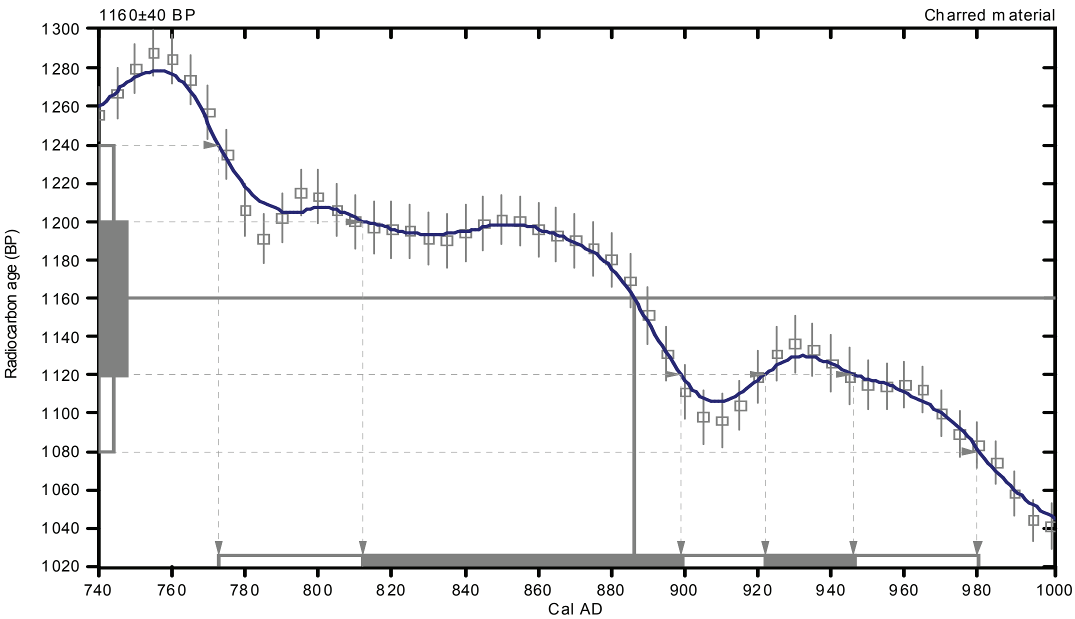
Conventional radiocarbon age: **1160±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 770 to 980 (Cal BP 1180 to 970)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 890 (Cal BP 1060)

1 Sigma calibrated results: (68% probability) Cal AD 810 to 900 (Cal BP 1140 to 1050) and Cal AD 920 to 950 (Cal BP 1030 to 1000)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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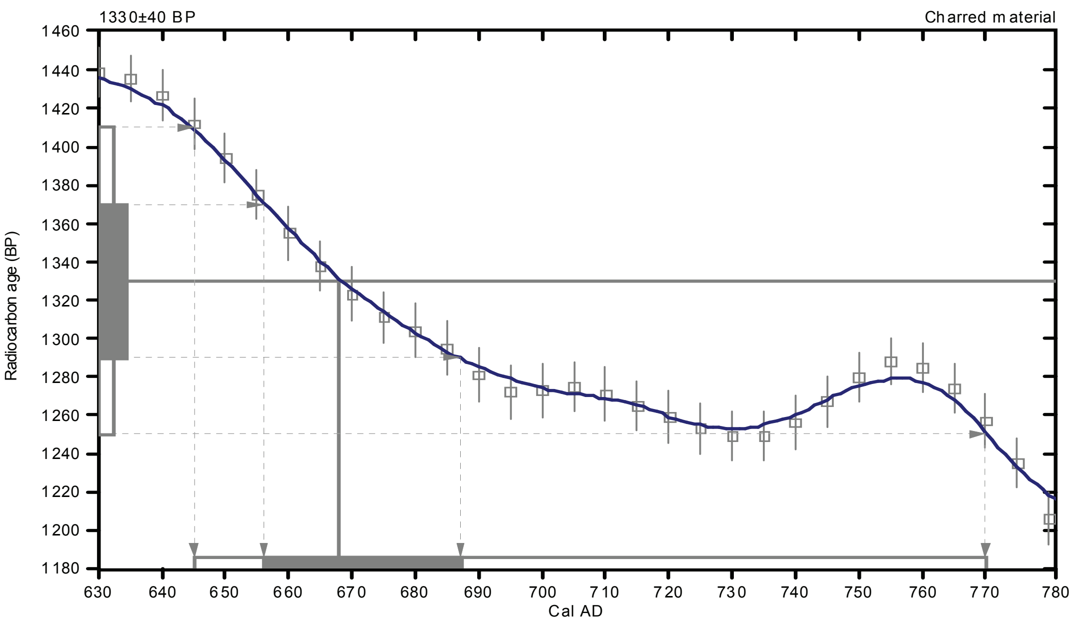
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

Laboratory number:	**Beta-258533**
Conventional radiocarbon age:	**1330±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 640 to 770 (Cal BP 1300 to 1180)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 670 (Cal BP 1280)
1 Sigma calibrated result: (68% probability)	Cal AD 660 to 690 (Cal BP 1290 to 1260)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **Beta-258534**

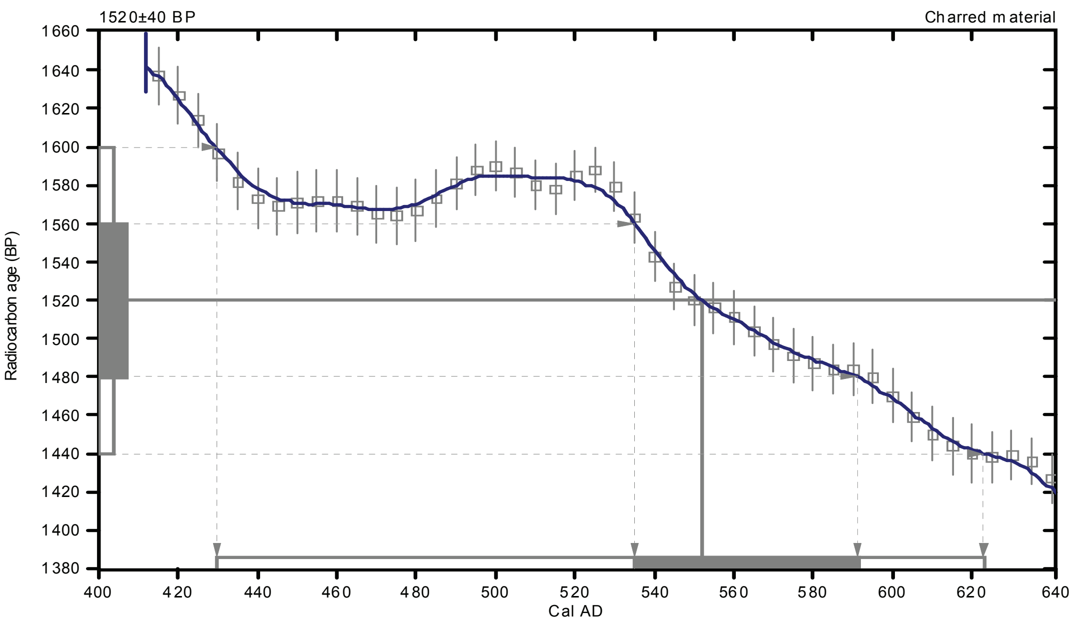
Conventional radiocarbon age: **1520±40 BP**

2 Sigma calibrated result: **Cal AD 430 to 620 (Cal BP 1520 to 1330)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 550 (Cal BP 1400)

1 Sigma calibrated result: Cal AD 540 to 590 (Cal BP 1420 to 1360)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258535**

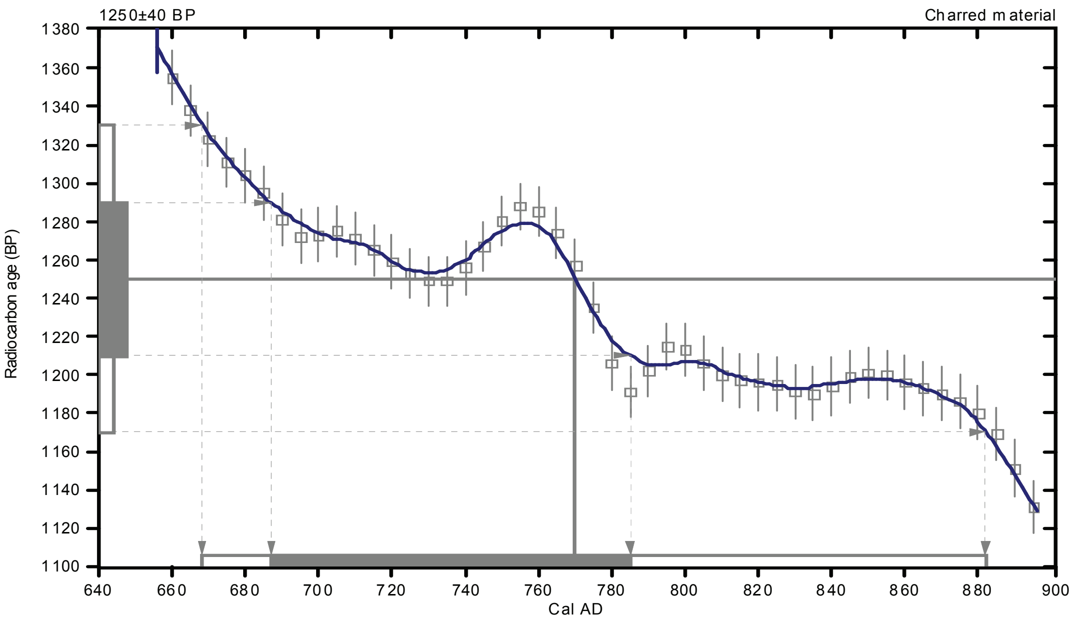
Conventional radiocarbon age: **1250±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 670 to 880 (Cal BP 1280 to 1070)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 770 (Cal BP 1180)

1 Sigma calibrated result: (68% probability) Cal AD 690 to 780 (Cal BP 1260 to 1160)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258536**

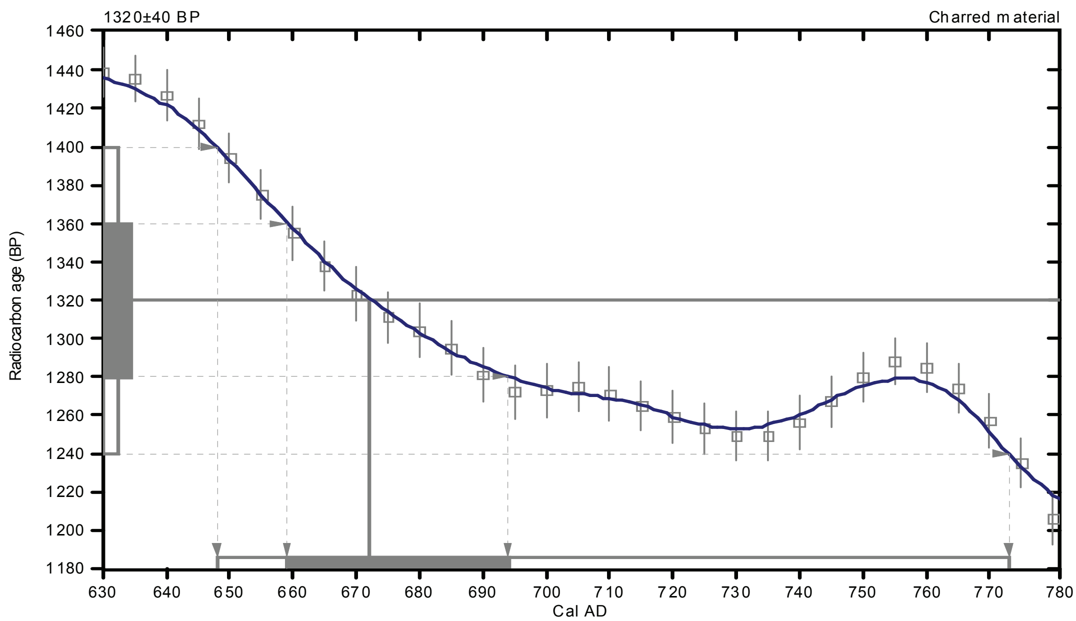
Conventional radiocarbon age: **1320±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 650 to 770 (Cal BP 1300 to 1180)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 670 (Cal BP 1280)

1 Sigma calibrated result: (68% probability) Cal AD 660 to 690 (Cal BP 1290 to 1260)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Radiocarbon Dating Laboratory

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May 20, 2009

Dr. Eric Blinman
Office of Archaeological Studies
P.O. Box 2087
Santa Fe, NM 87504-2087
USA

RE: Radiocarbon Dating Results For Samples 042-541-28, 042-1034/6-33, 042-713-36, 042-710-37, 042-739-40, 042-737-41, 042-786-45, 042-810-46, 042-842-49, 042-971-55, 042-972-56, 042-1003-64, 042-1013-63, 042-1019-67, 042-1031-68, 042-1041-73, 042-1069-78, 042-1070-82, 042-1071-75, 042-1072-80, 042-1077-81, 216-37-10, 216-53-13, 216-65-16, 216-66-14, 216-69-15, 216-76-18, 216-77-17, 218-19-8, 218-85-11, 218-100-12, 218-101-13, 218-136-14, 218-140-16, 218-155-23, 222-275-2, 300-252-21, 300-347-20, 300-390-23, 300-391-25, 300-392-26, 300-428-32, 300-433-38, 300-435-37, 300-457-41, 300-465-40, 300-480-43, 300-481-44

Dear Dr. Blinman:

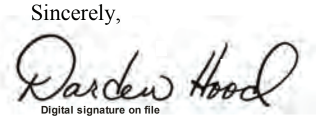
Enclosed are the radiocarbon dating results for 48 samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses proceeded normally. As usual, the method of analysis is listed on the report with the results and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Our invoice has been sent electronically. Thank you for your prior efforts in arranging payment. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,



Digital signature on file

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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman — Report Date: 5/20/2009

Office of Archaeological Studies — Material Received: 4/27/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258894	1020 +/- 40 BP	-23.1 o/oo	1050 +/- 40 BP

SAMPLE : 042-541-28
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 900 to 1030 (Cal BP 1050 to 920)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258895	980 +/- 40 BP	-23.0 o/oo	1010 +/- 40 BP

SAMPLE : 042-1034/6-33
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 980 to 1050 (Cal BP 970 to 900) AND Cal AD 1090 to 1130 (Cal BP 860 to 820)
Cal AD 1140 to 1140 (Cal BP 810 to 810)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258896	1000 +/- 40 BP	-24.3 o/oo	1010 +/- 40 BP

SAMPLE : 042-713-36
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 980 to 1050 (Cal BP 970 to 900) AND Cal AD 1090 to 1130 (Cal BP 860 to 820)
Cal AD 1140 to 1140 (Cal BP 810 to 810)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258897	940 +/- 40 BP	-23.4 o/oo	970 +/- 40 BP

SAMPLE : 042-710-37
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1000 to 1160 (Cal BP 950 to 790)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258898	2780 +/- 40 BP	-25.2 o/oo	2780 +/- 40 BP

SAMPLE : 042-739-40
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 1010 to 830 (Cal BP 2960 to 2780)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258899	940 +/- 40 BP	-23.9 o/oo	960 +/- 40 BP
SAMPLE : 042-737-41			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 1010 to 1170 (Cal BP 940 to 780)			
Beta - 258900	900 +/- 40 BP	-24.4 o/oo	910 +/- 40 BP
SAMPLE : 042-786-45			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 1030 to 1220 (Cal BP 920 to 730)			
Beta - 258901	1280 +/- 40 BP	-24.5 o/oo	1290 +/- 40 BP
SAMPLE : 042-810-46			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 660 to 780 (Cal BP 1290 to 1160)			
Beta - 258902	1330 +/- 40 BP	-23.6 o/oo	1350 +/- 40 BP
SAMPLE : 042-842-49			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 640 to 710 (Cal BP 1320 to 1240) AND Cal AD 750 to 760 (Cal BP 1200 to 1190)			
Beta - 258903	970 +/- 40 BP	-25.1 o/oo	970 +/- 40 BP
SAMPLE : 042-971-55			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 1000 to 1160 (Cal BP 950 to 790)			

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258904 SAMPLE : 042-972-56 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1000 to 1160 (Cal BP 950 to 790)	730 +/- 40 BP	-10.6 o/oo	970 +/- 40 BP
Beta - 258905 SAMPLE : 042-1003-64 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 420 to 610 (Cal BP 1530 to 1340)	1530 +/- 40 BP	-24.2 o/oo	1540 +/- 40 BP
Beta - 258906 SAMPLE : 042-1013-63 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 80 to 250 (Cal BP 1870 to 1700)	1830 +/- 40 BP	-24.2 o/oo	1840 +/- 40 BP
Beta - 258907 SAMPLE : 042-1019-67 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 560 to 660 (Cal BP 1390 to 1290)	1180 +/- 40 BP	-10.0 o/oo	1430 +/- 40 BP
Beta - 258908 SAMPLE : 042-1031-68 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 60 to 240 (Cal BP 1880 to 1710)	1850 +/- 40 BP	-24.6 o/oo	1860 +/- 40 BP

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Report Date: 5/20/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258909	1380 +/- 40 BP	-25.0 o/oo	1380 +/- 40 BP
SAMPLE : 042-1041-73			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 610 to 680 (Cal BP 1340 to 1270)			
Beta - 258910	1820 +/- 40 BP	-24.5 o/oo	1830 +/- 40 BP
SAMPLE : 042-1069-78			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 80 to 260 (Cal BP 1870 to 1690) AND Cal AD 300 to 310 (Cal BP 1650 to 1640)			
Beta - 258911	1360 +/- 40 BP	-25.7 o/oo	1350 +/- 40 BP
SAMPLE : 042-1070-82			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 640 to 710 (Cal BP 1320 to 1240) AND Cal AD 750 to 760 (Cal BP 1200 to 1190)			
Beta - 258912	1270 +/- 40 BP	-24.3 o/oo	1280 +/- 40 BP
SAMPLE : 042-1071-75			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 660 to 810 (Cal BP 1290 to 1140)			
Beta - 258913	1810 +/- 40 BP	-23.1 o/oo	1840 +/- 40 BP
SAMPLE : 042-1072-80			
ANALYSIS : AMS-Standard delivery			
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid			
2 SIGMA CALIBRATION : Cal AD 80 to 250 (Cal BP 1870 to 1700)			

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258914 SAMPLE : 042-1077-81 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 640 to 770 (Cal BP 1300 to 1180)	1320 +/- 40 BP	-24.5 o/oo	1330 +/- 40 BP
Beta - 258915 SAMPLE : 216-37-10 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 240 to 420 (Cal BP 1710 to 1530)	1710 +/- 40 BP	-24.7 o/oo	1710 +/- 40 BP
Beta - 258916 SAMPLE : 216-53-13 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 380 to 550 (Cal BP 1570 to 1400)	1600 +/- 40 BP	-24.5 o/oo	1610 +/- 40 BP
Beta - 258917 SAMPLE : 216-65-16 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 540 to 650 (Cal BP 1410 to 1300)	1460 +/- 40 BP	-24.2 o/oo	1470 +/- 40 BP
Beta - 258918 SAMPLE : 216-66-14 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 980 to 1160 (Cal BP 960 to 800)	980 +/- 40 BP	-24.3 o/oo	990 +/- 40 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258919	1090 +/- 40 BP	-23.1 o/oo	1120 +/- 40 BP

