MUSEUM OF NEW MEXICO

OFFICE OF ARCHAEOLOGICAL STUDIES

THE EXCAVATION OF A LATE ARCHAIC PIT STRUCTURE (LA 51912) NEAR OTOWI, SAN ILDEFONSO PUEBLO, NEW MEXICO

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ADMINISTRATIVE SUMMARY

Between July 13 and September 2, 1987, the Research Section, Laboratory of Anthropology, Museum of New Mexico (currently the Office of Archaeological Studies), conducted excavations at LA 51912, an archaeological site within a proposed New Mexico State Highway and Transportation Department right-of-way along State Road 502, near Otowi on the San Ildefonso Pueblo grant.

Results of the data recovery program indicate the presence of a Late Archaic pit structure and partially roofed extramural activity area with associated features and artifacts. Radiocarbon analysis suggests that the occupation of this component occurred between 540 B.C. ± 70 and A.D. 110 ± 70. Diagnostic artifacts include En Medio-phase materials.

A lithic and ceramic scatter to the west was collected and excavated. The recovered materials represent a wide range of cultural periods and appear related to the general artifact scatter distributed over this area of the Rio Grande. Diagnostic ceramic types from the Rio Grande Classic, Protohistoric, and Historic periods were present. This scatter was determined to be surficial.

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The efforts and cooperation of the field crew, volunteers, and laboratory staff have contributed to the successful completion of the Otowi project. Assisting the excavations were Nancy Akins, Anthony Martinez, Susan Moga, Rod North, and Dorothy Zamora. The San Ildefonso field crew was composed of Billy Bebout and Greg Martinez. Yvonne R. Oakes served as principal investigator, and Ann Noble as draftsperson. The artifact illustrations were drawn by Adisa J. Willmer and Stephen C. Lent. Tom Ireland edited the report.

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ENVIRONMENT

Physiography and Geology

The project area is located in a fault-zone feature known as the Española Basin, one in a chain of six or seven basins composing the Rio Grande rift extending from southern Colorado to southern New Mexico (Kelley 1979:281). This basin, which is an extension of the Southern Rocky Mountain province, is enclosed by uplands of alternating mountain ranges and uplifted plateaus, and the Rio Grande flows along the long axis of this feature (Kelley 1979:281).

The Sangre de Cristo Mountains form the east edge of the Española Basin, and the southern boundary is marked by the Cerrillos Hills and the northern edge of the Galisteo Basin. The La Bajada fault escarpment and the Cerros del Rio volcanic hills denote the southwestern periphery. The basin is bounded to the west by the Jemez volcanic field, and the Brazos and Tusas Mountains form the northwestern boundary (Kelley 1979:281). Erosion from the Nacimiento, Jemez, and Brazos uplifts to the north and northwest and the mature Laramide Sangre de Cristo uplift to the east provided most of the sediments for what is known as the Santa Fe group, the prominent geologic unit within the Española Basin. Subsequent erosion of upturned beds and elevated scarps has resulted in the highly dissected, rugged topography found in much of the project area. The Cerros del Rio volcanic field lies along the Cañada Ancha drainage, southwest of the project area. This field extends some distance to the west and consists of a variety of volcanic features. The Quaternary Terrace gravels, found south of the project area, are river gravel deposits that are exposed in the bottom of the tributary arroyos between the higher piedmont deposits and the lower valley bottom alluvium (Lucas 1984). Prehistorically, these gravels were a source for lithic materials.

Climate

The mean annual temperatures reported for the nearby weather stations of Santa Fe and Española are 48.6-49.3 degrees C and 49.4-50.7 degrees C, respectively (Gabin and Lesperance 1977). The climatological data further indicate that the study area conforms to the general temperature regime in New Mexico, that is, hot summers and relatively cool winters. The average frost-free growing season at Santa Fe is 164 days, while Española reports an average growing season of 152 days. The shorter growing season in Española may be attributable, in part, to cold air drainage through the Rio Grande and Rio Chama valleys (Reynolds 1956). Precipitation records from Santa Fe show an annual mean of 361-366 mm, while Española reports an annual precipitation mean of only 237-241 mm (Gabin and Lesperance 1977). Temperature, precipitation, and potential evapotranspiration data suggest that the Rio Grande river drainage in the vicinity of San Ildefonso Pueblo was a good risk for dry farm agriculture.

Flora

The project area is located within the arid and semiarid environment of the Upper Sonoran life zone (Bailey 1913) within a piñon-juniper climax community, which supports a variety of plant and animal species. Observed flora include piñon, juniper, prickly pear, cholla, yucca, muhly grass, grama grass, rabbitbrush, four-wing saltbush, gamble oak, Indian ricegrass, and cottonwood.

CULTURAL HISTORICAL BACKGROUND

Paleoindian Period

Three major subdivisions of Paleoindian adaptation have been proposed, based primarily on the appearance of a series of diagnostic projectile point types. These are: Clovis (10,000-9000 B.C.), Folsom (9000-8000 B.C.), and the terminal Paleoindian phase, which incorporates a number of distinctive technological traditions including the Agate Basin (8300-8000 B.C.) and the Cody complexes (6600-6000 B.C.) (Irwin-Williams and Haynes 1970; Judge 1973). The recovery of Paleoindian artifacts in association with extinct forms of Pleistocene megafauna initially led to the conclusion that Paleoindian groups subsisted primarily on big-game hunting (e.g., Willey 1966). While it is true that Clovis materials have been found in association with extinct species of mammoth, and Folsom materials with bison, it is also believed that wild plants and small game animals composed an important component of the resource system. Few of these items, however, have been documented in the archaeological record. There may have been a return to a more generalized hunting strategy during post-Folsom and terminal Paleoindian times, as evidenced by the use of less specialized projectile points.

Archaic Period

The Archaic period succeeds the Paleoindian and refers to a stage of migratory hunting and gathering cultures following a seasonal pattern of efficient exploitation of selected plant and animal species within a number of ecological zones (Schroedl 1976:11). This broadly based hunting and gathering adaptation appears to have existed between 7000 B.C. and A.D. 400 and culminates with an increased reliance on horticulture. Irwin-Williams's (1973) Oshara sequence, defined in the Arroyo Cuervo region of New Mexico, is frequently applied to Archaic developments in the northern Rio Grande. The Oshara phase designations are summarized below:

Jay Phase

Bracketed between 5500 and 4800 B.C., this phase has been defined as early Archaic or Paleoindian. The sites are generally small and consist of specialized activity areas and base camps. The subsistence strategy is characterized by hunting, quarrying, and general foraging. Artifact assemblages consist of large, slightly shouldered projectile points, lanceolate bifacial knives, and numerous well-made side scrapers.

Bajada Phase

The settlement pattern of the Bajada phase (4800 to 3300 B.C.) is similar to that of the preceding Jay phase, except that the sites are more numerous, containing small fire-cracked-rock-filled hearths and earth ovens. The diagnostic projectile point consists of a shouldered point with basal indentation.

San Jose Phase

The San Jose phase (3000 to 1800 B.C.) is marked by a dramatic increase in the number of sites. Sites consist of large scatters with cobble-filled hearths and earth ovens. Occasional posthole alignments suggest above-ground structures. In this essentially hunter and gatherer economy, tool kits are dominated by scrapers and large choppers in addition to shallow basin grinding slabs, one-hand manos and projectile points with indented bases, shorter blade-to-stem ratios, and the increased use of serrations along the blade.

Armijo Phase

In the Armijo phase (1800 B.C. to 800 B.C.), the settlement pattern continues to be similar to that of the San Jose phase with the addition of aggregations into large base camps or dry-cave sites. Storage facilities and large quantities of ground stone are present. Limited maize horticulture may occur during this interval. Armijo-phase projectile points are variations of stemmed corner-notched forms with increasingly long barbs.

En Medio Phase

A local manifestation of Basketmaker II, the En Medio phase (800 B.C. to A.D. 400) marks the end of the Archaic sequence. It is characterized by a full range of residential aggregations, shallow pit structures and above-ground structures, extended base camps, and logistical and special-use sites. An increased reliance on cultigens appears to characterize the final stages. A distinctive palmate-shaped, corner-notched projectile point occurs as isolated occurrences and on sites.

Pueblo Period

Researchers in the Rio Grande area have perceived the developments in that area as departing from the traditional Pecos classification as proposed by Kidder (1927) and Wendorf and Reed (1955).

The early portion of the Developmental period in the northern Rio Grande dates to between A.D. 600 and 900 and may be correlated with the late Basketmaker III and Pueblo I periods of the Pecos classification. Late Basketmaker sites are rare and tend to be small, with a ceramic assemblage composed primarily of Lino Gray, San Marcial Black-on-white, and various plain brown and red-slipped wares. The majority of the known Early Developmental sites are in the Albuquerque and Santa Fe districts (Frisbie 1967; Reinhart 1967; Peckham 1984). Although the settlement of the Rio Grande drainage has typically been attributed to immigration from southern areas (Bullard 1962; Jenkins and Schroeder 1974; Oakes 1978), investigations in the Corrales area suggest an in situ development of an indigenous population (Frisbie 1967; Lent 1987). Within the vicinity of the present study area, Early Developmental sites are scattered along the Rio Tesuque and Rio Nambe drainages (McNutt 1969; Peckham 1984:276).

Based on excavation data, Early Developmental habitation sites may be characterized as small villages of shallow, circular pithouse structures. The sites commonly feature between one and three pithouses (Stuart and Gauthier 1981), and rectilinear surface storage cists are often found in association. These pit structures appear to be closer to San Juan Anasazi examples than those of the Mogollon, although San Juan architectural "elaborations" such as benches, partitions, and slab linings are absent (Cordell 1979:43). Sites of this period tend to be located near intermittent tributaries of the Rio Grande, presumably for access to water and arable land. A preference for elevated settings in proximity to hunting and gathering resources is also exhibited, possibly because of their use as an overlook (Cordell 1979). Transition to above-ground rectilinear and contiguous habitation structures is more apparent in the Santa Fe district (Wendorf and Reed 1955:140); however, McNutt (1969) reports the presence of pithouses in the Red Mesa component of the Tesuque bypass site, near modern Tesuque Pueblo. A Late Developmental community (LA 835) located on the Pojoaque Pueblo Grant is composed of 12 to 15 small room blocks with associated kivas, as well as a Cibola-style great kiva. Ceramics recovered through excavation in conjunction with tree-ring dates suggest an occupation of between A.D. 800 and 1150. The variety of pottery and other materials of nonlocal origin associated with the site suggests that LA 835 may have served as a regional economic center (Stubbs 1954).

The Coalition period (A.D. 1200 to 1325) in the northern Rio Grande is marked by a shift from mineral pigment to organic paint in decorated pottery as well as substantial increases in number and size of habitation sites coincidental with systematic expansion into previously unoccupied areas. Although above-ground pueblos are constructed, pit structure architecture continues in the early phases of this period. Rectangular kivas, which are incorporated into room blocks, coexist with the subterranean circular structures (Cordell 1979:44). Frisbie (1967) notes the shift away from less optimal upland settings and a return to the permanent water and arable land adjacent to the major drainages. The Coalition period in the northern Rio Grande is characterized by two interdependent trends in population and settlement reflected in substantial population growth. This trend is suggested by the significant increase in the number and size of the habitation sites and the expansion of permanent year-round settlement by Anasazi agriculturalists into areas of greater latitude and elevation. The Chama, Gallina, Pajarito Plateau, Taos, and Galisteo Basin districts, which had been the focus of little Anasazi use prior to A.D. 1100 to 1200, were intensively settled during this period (Cordell 1979). Among the representative sites of the Coalition period are LA 4632, LA 12700, and nearby Otowi or Potsuwii (LA 169).

The Classic period, which postdates the abandonment of the San Juan Basin by sedentary agriculturalists, is characterized by Wendorf and Reed (1955:13) as a "time of general cultural florescence." During this period regional populations may have attained their greatest levels, and large communities with multiple plaza and room block complexes were established. The beginning of the Classic period in the northern Rio Grande coincides with the appearance of locally manufactured red-slipped and glaze-decorated ceramics in the Santa Fe, Albuquerque, Galisteo, and Salinas districts after ca. A.D. 1315 (Mera 1935; Warren 1980). In the Santa Fe area, the Galisteo Basin saw the evolution of some of the Southwest's most spectacular ruins. Many of these large pueblos were tested or excavated by N. C. Nelson in the early part of the 1900s (Nelson 1914, 1916). Possibly the first stratigraphic excavation in the United States was executed by Nelson on the room blocks and the midden of San Cristobal Pueblo (LA 80). Other projects in the Galisteo area include those by Smiley et al. (1953), the School of American Research (Lang 1977a), and a joint project between the Museum of New Mexico and Southern

Methodist University (Smiley, in progress). The majority of Classic sites were established between A.D. 1280 and 1320, but by the late 1400s, this area appears to have experienced a substantial decline in population. Sites during this period are characterized by a bimodal distribution, suggested by the presence of very large communities associated with small, agriculturally oriented structures such as fieldhouses and seasonally occupied farmsteads. This contrasts with the preceding Coalition period, where a greater range of site types characterized the settlement pattern. Investigations of the large pueblo sites on the Pajarito Plateau (termed "Biscuitware Province" because of its distinctive pottery, which contrasts with the Rio Grande glaze wares from the adjacent areas) include initial studies by Adolph Bandelier (1882), Hewett (1953), and Steen (1977), who recorded sites within Frijoles Canyon including Pueblo Canyon, Tshirege, and Tsankawi. More recently, large archaeological projects have included the Cochiti project (Biella and Chapman 1979), a UCLA intensive survey and limited excavation project (Hill and Trierweiler 1989), and a large National Park Service survey of Bandelier National Monument (McKenna and Powers 1986:2).

The San Ildefonsans trace their ancestry to north of Mesa Verde; their tradition holds that they migrated south to the Pajarito Plateau, establishing the villages of Otowi (also known as Potsuwii) and Tsankawi before settling in approximately the present site, possibly around A.D. 1300 (Edelman 1979:312-314). West of the Rio Grande, the Puye cliff dwellings, occupied between A.D. 1250 and the late 1500s, were also cited as a possible ancestral site (Luis Naranjo, personal communication, August 31, 1987).

Historic Period

The Historic occupation of the Rio Grande valley began with the first Spanish entradas of the sixteenth century. Coronado's expedition (1540-1542) visited the Tewa pueblos; however, the date for the first Spanish contact with San Ildefonso is uncertain. The first description of San Ildefonso comes from Castaño de Sosa's expedition journal (1590-1591), in which he noted four large whitewashed house blocks of coursed adobes, two and three stories high; ovens; and an immense plaza with a large kiva at its center (Castaño de Sosa 1965:110-121). In 1598, having settled his colonizing expedition at San Gabriel de Yunque-Yunque, Don Juan de Oñate visited the pueblo and changed its name from Bove to San Ildefonso, in honor of the Archbishop of Toledo.

Santa Fe was founded as the capital of New Spain in 1610, during the Colonization period (A.D. 1598-1680). In the Santa Fe area, populations were concentrated in the vicinity of the current plaza, but scattered ranchos were located up and down the Rio Arriba (upper Rio Grande) and Rio Abajo (lower Rio Grande) areas. The Spanish economy of that period was primarily supported by farming, sheep ranching, and limited trade and commerce with the Rio Grande pueblos and Old Mexico via the Camino Real. Many churches were built by the Franciscan friars using forced labor from the pueblos in an attempt to convert the Indians to Christianity. The churches were frequently built over the rubble of the Pueblo's own ceremonial kivas. The first mission was built at San Ildefonso in A.D. 1617 (Edelman 1979:312-316).

Severe social, religious, and economic repression of the Pueblo Indians by the Spaniards led to the Pueblo Revolt of 1680, during which numerous clerics, Pueblo Indians, and colonists were killed. Santa Fe was besieged by an alliance of Pueblo forces, and Governor Otermín was forced to surrender and evacuate the city. As the largest Tewa village, San Ildefonso played a leading role in the revolt and contributed numerous warriors, including moiety chiefs Francisco and Naranjo, who assisted Pope in coordinating the uprising. The Pueblo Revolt left the upper Rio Grande area unoccupied by Hispanic populations until De Vargas's "bloodless reconquest" in 1692. The San Ildefonsans fiercely resisted De Vargas and held out for two years against repeated Hispanic assaults on top of Black Mesa, the large volcanic plug that forms the northern boundary of the pueblo (Pearce 1965:17). The Refugee site, remaining from this period on top of Black Mesa, was photographed by Charles Lindbergh in 1929 at the invitation of A. V. Kidder (El Palacio 1981:29).

During the Colonial period (A.D. 1692-1821), to encourage resettlement of the New Mexico province, the Spanish government granted free title tracts of land to colonists, and by 1696 northern New Mexico was reoccupied with Hispanics living on approximately 140 land grants. Spanish Colonial habitation sites were characterized by small adobe room blocks and associated Majolica porcelain, glass, Mexican trade wares, metal, and Tewa ceramics. Because of increased Navajo and Comanche raiding, defensive towers (torreons) and enclosed plazas were frequently added to Spanish settlements. In A.D. 1742 a grant was made to Ramón Vigil and Pedro Sánchez for a tract of land situated between the Frijoles Grant and the San Ildefonso Pueblo. The San Ildefonso Pueblo grant, from the king of Spain, was confirmed by an act of Congress in 1858 (Scurlock 1981:134). By A.D. 1800 sheep herding and cattle raising began to replace farming as the dominant means of livelihood among the Spanish settlers, and in 1831 the first of many herds of sheep was driven from New Mexico to California. The pasturelands and open meadows of the Jemez Mountain foothills provided ample room for summer grazing, and the streams and valleys were probably frequented by Hispanic and Pueblo hunters and fishermen.

With the signing of the Treaty of Cordova on August 24, 1821, Mexico secured its independence from Spain, and New Mexico became part of the Mexican nation. That year brought the opening of the Santa Fe Trail, and expanded trade networks brought new settlers and goods for industrial manufacture. By the Treaty of Cordova, all Indians residing in New Mexico were granted full citizenship (Jenkins and Schroeder 1974:34-37). Following the troubled, short-lived Mexican period, General Stephen Kearny accepted the surrender of Acting Governor Juan Batista Vigil y Alarid, the colors of the republic of Mexico were hauled down, and the U.S. flag was run up over the Palace of the Governors in Santa Fe on August 18, 1846. In 1850, New Mexico was officially made a territory of the United States. By 1880, the small settlement on the Pajarito Plateau was destined to become Los Alamos. A post office was located at Otowi between 1921 and 1941, and at Totavi between 1949 and 1953 (Pearce 1965:115, 169). During World War II, the cafe, post office, and ranch complex at Otowi, which employed a number of San Ildefonsans, became a gathering place for the Manhattan Project scientists working on the atomic bomb at Los Alamos Scientific Laboratories. In recent Historic times, both San Ildefonso and its neighbor, Santa Clara, have become famed for their polished black and red incised pottery. The famous potter Maria Martinez, who produced black wares at San Ildefonso from the 1920s until her death in 1980, obtained clay from a shale deposit located in an arroyo a short distance from LA 51912 (Greg Martinez, personal communication, August 27, 1987).

ARCHAIC ADAPTATIONS: AN OVERVIEW

Most researchers agree that the shift from hunting and gathering to an agriculturally based system occurred during the Archaic period. The implications of this transition has occupied a central place in archaeological inquiry. The following overview of some of the major arguments is designed to give the reader the empirical background for later interpretations.

The concept that cultural systems remain relatively stable until they must respond to a situation for which they have no existing coping strategy underlies the framework of the research orientation of this project. A further assumption is that the ethnographic record forms the basis for theoretical statements that can be used to interpret archaeological remains, or to give meaning to those remains, a process that has been called middle range theory building (Raab and Goodyear 1967; Binford 1977).

The applicability of the Oshara tradition to Archaic developments in other areas has been disputed (Honea 1969; Cordell 1979; Stuart and Gauthier 1981, 1984). Although Judge (1982) considers Basketmaker II and En Medio to be synonymous in the San Juan Basin, Elyea and Hogan (1983:77) cite differences in subsistence as a criterion for distinguishing between the Late Archaic (En Medio) and Basketmaker II. They contend that the En Medio is a hunting and gathering adaptation and that Basketmaker II is an agricultural adaptation. Differences in projectile point morphology are used to distinguish En Medio and Basketmaker II (Laumbach 1980:871-876; Anderson and Sessions 1979:104-109; Anderson and Gilpin 1983:56-57). The implications of categorizing the periods into distinct cultural entities are discussed in Vogler (1982:158) and Kearns 1988:990). Much of the authors' discussions turn around interpretations of projectile point variability. Viewing stylistic or functional variability in terms of cultural identity appears premature until the relationships between subsistence bases, points of origin, and functional variation are better understood.

Research has documented Archaic sites across much of the northern Rio Grande region (Cordell 1979:23; Peckham 1984:276). Particularly dense concentrations of Archaic sites occur in the vicinity of Cerro Pedernal near Abiquiu, where mobile hunter and gatherer groups quarried Pedernal chert and Polvadera obsidian deposits for stone tool manufacture. A number of archaeological surveys have documented extensive evidence of Archaic-phase base camps and hunting sites, lithic workshops, and quarries in this area (Beal 1980; Baker and Winter 1981; Snow 1983; Lent 1987; Schaafsma 1978). A possible shallow basin-shaped stain was present on Schaafsma's site (Site No. AR-8), but absolute dates were not available).

Early Agriculture

Irwin-Williams (1973:9) wrote that maize was first introduced from Mesoamerica, and dry farming was adopted on a limited basis in northwestern New Mexico between 1,800 and 800 B.C. Lang (1977b) suggested that corn and the reliance on agriculture was introduced from the south, presumably by Cochise migrants, but Irwin-Williams (1973) believed that corn was adopted into a well-established, distinctive northern pre-Anasazi base. The shift to agriculture occupies a central place in archaeological inquiry; however, speculating about the causes underlying this shift is beyond the scope of this report. The following discussion will only touch on some of the highlights of the subject.

Pioneering studies of existing hunters and gatherers concluded that agriculture required a higher labor investment than hunting and gathering (Lee and Devore 1968; El-Najjar 1974; Yellen 1977). This suggests that some fairly compelling reasons must have existed for the acceptance of agriculture. In addition, there is good evidence that maize was grown and consumed long before its adoption (Dick 1965; Woodbury and Zubrow 1979). Models based on sedentary donor areas pushing excess population into the Southwest have been presented to account for this acceptance. These models rely heavily on Boserup's (1965) arguments that demographic pressure is the independent variable causing technological change.

Binford (1962, 1968) argues that an area that supports low-density hunting and gathering populations can receive increments of people from communities under demographic stress outside of the area, forcing both populations to adjust to the influx. Compatible with this notion is the concept of "scheduling" (Flannery 1968), which includes the observation that hunters and gatherers must schedule their activities to coincide with the availability of resources. Stuart and Gauthier (1984:9-24) view these types of evolutionary change as the consequence of two opposing social and demographic forces: power and efficiency. Power is, in their view, non-equilibrated growth, while a homeostatic system (such as hunter and gatherer adaptation) is efficient in rates of energy consumption.

While some researchers with a cultural/ecological perspective (Steward 1955; Flannery 1973; Hassan 1977) suggest environmental change as the impetus for the adoption of agriculture, others see gradual progressions towards more productive environments and increased sedentism (Madsen 1979; Perlman 1980). Rindos (1984) has argued that the adoption of agriculture was the result of the symbiotic interaction between people and the plants they consume, while domestication and reliance on cultigens are the product of long coevolution between the two. Others (Kelly 1966; Woodbury and Zubrow 1979) argue for a gradual, volunteeristic approach to the adoption of agriculture, a process involving a prolonged exposure to maize and its potential as a dependable food source. Wills (1988) argues that the value of maize was its predictability rather than how much food the plants produced, and that there was plenty of both wild plant and animal food available at the time maize was first adopted.

Berry (1982) argues that many radiocarbon dates associated with early corn agriculture are invalid or inaccurate, but Simmons (1986) has countered with radiocarbon dates which suggest a substantially earlier interval for the adoption of maize. Wills (1988), citing radiocarbon data from excavations in west-central New Mexico and east-central Arizona, concludes that (contrary to Haury 1962) agriculture probably began in the highlands rather than the lowlands no earlier than 3000-2800 B.P.

Rather than a large-scale diachronic phenomenon, it may be that differential and perhaps regional responses contributed to the reliance on cultigens by prehistoric groups. At Jemez Cave (Alexander and Reiter 1935) maize was radiocarbon dated to 2410 ± 360 B.P. At Ojala Cave (LA 12566) (Traylor et al. 1990), in the lower Alamo Canyon area on the Pajarito Plateau, maize was associated with artifacts identified as Chiricahua Cochise and San Jose/Armijo and with radiocarbon dates of B.C. 650 ± 145 and B.C. 590 ± 75.

Palynological evidence strongly suggests that prehistoric populations were aware of corn long before it was widely used, and that its adoption was a gradual process. In view of the efficiency of a hunting and gathering lifestyle with respect to agricultural pursuits (Lee and Devore 1968; El-Najjar 1974), it is probable that an increased reliance on cultigens did not occur on a wholesale basis until relatively late. This strategy may have been punctuated with episodes of hunting and gathering throughout the prehistoric period.

Early Structural Sites

Early structures are poorly represented in the archaeological record of the northern Rio Grande valley. Elsewhere, however, evidence of structural components have been recorded as early as Paleoindian times. Lodge floors were present at the Hanson Folsom site in Wyoming (Frison and Bradley 1980), and posthole configurations are present at the Hell Gap site in southeast Wyoming (Irwin-Williams et al. 1973). In general, however, structural sites are infrequently documented in the Paleoindian and early Archaic periods, possibly due to the difficulty of recognizing these types of structural deposits, and more may have actually existed than are documented in the archaeological record. At the Keystone Dam site, 23 to 41 structures, several of which are possible pit structures, 200 to 300 fire-cracked rock features, and trash filled pits are reported from a site radiocarbon dated to between 2500 and 1800 B.C. (O'Laughlin 1980). By the late to mid-Archaic, posthole configurations are present on San Jose-phase sites in the Arroyo Cuervo area (Irwin-Williams 1973:8). Archaic pit structures that have long been known from southeastern Arizona date to the San Pedro phase of the Cochise sequence, approximately 3000 B.C. to A.D. 500 (Sayles 1945). These "proto-pithouses" consist primarily of shallow circular depressions approximately 3 m in diameter with central hearth features and occasional postholes (Sayles 1945:3).

Many of the structural features at the Keystone and the San Pedro sites may represent pole and thatch dwellings similar to those of the Northern Paiute (Aikens et al. 1977), or ramadas with shallow depressions for floors, and may argue for standardized criteria in pit structure definition. Basketmaker II sites were primarily known from excavations in dry cave sites (Dick 1965; Haury 1950; Irwin-Williams and Tompkins 1968; Lindsay et al. 1968), which may also contain architectural features (Alexander and Reiter 1935). More structures are reported from mid-to-late Archaic times, from approximately 3000 B.C. to A.D. 1. Other relatively well-dated Late Archaic aceramic pit structure sites outside of the Rio Grande include those in central and southeastern Colorado (Fenega 1956; Conner and Langdon 1986; Euler and Stiger 1981; Stiger 1981; Kane et al. 1985); northwestern New Mexico (Eddy 1966; Henderson 1983); Arizona (Kearns 1988; Martin and Rinaldo 1950; Martin et al. 1962; Berry 1982; Gumerman 1966); and Utah (Hargrave 1935 [not well dated]; Sharrock et al. 1963). Pit structures in the middle Rio Grande Valley have been reported by Allan and McNutt (1955), Peckham (1957), Vyaticil and Brody (1958), Schorsch (1962), Skinner (1965, the Sedillo site), Vivian and Clendenen (1965, the Denison site), Frisbie (1967), Allan (1975), Hammack et al. (1983), and Reinhart (1967). Reinhart ("Rio Rancho Phase") reported radiocarbon dates of 962 B.C. ± 162 and 108 B.C. ± 206 from two aceramic pit structures.

Sites with early structural components in the northern Rio Grande include an aceramic pit structure (X29SF2) recorded at Nambe Falls by Skinner et al. (1980). No ceramics were found in association with the structure, which was partially destroyed by an old road cut. Its diameter was 6.5 m, and it had numerous floor features, including a hearth, postholes, and storage facilities. A radiocarbon date of A.D. 500 was obtained. A pit structure is reported by Glassow (1980:72) in north-central New Mexico with radiocarbon dates of around 2835 B.P. Six aceramic pit structures were excavated near Abiquiu, New Mexico (Stiger 1985). Radiocarbon dates from the structures and associated features range from 5050 ± 80 B.P. to 1120 ± 70 B.P. Stiger suggests that 3830 ± 60 B.P. to 1120 ± 70 B.P. represents an acceptable period of occupation at site LA 25358 and concludes that settlement changes in the Abiquiu area at the time of early food production might have involved decreased residential sedentism and less dependence on stored food at any one location (Stiger 1986:361-362). More recently, data from the Santa Fe Relief Route, southwest of Santa Fe, indicate the possibility of Archaic or Early Developmental structural components, and Late Archaic features are present at site LA 61282 (Maxwell 1988; Lent 1988). In the same general area, excavations for Bellamah Corporation in the Tierra Contenta subdivision have exposed several shallow pit structures of possible Late Archaic affiliation (Schmader, in preparation).

Gilman (1983:93) has reviewed ethnographic use of pit structures on a worldwide basis and concluded that they are usually associated with low population densities, overwintering, and temperate climates. The thermal efficiency of pit structures relative to above-ground structures has been noted by Farwell (1981:43-47), perhaps explaining why pit structures persevered in the form of large aggregations between A.D. 660 and 1200 in the Dolores Project area (Wilshusen 1988a:599-633) and appear to have persisted in the Gallina area of the Jemez Mountains as late as the 1300s (Dick 1976). Stuart and Farwell (1983:119) estimate that as many as 1,000 pit structures postdating A.D. 1000 are yet to be excavated in New Mexico. For example, a pit structure (EIP-49) was excavated in the vicinity of Tonque Pueblo containing a hearth radiocarbon dated to A.D. 1475 with associated Pueblo IV polychrome ceramics (Harlan et al. 1986:191-199).

Archaic Adaptation in the Northern Rio Grande

Because of a general bias towards the investigation of large Classic-period sites in the northern Rio Grande, the dynamics of the Archaic settlement system are poorly understood. The purpose of the following discussion will be to develop a model of Archaic land-use patterns. This model will be largely derived from general hunter and gatherer studies.

The archaic hunting and gathering adaptation consists of a primarily mobile adaptation in which small groups range over large segments of land in response to resource availability. Ethnographic studies have confirmed that these subsistence pursuits tend to encompass vast areas. Therefore, it is probable that the portion of the settlement system represented by the Archaic sites located within the project area represent only a fraction of the overall system.

Binford (1980) distinguishes between two basic types of mobility: foraging and collecting strategies. Foraging is a positioning strategy in which a group moves its residential base in response to the availability of food resources. Foraging can be understood as an encounter strategy in which entire residential groups move through the landscape in search of food. Foragers tend to display high residential mobility, procure food on a day-to-day basis, and usually do not store foods. Site types among foragers include the residential base or camp and the location where extractive activities occur. Collectors are characterized by low residential mobility, high logistical mobility, and storage. Site types include residential bases, logistical field camps, stations where task groups gather information, and caches (Binford 1980). Differences in mobility may be a conditioning factor in assemblage variability.

Binford (1979:278-280) has distinguished three types of gear hunters and gatherers commonly use. These include personal gear, situational gear, and site furniture. Site furniture consists of tools or raw materials left on a site in anticipation that the site will be reoccupied at a later date. Situational gear consists of the tools one needs to perform a specific activity. Personal gear is curated gear that a hunter and gatherer carries in anticipation of unforseen events.

Reher and Witter (1977) have argued that vegetative diversity is a prime consideration of hunters and gatherers in their selection of occupational loci. Chapman (1979), however, found that vegetative diversity was not a prime factor in the placement of Archaic sites in the White Rock Canyon area of the northern Rio Grande Archaic sites excavated in the San Juan Basin during the UII and NMAP projects. These sites exhibit little functional variation in residential sites, infrequent evidence of special-use sites, and short-term occupation by small groups (Hogan and Winter 1983; Vierra 1980). In the San Juan Basin, however, water availability may have been a more critical variable than the distribution of food resources. Wait (1976) argues that during the earlier phases of the Oshara tradition, the settlement pattern observed in the Star Lake and Arroyo Cuervo areas corresponds to a "restricted wandering pattern" (i.e., a community spends part of each year wandering and the rest at a settlement or central base). Moore (1980) argues that a nonterritorial, nonrestricted wandering strategy was better suited to the degree of local and regional variation of the area. Elyea and Hogan (1983:400), who disagree with these interpretations, feel that neither the restricted nor the nonrestricted settlement pattern model addresses the organizing principles underlying the Archaic settlement-subsistence system. Hunters and gatherers in the San Juan Basin were probably foragers who moved in and out of the area in concert with seasonal availability of subsistence resources. Archaic sites in the northern Rio Grande appear to represent a component of a regional hunter-gatherer settlement/subsistence system characterized by seasonal residential mobility, and increased reliance on corn agriculture in the later phases. The distribution of critical resources such as ricegrass, piñon nuts, game, and raw lithic materials probably conditioned the mobility of Archaic hunters and gatherers at least by Middle to Late Archaic times in this area.

Within the context of the current model, mobility is viewed as the primary variable conditioning the nature of the archaeological remains:

> An important point to be stressed here is that residential mobility and sedentism should be viewed on a sliding scale. That is, groups may move every day, every other day, once a month, every other month and so on. Additionally, groups may appear logistical as they overwinter on a store of foods, only to switch strategies to a highly mobile summer pattern. Or, a group may move its residence to a bulk resource (forager-type move) and pursue logistical strategies from the new residence [Stiger 1986:91].

The mobility of a hunting and gathering group may exist in proportion to a resource base. The base itself may in turn be conditioned by a number of variables, many of which may be environmental. These differences in mobility strategies may be the independent variables in assemblage composition. Lent et al. (1986) present a model of opportunistic resource procurement and punctuated mobility in the analysis of lithic artifacts present along a sample of Archaic and Anasazi sites in the Jemez Mountains. The authors concluded that under circumstances of greater residential mobility, the lithic assemblages of sedentary agriculturalists may appear similar to those of Archaic period hunters and gatherers. Lithic data from Anasazi and Archaic lithic scatters between Bernalillo and Clovis, New Mexico, suggested that site location and inferred site function for sites with Anasazi materials were the result of Pueblo groups pursuing a mobile hunting and gathering strategy (Harlan et al. 1986).

Data from the Rio Grande drainage suggests that it is likely that sedentary Pueblo cultures evolved in situ from an Archaic base after the introduction of cultivated maize. With respect to the current data base, sites such as LA 51912 suggest a bimodal subsistence pattern, that is, periods of residential stasis and punctuated mobility. This model is similar to the "restricted wandering pattern" described by Wait (1976); however, given the availability of specific resources in relation to the LA 51912 site location, resource procurement may have been more focused. The term wandering may imply an encounter strategy, one in which there is a diffusion of goals. We suggest purposeful scheduling for the occupants of LA 51912, in which resources are targeted and procured. As such, a collecting strategy similar to the model described by Binford (1980) may characterize the activities at this site. Base camps with ephemeral structures may have existed during the period in which the shift from hunting and gathering to reliance on cultigens occurred in the Rio Grande drainage. A sample of locations putatively identified as Archaic sites located along the proposed Santa Fe Relief Route (Lent 1987; Maxwell 1988; Wolfman et al. 1989) suggest similar variability in the distribution of site types. Large base camps have been documented as well as small special use/logistic sites located in dense piñon/juniper environments. Water control features in the vicinity of these camps suggest limited horticultural pursuits, and early structural locations are a possibility.

