EPISODIC EOLIAN EVENTS AND PRESERVATION OF MESA TOP ARCHAEOLOGICAL SITES ON THE PAJARITO PLATEAU, NEW MEXICO

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Abstract — Stratigraphic relationships and soil characteristics provide a geomorphic framework for Coalition and Classic period Ancestral Puebloan, Archaic, and Paleoindian sites located on mesa tops of the Pajarito Plateau near Los Alamos, New Mexico. Ancestral Puebloan sites are partially buried by eolian and/or colluvial deposits, and are generally in good archaeological context. It is inferred that 15 to 20 cm of eolian deposition began during the late Coalition period but occurred prior to the late Classic period. This episode of eolian deposition occurred between the late 1200s and early 1400s, following extended droughts during the 1200s. A minimum of 5 to 10 cm of additional eolian deposition occurred after the early 1400s; either during or after the Classic period. Coalition period sites are typically built on older soils or bedrock and are partially buried, and Classic period sites are typically built on top of young eolian deposits, with less burial; therefore in many cases these sites can be differentiated based on soil stratigraphic relationships. Mesa top Ancestral Puebloan sites are underlain by 0-2.5 m of Pleistocene and Holocene deposits overlying the ca. 1.25 Ma Bandelier Tuff, recording a sequence of discontinuous, truncated middle Pleistocene through mid- to late Holocene soils that represent episodic eolian deposition and soil formation followed by erosion. Although the older deposits are typically buried, some Archaic and Paleoindian sites have been exposed in excavations in good archaeological context, and the presence of latest Pleistocene to early Holocene deposits in many geomorphic settings indicates that the proper conditions exist for preservation of Paleoindian sites on the Pajarito Plateau.

INTRODUCTION

Eolian dust is an important component of Pajarito Plateau mesa top soils (Eberly et al., 1996; McFadden et al., 1996; Reneau et al.,1996a), and episodic influxes of eolian sediment have created favorable conditions for the preservation of archaeological sites. Eolian stratigraphy was examined as part of geomorphic studies conducted at several Pajarito Plateau mesa top archaeological sites at Los Alamos National Laboratory (LANL), in support of investigations conducted prior to land transfer (Vierra et al., 2002). This investigation included mapping and description of surficial geologic units to help define the geomorphic context of archaeological sites, and focused on identification of surficial processes associated with potential erosion or burial of cultural features. Sites were examined on the unnamed mesa between Los Alamos and Pueblo Canyons (referred to herein as the Airport tract sites) and on a small mesa remnant west of the town of White Rock, within the Cañada del Buey watershed (White Rock tract; Fig. 1; Drakos and Reneau, 2003, 2004). Additional data on buried mesa top archaeological sites and associated soils were obtained from a seismic hazards investigation on Pajarito Mesa, between Pajarito and Threemile Canyons (Kolbe et al., 1994; Reneau et al., 1995, 1996a; Fig. 1).

METHODS

Surficial geologic maps of the Airport tract and White Rock tract land transfer parcels were prepared at a scale of 1:1200. The mapping focused on units with potential archaeological significance. Soil descriptions follow Birkeland (1999); soil texture and grain size data are based on field descriptions, including field measurements of stickiness and plasticity. Soil horizon nomenclature is from Birkeland (1999) and Soil Survey Staff (1999). Buried soil horizons were numbered based on the overall stratigraphy for the study area, rather than for individual profiles (e.g., some profiles may have the surface soil profile sitting directly on buried soil b2 or b3 horizons, or the b1 soil may sit directly on the b3 soil). Carbonate stage for soils follows nomenclature developed by Gile et al. (1966). Preliminary age estimates for deposits were made based on soil descriptions and comparison of the general degree of soil development to previously dated sites on the Pajarito Plateau, and to soils described during the present investigation where radiocarbon dates were obtained. A calibrated (cal) 4.5 ka age valley-fill deposit in "EG&G gully" on the mesa east of the Airport tract sites (Longmire et al. 1996, pp. 48-49; Reneau et al., 1996a; calibrated radiocarbon ages from CALIB 5.01, Stuiver et al., 2005; Fig. 1), was used as a key reference site for the degree of soil development in a mid-Holocene unit within the Airport tract (Fig. 2). The relation of deposits with varying soil characteristics to cultural material (e.g., potsherds and lithics) provided additional information on the age of some layers. Remnants of a Pleistocene soil with 5YR color and moderately thick clay films that has an estimated age of at least 100-200 ka (McFadden et al. 1996), underlying cultural deposits at some locations, provided a clear demarcation of cultural versus archaeologically sterile sediments.