SAMPLE : 216-69-15
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 810 to 1010 (Cal BP 1140 to 940)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258920	1680 +/- 40 BP	-24.6 o/oo	1690 +/- 40 BP

SAMPLE : 216-76-18
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 250 to 420 (Cal BP 1700 to 1520)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258921	1660 +/- 40 BP	-24.6 o/oo	1670 +/- 40 BP

SAMPLE : 216-77-17
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 260 to 300 (Cal BP 1690 to 1650) AND Cal AD 310 to 430 (Cal BP 1640 to 1520)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258922	980 +/- 40 BP	-24.5 o/oo	990 +/- 40 BP

SAMPLE : 218-19-8
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 980 to 1160 (Cal BP 960 to 800)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258923	990 +/- 40 BP	-24.8 o/oo	990 +/- 40 BP

SAMPLE : 218-85-11
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 980 to 1160 (Cal BP 960 to 800)

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258924	1030 +/- 40 BP	-24.6 o/oo	1040 +/- 40 BP

SAMPLE : 218-100-12
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 900 to 920 (Cal BP 1050 to 1030) AND Cal AD 950 to 1040 (Cal BP 1000 to 920)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258925	920 +/- 40 BP	-24.5 o/oo	930 +/- 40 BP

SAMPLE : 218-101-13
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1020 to 1210 (Cal BP 930 to 740)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258926	5700 +/- 40 BP	-23.7 o/oo	5720 +/- 40 BP

SAMPLE : 218-136-14
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 4690 to 4460 (Cal BP 6640 to 6410)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258927	5460 +/- 40 BP	-23.7 o/oo	5480 +/- 40 BP

SAMPLE : 218-140-16
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 4360 to 4310 (Cal BP 6320 to 6260) AND Cal BC 4300 to 4260 (Cal BP 6250 to 6210)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258928	5520 +/- 40 BP	-24.8 o/oo	5520 +/- 40 BP

SAMPLE : 218-155-23
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 4450 to 4330 (Cal BP 6400 to 6280)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

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Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258929	1080 +/- 40 BP	-25.7 o/oo	1070 +/- 40 BP

SAMPLE : 222-275-2
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 890 to 1030 (Cal BP 1060 to 920)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258930	1720 +/- 40 BP	-24.3 o/oo	1730 +/- 40 BP

SAMPLE : 300-252-21
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 230 to 410 (Cal BP 1720 to 1540)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258931	5710 +/- 40 BP	-25.1 o/oo	5710 +/- 40 BP

SAMPLE : 300-347-20
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 4680 to 4460 (Cal BP 6630 to 6410)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258932	5360 +/- 40 BP	-23.0 o/oo	5390 +/- 40 BP

SAMPLE : 300-390-23
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 4340 to 4220 (Cal BP 6290 to 6170) AND Cal BC 4200 to 4160 (Cal BP 6150 to 6110)
Cal BC 4120 to 4110 (Cal BP 6070 to 6060) AND Cal BC 4100 to 4070 (Cal BP 6050 to 6020)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258933	1390 +/- 40 BP	-24.2 o/oo	1400 +/- 40 BP

SAMPLE : 300-391-25
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 590 to 670 (Cal BP 1360 to 1280)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman

Report Date: 5/20/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258934 SAMPLE : 300-392-26 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 650 to 770 (Cal BP 1300 to 1180)	1320 +/- 40 BP	-25.3 o/oo	1320 +/- 40 BP
Beta - 258935 SAMPLE : 300-428-32 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 690 to 900 (Cal BP 1260 to 1050)	1220 +/- 40 BP	-25.5 o/oo	1210 +/- 40 BP
Beta - 258936 SAMPLE : 300-433-38 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 420 to 610 (Cal BP 1530 to 1340)	1540 +/- 40 BP	-24.8 o/oo	1540 +/- 40 BP
Beta - 258937 SAMPLE : 300-435-37 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 610 to 690 (Cal BP 1340 to 1260)	1350 +/- 40 BP	-23.7 o/oo	1370 +/- 40 BP
Beta - 258938 SAMPLE : 300-457-41 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 430 to 620 (Cal BP 1520 to 1330)	1520 +/- 40 BP	-25.1 o/oo	1520 +/- 40 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman

Report Date: 5/20/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 258939 SAMPLE : 300-465-40 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 770 to 980 (Cal BP 1180 to 970)	1160 +/- 40 BP	-24.9 o/oo	1160 +/- 40 BP
Beta - 258940 SAMPLE : 300-480-43 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 430 to 620 (Cal BP 1520 to 1330)	1500 +/- 40 BP	-23.5 o/oo	1520 +/- 40 BP
Beta - 258941 SAMPLE : 300-481-44 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 390 to 550 (Cal BP 1560 to 1400)	1560 +/- 40 BP	-22.8 o/oo	1600 +/- 40 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.1:lab. mult=1)

Laboratory number: **Beta-258894**

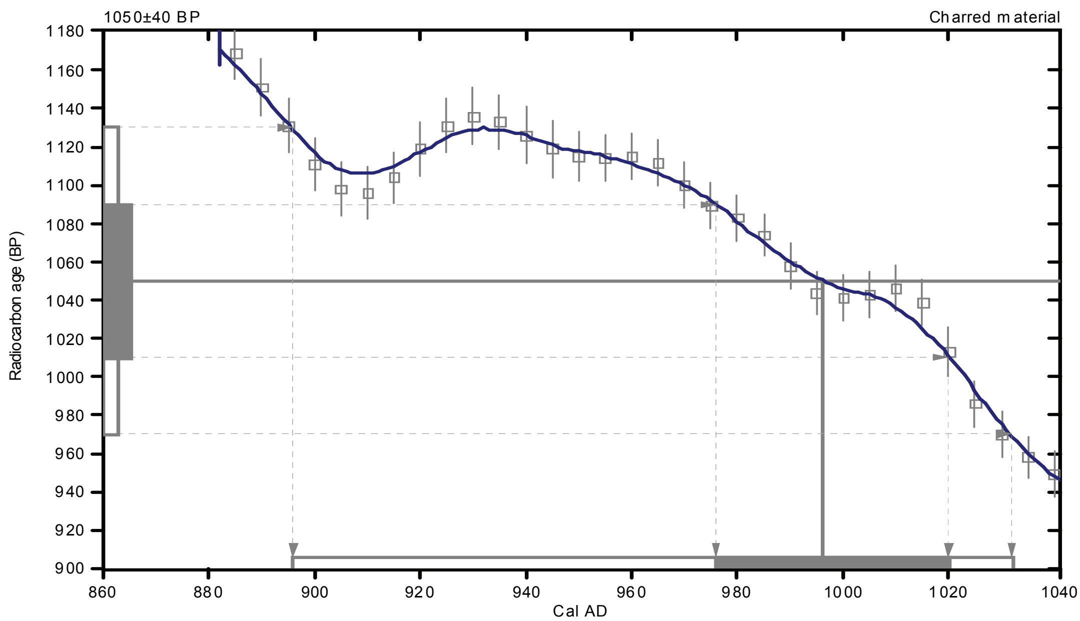
Conventional radiocarbon age: **1050±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 900 to 1030 (Cal BP 1050 to 920)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1000 (Cal BP 950)

1 Sigma calibrated result: (68% probability) Cal AD 980 to 1020 (Cal BP 970 to 930)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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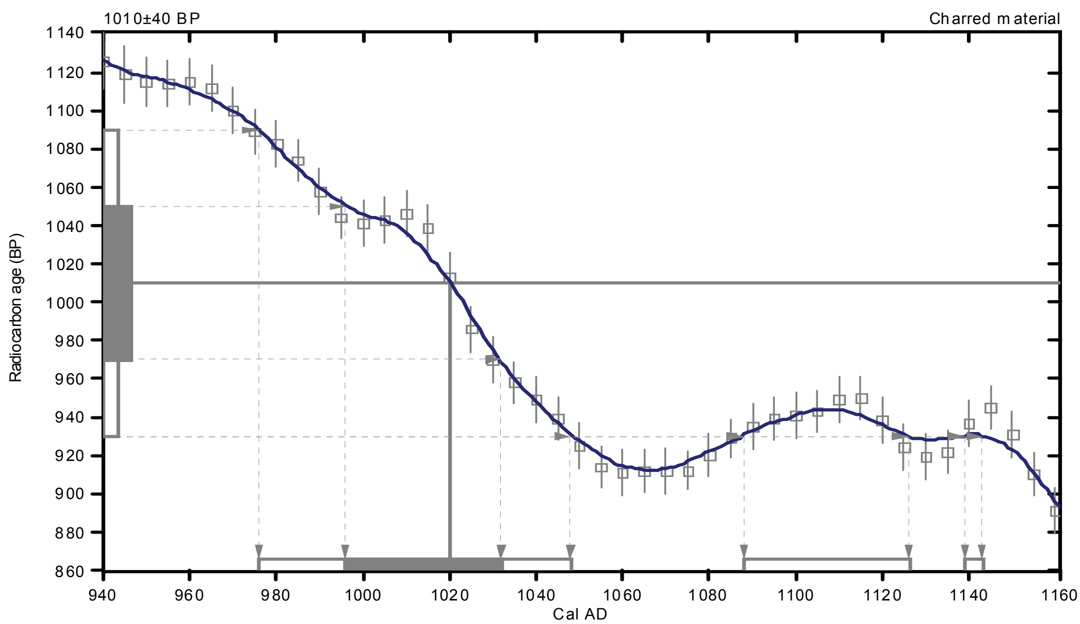
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23:lab. mult=1)

Laboratory number:	**Beta-258895**
Conventional radiocarbon age:	**1010±40 BP**
2 Sigma calibrated results:	**Cal AD 980 to 1050 (Cal BP 970 to 900) and**
(95% probability)	**Cal AD 1090 to 1130 (Cal BP 860 to 820) and**
	Cal AD 1140 to 1140 (Cal BP 810 to 810)

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1020 (Cal BP 930)
1 Sigma calibrated result: (68% probability)	Cal AD 1000 to 1030 (Cal BP 950 to 920)



References:

Database used
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number: **Beta-258896**

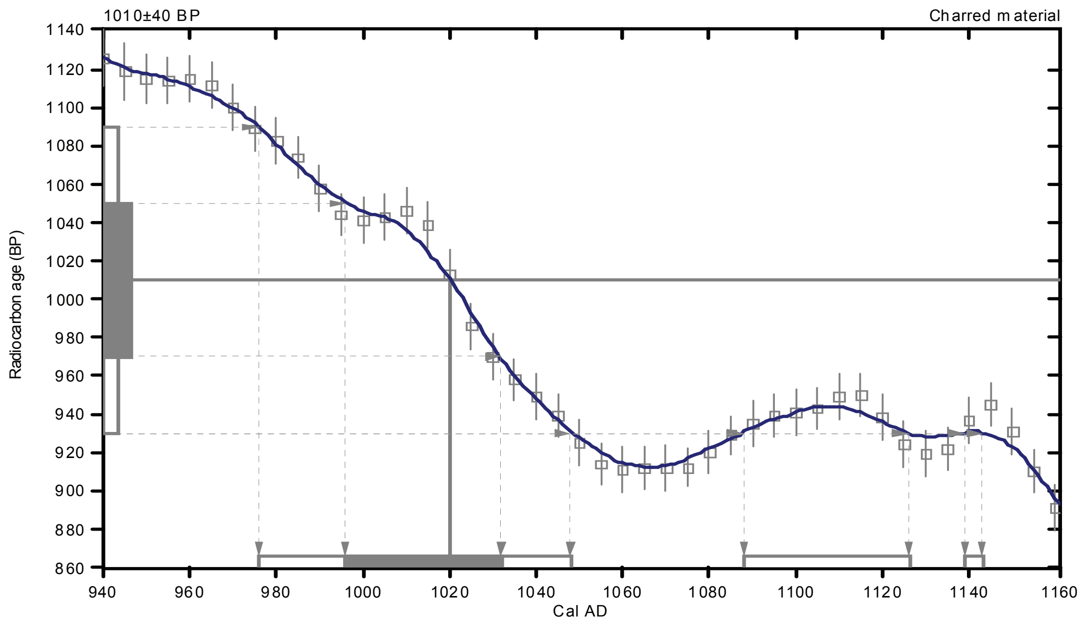
Conventional radiocarbon age: **1010±40 BP**

2 Sigma calibrated results: **Cal AD 980 to 1050 (Cal BP 970 to 900) and**
(95% probability) **Cal AD 1090 to 1130 (Cal BP 860 to 820) and**
Cal AD 1140 to 1140 (Cal BP 810 to 810)

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1020 (Cal BP 930)

1 Sigma calibrated result: Cal AD 1000 to 1030 (Cal BP 950 to 920)
(68% probability)



References:

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.4:lab. mult=1)

Laboratory number: **Beta-258897**

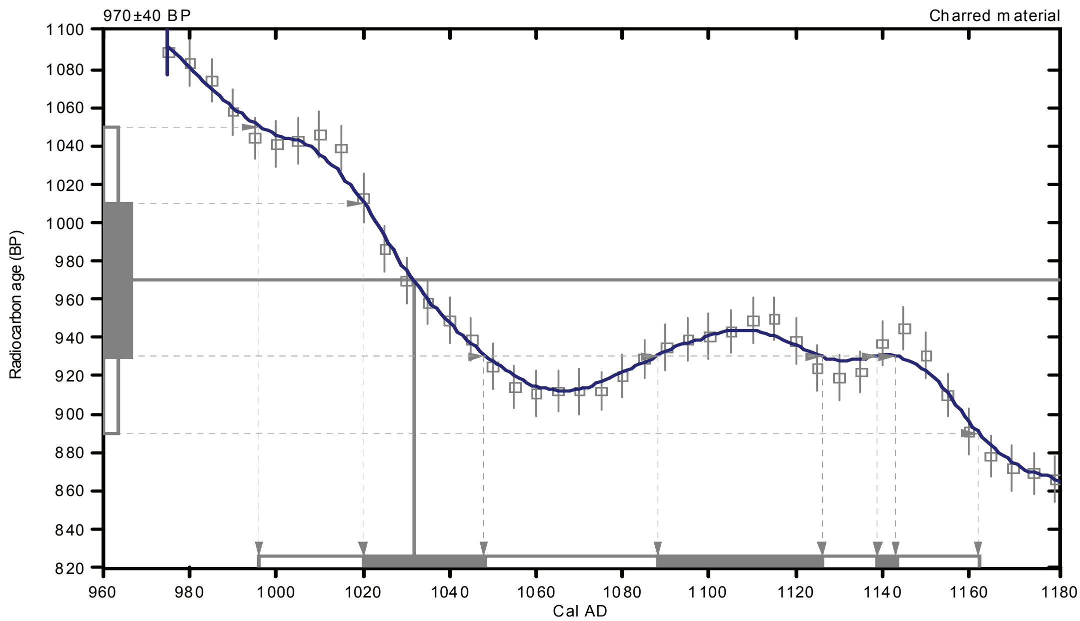
Conventional radiocarbon age: **970±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1000 to 1160 (Cal BP 950 to 790)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1030 (Cal BP 920)

1 Sigma calibrated results: (68% probability) Cal AD 1020 to 1050 (Cal BP 930 to 900) and
Cal AD 1090 to 1130 (Cal BP 860 to 820) and
Cal AD 1140 to 1140 (Cal BP 810 to 810)



References:

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.2:lab. mult=1)

Laboratory number: **Beta-258898**

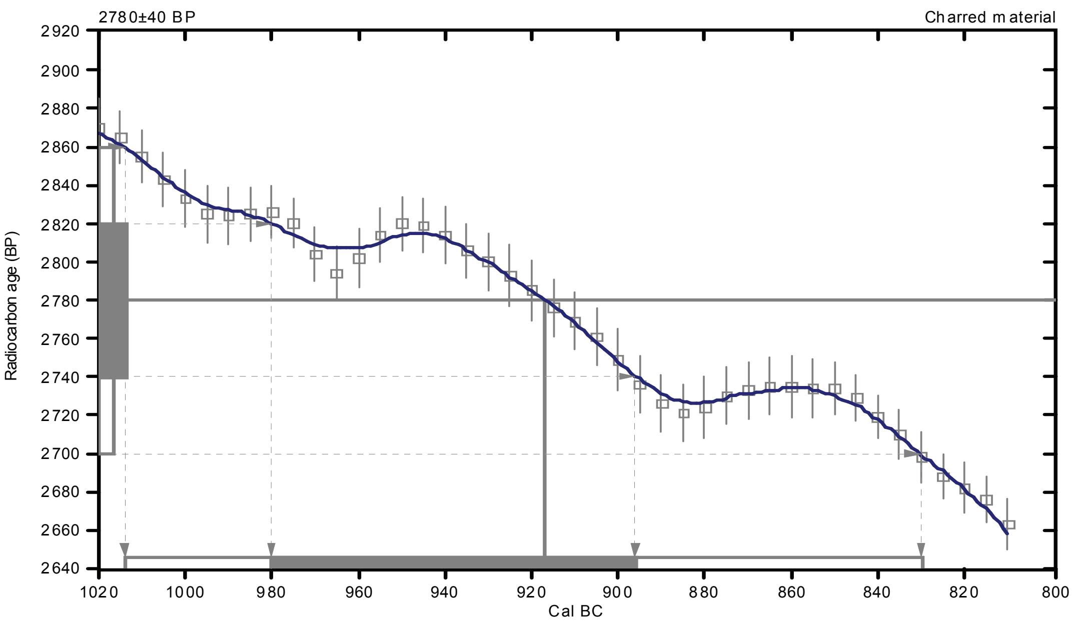
Conventional radiocarbon age: **2780±40 BP**

2 Sigma calibrated result: (95% probability) **Cal BC 1010 to 830 (Cal BP 2960 to 2780)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 920 (Cal BP 2870)

1 Sigma calibrated result: (68% probability) Cal BC 980 to 900 (Cal BP 2930 to 2850)



References:

Database used

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Calibration Database

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.9:lab. mult=1)