EXCAVATION METHODS

Field Techniques

To implement the research objectives defined during the testing program (Sullivan and Lent 1987:25), a crew was fielded consisting of a project director, a cultural resource assistant, and two laborers from San Ildefonso Pueblo.

Horizontal and vertical controls were established in reference to Highway Department right-of-way markers. Although the surface artifact scatter was collected during the testing program, additional artifacts were exposed during the interval between the testing and data recovery phases. These artifacts were marked with pin flags and piece-plotted with a transit. The excavation units initiated during the testing period were reopened, and an additional 53 were excavated (Figs. 3 and 4). Thirty auger holes were also excavated to aid feature definition (see section entitled "Auger Holes").

Systematic excavation focused on:

1. Reestablishing the horizontal 1.0 m grid system left in place during the test excavations.

2. Reexcavating the backfilled test trench in order to expose the underlying stratigraphy.

3. Establishing vertical controls using Datums A, B and C (Datum A calibrated at an arbitrary +10.00 m) and horizontal controls by establishing the central point of the grid system at 10N/10E.

4. Excavating in arbitrary 10 and 20 cm levels. When cultural stratigraphy was exposed, the excavations were modified to accommodate these strata.

5. Excavating all units until sterile soil was attained (unless otherwise indicated).

6. Screening all fill through 1/4 inch mesh and collecting all lithic, faunal and ground stone artifacts. A higher degree of resolution was achieved by screening feature fill through 1/8 inch mesh. Artifacts were bagged and provenienced separately.

7. Documenting all data recovered from culturally deposited contexts as well as mapping, recording, and photographing all features.

8. Collecting dendrochronological, obsidian hydration, and radiocarbon samples from appropriate contexts. Because of the presumed antiquity of the site, emphasis was placed on obtaining rigorous chronometric data.

9. Collecting macrobotanical and palynological from occupational surfaces,

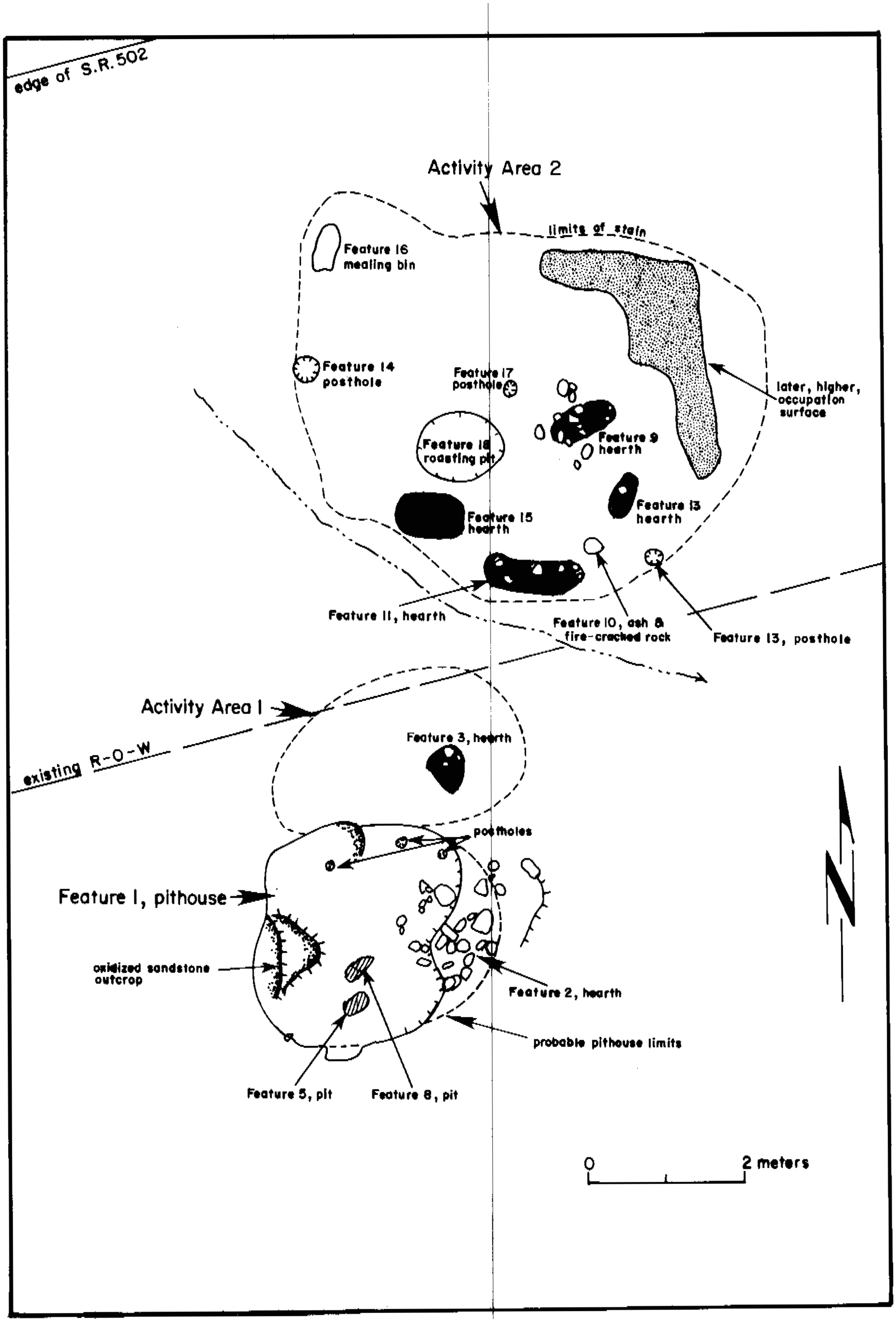

Figure 3. LA 51912, site map.

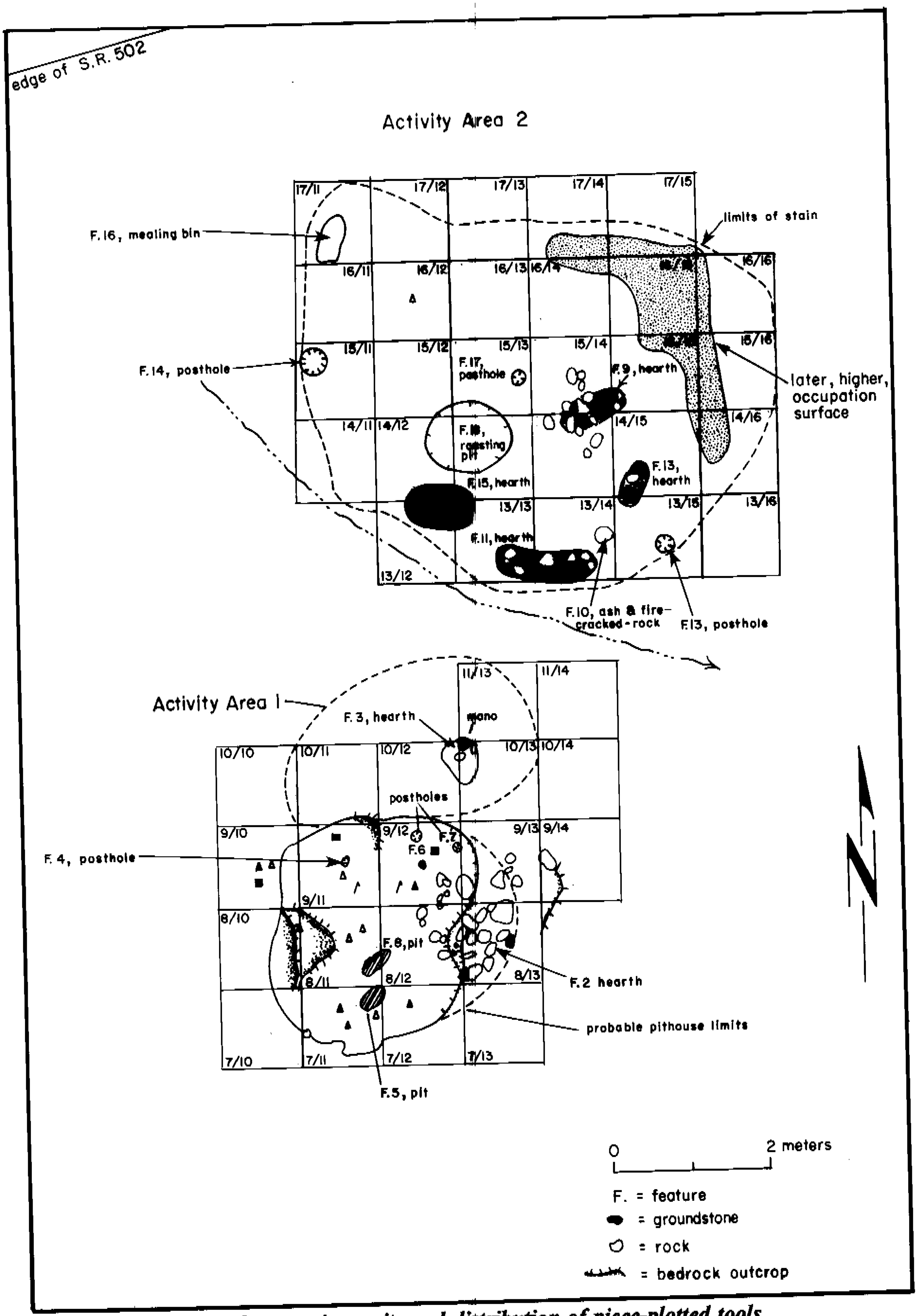

Figure 4. Location of excavation units and distribution of piece-plotted tools.

activity areas, structures, and features to provide information on prehistoric subsistence strategies.

10. Completing and backfilling the site when it was determined that all information potential had been exhausted.

11. Preparing a site map at the conclusion of the field work showing the intrasite disposition of the structures, features, and artifact concentrations in relation to the excavations.

Laboratory Techniques

At the completion of the excavation program, all of the recovered artifacts were cleaned and labeled. The collected samples were processed and submitted for analysis to various professional laboratories contracting with the Research Section. Lithic, ceramic, and faunal artifacts were analyzed by qualified members of the research staff. All field notes, photographs, maps, and other documentation are on file or in storage at the Laboratory of Anthropology, Museum of New Mexico, Santa Fe.

Analysis of the artifact assemblages emphasized site structure, site function, and temporal data through the use of diagnostic items. Site structure data provide information on group size, structure, internal site organization, site reuse, and past logistical strategies. Site function has typically been inferred from site location, faunal and floral analysis, and assemblage composition.

Statistical analyses applied to the artifact classes focused on both pattern recognition and pattern evaluation. Analyses were framed at both artifact and assemblage levels to obtain variation within classes. Data were entered on D-Base III, and the statistical packages used include SPSS and SURFER. Additional information on data manipulation is presented at the beginning of each analysis section under "Methods."

EXCAVATION RESULTS

Results of the data recovery program at LA 51912 yielded the remains of a pit structure and partially roofed extramural activity area dating to the Late Archaic period. The stratigraphy of the site and the features are described below.

Arbitrary Levels

Surface. The surface levels above Feature 1 (the pit structure) were collected during Sullivan and Lent's (1987) test excavations. The surface above Feature 19 was disturbed by postoccupational shoulder fill and road grading operations. Artifacts are present on the surface.

Levels 1-6. These arbitrary levels consisted of structural overburden above Feature 1. The matrix was composed primarily of well-consolidated sandy clay with gravel lenses and caliche inclusions. Pockets and specks of charcoal were present, which increased in frequency towards the base of the level. Artifacts were present throughout these levels. Level 6 terminated above a series of ashy, cultural levels except along the west one-half of the feature, where bedrock was encountered. Level 6 was excavated to a maximum depth of 11.29 mbd.

Level 7. This arbitrary level consisted of cultural fill overlying Feature 1. It was composed of sandy clay with lenses and pockets of charcoal, decomposed sandstone bedrock, and artifact inclusions. The level became increasingly compact towards the base of the level. An activity area consisting of a biface reduction/curation locale was present in 8N/13E and continued into Stratum 102. The top of Feature 2 (see description below) was defined in grids 9N/13E and 8N/13E. Rodent disturbance was present throughout the level. Ash staining from the underlying ashy substratum 102 was also present, particularly towards the base of 8-9N/11-12E. This level was excavated to a maximum depth of 11.33 mbd.

Level 8. Level 8 consisted of an arbitrary level overlying a stratum of cultural fill (Stratum 101). It was a grayish sandy clay with pockets and lenses of ash, pockets of clean sand, bedrock, and artifact inclusions. The interface between bedrock and the edge of the structure was defined along the western edge of this level, primarily in 7-9N/10E. Significant amounts of rodent disturbance were present throughout the level. A large shelf of bedrock, which was apparently incorporated into the architecture of the pit structure, was present at this level in 8N/10-11E. Level 8 occurred between 10.98 and 11.34 mbd.

Cultural Deposits

Activity Area 1

This area consisted of a compacted surface (Stratum 100), associated artifacts, and Feature 3, a hearth. It was defined as an activity area contiguous to the pit structure (to the north) and may have included a ground level entryway to the structure. No radiocarbon dates were obtained from the feature or the occupational surface, but by stratigraphic association with the adjacent pit structure and activity area it appeared to be contemporaneous with Stratum 30 and Stratum 102.

Activity Area 2

This area was located 1.85 m north of Activity Area 1, across a small southeast-flowing drainage, which is undoubtedly postoccupational (Fig. 5). The activity area was defined by a charcoal- and ash-stained occupation surface measuring 4.4 m N-S by 5.93 m E-W and associated Features 9-18 (see feature descriptions below). This extramural activity area occurred at approximately the same elevation as the pit structure. The presence of three postholes (Features 13, 14, and 17) suggest that this area may have partially roofed with a brush/ramada structure. The remaining features consisted of hearths, a possible mealing bin, and a large central roasting pit. Sterile, highly consolidated postoccupational fill deposited by the Highway Department (Stratum 25) overlays the cultural strata. It is likely that this area did not sustain the degree of burning experienced by the nearby pit structure. The artifact assemblage recovered from Activity Area 2 was aceramic and composed primarily of lithic artifacts; however, analysis of the debitage suggests that activities different from those suggested for the pit structure occurred at this locale. Stratigraphic data and radiocarbon dates (see radiocarbon dates for the features included in this activity area, as well as for Stratum 102) from the burned features suggest that the activity area and the structure are contemporaneous.

Stratum 25 (9.98 to 10.43 mbd)

This stratum consisted of postoccupational fill (NMSHTD shoulder fill) overlying Activity Area 2. It was composed of a thick deposit of reddish-tan clay with calcium carbonate inclusions and was highly compacted and artifactually sterile.

Stratum 30 (10.43 to 10.68 mbd)

This stratum consisted of the occupational surface associated with Activity Area 2 (partially roofed extramural activity area). The stratum was an ashy lens, possibly foot compacted, and it was associated with Features 9-18. Radiocarbon samples obtained north of Feature 15 at 11.55-11.65 mbd suggest a date of 2110 ± 70 B.P. (Beta-23863).

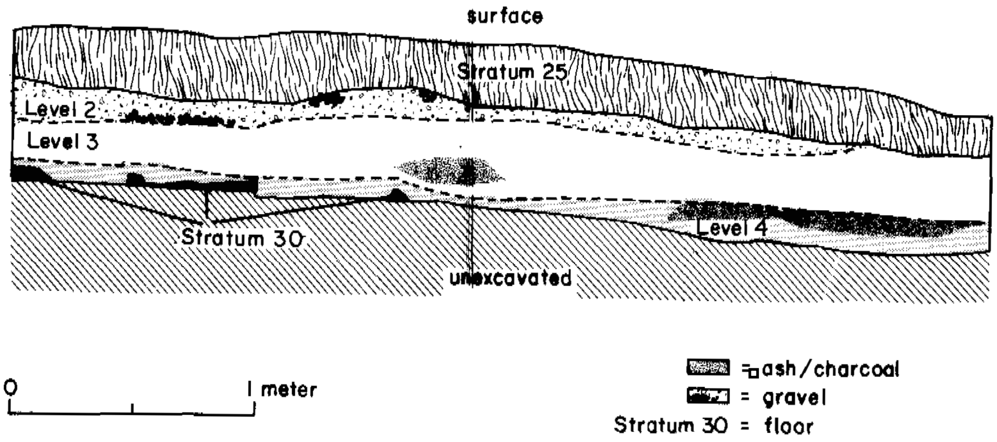

Figure 5. Activity Area 2, plan and profile, LA 51912.

Stratum 100 (11.00 to 11.48 mbd)

This stratum was an occupational surface located outside and north of the pit structure. It is contiguous to Stratum 102 (see below) and associated with Feature 3 (an exterior hearth). It consists of an ashy gray lens, approximately 5-15 cm thick, mottled with pockets of charcoal and artifact inclusions. Some gravel lenses are also apparent in 10N/10E. Several sandstone cobbles are present in random orientation. Feature 3 is present in 10N/12E and 10N/13E. No radiocarbon dates were obtained from this stratum.

Stratum 101 (11.35 to 11.38 mbd)

This stratum was the contact zone above the occupational surface of Feature 1 (Stratum 102). It consisted of a discontinuous mottled and ash-stained sandy lens, which was clay capped in 8N/11E. Bedrock abuts Stratum 101 in 8N/10E. Artifacts associated with the pit structure floor are present throughout the stratum. Rodent disturbance is also present. A fragmentary obsidian projectile point (FS 160), probably broken in manufacture, was sourced to Polvadera

Peak (XRF 160) and obsidian hydration dated to 1987 ± 113 B.P. A radiocarbon date from a charcoal specimen recovered from this stratum dated to 2030 ± 70 B.P. (Beta-29292).

Stratum 102 (11.36 to 11.47 mbd)

This stratum consisted of the occupational surface of the pit structure (Feature 1). The floor fill layer was an undulating lens of dark gray ash overlying bedrock to the west and soft, decomposing bedrock elsewhere. The bedrock/decomposing bedrock substratum over which this cultural level was located was very irregular in several areas and contained pockets of brown-gray sandy clay. The floor was unprepared, and it appears that the occupants may have utilized the available ground surface. Some roof fall and an adobe roof cast was present in 8N/13E. Feature 2, a hearth, was present along the eastern edge of the occupational surface (see feature descriptions below). Inclusions of green and pink clay occur in 9N/10E, postholes (Features 4, 6, and 7) along the southern perimeter, and subfloor storage pits (Features 5, 8) in 7-8N/11E. Two En Medio projectile points were recovered from this layer: a whole point from 9N/12E and a base from 7N/12E (during test excavations). A scraper and bone awl fragments were recovered from 9N/11E. A biface reduction area, first defined in Level 7, 8N/13E, and located within the hearth area, is associated with this stratum as well. A single goosefoot seed was present at 9N/11E (Appendix). Three radiocarbon samples were obtained, two from the floor (2400 ± 100 B.P. and 1950 ± 70 B.P., Beta-29295 and Beta-23857) and one from the hearth (2490 ± 70 B.P., Beta-23854).

Stratum 103

This stratum occurred below 11.51 mbd and was defined as sterile soil. It consisted of highly compacted orange-tan sandy clay with calcium carbonate inclusions.

Stratum 24 (10.95 to 11.27 mbd)

Stratum 24 consisted of hearth fill from Feature 2 (see feature description below). Fill from this feature consisted of a concentration of fire-cracked rock, charcoal, and ash. Radiocarbon analysis places its use at 2490 ± 70 B.P. (Beta-23554).

Stratum 150 (10.55 to 10.71 mbd)

This stratum consisted of fill from Feature 15. The fill from this feature consisted of approximately 16 cm of dark, ashy soil with small gravels, areas of charcoal concentrations, and a shallow ash basin at the east end of the feature. Mottling from burning of the feature extended north. Radiocarbon samples obtained from this feature dated to A.D. 133 but appear to have been rodent disturbed.

Stratum 110 (10.81 to 10.87 mbd)

This designation was applied to fill from Feature 11, a deflated, kidney-shaped hearth (see feature description below). The results of radiocarbon analysis place the use of this feature at 2400 ± 70 B.P. (Beta-23860).

Feature Descriptions

Feature 1 (10.95-11.50 mbd)

Feature 1 consisted of a pit structure with associated features, activity areas, and artifacts (Fig. 6). Located in a drainage at the base of a sandstone and gravel alluvial terrace remnant, the structure was overlain with colluvial fill from a knoll located to the west. The fill consisted primarily of alluvial and eolian sand deposits, with several postoccupational lenses. The cultural strata originated from the later Pueblo component of the site, which is represented by an extensive artifact scatter along the top and slopes of the knoll to the west; however, no artifacts were associated with any of these lenses.

The pit structure was shallow and basin-shaped in profile, and circular in plan, measuring 2.5 m (north-south) by 2.7 m (east-west), and it was 55 cm deep. Along the southeastern and eastern edges, the structure was excavated into friable bedrock, while the natural bedrock contours were utilized to form the west wall. The southwestern perimeter of the structure was excavated into sterile soil.

Postholes, primarily located along the north side, may have supported a roof. Entrance may have been gained either through the roof or from the north, since the floor extends outside the structure and is contiguous with an associated extramural activity area (Activity Area 1). Evidence of roofing elements included two burned vigas and a roof cast located above the occupation surface. The presence of walls may be somewhat problematic, since it appears that Feature 2 may have been located partially outside of the projected structure area (to the east), which would suggest that only a partial wall, or none at all, was present along the eastern edge of the feature.

From the quantity of charcoal, oxidized sandstone elements, and the oxidation ring along the bedrock on the western edge of the feature, it appears that the structure was extensively burned. Features 2 and 4-8 were exposed in association with the pit (see descriptions below). To the east, the pit bows into the interior, and Feature 2, a slab-lined hearth, is located along the middle of the eastern edge of the structure (see description below). An occupation surface, or floor, designated Stratum 102, was located at 11.36-11.38 mbd (see description above). Three postholes (Features 4, 6, 7) were located near the northern edge, and Features 5 and 8 were subfloor pits. High quantities of chipped stone were present within the structure, in association with ground stone, bone, bone awl fragments, and two late Archaic projectile points resembling those described for the En Medio complex (800 B.C.-A.D. 400; see artifact descriptions below). Corrected radiocarbon dates from the main hearth feature (Feature 2) and the occupation

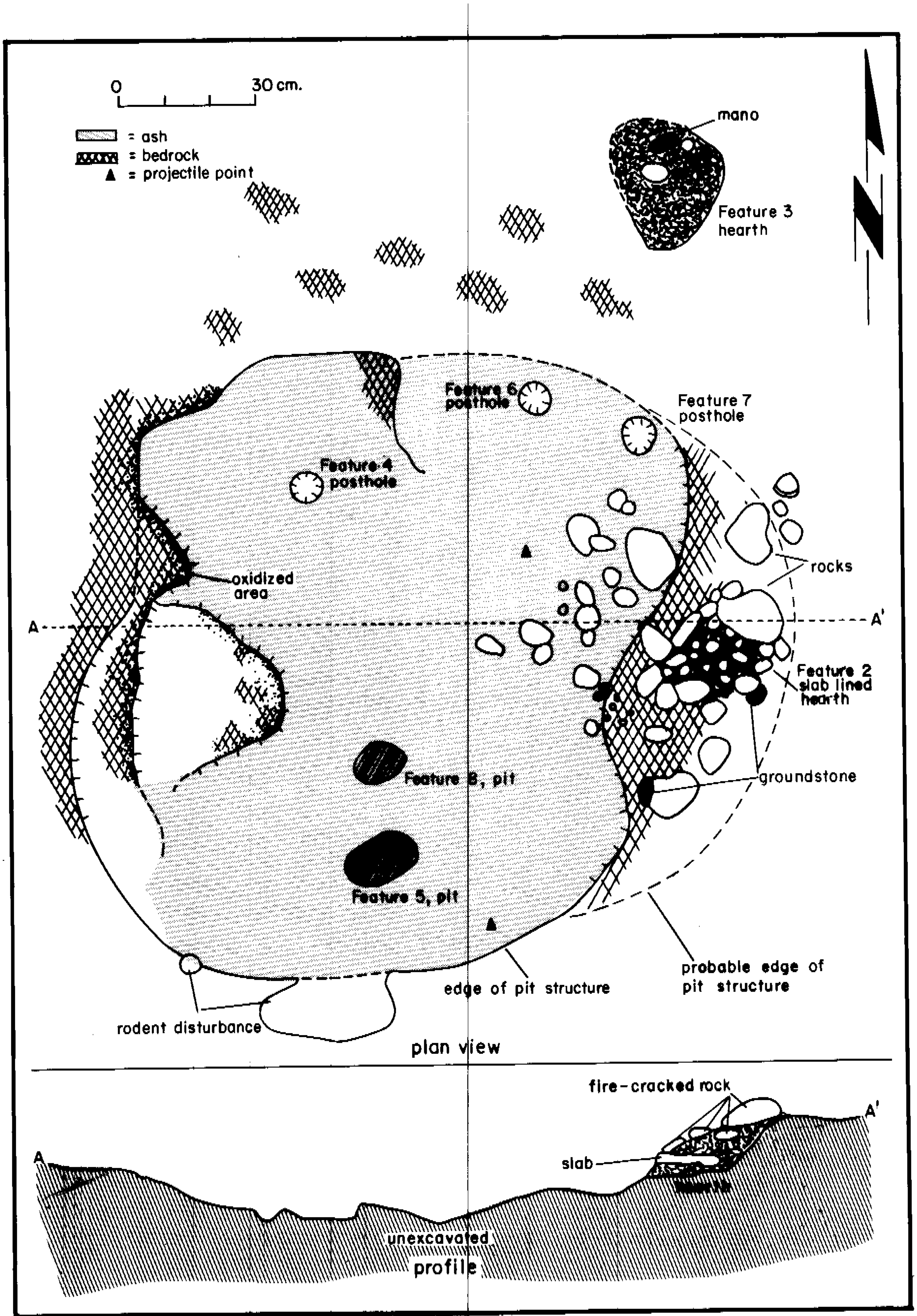

Figure 6. Pit structure, plan and profile, LA 51912.

surface (Stratum 102) suggest a range of between 2490 ± 70 B.P and 1950 ± 70 B.P. (Beta-23854; Beta 29295; Beta-23857).

Feature 2 (10.95-11.27 mbd)

Feature 2 consisted of a slab-lined hearth associated with the pit structure (Fig. 7) and constructed on a low sandstone bedrock shelf above the floor (Stratum 102). Its dimensions were approximately 80 cm north-south by 1.0 m east-west. Located along the eastern wall of the structure, it consisted of fire-cracked rock, ashy and charcoal laden fill, and oxidized sandstone hearth elements, which have slumped to the west and directly onto the floor (Stratum 102). Although it may have been partly extramural (possibly for ventilation), there is a higher probability that it was included in the roofed-over area of the pit structure as an interior feature. A portion of the hearth may also have been located on the exterior of the pit structure for ventilation. The hearth fill was composed primarily of fire-cracked rock, dense charcoal and ash, and lithic artifacts. An associated reduction area was located within the feature. The hearth appeared to have been constructed above the floor, perhaps inset into the bedrock that dominated the eastern edge of the structure. The base of the hearth was slab-lined. The slabs, which may have comprised the sides of the feature, had collapsed. When in use, they may have consisted of upright tabular sandstone elements. Only the eastern edge and a portion of the base of the feature was intact, with elements sloughing down from the western margin of the pit. There was approximately 10 cm of gray ashy fill below the slab-lined basal elements, suggesting that the feature has been remodeled. Chunks of sandstone on and above this ash lens appear to have been used as footings for upright slabs, which subsequently collapsed and may have been held in place by fill.

Two items of ground stone were recorded in association with the feature (see artifact descriptions). A reduction area of obsidian debitage and a uniface were present in the west half of 8N/13E, and two Late Archaic projectile points were located a short distance to the northwest, one of which was dated through obsidian hydration to 3374 ± 657 B.P. (Appendix 1). Carbonized plant remains within the primary hearth fill dated to 2490 ± 70 (Beta-23854).

Feature 3 (11.34-11.42 mbd)

This feature was an oval depression, probably representing a hearth associated with extramural Activity Area 1, and located in 10N/12-13E (Fig. 8). The feature was roughly oval in shape. Several burned sandstone elements and a mano (FS 149) were present within the fill, which was composed of dark gray, ashy soil on the upper levels, grading into a mix of sand, ash, and charcoal. The west edge of this feature had been rodent disturbed. There was no sign of oxidation in the matrix surrounding this feature. The upper levels of the feature may have eroded away. No radiocarbon or tree-ring dates were obtained. Pollens and flotation samples were sterile.

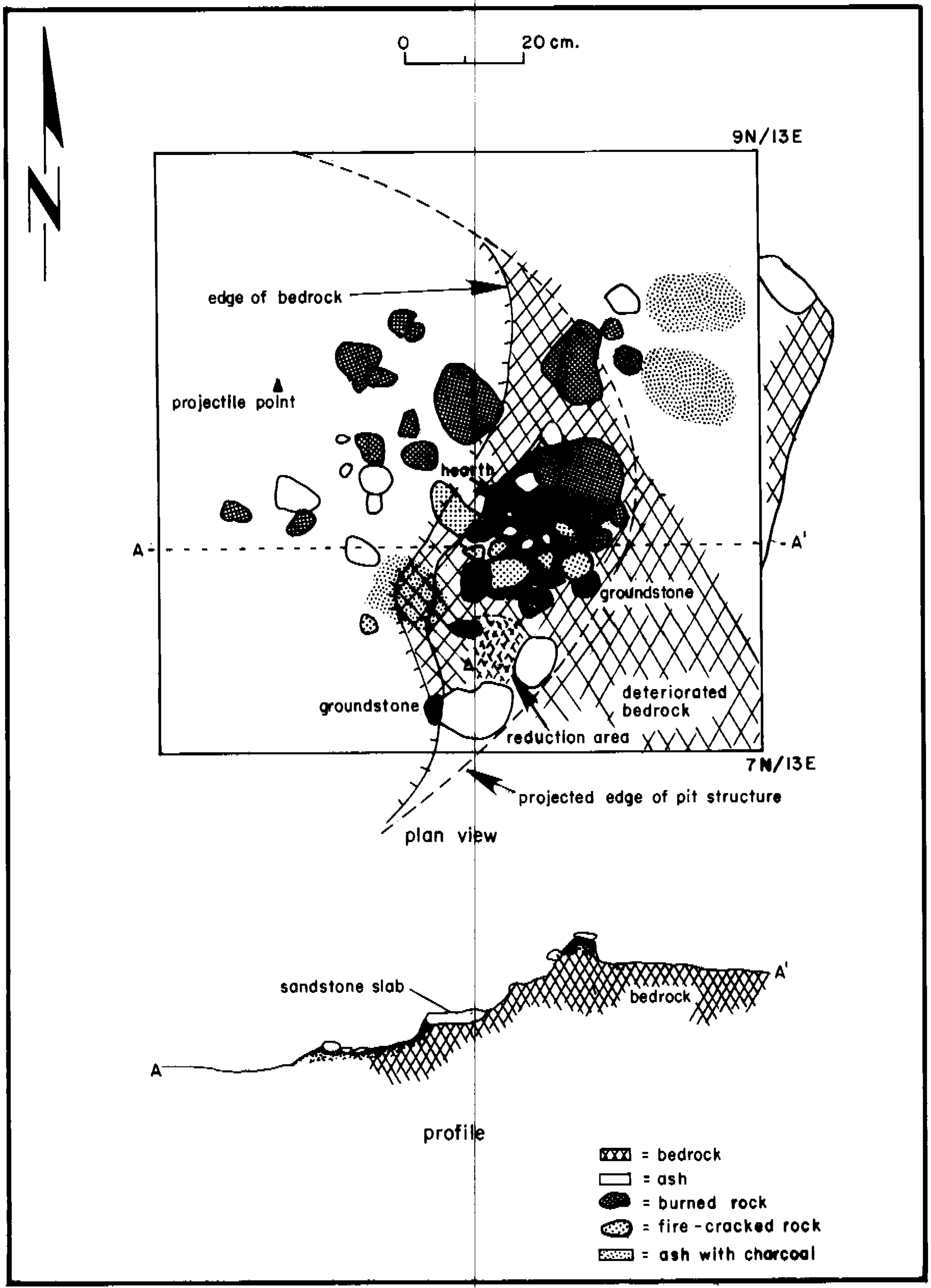

Figure 7. Feature 2, main hearth in pit structure, plan and profile, LA 51912.

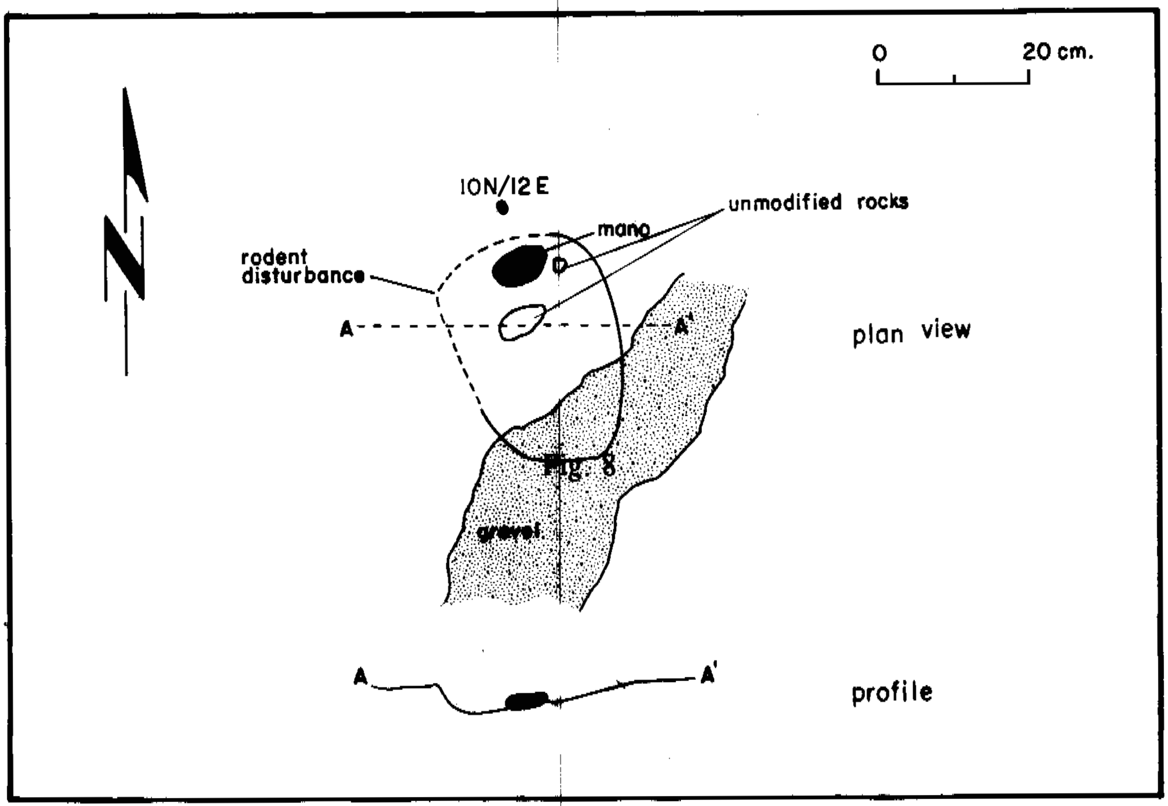

Figure 8. Feature 3, extramural hearth, Activity Area 1, LA 51912.