Age estimates for soils in Airport tract sites are also based on comparison with soils and stratigraphic units described in trenches on Pajarito Mesa (Kolbe et al., 1994; Reneau et al., 1995, 1996a; Fig. 1). Age constraints for the Pajarito Mesa eolian and colluvial slopewash deposits are provided by numerous radiocarbon dates, and by stratigraphic position relative to the ca. 50-60 ka El Cajete pumice (age from Toyoda et al., 1995; Reneau et al., 1996b). The Pajarito Mesa trenches also exposed ten inferred buried archaeo-

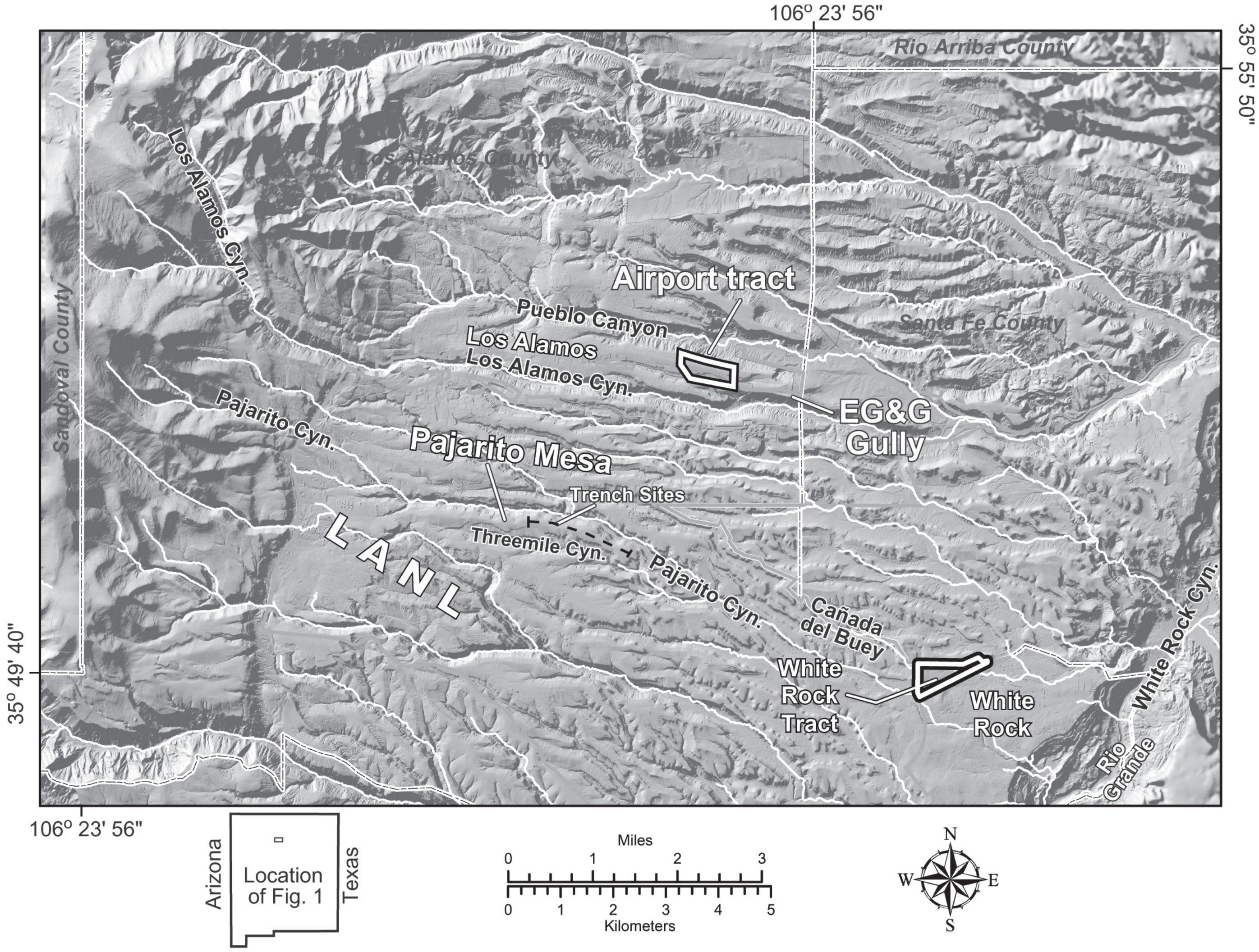

FIGURE 1. Digital elevation model (DEM) map of Pajarito Plateau showing study areas.

logical sites, including six dating to Ancestral Puebloan occupation and three to the Paleoindian era (Reneau et al., 1995), that are utilized to help define the soil stratigraphic context of mesa top archaeological sites. Age estimates for late Holocene eolian deposition are based on combined evidence from the Airport and White Rock tracts and Pajarito Mesa, which indicate the same depositional events occurred in all three areas.