Laboratory number: **Beta-258899**

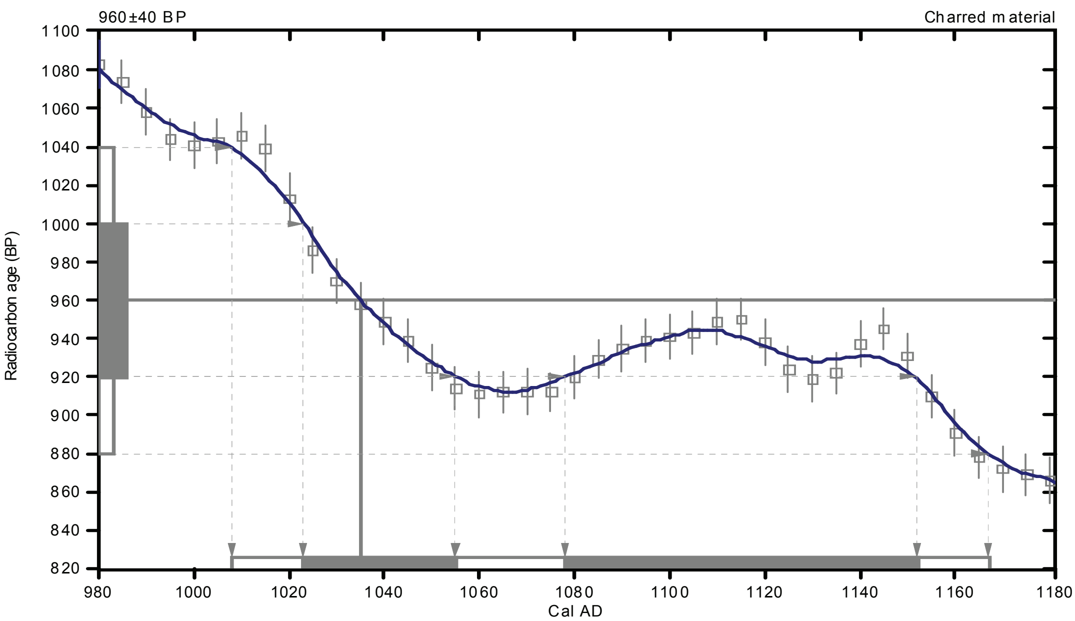
Conventional radiocarbon age: **960±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1010 to 1170 (Cal BP 940 to 780)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1040 (Cal BP 920)

1 Sigma calibrated results: (68% probability) Cal AD 1020 to 1060 (Cal BP 930 to 900) and Cal AD 1080 to 1150 (Cal BP 870 to 800)



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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.4:lab. mult=1)

Laboratory number: **Beta-258900**

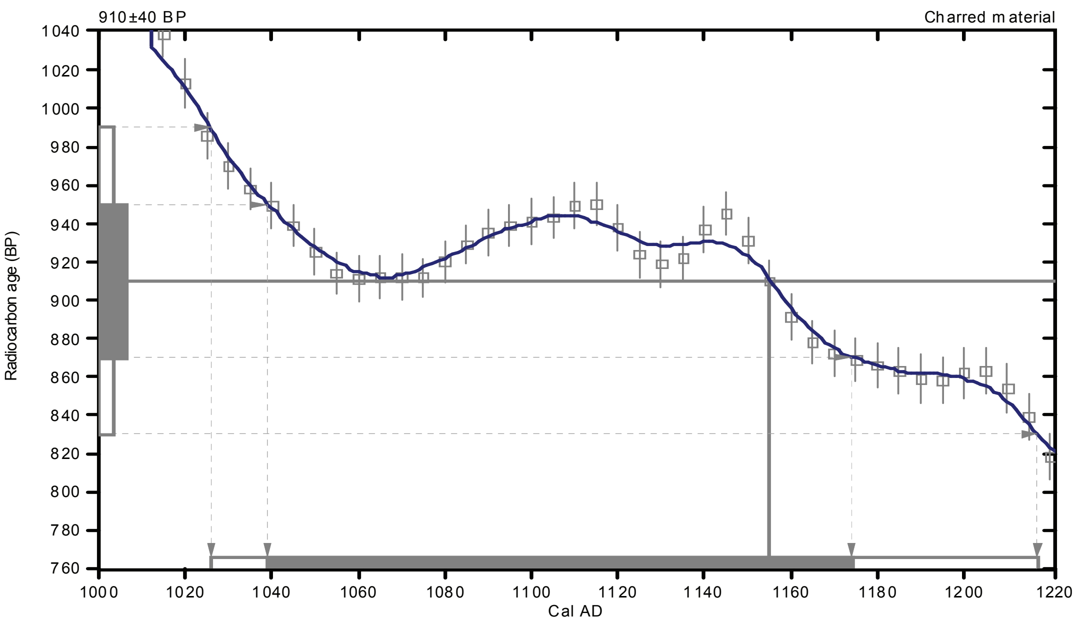
Conventional radiocarbon age: **910±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1030 to 1220 (Cal BP 920 to 730)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1160 (Cal BP 800)

1 Sigma calibrated result: (68% probability) Cal AD 1040 to 1170 (Cal BP 910 to 780)



References:

Database used

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258901**

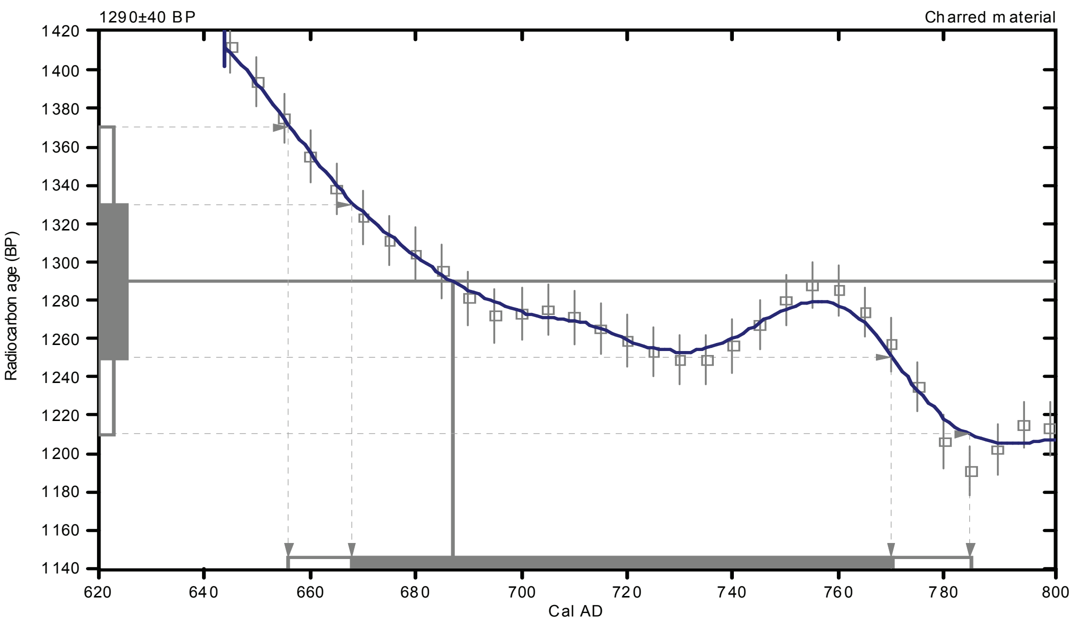
Conventional radiocarbon age: **1290±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 660 to 780 (Cal BP 1290 to 1160)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 690 (Cal BP 1260)

1 Sigma calibrated result: (68% probability) Cal AD 670 to 770 (Cal BP 1280 to 1180)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.6:lab. mult=1)

Laboratory number: **Beta-258902**

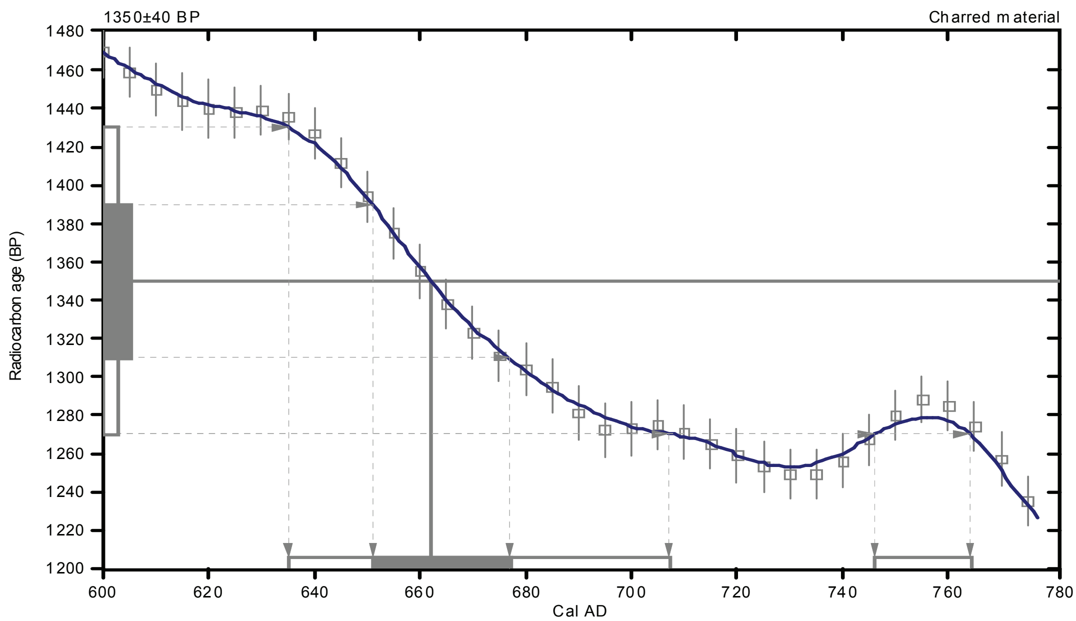
Conventional radiocarbon age: **1350±40 BP**

2 Sigma calibrated results: (95% probability) **Cal AD 640 to 710 (Cal BP 1320 to 1240) and Cal AD 750 to 760 (Cal BP 1200 to 1190)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 660 (Cal BP 1290)

1 Sigma calibrated result: (68% probability) Cal AD 650 to 680 (Cal BP 1300 to 1270)



References:

Database used

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Calibration Database

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **Beta-258903**

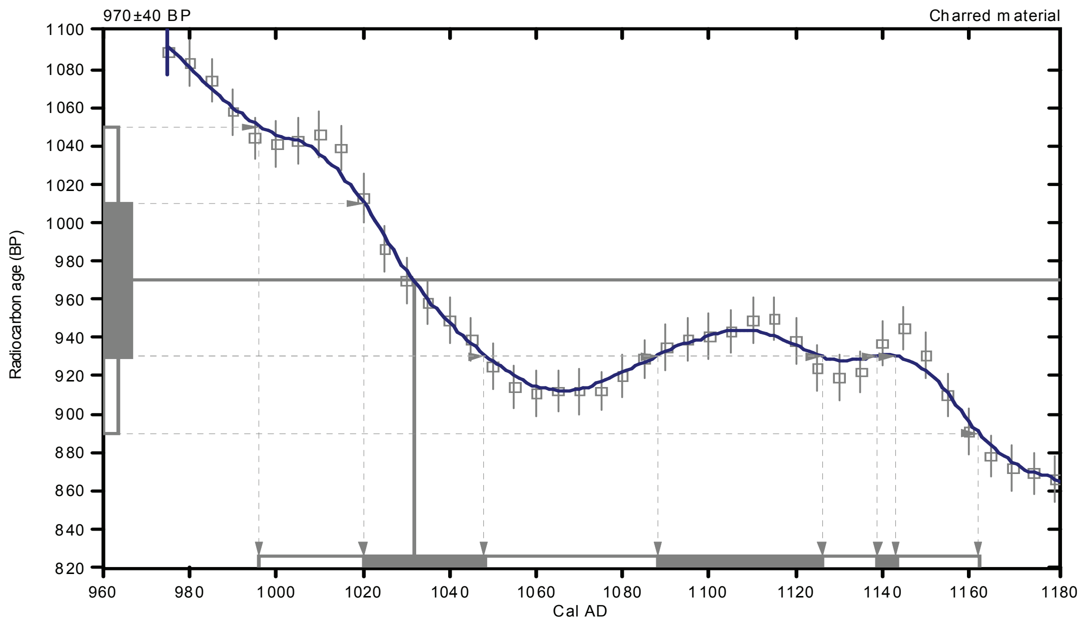
Conventional radiocarbon age: **970±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1000 to 1160 (Cal BP 950 to 790)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1030 (Cal BP 920)

1 Sigma calibrated results: (68% probability) Cal AD 1020 to 1050 (Cal BP 930 to 900) and
Cal AD 1090 to 1130 (Cal BP 860 to 820) and
Cal AD 1140 to 1140 (Cal BP 810 to 810)



References:

Database used
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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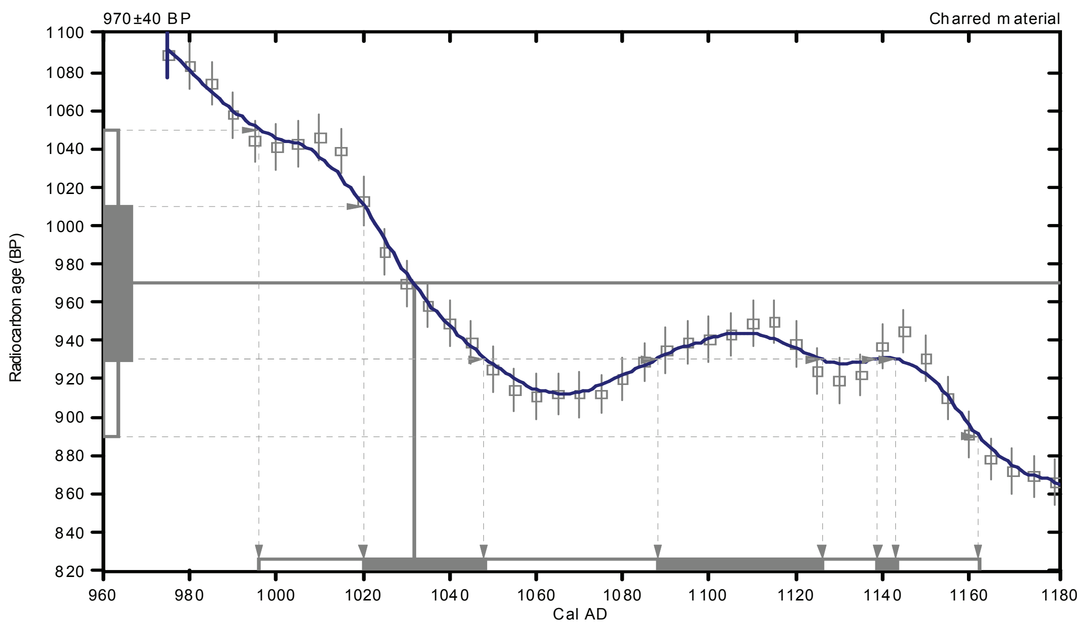
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-10.6:lab. mult=1)

Laboratory number:	**Beta-258904**
Conventional radiocarbon age:	**970±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 1000 to 1160 (Cal BP 950 to 790)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1030 (Cal BP 920)
1 Sigma calibrated results: (68% probability)	Cal AD 1020 to 1050 (Cal BP 930 to 900) and Cal AD 1090 to 1130 (Cal BP 860 to 820) and Cal AD 1140 to 1140 (Cal BP 810 to 810)



References:

Database used
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Calibration Database
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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

Laboratory number: **Beta-258905**

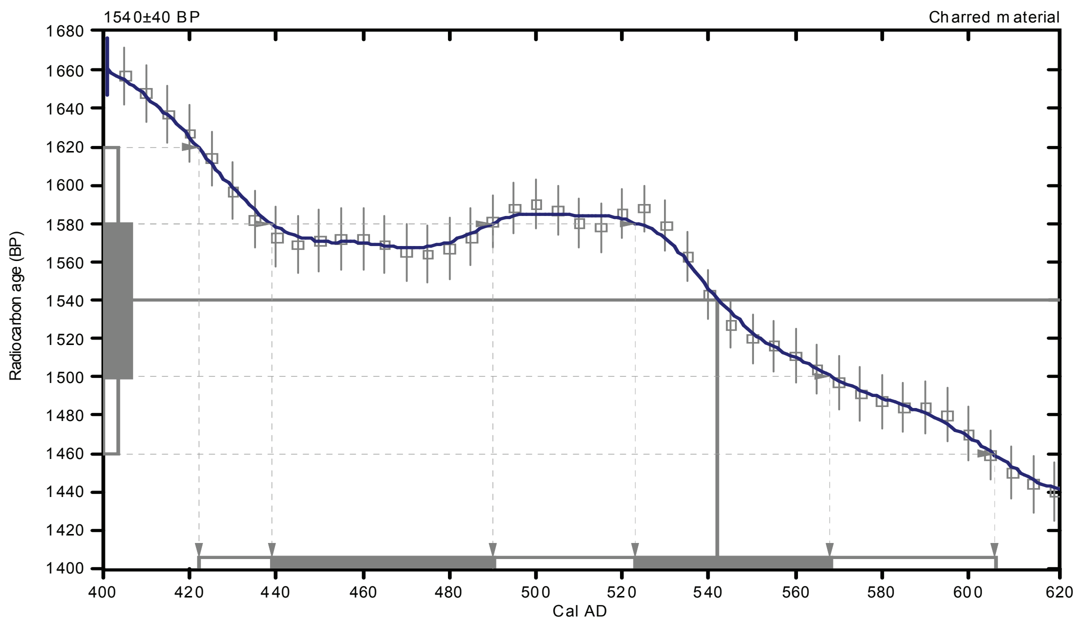
Conventional radiocarbon age: **1540±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 420 to 610 (Cal BP 1530 to 1340)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 540 (Cal BP 1410)

1 Sigma calibrated results: (68% probability) Cal AD 440 to 490 (Cal BP 1510 to 1460) and Cal AD 520 to 570 (Cal BP 1430 to 1380)



References:

Database used
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

Laboratory number: **Beta-258906**

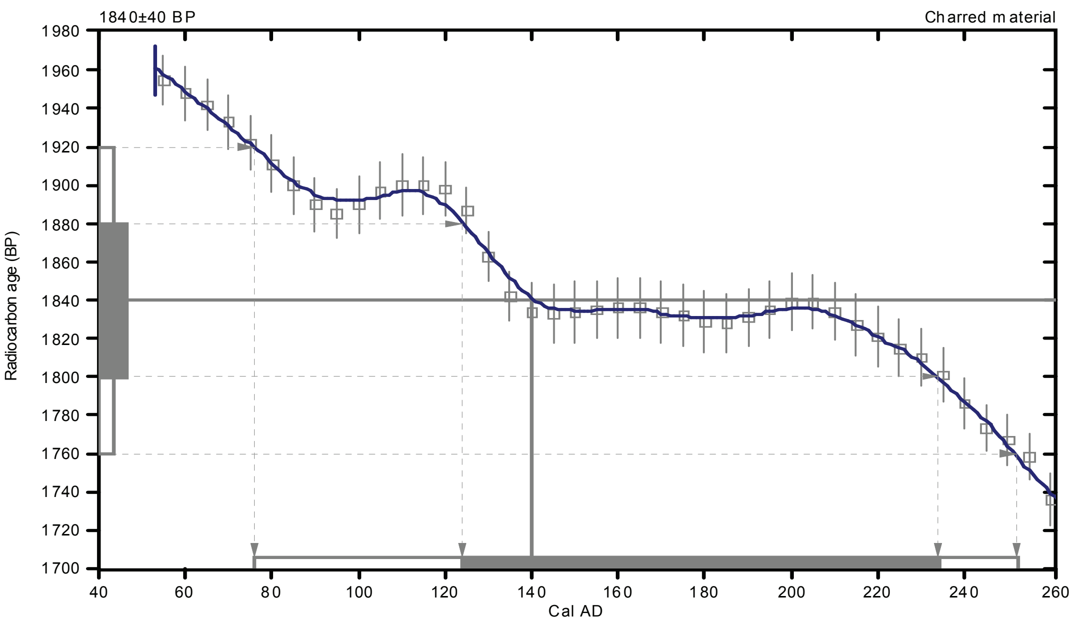
Conventional radiocarbon age: **1840±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 80 to 250 (Cal BP 1870 to 1700)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 140 (Cal BP 1810)