Feature 4 (11.54-11.61 mbd)

This feature consisted of a posthole associated with Stratum 102, the floor of the pit structure. It was circular, 14 cm in diameter, 7 cm deep, and located in the northwest quadrangle of the pit structure. The fill was sterile sand with an occasional speck of charcoal. No artifacts were present in the feature.

Feature 5 (11.46-11.57 mbd)

This feature was a subfloor pit associated with Stratum 102, the floor of the pit structure (Fig. 9). It was an irregular oval, 26 by 29 cm, in the south half of the structure in 7N/11E. The fill consisted of sterile sand with a few charcoal specks, and it appeared rodent disturbed. No artifacts, pollen remains, or macrobotanical materials were recovered from this feature.

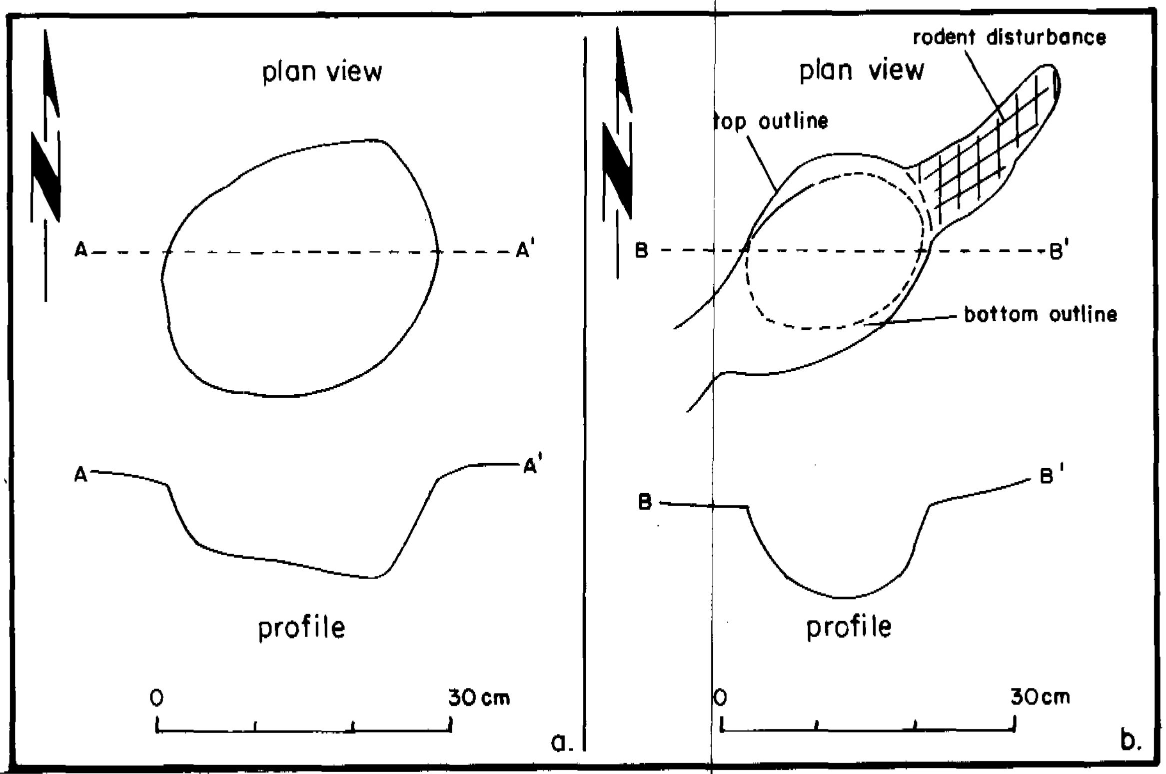

Figure 9. Feature 5, subfloor pit; and Feature 8, subfloor storage pit, LA 51912.

Feature 6 (11.54-11.59 mbd)

This feature consisted of a circular post mold (the clay cast of a deteriorated post) located along the northeast edge of the structure (9N/12E). The fill was sterile sand with very few charcoal specks, and the entire feature was surrounded by sterile sand. No cultural material was present in this feature, nor were any macrobotanical or pollen samples recovered.

Feature 7 (11.49-11.60 mbd)

This feature was a circular post hole associated with Stratum 102. Located in 9N/12E, it measured 13 cm in diameter. The fill consisted of sand with charcoal specks. No cultural materials were present inside this feature. No botanical or pollen remains were recovered from Feature 7.

Feature 8 (11.46-11.55 mbd)

This feature consisted of an elliptical subfloor storage cist or pit excavated into the floor (Stratum 102) in the pit structure (Fig. 9). Located a short distance north of Feature 5, it measured 19 cm in diameter and was 11 cm deep. The fill, sandy loam with charcoal specks, was extensively disturbed by rodents. No artifacts or botanical remains were present in this feature.

(The measurements for Features 9 to 18 have been corrected from the field notes to agree with the main datum (Datum A) and Datum C.)

Feature 9 (10.77-10.81 mbd)

This feature was a deflated hearth near the center of extramural Activity Area 2. The dimensions of this feature were 1.30 m north-south by 0.9 m east-west, and 4 cm deep. It was composed of an irregular charcoal stain and a concentration of fire-cracked rock. The fill alternated between dense pockets of charcoal and sterile tan sand, with substantial mottling. Because of this mottling, the edges of the feature were relatively difficult to define. Large chunks of charcoal were present in the fill, in association with a fire-cracked, one-hand mano and an obsidian flake. A radiocarbon date (Beta-23861) suggests that this hearth was in use in 2200 ± 80 B.P. There were no indications of prehistoric botanical materials.

Feature 10 (10.73-10.76 mbd)

This feature consisted of a shallow ash pit and a concentration of fire-cracked rock in the south-southeastern area of Activity Area 2. It measured 6 cm in diameter and a maximum of 3 cm deep. This feature may have been redeposited hearth materials from Feature 11 (see description below). The fill consisted of a single concentration of charcoal, with a thin lens emanating away from this concentration in several directions. Intermittent charcoal staining continued to the southwest until joining Feature 11. A corrected radiocarbon date (Beta-23860) suggests that this feature was in use in 2250 ± 90 B.P.

Feature 11 (10.81-10.87 mbd)

This feature consisted of a hearth located along the southern perimeter of Activity Area 2 and adjacent to a small drainage (Excavation Units 13/14, 15/13, 14/13, 13/13) (Fig. 10). The dimensions of this feature were 50 cm north-south by 1.3 m east-west. The feature was composed of 11-12 burned slabs, 7 of which form an oval basin and a heavy concentration of ash and charcoal. Outside this area the soil was mottled, with a heavy concentration of charcoal west of the hearth, between Features 11 and 15. This concentration may be redeposited from one or both of these features. No artifacts were associated with Feature 11; however, there was a concentration of 112 obsidian flakes located 6 cm south. Feature 11 was radiocarbon dated to 2400 ± 70 B.P.

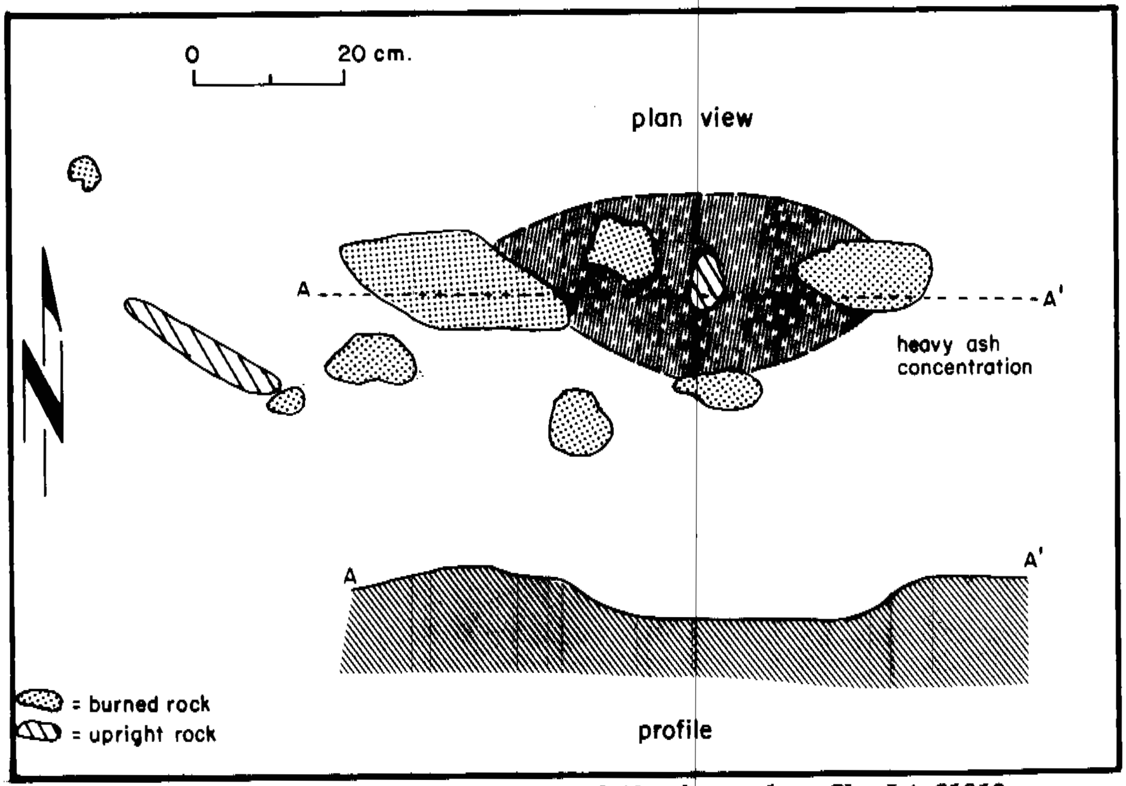

Figure 10. Feature 11, hearth, Test Pits 9 and 12, plan and profile, LA 51912.

Feature 12 (10.78-10.94 mbd)

This feature consisted of a basin-shaped hearth in the southeast corner of Activity Area 2 (Excavation Units 14/15, 13/15), measuring 0.44 m north-south by 0.48 m east-west. The fill consisted of sandy ash containing approximately 20 items of fire-cracked rock, and an occasional concentration of charcoal. This stratum overlay a mottled clay layer, which in turn rested on light tan sterile sand. No radiocarbon samples or cultural materials were recovered from this feature.

Feature 13 (10.76-10.94 mbd)

This feature consisted of a small posthole located along the southwest edge of Activity Area 2 in Excavation Unit 13/15. It measured 12.5 cm in diameter and contained sterile sand fill.

Feature 14 (10.35-10.59 mbd)

This feature was a large posthole in Excavation Unit 15/11 along the west edge of Activity Area 2. The feature measured 25 cm in diameter. A partially burned juniper post remnant was present inside the posthole and was collected as a tree-ring sample (FS 334). However, the tree-ring curve for this area does not extend far back enough in time to provide an age estimate. The fill from the feature and surrounding the post consisted of alternating lenses of compact clay, gravel inclusions, sandy loam, and deteriorating sandstone bedrock. Rodent disturbance is present throughout the feature, primarily towards the central portion. The base of the feature may possibly have been clay lined. No other chronometric data or samples were obtained, and no cultural material was present.

Feature 15 (10.58-10.74 mbd)

This feature consisted of an elliptical hearth near the southwestern edge of Activity Area 2 (Excavation Units 14/13, 13/13, 14/15, 14/12). The feature was composed of six oxidized tabular sandstone hearth elements measuring 1.0 m north-south by 82 cm east-west (Fig. 11). Fill from this hearth consisted of 16 cm of dark ashy fill with small gravel inclusions and occasional dense charcoal concentrations. A shallow ash basin was located at the east end of the feature, and a similar ash filled basin was located at the north end. Two obsidian flakes were recovered in the fill. Radiocarbon dating provided an estimated age of 1840 ± 70 B.P. (Beta-23862).

Feature 16 (10.57-10.71 mbd)

This feature consisted of a mealing bin in the northwest corner of Activity Area 2, Excavation Unit 16/13 (Fig. 12). The feature, an irregular oval, measured 66 cm north-south by 36 cm east-west. It was excavated into the activity area's occupational surface. The south side of the feature was composed of sandstone bedrock sloping to the north, with sandy ashy loam fill. No evidence of oxidation was apparent on the sides or base of this feature, and the fill may have been deposited subsequent to the abandonment of the feature. The sloping sandstone bedrock and associated depression may have served as a metate rest and collection area during processing activities. However, no evidence of wild or domesticated plant species was present in the botanical samples.

Feature 17 (10.71-10.93 mbd)

This feature consisted of two concentric pits in the center of Activity Area 2 in Excavation Unit 15/13 (Fig. 12). These two concentric depressions may have represented a posthole excavated into the center of a circular pit. The larger pit measured 42 cm north-south by 30 cm east-west, while the smaller posthole measured 15 cm in diameter. The fill consisted of a dense concentration of burned charcoal (a burned post?), and the fill of the posthole contained denser ash and charcoal, which were visible in the profile.

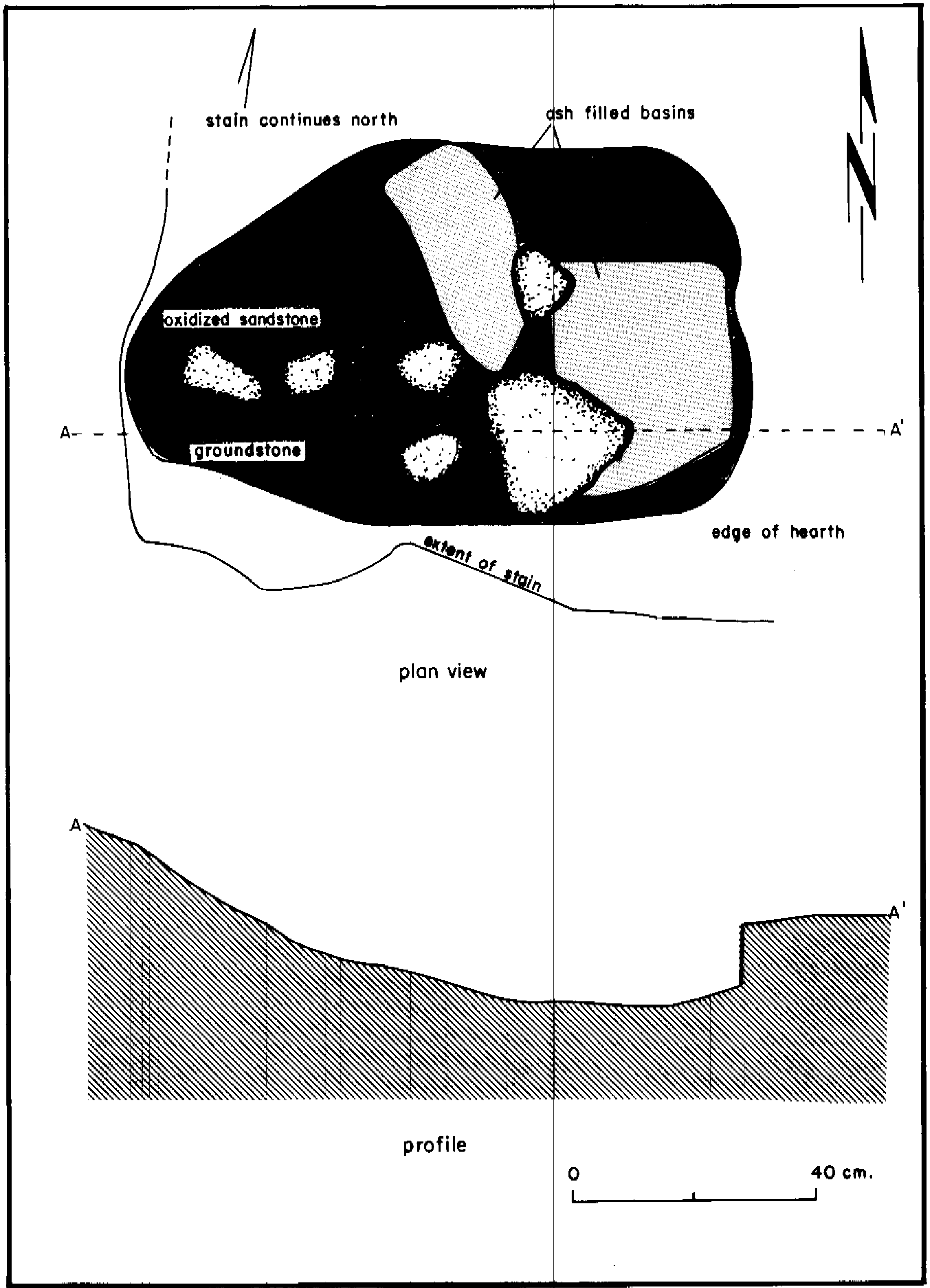

Figure 11. Feature 15, hearth, plan and profile, LA 51912.

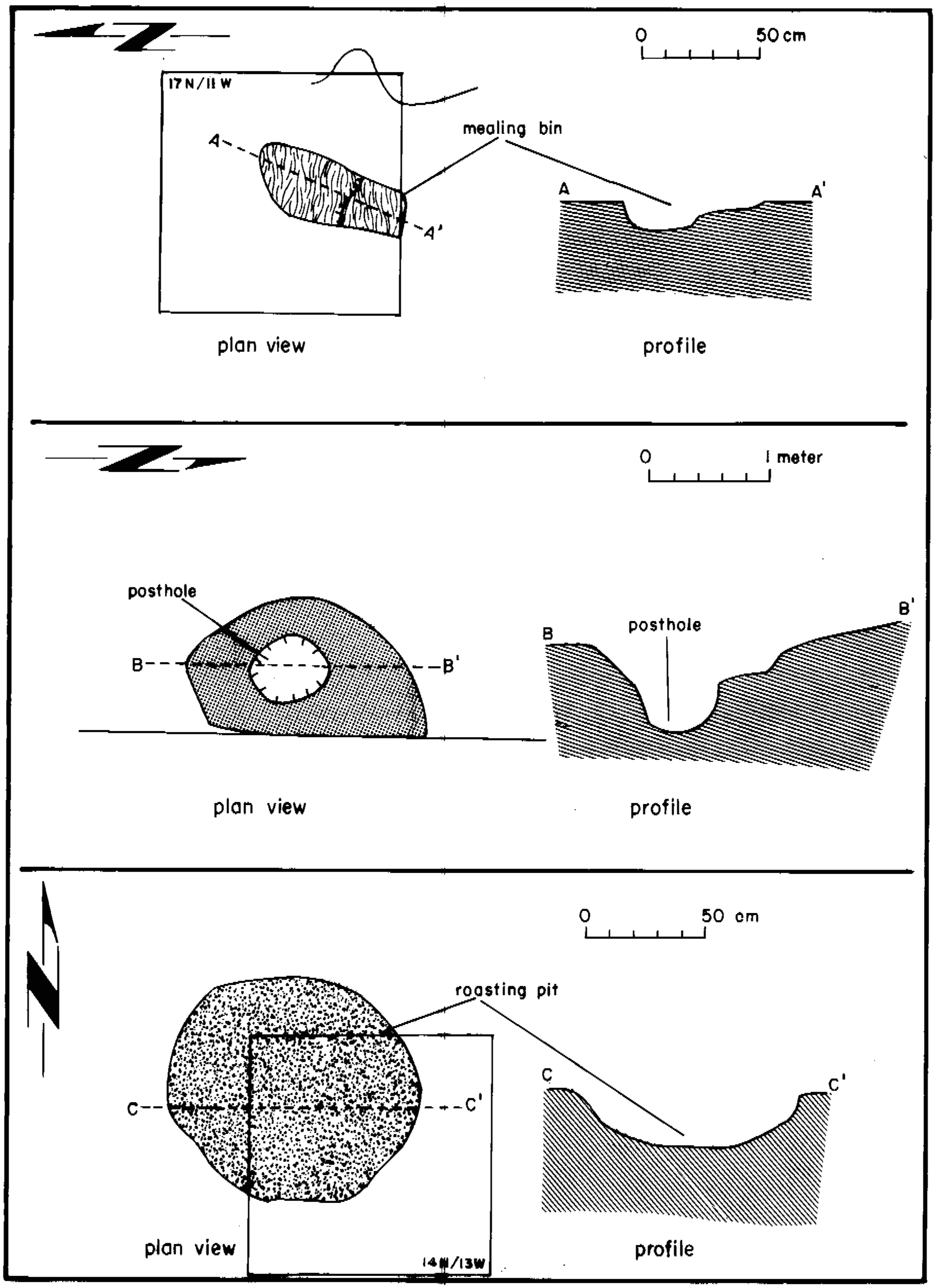

Figure 12. Feature 16, possible mealing bin, plan and profile; Feature 17, large posthole, plan and profile; Feature 18, roasting pit, plan and profile, LA 51912.

No macrobotanical or pollen remains were retrieved. Charcoal from the posthole dates to 1900 ± 70 B.P. (Beta-23864).

Feature 18 (10.73-10.86 mbd)

This feature consisted of a circular roasting pit near the center of Activity Area 2 in Excavation Units 15/13, 14/13, 15/12, and 13/12 (Fig. 12). The feature measured 96 cm north-south by 93 cm east-west. The fill consisted of 55 fire-cracked sandstone and quartzite cobbles and was characterized by dense ash with high quantities of charcoal overlying sterile yellow-to-tan sand. The feature may have been rock lined along the southern end. Eleven obsidian flakes were recovered from the interior. No botanical materials were discerned during analysis.

Auger Holes

Subsequent to the excavation of the pit structure, a series of auger holes were excavated to test for additional subsurface deposits. Soil augering was designed to supplement the 13 auger holes placed during the testing phase (Sullivan and Lent 1987:12). During data recovery, a series of 30 auger holes were systematically excavated over the site to an average depth of 81 cm below the immediate ground surface. Subsurface stratigraphy consisted of eolian sand, followed by increasingly compacted sandy clay underlain with either sterile (clay with calcium carbonate inclusions) soil or bedrock. Ash was encountered in Auger Holes 14-17 at an average depth of 64 cm below the ground surface. Excavation Unit 6 was then excavated in this area, confirming the presence of substantial subsurface remains in Activity Area 2.

CHRONOMETRIC DATA

Methods

Eleven radiocarbon, 8 tree-ring, and 15 obsidian hydration samples were recovered from LA 51912 and submitted for analysis. Specific methods employed during the course of each specific analysis are outlined in individual reports presented in Appendix 1. The results are presented below.

Radiocarbon Dates

Eleven carbonized wood and plant samples from cultural features and occupational surfaces defined at LA 51912 were submitted for analysis (Table 1). Corrected radiocarbon dates (Beta Analytic 12/11/87, 12/1/88, and 1/31/89) are presented in the following table along with the features or strata with which they were associated.

Table 1. Radiocarbon dates, LA 51912

Beta number	FS number	Feature/Stratum	C-14 date
23854	82	Feature 2, pit structure hearth	2490 ± 70 B.P.*
23857	191	Stratum 102	1950 ± 90 B.P.
29295	73	Stratum 102	2440 ± 100 B.P.
23859	354	Feature 10, fire-cracked rock, ash dump	2250 ± 70 B.P.
23860	357	Feature 11, hearth	2400 ± 70 B.P.
23861	360	Feature 9, hearth	2200 ± 80 B.P.
23862	373	Feature 15, hearth	1840 ± 80 B.P.
23863	381	Stratum 30	2110 ± 80 B.P.
23864	386	Feature 17, posthole	1900 ± 70 B.P.
29292	61	Stratum 101	2030 ± B.P.
29293	94	Pit structure fill	1810 ± 30 B.P.

* Corrected for C-4 photosynthetic pathway. Source: Darden Hood 12/88 Beta Analytic.

Obsidian Hydration

Obsidian hydration analysis was performed by John Montgomery at the Obsidian Hydration Laboratory at Eastern New Mexico University, Portales, on 15 obsidian samples from LA 51912. The sources for the obsidian artifacts were provided by Bart Olinger. These were obtained through X-ray fluorescence (XRF) methods at Los Alamos National Laboratories. Olinger's data are presented in Appendix 1. Artifacts associated with cultural strata are presented in Table 2. Rim readings from the remaining artifacts are presented in Appendix 1.

Table 2. Selected obsidian lithic samples, LA 51912

FS number	Artifact Type	XRF number	Source	Hydration Date
57	En Medio projectile point base	057-A	Obsidian Ridge	3374 ± 657
174	Whole En Medio point	057-B	Obsidian Ridge	No rim date
160	Point fragment	160	Polvadera Peak	1987 ± 113 B.P.
338	Biface fragment	338	Obsidian Ridge	591 ± 139 B.P.
38	Biface	038	Obsidian Ridge	1642 ± 227 B.P.
93	Biface fragment	093	Cerro del Medio	3420 ± 204 B.P.
153	Biface fragment	153	Cerro del Medio	3834 ± 438 B.P.

* Recovered from floor of pit structure (Stratum 102) during testing.

Tree-Ring Analysis

Eight tree-ring samples from LA 51912 were submitted for dendrochronological analysis to the Laboratory of Tree-Ring research in Tucson, Arizona. Their response is presented in Appendix 1. No dates were derived because their master chronology does not extend far enough in time (approximately to A.D. 600) to overlap with these samples. The specimens were added to the master list until the sequence is extended.

Discussion

The radiocarbon dates from LA 51912 suggest that the pit structure (Feature 1) was occupied somewhere between 2490 ± 70 B.P. and 1950 ± 70 B.P. (540 B.C. ± 80). Activity Area 2 shows six results ranging from 2400 ± 70 B.P. to 1840 ± 80 B.P. (450 B.C. ± 70 and A.D. 110 ± 80). Although radiocarbon dating has received criticism from the scientific community, improvements in radiocarbon techniques have increased its reliability in recent years. At LA 51912, the relatively high quantity of C-14 dates from this small site, the majority of which cluster around a mean with a low standard deviation, suggest that the primary occupation of the site occurred several centuries B.C., well within the range proposed by Irwin-Williams (1973:11-12) for the En Medio complex. The dates derived for the obsidian hydration are somewhat more problematic and occasionally conflicting. The error coefficients are also, in some instances, relatively pronounced. However, several of the hydration dates intersect with the C-14 curve, suggesting that the obsidian artifacts were deposited within the Late Archaic component. Certainly the closest correspondence between the two dating methods exists between sample number 167-5 (2490 B.P ± 70 and the hydration date of 2356 B.P ± 66), and between sample number 160 (1950 ± 70 B.P. and 1987 ± 113 B.P.). The projectile points, which were dated through both C-14 association and obsidian hydration, are also consistent with the descriptions of the morphological attributes and temporal intervals typically given for the En Medio complex (800 B.C.- A.D. 400). The tree-ring dates from LA 51912 will remain archived against a time when the master tree-ring list for this area is extended far back enough in time to provide a comparison. The interested reader is referred to Ahlstrom (1985) and Blinman (1990) for overviews and critiques of current absolute dating techniques.

POLLEN ANALYSIS

Methods

Pollen analysis was performed by Glenna Dean at the Castetter Laboratory for Ethnobotanical Studies, Albuquerque. Fifteen sediment samples, collected from a variety of features and cultural contexts, were submitted for analysis. The methods used during the course of the analysis are discussed in Appendix 2.

Results

The results of the analysis of the palynological data set from LA 51912 do not provide any substantive insights into the prehistoric subsistence patterns of the Late Archaic adaptive system. As noted in Sullivan and Lent (1987), preservation was extremely poor due to modern-day erosion. A number of pollen taxa were identified in the pollen analysis, and a high probability exists that they were deposited postoccupationally. No corn pollen was found.

Although there is a risk that pollen will be destroyed by heat, a sample from the hearth was taken. The antiquity and condition of the site precluded a great latitude of sampling options. According to the research design (Sullivan and Lent 1987:24), subsistence data were a priority. Since hearths figure prominently in food processing, a decision was made to sample all areas having information potential. This technique is sometimes informally referred to as "shotgun" sampling.

Species identification of carbonized materials from Feature 2 (main pit structure hearth) prior to obtaining radiocarbon samples suggested that sagebrush and coniferous species were being burned. Species of cheno-am, sagebrush, and low-spine composites were present below the lower slab, which contained substantial quantities of charcoal and ash, which may have been partially shielded from the heat. The absence of domesticates or wild plant products from the flotation samples (Appendix 2) confirms the results of the palynological analysis from LA 51912.

BOTANICAL ANALYSIS

Methods

A total of 26 samples was systematically collected from features and occupational surfaces at LA 51912. These were analyzed by Mollie S. Toll from the Castetter Laboratory. Methods used for extracting botanical specimens from the flotation samples are discussed in Appendix 3.

Results

The results of the flotation analysis were disappointing from the perspective of revealing the prehistoric economy of the site. In Appendix 3, Feature 2 is incorrectly referred to as an extramural hearth. However, it is probable that this feature was included in the roofed-over portion of the pit structure. No evidence whatsoever of cultivars (particularly corn) was detected, confirming the pollen analysis. Charcoal from the feature fill consisted primarily of coniferous species, although a single sample, FS 82, was probably big sage. The total absence of domesticates as well as the paucity of wild plant species (a single charred goosefoot seed) is a significant finding in itself, especially in view of the ground stone artifacts, heating features, mealing bin, and storage facilities at the site. It may be that the site was too contaminated by erosion or other sources for botanical remains to be present. This is unlikely, since abundant charcoal was recovered; this assumes that other charred plant remains, if present, would also be detected. Two remaining possibilities exist: either some of the features were misinterpreted (i.e., the mealing bin), or no food processing occurred at this site whatsoever. This seems improbable, since ground stone and other features were present in association with reliable stratigraphic contexts. Either poor preservation inhibited the recovery of meaningful subsistence data, or the bulk processing and storage of wild or domesticated foods played a subordinate role at LA 51912.

CERAMIC ARTIFACTS

Methods

Results from the analysis of ceramic artifacts located on the surface of LA 51912 are presented below. This assemblage formed the later component of this site. The sherds were piece-plotted and collected. Two surface concentrations were tested by means of 1 by 1 m excavation units and were determined to be confined to the first 10 cm of surface deposition.

All ceramic items collected during data recovery were analyzed. Taxonomic data for individual sherds include sherd type, paste characteristics, vessel width, vessel type, portion, slip, polish, and decoration. These variables were used to categorize the sherds by pottery types, which are summarized in Table 3.

Table 3. Ceramic artifacts collected from the surface, LA 51912

Type	Quantity	Temporal Interval
Semi-obliterated corrugated	4	
Gray ware, unknown	18	
Kwahe'e Black-on-white	2	A.D. 1100-1200
Tewa Black	2	A.D. 1600-1800+ (Schaafsma 1979)
Sankawi Black-on-cream	3	A.D. 1550-1650 (Harlow 1973:76-77)
Sapawi Micaceous	1	A.D. 1450-1600 (Warren 1981:Table 1)
Vadito Micaceous	4	A.D. 1600 (?) to 1800 (?) (Dick 1965; Warren 1981)
Brown ware, unknown	1	
Total	35	

Conclusions

Analysis of the materials recovered during test excavations of LA 51912 (Sullivan and Lent 1987:17-18) suggested that the majority of the ceramic types dated to the Classic period (A.D. 1415 to 1550), as well as the Protohistoric and Historic periods. The results of the pottery analysis from the data recovery program is consistent with these findings. It was determined on the basis of architectural variables and radiocarbon dates that the sherd scatter was not associated with the subsurface remains. The ceramics, covering a wide temporal range, appear to be a part of the general artifact scatter distributed over a large area in this populated region of the Rio Grande. As such, they do not contribute in any substantive way to our interpretation of the subsurface features.

FAUNAL REMAINS

All faunal remains recovered from LA 51912 were analyzed, a total of 147 items (Table 4). Faunal analysis was performed by Nancy Akins of the Research Section staff. Taxonomic data monitored for each item included the taxon, side, element, portion, age, burn, color, and condition. The full analysis records will be submitted to the New Mexico State Historic Preservation Division's Archaeological Records Management System files at the conclusion of the project.

All of the faunal remains were fragmentary. Faunal items were distributed unevenly over the site. A single item was recovered from the surface, a large fossilized mammal bone. Most of bones were recovered from either the formal features or the structural fill and the floor of the pit structure. Only three faunal items were found on the floor of Activity Area 2 (Stratum 30). Ten faunal items were recovered from Stratum 100, the surface associated with Activity Area 2. The floor of the pit structure, Stratum 102, had 29 faunal items, which constituted 19.7 percent of the total assemblage, including three awl fragments recovered from 9N/11E.

Perhaps the most significant information to emerge from the data set is the high percentage of burned items, 90.8 percent. Much of the floor of the pit structure was burned, and several features were highly burned, but it is unclear whether the faunal remains were burned during the course of processing or post-occupationally. Seventeen fossilized bones were present in the assemblage, 16 from pit fill and 1 from the surface. Fossilized bones frequently occur within the terrace gravels adjacent to the site. The dominant species category was small mammal, constituting 15 percent of the total assemblage, followed by medium-to-large mammal (11.56 percent) and large mammal (8.9 percent). A "snap break" was identified on a medium mammal long bone fragment (FS 198).

The quantity and condition of the faunal remains suggests that the procurement and processing of faunal materials occupied a relatively important position in the site economy. The emphasis on medium-to-large mammals in the assemblage may indicate a hunting focus. These hunting activities could have occurred in conjunction with quarrying activities near the obsidian sources (Obsidian Ridge, Cerro del Medio, Polvadera Peak) isolated by the X-ray fluorescence data. The presence of awl fragments associated with cultural strata within the pit structure indicates specialized activities. Bone awl usage is typically associated with puncturing hides for sewing, weaving, basketry, and other tasks involving perforation (Barnett 1973:25). It can be assumed that the presence of these artifacts suggests some degree of involvement with one of these activities.

Table 4. Faunal remains, LA 51912

Species	Feature 1								Excavation Units 13-16N/11-15E						Surface	Site totals	
	Fill		Stratum 102		Stratum 100		Totals		Levels 3, 4		Stratum 30		Totals				
	#	% burned	#	% burned	#	% burned	#	% burned	#	% burned	#	% burned	#	% burned	#	#	% burned
Rodent			1	100.0			1	1.7								1	1.5
Small mammal	3	75.0	11	100.0	8	100.0	22	37.3								22	33.8
Cottontail rabbit	1	0.0					1	1.7								1	1.5
Medium mammal	1	0.0					1	1.7								1	1.5
Medium-to-large mammal	6[a]	100.0	10	100.0	1	100.0	17	28.8			1	100.0	1	16.6		18	27.7
Large mammal	8[a]	100.0	4	100.0	1	100.0	13	22.0	3[b]	0.0	2	100.0	5	83.3		18	27.7
Artiodactyl	1	100.0	3[a]	100.0			4	6.8								4	6.1
Totals	20		29		10		59		3		3		6			65	
% burned		85.0		100.0		100.0		94.9		0.0		100.0		50.0			90.8
% checked		15.0		13.8		0.0		11.9		66.7		0.0		33.3			13.8
Fossil bone	16														1	17	

[a] awl fragment
[b] one worked edge and polish

small mammal = jackrabbit or smaller
medium mammal = jackrabbit to coyote
large mammal = larger than coyote
artiodactyl = hoofed mammal

LITHIC ARTIFACT ANALYSIS

Lithic analysis was performed by Daisy Levine and Peter Bullock, data entry by Rod North. Statistical analysis was conducted by Tim Maxwell, Anthony Martinez, and Rod North.