SETTING

Pajarito Plateau mesas are typified by gently east-sloping surfaces underlain by the ca. 1.25 Ma Tshirege Member of the Bandelier Tuff (Griggs, 1964; Smith et al., 1970; age from Phillips, 2004), separated by intervening canyons (Fig. 1). The Airport tract and Pajarito Mesa are in the central part of the Pajarito Plateau and the White Rock tract is in the eastern part of the plateau. The sites lie at elevations of 1960 to 2220 m. The modern climate is semiarid, with mean annual precipitation of about 350-450 mm (Bowen, 1990). Vegetation is dominated by piñon-juniper woodlands to the east and Ponderosa pine forests to the west (McKown et al., 2003).

SURFICIAL GEOLOGIC UNITS AND GEOARCHAEOLOGY

Airport tract surficial deposits

The Airport tract includes a gently east-sloping mesa between an unnamed tributary to Pueblo Canyon on the north and DP Canyon, a tributary to Los Alamos Canyon, on the south. The mesa is capped by colluvial and eolian deposits that thin to exposed bedrock near the mesa edge (Fig. 3). Holocene soils and sediments unconformably overlie thin Pleistocene soils. Eolian deposits located in the approximate center of the mesa include latest Holocene and middle or early Holocene deposits that overlie Pleistocene soils and bedrock (map unit Qc2, Fig. 3), whereas deposits near the mesa edge consist of latest Holocene deposits overlying Pleistocene soils and bedrock (map unit Qc1). A tributary drainage to Pueblo Canyon that heads in the tract is incised to a depth of up to 20 m below the mesa top. The tributary drainage contains a narrow strip of young (historic in age) alluvium consisting of gravelly medium to coarse sand.

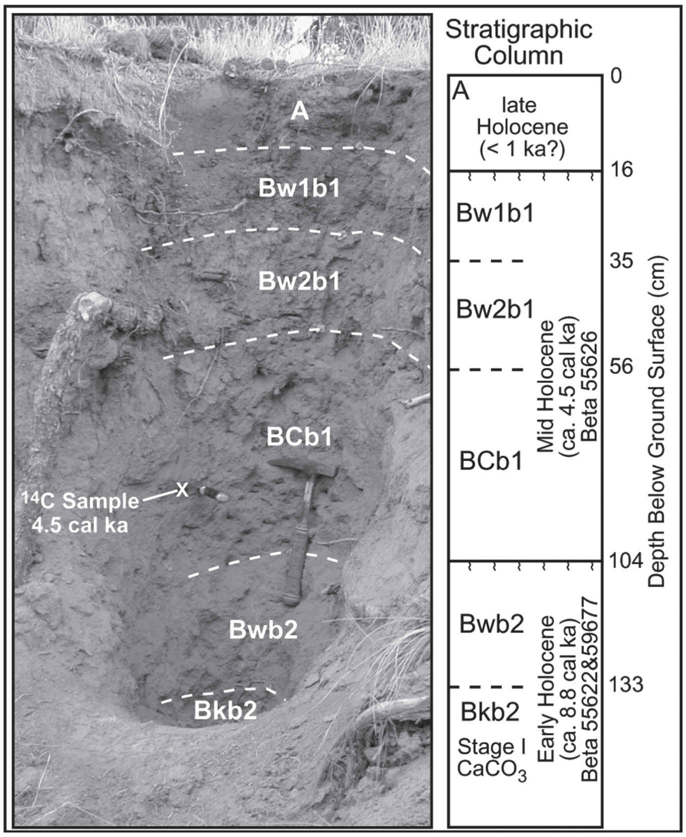

FIGURE 2. Soil stratigraphy and ^{14}C sample location, EG&G gully site.

Soils were described at four archaeological sites within the Airport tract, and in a ca. 4.5 cal ka valley-fill deposit overlying a ca. 8.8 cal ka deposit in "EG&G gully" east of the Airport tract (Figs. 1, 3). These ages are based on three radiocarbon dates from charcoal collected from an upper and a lower soil at the site (Fig. 2; Longmire et al., 1995; Reneau et al., 1996a). The age of the upper soil, with an A-Bw1b1-Bw2b1-BCb1 profile, is constrained by one sample that yielded an age of 4020 ± 80 ^{14}C BP and a date of 4543 cal BP with a two-sigma range of 4297 to 4824 cal BP. The age of the lower soil, with a Bwb2-Bkb2 profile and Stage I carbonate horizon (Fig. 2), is constrained by two samples statistically the same at the 95% confidence level that were combined to yield an age of 7949 ± 72 ^{14}C BP and a date of 8810 cal BP with a two-sigma range of 8607 to 8997 cal BP.