1 Sigma calibrated result: (68% probability) Cal AD 120 to 230 (Cal BP 1830 to 1720)



References:

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-10:lab. mult=1)

Laboratory number: **Beta-258907**

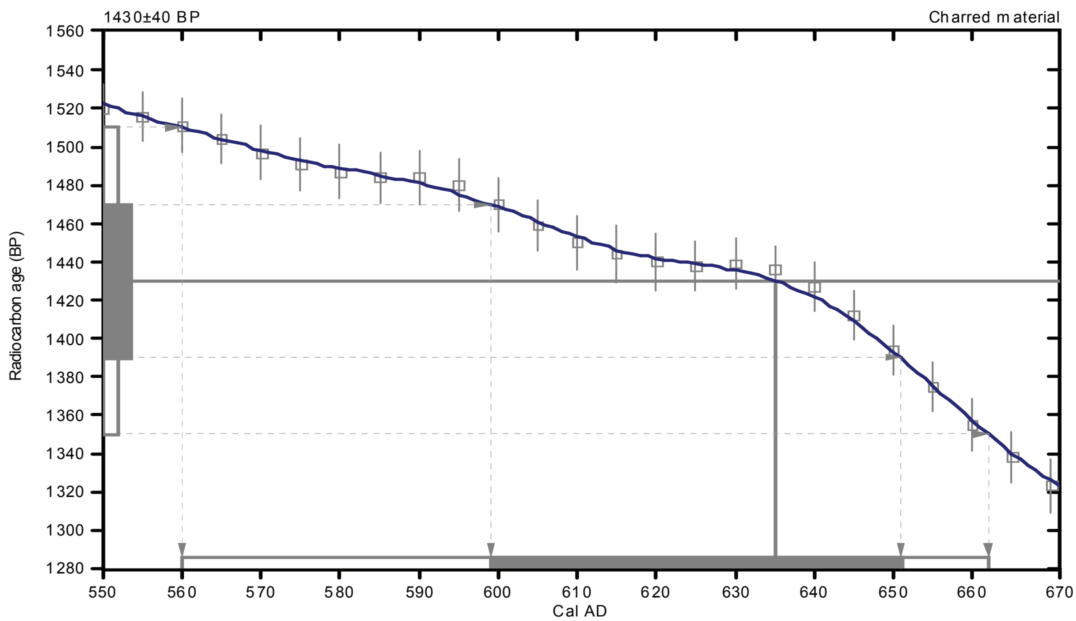
Conventional radiocarbon age: **1430±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 560 to 660 (Cal BP 1390 to 1290)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 640 (Cal BP 1320)

1 Sigma calibrated result: (68% probability) Cal AD 600 to 650 (Cal BP 1350 to 1300)



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Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.6:lab. mult=1)

Laboratory number: **Beta-258908**

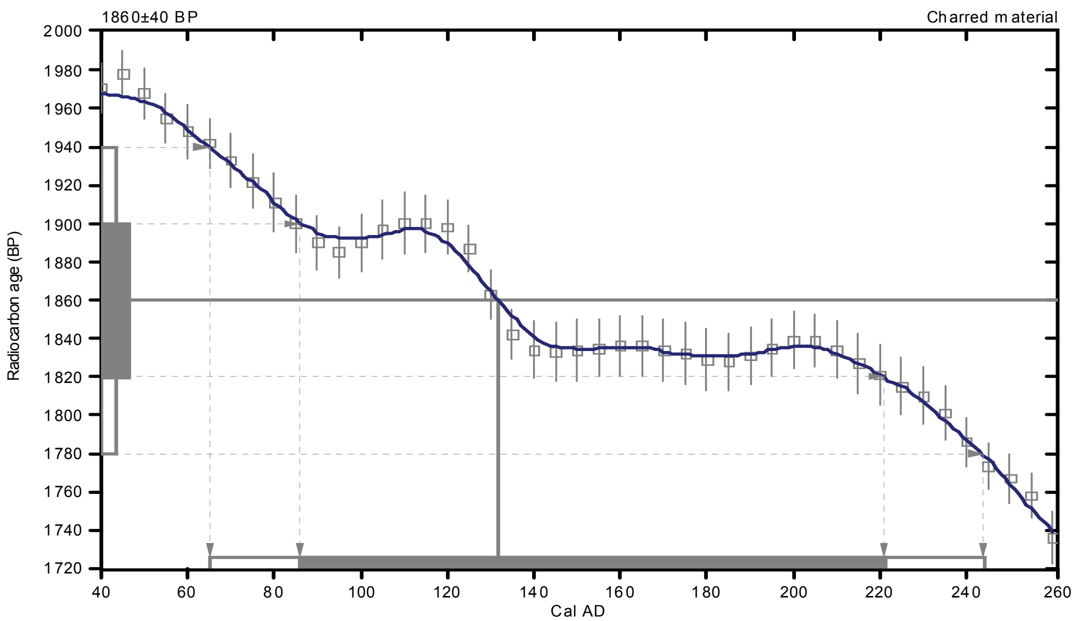
Conventional radiocarbon age: **1860±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 60 to 240 (Cal BP 1880 to 1710)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 130 (Cal BP 1820)

1 Sigma calibrated result: (68% probability) Cal AD 90 to 220 (Cal BP 1860 to 1730)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25:lab. mult=1)

Laboratory number: **Beta-258909**

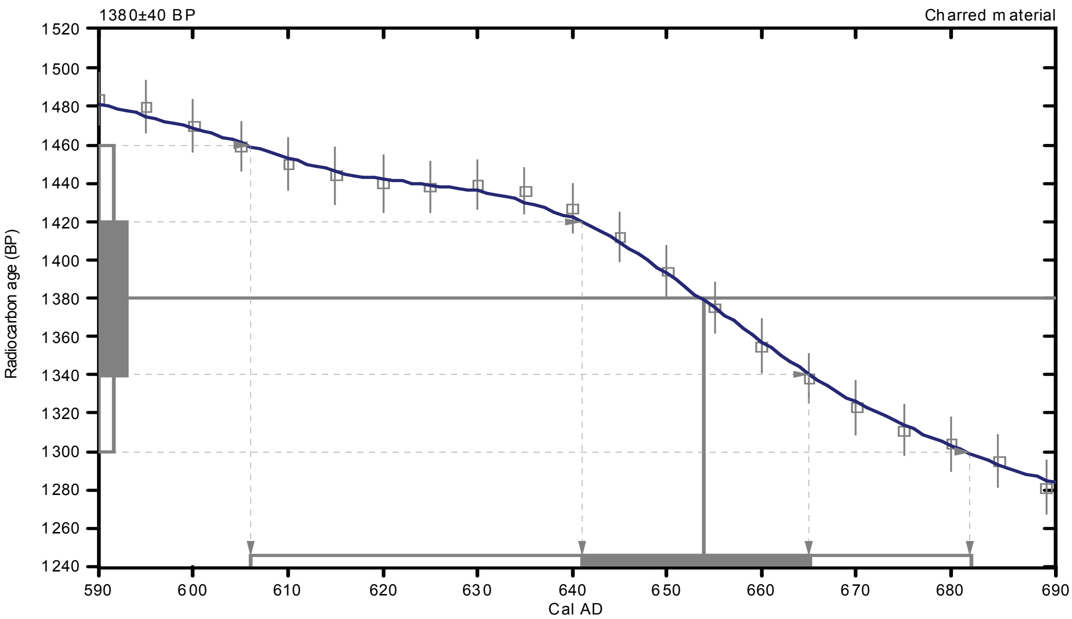
Conventional radiocarbon age: **1380±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 610 to 680 (Cal BP 1340 to 1270)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 650 (Cal BP 1300)

1 Sigma calibrated result: (68% probability) Cal AD 640 to 660 (Cal BP 1310 to 1280)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258910**

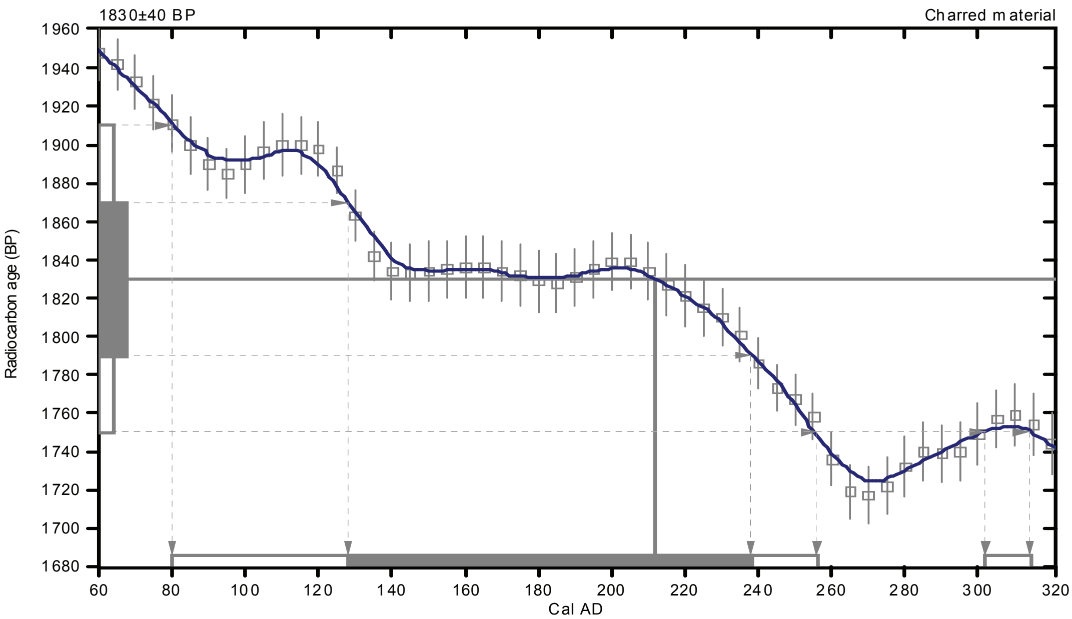
Conventional radiocarbon age: **1830±40 BP**

2 Sigma calibrated results: (95% probability) **Cal AD 80 to 260 (Cal BP 1870 to 1690) and Cal AD 300 to 310 (Cal BP 1650 to 1640)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 210 (Cal BP 1740)

1 Sigma calibrated result: (68% probability) Cal AD 130 to 240 (Cal BP 1820 to 1710)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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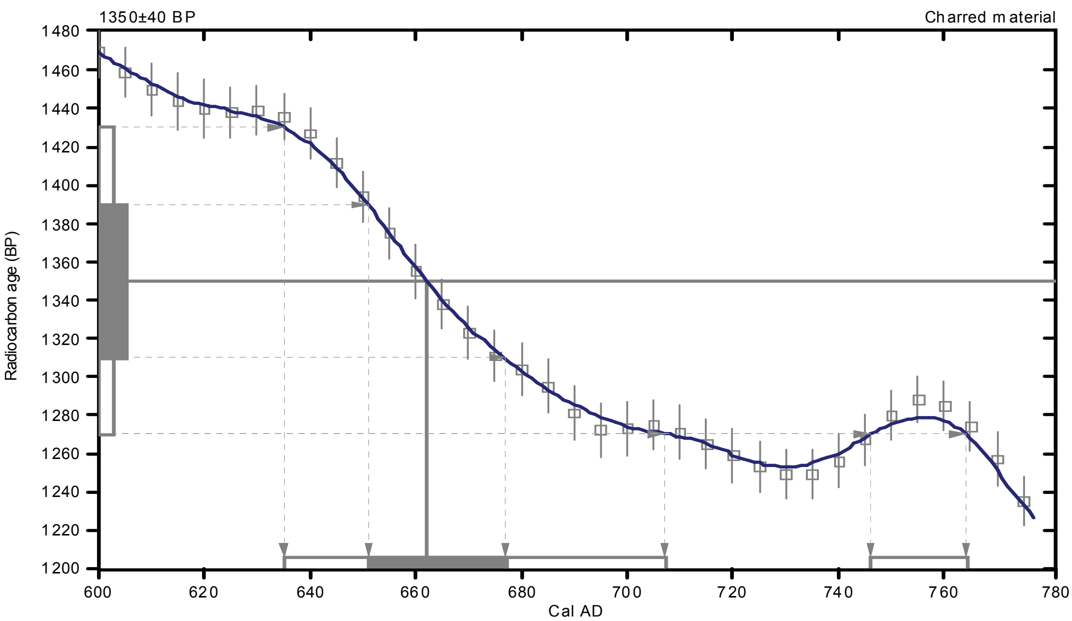
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.7:lab. mult=1)

Laboratory number:	**Beta-258911**
Conventional radiocarbon age:	**1350±40 BP**
2 Sigma calibrated results: (95% probability)	**Cal AD 640 to 710 (Cal BP 1320 to 1240) and Cal AD 750 to 760 (Cal BP 1200 to 1190)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 660 (Cal BP 1290)
1 Sigma calibrated result: (68% probability)	Cal AD 650 to 680 (Cal BP 1300 to 1270)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number: **Beta-258912**

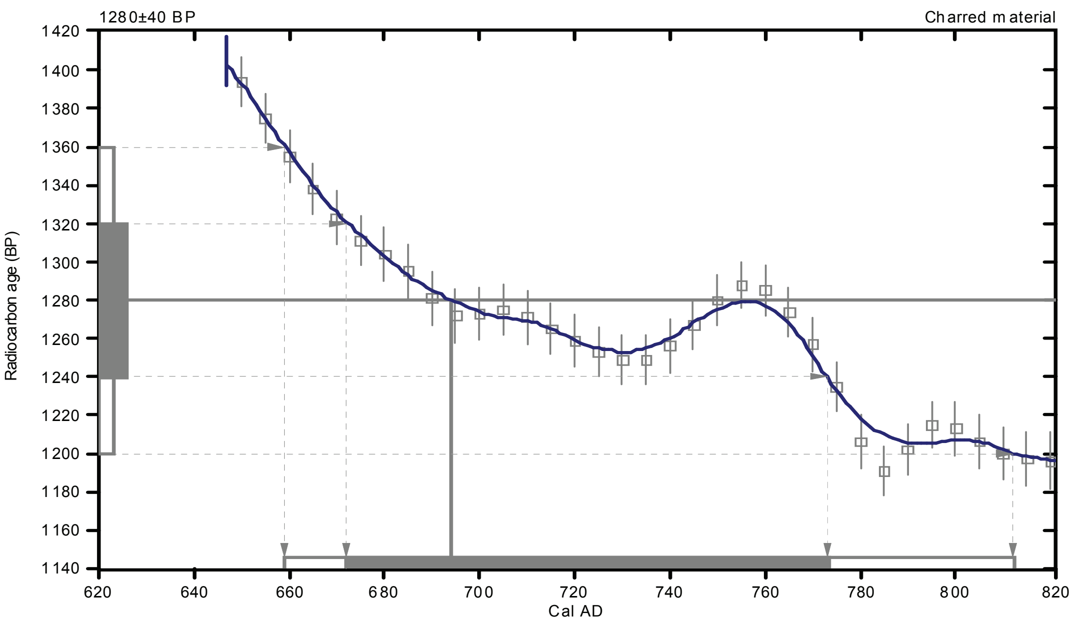
Conventional radiocarbon age: **1280±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 660 to 810 (Cal BP 1290 to 1140)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 690 (Cal BP 1260)

1 Sigma calibrated result: (68% probability) Cal AD 670 to 770 (Cal BP 1280 to 1180)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.1:lab. mult=1)

Laboratory number: **Beta-258913**

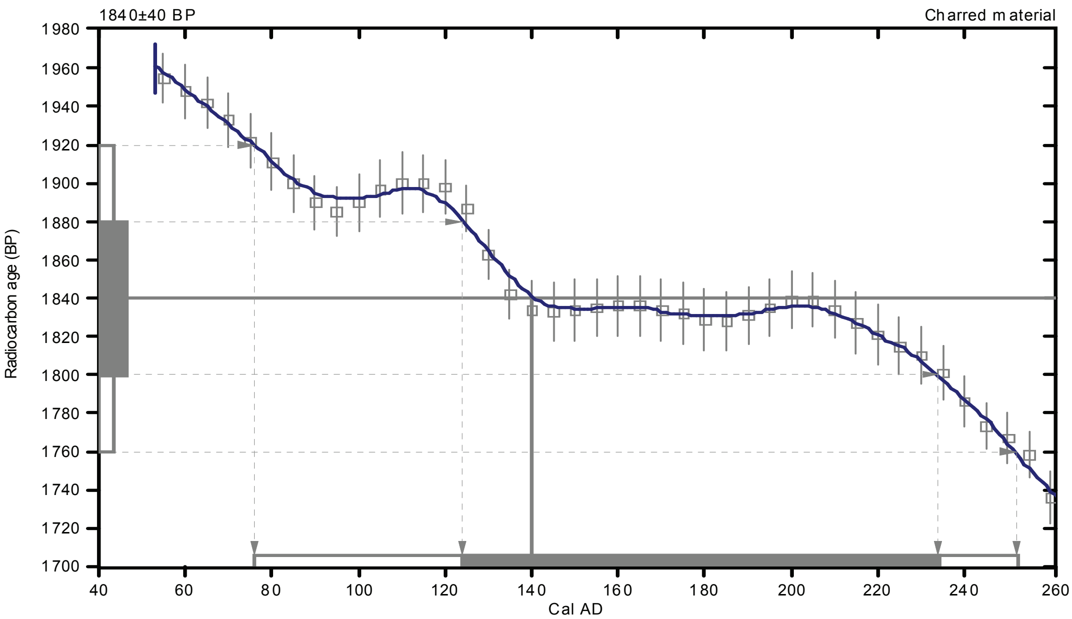
Conventional radiocarbon age: **1840±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 80 to 250 (Cal BP 1870 to 1700)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 140 (Cal BP 1810)

1 Sigma calibrated result: (68% probability) Cal AD 120 to 230 (Cal BP 1830 to 1720)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258914**

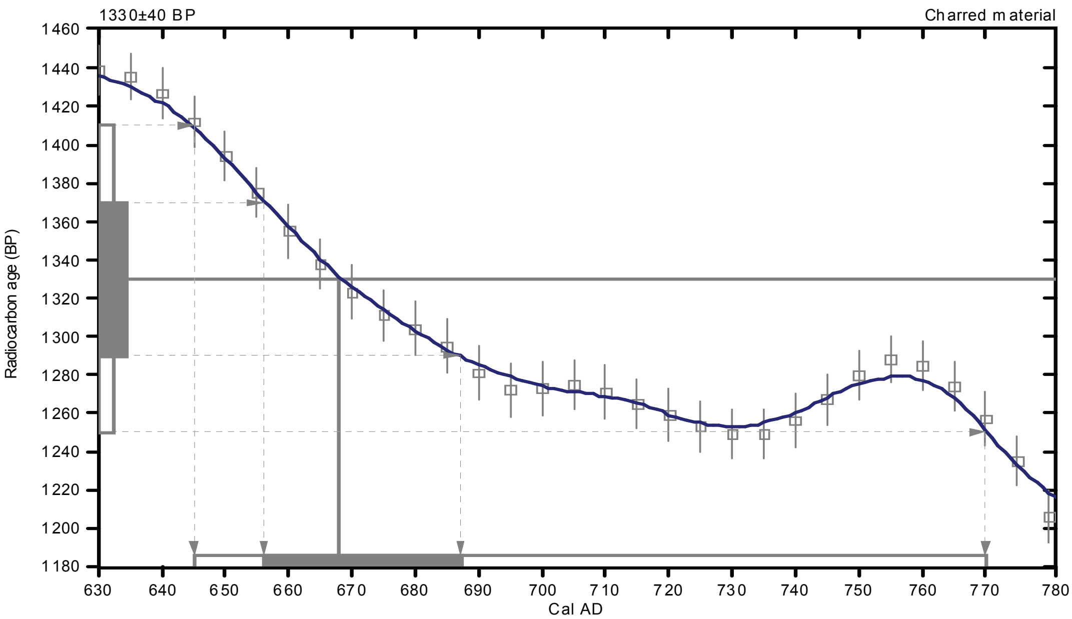
Conventional radiocarbon age: **1330±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 640 to 770 (Cal BP 1300 to 1180)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 670 (Cal BP 1280)