Methods

Variables monitored on individual artifacts during the analysis of the lithic artifact assemblage included material type, artifact type, percentage of dorsal cortex, portion, flake dimension, presence of retouch, presence of utilization, platform type, texture, recycling, and heat treatment.

Biface flakes were defined using a modified polythetic set (Acklen et al. 1983) developed primarily through experimental observations (Acklen and Doleman, personal communication, 1982). The following list presents the variables monitored for flakes with platforms present, and those on which the platforms were collapsed or missing. Flakes meeting 70 percent or more of the criteria listed were considered to represent some later stage (occasionally referred to as tertiary) of lithic reduction, that is, biface thinning, tool manufacture, or retouch.

Flakes with platforms:

1. Platform type is (a) multifaceted; (b) prepared (retouched and/or abraded).
2. Platform is lipped.
3. Platform angle is less than 45 degrees.
4. Dorsal scar orientation is: (a) parallel; (b) multidirectional; (c) bidirectional.
5. Dorsal topography is regular.
6. Edge outline is even.
7. Flake is less than 5 mm thick.
8. Flake has a relatively even thickness from proximal to distal end.
9. Bulb of percussion is weak.
10. There is a pronounced ventral curvature.

Flakes with collapsed or missing platforms:

1. Dorsal scar orientation is (a) parallel; (b) multidirectional; (c) bidirectional.
2. Dorsal topography is regular.
3. Edge outline is relatively even.
4. Flake is less than 5 mm thick.
5. Flake has a relatively even thickness from proximal to distal end.
6. Bulb of percussion is weak.
7. There is pronounced dorsal curvature.

Because the lithic artifact data set was comparatively small, only basic statistical methods (such as cross-tabulations, ratios, percentages, and chi-square) were used. A tertiary index and a core reduction (manufacturing) index (Chapman 1982) were calculated. In the core reduction index, tertiary flakes are not included. The tertiary index is derived by dividing the frequency of biface flakes by the sum of core flakes and angular debris. The core reduction index is computed by using the formula

$$\frac{F\text{-}AD}{C}$$

where F represents the percentage of unutilized core flakes, AD the percentage of unutilized angular debris, and C the percentage of unutilized cores. Tertiary flakes are excluded from this equation. This process is similar to the manufacturing index as defined by Chapman (1982) and tested by Acklen et al. (1983), but it may monitor the type of core reduction more accurately.

Debitage

Morphological attributes on 1,747 items of debitage were monitored and are presented below, and SPSS program cross-tabulations are presented in Appendix 4, Tables 1-16. Actual counts are given in the tables, while percentages are used in the discussions below.

Artifact Type and Material Selection

In all, 62.9 percent of the assemblage is composed of core flakes, whereas 2.4 percent of the total is angular debris, yielding a flake-to-angular-debris ratio of 26:1. Core flakes account for 62.9 percent of the overall assemblage, while biface flakes compose 34.1 percent of the total. Also present are 0.5 percent rejuvenation flakes and 0.1 percent blade flakes (Appendix 4, Table 1). The dominant material type (by a large margin) is Jemez obsidian (85.7 percent), followed by chalcedony (9.7 percent), chert (4.1 percent), basalt (0.3 percent), and quartzite (0.2 percent) (Appendix 4, Table 1).

Cortex

Continuous cortex data (Appendix 4, Table 1) suggest that 91.2 percent of the total amount of the recovered core flakes is noncortical. Cortex is absent on 93.6 percent of the obsidian flakes, and 3.0 percent has less than 25 percent. Cortex covering the entire dorsal surface of the artifact is present on only 0.5 percent of the obsidian materials (Appendix 4, Table 2). Cross-tabulating artifact type by material type (Appendix 4, Table 3) suggests that core flakes have the most cortex (7.3 percent), followed by angular debris (0.10 percent). Only 0.8 percent percent of core flakes and biface flakes have 100 percent cortex, whereas most cortex (0.4 percent) occupied less than 25 percent of the dorsal surface.

Portion

Of the combined debitage, 27.3 percent is whole (Appendix 4, Table 4), 72.7 percent is broken, 24.0 percent is distal and medial, and 20.8 percent is medial only. In the whole flakes category, 77.6 percent are manufactured from Jemez obsidian. Proportionately, there are more obsidian broken flakes (88.8 percent) than chalcedony (7.7 percent) or chert (3.15 percent). Whole core flakes form 14.1 percent of the assemblage, and biface flakes 10.5 percent (Appendix 4, Table 5).

Platforms

Monitored platform data are presented in Appendix 4, Table 6. Of the monitored debitage, 58.2 percent have absent platforms, 8.6 percent are crushed or collapsed, 8.1 percent are single faceted, and 6.1 percent are ground and/or prepared. In the category of core flakes, 9.2 percent had single facet platforms, and 5.3 percent were ground and/or prepared (Appendix 4, Table 7). The most prevalent platform type for tertiary debitage is collapsed or crushed (12.3 percent).

Heat Treatment

The dominant heat treated material type is chalcedony (1.0 percent; see Appendix 4, Table 8). Both chert and Jemez obsidian exhibit some form of heat modification (0.4 percent each). Core flakes (1.2 percent) and small angular debris (0.5 percent) are the artifact types displaying the most evidence of heat modification (Appendix 4, Table 9).

Modified Edges

Appendix 4, Table 10, presents the frequency of modified edges by material type. Overall, 11.3 percent of the assemblage displays some degree of modification. Obsidian is the material type with the highest amount of modified edges (10.3 percent), followed by chalcedony (4.8 percent). Jemez obsidian is also the material type with more than two modified edges recorded for a single item (0.5 percent of the total assemblage). The core flake is the debitage type showing the most edge modification (8.4 percent of overall assemblage; Appendix 4, Table 11), followed by biface flakes (8.3 percent); however, 88.7 percent of the combined artifacts are unmodified.

Retouched and Utilized Debitage

In the category of informal tools, the material type with the highest frequency of unidirectional and bidirectional retouch is Jemez obsidian (5.4 percent), followed by chalcedony (0.2 percent). Retouch is absent on 94.0 percent of the assemblage (Appendix 4, Table 12). Core flakes display the highest frequency of marginal retouch (4.8 percent), and biface flakes are the next most frequently retouched (1.1 percent of total). Also in the core flake category, 4.0

percent show unidirectional retouch, 0.7 percent bidirectional retouch, and biface flakes have 0.9 percent unidirectional retouch and 0.2 percent bidirectional retouch. A total of 11.9 percent of the core flakes are utilized, as well as a relatively high number of biface flakes (48 or 8.0 percent) (Appendix 4, Table 13).

Cores

Five cores were recovered from the excavations at LA 51912. Attributes monitored during core analysis include material type, artifact type, dimensions, texture, platform data, whether or not use potential of core is exhausted, alteration, percentage of cortex, kind of cortex, and type, number, and location of damaged edges.

Although 85.7 percent of the debitage is composed of obsidian, no cores were of Jemez obsidian. Instead, the cores appear to be manufactured from several varieties of chert and chalcedony and may have been quarried locally. Only two cores were recovered from the interior of the pit structure, and one from Activity Area 2. Two cores were recovered from the surface and may not be associated with the occupation of the pit structure and associated activity areas. Of the combined cores, three were of chert, and two were of chalcedony. Platform data suggest that four were multidirectional and one unidirectional. Four were heat treated, and one was fire-cracked. Although four cores were considered to be expended (exhausted), flake removal potential existed on the chert core recovered from Level 7 at 9N/10E within the pit structure.

Tools

A total of 45 formal tools were recovered from the excavations at LA 51912, including 9 projectile points (Fig. 13). Thirteen items of ground stone were also recovered. These are presented in Table 5. The distribution of tools on the surface of the site is presented in Figure 4. A hoe and various bifaces and unifaces are illustrated in Figs. 14 and 15.

Projectile Points

Nine projectile points were recovered during excavation (Fig. 13) and one during test excavations (Sullivan and Lent 1987:Fig. 7; see also FS 57). Attributes monitored during analysis include material type, projectile point type, dimensions, weight, stem length and width, blade shape and modification, portion, stem edge shape, basal morphology, shape of cross-section, stem modification, and basal condition.

Appendix 4, Table 14, presents material type by projectile point type. All of the projectile points were manufactured from Jemez obsidian. Four whole or fragmentary En Medio points were recovered, one San Jose type, one preform or blank, one Archaic unknown type, and two nondiagnostic types. The base and midsection of an En Medio point (FS 57-A) recovered during testing is included in this analysis because it was recovered from good context and is a temporally diagnostic artifact. Several tools were included in the obsidian sourcing and obsidian hydration analyses (see Table 2).

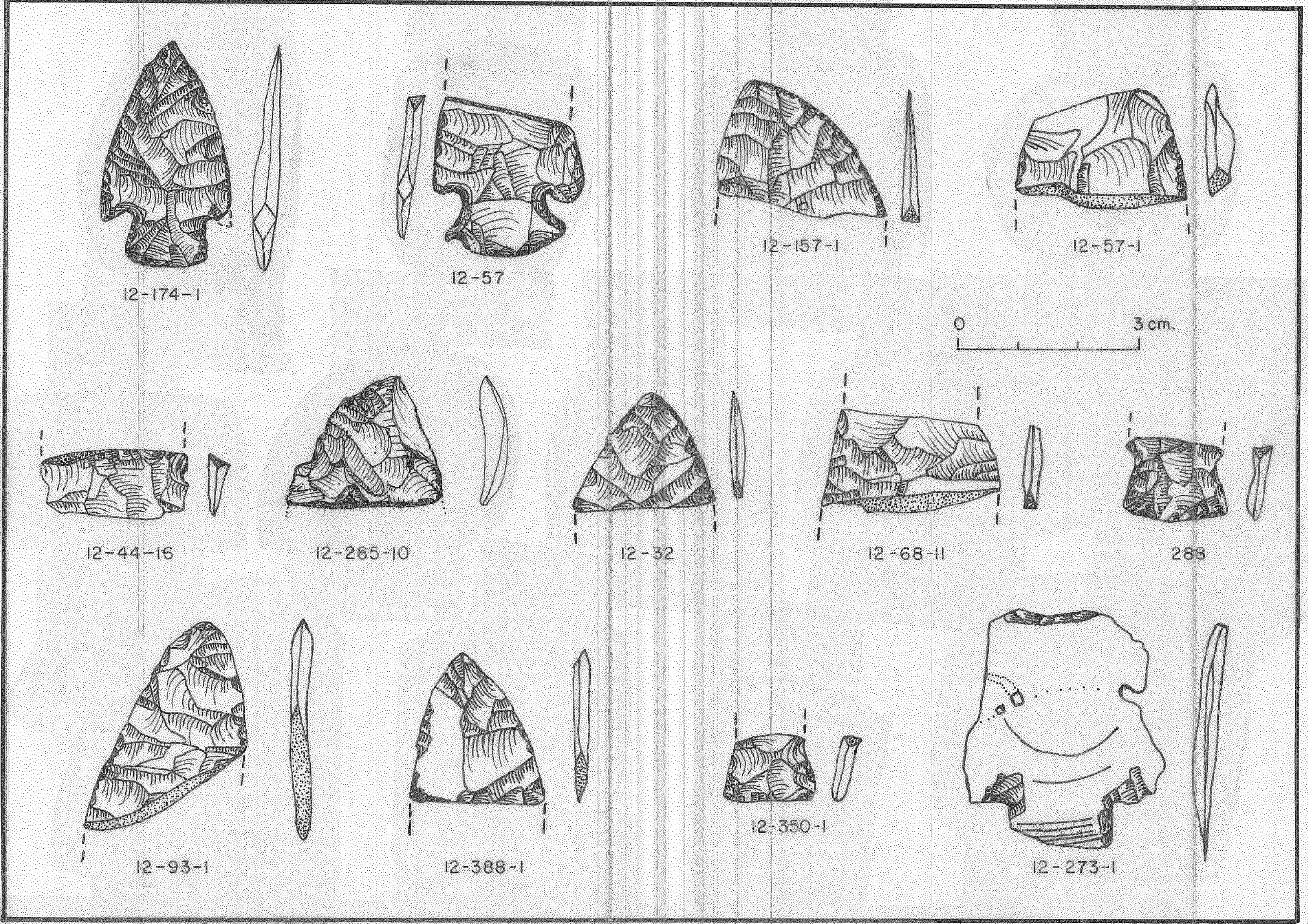

Figure 13. Whole and fragmentary projectile points, midsections, tips, bases, preforms, and bifaces, LA 51912.

Table 5. Tools by Material Type, LA 51912[1]

Tool	Basalt	Quartzite	Chert	Chalcedony	3400	3500	3524	3525	3530	Sandstone	Micaceous Schist
Chopper	2	1	1								
Hammerstone		1									
Hoe											1
Doublesided Biface					1						
Biface			3	1			5	8	1		
Projectile point[2]						2	3	2	2		
Cobble uniface			3	1							
Uniface							2	2			
Roughout							1				
Compound tool			1	1							
One-hand mano	6										
Two-hand mano	2										
Mano fragment	2									1	
Metate fragment										1	
Slab metate		1									

[1] Obsidian source numbers from Warren (1979).

[2] Does not include projectile point recovered during test excavations.

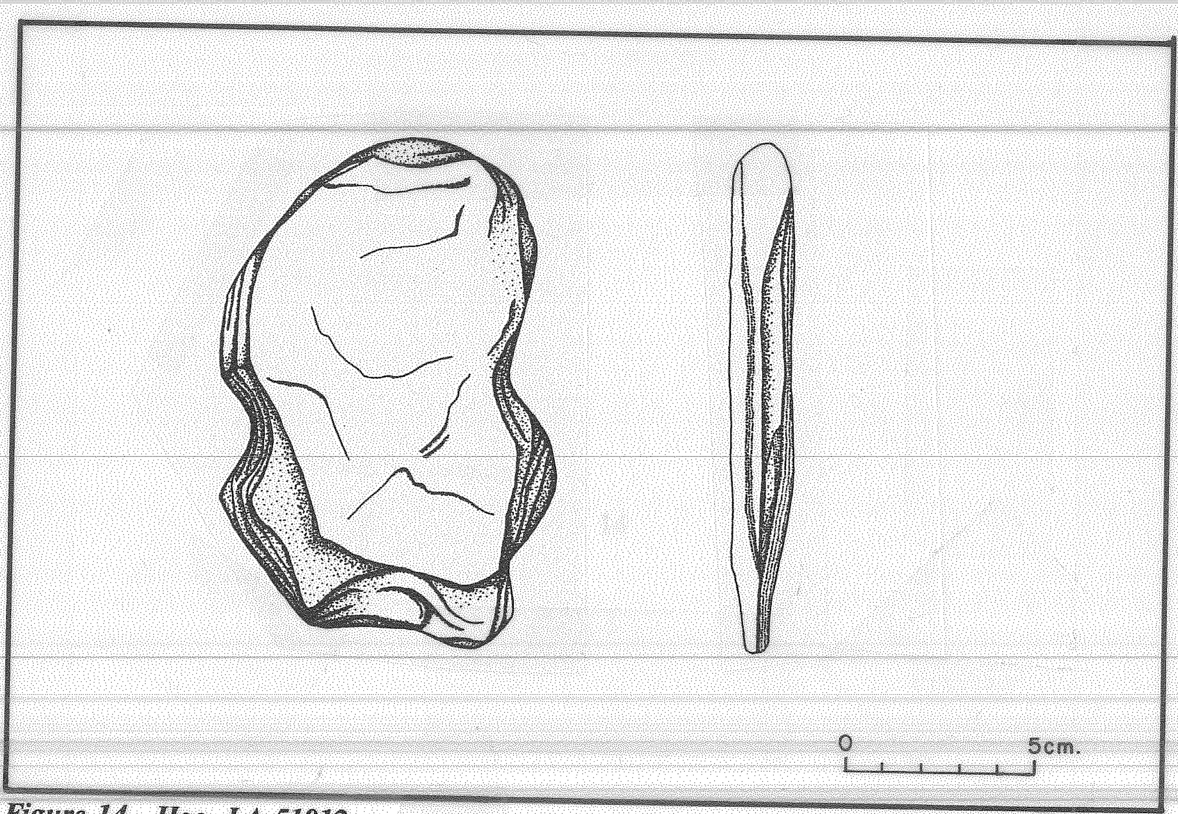

Figure 14. Hoe, LA 51912.

Discussion

Implicit in the analysis is an assumption that material remains on an archaeological site reflect the range of activities performed at that site. However, with some notable exceptions, items critical to subsistence are carried off for further use, leaving only the byproducts of the activities, many of which may not be visible archaeologically. Ethnographic data from Far North Eskimo groups (Binford 1977:11) shows that there is an inverse relationship between the importance of an item as measured by the frequency with which it is carried, and its occurrence as an item remaining on the site.

SURFER program contour maps and three-dimensional graphics (Fig. 16) illustrate the distribution of core flakes on the pit structure floor. According to these figures, this distribution appears to be relatively uniform, except for a hiatus in the vicinity of 7 N/11E. This graphic also suggests that there is a concentration of core flakes occurring at 8N/10E.

The distribution of lithic artifact types according to their provenience on the site is presented in Appendix 4, Table 15. Of the combined artifact types, 65.4 percent (N=719) of

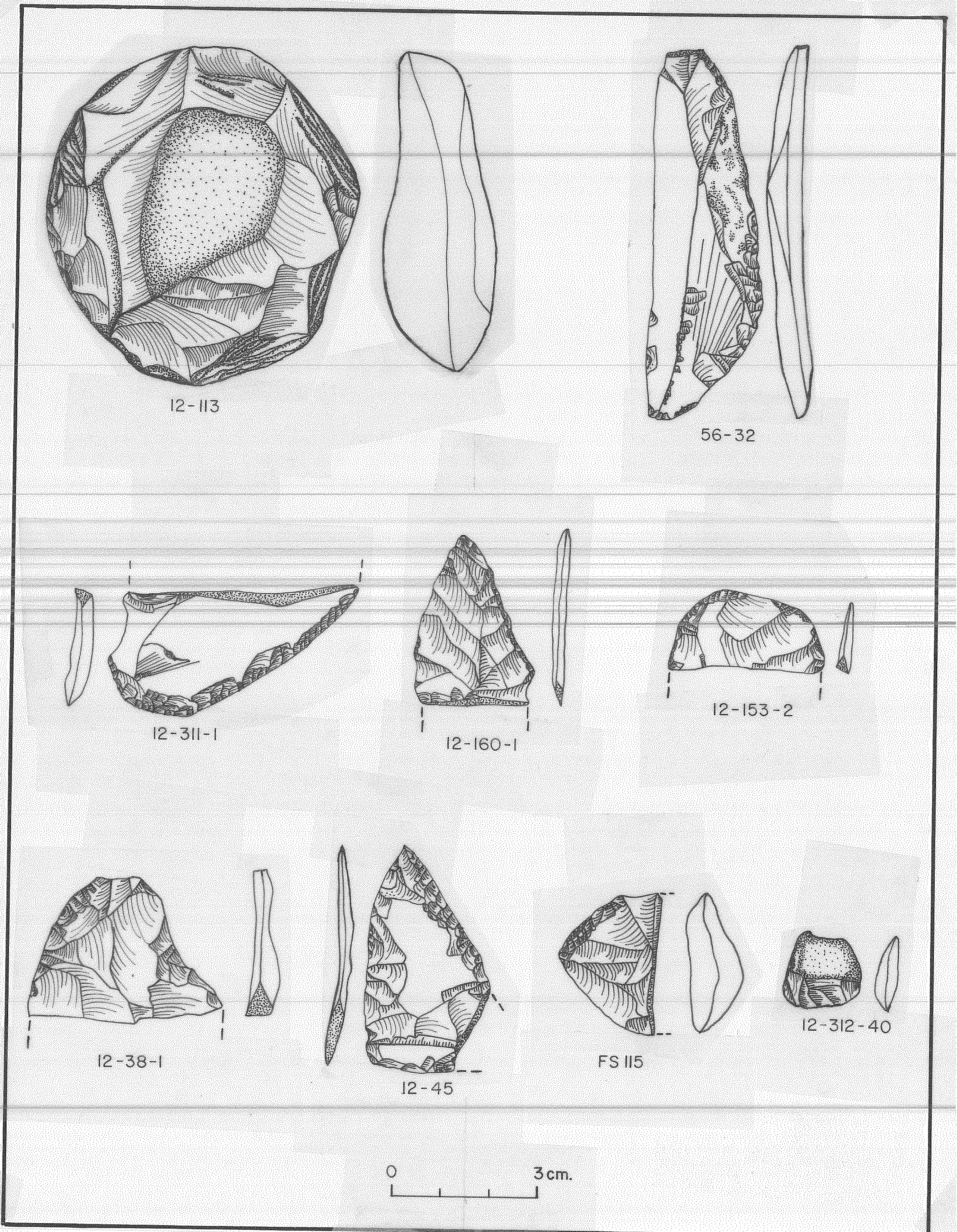

Figure 15. Bifaces and unifaces, LA 51912.

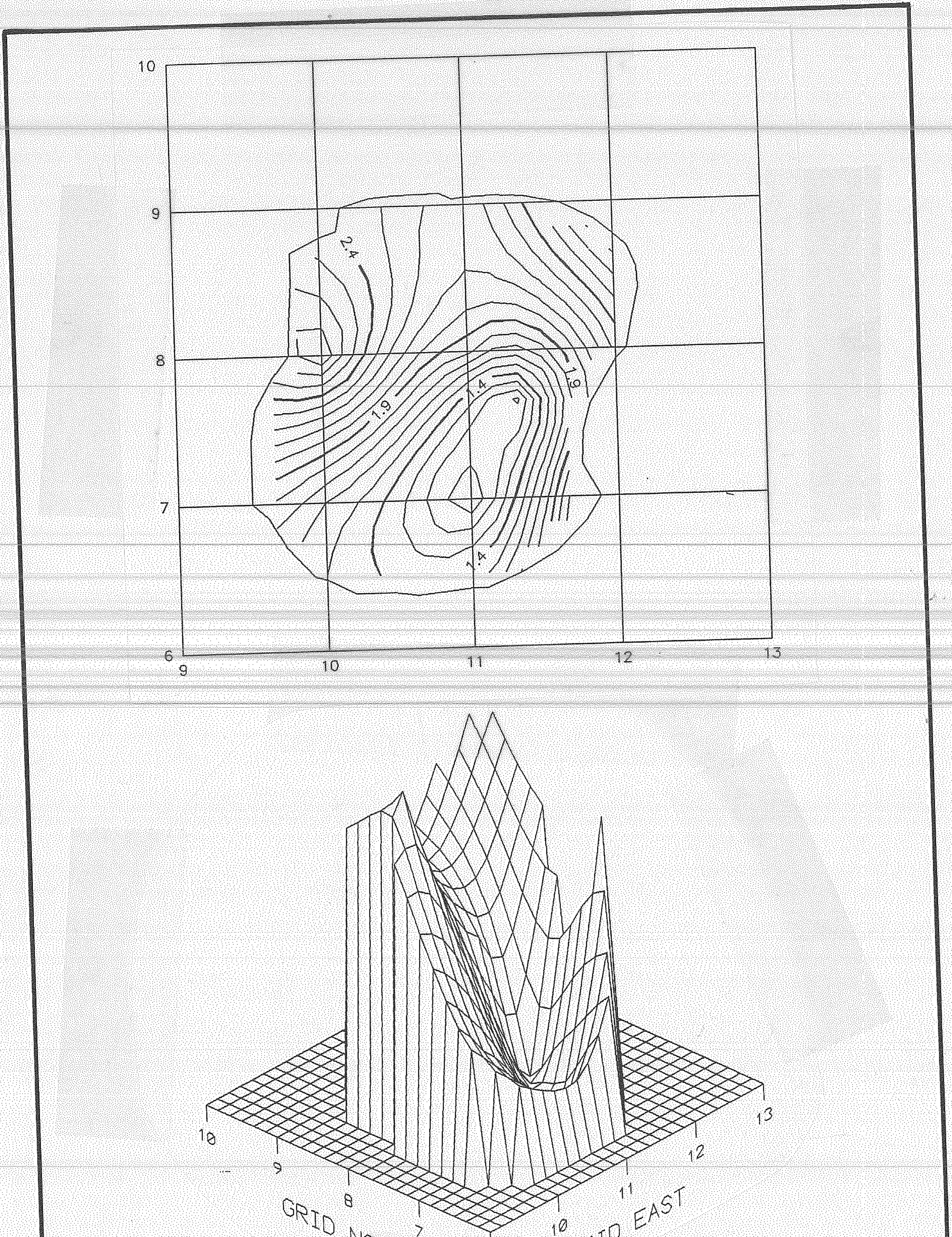

Figure 16. Distribution of lithic debitage, pit structure floor, contour and projection, LA 51912.

the core flakes and 76.1 percent (N=453) of the biface flakes occur within the pit structure and the pit structure features. Activity Area 2 contains 31.9 percent of the core flakes and 23.8 percent of the biface flakes, and Activity Area 3, 2.6 percent of the core flakes and 0.4 percent of the biface flakes. Seven rejuvenation flakes also occur inside of the pit structure. Only 23 items of angular debris (1.3 percent of total assemblage) occur within the structure, 0.9 percent in Activity Area 2, and 0.6 percent in Activity Area 3. Artifact types associated with occupational strata (Stratum 102, pit structure floor; Stratum 100, Activity Area 1 floor; Stratum 30, Activity Area 2 floor) consist of 31 core flakes, 1 large piece of angular debris, and 11 biface flakes associated with Stratum 30; 38 core flakes, 1 small piece of angular debris, and 30 biface flakes associated with Stratum 100; and 230 core flakes, 10 small pieces of angular debris, and 180 biface flakes associated with Stratum 102. The chi-square test shows significant differences between occupational strata and reduction sequences at the 0.5 level (chi-square = 27.099, DF = 15, P = 0.0279, no Yates correction and E.F. > 5).

The variability may be explained by statistical error as well as de facto differences between assemblages. In excess of 200 biface flakes were concentrated in a fairly circumscribed area close to the pit structure hearth (F2) in grids 8N/12E and 8N/13, and they are associated with the feature as well as the pit structure floor (Stratum 102). There is also some suggestion of variability in frequencies of cortex between the occupation surfaces of the pit structure in relation to Activity Areas 2 and 3 (Appendix 4, Table 17). Noncortical debris dominates the lithic assemblage of the pit structure, but is less frequent in the activity areas. It appears that, while biface manufacture and curation was occurring to some degree in the associated extramural activity areas, it may have been one of the principal activities within the structure.

Since it was unclear whether the surface artifacts were associated with the pit structure and activity areas, these items were excluded from the core reduction index. However, this did not affect the computation too drastically because only 1.4 percent of the debitage (core flakes and angular debris) was located on the surface of the site. Results were significantly altered by the frequency of cores, only three of which occur within the context of controlled subsurface stratigraphy. These are manufactured from local materials, and no obsidian cores were recovered. The core reduction index, which was calculated to be 17.5, holds no surprises. This value is extremely high, reflecting the high incidence of tertiary reduction, an evaluation consistent with the tertiary index of 0.53. Biface flakes, in fact, account for 34.1 percent of the combined debitage, which is dominated by obsidian, a material type frequently selected for biface manufacture within the Rio Grande drainage and elsewhere.

Lithic material selection may reflect area of contact and variations in subsistence strategies. The low frequency of cores overall in combination with the absence of obsidian cores and the very low percentage of cortical materials suggests that partially decortified materials were introduced to the site from quarry areas in the Jemez Mountains.

Projectile point morphology on several whole and fragmentary items and discarded preform or projectile point blanks suggests affinities with the En Medio complex (800 B.C.-A.D. 400) (Irwin-Williams 1973:Fig. 6). Comparison of the temporal intervals given by Irwin-Williams with absolute dates obtained from strata and features associated with the projectile points shows that they fall with the conventional range of Late Archaic adaptation in this area. Collecting attractive projectile points appears to have been as popular an activity in prehistoric times as is is today, which probably accounts for the presence of the San Jose point in this late

Archaic assemblage.

It is evident on the basis of the debitage analysis alone that one of the major activity at LA 51912 was the manufacture and curation of a variety of lithic tools. The abundance of tertiary debitage alone would support this conclusion. However, a number of projectile points and bifacial and unifacial tools were also present. Informal tools, such as retouched and utilized flakes, are also present in significant numbers (Appendix 4, Tables 10-13). A reconstructed biface, recovered from two separate proveniences, was apparently broken in manufacture when the attempted notching resulted in breakage and subsequent discard (Fig. 17). A biface "roughout" or blank was also present, suggesting potential or aborted biface manufacture (Table 5).

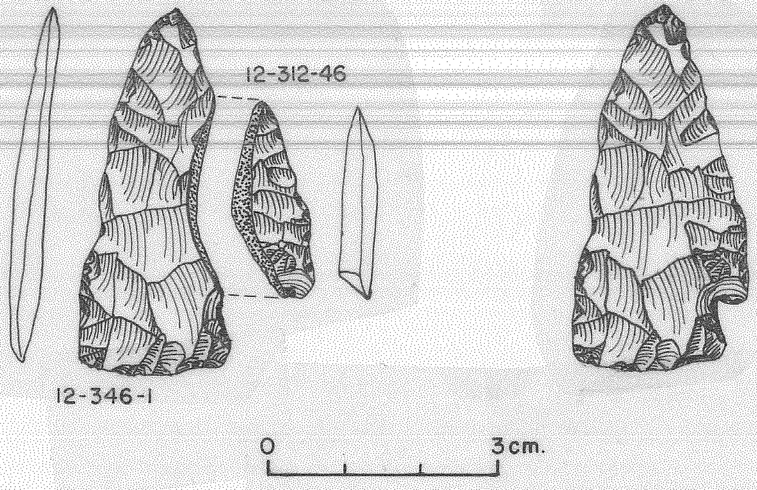

Figure 16. A projectile point broken in manufacture, LA 51912.

Gould et al. (1979:149) defines the range of the optimal cutting edge as 19 to 59 degrees, and the scraping edge at 40 to 89 degrees. Schutt (1980) selected edge angles between 30 and 60 degrees to meet the functional requirements of certain tasks. Wilmsen (1968:156-8) and Semenov (1964:205), citing ethnographic data, have postulated various technological functions fulfilled by specific edge angle categories. Wilmsen attributed edge angles of 26 to 35 degrees to cutting tools, 36 to 55 degrees to general tools, and 66 to 75 degrees to heavy duty tools. The mean edge angle monitored for the Otowi bifacial retouched tool assemblage was 49.33 degrees, which agrees with the average edge angles attributed to lithic tools selected for more generalized usage.

Edge angles on scraping tools were even more acute, averaging 56 degrees. Scrapers (associated with woodworking, bone working, and hide scraping) generally require an acute edge angle to efficiently perform those tasks. Hayden's (1979:124) observations of south central Australian aboriginal tool use corroborates Wilmsen's identification of the 66 to 75 degree angle category as important in woodworking. The average edge angle of 56 degrees on scraping tools from the Otowi assemblage falls somewhat short of that figure and more in the generalized tool class.

Ground Stone

The ground stone assemblage accounts for some 13 items, 30 percent of which are fragmentary. Although attempts have been made to stratify ground stone along functional and/or diagnostic lines (e.g., one-hand manos characteristic of Archaic times), these attempts have generally been unsatisfactory. Both two-hand and one-hand manos are present at the site, suggesting form/function relationships. Ground stone directly associated with occupational strata is confined to the pit structure within Feature 3 (Activity Area 3). The ground stone assemblage is manufactured from local materials available along the nearby Pleistocene terrace remnants to the south. These items may have been curated for possible reuse, as so-called site furniture (Binford 1979:255-273). Alternatively, large items of ground stone may have been discarded as too cumbersome and too readily available to warrant transportation.

SUMMARY AND CONCLUSIONS

The data recovery program by the Research Section at LA 51912 for NMSHTD exposed a multicomponent site consisting of a nonaggregated artifact scatter and an a Late Archaic pit structure with two associated extramural activity areas.

A synthesis of the data analysis suggests that:

1. In all likelihood (with the possible exception of a few lithic artifacts), the pit structure and activity areas are not associated with the surface artifact scatter. Diagnostic ceramics present on the surface of the site cover a wide temporal range and are probably a sample of the ubiquitous artifact scatter in this populated Pueblo area.

2. The lithic artifact assemblage is dominated by obsidian derived from three specific sources in the Jemez Mountains. Other material types encountered at the site appear to be locally procured.

3. Lithic reduction corresponds to a nonexpedient technology, emphasizing facially retouched tool production and biface reduction and maintenance. This conclusion is supported by the de facto refuse, which includes several bifaces and projectile points broken in manufacture. Statistical data suggest that there were significant differences in the activities performed within the structure as compared to exterior Activity Areas 1 and 2. There is greater evidence of intensive biface curation and reduction inside the structure.

4. Despite evidence for food processing (hearths, roasting pits, ground stone, storage facilities), this evidence is circumstantial and not corroborated by the palynological and macrobotanical analysis. Results of the botanical analysis were probably severely affected by the poor condition of the features from which the samples were taken.

5. Tool types consist of both formal and informal tool categories. Numerous bifaces were apparently used for scraping. A comparison of edge angle data with ethnographic examples suggests that inferred tool use falls into the less task-specific and into the more generalized tool category.

6. Data from faunal analysis indicates that the total assemblage is fragmentary, and 90.8 percent of it is burned. The presence of several bone awls suggests that sewing or basketry might have been included in the range of on-site activities, particularly within the structure.

7. Chronometric data, particularly radiocarbon analysis, suggest an occupation between 2490 and 1950 ± 70 B.P.; these dates are partly corroborated by the obsidian hydration data. En Medio-style projectile points, recovered from the floor of the pit structure, are morphologically consistent with the temporal intervals typically given for the En Medio complex (800 B.C. to A.D. 400)

Prior archaeological research in the northern Rio Grande suggests a prolonged pattern of use by hunter and gatherer groups, intensive use by Puebloan groups, aggregation into villages concentrated along the Rio Grande drainage, and eventual settlement by European agriculturalists. Current research suggests that the exploitation of the northern Rio Grande Valley by mobile groups may have been more extensive than previously supposed, extending throughout Pueblo and protohistoric times.

Earlier in this discussion, ethnographic hunting and gathering models were presented to provide analogs with Late Archaic settlement and subsistence in the northern Rio Grande. A comparison between these models and a sample of Late Archaic sites (both structural and nonstructural) in the Southwest was discussed. We suggested that mobility is one of the critical independent variables governing the character of archaeological deposits. We also noted that the Late Archaic period encompasses a shift away from a hunting and gathering economy in the later phases in favor of a more circumscribed, agrarian-based adaptation. However, specifying the conditions that encouraged this shift is beyond the scope of the LA 51912 data base. A regional synthesis including comprehensive data from known Late Archaic sites in the area may constitute a more appropriate venue for the formulation interpretive statements. These may concur with Irwin-Williams's original hypothesis of a preexisting Archaic founding population rather than settlement due to immigration from the south, as others have argued. Implicit in the argument is the assumption that the artifact assemblages remaining at the site provide only a fragmentary picture of the spectrum of on-site activities. Foremost among these considerations is the actual physiographic location of the site itself.