Airport tract geoarchaeology

Two Coalition period (1150-1325 AD) and two Classic period (1325-1600 AD; see Fig. 4 for chronology) Ancestral Puebloan archaeological sites were investigated in the Airport tract (Vierra et al., 2002). LA 86534 is a Coalition period (probable middle or late Coalition period) roomblock, likely occupied for <10-15 yrs sometime between 1190 and 1300 AD, and LA 135290 is an early or middle Coalition period roomblock, likely occupied for <10-15 yrs sometime between 1180 and 1220 AD (Vierra, unpubl., 2007). The Coalition period roomblocks are buried by silty eolian sediment mixed with roomblock-derived colluvium that together comprise post-occupation deposits (POD) (Fig. 5). Soils formed in Coalition period POD exhibit A-Bw (or A-Bw1-Bw2) profiles (Table 1; Drakos and Reneau, 2004). The Coalition period sites are built on top of eroded mid-Holocene or Pleistocene deposits (Fig. 5). Erosion of these older deposits occurred sometime between the middle Holocene and the beginning of the Coalition period, removing an unknown thickness of sediment.

LA 139418 is a Classic period grid garden and LA 141505 is a Classic period field house (Vierra, unpubl., 2007). The Classic period sites are buried by thin eolian deposits that have weakly developed soils with A or AC horizons only, and are constructed on top of the Bw horizon formed in Coalition-period POD and in non-cultural eolian deposits (Fig. 5). The Coalition and Classic period sites on this mesa can therefore be distinguished based on stratigraphic relationships.

Eolian deposits at LA 86534 and LA 135290 are similar, and we infer that most of the recent eolian deposition observed at the Airport tract sites occurred sometime after the middle or late Coalition period occupation at LA 86534 and prior to use of the nearby Classic period sites. Where it has not been eroded, this eolian deposit is approximately 15 to 20 cm thick. A second, more recent eolian event occurred after abandonment of the Classic period sites, resulting in deposition of an additional 5 to 10 cm or more of fine-grained sediment across the mesa top. It is possible that eolian deposits from this later period were originally thicker, being partially removed by erosion. Eolian deposits are thicker inside and next to roomblocks than elsewhere on the mesa, owing to the greater trapping efficiency at these sites. This effect is most pronounced at LA 135290, where the thickness of postoccupation eolian and colluvial deposits is 40 to 70 cm within the roomblock, whereas thickness outside of the roomblock mound is 10 to 20 cm (Drakos and Reneau, 2004). Animal burrowing also seems to be more active in the abandoned roomblocks, which results in mixing of material at these sites.

Stratigraphy of deposits underlying Airport tract sites

The Airport tract sites are underlain by a sequence of truncated Pleistocene and Holocene soils that are inferred to represent deposition and soil formation followed by erosion in the mid- Pleistocene (buried soil "b3"), the late Pleistocene (buried soil "b2"), and the mid-Holocene (buried soil "b1") overlying Bandelier Tuff bedrock (Fig. 5). The b2 soil is a relatively well-developed, partially eroded soil with 7.5YR hue, moderately thick clay films, and Stage I carbonate (Table 1; Drakos and Reneau, 2004). The degree of soil development exhibited by the b2 soil, as shown by its color and clay content, is much greater than that observed in the overlying b1 soil, which either lacks clay films or has few thin films; typically exhibits 10YR hue; and lacks carbonate or has Stage I- carbonate morphology. The difference in soil properties between the b1 and b2 soil suggests a period of landscape stability and soil development prior to erosion of the b2 soil. The b1 soil is overlain by a less than 800 year-old (post-early Coalition period) eolian deposit.

Total thickness of Holocene and Pleistocene sediment deposits is less than 1.5 m, and thickness of Pleistocene deposits ranges

TABLE 1. Representative soil profiles from mesa top sites. See Drakos et al., this volume, Appendix A, for key to symbols.