1 Sigma calibrated result: (68% probability) Cal AD 660 to 690 (Cal BP 1290 to 1260)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.7:lab. mult=1)

Laboratory number: **Beta-258915**

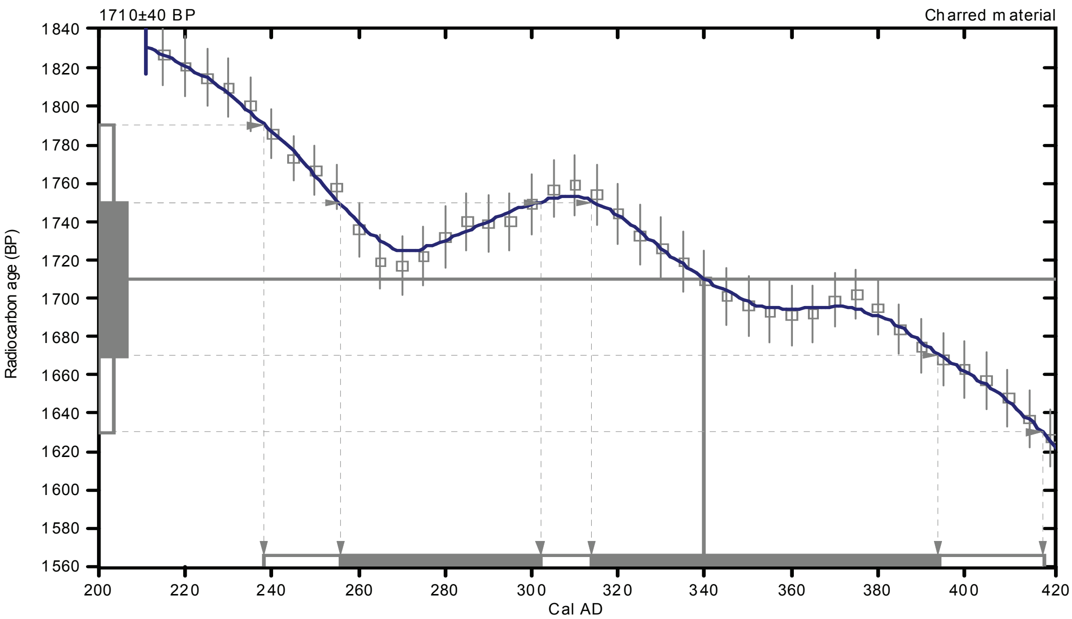
Conventional radiocarbon age: **1710±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 240 to 420 (Cal BP 1710 to 1530)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 340 (Cal BP 1610)

1 Sigma calibrated results: (68% probability) Cal AD 260 to 300 (Cal BP 1690 to 1650) and Cal AD 310 to 390 (Cal BP 1640 to 1560)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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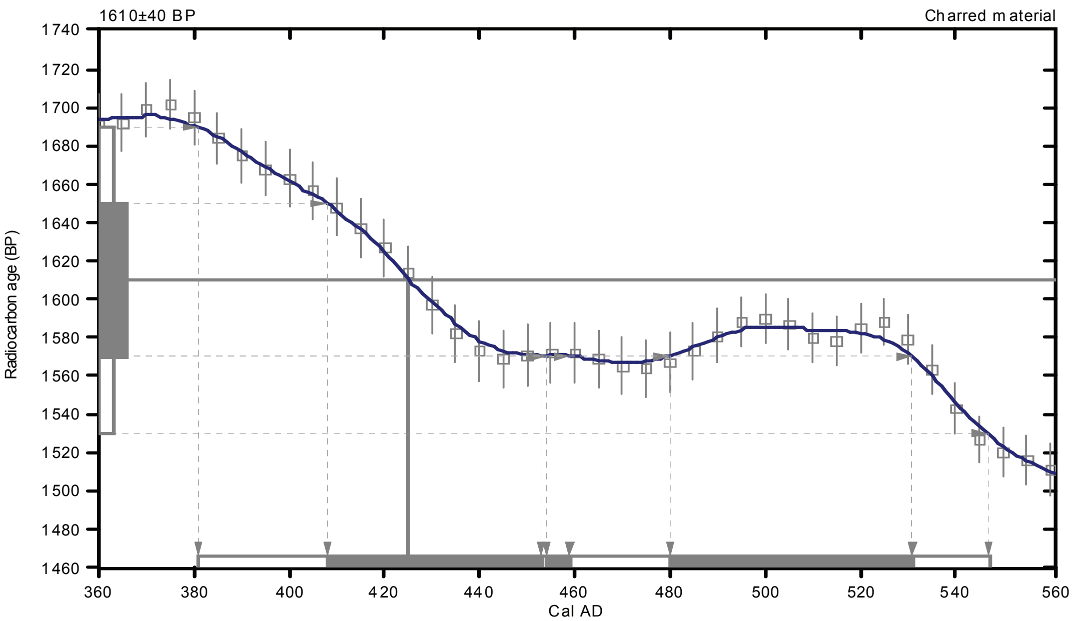
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number:	**Beta-258916**
Conventional radiocarbon age:	**1610±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 380 to 550 (Cal BP 1570 to 1400)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 420 (Cal BP 1520)
1 Sigma calibrated results: (68% probability)	Cal AD 410 to 450 (Cal BP 1540 to 1500) and Cal AD 450 to 460 (Cal BP 1500 to 1490) and Cal AD 480 to 530 (Cal BP 1470 to 1420)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

Laboratory number: **Beta-258917**

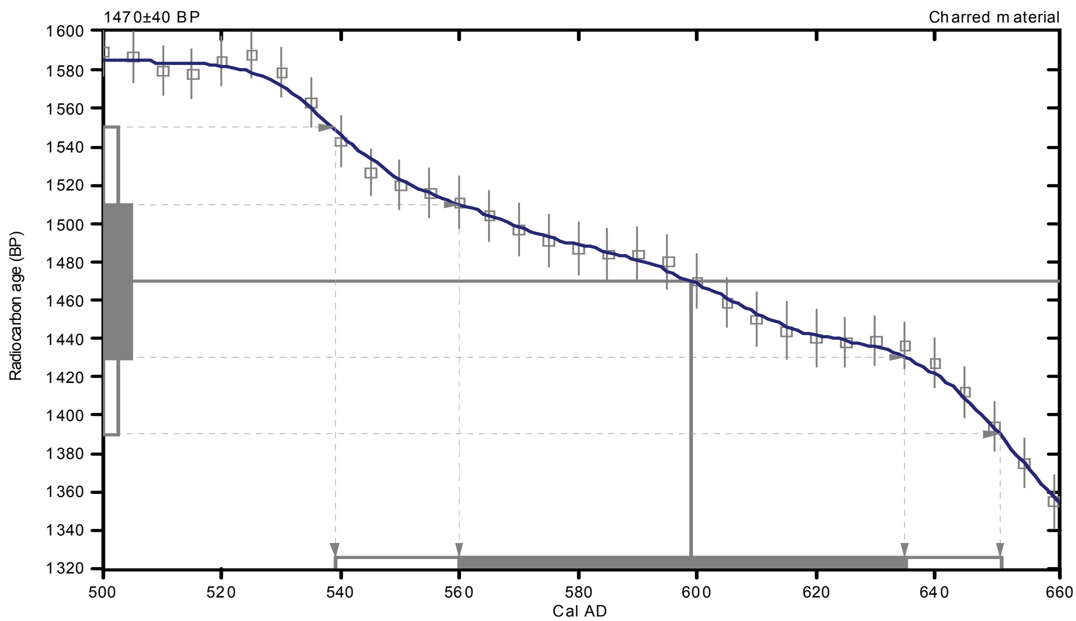
Conventional radiocarbon age: **1470±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 540 to 650 (Cal BP 1410 to 1300)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 600 (Cal BP 1350)

1 Sigma calibrated result: (68% probability) Cal AD 560 to 640 (Cal BP 1390 to 1320)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number: **Beta-258918**

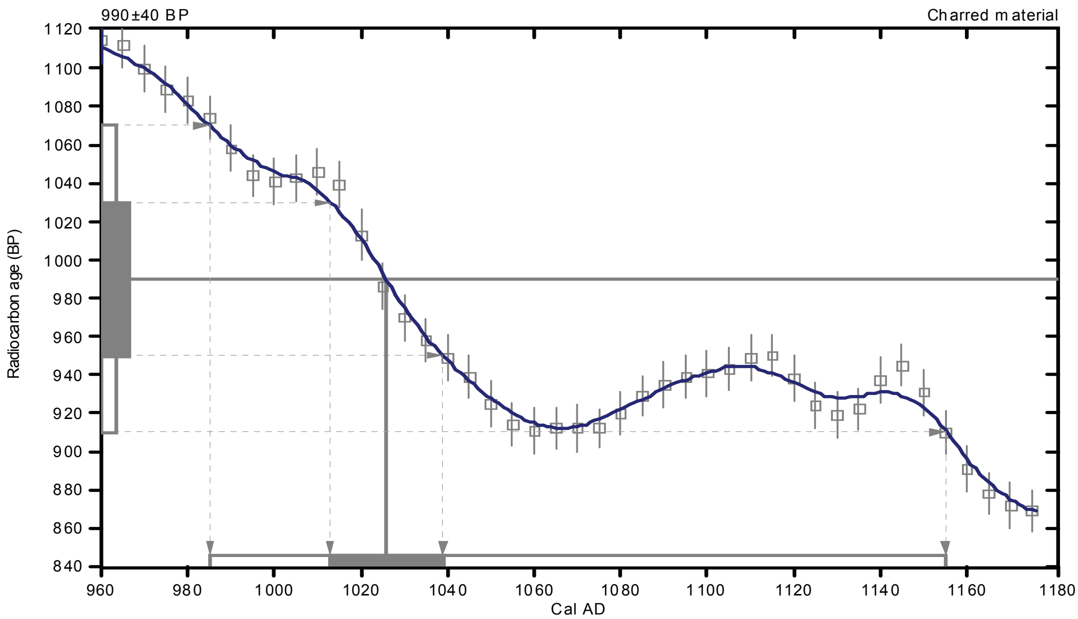
Conventional radiocarbon age: **990±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 980 to 1160 (Cal BP 960 to 800)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1030 (Cal BP 920)

1 Sigma calibrated result: (68% probability) Cal AD 1010 to 1040 (Cal BP 940 to 910)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.1:lab. mult=1)

Laboratory number: **Beta-258919**

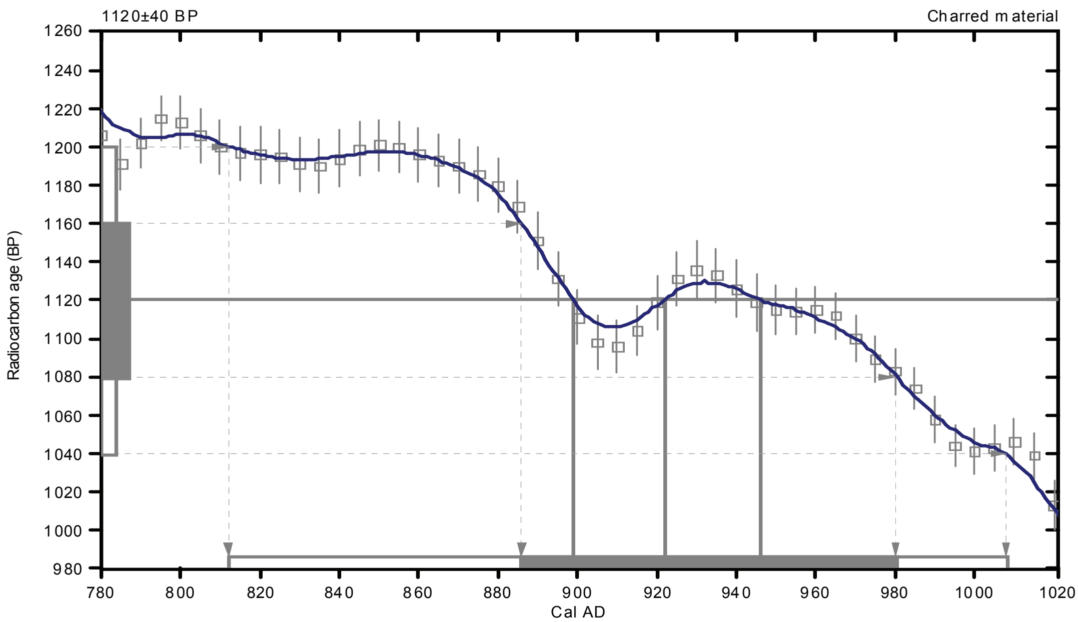
Conventional radiocarbon age: **1120±40 BP**

2 Sigma calibrated result: **Cal AD 810 to 1010 (Cal BP 1140 to 940)**
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve: Cal AD 900 (Cal BP 1050) and
Cal AD 920 (Cal BP 1030) and
Cal AD 950 (Cal BP 1000)

1 Sigma calibrated result: Cal AD 890 to 980 (Cal BP 1060 to 970)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.6:lab. mult=1)

Laboratory number: **Beta-258920**

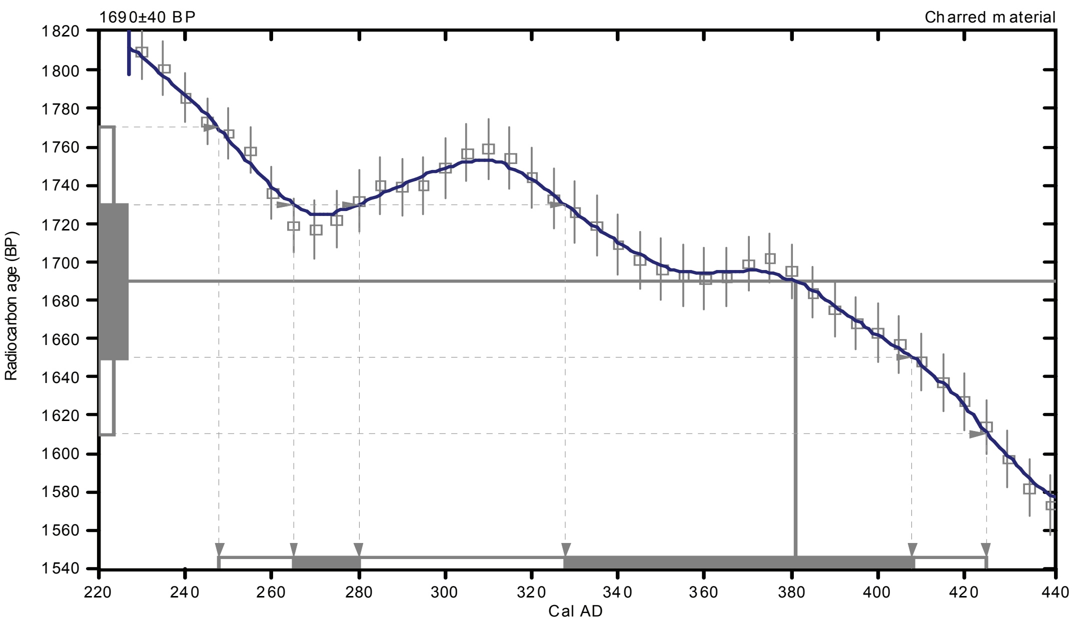
Conventional radiocarbon age: **1690±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 250 to 420 (Cal BP 1700 to 1520)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 380 (Cal BP 1570)

1 Sigma calibrated results: (68% probability) Cal AD 260 to 280 (Cal BP 1680 to 1670) and Cal AD 330 to 410 (Cal BP 1620 to 1540)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.6:lab. mult=1)

Laboratory number: **Beta-258921**

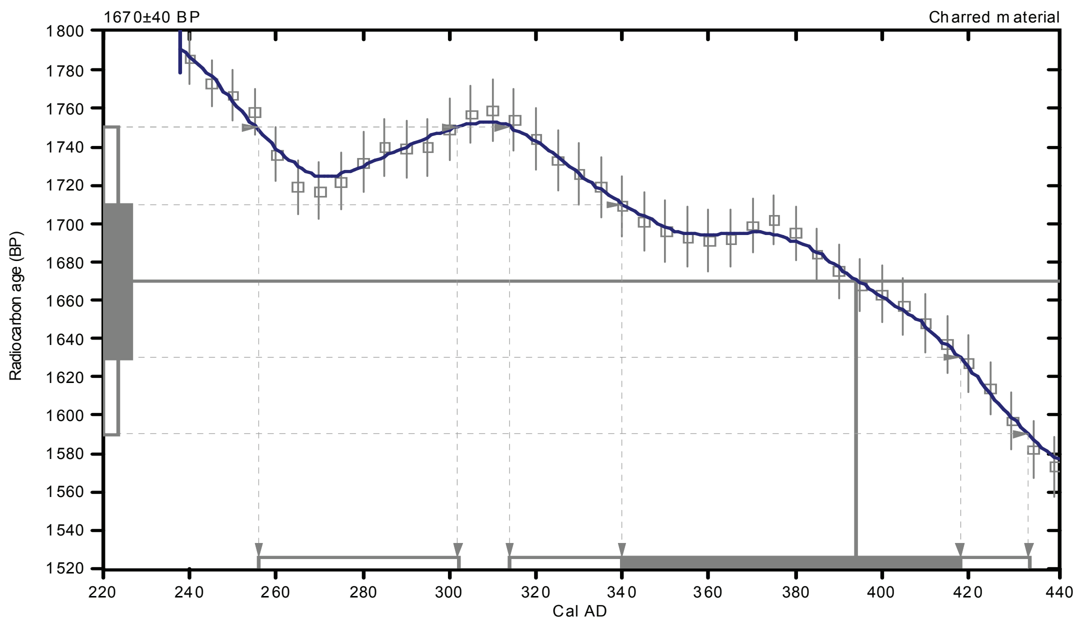
Conventional radiocarbon age: **1670±40 BP**

2 Sigma calibrated results: **Cal AD 260 to 300 (Cal BP 1690 to 1650) and**
(95% probability) **Cal AD 310 to 430 (Cal BP 1640 to 1520)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 390 (Cal BP 1560)

1 Sigma calibrated result: Cal AD 340 to 420 (Cal BP 1610 to 1530)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258922**