As described in the earlier section on the natural environment, LA 51912 is ideally situated to exploit a variety of natural zones. Located along a natural access route, the occupants of Otowi could exploit the resources of the Jemez Mountains (which include a variety of foraging, hunting, and quarrying areas). The immediate site vicinity provides opportunities to hunt game along the Rio Grande and utilize aquatic resources and arable land. Quarrying local raw materials from the terrace gravels may have also been an option. Prior to its destruction, a permanent fresh water spring was located several hundred meters north of the site. From a logistical viewpoint, LA 51912 was strategically situated in an optimal resource area. Selecting from these wide range of choices may have involved some degree of scheduling.

Activities suggested by the current data base include the quarrying of raw materials, lithic biface and projectile point curation and manufacture, processing fauna, and other tasks involving the use of ground stone and bone awls. The results of a thorough botanical analysis has effectively eliminated the presence of domesticated or wild plant remains. These conclusions are problematic, particularly in light of storage facilities, features, and the ground stone assemblage. However, the absence of cultigens may be consistent with the model of the Late Archaic period (cf. Elyea and Hogan 1983:77), in which En Medio was more of a hunting and gathering economy, and Basketmaker II was more agricultural. Factors accounting for the abundance of ground stone are not immediately apparent. Excluding sampling error, we might speculate that perishable items were being processed that did not preserve in the archaeological record or that ground stone was put to use for objectives other than grinding (such as processing hides). Wear patterns resulting from such activities are as yet poorly understood and warrant further investigation.

A single occupational episode is postulated for this site. A poorly preserved occupational surface was present within the pit structure and the two activity areas (determined to be contemporaneous based on stratigraphic evidence and radiocarbon data).

If the structure or activity areas were reoccupied, this was not reflected in the stratigraphic record. The structure appeared substantially burned, and burned roof fall was present, but it was not determined whether this burning occurred at the time of abandonment. Wilshusen (1988b:677-678), citing experimental data as well as prehistoric architectural examples, suggests that pit structures rarely ignite spontaneously, and that accidental combustion does not constitute a convincing argument for abandonment. The majority of the burning at LA 51912 may have been the combined result of charcoal and ash scattered from the numerous hearth features, and a fire that was deliberately set. However, presence of de facto refuse might be at variance with the notion of deliberately setting fire to the structure at the time of abandonment. Alternatively, it may question the concept of site furniture.

Kelley and Lent (1982:984-897) have suggested that the presence of thermal features within a site are unreliable indexes of seasonality, and that hearths are used by Navajo sheepherders not only during winter months, but during fall and late spring occupations as well. Selecting for shelter against the elements may not have been a primary consideration at LA 51912 because there is ample evidence of extramural activities, and the entry to the structure may have been at ground level. The aspect of the site is primarily north and not south, as would be expected to maximize solar exposure. An oxidized adobe roof cast was recovered from a floor fill stratum on the interior of the structure.

O'Laughlin (1980:234) interprets plastering the interior of a jacal superstructure as indicative of a dwelling used during colder parts of the year. To this it might added that under certain circumstances, it may be just as necessary to keep out the wind as the cold. Architecture, features, environmental variables, and site location make it difficult to infer at what time of the year LA 51912 was occupied, but it was probably not occupied during the coldest winter months.

The occupants of LA 51912 may have spent at least part of the year in mobile pursuits and other parts in more domestic activities in the vicinity of their structure. Whether the resources encountered at the site were obtained through exchange with other groups or by the occupants themselves is unknown. On-site activities include biface and projectile point curation and production, and possibly hide and bone processing. Fauna from large mammals such as mule deer and elk suggest a connection with the faunal population of the Jemez Mountains and the surrounding foothills. The fragmentary nature of the assemblage suggests that disarticulated portions may have been introduced onto the site.

A subsistence strategy based on comparisons between ethnographic examples and the existing prehistoric data base suggests that this strategy may conform most closely to the patterns proposed for a collecting strategy, that is, one expressed by decreased residential mobility, high logistical mobility, and storage. Within this framework, LA 51912 may have functioned as a base camp supporting a variety of logistical pursuits. Lack of information concerning other Late Archaic structural sites precludes making any general observations with respect to regional settlement patterns. However, natural environments like the Rio Grande drainage and Jemez Mountain foothills may have provided the right combination of variables to encourage early agriculture. Early structural sites similar to LA 51912 have the potential to provide substantial insight into the dynamics of Late Archaic subsistence systems.

REFERENCES CITED

Acklen, John C., Kurt F. Anschuetz, Scott P. Berger, Mark E. Harlan, Stephen C. Lent, and James L. Moore

1983 *Supplemental Inventory of 53 Archaeological Sites for the Mountain Land Exchange.* PNM Archaeological Report No. 4. Public Service Company of New Mexico, Albuquerque.

Ahlstrom, Richard Van Ness

1985 *The Interpretation of Archaeological Tree-Ring Dates.* Ph.D. dissertation, University of Arizona, Tucson.

Aikens, C. Melvin, David L. Cole, and Robert Stuckenrath

1977 *Excavations at Dirty Shame Rockshelter, Southeastern Oregon.* Tebiwa: Miscellaneous Papers of the Idaho State Museum of Natural History 4. Pocatello, Idaho.

Allan, William C.

1975 An Archeological Survey of a Floodwater Retarding Structure in the Corrales Watershed. In *Archaeological Reports*, Cultural Resources Management Projects 1, edited by F. J. Broilo and D. E. Stuart, pp. 145-158. Office of Contract Archeology, Albuquerque.

Allan J. W., and C. H. McNutt

1955 A Pithouse Site near Santa Ana Pueblo, New Mexico. *American Antiquity* 20(3):241-255.

Alexander, H. C., and P. Reiter

1935 *The Excavation of Jemez Cave, New Mexico.* Monograph of the School of American Research 4. Santa Fe.

Anderson, Joseph K., and Dennis Gilpin

1983 Cultural History. In *Cultural Resource Investigations on Gallegos Mesa: Excavation in Blocks XIII and IX, and Testing Operations in Blocks X and XI, Navajo Indian Irrigation Project, San Juan County, New Mexico*, edited by Lawrence E. Vogler, Dennis Gilpin, and Joseph K. Anderson, pp. 39-68. Navajo Nation Papers in Anthropology No. 24. Navajo Nation Cultural Resource Management Program, Window Rock, Arizona.

Anderson, Joseph K., and Steven E. Sessions

1979 Archaic Settlement. In *The Archaeology of Southwest Gallegos Mesa: The EPCC Survey Project*, edited by Steven E. Sessions, pp. 61-127. Navajo Nation Papers in Anthropology 1. Navajo Nation Cultural Resource Management Program, Window Rock, Arizona.

Bailey, Vernon

1913 *Life Zones and Crop Zones of New Mexico.* North American Fauna No. 35. U.S. Government Printing Office, Washington, D.C.

Baker, Craig, and Joseph C. Winter, eds.

1981 *High Altitude Adaptations along Redondo Creek: The Baca Geothermal Project.* Office of Contract Archeology, University of New Mexico, Albuquerque.

Bandelier, Adolph F.

1882 *The Southwestern Journals of Adolph F. Bandelier: 1880-1882.* Edited and annotated by Charles H. Lange and Carroll L. Riley. University of New Mexico Press, Albuquerque.

Barnett, Franklin

1973 *Dictionary of Prehistoric Indian Artifacts of the American Southwest.* Northland Press, Flagstaff, Arizona.

Beal, John D.

1980 1979 Sample and Site Specific Testing Program at Abiquiu Reservoir. Ms. on file, School of American Research, Santa Fe.

Berry, Michael S.

1982 *Time, Space and Transition in Anasazi Prehistory.* University of Utah Press, Salt Lake City.

Biella, Jan V., and R. C. Chapman, eds.

1979 *Archaeological Investigation in Cochiti Reservoir, New Mexico.* Vol. 4. Office of Contract Archeology, University of New Mexico, Albuquerque.

Binford, Lewis R.

1962 Archaeology as Anthropology. *American Antiquity* 28(2):217-225.

1968 Post-Pleistocene Adaptations. In *New Perspectives in Archaeology*, edited by Sally R. Binford, pp. 313-341. Aldine, Chicago.

1977 Forty-seven Trips: A Case Study in the Character of Archaeological Formation Processes. In *Stone Tools as Cultural Markers: Change, Evolution and Complexity*, edited by R. V. S. Wright, pp. 24-36. Australian Institute of Aboriginal Studies, Canberra.

1979 Organization and Formation Processes: Looking at Curated Technology. *Journal of Anthropological Research* 35:255-273.

1980 Willow Smoke and Dog's Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1):4-20.

Blinman, Eric

1990 Chronological Techniques and Anasazi Archaeology in the Mesa Verde Region. In *Chronology and Cultural Evolution in Prehistoric American Southwest: A Reassessment*, edited by Stephen Plog and Wirt H. Wills. University of Arizona Press, Tucson.

Boserup, Ester

1965 The Conditions of Agricultural Growth. Aldine Publishing Company, Chicago.

Breternitz, David A.

1966 An Appraisal of Tree-Ring Dated Pottery in the Southwest. Anthropological Papers of the University of Arizona 10. University of Arizona Press, Tucson.

Bullard, William Rotch, Jr.

1962 The Cerro Colorado Site and Pithouse Architecture in the Southwestern United States prior to A.D. 900. Papers of the Peabody Museum of Archaeology and Ethnology 44(2). Harvard University, Cambridge.

Castaño de Sosa, Gaspar

1965 *A Colony on the Move: Gaspar Castaño de Sosa's Journal, 1590-1591*. Albert H. Schroeder and Dan S. Matson, editors and translators. School of American Research, Santa Fe.

Chapman, Richard C.

1979 The Archaic Occupation of White Rock Canyon. In *Adaptive Change in the Northern Rio Grande Valley*, edited by J. V. Biella and R. C. Chapman, pp. 75-101. Archaeological Investigations in Cochiti Reservoir, New Mexico, vol. 4. University of New Mexico Press, Albuquerque.

1982 Dating Archeological Sites with Lithic Manufacturing Debris. In *Inventory Survey of the Lower Hidden Mountain Floodpool Lower Rio Puerco Drainage, Central New Mexico*, edited by P. Eidenbach. Human Systems Research, Tularosa, New Mexico.

Conner, Carl E., and Danni L. Langdon

1986 Archaeological Investigations at Battlement Mesa, Colorado. Ms. on file, Grand River Institute, Grand Junction, Colorado.

Cordell, Linda S.

1979 *A Cultural Resources Overview of the Middle Rio Grande Valley, New Mexico*. USDA Forest Service, Albuquerque.

Dick, H. W.

1965 *Bat Cave*. Monograph No. 27. School of American Research, Santa Fe.

Eddy, F. W.
1966 *Prehistory of the Navajo Reservoir District in Northwestern New Mexico*. Parts 1 and 2. Museum of New Mexico Papers in Anthropology No. 15. Santa Fe.

Edelman, Sandra A.
1979 San Ildefonso Pueblo. In *Handbook of North American Indians*. Vol. 9, pp. 308-316. Smithsonian Institution, Washington, D. C.

El-Najjar, M. Y.
1974 *People of the Canyon de Chelly: A Study of Their Biology and Culture*. Ph.D. dissertation, Department of Anthropology, Arizona State University, Tempe.

El Palacio
1981 Charles Lindbergh's Air Photographs of the Southwest. *El Palacio* 87(3):27-39.

Elyea, Jeanette, and Patrick Hogan
1983 The Archaic Adaptation. In *Economy and Interaction along the Chaco River*, edited by Patrick Hogan and Joseph C. Winter, pp. 393-402. Office of Contract Archeology, Albuquerque.

Euler, R. T., and M. Stiger
1981 The 1981 Test Excavations at Five Archaeological Sites in Curecanti National Recreation Area, Intermountain Colorado. Ms. on file with National Park Service, Midwest Archaeological Center, Lincoln, Nebraska.

Farwell, Robin Y.
1981 Pit Houses: Prehistoric Energy Conservation? *El Palacio* 87(3):43-47.

Fenega, F.
1956 Excavations at the Ignacio, Colorado, Field Camp: Site LA 2605. In *Pipeline Archaeology*, edited by Fred Wendorf, Nancy Fox, and Orian L. Lewis, pp. 207-214. Laboratory of Anthropology and Museum of Northern Arizona, Santa Fe and Flagstaff.

Flannery, Kent V.
1968 Archaeological Systems Theory and Early Mesoamerica. In *Anthropological Archeology in the Americas*, edited by Betty J. Meggers, pp. 67-87. Anthropological Society of Washington, Washington, D.C.

1973 The Origins of Agriculture. *Annual Review of Anthropology* 2:271-310.

Frisbie, T. R.
1967 *The Excavation and Interpretation of the Artificial Leg Basketmaker to Pueblo I Sites near Corrales, New Mexico*. Master's thesis, University of New Mexico, Albuquerque.

Frison, George C., and Bruce A. Bradley
1980 *Folsom Tools and Technology and the Hanson Site, Wyoming*. University of New Mexico Press, Albuquerque.

Gabin, Vickie L., and Lee E. Lesperance
1977 New Mexico Climatological Data: Precipitation, Temperature, Evaporation, and Wind, Monthly and Annual Means, 1850-1975. W. K. Summers, Socorro.

Gilman, Patricia Ann
1983 *Changing Architectural Forms in the Prehistoric Southwest.* Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

Glassow, Michael A.
1980 *Prehistoric Agricultural Development in the Northern Southwest.* Ballena Press Anthropological Papers No. 16. Ballena Press, Socorro, New Mexico.

Gould, Richard A., Dorothy A. Koster, and Anna H. L. Sontz
1971 The Lithic Assemblage of the Western Desert Aborigines of Australia. *American Antiquity* 36(2).

Gumerman, George J.
1966 Two Basketmaker II Pithouse Villages in Eastern Arizona: A Preliminary Report. *Plateau* 40(4)113-187.

Haecker, Charles M.
1986 *A Cultural Resource Survey Along State Road 4 within the San Ildefonso Pueblo Grant.* Environmental Section, Technical Report Bureau, New Mexico State Highway Department, Santa Fe.

Hammack, N. S., A. Ferg, and B. Bradley
1983 Excavations at Three Developmental Period Sites near Zia and Santa Ana Pueblo, New Mexico. CASA Papers No. 2.

Hargrave, Lyndon Lane
1935 *Report on Archaeological Reconnaissance in the Rainbow Plateau Area of Northern Arizona and Southern Utah.* University of California Press, Berkeley.

Harlan, Mark E., Stephen C. Lent, John C. Acklen, Kurt F. Anschuetz, John B. Broster, James L. Moore, and Bradley J. Vierra.
1986 Archeological Investigations for the Eastern Interconnection Project. Public Service Company of New Mexico, Albuquerque.

Harlow, Francis H.
1973 *Matte Paint Pottery of the Tewa, Keres and Zuni Pueblos.* Museum of New Mexico, Santa Fe.

Hassan, Fekri A.
1977 The Dynamics of Agricultural Origins in Palestine: A Theoretical Model. In *Agricultural Origins*, edited by C. Reed, pp. 589-609. Mouton, The Hague.

Haury, Emil W.

1950 The Stratigraphy and Archaeology of Ventana Cave. University of Arizona Press, Tucson.

1962 The Greater American Southwest. In *Courses toward Urban Life: Some Archaeological Considerations of Cultural Alternates*, edited by Robert J. Braidwood and Gordon R. Willey, pp. 106-131. Viking Fund Publications in Anthropology No. 32. New York.

Hayden, Brian

1979 *Paleolithic Reflections: Lithic Technology and Ethnographic Excavations among Australian Aborigines.* Australian Institute of Aboriginal Studies. Humanities Press, New Jersey.

Henderson, Ruth W.

1983 *Site H-26-56 in Cultural Resource Investigations on Gallegos Mesa: Excavations in Blocks VIII and IX and Testing Operations in Blocks X and XI, Navajo Indian Irrigation Project, San Juan County, New Mexico.* Edited by Lawrence E. Vogler, Dennis Gilpin, and Joseph K. Anderson. Navajo Nation Papers in Anthropology No. 24, Vol 1, pp. 338-408. Window Rock, Arizona.

Hewett, Edgar Lee

1953 *Pajarito Plateau and its Ancient People.* Revised by B. B. Dutton. School of American Research and University of New Mexico Press, Santa Fe and Albuquerque.

Hill, James N., and Nicholas Trierweiler

1989 *Prehistoric Responses to Food Stress on the Pajarito Plateau, New Mexico: Technical Report and Results of the Pajarito Archaeological Research Project, 1977-1985.* University of California, Los Angeles.

Hogan, Patrick, and Joseph C. Winter, eds.

1983 *Economy and Interraction along the Lower Chaco River.* Office of Contract Archeology, University of New Mexico, Albuquerque.

Honea, K. H.

1969 The Rio Grande Complex and the Northern Plains. *Plains Anthropologist* 14(43):57-70.

Irwin-Williams, Cynthia

1973 *The Oshara Tradition: Origins of Anasazi Culture.* Eastern New Mexico University Contributions in Anthropology 5(1). Portales, New Mexico.

Irwin-Williams, Cynthia, and C. Vance Haynes, Jr.

1970 Climatic Change and Population Dynamics in the Southwestern United States. *Quaternary Research* 1:59-71.

Irwin-Williams, Cynthia, Henry Irwin, George Agogino, and C. Vance Haynes.

1973 Hell Gap: Paleo-Indian Occupation on the High Plains. *Plains Anthropologist* 18(59):40-53.

Irwin-Williams, Cynthia, and S. Tompkins

1968 *Excavations at En Medio Shelter, New Mexico.* Interim report of the Anasazi origins project of Eastern New Mexico University. Eastern New Mexico Contributions in Anthropology 1(2). Portales.

Farwell, Robin Y.

1981 Pit Houses: Prehistoric Energy Conservation? *El Palacio* 87(3):43-47).

Fenega, F., and F. Wendorf

1956 Excavations at the Ignacio, Colorado, Field Camp: Site LA 2605. In *Pipeline Archaeology,* edited by Myra E. Jenkins and Albert H. Schroeder.

Jenkins, Myra E., and Albert H. Schroeder

1974 *A Brief History of New Mexico.* University of New Mexico Press, Albuquerque.

Judge, W. James.

1973 *The PaleoIndian Occupation of the Central Rio Grande Valley, New Mexico.* University of New Mexico Press, Albuquerque.

1982 The Paleo-Indian and Basketmaker Periods: An Overview and Some Research Problems. In *The San Juan Tomorrow, Planning for Conservation of Cultural Resources in the San Juan Basin*, edited by Fred Plog and Walter Wait, pp. 5-57. National Park Service and School of American Research, Santa Fe.

Kane, Allen, James H. Kleidon, and Mark Stiger

1985 Investigations at Site 5MT2731, an Aceramic Site, with Emphasis on Casa de Nada, an Archaic and Anasazi Multiple Occupation Area. Ms. on file with the Bureau of Reclamation, Upper Colorado Region, Salt Lake City.

Kearns, Timothy M.

1988 Basketmaker II Synthesis. In *Excavation in the Middle La Plata Valley for San Juan Coal Company*, vol. 3. Division of Conservation Archaeology No. 6. Farmington.

Kelley, N. Edmund

1980 *The Contemporary Ecology of Arroyo Hondo, New Mexico.* School of American Research Press, Santa Fe.

Kelley, Vincent C.

1979 Geomorphology of the Española Basin. In *New Mexico Geological Society Guidebook: Santa Fe County (30th Field Conference)*, pp. 281-288.

Kelley, Klara B., and Stephen C. Lent

1982 Ethnoarcheological Experiment: PM 81. In *Anasazi and Navajo Land Use in the McKinley Mine Area near Gallup, New Mexico.* Vol. 1, pp. 980-992. Office of Contract Archeology, University of New Mexico, Albuquerque.

Kelly, J. Charles

1966 Mesoamerica and the Southwestern United States. In *Archaeological Frontiers and External Connections*, edited by G. F. Echolm and G. R. Willey, pp. 95-110. University of Texas Press, Austin.

Kidder, A. V.

1927 Southwestern Archaeological Conference. *Science* 66:480-491.

Lang, Richard W.

1977a *Archaeological Survey of the Upper San Cristobal Arroyo Drainage, Galisteo Basin, Santa Fe County, New Mexico.* School of American Research Contract Program, Santa Fe.

1977b The Prehistoric Pueblo Cultural Sequence in the Northern Rio Grande. Paper delivered at the 50th Pecos Conference, Pecos, New Mexico.

Laumbach, Karl W.

1980 *Lithic Artifacts In Prehistory and History of the Ojo Amarillo.* Vol. 3, *Archaeological Investigations of Block II, Navajo Indian Irrigation Project, San Juan County, New Mexico*, pp. 849-958. New Mexico State University, Las Cruces.

Lee, Richard B., and Irvin DeVore, eds.

1968 *Man the Hunter.* Aldine Publishing, New York.

Lent, Stephen C.

1987 Testing Results at LA 58973 Near Corrales, New Mexico. Laboratory of Anthropology Notes 392. Museum of New Mexico, Santa Fe.

1988 A Proposed Data Recovery Plan for LA 6182, Located adjacent to Airport Road, Santa Fe, New Mexico. Laboratory of Anthropology Notes 437. Museum of New Mexico, Santa Fe.

Lent, Stephen C., Mark E. Harlan, and Gale McPherson

1986 Preliminary Results of an Archeological Survey in the Jemez Mountains of New Mexico for the Public Service Company of New Mexico's OJO Line Extension Project. Draft copy on file, Public Service Company of New Mexico, Albuquerque.

Lindsay, A. J., Jr., J. R. Ambler., M. A. Stein, and P. M. Hobler.

1968 Survey and Excavations North and East of Navajo Mountain, Utah, 1959-1962. Museum of Northern Arizona Bulletin No. 45. Flagstaff.

Lucas, Mary Beth

1984 Norton-Tesuque 115 kV Transmission Project Earth Resources Technical Report. Ms. on file, Public Service Company of New Mexico, Albuquerque.

Madsen, David B.
1979 The Fremont and the Sevier: Defining Prehistoric Agriculturalists North of the Anasazi. *American Antiquity* 44(4):711-722.

Martin, Paul S., and John B. Rinaldo
1950 *Sites of the Reserve Phase Pine Lawn Valley, Western New Mexico.* Fieldiana: Anthropology 38(3). Field Museum of Natural History. Chicago

Martin, P. S., J. B. Rinaldo, W. A., Longacre, C. Cromm, L. Freemen, Jr., and J. Schoenwetter.
1962 *Chapters in the Prehistory of Eastern Arizona I.* Fieldiana: Anthropology 52. Field Museum of Natural History. Chicago.

Maxwell, Timothy D.
1988 *Archaeological Survey of the Proposed Santa Fe Bypass, Santa Fe County.* Laboratory of Anthropology Notes No. 413. Museum of New Mexico, Santa Fe.

McKenna, Peter J., and Robert P. Powers
1986 Preliminary Report on the 1985 Test Survey of Bandelier National Monument, New Mexico. Prepared for the National Park Service, Southwest Region, Santa Fe.

McNutt, Charles H.
1969 Early Puebloan Occupation at the Tesuque By-Pass and within the Upper Rio Grande Valley. Anthropological Papers of the University of Michigan 40. University of Michigan, Ann Arbor.

Mera, H. P.
1934 *A Survey of the Biscuit Ware Area in Northern New Mexico.* Laboratory of Anthropology Technical Series, Bulletin 86. Museum of New Mexico, Santa Fe.

1935 *Ceramic Clues to the Prehistory of North-Central New Mexico.* Laboratory of Anthropology Technical Series, Bulletin 8. Museum of New Mexico, Santa Fe.

McNutt, Charles H.
1969 *Early Puebloan Occupation at Tesuque By-Pass and within the Upper Rio Grande Valley.* Anthropological Papers of the University of Michigan 40. Ann Arbor.

Moore, James L.
1980 Archaic Settlement and Subsistence. In *Human Adaptations in a Marginal Environment: The UII Mitigation Project,* edited by J. L. Moore and J. C. Winter, pp. 15-28. Office of Contract Archeology, University of New Mexico, Albuquerque.

Nelson, Nels C.
1914 *Pueblo Ruins of the Galisteo Basin, New Mexico.* Anthropological Papers of the American Museum of Natural History 15, part 1. New York.

1916 Chronology of the Tano Ruins, New Mexico. *American Anthropologist* 18(2):159-180.

Oakes, Yvonne R.
1978 Excavations at Deadman's Curve, Tijeras Canyon, New Mexico: New Mexico State Highway Department Projects I-040-3(55) 171 and I-040-3(36) 169. Ms. on file, Laboratory of Anthropology, Museum of New Mexico, Santa Fe.

O'Laughlin, Thomas C.
1980 *The Keystone Dam Site and Other Archaic and Formative Sites in Northwest El Paso.* El Paso Centennial Museum Publications in Anthropology 8. El Paso.

Pearce, T. M.
1965 *New Mexico Place Names.* University of New Mexico Press, Albuquerque.

Peckham, Stewart
1957 Three Excavation Unithouses near Albuquerque, New Mexico. In *Highway Salvage Archaeology* 3(12):39-70. New Mexico State Highway Department and Museum of New Mexico, Santa Fe.

1984 The Anasazi Culture of the Rio Grande Rift. In *New Mexico Geological Society Guidebook: Rio Grande Rift, Northern New Mexico (35th Field Conference),* pp. 275-281.

Perlman, Stephen M.
1980 An Optimum Diet Model, Coastal Variability, and Hunter-gatherer Behavior. In *Advances in Archaeological Theory and Method,* edited by M. B. Schiffer, pp. 257-310. Academic Press, New York.

Raab, L. M., and Goodyear, A. C.
1984 Middle Range Theory in Archaeology: A Critical Review of Origins and Applications. *American Antiquity* 49:255-268.

Reinhart, Theodore R.
1967 The Rio Rancho Phase: A Preliminary Report in Early Basketmaker Culture in the Middle Rio Grande Valley, New Mexico. *American Antiquity* 32:458-470.

Reher, Charles A., and D. C. Witter
1977 Archaic Settlement and Vegetative Diversity. In *Settlement and Subsistence along the Lower Chaco River: The CGP Survey,* edited by Charles A. Reher, pp. 113-126. University of New Mexico Press, Albuquerque.

Reynolds, S. E.

1956 *Climatological Summary, New Mexico: Temperature 1850-1954; Frost 1950-1954; and Evaporation 1912-1954.* Technical Report 5. State of New Mexico, State Engineer's Office, Santa Fe.

Rindos, David

1984 The Origins of Agriculture: An Evolutionary Perspective. Academic Press, New York.

Sayles, E. B.

1945 *The San Simon Branch Excavations at Cave Creek and in the San Simon Valley I: Material Culture.* Medallion Papers No. 34. Gila Pueblo, Globe, Arizona.

Schaafsma, Curtis F.

1978 Archaeological Studies in the Abiquiu Reservoir District. *Discovery*, pp. 41-69. School of American Research, Santa Fe.

1979 *The Cerrito Site (AR4). A Piedra Lumbre Phase Settlement at Abiquiu Reservoir.* School of American Research, Santa Fe.

Schorsch, Russell L.

1962 A Basket Maker III Excavation Unit House near Albuquerque. *El Palacio* 9(2):114-118.

Schroedl, Alan

1976 *The Archaic in the Northern Colorado Plateau.* Ph.D. dissertation, University of Utah, Provo.

Scurlock, Dan

1981 Ethnohistorical Investigations: Euro-American History of the Study Area. In *High Altitude Adaptations along Redondo Creek: The Baca Geothermal Anthropological Report*, pp. 129-160. Office of Contract Archeology, University of New Mexico, Albuquerque.

Schutt, Jeanne A.

1980 *The Analysis of Wear Patterns Resulting from the Use of Flake Tools in Manufacturing and Processing Activities: A Preliminary Report in Human Adaptations in a Marginal Environment. The UII Mitigation Project.* Edited by James L. Moore and Joseph C. Winter. Office of Contract Archeology, University of New Mexico, Albuquerque.

Semenov, S. A.

1964 *Prehistoric Technology.* Barnes and Noble, New York.

Sharrock, Floyd W., Kent C. Day, and David S. Dibble

1963 *1961 Excavations, Glen Canyon Area.* University of Utah Anthropological Papers No. 63. Salt Lake City.

Simmons, Alan H.
1986 New Evidence for the Early Use of Cultigens in the American Southwest. *American Antiquity* 51:73-88.

Skinner, S. Alan
1965 The Sedillo Site: A Excavation Unithouse Village in Albuquerque. *El Palacio* 72(1):5-24.

Skinner, S. Alan, Chester Shaw, Carol Carter, Maynard Clift, and Carol Heathington
1980 *Archaeological Investigations at Nambe Falls.* Archaeological Research Program, Research Report 121. Southern Methodist University, Dallas.

Smiley, T. L., S. A. Stubbs, and B. Bannister
1953 *The Foundation for the Dating of Some Late Archeological Sites in Tree-Ring Methods and Pottery Analysis.* Laboratory of Tree-Ring Research Bulletin 6. University of Arizona, Tucson.

Snow, David H.
1983 The Llano Piedra Lumbre Site: A Multicomponent Lithic Scatter in Rio Arriba County, New Mexico. Laboratory of Anthropology Notes 111c. Museum of New Mexico, Santa Fe.

Steen, Charles R.
1977 *Pajarito Plateau Archaeological Survey and Excavations.* Los Alamos Scientific Laboratories 77-74. Los Alamos, New Mexico.

Steward, Julian
1955 *Theory of Culture Change.* University of Illinois Press, Urbana.

Stiger, M.
1981 Archeological Investigations in Curecanti National Recreation Area, 1979. Ms. on file, USDI, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

1985 Report of Excavations, Sites LA 25358 and LA 47940. Ms. on file, Chambers Consultants and Flanners. Albuquerque, New Mexico.

1986 *Technological Organization and Spatial Structure in the Archaeological Record.* Ph.D. dissertation, University of New Mexico, Albuquerque.

Stuart, David E., and Robin Farwell
1983 Out of Phase: Late Pithouse Occupations in the Highlands of New Mexico. In *High Altitude Adaptations in the Southwest*, pp. 115-157. Edited by J. C. Winter. USDA, Forest Service, Southwest Region.

Stuart, David E., and Rory P. Gauthier

1981 *Prehistoric New Mexico: Background for Survey.* New Mexico State Historic Preservation Bureau, Santa Fe.

1984 *Prehistoric New Mexico: Background for Survey.* 2d edition. New Mexico Archeological Council, Albuquerque.

Stubbs, Stanley A.

1954 Summary Report on an Early Site in Tesuque Valley, New Mexico. *El Palacio* 61(2):43-45.

Traylor, Diane, Lynadi Hubbell, Nancy Wood, and Barbara Fiedler

1990 *1977 La Mesa Fire Study: An Investigation of Fire and Fire Suppression Impact on Cultural Resources in Bandelier National Monument.* Southwest Cultural Resources Center Professional Papers No. 28. Santa Fe.

Vierra, Bradley J.

1980 A Summary and Comparison of Excavated Archaic and Anasazi Sites. In *Human Adaptations in a Marginal Environment: The UII Mitigation Project*, edited by J. L. Moore and J. C. Winter, pp. 382-389. Office of Contract Archeology, University of New Mexico, Albuquerque.

Vivian, R. Gwinn, and Nancy Wilkinson Clendenen

1965 The Denison Site: Four Pit Houses near Isleta, New Mexico. *El Palacio* 72(2):5-14.

Vogler, Lawrence E.

1982 Summary of Prehistoric Cultural Resources. In *Gallegos Mesa Settlement and Subsistence: A Set of Explanatory Models for Cultural Resources on Blocks VIII, XI, X, and XI, Navajo Indian Irrigation Project*, edited by Lawrence E. Vogler, Dennis Gilpin, and Joseph K. Anderson, pp. 147-284. Navajo Nation Papers in Anthropology 12(1). Navajo Nation Cultural Resource Management Program, Window Rock, Arizona.

Vyaticil, Natalie, and J. J. Brody

1958 Two Pit Houses near Zia Pueblo. *El Palacio* 65(5).

Wait, Walter

1976 An Archaeological Survey of Star Lake: A Report on the Prehistoric, Historic and Current Cultural Resources of the Star Lake Area, McKinley County, Northwestern New Mexico. Draft report prepared for the Peabody Coal Company by Southern Illinois University, Carbondale.

Warren, A. H.

1979 *Lithics Identification and Quarry Source Workshop.* Cultural Resources Management Division Workshop, New Mexico State University, Las Cruces.

1980 Prehistoric Pottery of Tijeras Canyon. In *Tijeras Canyon: Analyses of the Past*, edited by Linda S. Cordell, pp. 149-168. Maxwell Museum of Anthropology and the Museum of New Mexico Press, Albuquerque.

1981 The Micaceous Pottery of the Rio Grande. Archaeological Society of New Mexico Anthropological Papers 6. Santa Fe.

Wendorf, Fred, and Erik K. Reed
1955 An Alternative Reconstruction of Northern Rio Grande Prehistory. *El Palacio* 62(5, 6):131-173.

Willey, Gordon R.
1966 *North and Middle America: An Introduction to Archaeology*. Vol. 1. Prentice-Hall, Englewood Cliffs, New Jersey.

Wills, W. H.
1988 *Early Prehistoric Agriculture in the American Southwest*. School of American Research, Santa Fe.

Wilmsen, Edwin N.
1968 Functional Analysis of Flaked Stone Artifacts. *American Antiquity* 33:156-161.

Wilshusen, Richard
1988a Architectural Trends in Prehistoric Anasazi Sites during A.D. 600-1200. In *Dolores Archaeological Program. Supporting Studies: Additive and Reductive Technologies*. Compiled by Eric Blinman, Carl J. Phagan, and Richard Wilshusen. USDI, Bureau of Reclamation, Denver, Colorado.

1988b Abandonment of Structures. In *Dolores Archaeological Program. Supporting Studies: Additive and Reductive Technologies*. Compiled by Eric Blinman, Carl J. Phagan, and Richard Wilshusen. USDI, Bureau of Reclamation, Denver, Colorado.

Willey, Gordon R., and Phillip Phillips
1958 *Method and Theory in American Archaeology*. University of Chicago Press.

Wolfman, Daniel, Timothy D. Maxwell, David A. Phillips, Jr., Joan Gaunt, and Mollie Toll
1989 *The Santa Fe Relief Route: Initial Results and Data Recovery Plan, Santa Fe County, New Mexico*. Laboratory of Anthropology Notes 496. Museum of New Mexico, Santa Fe.

Woodbury, Richard B., and Ezra B. W. Zubrow
1979 Agricultural Beginnings: 2000 B.C.-A.D. 500. In *Handbook of North American Indians*, vol. 9, *Southwest*, edited by A. Ortiz, pp. 43-60. Smithsonian Institution, Washington, D.C.

Yellen, J. E.
1977 Archaeological Approaches to the Present. Academic Press, New York.

Appendix 1: Chronometric Data

EASTERN NEW MEXICO UNIVERSITY Portales 88130

Agency for Conservation Archaeology

January 24, 1989

Mr. Steve Lent
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Laboratory of Anthropology, Research Section
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Santa Fe, NM 87504-2087

Dear Mr. Lent:

This letter details the results of the obsidian hydration analysis done on 15 samples from site LA 51912. No attempt was made to derive a calendric age for the reported hydration readings. Calculation of calendric dates can be accomplished by correlating other dates associated with these obsidian artifacts or through induced hydration measurements of geochemically similar obsidians.