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	CaCO3	CaCO3 Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
Airport Tract Sites															
LA-135290, Profile 5, Early or Middle Coalition period roomblock, 101.5N, 116E, E-W trench to E. of roomblock (September 10, 2003)													**135290-5**		
A	0-8	5	10YR4/3	10YR3/3	sil	m-1msbk	so-lo	so.po	n.o.	none	-	cs		<700-800 yrs	post-Puebloan colluvium; contains potsherds, abundant charcoal, abundant krotivenas @ Bwb1 boundary
Bw	8-34	5	10YR4/4	10YR3/3	si	2msbk	sh-h	ss,ps	n.o.	none	-	ci			
Bwb1	34-64	<2	10YR5/4	10YR3/3	si	2-3fsbk	h	ss,p	n.o.	none	-	gs		mid Holocene (4-5 ka?)	
Btjb1	64-80	<2	8.75YR5/4	8.75YR4/3	sicl	2-3msbk	h	ss,ps	1npobr	none	-	cs			
Btkb1	80-97	<2	8.75YR5/4	8.75YR4/3	sic	2-3msbk	h	ss,p	1npobr	es	I	aw			CaCO3 filaments locally common
Btkb2	97-122	5	7.5YR5/4	7.5YR3/3	sicl	2m-csbk	h	ss,p	2-3mkpobrpf	e-es	I	ai		late Pleistocene	clay films locally on ped faces
R	122+		5YR5/6 pockets											1.22 Ma	tuff rubble w/pockets of "big orange" (pockets with
LA 139418-4, Classic period grid garden, 86N, 121E (15 m E of grid garden) (July 17, 2003)													**139418-4**		
AC	0-6	<2	10YR5/4	10YR4/3	sil	1msbk	so	so,ps	n.o.	none	-	as		<500 yrs?	
Bw	6-16	<2	10YR5/3	10YR4/3	sil	2msbk	so-sh	so,ps	n.o.	none	-	vas		<700-800 yrs	
Btb2	16-34	<2	7.5YR5/4	7.5YR3/3	sic	2-3fsbk	h	s,p	3npobrpf	none	-	cs			
Btk1b2	34-42	<2	7.5YR5/3	7.5YR4/3	sic	2msbk	h	ss,p	2npobrpf	es	I	cs		late Pleistocene	thin CaCO3 filaments
Btk2b2	42-64	<2	7.5YR4/4	7.5YR4/3	si	2msbk	h	ss,ps	1npobr	ev	I+	as			CaCO3 filaments, + coatings on ped faces
Btkb3	64-74	2	7.5YR5/3	7.5YR4/4	sic	2msbk	h	ss,p	4n-mkpobr	e-	I-	vas		Pleistocene	possible remnant b3 buried soil, very few thin CaCO3 filaments
R	74+													1.22 Ma	Qbt rubble
LA 141505, Profile 2, Classic period field house, 107.6N, 104E (January 6, 2004)													**141505-2**		
A	0-19	80-90	10YR4/3.5	10YR3/3	sil	1fsbk	so-sh	so,ps	n.o.	none	-	cs		<600 to 800 yrs	tuff blocks (wall), eolian material plus wall fall, post-Puebloan
Bw1	19-34	<1	8.75YR4/4	8.75YR3/3	sil	1-2msbk	sh	ss,ps	n.o.	none	-	cs			siltans; possible POD equivalent?
Bwb1	34-54	<1	8.75YR4/3	8.75YR3/3	si	2f-msbk	h	ss,p	n.o.	none	-	cs			abundant siltans; possible b1?
Btjb1	54-76	<1	7.5YR5/4	7.5YR4/3	sic	2f-msbk	h	s.p	2nbrpo	none	-	cs		Mid Holocene (4-6 ka?)	
Btjkb1	76-96	<1	7.5YR5/4	7.5YR3/4	sil	2msbk	h	ss,ps	1nbr	e	I-	as			> 2 mm (< 4 mm) nodules plus rare CaCO3 filaments; age based on weak Stage I CaCO3
Btkb2	96-116	2	7.5YR4/4	7.5YR3/4	scl	2msbk	h	ss,ps	2-3mkpobrpf	e	1	aw		late Pleistocene	CaCO3: few filaments, plus discontinuous coatings on ped faces
R	116+													1.22 Ma	Qbt rubble + remnant "big orange" (Btkb3)
LA-86534, Middle or Late Coalition period roomblock, E Wall, 108N, 103E (July 12, 2002)													**86534-1**		
A	0-8	<2	7.5YR4/3	7.5YR3/2	ls	1msbk	so	so po	no	none	-	cs		< 750-850 yrs	abundant organics, vfs-si, scattered ms-cs, w/ tuff blocks at surface, possible cumulative A horizon
Bw	8-25	<2	7.5YR5/3	7.5YR4/3	sl	2msbk	so-sh	ss ps	no	none	-	as			si +vfs, young
Btb3	25-45	<2	5YR4/4	5YR4/3	sicl	2-3fabk	sh	vs vp	3nkbrpopf	non	-	as (?)		Pleistocene	si + clay
R	45+														Qbt
White Rock Tract Multicomponent Site															
LA-12587, White Rock Land Transfer Parcel, N. wall of excavation grid, 17m E of room block, Qbt emerges 3m to E (Jan. 22, 2003)													**12587-6**		Aspect: E sloping top of mesa
A	0-3	30-40	10YR4/4	10YR3/4	scl	2mpl	so-sh	ss,ps	n.o.	none	-	cs		< 700-800 yrs	contains artifacts; scattered tuff clasts on surface
Bw	3-12	20-30	10YR4/4	10YR3/4	scl	1f-msbk	so-sh	ss,ps	n.o.	none	-	aw			some cicada burrows are sh; artifacts to base
Btkb3	12-19	50	(5YR4/4)	5YR4/4	cl	1f sbk	so	s,p	3ncopobr	e	I	ai		Pleistocene	100-200k eroded soil?
R	19+														Qbt
LA-12587, White Rock Land Transfer Parcel, 96N, 103E, N wall of excavation grid (Jan. 10, 2003)													**12587-10**		Aspect: flat mesa
A	0-5	10	10YR4/4	10YR3/3	ls	2msbk	so-sh	so,po	n.o.	none	-	gs			litter at surface, next to pinon
Bw1	5-10	10-20	7.5YR4/3	7.5YR3/3	scl	2 f-msbk	sh	ss,ps	n.o.	e	-	gs			artifacts in gravel
Bw2	10-20	10-20	10YR5/4	10YR4/3	scl	1msbk	so	ss,ps	n.o.	e-es	-	cs		< 700 yrs?	artifacts, Bwk?
Bwk1 (ash + mortar)	20-26	5-10	10YR6/4	10YR4/4	scl	1msbk	so	ss,ps	n.o.	es	-	cs			finer sand than Bw2 (ashy)
IIBwk2	26-40	50	7.5YR5/4	7.5YR4/4	scl	1fsbk	so	ss,p	n.o.	es-ev	-	ai		700-800 yrs?	artifacts, construction rubble?, thin clay films in chunks of reworked soil
IIIBtkb3	40-48		5YR5/4	5YR4/4	sc	2-3msbk	sh-h	s,p	2ncobr	es	1	as		Pleistocene	100-200k eroded soil?
R	48+														tuff