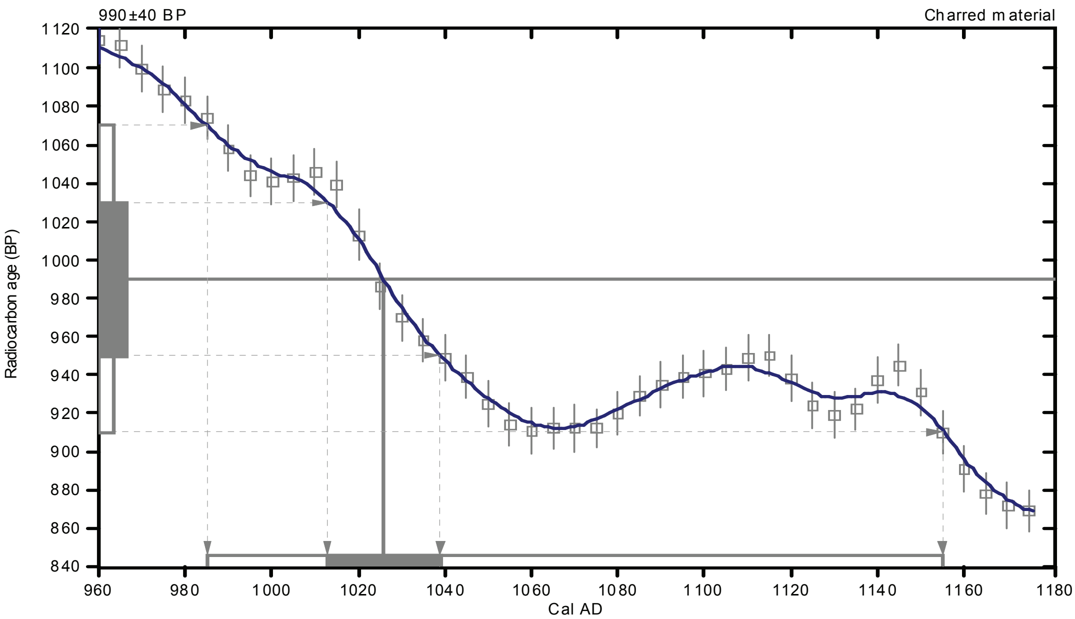
Conventional radiocarbon age: **990±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 980 to 1160 (Cal BP 960 to 800)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1030 (Cal BP 920)

1 Sigma calibrated result: (68% probability) Cal AD 1010 to 1040 (Cal BP 940 to 910)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number: **Beta-258923**

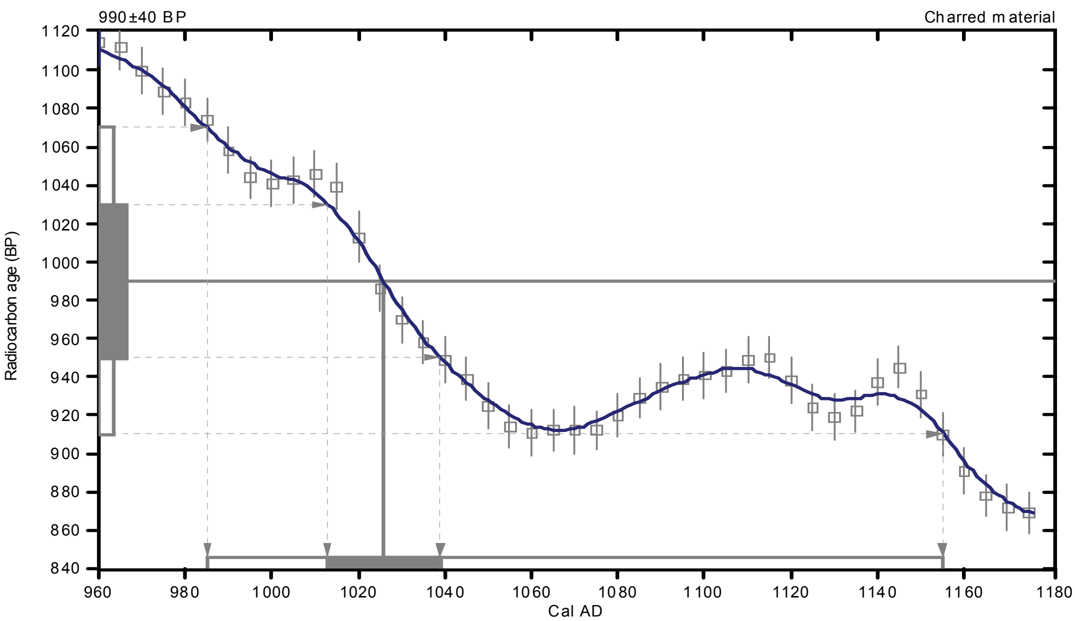
Conventional radiocarbon age: **990±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 980 to 1160 (Cal BP 960 to 800)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1030 (Cal BP 920)

1 Sigma calibrated result: (68% probability) Cal AD 1010 to 1040 (Cal BP 940 to 910)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.6:lab. mult=1)

Laboratory number: **Beta-258924**

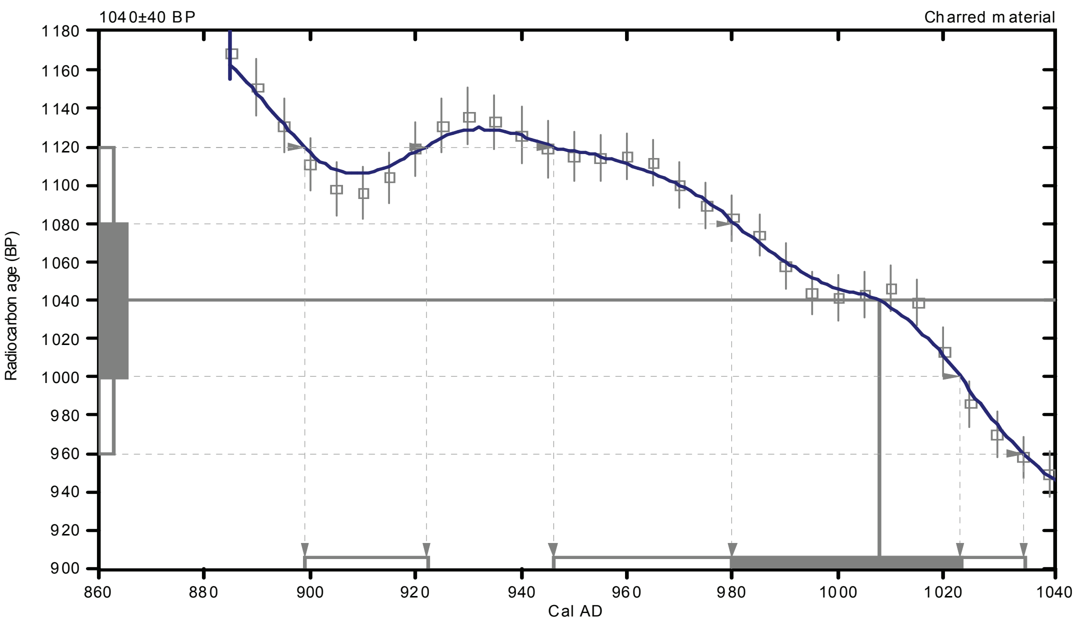
Conventional radiocarbon age: **1040±40 BP**

2 Sigma calibrated results: **Cal AD 900 to 920 (Cal BP 1050 to 1030) and**
(95% probability) **Cal AD 950 to 1040 (Cal BP 1000 to 920)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1010 (Cal BP 940)

1 Sigma calibrated result: Cal AD 980 to 1020 (Cal BP 970 to 930)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-258925**

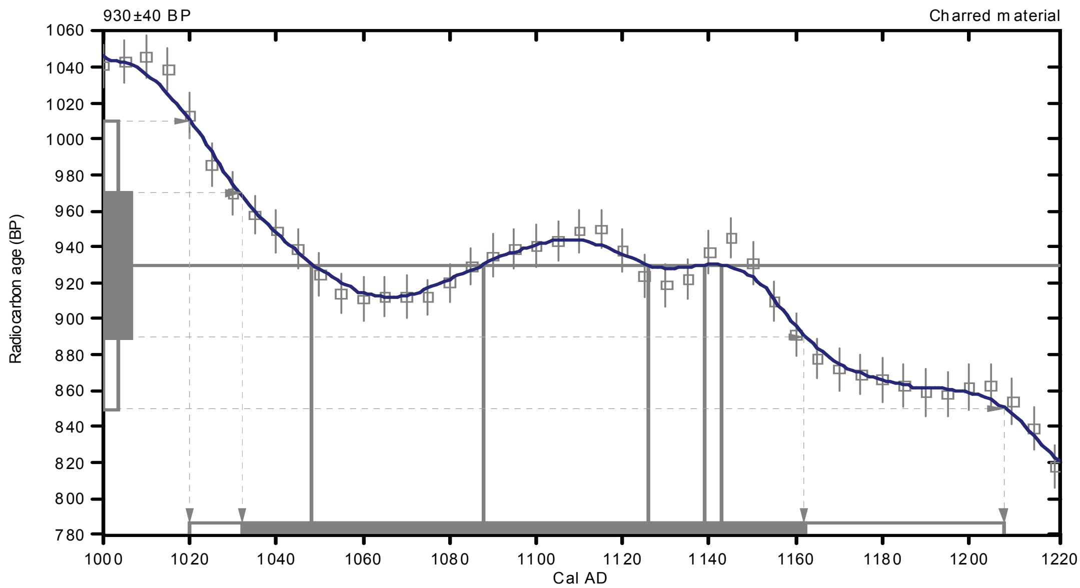
Conventional radiocarbon age: **930±40 BP**

2 Sigma calibrated result: **Cal AD 1020 to 1210 (Cal BP 930 to 740)**
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve: Cal AD 1050 (Cal BP 900) and
Cal AD 1090 (Cal BP 860) and
Cal AD 1130 (Cal BP 820) and
Cal AD 1140 (Cal BP 810) and
Cal AD 1140 (Cal BP 810)

1 Sigma calibrated result: Cal AD 1030 to 1160 (Cal BP 920 to 790)
(68% probability)



References:
Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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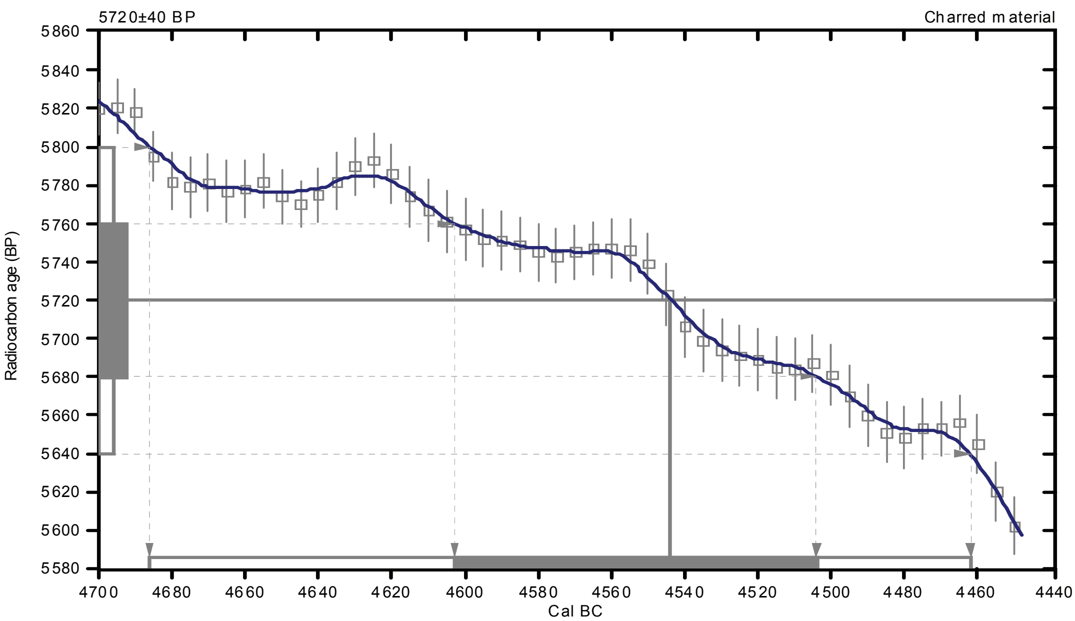
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7:lab. mult=1)

Laboratory number:	**Beta-258926**
Conventional radiocarbon age:	**5720±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal BC 4690 to 4460 (Cal BP 6640 to 6410)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal BC 4540 (Cal BP 6490)
1 Sigma calibrated result: (68% probability)	Cal BC 4600 to 4500 (Cal BP 6550 to 6450)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7:lab. mult=1)

Laboratory number: **Beta-258927**

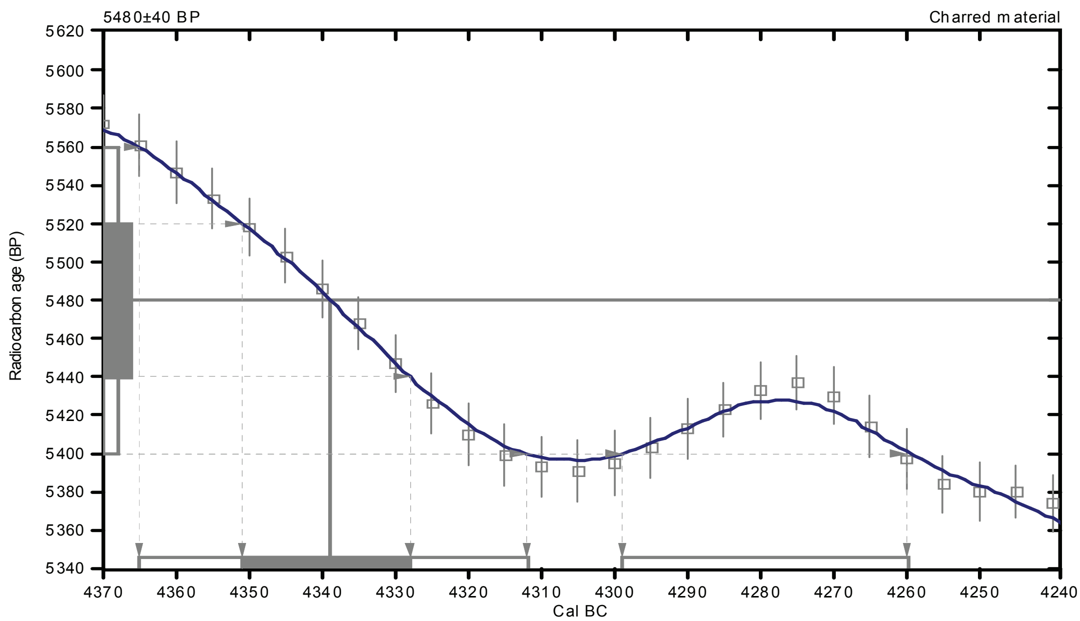
Conventional radiocarbon age: **5480±40 BP**

2 Sigma calibrated results: (95% probability) **Cal BC 4360 to 4310 (Cal BP 6320 to 6260) and Cal BC 4300 to 4260 (Cal BP 6250 to 6210)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 4340 (Cal BP 6290)

1 Sigma calibrated result: (68% probability) Cal BC 4350 to 4330 (Cal BP 6300 to 6280)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number: **Beta-258928**

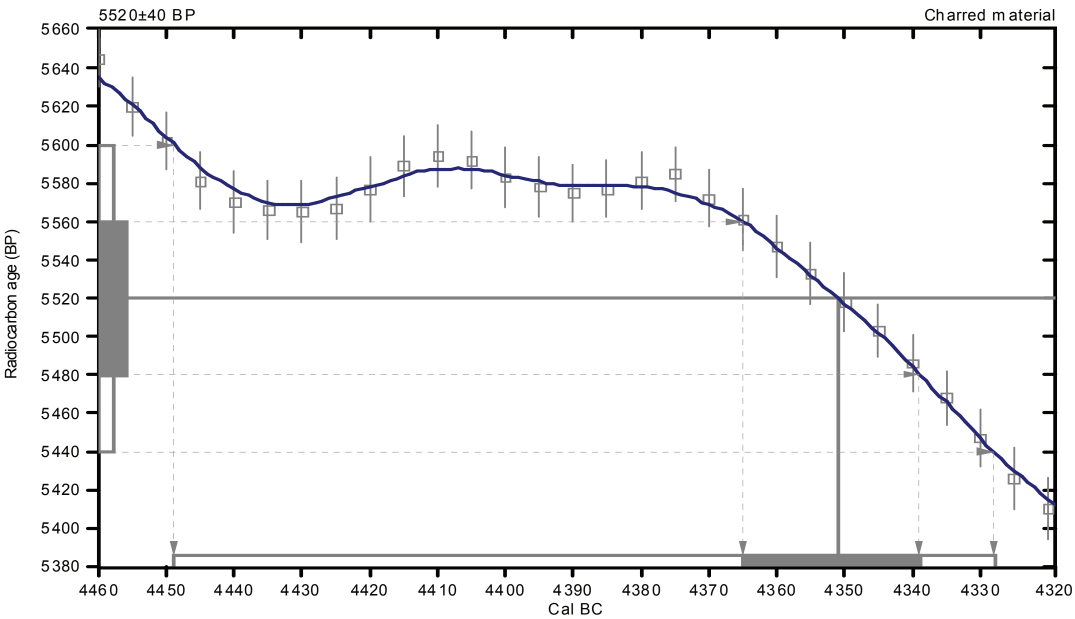
Conventional radiocarbon age: **5520±40 BP**

2 Sigma calibrated result: (95% probability) **Cal BC 4450 to 4330 (Cal BP 6400 to 6280)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 4350 (Cal BP 6300)

1 Sigma calibrated result: (68% probability) Cal BC 4360 to 4340 (Cal BP 6320 to 6290)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.7:lab. mult=1)

Laboratory number: **Beta-258929**

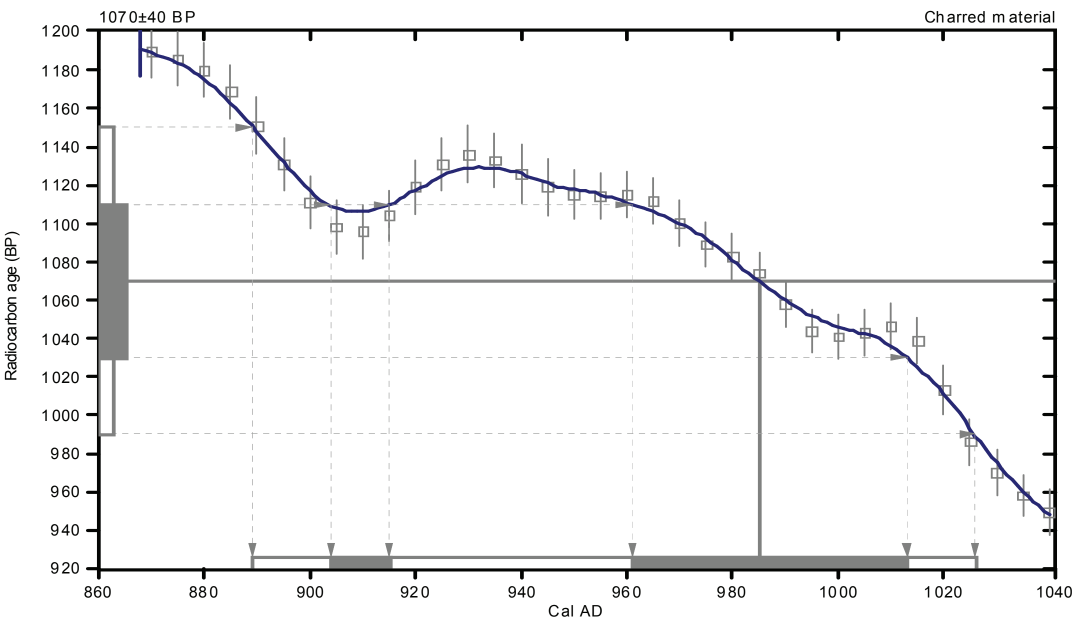
Conventional radiocarbon age: **1070±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 890 to 1030 (Cal BP 1060 to 920)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 980 (Cal BP 960)