Methods

All samples were prepared using the methods outlined by Michels and Tsong (1980) and Michels and Bebrich (1971). The first step in the procedure was to apply isotropic epoxy to the surface of the obsidian sample. The obsidian was then heated in a kiln at 140^{o}F (60^{o}C) for two hours to insure maximum cure. It has been demonstrated that the epoxy protects the hydration surface of the obsidian during sawing (Katsui and Kondo 1976).

Next, a wedge was cut from each sample by making two parallel cuts perpendicular to the edge of the artifact. An oil-cooled Raytech Trimsaw with a 4-inch diamond-edged blade was used. The wedge is then removed from the artifact. The wedge was cleaned with soap and ethyl alcohol to remove any remaining traces of oil.

The initial grinding phase was begun by mounting the wedge onto a glass microscope slide. Lakeside thermoplastic (quartz) cement was used as the mounting medium. The catalog number of the sample was etched onto the slide to protect provenience. The wedge was ground to approximately half of its original thickness using a slurry of water and fine-grained (400) corundum grit. All grinding was done by hand on a glass plate using a "Figure-8" motion.

After the wedge was ground halfway, the slide was cleaned to remove traces of grit, a pencil line was drawn on the wedge to mark the hydrated surfaces of the piece, and the wedge was now ground (in the same manner as described above) to an approximate thickness of .003 inch. This maximizes the optical qualities of the obsidian under the microscope.

The final stage of sample preparation was the application of the cover slip. All cover slips were applied using heated Canada Balsam instead of the Lakeside thermoplastic (quartz) cement. The mounting medium was changed at this point simply because it was found that fewer and smaller air bubbles are created using the Canada Balsam during cover slip application. The clarity of the slide was greatly improved using Canada Balsam.

All hydration rims were observed and measured using a Nikon Labophot POL petrographic microscope with a polarized light source (X-Nichols) and a 1/4 wave/red tint plate at 600 diameters. The tint plate creates a dark background upon which the hydration rim appears blue due to the difference in biorefringence. This helps to differentiate the interior of the hydration rim, thus making measurements more accurate.

All measurements were done with a filar eyepiece interfaced with a TI-50 calculator for automatic data recording. At the beginning of each day, the optics of the microscope were calibrated against a standard to compensate for any changes in barometric pressure and temperature. Measurements were taken by two independent observers. Exterior sides of the samples were scanned to find the widest and narrowest portions of the hydration rim. Each observer made five measurements at five different locations. The ten measurements were then averaged and the depth of the hydration rim (in microns) and the standard deviation were calculated. The two observers worked no more than four consecutive hours to reduce the chance of error due to eye strain. In cases where neither observer could identify a rim, a third independent observer was asked to examine the slide. If no rim was found by the third observer, a second slide was prepared and the procedure repeated. If no rim was observed on the second slide, it was assumed there was none present on the sample.

All measurements and calculations were recorded on ENMU-OHL data sheets. Other notable optical observations (i.e., hydration rims along cracks, quality of hydration rim, etc.) also were recorded.

Results

Of the 15 samples submitted, rims were found on only 13. Sample No. 0081 (a flake fragment) was prepared twice and no rim was found. Sample No. 057B (a projectile point) was prepared three times and no rim was found. The rim measurements obtained for the remaining 13 samples are presented in Table 1.

There does not appear to be strong clustering in the hydration rim measurements. In fact, there is a good deal of dispersion in the data, given the range of standard deviations with the rim measurements. A plot of the frequency of each rim measurement reveals two medians (3.3 and 3.5) which bracket the mean (about 3.4). Therefore, even though the data appears to be normally distributed, it is not. The small number of samples makes generalities difficult.

Without associated dates (e.g., radiocarbon) for calibration, we cannot provide a calendar date for the rim measurements obtained from LA 51912. In addition, the <u>specific</u> source for each piece of obsidian would be required before calendric dates (or even a relative chronology) could be calculated.

The projectile point base (Sample No. 057A) has the largest rim measurement of the artifacts examined. It may be that this artifact is the oldest of the ones examined here, if one assumes that all are from the same source and can therefore be compared

Table 1. Hydration Rim Measurements for Fifteen Obsidian Samples from LA 51912.

Sample No.	Rim Depth (in microns)	Standard Deviation
0081	---	---
038	4.1	0.6
057A	4.9	0.7
057B	---	---
093	4.2	0.6
106	2.9	0.3
153	3.5	0.3
160	3.3	0.6
338	1.7	0.2
1674	3.5	0.5
1675	3.3	0.4
2841	2.7	0.3
2843(4)*	3.4	0.2
2871	3.8	0.7
2872	3.0	0.4

*Note: This artifact was labelled with 2843, although its bag was labelled 2844.

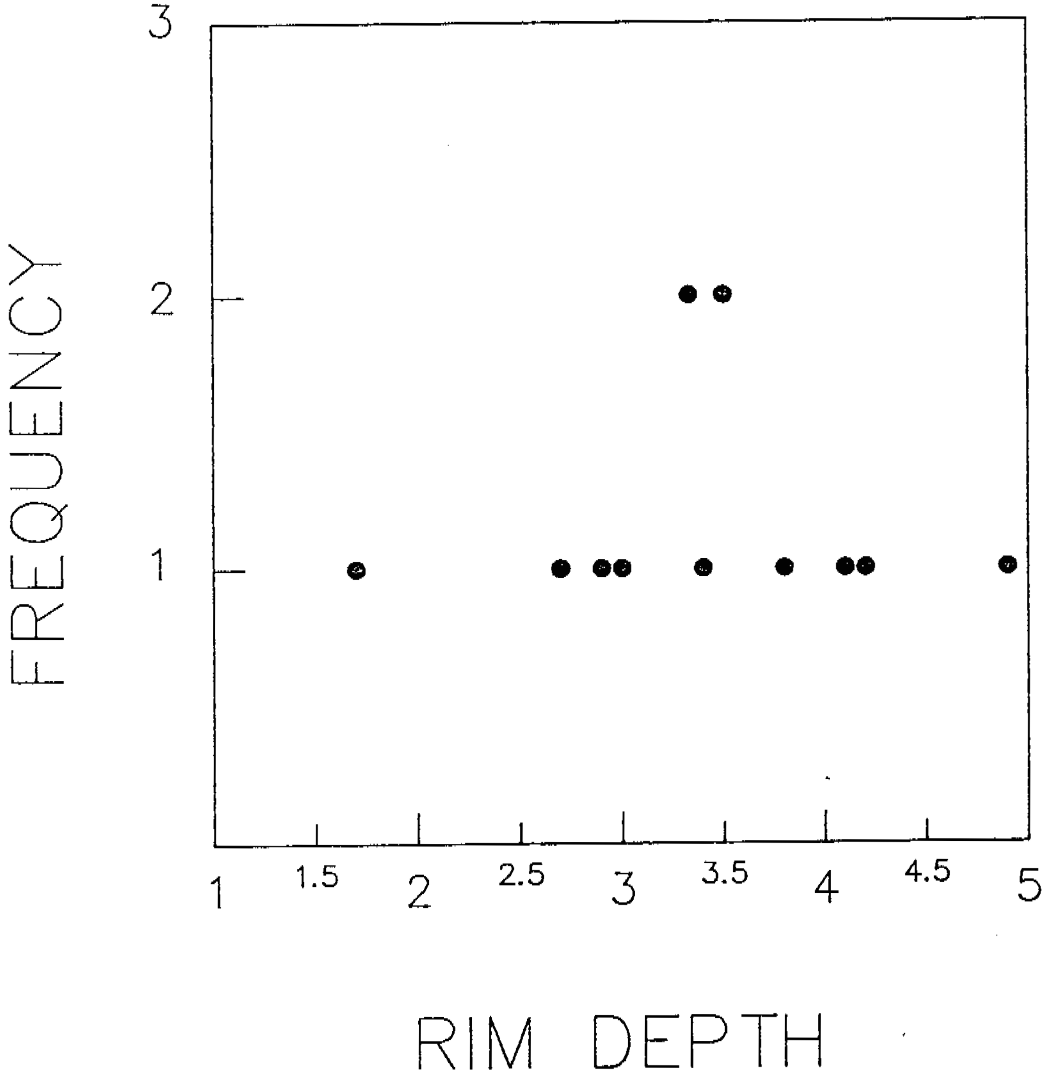

Figure 1. Plot of rim depth by frequency of occurrence.

relative to each other. The basal morphology of this projectile point strongly resembles those reported for the En Medio Complex (800 B.C. - A.D. 400) by Irwin-Williams (1973:Figure 6). Unfortunately, none of the other artifacts examined for hydration rims are culturally or temporally diagnostic.

Summary

Fifteen obsidian samples were submitted for obsidian hydration analysis. Hydration rim measurements were obtained for 13 of these samples. The results indicate that the samples contain high standard deviations. While there may be clustering of the measurements, the small sample size makes interpretation difficult. There is not enough information to allow for an attempt to give calendric dates for these samples. Without other chronometric measures or an established hydration rate for the obsidian source(s) and a detailed environmental history of the site, no definitive interpretations can be made about the data.

I hope that this information helps you with your interpretations of LA 51912. The fifteen obsidian samples will be returned to you under separate cover. If you have any questions, please do not hesitate to contact me at (505) 562-2254.

Sincerely,

John Montgomery

John L. Montgomery, Ph.D.
Co-Director, Obsidian Hydration Laboratory

References Cited

Irwin-Williams, C.
1973 *The Oshara Tradition: Origins of Anasazi Culture.* Eastern New Mexico University Contributions in Anthropology 5(1). Eastern New Mexico University, Portales.

Katsui, Y., and Y. Kondo
1976 Variation in Obsidian Hydration Rates for Hokkaido, Northern Japan. In *Advances in Obsidian Glass Studies: Archaeological and Geochemical Perspectives*, edited by R.E. Taylor, pp. 120-140. Noyes Press, New Jersey.

Michels, J.W., and C.A. Bebrich
1971 Obsidian Hydration Dating. In *Dating Techniques for the Archaeologist*, edited by H.N. Michael and E.K. Ralph, pp. 164-221. MIT Press, Cambridge, Massachusetts.

Michels, J.W., and I.S.T. Tsong
1980 Obsidian Hydration Dating: A Coming of Age. In *Advances in Archaeological Method and Theory*, vol. 3, edited by M.B. Schiffer, pp. 405-444. Academic Press, New York.

Appendix 2: Pollen Analysis

POLLEN ANALYSIS OF ARCHEOLOGICAL SAMPLES FROM LA 51912, OTOWI, SANTA FE COUNTY, NEW MEXICO

Report Prepared For:

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Technical Series Report Number 221

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INTRODUCTION

Archeological excavations were undertaken in advance of highway construction at site LA 51912, Otowi, in Santa Fe County, New Mexico by personnel from the Laboratory of Anthropology (LA), Museum of New Mexico from July to September, 1987. Under the general direction of archeologist Stephen C. Lent, the excavations focused on a pithouse and closely associated hearths, as well as a mealing bin and numerous other hearth features associated with an activity area located a few meters away from the pithouse across an arroyo. Dendrochronological samples from the pithouse and activity area pre-date the local master chronology's beginning date of 322 BC (Stephen Lent, personal communication 1987), and at least that portion of the site is thought to date to the Basketmaker II period (Yvonne Oakes, letter 7 October 1987). A later Pueblo III/IV period occupation is evidenced by diagnostic ceramics and projectile points (Sullivan and Lent 1987). I have not visited the site area.

Fifteen sediment samples were submitted for pollen analysis to the Castetter Laboratory for Ethnobotanical Studies (CLES), University of New Mexico. The proveniences of the samples are given in Table 1. Results of the pollen analysis will be discussed below by type of feature, following a discussion of laboratory techniques and other pertinent considerations.

Laboratory Techniques

Chemical extractions of the samples were performed by myself and CLES personnel using a procedure designed for arid Southwest sediments. This process involves chemical dissolution of carbonates and silicates, chemical acetolysis of organics and cellulose, and mechanical removal of fine charcoal by short-centrifugation. The process is described in detail as follows:

1) Each sample was screened through a tea strainer (mesh openings of about 2 mm) into a beaker to a total screened weight of 25 grams. One very sandy sample from the pithouse floor contact was screened to a weight of 40 grams, so that the volume of sediment remaining after decanting (step 3 below) would be similar to that from the other samples from finer sediments. The sediments of six hearth samples were moist, while the remaining nine samples were dry. Each screened sample was "spiked" with three tablets of pressed <u>Lycopodium</u> (clubmoss) spores (batch 201890, Dept.

TABLE 1: PROVENIENCES OF POLLEN SAMPLES FROM LA 51912, OTOWI, SANTA FE COUNTY, NEW MEXICO

CLES NO.	LA NO.	PROVENIENCE
87286	155	Surface sample, highway stake S of F-1, pithouse
87288	202	floor contact, F-1, pithouse
88001	194	ashy layer/occupation surface, F-1, pithouse
88002	204	under slab lining of F-2, hearth of F-1, pithouse
87289	393	fill of F-16, mealing bin
88003	147	under mano in fill of F-3, hearth
87290*	359*	under slab at base of F-9, hearth
88004*	361*	under slab at base, W end of F-9, hearth
88005*	356*	under rock at base of F-11, hearth
88006*	384*	under large slab at base of F-15, hearth
87287*	396*	top of fill of F-18, roasting pit
88007*	391*	F-18, roasting pit
88008	270	under mano at top of fill, Test Pit 7
88009	306	under mano, Test Pit 13
88010	370	ashy lens, Test Pit 23

* sample sediments moist when received by CLES

Quat. Geol., Lund, Sweden), for a total addition of 33,900 +/- 400 marker grains.

2) Concentrated hydrochloric acid (38%) was added to remove carbonates, and the samples were allowed to sit overnight.

3) Distilled water was added to the samples, and the acid and dissolved carbonates washed out by repeated centrifugation at 2,000 RPM in tapered 50 ml tubes. The concentrated residues were transferred back into numbered beakers and more distilled water was added. The water-sediment mixture was swirled, allowed to sit 10 seconds, and the fines decanted off of the settled heavy residue into another beaker. This process was repeated three times. Essentially similar to bulk soil flotation, this procedure differentially floated off light materials, including pollen grains, from heavier non-palynological matter. The fine "floated" fractions were

concentrated by centrifugation at 2,000 RPM; the heavy fraction remaining in the beakers was discarded.

4) The fine fractions were transferred back into numbered plastic beakers and mixed with 48% hydrofluoric acid to remove smaller silicates. This mixture was stirred occasionally and allowed to sit overnight.

5) Distilled water was added to dilute the acid-residue mixture, which was transferred to the 50-ml centrifuge tubes again. Centrifugation and washing of the compacted residue with distilled water was repeated as above to remove acid and dissolved siliceous compounds.

6) Trisodium phosphate (5% solution), a wetting agent, was mixed with the residue and centrifuged. Repeated centrifuge-assisted rinses with distilled water subsequently removed much fine charcoal and small organic matter, and eventually made most of the samples taken from hearth fill feasible to count. Only 10 samples contained enough residue at the end of this procedure to warrant acetolysis. The residues of those 10 samples were washed with glacial acetic acid to remove remaining water in preparation for this next step.

7) Acetolysis mixture (9 parts acetic acid anhydride to 1 part concentrated sulfuric acid) was added to the residue in the plastic centrifuge tubes to destroy small organic particles. The tubes were heated in a boiling water bath for 5 minutes, followed by cooling in another water bath for about 5 minutes. The residues were compacted by centrifugation, the acetolysis mixture poured off, and the residues washed with glacial acetic acid. Multiple centrifuge-assisted washes with distilled water followed to remove remaining traces of acid and dissolved organic compounds. Total exposure of the residues to acetolysis mixture was about 15 minutes.

8) All 15 samples were washed in warm dilute methanol, and small silicates, organic material, and charcoal were differentially floated off of the palyniferous residues by centrifugation at 2,000 RPM for time periods varying from 45 to 60 seconds. Remaining residues were stained with Saffranin O, mixed with liquid glycerol, and stored in 3-dram stoppered vials.

Microscope slides were made using liquid glycerol as the mounting medium under 22 x 22 mm cover slips sealed with fingernail polish. The liquid mounting medium allowed the grains to be turned over during microscopy, facilitating identifications.

The slides were counted using a Nikon Alphaphot microscope at a magnification of 400 X. Identifications were made to the family or genus level, as possible. Grains which could not be identified despite well-preserved morphological details were tallied as "Unknowns." Pollen grains too degraded (crumpled or corroded) to identify further were tallied as "Unidentifiable." Grains which occurred as clumps were counted as a single occurrence (one grain), and notes were made of the number of grains visible in each clump. Following the pollen count, the uncounted portion of the slides from inside the pithouse and from the mealing bin was scanned at 200 X in search of the larger grains of cultivated plants such as corn. No such remains were seen in scans of the samples reported here.

Only 19 pollen types were recognized from the modern and archeological samples, as listed in Table 2. These are types which correspond with the vegetation in the general location of the site (Sullivan and Lent 1987: 5). The artificial pollen category of juniper/cottonwood (Juniperus/Populus) reflects uncertainties in the identification of individual grains due to similarities of size and surface details. A flattened spherical grain with faint speckles on its exterior surfaces could be either a degraded cottonwood or juniper grain, or even a spore. The presence of spores in all of the pollen samples prompted caution in identifications of questionable grains, and the combination of juniper and cottonwood pollen grains in this analysis was thought to be a more useful compromise than counting the ambiguous grains among the Unidentifiables.

The degree of preservation of the spines present on pollen grains from the Compositae is also crucial to their identification. Grains bearing spines 2.5u or lower are classed as Low-Spine Compositae, with the working assumption that these were produced by the primarily wind-pollinated genera of the family. Grains bearing spines longer than 2.5u are classed as High-Spine Compositae, with the working assumption that these were produced by the primarily insect-pollinated genera of the family. Problems enter when the spines are normally 2.5u in length, or have been eroded down to that level. For the present study, grains of primarily insect-pollinated rabbitbrush (Chrysothamnus) are probably included with the Low-Spine Compositae because of the short length (2.5u) of the spines.

Preservation of the pollen grains was fair to poor, with severely degraded Unidentifiable grains ranging in the archeological samples from 20% to 49% of the total count. Seven of the fourteen archeological samples contained pollen grains too poorly preserved to warrant extensive counting; six of these were from hearths or pit fill. Sufficient charcoal could not be

TABLE 2: POLLEN TYPES RECOGNIZED IN ARCHEOLOGICAL SAMPLES FROM LA 51912, OTOWI, SANTA FE COUNTY, NEW MEXICO

Taxon	**Common Name**
Pinaceae	saccate genera of the Pine family
Pinus	Pine
Picea	Spruce
Abies	Fir
Juniperus	Juniper
Juniperus/Populus	Juniper and Cottonwood (Populus) types, combined here due to uncertain identification of individual grains
Quercus	Oak
Rhus	Sumac
Cheno/Am	genera of the Goosefoot family (Chenopodiaceae) and species of the genus Amaranthus (pigweed)
Sarcobatus	Greasewood
Ephedra	Mormon Tea
Gramineae	genera of the Grass family
Low-Spine Compositae	wind-borne genera of the Sunflower family
Artemisia	Sagebrush
High-Spine Compositae	insect-borne genera of the Sunflower family
Sphaeralcea	Globe Mallow
Leguminosae	genera of the Bean family
Solanaceae	genera of the Nightshade family
Umbelliferae	genera of the Parsley family

removed from two other hearthfill samples to obtain a 200-grain count within the time frame for the analysis.

Limitations of Pollen Data

Two related but separate statistical considerations should be considered in order to evaluate the pollen data reported here. The first consideration is the "200-grain count" derived from the work of Barkley (1934), and expanded by Martin (1963: 30-31). Counting pollen grains to a total of 200 per sample allows the microscopist to produce taxonomic inventories with a 0.90 coefficient of reliability. Taxa occurring in numbers too low to be seen at this level of accuracy are considered too minor to affect the analytical utility of the count. Counting more than 200 grains would increase the accuracy or "statistical validity" of the analysis, but at the expense of greatly increased time at the microscope. Fewer grains than 200 can certainly be counted, but with a sharp decline in accuracy in terms of the kinds of pollen present in the sample.

The second consideration is the "1000-grain-per-gram" rule summarized by Hall (1981: 202) and used as an indicator of the degree of pollen destruction in a sample. An estimate of the number of pollen grains present in a gram of sample is determined by the addition of known numbers of marker grains ("spike") to the sample at the beginning of the processing procedure (Benninghoff 1962; Maher 1981). Separate tallies are then kept of the spike grains and pollen grains counted under the microscope, allowing the proportion of available pollen grains actually seen to be estimated by means of a mathematical equation. Pollen grains can be recovered in the tens of thousands per gram in well-preserved sediments; amounts fewer than 1000 per gram are a signal to the analyst that biological degradation or abnormal pollen deposition should be considered in the analysis.

A further refinement of this observation is a categorization of the degree of degradation seen in the pollen grains which do remain for analysis in a sample. It is known that the pollen grains from different taxa do not degrade at the same rate, rather that degradation is differential (Holloway 1981, and references cited therein). Some pollen taxa are relatively resistant to destruction, remaining part of the pollen record long after other types have disappeared altogether. Many pollen types degrade beyond recognition, while others are so distinct in shape that they remain recognizable even when degraded to optically clear "ghost grains" lacking sufficient structure to take up stain. Thus, differential degradation is compounded by differential recognition. Cushing (1967) devised a six-step scale for preservation/degradation observations; Hall (1981) refined this to a four-step scale. The utility of such scales is that they provide quantifiable evidence of degradation independent of the goals of 200-grain counts or 1000 grains per gram. The amounts and degrees of degradation have direct implications for the representativeness of the pollen counted by the analyst.

Since "perfect" pollen grains are rarely seen in archeological samples, tabulating the degrees of degradation in this analysis has been eliminated in favor of a single category (the Unidentifiables) to measure only severe degradation. These grains are included in the 200-grain count. If a pollen grain is well enough preserved to identify to genus or family, that identification is made without special notes being taken of its condition. This means that a tally of pine (Pinus) grains, for instance, would include grains in all conditions ranging from crumpled through corroded, since even very degraded grains are often identifiable as pine. More severely degraded grains would be tallied at the higher family level (Pinaceae). If, however, a pollen grain is too degraded to assign positively even to family, it is classed as an Unidentifiable with notes as to the cause (degraded or crumpled). Grains which are too degraded to distinguish confidently as a pollen grain or as a spore are not counted at all. Thus, in this analysis, the Unidentifiable category is a direct measure of severe degradation observed during the count of a given sample, and is comparable across all samples. Hall (personal communication, 1988) considers this definition of degradation significant at lower percentages than the more inclusive definition he routinely uses for samples from non-archeological contexts.

In sum, three considerations must be weighed simultaneously for each pollen spectrum in the following report: statistical validity (200-grain count), relative abundance (1000 grains per gram, "rule of thumb"), and representativeness (degree of degradation). It is possible to have less than 1000 grains of pollen per gram of sample (as from an archeological context which biased the pollen rain, such as an enclosed room), which laboratory procedures could concentrate sufficiently to yield a 200-grain count. Use of such a count from a sample which also contained a large percentage of degraded grains could lead to grossly erroneous conclusions on all fronts, since differential degradation of all taxa originally present in the sediment would result in altered proportions of those still present or in differentially recognizable condition.

Implications of Sampling Loci

Practically speaking, greater or lesser numbers of pollen grains are recoverable from probably any archeological context. Given this, it follows that the archeological implications of the sampled context become paramount for the interpretation of the recovered pollen spectrum. Just as one example, a pollen sample from pit fill sediments provides pollen information on the pit fill. If research questions are directed at events connected with the filling of the pit, the recovered pollen spectrum probably will be appropriate. If, however, research questions are directed at any function(s) of the pit before it filled with sediments, then the recovered pollen spectrum from this sample will probably not be appropriate.

Another example is pollen recovered from burned contexts such as hearths, as reported in this analysis. Since pollen grains are destroyed by heat (Ruhl 1986) as well as by exposure to fire, it is likely that few, if any, of the pollen grains recovered from these burned contexts relate to the <u>use</u> of the feature per se. Unusual circumstances are occasionally present in a specific hearth, such as sealing layers of adobe between seperate fire basins in a remodeled hearth, which could conceivably allow pollen to be preserved in an interpretable context. Samples taken from less-oxidized locations, such as at the edge of the basin fill, could also yield pollen grains which are interpretable in an archeological sense. Precise sampling procedure is implied for both of these situations.

For most routine hearth samples, it is highly likely that the recovered pollen grains post-date the active (burning) use of the feature, and indeed were preserved by the very absence of burning. Research questions aimed at identifying vegetal foods cooked in the hearth will most likely not be addressable with the pollen spectrum recovered from hearthfill, and are instead the classic provenience of flotation analyses. However, since hearths are likely depositories for floor sweepings, questions aimed at identifying the plants which were present in the structure (or in the area if the hearth is not inside a structure) are reasonable and could justify the pollen analysis of hearthfill. Finely-tuned research questions are required. In all instances, pollen data should be integrated with flotation data, since each data set is usually preserved by different conditions.

Such considerations affect sampling decisions made in the field as well as in the laboratory. What questions are the recovered pollen grains expected to answer? Given that pollen grains are destroyed by fire, can pollen recovered from a burned feature be related to the use of that feature in an archeological sense? Does the fact that pollen grains are recoverable from burned areas especially enhance their ability to provide answers, or make those answers more pertinent to the understanding of the burned areas? Or is it more likely that pollen samples from unburned areas provide less biased data and more defensible interpretations?

Location-specific archeological considerations often dictate where samples will be taken; the lack of preserved floor surfaces may require pollen samples to be taken from burned contexts or feature fill. Research questions formulated by the archeologist must be "field tested" to take into account the anticipated recovery of pollen grains from a sampling locus, and the implications of those recovered grains for site formation processes. In sampling situations where feature preservation is good, the decision as to where to sample is easier in one sense, but still requires forethought on the implications of the pollen grains expected to be recovered.

RESULTS OF ANALYSIS

Surface Sample

The pollen spectrum recovered from surface sample 155 is presented in Table 3. As shown there, it contains over 19,000 pollen grains per gram of sample, and 8% of the pollen grains are unidentifiable due to severe degradation. These figures serve as a baseline for pollen deposition and biological activity in the site area in exposed sediments. As will be seen, none of the archeological sediments approached either the high numbers of grains per gram or the relatively low percentage of Unidentifiables seen in this sample.

Dominating the surface sample are the wind-borne grains of juniper and undifferentiated juniper/cottonwood at 40%, followed by conifers (Pinus, Picea, and undifferentiated saccate Pinaceae genera) at 25%. The remaining grains are mostly wind-borne Low-Spine Compositae, Cheno/Am, and grass (Gramineae). As discussed in the Introduction, pollen grains of insect-pollinated rabbitbrush (Chrysothamnus) may be included in the nominally wind-pollinated Low-Spine Compositae because of their short spines. The wind-borne pollen of sagebrush (Artemisia) is notably low at 0.5%. The July date of this surface sample is between major pollination peaks for the area's wind-borne arboreal (spring) and non-arboreal (fall) plants.

Pithouse Feature 1 and Associated Hearth Features 2 and 3

Two samples were submitted from within the Feature 1 pithouse, and their pollen spectra are presented in Table 3. Sample 202 from the floor contact contains poorly preserved pollen estimated to number 37 grains per gram of sample. Sample 194, from the occupation surface in an adjacent

TABLE 3: POLLEN SPECTRA FROM THE MODERN SURFACE, PITHOUSE FEATURES, AND ADJACENT ACTIVITY AREA, LA 51912, OTOWI, SANTA FE COUNTY, NEW MEXICO

expressed as percentages
*one or more clumps of 3 or more grains seen during count
( ) number of grains in pollen-deficient samples
@ pollen extracted without use of acetolysis
& slide also scanned for presence of pollen from cultivated plants

	surface	floor contact	occupation surface	F-2 hearth under lining	F-3 hearth under mano
Sample No.	155	202&	194@&	204@	147@
Pinaceae	5	-	12	0.5	(1)
Pinus	18	-	14	-	-
Picea	2	-	-	-	-
Abies	-	-	-	-	-
Juniperus	12	-	-	0.5	-
Juniperus/*Populus*	28	-	5	-	-
Quercus	2	-	-	1	-
Rhus	-	-	-	-	-
Cheno/Am	7	-	11*	20	(15)
Sarcobatus	-	-	-	0.5	-
Ephedra	-	-	-	-	-
Gramineae	3	-	4	5	-
Low-Spine Compositae	11	-	9	13	(4)
Artemisia	0.5	-	15	22*	-
High-Spine Compositae	1	-	2	6	(2)
Sphaeralcea	-	-	-	-	-
Leguminosae	-	-	1	-	-
Solanaceae	-	-	0.5	-	-
Umbelliferae	-	-	-	0.5	-
Unknown	0	0	2	2	0
Unidentifiable	8	(3)	26*	30*	(7)
Total Pollen Counted	211	3	207	200	29
Total Spike Counted	15	69	196	278	55
No. Grains/gram (est.)	19,074	37	1,432	976	715

grid square, contains better preserved pollen estimated at about 1400 grains per gram. Neither sample yielded evidence of cultivated plants such as corn.

As discussed in the Introduction, the very low numbers of grains per gram seen for sample 202 likely reflect the prehistoric exclusion of pollen rain by the pithouse structure. However, severe degradation has also been at work as seen in the sample's total of three Unidentifiable pollen grains. Degradation at 26% is also severe for sample 194 from the adjacent grid square, but details on the sampling loci which might help account for the differences in pollen content were not specified in the archeological documentation included with these two samples.

Sample 194 from the occupation surface within the pithouse is similar to the surface sample in its 26% of pine family pollen. The lower percentage of juniper/cottonwood type pollen is of less significance, considering the sample's high rates of degradation, because these pollen grains are thin-walled and consequently poorly preserved in most sediments. The remainder of the pollen spectrum also closely resembles that of the surface sample, with the exception of sagebrush (Artemisia) pollen. This is a thick-walled pollen type not readily lost from the pollen record, and its comparative abundance in sample 194 most likely reflects the prehistoric presence of the plant within the structure sometime during its use. Whether sagebrush was used prehistorically as bedding, as fuel, and/or for food (Castetter 1935: 21, 25) can be better determined from the macrobotanical evidence from any flotation analyses.

Feature 2, a slab-lined hearth, is described by the archeologist as associated with the Feature 1 pithouse (Stephen Lent, specimen inventory notes 1987), and appears on field drawings as immediately beyond the eastern limit of the pithouse floor. Sample 204 was taken from beneath the lower slab lining the hearth. Given this sampling locus, the pollen spectrum shown in Table 3 could be expected to pre-date the construction of the hearth lining, and possibly even pre-date the use of the hearth itself. The pollen spectrum has therefore been subjected to potentially destructive temperatures throughout the use life of the hearth. These considerations render interpretation of the predominant sagebrush, Cheno/Am, and Low-Spine Compositae pollen types ambiguous at best. Evidence for degradation is high at 30%, and, together with the relatively low number of grains per gram, indicates that the pollen spectrum has been severely affected by differential destruction.

Feature 3 is another hearth, located in an activity area north of the Feature 1 pithouse and south of a roughly east-west arroyo which bisects the site. Sample 147 originates from beneath a mano found in the fill of the feature. The burned or unburned condition of the mano was not described in the sample's documentation. If unburned, the mano would likely have been deposited in the hearth after its last thermal use, perhaps along with other trash. Thermally-affected hearth deposits beneath the mano, then, could be expected to yield little pollen as discussed in the Introduction. Table 3 presents the predominantly wind-borne pollen content of the sample, estimated at about 700 grains per gram of sample. Seven of the 29 pollen grains seen during the count, or about 24% of the total, were severely degraded. Taken together, these two considerations suggest that the sample is too poorly preserved for meaningful pollen analysis. The analysis of any macrobotanical remains from flotation should be more productive.

Hearth Features 9, 11, 15, and 18

These four hearth features are located in an activity area north of the arroyo bisecting the site. Six samples were submitted for analysis, four of which originate beneath basal rocks or slabs lining the hearths. Their pollen spectra are presented in Table 4, which shows that only one of the six samples was able to be counted to a total of 200 grains. The sampling loci for these pollen samples are ambiguous contexts for evidence of prehistoric behavior, and make the contributions from any analysis of macrobotanical remains and flotation samples from the fill of the hearths especially important.

Hearth Feature 9 had two samples submitted for pollen analysis, each from beneath a basal slab. Both samples could be expected to pre-date construction of the hearth. As shown in Table 4, the samples differ in their pollen contents and relative rates of degradation.

Sample 359 from Feature 9 is the only sample from the four hearth features which could be counted to 200 grains. It contains the highest amounts of juniper/cottonwood pollen, at 30%, of all the archeological samples. Wind-borne pollen from Cheno/Ams, Low-Spine Compositae, and grasses dominate the remainder of the spectrum. Compared with surface sample 155, hearth sample 359 is unusual in its high amount (26%) of Cheno/Am pollen. The sample also contains the only grain of globemallow (<u>Sphaeralcea</u>) pollen seen in this study. Thus, while a substantial amount of degradation is evidenced by the 20% Unidentifiables, the preservation of juniper/cottonwood pollen suggests that the sample is less affected by random degradation that it would appear from the numbers alone. As

TABLE 4: POLLEN SPECTRA FROM VARIOUS HEARTH FEATURES, LA 51912, OTOWI, SANTA FE COUNTY, NEW MEXICO

expressed as percentages
* one or more clumps of 3 or more grains seen during count
( ) number of grains in pollen-deficient samples
@ pollen extracted without use of acetolysis
all sample sediments were moist

	F-9, under basal slab	F-9, under W basal slab	F-11, under basal rock	F-15, under basal slab	F-18, top of fill	F-18, fill
Sample No.	359	361	356@	384	396	391
Pinaceae	4	(6)	-	(4)	(1)	(2)
Pinus	1	(3)	(1)	-	-	-
Picea	-	(1)	-	-	-	-
Abies	-	-	-	-	-	-
Juniperus	-	-	-	-	-	-
Juniperus/*Populus*	30	(2)	-	-	(2)	(4)
Quercus	-	-	-	(1)	-	-
Rhus	-	-	-	-	-	-
Cheno/Am	26	(9*)	(5)	(2)	(5)	(7)
Sarcobatus	-	-	-	-	-	-
Ephedra	1	-	-	-	-	-
Gramineae	5	-	-	(3)	-	(1)
Low-Spine Comp.	7	-	(1)	-	(2)	(1)
Artemisia	1	-	(1)	-	-	-
High-Spine Comp.	2	-	-	(3)	(1)	-
Sphaeralcea	0.5	-	-	-	-	-
Leguminosae	2	-	-	-	-	-
Solanaceae	-	-	-	-	-	-
Umbelliferae	-	-	-	-	-	-
Unknown	0	0	0	0	0	0
Unidentifiable	20	(3)	(0)	(3)	(2)	(3)
Total Pollen Counted	208	24	8	16	13	18
Total Spike Counted	218	53	54	28	14	16
No. Grains/g (est.)	1,294	614	201	775	1,259	1,526

discussed above for hearth Feature 2, it logically pre-dates the construction of hearth Feature 9.

Companion sample 361 from beneath a slab at the west end of hearth Feature 9 was found to be essentially devoid of pollen, as shown in Table 4. Estimated to contain about 600 grains per gram, the sample nonetheless evidences only about half the amount of degradation as sample 359. In the absence of other archeological details, it is also logical to conclude that the sampled locus contains pollen pre-dating construction of the hearth feature.