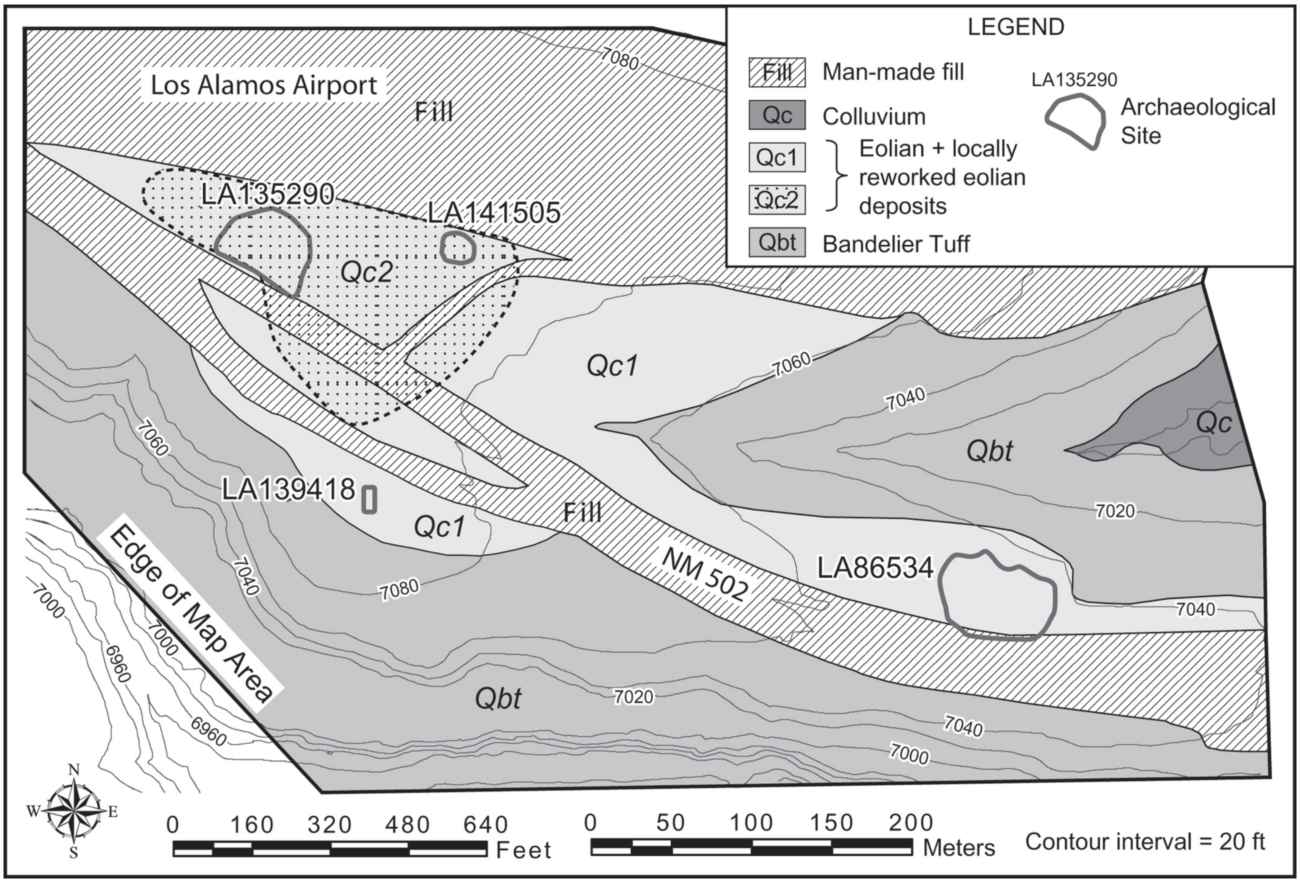

FIGURE 3. Geomorphology and location of archaeological sites, Airport tract. See Figure 1 for location.