1 Sigma calibrated results: (68% probability) Cal AD 900 to 920 (Cal BP 1050 to 1040) and Cal AD 960 to 1010 (Cal BP 990 to 940)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

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Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

Laboratory number: **Beta-258930**

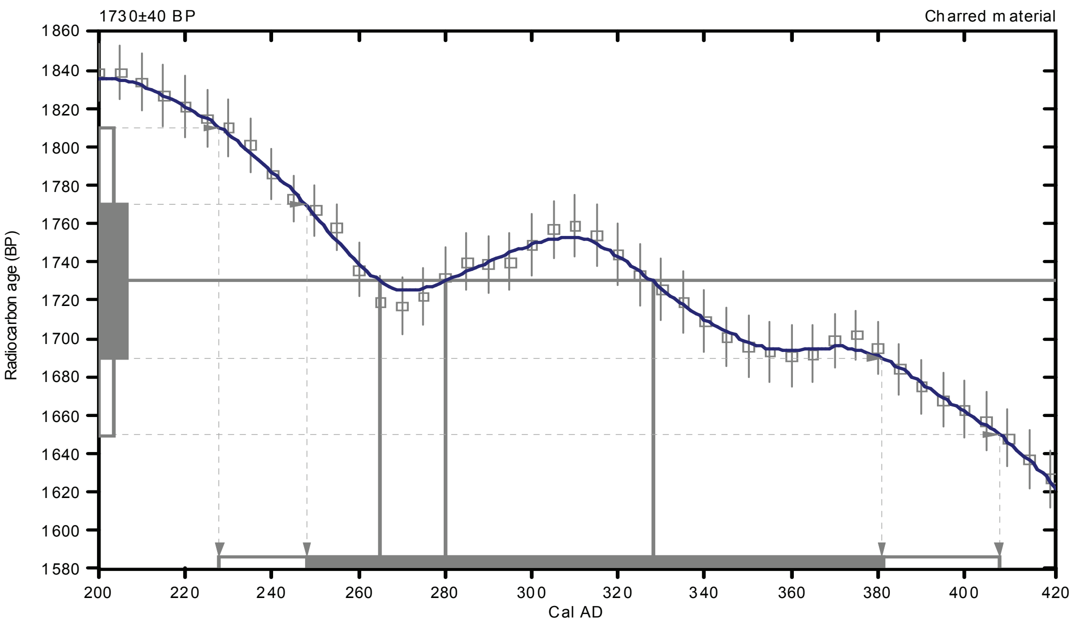
Conventional radiocarbon age: **1730±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 230 to 410 (Cal BP 1720 to 1540)**

Intercept data

Intercepts of radiocarbon age with calibration curve: Cal AD 260 (Cal BP 1680) and
Cal AD 280 (Cal BP 1670) and
Cal AD 330 (Cal BP 1620)

1 Sigma calibrated result: (68% probability) Cal AD 250 to 380 (Cal BP 1700 to 1570)



References:

Database used

INTCAL04

Calibration Database

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Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **Beta-258931**

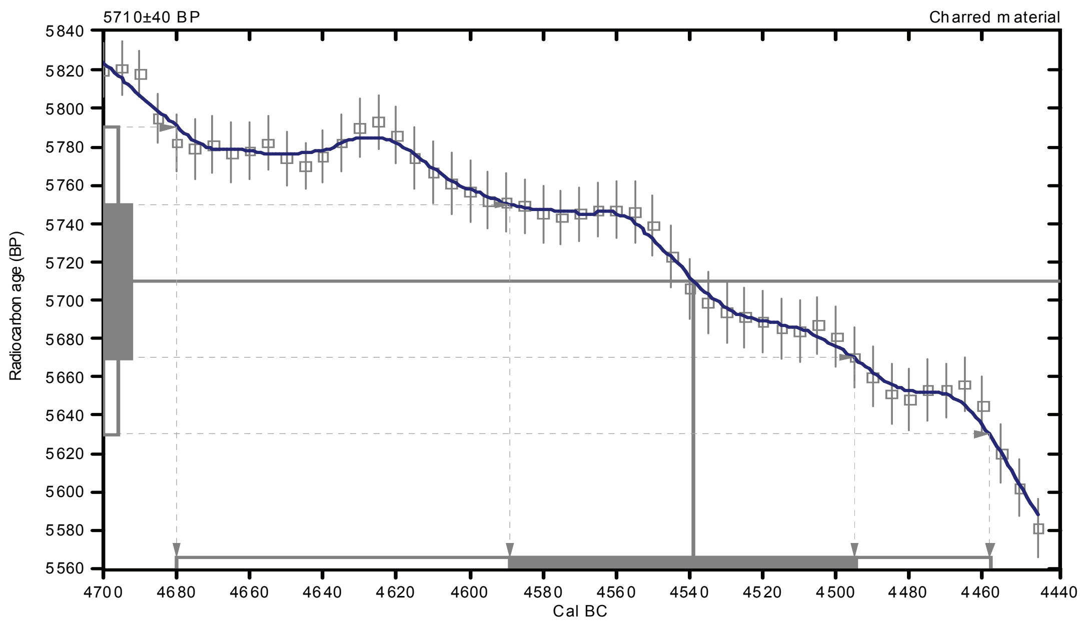
Conventional radiocarbon age: **5710±40 BP**

2 Sigma calibrated result: (95% probability) **Cal BC 4680 to 4460 (Cal BP 6630 to 6410)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 4540 (Cal BP 6490)

1 Sigma calibrated result: (68% probability) Cal BC 4590 to 4500 (Cal BP 6540 to 6440)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23:lab. mult=1)

Laboratory number: **Beta-258932**

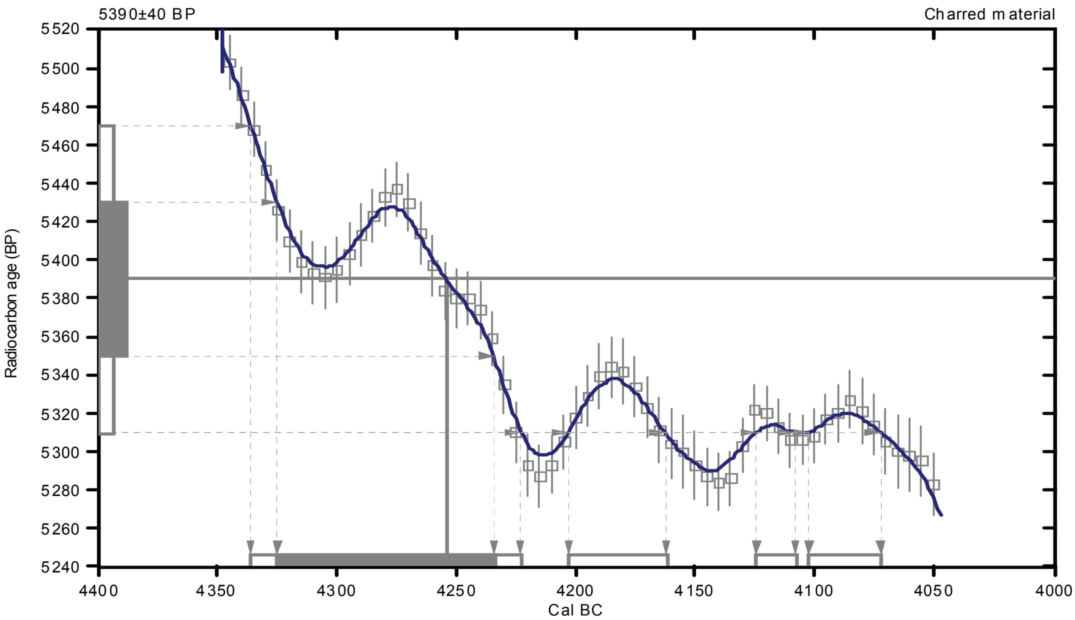
Conventional radiocarbon age: **5390±40 BP**

2 Sigma calibrated results: (95% probability) **Cal BC 4340 to 4220 (Cal BP 6290 to 6170) and Cal BC 4200 to 4160 (Cal BP 6150 to 6110) and Cal BC 4120 to 4110 (Cal BP 6070 to 6060) and Cal BC 4100 to 4070 (Cal BP 6050 to 6020)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 4250 (Cal BP 6200)

1 Sigma calibrated result: (68% probability) Cal BC 4320 to 4230 (Cal BP 6280 to 6180)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.2:lab. mult=1)

Laboratory number: **Beta-258933**

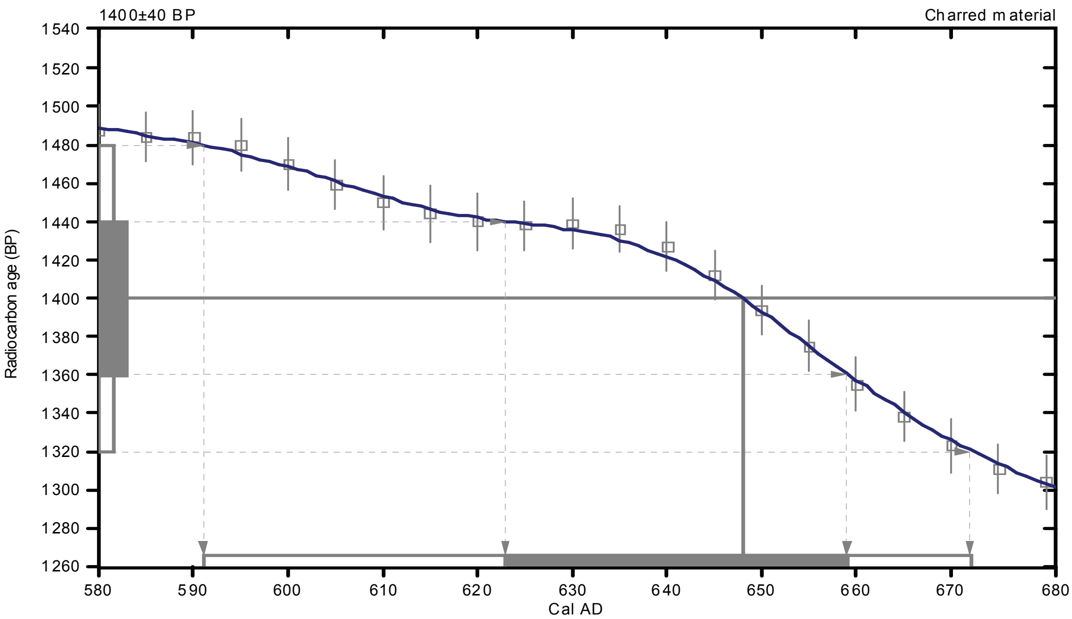
Conventional radiocarbon age: **1400±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 590 to 670 (Cal BP 1360 to 1280)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 650 (Cal BP 1300)

1 Sigma calibrated result: (68% probability) Cal AD 620 to 660 (Cal BP 1330 to 1290)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.3:lab. mult=1)

Laboratory number: **Beta-258934**

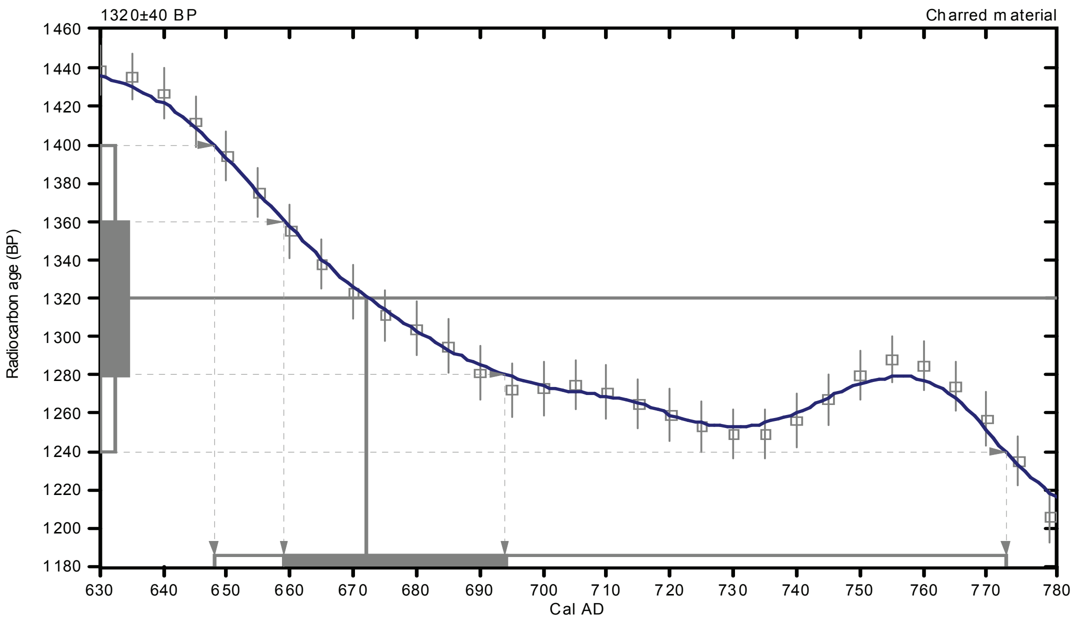
Conventional radiocarbon age: **1320±40 BP**

2 Sigma calibrated result: **Cal AD 650 to 770 (Cal BP 1300 to 1180)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 670 (Cal BP 1280)

1 Sigma calibrated result: Cal AD 660 to 690 (Cal BP 1290 to 1260)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.5:lab. mult=1)

Laboratory number: **Beta-258935**

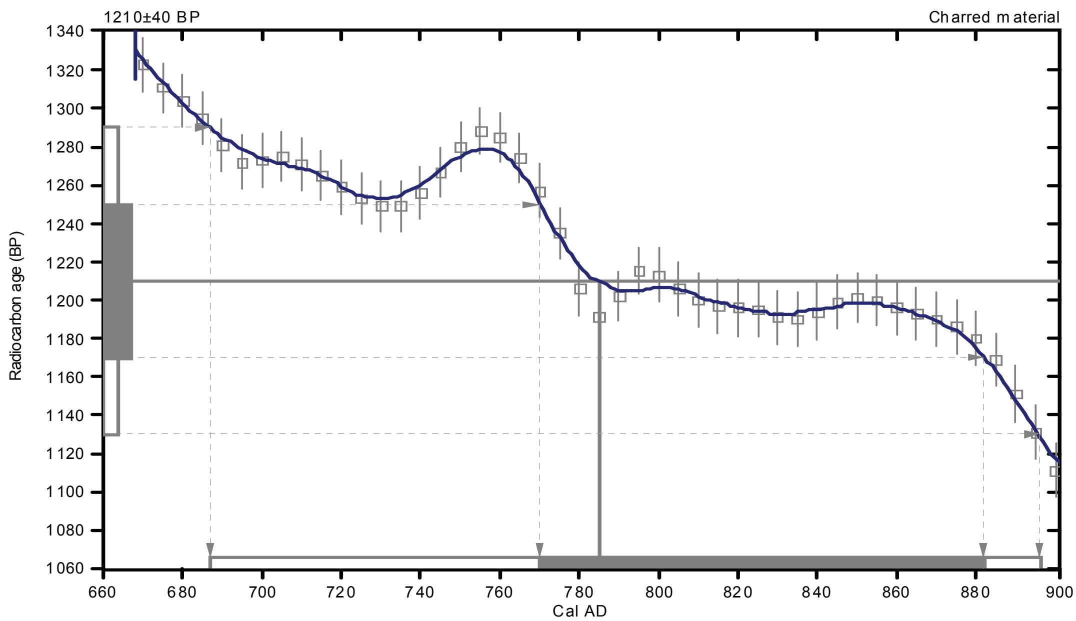
Conventional radiocarbon age: **1210±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 690 to 900 (Cal BP 1260 to 1050)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 780 (Cal BP 1160)

1 Sigma calibrated result: (68% probability) Cal AD 770 to 880 (Cal BP 1180 to 1070)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number: **Beta-258936**

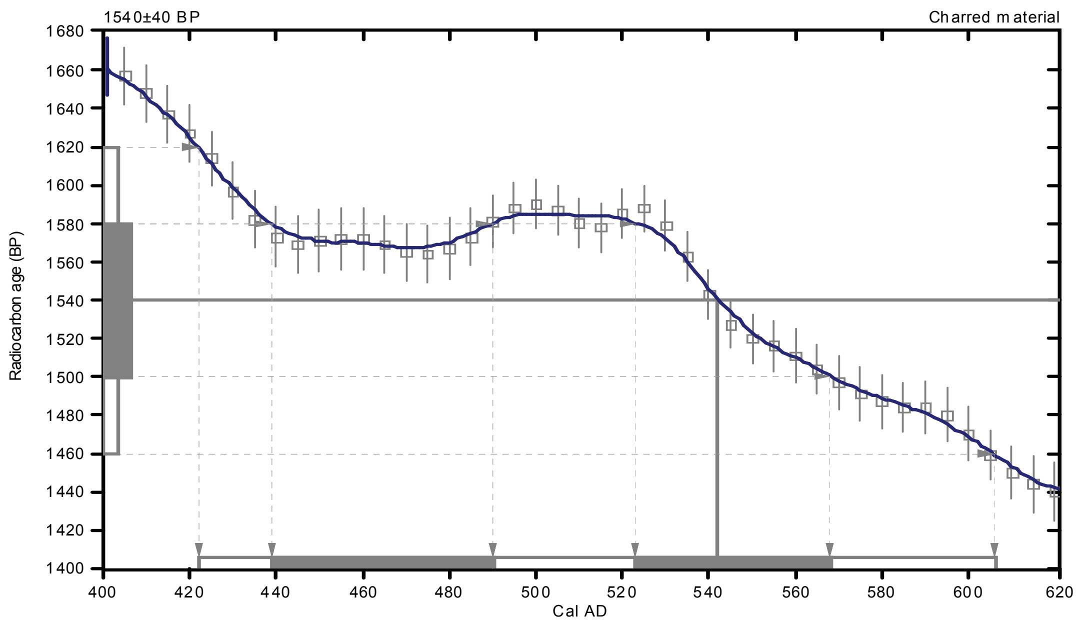
Conventional radiocarbon age: **1540±40 BP**

2 Sigma calibrated result: **Cal AD 420 to 610 (Cal BP 1530 to 1340)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 540 (Cal BP 1410)