Hearth Feature 11 was located south of hearth Feature 9 and just north of the edge of the arroyo bisecting the site. Sample 356, taken from beneath a rock at the base of the hearth, was found to be essentially devoid of pollen as shown in Table 4. The absence of any Unidentifiables among the eight grains counted does not mean that there was no degradation within the sample, since notes were not made of a pollen grain's condition if it was identifiable at least to the family level. It does mean that no severely degraded grains were seen by the time at least 50 "spike" grains were counted. The estimate of only 201 pollen grains per gram of sample suggests differential degradation of the pollen spectrum before or after construction of the hearth feature. As with hearth Features 2 and 9, this sample logically contains pollen pre-dating construction of the feature.

Hearth Feature 15 was located northwest of hearth Feature 11, and was similarly sampled for pollen beneath a large slab at the base of the hearth. As shown in Table 4, it too contains low numbers of grains per gram of sample, but additionally evidences relatively high numbers of severely degraded grains (3 out of 16). Whether that degradation preceded the construction of the hearth or is the result of the thermal use of the feature cannot be determined. The pollen spectrum logically pre-dates construction of the feature.

Feature 18 is a roasting pit located near the center of the activity area in which the previous three hearth features were also located. Two pollen samples were submitted for analysis from Feature 18. Sample 396 is from the top of the feature's fill, while sample 391 is from the fill. As shown in Table 4, both samples contain over 1200 grains per gram of sample, but both were too laden with unremovable charcoal to make it possible to achieve a 200-grain pollen count within the timeframe for this analysis. Both samples contain relatively fragile juniper/cottonwood pollen, and demonstrate moderate rates of degradation. Macrobotanical analysis of flotation samples will undoubtedly help in interpretation of the feature.

Feature 16 Mealing Bin, and the Fill of Various Test Pits

Mealing bin Feature 16 was located on the northwestern edge of the activity area which also contained hearth Features 9, 11, 15, and 18 discussed above. Sample 393 was taken from the fill of the feature. As shown in Table 5, the pollen spectrum from this fill sample evidences 49% grains degraded beyond recognition, the most severe of this study. In light of such severe degradation, little can be made of the identifiable pollen types remaining in the spectrum, despite the estimate of over 1800 grains per gram of sample. Following the completion of the 200-grain count, the remainder of the slide was scanned for the pollen of cultivated plants such as corn. None was seen. The presence of Cheno/Am and sagebrush pollen in the feature fill does not address the use of the mealing bin prior to accumulation of its fill, and it remains for macrobotanical analysis of flotation samples to shed light on the grinding activities conducted in the feature.

Sample 270 from Test Pit 7, and sample 306 from Test Pit 13 were both taken from beneath manos present in the fill. Sample 270 was described as taken from the top of the fill, while sample 306 was described as taken from Level 3. As shown in Table 5, neither sample contains more than about 700 grains per gram of sample, and both evidence high amounts of degradation. Given the sampling loci, amounts of degradation, and low numbers of grains per gram, little can be made of either pollen spectrum.

Sample 370 was taken from an ashy lens in Test Pit 23. The pollen spectrum, presented in Table 5, shows an estimate of more than 3000 grains per gram of sample, twice as many grains as any other archeological sample in this study and including 7% juniper and juniper/cottonwood pollen. Yet the sample also evidences 25% severely degraded grains. No other information regarding the sampling locus was included in the sample documentation, and these observations remain unexplained. Data present in the macrobotanical analysis of flotation samples, combined with better archeological understanding of the sampling locus, may shed light on the high percentages of Cheno/Am and sagebrush pollen present in this sample.

TABLE 5: POLLEN SPECTRA FROM FEATURE 16 MEALING BIN, AND THE FILL OF VARIOUS TEST PITS, LA 51912, OTOWI, SANTA FE COUNTY, NEW MEXICO

expressed as percentages
* one or more clumps of 3 or more grains seen during count
( ) number of grains in pollen-deficient samples
@ pollen extracted without use of acetolysis
& slide also scanned for presence of pollen from cultivated plants

Sample No.	F-16, mealing bin 393&	TP 7, under mano 270	TP 13, under mano 306@	TP 23, ashy lens 370
Pinaceae	2	(1)	(1)	1
Pinus	2	(1)	-	1
Picea	-	-	-	-
Abies	-	(1)	-	-
Juniperus	-	(1)	-	1
Juniperus/_Populus_	2	(1)	-	6
Quercus	-	-	-	1
Rhus	-	(1)	-	-
Cheno/Am	14	(6)	(10)	36
Sarcobatus	-	-	-	-
Ephedra	-	(1)	-	-
Gramineae	2	(1)	-	3
Low-Spine Compositae	6	(2)	(1)	6
Artemisia	16	-	(3*)	10*
High-Spine Compositae	1	(1)	(1)	5
Sphaeralcea	-	-	-	-
Leguminosae	3	-	-	3
Solanaceae	3	-	-	-
Umbelliferae	-	-	-	-
Unknown	2	0	0	2
Unidentifiable	49*	(9)	(11)	25*
Total Pollen Counted	201	26	27	204
Total Spike Counted	146	50	57	88
No. Grains/gram (est.)	1,867	705	642	3,144

SUMMARY

As discussed in the Introduction, an archeological pollen sample cannot be separated from its sampling locus and the cultural and non-cultural events that influenced the sediments in which the pollen record accumulated. Archeological realities usually dictate where samples can be taken. The pollen samples analyzed in the present study are unfortunately characterized by lack of preservation or by contexts that are ambiguous in terms of archeological interpretation.

On the bright side, the burned features available for sampling at site LA 51912 should yield a good macrobotanical record from flotation samples. The absence of pollen evidence of cultivated plants at the site can potentially be rectified by the recovery of charred remains from the hearth deposits. Likewise, charred seeds of some of the plants represented in the pollen record may show them to have had an economic use in addition to a strictly environmental presence.

REFERENCES CITED

Barkley, Fred A.
1934 The Statistical Theory of Pollen Analysis. Ecology (13) 3: 283-289.

Benninghoff, W.S.
1962 Calculation of Pollen and Spore Density in Sediments by Addition of Exotic Pollen in Known Quantities. Pollen et Spores (4): 332-333.

Castetter, Edward F.
1935 Uncultivated Native Plants used as Sources of Food. The University of New Mexico Bulletin No. 266. Albuquerque.

Cushing, Edward J.
1967 Evidence for Differential Pollen Preservation in Late Quaternary Sediments in Minnesota. Review of Palaeobotany and Palynology (4): 87-101.

Hall, Stephen A.
1981 Deteriorated Pollen Grains and the Interpretation of Quaternary Pollen Diagrams. Review of Palaeobotany and Palynology (32): 193-206.

Holloway, Richard G.
1981 Preservation and Experimental Diagenesis of the Pollen Exine. Unpublished PhD dissertation, Texas A&M University. College Station.

Maher, Louis J., Jr.
1981 Statistics for Microfossil Concentration Measurements Employing Samples Spiked with Marker Grains. Review of Palaeobotany and Palynology (32): 153-191.

Martin, Paul S.
1963 The Last 10,000 Years. University of Arizona Press. Tucson.

Ruhl, Donna L.
1986 Extraction and Thermal Alteration of Pollen Embedded in Clay. Ceramic Notes No. 3 (Prudence M. Rice, ed.). Ceramic Technology Laboratory, Florida State Museum. Gainesville.

Sullivan, Richard B. and Stephen C. Lent
1987 Testing Results and Research Design for LA 51912 along SR 4, San Ildefonso Pueblo Grant, Santa Fe County, New Mexico. Laboratory of Anthropology Note No. 385. Museum of New Mexico. Santa Fe.

Appendix 3: Botanical Analysis

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FLOTATION FROM AN EARLY PIT STRUCTURE (LA 51912, OTOWI)
IN NORTH CENTRAL NEW MEXICO

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CASTETTER LABORATORY FOR ETHNOBOTANICAL STUDIES, TECHNICAL SERIES #231

INTRODUCTION

Excavation of LA 51912 (Otowi) preceded construction on State Road 4 south of San Ildefonso Pueblo, in Santa Fe county, north-central New Mexico. The site included a pithouse and an associated, partially-roofed activity area. Materials dating to the late Archaic period were of particular interest. With carbon-14 dates averaging in the first century B.C. (Beta Analytic lab numbers 23854 - 23864), the site is one of the earliest pitstructures investigated in this area of the Rio Grande drainage. Numerous grinding implements, subfloor storage features, and a mealing bin all suggested an early agricultural locus. Plant remains were sought as potential direct evidence of the subsistence base for this early occupation. Protection of the cultural deposits by pitstructure walls and approximately 60 cm of overlying sediments, and recovery of abundant charred materials in flotation samples are all factors which seemed in favor of finding economic floral remains. A later Pueblo III/IV period occupation was not sampled for botanical remains.

METHODS

The 26 soil samples collected during excavation were processed at the Museum of New Mexico Laboratory of Anthropology by the simplified "bucket" version of flotation (see Bohrer and Adams 1977). Each sample was first measured as to volume using a 1000 ml graduated cylinder (samples ranged in size from 500 to 4200 ml, with an average volume of 2258 ml). Each sample was immersed in a bucket of water, and a 30-40 second interval allowed for settling out 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 fabric was lifted out and laid flat on coarse mesh screen trays, until the recovered material had dried. 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. All samples were examined in their entirety.

From each of the 16 flotation samples with sufficient charcoal, a sample of 20 pieces of charcoal was identified (10 from the 4 mm screen, and 10 from the 2 mm screen). Each piece was snapped to expose a fresh transverse section, and identified at 45x. Low-power, incident light identification of wood specimens does not often allow species- or even genus-level precision, but can provide reliable information useful in distinguishing broad patterns of utilization of a major resource class.

RESULTS

Pithouse (Feature 1) and Extramural Hearths (Features 2 and 3)

Flotation samples from within the pitstructure numbered four occupation surface locations, two postholes, and a pit (Table 1). One floor grid (FS #186) netted a single charred goosefoot seed, but other pitstructure samples were completely devoid of any carbonized food products. Chenopodium seeds are repeatedly the single most abundant and ubiquitous wild plant food remains found in Anasazi sites in north-central and northwestern New Mexico (Toll 1981, 1983, 1985). In the ethnobotanical literature we find continual references to the widespread historical use of goosefoot's tender spring greens and summer seed crop (Castetter 1935, Elmore 1944, Jones 1930, Swank 1932). In view of the expected subsistence focus on agriculture, I was surprised by the complete absence of any cultivars (and in particular, tiny fragments of charred corn cobs, which are ubiquitous in Anasazi sites). Pollen samples from the pitstructure were similarly empty of domesticates (Dean 1988:Table 3). Flotation samples from the pitstructure ranged in size from 0.2 to 4.9 grams per liter of original soil sample, with an average of 2.1; this is distinctly smaller than samples from activity area features, which ranged in size from 0.2 to 23.8 grams per liter, with an average of 16.4.

Two hearths were located in an adjacent, partially roofed-over work area. Feature 2 (FS #203) contained a single modern grass caryopsis, but Feature 3 had no identifiable plant remains.

Charcoal from locations within the pitstructure tended to have a sizeable juniper component, with some pinyon, and varying amounts of

Table 1. Flotation Results, Pithouse (10 samples): LA 51912, Otowi.

FS	Provenience	Juniperus	Pinus edulis	Gramineae	Chenopodium	Misc.	Unknown	TOTAL
177	Floor [7N/12E]							0
186	Floor [9N/11E]				1/0.6*			1/0.6
190	Floor [8N/12E]							0
192	Floor contact [9N/12E]							0
189	Fea.4, posthole							0
188	Fea.5, pit							0
193	Fea.6, posthole							0
203	Fea.2, extramural hearth			1/0.6				1/0.6
150	Fea.3, extramural hearth							0
Ubiquity: [number of samples]		0	0	1	1	0	0	

[Number before slash indicates actual number of seeds recovered/ number after slash indicates number of seeds per liter of original soil sample].

undetermined conifer (Tables 2 and 3). One floor grid (7N/12E, FS #173) held a notable concentration of pinyon (26% of pieces, 30% by weight, in contrast to overall averages of 12 to 19%).

Activity Area

An activity area located several meters to the north across a small arroyo contained an abundance of features, many with sizeable concentrations of carbonized materials. Sampled heating features included an ash and fire-cracked rock concentration (Fea. 10), four hearths (Fea. 9, 11, 12, 15), and a roasting pit (Fea. 18). A mealing bin (Fea. 16) and three postholes (Fea. 13, 14, 17) were also sampled.

Carbonized juniper seeds (found in a hearth, posthole, and roasting pit) were the only floral specimens that clearly belonged to the cultural occupation. Though there is some ethnobotanical record of the consumption of juniper berries, strong aromatic resins generally limited such use to seasoning or a stress food (Castetter 1935:31-32, Swank 1932:50). These seeds were more likely linked to juniper fuel use at Otowi. The presence of juniper and pinyon trees in the modern site environs was attested to by fragments of unburned, undegraded juniper twigs (Fea. 9 and 10) and pinyon nutshell (Fea. 13). Other ambient materials were present in very low frequency in Features 9, 15, and 17.

Charcoal from activity area features was again exclusively coniferous (Tables 2 and 3). Juniper and undetermined conifer tended to be the major constituents of individual samples. Pinyon was a larger component than the overall average in two hearths (Fea. 9 and 15) and the ash/fire-cracked rock concentration (Fea. 10).

Table 2. Composition of Charcoal from Flotation Samples: LA 51912.

FS	Provenience	*Juniperus* [Juniper]	*Pinus edulis* [Pinyon]	Undetermined conifer	TOTAL
190	Feature 1 floor	10 [0.3g]	2 [<0.05g]	8 [0.2g]	20 [0.5g]
150	Feature 3 hearth	11 [0.9g]	1 [0.4g]	8 [1.2g]	20 [2.5g]
362	Feature 9 hearth	6 [0.2g]	4 [0.1g]	10 [0.2g]	20 [0.5g]
355	Feature 10 ash/fire-cracked rock	2 [0.1g]	10 [0.3g]	8 [0.1g]	20 [0.5g]
363	Feature 11 hearth	11 [1.2g]	1 [0.1g]	8 [0.6g]	20 [1.9g]
400	Feature 12 hearth	7 [0.1g]	2 [0.1g]	11 [0.3g]	20 [0.5g]
331	Feature 14 posthole	17 [0.8g]		3 [<0.05g]	20 {0.8g]
333	Feature 14 posthole	6 [0.1g]	1 [<0.05g]	13 [0.3g]	20 [0.4g]
375	Feature 15 hearth	2 [<0.05g]	8 [0.1g]	10 [0.1g]	20 [0.2g]
376	Feature 15 hearth	5 [0.1g]	2 [<0.05g]	13 [0.2g]	20 [0.2g]
387	Feature 17 posthole	6 [<0.05g]	1 [<0.05g]	13 [0.1g]	20 [0.1g]
398	Feature 18 roasting pit	15 [0.7g]		5 [0.2g]	20 [0.9g]
401	Feature 18 roasting pit	3 [0.2g]	5 [0.1g]	12 [0.3g]	20 [0.6g]
61	Test Pit 3	9 [0.4g]		11 [0.3g]	20 [0.7g]
282	Test Pit 9	8 [0.3g]	2 [0.1g]	10 [0.2g]	20 [0.6g]

Table 2. Composition of Charcoal from Flotation Samples: LA 51912, cont.

FS	Provenience	*Juniperus* [Juniper]	*Pinus edulis* [Pinyon]	Undetermined conifer	TOTAL
307	Test Pit 12	9 [0.4g]	1 [0.1g]	10 [0.4g]	20 [0.9g]
Total pieces		127 40%	40 12%	153 48%	320 100%
Total weight		5.8g 49%	1.4g 12%	4.7g 39%	11.9g 100%

Table 3. Composition of Charcoal Submitted for C-14 Dating: LA 51912.

FS	Provenience	*Juniperus* [Juniper]	*Pinus edulis* [Pinyon]	Undetermined conifer	TOTAL
73	Feature 1 9N/11E fill above floor	23 [2.2g]	5 [0.3g]	11 [0.9g]	39 [3.4g]
94	Feature 1 9N/12E lev. 6, fill	15 [5.5g]	2 [0.9g]	3 [0.3g]	20 [6.7g]
173	Feature 1 7N/12E lev. 7, fill	14 [1.0g]	10 [1.2g]	14 [1.8g]	38 [4.0g]
360	Feature 9 hearth	16 [5.6g]	9 [1.5g]	6 [0.6g]	31 [7.7g]
373	Feature 15 hearth			8 [1.3g]	8 [1.3g]
Total pieces		68 50%	26 19%	42 31%	136 100%
Total weight		14.3g 62%	3.9g 17%	4.9g 21%	23.1g 100%

Table 4. Flotation Results, Activity Area (14 samples): LA 51912, Otowi.

FS	Provenience	Juniperus	Pinus edulis	Gramineae	Chenopodium	Misc.	Unknown	TOTAL
362	Fea.9, hearth	1/0.4* [twig]					1/0.4*	2/0.8
355	Fea.10, ash and fire-cracked rock	[twig]						0
363	Fea.11, hearth							0
400	Fea.12, hearth							0
320	Fea.13, posthole		1/0.5					1/0.5
331	Fea.14, posthole							0
332	Fea.14, posthole							0
333	Fea.14, posthole							0
375	Fea.15, hearth					1/0.7[a]		1/0.7
376	Fea.15, hearth							0
395	Fea.16, mealing bin							0
387	Fea.17, posthole	1/0.3*				1/0.3[b]		2/0.6
398	Fea.18, roasting pit	5/2.0*						5/2.0
400	Fea.18, roasting pit							0
Ubiquity: [number of samples]		4	1	0	0	2	1	

[Number before slash indicates actual number of seeds recovered/ number after slash indicates number of seeds per liter of original soil sample].

*charred

[a] Leguminosae seed pod

[b] cf. *Marrubium* (seed capsule, mint family)

Test Pits

Three flotation samples were submitted from test pit locations. Of these, Test Pit 9 was the only sample to contain cultural floral remains (Table 5). A single charred juniper seed was present, as characterized several features in the activity area. All three test pit samples were analyzed for charcoal composition: juniper and undetermined conifer were co-dominants, with approximately equal contributions, and pinyon was a much smaller component (Table 2).

DISCUSSION AND SUMMARY

Although a number of factors at this site suggested preservation of botanical materials might be good, very few specimens were present. Protection of cultural deposits by overlying sediments (in this case averaging about 60 cm) and especially by architectural structures, is ordinarily propitious for preservation of floral artifacts. In this case, though, overall production of organic materials in flotation samples (grams of floated material per liter of soil) was actually higher in outdoor activity area features than within the pithouse itself. Despite a substantial sitewide sample weight average of 13.3 g (or 9.9 grams per liter of soil), a total of only 11 items (spread over 6 samples) were found which could be considered evidence of prehistoric botanical use. Soil sample size was sufficient (average 2218 ml) to allow recovery of low frequency items.

Charred specimens of edible plant species included juniper seeds in five samples, and a single goosefoot seed. Not a single corn cupule was encountered, reiterating the pollen results (Dean 1988). Corn cobs are

Table 5. Flotation Results, Test Pits (3 samples): LA 51912, Otowi.

FS	Provenience	Juniperus	Pinus edulis	Gramineae	Chenopodium	Misc.	Unknown	TOTAL
61	Test Pit 3							0
282	Test Pit 9	1/0.8*						1/0.8
307	Test Pit 12							0
Ubiquity: [number of samples]		1	0	0	0	0	0	

[Number before slash indicates actual number of seeds recovered/ number after slash indicates number of seeds per liter of original soil sample].

*charred

relatively durable byproducts that can be expected to turn up throughout any Anasazi site where maize farming was part of the subsistence base. The common practice of recycling spent cobs as fuel ensured preservation by carbonization. Absence of corn remains in so many sizeable flotation samples is a reliable indicator that subsistence at this site was not based on agriculture.

So what were all the groundstone artifacts, heating features, the mealing bin, and storage feature about at Otowi? The single weed seed hardly provides satisfying evidence of what processing and storage activities took place at this site. Neither do the juniper seeds suggest a convincing functional complex, though they were found in repeated samples. Juniper berries have never operated as a dietary mainstay, as their nutritional value is not high and their resinous oils have a powerful flavor. More likely, these seeds were associated with the juniper wood used throughout the site.

Our most confident conclusions about subsistence at this site are negative. We have made a thorough search, through 26 flotation samples and 16 pollen samples, and have found no evidence of domesticates. Given the demonstrated durability of corn cob remains, and their ubiquity elsewhere, their absence here is a reliable indication that the site was non-agricultural. We have, however, no good evidence of what wild plant products were milled, heated, and stored at this site.

REFERENCES CITED

Bohrer, Vorsila L., and Karen R. Adams. 1977. Ethnobotanical techniques and approaches at the Salmon Ruin, New Mexico. San Juan Valley Archeological Project, Technical Series 2; Eastern New Mexico University Contributions in Anthropology 8(1).

Castetter, Edward F. 1935. Uncultivated native plants used as sources of food. Ethnobiological Studies of the American Southwest 1, University of New Mexico Bulletin, Biological Series 4(1).

Dean, Glenna. 1988. Pollen analysis of archeological samples from LA 51912, Otowi, Santa Fe county, New Mexico. Ms. on file, Laboratory of Anthropology, Research Section, Museum of New Mexico, Santa Fe. Castetter Laboratory for Ethnobotanical Studies, Technical Series 221.

Elmore, Francis H. 1944. Ethnobotany of the Navajo. University of New Mexico Bulletin, Monograph Series 1(7).

Jones, Volney. 1930. The ethnobotany of the Isleta Indians. Unpublished M.A. thesis, Department of Anthropology, University of New Mexico.

Swank, G.R. 1932. The ethnobotany of the Acoma and Laguna Indians. Unpublished M.A. thesis, Department of Anthropology, University of New Mexico, Albuquerque.

Toll, Mollie S. 1981. Flotation and macrobotanical analyses at 29SJ629: a Pueblo I-II village in Chaco Canyon. Ms. on file, Division of Cultural Research, National Park Service, Santa Fe. Castetter Laboratory for Ethnobotanical Studies, Technical Series 49.

Toll, Mollie S. 1983. Changing patterns of plant utilization for food and fuel: evidence from flotation and macrobotanical remains. In Economy and interaction along the lower Chaco River: the Navajo Mines Archeological Program, Mining Area III, edited by Patrick Hogan and Joseph C. Winter, pp. 331-350. Office of Contract Archeology, University of New Mexico, Albuquerque.

Toll, Mollie S. 1985. Plant utilization at a Chacoan town site: Pueblo Alto. Ms. on file, Division of Cultural Research, National Park Service, Santa Fe.

Appendix 4: SPSS Tables

Appendix 4, Table 1

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Crosstabulation:     MATL      Material Type                              By TYPE      Artifact Type

            Count  |
          Row Pct  |Flake    |Lg. Angu|Sm. Angu|Biface F|Blade    |Rejuv. F|
  TYPE->  Col Pct  |         |lar Debr|lar Debr|lake    |         |lake    |  Row
          Tot Pct  |        1|       2|       3|       4|        5|       6| Total
MATL       --------+---------+--------+--------+--------+---------+--------+
        bs         |     5   |        |        |        |         |        |    5
  Basalt           |  100.0  |        |        |        |         |        |   .3
                   |     .5  |        |        |        |         |        |
                   |     .3  |        |        |        |         |        |
                   +---------+--------+--------+--------+---------+--------+
        ch         |   126   |        |    22  |    21  |         |        |  169
  Chalcedony       |   74.6  |        |  13.0  |  12.4  |         |        |  9.7
                   |   11.5  |        |  57.9  |   3.5  |         |        |
                   |    7.2  |        |   1.3  |   1.2  |         |        |
                   +---------+--------+--------+--------+---------+--------+
        crt        |    49   |     1  |    11  |    10  |         |        |   71
  Chert            |   69.0  |   1.4  |  15.5  |  14.1  |         |        |  4.1
                   |    4.5  |  25.0  |  28.9  |   1.7  |         |        |
                   |    2.8  |    .1  |    .6  |    .6  |         |        |
                   +---------+--------+--------+--------+---------+--------+
        jzoba      |   916   |     2  |     5  |   564  |      2  |     9  | 1498
  Jemez Obsidian   |   61.1  |    .1  |    .3  |  37.7  |     .1  |    .6  | 85.7
                   |   83.3  |  50.0  |  13.2  |  94.8  |  100.0  |  100.0 |
                   |   52.4  |    .1  |    .3  |  32.3  |     .1  |    .5  |
                   +---------+--------+--------+--------+---------+--------+
        qzt        |     3   |     1  |        |        |         |        |    4
  Quartzite        |   75.0  |  25.0  |        |        |         |        |   .2
                   |     .3  |  25.0  |        |        |         |        |
                   |     .2  |    .1  |        |        |         |        |
                   +---------+--------+--------+--------+---------+--------+
           Column     1099        4       38      595        2         9      1747
            Total     62.9       .2      2.2     34.1       .1        .5     100.0

Number of Missing Observations =        0
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Appendix 4, Table 2

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Crosstabulation:     MATL      Material Type                           By CORTX     Cortex

           Count  |
         Row Pct  |Absent   |<25%     |25-50%  |>50%     |100%     |Unknown |
CORTX->  Col Pct  |         |         |        |         |         |        |  Row
         Tot Pct  |       0 |       1 |      2 |       3 |       4 |      5 | Total
MATL      --------+---------+---------+--------+---------+---------+--------+
              bs  |     4   |     1   |        |         |         |        |    5
  Basalt          |  80.0   |  20.0   |        |         |         |        |   .3
                  |    .3   |   1.4   |        |         |         |        |
                  |    .2   |    .1   |        |         |         |        |
                  +---------+---------+--------+---------+---------+--------+
              ch  |   130   |    16   |    12  |      5  |      6  |        |  169
  Chalcedony      |  76.9   |   9.5   |   7.1  |    3.0  |    3.6  |        |  9.7
                  |   8.2   |  22.9   |  24.0  |   26.3  |   42.9  |        |
                  |   7.4   |    .9   |    .7  |     .3  |     .3  |        |
                  +---------+---------+--------+---------+---------+--------+
             crt  |    55   |     8   |     5  |      3  |         |        |   71
  Chert           |  77.5   |  11.3   |   7.0  |    4.2  |         |        |  4.1
                  |   3.5   |  11.4   |  10.0  |   15.8  |         |        |
                  |   3.1   |    .5   |    .3  |     .2  |         |        |
                  +---------+---------+--------+---------+---------+--------+
           jzoba  |  1402   |    45   |    31  |     11  |      8  |      1 | 1498
  Jemez Obsidian  |  93.6   |   3.0   |   2.1  |     .7  |     .5  |     .1 | 85.7
                  |  88.0   |  64.3   |  62.0  |   57.9  |   57.1  |  100.0 |
                  |  80.3   |   2.6   |   1.8  |     .6  |     .5  |     .1 |
                  +---------+---------+--------+---------+---------+--------+
             qzt  |     2   |         |     2  |         |         |        |    4
  Quartzite       |  50.0   |         |  50.0  |         |         |        |   .2
                  |    .1   |         |   4.0  |         |         |        |
                  |    .1   |         |    .1  |         |         |        |
                  +---------+---------+--------+---------+---------+--------+
          Column     1593        70       50        19        14         1    1747
           Total     91.2       4.0      2.9       1.1        .8        .1   100.0

Number of Missing Observations =        0
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Appendix 4, Table 3

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                                    SPSS/PC+

Crosstabulation:     TYPE       Artifact Type                      By CORTX      Cortex

                Count  |
              Row Pct  |Absent  |<25%    |25-50%  |>50%    |100%    |Unknown |
CORTX->       Col Pct  |        |        |        |        |        |        | Row
              Tot Pct  |      0 |      1 |      2 |      3 |      4 |      5 | Total
TYPE           --------+--------+--------+--------+--------+--------+--------+
                    1  |   970  |    62  |    38  |    16  |    12  |     1  |  1099
  Flake                |  88.3  |   5.6  |   3.5  |   1.5  |   1.1  |    .1  |  62.9
                       |  60.9  |  88.6  |  76.0  |  84.2  |  85.7  | 100.0  |
                       |  55.5  |   3.5  |   2.2  |    .9  |    .7  |    .1  |
                       +--------+--------+--------+--------+--------+--------+
                    2  |     1  |        |     2  |     1  |        |        |     4
  Lg. Angular Debr     |  25.0  |        |  50.0  |  25.0  |        |        |    .2
                       |    .1  |        |   4.0  |   5.3  |        |        |
                       |    .1  |        |    .1  |    .1  |        |        |
                       +--------+--------+--------+--------+--------+--------+
                    3  |    25  |     3  |     8  |     2  |        |        |    38
  Sm. Angular Debr     |  65.8  |   7.9  |  21.1  |   5.3  |        |        |   2.2
                       |   1.6  |   4.3  |  16.0  |  10.5  |        |        |
                       |   1.4  |    .2  |    .5  |    .1  |        |        |
                       +--------+--------+--------+--------+--------+--------+
                    4  |   587  |     4  |     2  |        |     2  |        |   595
  Biface Flake         |  98.7  |    .7  |    .3  |        |    .3  |        |  34.1
                       |  36.8  |   5.7  |   4.0  |        |  14.3  |        |
                       |  33.6  |    .2  |    .1  |        |    .1  |        |
                       +--------+--------+--------+--------+--------+--------+
                    5  |     1  |     1  |        |        |        |        |     2
  Blade                |  50.0  |  50.0  |        |        |        |        |    .1
                       |    .1  |   1.4  |        |        |        |        |
                       |    .1  |    .1  |        |        |        |        |
                       +--------+--------+--------+--------+--------+--------+
                    6  |     9  |        |        |        |        |        |     9
  Rejuv. Flake         | 100.0  |        |        |        |        |        |    .5
                       |    .6  |        |        |        |        |        |
                       |    .5  |        |        |        |        |        |
                       +--------+--------+--------+--------+--------+--------+
                Column    1593       70       50       19       14        1     1747
                 Total    91.2      4.0      2.9      1.1       .8       .1    100.0

Number of Missing Observations =        0
```

Appendix 4, Table 4

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                               SPSS/PC+

Crosstabulation:     MATL      Material Type                              By PORT      Portion

             Count  |
           Row Pct  |Proximal|Distal  |Medial  |1/3     |2/3     |Lateral |Indeterm|Whole   |
  PORT->   Col Pct  |        |        |        |        |        |Edge    |inate   |        |  Row
           Tot Pct  |      1 |      2 |      3 |      4 |      5 |      6 |      7 |      8 | Total
MATL        --------+--------+--------+--------+--------+--------+--------+--------+--------+
            bs      |     1  |     1  |        |     1  |        |        |        |     2  |     5
  Basalt            |  20.0  |  20.0  |        |  20.0  |        |        |        |  40.0  |    .3
                    |    .9  |   1.4  |        |    .2  |        |        |        |    .4  |
                    |    .1  |    .1  |        |    .1  |        |        |        |    .1  |
                    +--------+--------+--------+--------+--------+--------+--------+--------+
            ch      |     9  |    12  |    12  |    37  |    11  |     9  |     8  |    71  |   169
  Chalcedony        |   5.3  |   7.1  |   7.1  |  21.9  |   6.5  |   5.3  |   4.7  |  42.0  |   9.7
                    |   7.9  |  16.2  |   3.3  |   8.8  |   7.3  |  12.9  |  10.3  |  14.9  |
                    |    .5  |    .7  |    .7  |   2.1  |    .6  |    .5  |    .5  |   4.1  |
                    +--------+--------+--------+--------+--------+--------+--------+--------+
            crt     |     5  |     6  |    13  |     6  |     4  |     3  |     3  |    31  |    71
  Chert             |   7.0  |   8.5  |  18.3  |   8.5  |   5.6  |   4.2  |   4.2  |  43.7  |   4.1
                    |   4.4  |   8.1  |   3.6  |   1.4  |   2.6  |   4.3  |   3.8  |   6.5  |
                    |    .3  |    .3  |    .7  |    .3  |    .2  |    .2  |    .2  |   1.8  |
                    +--------+--------+--------+--------+--------+--------+--------+--------+
            jzoba   |    99  |    55  |   337  |   376  |   136  |    58  |    67  |   370  |  1498
  Jemez Obsidian    |   6.6  |   3.7  |  22.5  |  25.1  |   9.1  |   3.9  |   4.5  |  24.7  |  85.7
                    |  86.8  |  74.3  |  92.8  |  89.5  |  90.1  |  82.9  |  85.9  |  77.6  |
                    |   5.7  |   3.1  |  19.3  |  21.5  |   7.8  |   3.3  |   3.8  |  21.2  |
                    +--------+--------+--------+--------+--------+--------+--------+--------+
            qzt     |        |        |     1  |        |        |        |        |     3  |     4
  Quartzite         |        |        |  25.0  |        |        |        |        |  75.0  |    .2
                    |        |        |    .3  |        |        |        |        |    .6  |
                    |        |        |    .1  |        |        |        |        |    .2  |
                    +--------+--------+--------+--------+--------+--------+--------+--------+
            Column      114       74      363      420      151       70       78      477     1747
             Total      6.5      4.2     20.8     24.0      8.6      4.0      4.5     27.3    100.0

Number of Missing Observations =       0
```

Appendix 4, Table 5

```
                                   SPSS/PC+

Crosstabulation:     TYPE      Artifact Type                         By PORT      Portion

            Count |
          Row Pct |Proximal|Distal  |Medial  |1/3     |2/3     |Lateral |Indeterm|Whole   |
  PORT->  Col Pct |        |        |        |        |        |Edge    |inate   |        |  Row
          Tot Pct |      1 |      2 |      3 |      4 |      5 |      6 |      7 |      8 | Total
TYPE      --------+--------+--------+--------+--------+--------+--------+--------+--------+
                1 |    89  |    47  |   276  |   237  |    78  |    61  |    64  |   247  |  1099
  Flake           |   8.1  |   4.3  |  25.1  |  21.6  |   7.1  |   5.6  |   5.8  |  22.5  |  62.9
                  |  78.1  |  63.5  |  76.0  |  56.4  |  51.7  |  87.1  |  82.1  |  51.8  |
                  |   5.1  |   2.7  |  15.8  |  13.6  |   4.5  |   3.5  |   3.7  |  14.1  |
                  +--------+--------+--------+--------+--------+--------+--------+--------+
                2 |        |        |        |        |        |        |        |     4  |     4
  Lg. Angular Debr|        |        |        |        |        |        |        | 100.0  |    .2
                  |        |        |        |        |        |        |        |    .8  |
                  |        |        |        |        |        |        |        |    .2  |
                  +--------+--------+--------+--------+--------+--------+--------+--------+
                3 |     1  |        |        |        |        |        |        |    37  |    38
  Sm. Angular Debr|   2.6  |        |        |        |        |        |        |  97.4  |   2.2
                  |    .9  |        |        |        |        |        |        |   7.8  |
                  |    .1  |        |        |        |        |        |        |   2.1  |
                  +--------+--------+--------+--------+--------+--------+--------+--------+
                4 |    23  |    27  |    87  |   179  |    72  |     9  |    14  |   184  |   595
  Biface Flake    |   3.9  |   4.5  |  14.6  |  30.1  |  12.1  |   1.5  |   2.4  |  30.9  |  34.1
                  |  20.2  |  36.5  |  24.0  |  42.6  |  47.7  |  12.9  |  17.9  |  38.6  |
                  |   1.3  |   1.5  |   5.0  |  10.2  |   4.1  |    .5  |    .8  |  10.5  |
                  +--------+--------+--------+--------+--------+--------+--------+--------+
                5 |        |        |        |     1  |     1  |        |        |        |     2
  Blade           |        |        |        |  50.0  |  50.0  |        |        |        |    .1
                  |        |        |        |    .2  |    .7  |        |        |        |
                  |        |        |        |    .1  |    .1  |        |        |        |
                  +--------+--------+--------+--------+--------+--------+--------+--------+
                6 |     1  |        |        |     3  |        |        |        |     5  |     9
  Rejuv. Flake    |  11.1  |        |        |  33.3  |        |        |        |  55.6  |    .5
                  |    .9  |        |        |    .7  |        |        |        |   1.0  |
                  |    .1  |        |        |    .2  |        |        |        |    .3  |
                  +--------+--------+--------+--------+--------+--------+--------+--------+
           Column     114       74      363      420      151       70       78      477     1747
            Total     6.5      4.2     20.8     24.0      8.6      4.0      4.5     27.3    100.0

Number of Missing Observations =        0
```