from 0.2 to 0.6 m. The b2 soil may be correlative with a pre-El Cajete (>50-60 ka) Pajarito Mesa soil (discussed below), or may be correlative with the 33.66 ^{14}C ka soil formed in eolian deposits in Rendija Canyon at LA 99396 (Drakos and Reneau, 2004). We infer that the mid-Holocene b1 soil is correlative to the 4.5 cal ka b1 soil at EG&G gully. Locally, relatively thick deposits along mesa-top drainages or swales include an early Holocene stratigraphic record (e.g., a 2 m-thick early Holocene deposit at EG&G gully). The thickness of deposits is affected by geomorphic position, with thicker deposits filling mesa top swales and shallow valleys (e.g., LA 135290 and EG&G gully) and stripped surfaces located near the mesa edges or on narrow mesa tops (e.g., LA 86534). The presence of mid-Holocene deposits underlying unit Qc2 in the west-central part of the Airport tract indicates that there is potential for the preservation of buried Archaic period (5500 BC to AD 600; Vierra et al., 2002) sites in this area.

Pajarito Mesa deposits and comparison with airport tract soils

Surficial deposits on Pajarito Mesa, located approximately 4 km southwest of the Airport tract mesa (Fig. 1), were described in exploratory trenches totaling 1340 m in length as part of a seismic hazards investigation (Kolbe et al., 1994; Reneau et al., 1995, 1996a). Pajarito Mesa soils are formed in a mixture of Bandelier Tuff, post-Bandelier alluvium and pumice, and eolian sand and silt. Laboratory analyses indicate that the upper Pajarito Mesa section has 55%-65% silt (Reneau et al., 1996a). The ca. 50-60 ka El Cajete pumice forms a marker bed within Pajarito Mesa soils that is absent in the Airport tract soils (Figs. 5, 6). The Paja-

Years AD	Cultural Period (Vierra et al., 2002)		Eolian Event
Post-1600	Historic		? ? ? post-mid 1400s eolian dep. ? ?
1500-1600	Late	Classic period	
1400-1500	Middle		
1325-1400	Early		ca. 1290-1410 eolian dep.
1250-1325	Late	Coalition period	
1200-1250	Middle		
1150-1200	Early		

FIGURE 4. Ancestral Puebloan time periods and recent eolian events; 1290-1410 AD age estimate from Pajarito Mesa, consistent with evidence from other sites.