1 Sigma calibrated results: Cal AD 440 to 490 (Cal BP 1510 to 1460) and
(68% probability) Cal AD 520 to 570 (Cal BP 1430 to 1380)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7:lab. mult=1)

Laboratory number: **Beta-258937**

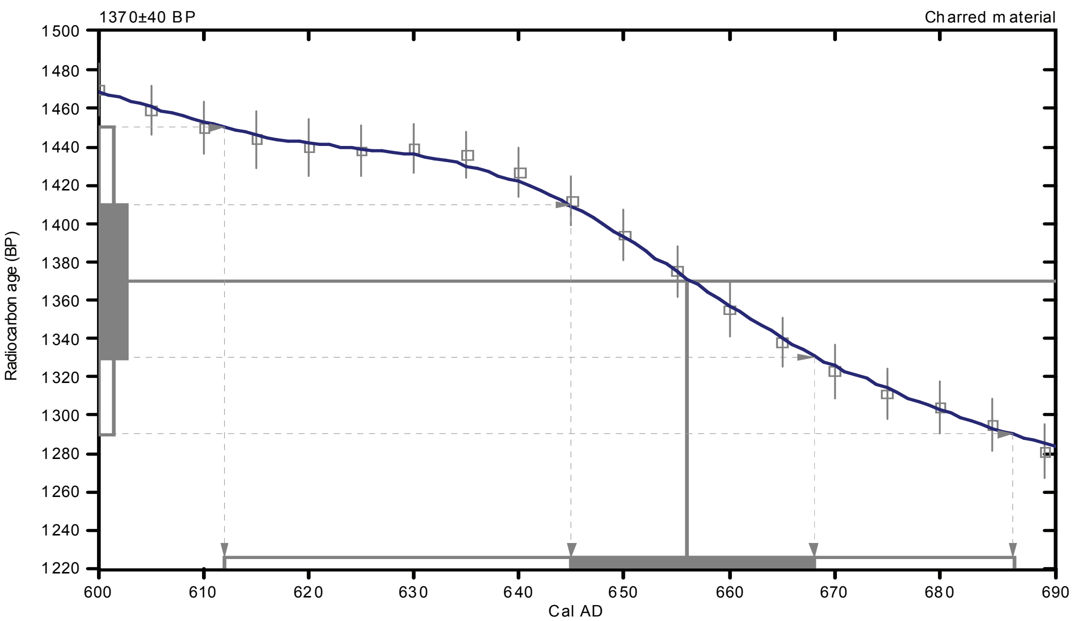
Conventional radiocarbon age: **1370±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 610 to 690 (Cal BP 1340 to 1260)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 660 (Cal BP 1290)

1 Sigma calibrated result: (68% probability) Cal AD 640 to 670 (Cal BP 1300 to 1280)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **Beta-258938**

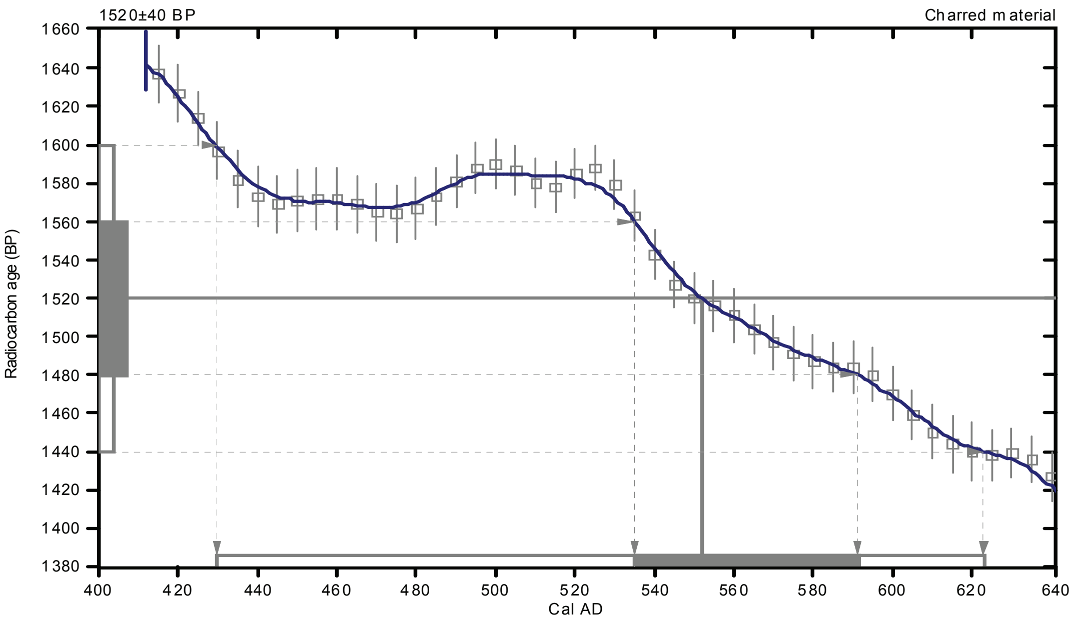
Conventional radiocarbon age: **1520±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 430 to 620 (Cal BP 1520 to 1330)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 550 (Cal BP 1400)

1 Sigma calibrated result: (68% probability) Cal AD 540 to 590 (Cal BP 1420 to 1360)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

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Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.9:lab. mult=1)

Laboratory number: **Beta-258939**

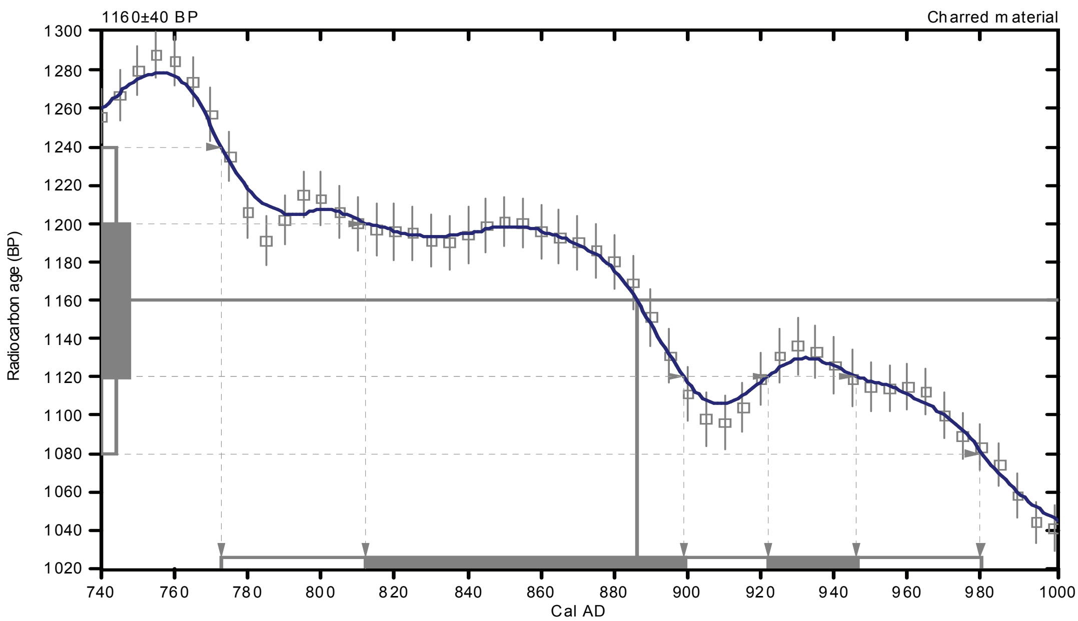
Conventional radiocarbon age: **1160±40 BP**

2 Sigma calibrated result: **Cal AD 770 to 980 (Cal BP 1180 to 970)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 890 (Cal BP 1060)

1 Sigma calibrated results: Cal AD 810 to 900 (Cal BP 1140 to 1050) and
(68% probability) Cal AD 920 to 950 (Cal BP 1030 to 1000)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.5:lab. mult=1)

Laboratory number: **Beta-258940**

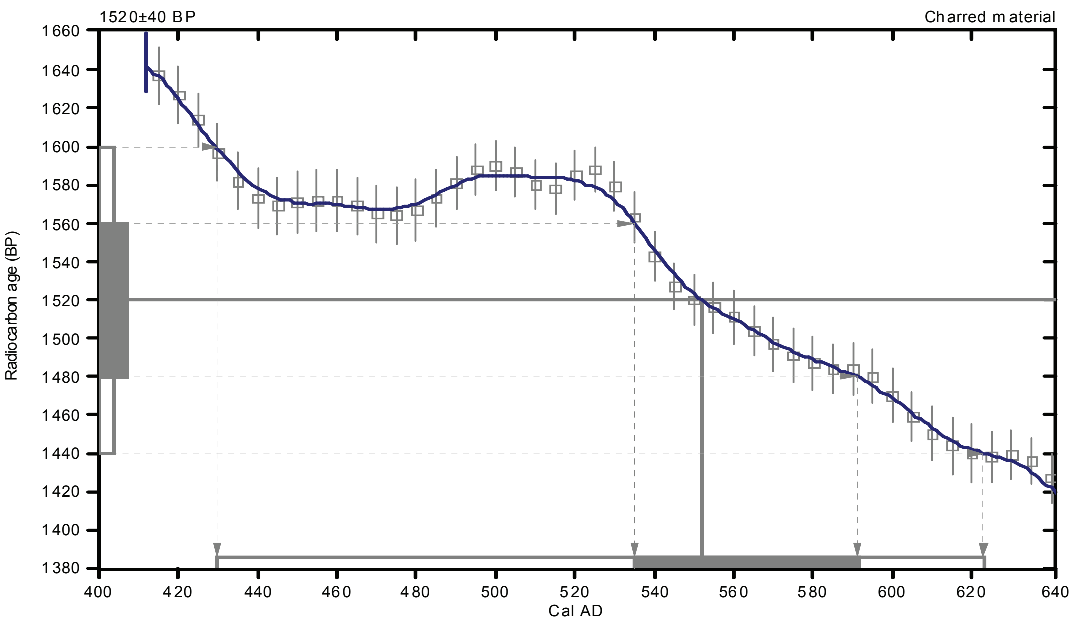
Conventional radiocarbon age: **1520±40 BP**

2 Sigma calibrated result: **Cal AD 430 to 620 (Cal BP 1520 to 1330)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 550 (Cal BP 1400)

1 Sigma calibrated result: Cal AD 540 to 590 (Cal BP 1420 to 1360)
(68% probability)



References:

Database used
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Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.8:lab. mult=1)

Laboratory number: **Beta-258941**

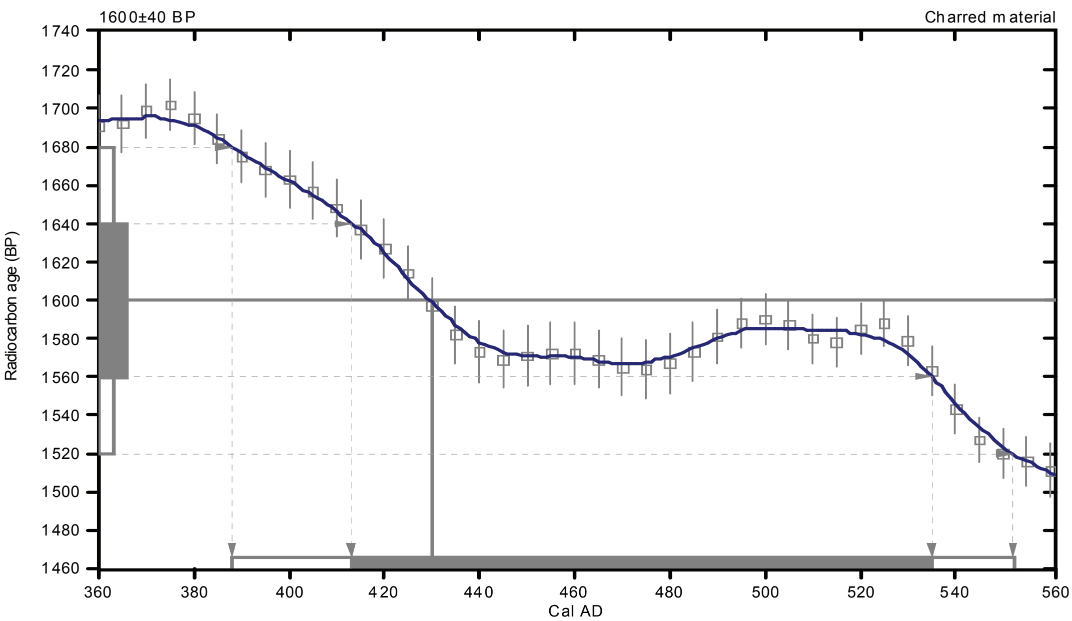
Conventional radiocarbon age: **1600±40 BP**

2 Sigma calibrated result: **Cal AD 390 to 550 (Cal BP 1560 to 1400)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 430 (Cal BP 1520)

1 Sigma calibrated result: Cal AD 410 to 540 (Cal BP 1540 to 1420)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
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President

Ronald Hatfield
Christopher Patrick
Deputy Directors

March 10, 2010

Dr. Eric Blinman
Office of Archaeological Studies
P.O. Box 2087
Santa Fe, NM 87504-2087
USA

RE: Radiocarbon Dating Results For Samples 042-12-58m, 042-18-77m

Dear Dr. Blinman:

Enclosed are the radiocarbon dating results for two samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses proceeded normally. As usual, the method of analysis is listed on the report with the results and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Our invoice has been sent separately. Thank you for your prior efforts in arranging payment. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood
Digital signature on file

BETA ANALYTIC INC.

DR. M.A. TAMERS and MR. D.G. HOOD

4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Dr. Eric Blinman — Report Date: 3/10/2010

Office of Archaeological Studies — Material Received: 2/12/2010

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 275121	1510 +/- 40 BP	-25.6 o/oo	1500 +/- 40 BP

SAMPLE : 042-12-58m
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 440 to 490 (Cal BP 1510 to 1460) AND Cal AD 520 to 640 (Cal BP 1430 to 1310)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 275122	1450 +/- 40 BP	-24.8 o/oo	1450 +/- 40 BP

SAMPLE : 042-18-77m
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 550 to 660 (Cal BP 1400 to 1290)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.6:lab. mult=1)

Laboratory number: **Beta-275121**

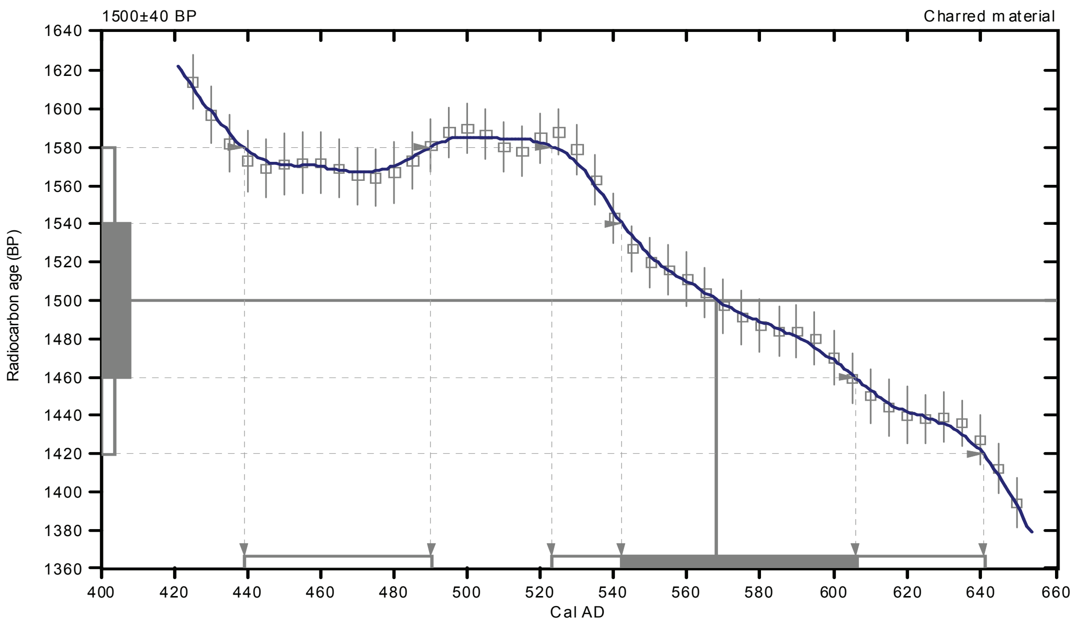
Conventional radiocarbon age: **1500±40 BP**

2 Sigma calibrated results: **Cal AD 440 to 490 (Cal BP 1510 to 1460) and**
(95% probability) **Cal AD 520 to 640 (Cal BP 1430 to 1310)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 570 (Cal BP 1380)

1 Sigma calibrated result: Cal AD 540 to 610 (Cal BP 1410 to 1340)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.8:lab. mult=1)

Laboratory number: **Beta-275122**

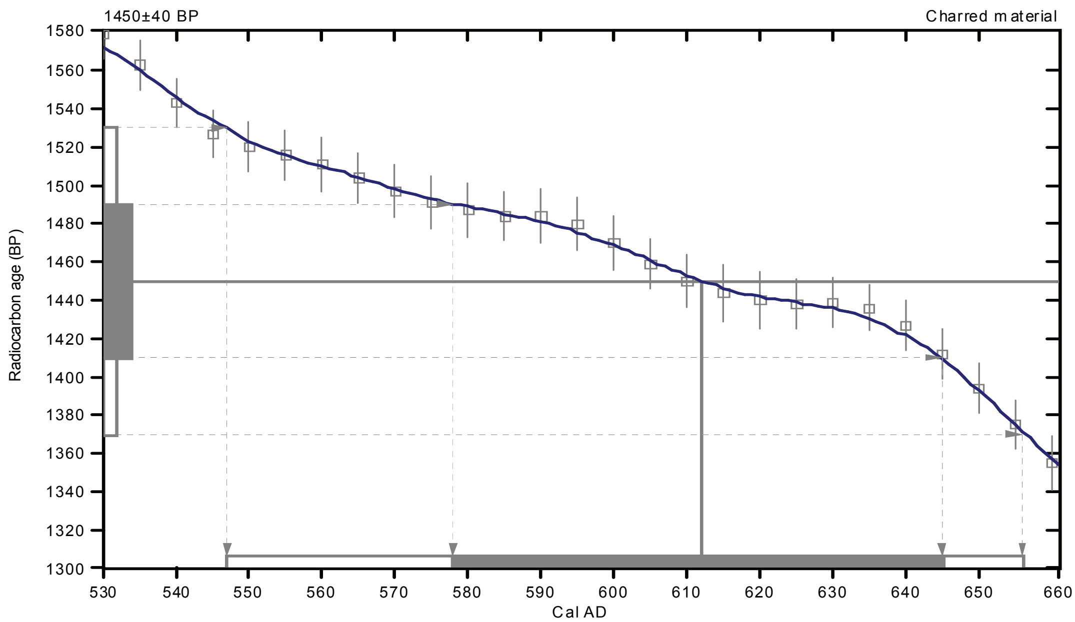
Conventional radiocarbon age: **1450±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 550 to 660 (Cal BP 1400 to 1290)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 610 (Cal BP 1340)

1 Sigma calibrated result: (68% probability) Cal AD 580 to 640 (Cal BP 1370 to 1300)



References:

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Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
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