Appendix 4, Table 6

```
Crosstabulation:   MATL     Material Type                            By PLATF    Platform Type       MATL     Material Type

           Count |
         Row Pct |Absent   |Single f|Multifac|Retouche|Collapse|Battered|Ground/p|Lipped  |1/8     |2/8     |3/8     |        |        |
PLATF->  Col Pct |         |acet    |et      |d/dorsal|d/crushe|        |repared |        |        |        |        |        |        | Row
         Tot Pct |      0  |     1  |     2  |     3  |     4  |     5  |     6  |     8  |     9  |    10  |    11  |    12  |    13  | Total
MATL    ---------+---------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
            bs   |      1  |     1  |     1  |        |        |        |        |        |        |        |        |     1  |     1  |     5
  Basalt         |   20.0  |  20.0  |  20.0  |        |        |        |        |        |        |        |        |  20.0  |  20.0  |    .3
                 |     .1  |    .7  |   1.9  |        |        |        |        |        |        |        |        |  14.3  |   2.7  |
                 |     .1  |    .1  |    .1  |        |        |        |        |        |        |        |        |    .1  |    .1  |
                 +---------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
            ch   |     95  |    25  |     7  |     1  |     5  |     1  |     6  |        |    13  |     1  |        |        |    15  |   169
  Chalcedony     |   56.2  |  14.8  |   4.1  |    .6  |   3.0  |    .6  |   3.6  |        |   7.7  |    .6  |        |        |   8.9  |   9.7
                 |    9.3  |  17.6  |  13.0  |  33.3  |   3.3  | 100.0  |   5.7  |        |  12.3  |   1.2  |        |        |  40.5  |
                 |    5.4  |   1.4  |    .4  |    .1  |    .3  |    .1  |    .3  |        |    .7  |    .1  |        |        |    .9  |
                 +---------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
            crt  |     48  |     9  |     2  |        |     3  |        |     1  |        |     1  |     2  |        |        |     5  |    71
  Chert          |   67.6  |  12.7  |   2.8  |        |   4.2  |        |   1.4  |        |   1.4  |   2.8  |        |        |   7.0  |   4.1
                 |    4.7  |   6.3  |   3.7  |        |   2.0  |        |    .9  |        |    .9  |   2.3  |        |        |  13.5  |
                 |    2.7  |    .5  |    .1  |        |    .2  |        |    .1  |        |    .1  |    .1  |        |        |    .3  |
                 +---------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
            jzoba|    871  |   106  |    44  |     2  |   142  |        |    99  |    37  |    92  |    83  |     1  |     6  |    15  |  1498
  Jemez Obsidian |   58.1  |   7.1  |   2.9  |    .1  |   9.5  |        |   6.6  |   2.5  |   6.1  |   5.5  |    .1  |    .4  |   1.0  |  85.7
                 |   85.6  |  74.6  |  81.5  |  66.7  |  94.7  |        |  93.4  | 100.0  |  86.8  |  96.5  | 100.0  |  85.7  |  40.5  |
                 |   49.9  |   6.1  |   2.5  |    .1  |   8.1  |        |   5.7  |   2.1  |   5.3  |   4.8  |    .1  |    .3  |    .9  |
                 +---------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
            qzt  |      2  |     1  |        |        |        |        |        |        |        |        |        |        |     1  |     4
  Quartzite      |   50.0  |  25.0  |        |        |        |        |        |        |        |        |        |        |  25.0  |    .2
                 |     .2  |    .7  |        |        |        |        |        |        |        |        |        |        |   2.7  |
                 |     .1  |    .1  |        |        |        |        |        |        |        |        |        |        |    .1  |
                 +---------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
          Column     1017      142       54        3      150        1      106       37      106       86        1        7       37     1747
(Continued) Total    58.2      8.1      3.1       .2      8.6       .1      6.1      2.1      6.1      4.9       .1       .4      2.1    100.0

                                                                                     Number of Missing Observations =       0
```

Appendix 4, Table 7

```
Crosstabulation:     TYPE      Artifact Type                         By PLATF     Platform Type            Artifact Type


                 Count |
               Row Pct |Absent  |Single f|Multifac|Retouche|Collapse|Battered|Ground/p|Lipped  |1/8     |2/8     |3/8     |        |        |
  PLATF->      Col Pct |        |acet    |et      |d/dorsal|d/crushe|        |repared |        |        |        |        |        |        | Row
               Tot Pct |       0|       1|       2|       3|       4|       5|       6|       8|       9|      10|      11|      12|      13| Total
TYPE           --------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                     1 |   661  |   101  |    39  |     3  |    76  |     1  |    67  |    16  |    58  |    37  |     1  |     6  |    33  |  1099
  Flake                |  60.1  |   9.2  |   3.5  |    .3  |   6.9  |    .1  |   6.1  |   1.5  |   5.3  |   3.4  |    .1  |    .5  |   3.0  |  62.9
                       |  65.0  |  71.1  |  72.2  | 100.0  |  50.7  | 100.0  |  63.2  |  43.2  |  54.7  |  43.0  | 100.0  |  85.7  |  89.2  |
                       |  37.8  |   5.8  |   2.2  |    .2  |   4.4  |    .1  |   3.8  |    .9  |   3.3  |   2.1  |    .1  |    .3  |   1.9  |
                       +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                     2 |     4  |        |        |        |        |        |        |        |        |        |        |        |        |     4
  Lg. Angular Debr     | 100.0  |        |        |        |        |        |        |        |        |        |        |        |        |    .2
                       |    .4  |        |        |        |        |        |        |        |        |        |        |        |        |
                       |    .2  |        |        |        |        |        |        |        |        |        |        |        |        |
                       +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                     3 |    38  |        |        |        |        |        |        |        |        |        |        |        |        |    38
  Sm. Angular Debr     | 100.0  |        |        |        |        |        |        |        |        |        |        |        |        |   2.2
                       |   3.7  |        |        |        |        |        |        |        |        |        |        |        |        |
                       |   2.2  |        |        |        |        |        |        |        |        |        |        |        |        |
                       +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                     4 |   314  |    41  |    14  |        |    73  |        |    39  |    21  |    44  |    44  |        |     1  |     4  |   595
  Biface Flake         |  52.8  |   6.9  |   2.4  |        |  12.3  |        |   6.6  |   3.5  |   7.4  |   7.4  |        |    .2  |    .7  |  34.1
                       |  30.9  |  28.9  |  25.9  |        |  48.7  |        |  36.8  |  56.8  |  41.5  |  51.2  |        |  14.3  |  10.8  |
                       |  18.0  |   2.3  |    .8  |        |   4.2  |        |   2.2  |   1.2  |   2.5  |   2.5  |        |    .1  |    .2  |
                       +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                     5 |        |        |     1  |        |     1  |        |        |        |        |        |        |        |        |     2
  Blade                |        |        |  50.0  |        |  50.0  |        |        |        |        |        |        |        |        |    .1
                       |        |        |   1.9  |        |    .7  |        |        |        |        |        |        |        |        |
                       |        |        |    .1  |        |    .1  |        |        |        |        |        |        |        |        |
                       +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                     6 |        |        |        |        |        |        |        |        |     4  |     5  |        |        |        |     9
  Rejuv. Flake         |        |        |        |        |        |        |        |        |  44.4  |  55.6  |        |        |        |    .5
                       |        |        |        |        |        |        |        |        |   3.8  |   5.8  |        |        |        |
                       |        |        |        |        |        |        |        |        |    .2  |    .3  |        |        |        |
                       +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                Column    1017      142       54        3      150        1      106       37      106       86        1        7       37     1747
(Continued)      Total    58.2      8.1      3.1       .2      8.6       .1      6.1      2.1      6.1      4.9       .1       .4      2.1    100.0

                                                                                      Number of Missing Observations =        0
```

Appendix 4, Table 8

```
                                   SPSS/PC+

Crosstabulation:      MATL      Material Type

               Count  |
             Row Pct  |None     |Potlids  |Cracklin|Oxidized|1/2, 1/3|
HEATTRET->   Col Pct  |         |         |g       |        |, 2/1, 2|  Row
             Tot Pct  |       0 |       1 |      2 |      3 |      4 | Total
MATL         --------+--------+--------+--------+--------+--------+
          bs          |     5  |        |        |        |        |    5
  Basalt              |  100.0 |        |        |        |        |   .3
                      |     .3 |        |        |        |        |
                      |     .3 |        |        |        |        |
                      +--------+--------+--------+--------+--------+
          ch          |   152  |      1 |     12 |      2 |      2 |  169
  Chalcedony          |   89.9 |     .6 |    7.1 |    1.2 |    1.2 |  9.7
                      |    8.9 |   33.3 |   70.6 |   25.0 |   66.7 |
                      |    8.7 |     .1 |     .7 |     .1 |     .1 |
                      +--------+--------+--------+--------+--------+
          crt         |    65  |        |      5 |        |      1 |   71
  Chert               |   91.5 |        |    7.0 |        |    1.4 |  4.1
                      |    3.8 |        |   29.4 |        |   33.3 |
                      |    3.7 |        |     .3 |        |     .1 |
                      +--------+--------+--------+--------+--------+
          jzoba       |  1490  |      2 |        |      6 |        | 1498
  Jemez Obsidian      |   99.5 |     .1 |        |     .4 |        | 85.7
                      |   86.8 |   66.7 |        |   75.0 |        |
                      |   85.3 |     .1 |        |     .3 |        |
                      +--------+--------+--------+--------+--------+
          qzt         |     4  |        |        |        |        |    4
  Quartzite           |  100.0 |        |        |        |        |   .2
                      |     .2 |        |        |        |        |
                      |     .2 |        |        |        |        |
                      +--------+--------+--------+--------+--------+
             Column      1716         3       17        8        3    1747
              Total      98.2        .2      1.0       .5       .2   100.0

Number of Missing Observations =        0
```

Appendix 4, Table 9

```
                               SPSS/PC+

Crosstabulation:     TYPE      Artifact Type

             Count  |
           Row Pct  |None    |Potlids |Cracklin|Oxidized|1/2, 1/3|
HEATTRET-> Col Pct  |        |        |g       |        |, 2/1, 2|  Row
           Tot Pct  |     0  |     1  |     2  |     3  |     4  | Total
TYPE       ---------+--------+--------+--------+--------+--------+
                 1  |  1079  |     3  |    12  |     3  |     2  |  1099
  Flake             |  98.2  |    .3  |   1.1  |    .3  |    .2  |  62.9
                    |  62.9  | 100.0  |  70.6  |  37.5  |  66.7  |
                    |  61.8  |    .2  |    .7  |    .2  |    .1  |
                    +--------+--------+--------+--------+--------+
                 2  |     4  |        |        |        |        |     4
  Lg. Angular Debr  | 100.0  |        |        |        |        |    .2
                    |    .2  |        |        |        |        |
                    |    .2  |        |        |        |        |
                    +--------+--------+--------+--------+--------+
                 3  |    31  |        |     5  |     1  |     1  |    38
  Sm. Angular Debr  |  81.6  |        |  13.2  |   2.6  |   2.6  |   2.2
                    |   1.8  |        |  29.4  |  12.5  |  33.3  |
                    |   1.8  |        |    .3  |    .1  |    .1  |
                    +--------+--------+--------+--------+--------+
                 4  |   591  |        |        |     4  |        |   595
  Biface Flake      |  99.3  |        |        |    .7  |        |  34.1
                    |  34.4  |        |        |  50.0  |        |
                    |  33.8  |        |        |    .2  |        |
                    +--------+--------+--------+--------+--------+
                 5  |     2  |        |        |        |        |     2
  Blade             | 100.0  |        |        |        |        |    .1
                    |    .1  |        |        |        |        |
                    |    .1  |        |        |        |        |
                    +--------+--------+--------+--------+--------+
                 6  |     9  |        |        |        |        |     9
  Rejuv. Flake      | 100.0  |        |        |        |        |    .5
                    |    .5  |        |        |        |        |
                    |    .5  |        |        |        |        |
                    +--------+--------+--------+--------+--------+
            Column     1716        3       17        8        3     1747
             Total     98.2       .2      1.0       .5       .2    100.0

Number of Missing Observations =        0
```

Appendix 4, Table 10

```
Crosstabulation:     MATL      Material Type

                Count  |
              Row Pct  |
MODEDG->      Col Pct  |                                       |  Row
              Tot Pct  |       0 |       1 |       2 |       3 | Total
MATL           --------+---------+---------+---------+---------+
                 bs    |       5 |         |         |         |     5
  Basalt               |   100.0 |         |         |         |    .3
                       |      .3 |         |         |         |
                       |      .3 |         |         |         |
                       +---------+---------+---------+---------+
                 ch    |     161 |       6 |       2 |         |   169
  Chalcedony           |    95.3 |     3.6 |     1.2 |         |   9.7
                       |    10.4 |     3.7 |     7.4 |         |
                       |     9.2 |      .3 |      .1 |         |
                       +---------+---------+---------+---------+
                 crt   |      62 |       7 |       2 |         |    71
  Chert                |    87.3 |     9.9 |     2.8 |         |   4.1
                       |     4.0 |     4.3 |     7.4 |         |
                       |     3.5 |      .4 |      .1 |         |
                       +---------+---------+---------+---------+
                 jzoba |    1318 |     149 |      23 |       8 |  1498
  Jemez Obsidian       |    88.0 |     9.9 |     1.5 |      .5 |  85.7
                       |    85.0 |    92.0 |    85.2 |   100.0 |
                       |    75.4 |     8.5 |     1.3 |      .5 |
                       +---------+---------+---------+---------+
                 qzt   |       4 |         |         |         |     4
  Quartzite            |   100.0 |         |         |         |    .2
                       |      .3 |         |         |         |
                       |      .2 |         |         |         |
                       +---------+---------+---------+---------+
                Column      1550       162        27         8    1747
                 Total      88.7       9.3       1.5        .5   100.0

Number of Missing Observations =        0
```

Appendix 4, Table 11

```
Crosstabulation:     TYPE      Artifact Type

                Count  |
              Row Pct  |
MODEDG->      Col Pct  |                                       |  Row
              Tot Pct  |       0 |       1 |       2 |       3 | Total
TYPE           --------+---------+---------+---------+---------+
                    1  |     953 |     116 |      23 |       7 |  1099
  Flake                |    86.7 |    10.6 |     2.1 |      .6 |  62.9
                       |    61.5 |    71.6 |    85.2 |    87.5 |
                       |    54.6 |     6.6 |     1.3 |      .4 |
                       +---------+---------+---------+---------+
                    2  |       4 |         |         |         |     4
  Lg. Angular Debr     |   100.0 |         |         |         |    .2
                       |      .3 |         |         |         |
                       |      .2 |         |         |         |
                       +---------+---------+---------+---------+
                    3  |      37 |       1 |         |         |    38
  Sm. Angular Debr     |    97.4 |     2.6 |         |         |   2.2
                       |     2.4 |      .6 |         |         |
                       |     2.1 |      .1 |         |         |
                       +---------+---------+---------+---------+
                    4  |     546 |      44 |       4 |       1 |   595
  Biface Flake         |    91.8 |     7.4 |      .7 |      .2 |  34.1
                       |    35.2 |    27.2 |    14.8 |    12.5 |
                       |    31.3 |     2.5 |      .2 |      .1 |
                       +---------+---------+---------+---------+
                    5  |       2 |         |         |         |     2
  Blade                |   100.0 |         |         |         |    .1
                       |      .1 |         |         |         |
                       |      .1 |         |         |         |
                       +---------+---------+---------+---------+
                    6  |       8 |       1 |         |         |     9
  Rejuv. Flake         |    88.9 |    11.1 |         |         |    .5
                       |      .5 |      .6 |         |         |
                       |      .5 |      .1 |         |         |
                       +---------+---------+---------+---------+
                Column      1550       162        27         8    1747
                 Total      88.7       9.3       1.5        .5   100.0

Number of Missing Observations =        0
```

Appendix 4, Table 12

```
Crosstabulation:     MATL      Material Type

              Count  |
            Row Pct  |Absent   |Unidirec|Bidirect|
  RTCH->    Col Pct  |         |tional  |ional   |  Row
            Tot Pct  |       0 |      1 |      2 | Total
MATL        --------+--------+--------+--------+
         bs          |     5   |        |        |    5
  Basalt             |  100.0  |        |        |   .3
                     |     .3  |        |        |
                     |     .3  |        |        |
                     +--------+--------+--------+
         ch          |   167   |      1 |      1 |  169
  Chalcedony         |  98.8   |     .6 |     .6 |  9.7
                     |  10.2   |    1.1 |    5.9 |
                     |   9.6   |     .1 |     .1 |
                     +--------+--------+--------+
         crt         |    63   |      6 |      2 |   71
  Chert              |  88.7   |    8.5 |    2.8 |  4.1
                     |   3.8   |    6.8 |   11.8 |
                     |   3.6   |     .3 |     .1 |
                     +--------+--------+--------+
         jzoba       |  1403   |     81 |     14 | 1498
  Jemez Obsidian     |  93.7   |    5.4 |     .9 | 85.7
                     |  85.4   |   92.0 |   82.4 |
                     |  80.3   |    4.6 |     .8 |
                     +--------+--------+--------+
         qzt         |     4   |        |        |    4
  Quartzite          | 100.0   |        |        |   .2
                     |    .2   |        |        |
                     |    .2   |        |        |
                     +--------+--------+--------+
             Column     1642       88       17     1747
              Total     94.0      5.0      1.0    100.0

Number of Missing Observations =         0
```

Appendix 4, Table 13

```
Crosstabulation:     TYPE      Artifact Type

             Count  |
           Row Pct  |Absent   |Unidirec|Bidirect|
  RTCH->   Col Pct  |         |tional  |ional   |  Row
           Tot Pct  |       0 |      1 |      2 | Total
TYPE       --------+--------+--------+--------+
                 1  |  1014   |    72  |    13  |  1099
  Flake             |  92.3   |   6.6  |   1.2  |  62.9
                    |  61.8   |  81.8  |  76.5  |
                    |  58.0   |   4.1  |    .7  |
                    +--------+--------+--------+
                 2  |     4   |        |        |     4
  Lg. Angular Debr  | 100.0   |        |        |    .2
                    |    .2   |        |        |
                    |    .2   |        |        |
                    +--------+--------+--------+
                 3  |    37   |        |     1  |    38
  Sm. Angular Debr  |  97.4   |        |   2.6  |   2.2
                    |   2.3   |        |   5.9  |
                    |   2.1   |        |    .1  |
                    +--------+--------+--------+
                 4  |   577   |    15  |     3  |   595
  Biface Flake      |  97.0   |   2.5  |    .5  |  34.1
                    |  35.1   |  17.0  |  17.6  |
                    |  33.0   |    .9  |    .2  |
                    +--------+--------+--------+
                 5  |     2   |        |        |     2
  Blade             | 100.0   |        |        |    .1
                    |    .1   |        |        |
                    |    .1   |        |        |
                    +--------+--------+--------+
                 6  |     8   |     1  |        |     9
  Rejuv. Flake      |  88.9   |  11.1  |        |    .5
                    |    .5   |   1.1  |        |
                    |    .5   |    .1  |        |
                    +--------+--------+--------+
            Column     1642       88       17      1747
             Total     94.0      5.0      1.0     100.0

Number of Missing Observations =        0
```

Appendix 4, Table 14

```
                                   SP$S/PC+

Crosstabulation:     MATTYPE   Material Type

               Count  |
             Row Pct  |undeterm|Archaic-|San Jose|En Medio|Undeterm|
PROJTYPE->   Col Pct  |ined    |undeterm|        |        |ined Pre|  Row
             Tot Pct  |       1|       3|      13|      15|      25| Total
MATTYPE      --------+--------+--------+--------+--------+--------+
         3500         |     1  |        |        |     1  |        |    2
                      |  50.0  |        |        |  50.0  |        | 22.2
                      |  50.0  |        |        |  25.0  |        |
                      |  11.1  |        |        |  11.1  |        |
                      +--------+--------+--------+--------+--------+
         3524         |     1  |        |        |     2  |     1  |    4
                      |  25.0  |        |        |  50.0  |  25.0  | 44.4
                      |  50.0  |        |        |  50.0  | 100.0  |
                      |  11.1  |        |        |  22.2  |  11.1  |
                      +--------+--------+--------+--------+--------+
         3525         |        |        |        |     1  |        |    1
                      |        |        |        | 100.0  |        | 11.1
                      |        |        |        |  25.0  |        |
                      |        |        |        |  11.1  |        |
                      +--------+--------+--------+--------+--------+
         3530         |        |     1  |     1  |        |        |    2
                      |        |  50.0  |  50.0  |        |        | 22.2
                      |        | 100.0  | 100.0  |        |        |
                      |        |  11.1  |  11.1  |        |        |
                      +--------+--------+--------+--------+--------+
              Column         2        1        1        4        1      9
               Total      22.2     11.1     11.1     44.4     11.1  100.0

Number of Missing Observations =          0
```

Appendix 4, Table 15

```
Crosstabulation:     TYPE      Artifact Type                          By TPNO      Test Pit No.
                                                                                   - - - - Page  1 of  4

             Count |
           Row Pct |        |        |        |        |        |        |        |        |        |        |
   TPNO->  Col Pct |        |        |        |        |        |        |        |        |        |        |  Row
           Tot Pct |1       |10      |11      |12      |13      |14      |15      |16      |17      |18      | Total
TYPE       --------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                 1 |        |    16  |    30  |    13  |    17  |    54  |    35  |     3  |     8  |     5  |  1099
  Flake            |        |   1.5  |   2.7  |   1.2  |   1.5  |   4.9  |   3.2  |    .3  |    .7  |    .5  |  62.9
                   |        |  69.6  |  73.2  |  65.0  |  94.4  |  65.1  |  74.5  |  75.0  |  72.7  |  62.5  |
                   |        |    .9  |   1.7  |    .7  |   1.0  |   3.1  |   2.0  |    .2  |    .5  |    .3  |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                 2 |        |        |        |        |        |        |        |        |        |        |     4
  Lg. Angular Debr |        |        |        |        |        |        |        |        |        |        |    .2
                   |        |        |        |        |        |        |        |        |        |        |
                   |        |        |        |        |        |        |        |        |        |        |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                 3 |        |        |        |     1  |     1  |        |     1  |     1  |     1  |        |    38
  Sm. Angular Debr |        |        |        |   2.6  |   2.6  |        |   2.6  |   2.6  |   2.6  |        |   2.2
                   |        |        |        |   5.0  |   5.6  |        |   2.1  |  25.0  |   9.1  |        |
                   |        |        |        |    .1  |    .1  |        |    .1  |    .1  |    .1  |        |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                 4 |     1  |     7  |    11  |     6  |        |    28  |    11  |        |     2  |     3  |   595
  Biface Flake     |    .2  |   1.2  |   1.8  |   1.0  |        |   4.7  |   1.8  |        |    .3  |    .5  |  34.1
                   | 100.0  |  30.4  |  26.8  |  30.0  |        |  33.7  |  23.4  |        |  18.2  |  37.5  |
                   |    .1  |    .4  |    .6  |    .3  |        |   1.6  |    .6  |        |    .1  |    .2  |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                 5 |        |        |        |        |        |        |        |        |        |        |     2
  Blade            |        |        |        |        |        |        |        |        |        |        |    .1
                   |        |        |        |        |        |        |        |        |        |        |
                   |        |        |        |        |        |        |        |        |        |        |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                 6 |        |        |        |        |        |     1  |        |        |        |        |     9
  Rejuv. Flake     |        |        |        |        |        |  11.1  |        |        |        |        |    .5
                   |        |        |        |        |        |   1.2  |        |        |        |        |
                   |        |        |        |        |        |    .1  |        |        |        |        |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
            Column       1       23       41       20       18       83       47        4       11        8     1747
(Continued)  Total      .1      1.3      2.3      1.1      1.0      4.8      2.7       .2       .6       .5    100.0
```

Appendix 4, Table 15 (continued)

```
Crosstabulation:     TYPE      Artifact Type                              By TPNO      Test Pit No.
                                                                                       - - - - Page  2 of  4

                Count |
              Row Pct |         |         |         |         |         |         |         |         |         |         |  Row
TPNO->        Col Pct |         |         |         |         |         |         |         |         |         |         |  Total
              Tot Pct |19       |20       |21       |22       |23       |24       |25       |27       |28       |29       |
TYPE          --------+---------+---------+---------+---------+---------+---------+---------+---------+---------+---------+
                    1 |    10   |    18   |    10   |    13   |     9   |    29   |     4   |     4   |     1   |         |  1099
  Flake               |    .9   |   1.6   |    .9   |   1.2   |    .8   |   2.6   |    .4   |    .4   |    .1   |         |  62.9
                      |  83.3   |  81.8   |  66.7   |  65.0   |  75.0   |  69.0   |  66.7   |  57.1   |  50.0   |         |
                      |    .6   |   1.0   |    .6   |    .7   |    .5   |   1.7   |    .2   |    .2   |    .1   |         |
                      +---------+---------+---------+---------+---------+---------+---------+---------+---------+---------+
                    2 |         |         |         |         |         |         |         |         |         |         |     4
  Lg. Angular Debr    |         |         |         |         |         |         |         |         |         |         |    .2
                      |         |         |         |         |         |         |         |         |         |         |
                      |         |         |         |         |         |         |         |         |         |         |
                      +---------+---------+---------+---------+---------+---------+---------+---------+---------+---------+
                    3 |     1   |         |         |         |         |         |     1   |         |         |         |    38
  Sm. Angular Debr    |   2.6   |         |         |         |         |         |   2.6   |         |         |         |   2.2
                      |   8.3   |         |         |         |         |         |  16.7   |         |         |         |
                      |    .1   |         |         |         |         |         |    .1   |         |         |         |
                      +---------+---------+---------+---------+---------+---------+---------+---------+---------+---------+
                    4 |     1   |     4   |     5   |     7   |     3   |    13   |     1   |     3   |     1   |     1   |   595
  Biface Flake        |    .2   |    .7   |    .8   |   1.2   |    .5   |   2.2   |    .2   |    .5   |    .2   |    .2   |  34.1
                      |   8.3   |  18.2   |  33.3   |  35.0   |  25.0   |  31.0   |  16.7   |  42.9   |  50.0   | 100.0   |
                      |    .1   |    .2   |    .3   |    .4   |    .2   |    .7   |    .1   |    .2   |    .1   |    .1   |
                      +---------+---------+---------+---------+---------+---------+---------+---------+---------+---------+
                    5 |         |         |         |         |         |         |         |         |         |         |     2
  Blade               |         |         |         |         |         |         |         |         |         |         |    .1
                      |         |         |         |         |         |         |         |         |         |         |
                      |         |         |         |         |         |         |         |         |         |         |
                      +---------+---------+---------+---------+---------+---------+---------+---------+---------+---------+
                    6 |         |         |         |         |         |         |         |         |         |         |     9
  Rejuv. Flake        |         |         |         |         |         |         |         |         |         |         |    .5
                      |         |         |         |         |         |         |         |         |         |         |
                      |         |         |         |         |         |         |         |         |         |         |
                      +---------+---------+---------+---------+---------+---------+---------+---------+---------+---------+
               Column       12        22        15        20        12        42         6         7         2         1    1747
(Continued)    Total        .7       1.3        .9       1.1        .7       2.4        .3        .4        .1        .1   100.0
```

Appendix 4, Table 15 (continued)

```
                               SPSS/PC+

Crosstabulation:     TYPE      Artifact Type                          By TPNO      Test Pit No.
                                                                                     - - - - Page  3 of  4

            Count  |
          Row Pct  |        |        |        |        |        |        |        |Pithouse|Pithouse|Actv. Ar|
  TPNO->  Col Pct  |        |        |        |        |        |        |        |        | Hearth |ea 1 Hea|   Row
          Tot Pct  |30      |31      |59      |6       |7       |8       |9       |f1      |f2      |f3      |  Total
TYPE      ---------+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                1  |      1 |      5 |     13 |     17 |     10 |     10 |     14 |    713 |      6 |      1 |   1099
  Flake            |     .1 |     .5 |    1.2 |    1.5 |     .9 |     .9 |    1.3 |   64.9 |     .5 |     .1 |   62.9
                   |   25.0 |   83.3 |   65.0 |   81.0 |   47.6 |   66.7 |   66.7 |   59.8 |   54.5 |  100.0 |
                   |     .1 |     .3 |     .7 |    1.0 |     .6 |     .6 |     .8 |   40.8 |     .3 |     .1 |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                2  |        |        |      1 |        |        |      1 |        |      2 |        |        |      4
  Lg. Angular Debr |        |        |   25.0 |        |        |   25.0 |        |   50.0 |        |        |     .2
                   |        |        |    5.0 |        |        |    6.7 |        |     .2 |        |        |
                   |        |        |     .1 |        |        |     .1 |        |     .1 |        |        |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                3  |      1 |        |        |      1 |        |        |        |     21 |        |        |     38
  Sm. Angular Debr |    2.6 |        |        |    2.6 |        |        |        |   55.3 |        |        |    2.2
                   |   25.0 |        |        |    4.8 |        |        |        |    1.8 |        |        |
                   |     .1 |        |        |     .1 |        |        |        |    1.2 |        |        |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                4  |      2 |      1 |      6 |      3 |     10 |      4 |      7 |    448 |      5 |        |    595
  Biface Flake     |     .3 |     .2 |    1.0 |     .5 |    1.7 |     .7 |    1.2 |   75.3 |     .8 |        |   34.1
                   |   50.0 |   16.7 |   30.0 |   14.3 |   47.6 |   26.7 |   33.3 |   37.6 |   45.5 |        |
                   |     .1 |     .1 |     .3 |     .2 |     .6 |     .2 |     .4 |   25.6 |     .3 |        |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                5  |        |        |        |        |        |        |        |      2 |        |        |      2
  Blade            |        |        |        |        |        |        |        |  100.0 |        |        |     .1
                   |        |        |        |        |        |        |        |     .2 |        |        |
                   |        |        |        |        |        |        |        |     .1 |        |        |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
                6  |        |        |        |        |      1 |        |        |      7 |        |        |      9
  Rejuv. Flake     |        |        |        |        |   11.1 |        |        |   77.8 |        |        |     .5
                   |        |        |        |        |    4.8 |        |        |     .6 |        |        |
                   |        |        |        |        |     .1 |        |        |     .4 |        |        |
                   +--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
            Column        4        6       20       21       21       15       21     1193       11        1     1747
(Continued)  Total       .2       .3      1.1      1.2      1.2       .9      1.2     68.3       .6       .1    100.0
```

Appendix 4, Table 15 (continued)

```
Crosstabulation:     TYPE       Artifact Type


              Count   |
            Row Pct  |Actv. Ar|        |        |
   TPNO->   Col Pct  |ea 2 Hea|        |        | Row
            Tot Pct  |f9      |ff      |p       | Total
TYPE        --------+--------+--------+--------+
                  1  |      1 |      1 |     28 |  1099
  Flake              |     .1 |     .1 |    2.5 |  62.9
                     |  100.0 |  100.0 |   75.7 |
                     |     .1 |     .1 |    1.6 |
                     +--------+--------+--------+
                  2  |        |        |        |     4
  Lg. Angular Debr   |        |        |        |    .2
                     |        |        |        |
                     |        |        |        |
                     +--------+--------+--------+
                  3  |        |        |      8 |    38
  Sm. Angular Debr   |        |        |   21.1 |   2.2
                     |        |        |   21.6 |
                     |        |        |     .5 |
                     +--------+--------+--------+
                  4  |        |        |      1 |   595
  Biface Flake       |        |        |     .2 |  34.1
                     |        |        |    2.7 |
                     |        |        |     .1 |
                     +--------+--------+--------+
                  5  |        |        |        |     2
  Blade              |        |        |        |    .1
                     |        |        |        |
                     |        |        |        |
                     +--------+--------+--------+
                  6  |        |        |        |     9
  Rejuv. Flake       |        |        |        |    .5
                     |        |        |        |
                     |        |        |        |
                     +--------+--------+--------+
             Column         1        1       37    1747
              Total        .1       .1      2.1   100.0

Number of Missing Observations =        0
```

Appendix 4, Table 16

```
                                       SPSS/PC+                Table

Crosstabulation:      TYPE
                   By STRAT

 STRAT->      Count   |                                        |  Row
                      |030      |100      |102      |oth       |  Total
TYPE              --------+---------+---------+---------+---------+
      C. Flake      1 |     31  |     38  |    230  |    800  |  1099
                      +---------+---------+---------+---------+
      L. Ang. Deb.  2 |         |         |         |      4  |     4
                      +---------+---------+---------+---------+
      S. Ang. Deb   3 |      1  |      1  |     10  |     26  |  - 38
                      +---------+---------+---------+---------+
      Biface Flake  4 |     11  |     30  |    180  |    374  |   595
                      +---------+---------+---------+---------+
      Blade         5 |         |         |         |      2  |     2
                     -+---------+---------+---------+---------+
      Rej. Flake    6 |         |         |      3  |      6  |     9
                      +---------+---------+---------+---------+
             Column        43        69       423      1212      1747
              Total       2.5       3.9      24.2      69.4     100.0

Page    6                              SPSS/PC+

 Chi-Square    D.F.      Significance       Min E.F.     Cells with E.F.< 5
 ----------    ----      ------------       --------     ------------------

   27.09979     15          .0279              .049      13 OF    24 ( 54.2%)

Number of Missing Observations =        0
```

Appendix 4, Table 17

```
                                      SPSS/PC+               Table

Crosstabulation:      CORTX
                   By STRAT

 STRAT->      Count  |                                            |  Row
                     |030      |100      |102      |oth           |  Total
CORTX          ------+---------+---------+---------+--------------+
     Absent       0  |     38  |     65  |    408  |   1082       |   1593
                     +---------+---------+---------+--------------+
                  1  |      3  |         |      5  |     62       |     70
     25%             +---------+---------+---------+--------------+
     25-50%       2  |      2  |      2  |      6  |     40       |     50
                     +---------+---------+---------+--------------+
     50%          3  |         |         |      3  |     16       |     19
                     +---------+---------+---------+--------------+
                  4  |         |      2  |      1  |     11       |     14
    100%             +---------+---------+---------+--------------+
    Unknown       5  |         |         |         |      1       |      1
                     +---------+---------+---------+--------------+
            Column         43        69       423      1212          1747
             Total        2.5       3.9      24.2      69.4         100.0

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 Chi-Square    D.F.      Significance       Min E.F.     Cells with E.F.< 5
 ----------    ----      ------------       --------     ------------------

   30.91327     15           .0090              .025     14 OF     24 ( 58.3%

Number of Missing Observations =          0
```