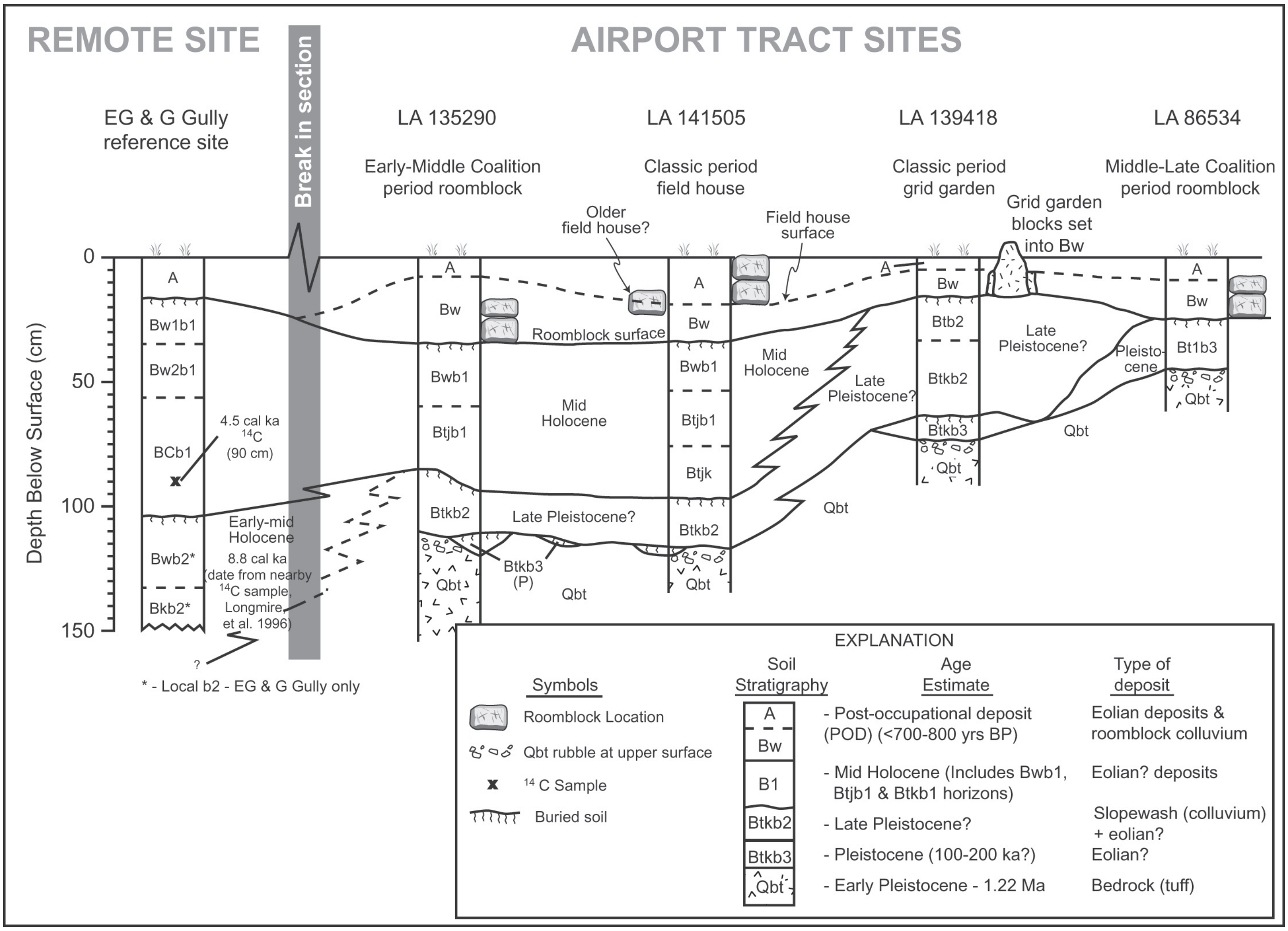

FIGURE 5. Schematic stratigraphic correlation chart of Airport tract sites compared to EG&G gully reference site. No horizontal scale.

rito Mesa trenches exposed 10 buried cultural features that had no surface expression, including at least six Ancestral Puebloan sites within 100 m of identified Coalition or Classic period structures. Notably, three of the buried sites were inferred hearths that yielded radiocarbon ages of 8.8 to 9.5 cal ka, corresponding to the Paleoindian period (Cordell, 1984; Vierra et al., 2002).

The relationships observed in the Airport tract soils are generally similar to the stratigraphy of Pajarito Mesa units 3b, 2a, and 1 (Reneau et al., 1995). Pajarito Mesa unit 1 yielded radiocarbon dates of ca. 1290 cal AD or younger, has a thickness of 0.1 to 0.3 m, may represent two separate eolian events (unit 1a and 1b), and is inferred to be correlative with the Airport tract post-early Coalition period deposits (Fig. 6). Radiocarbon dates from Pajarito Mesa unit 1b, which appears correlative with the eolian deposit burying Coalition period Airport tract sites, indicate primary deposition at ca. 1290 to 1410 AD (Reneau et al., 1995). Pajarito Mesa unit 2a is a composite of deposits dated at ca. 2-3 cal ka, 9-10 cal ka, 26 ^{14}C ka, and 28-30 ^{14}C ka in different parts of the trenches (Fig. 6). The Airport tract b1 soil is likely correlative with the ca. 2-3 cal ka Pajarito Mesa deposit or is a mid-Holocene deposit that was either not observed or not dated during the Pajarito Mesa investigation. Unit thickness and soil characteristics are consistent with the interpretation that the Airport tract b2 soil is correlative with Pajarito Mesa unit 3b, predating the El Cajete pumice (Fig. 6), although it may also partly correlate with late Pleistocene or early Holocene unit 2a deposits. For example, the early Holocene b2 deposit at EG&G gully may correlate with the Pajarito Mesa unit 2a 9-10 cal ka deposit. Pajarito Mesa units 2a and 3b and Airport tract buried soils b1 and b2 include significant components of silt, indicating a common genesis as eolian deposits. The Airport tract b3 soil and Pajarito Mesa unit 3e deposit are both characterized by well-developed stripped soils with 5YR-7.5YR hue formed in part in Bandelier Tuff rubble and preserved in low areas in the undulating tuff surface, and appear to be correlative with one another.

The stratigraphic correlations observed between the mesa top deposits at Pajarito Mesa and the Airport tract are consistent with concurrent periods of eolian deposition and erosion on these parts of the Pajarito Plateau since eruption of the Bandelier Tuff. Significantly, the past 700-800 yrs have been characterized by 10-30 cm net deposition on the crest of both mesas from at least two eolian events, resulting in the burial and preservation of Ancestral

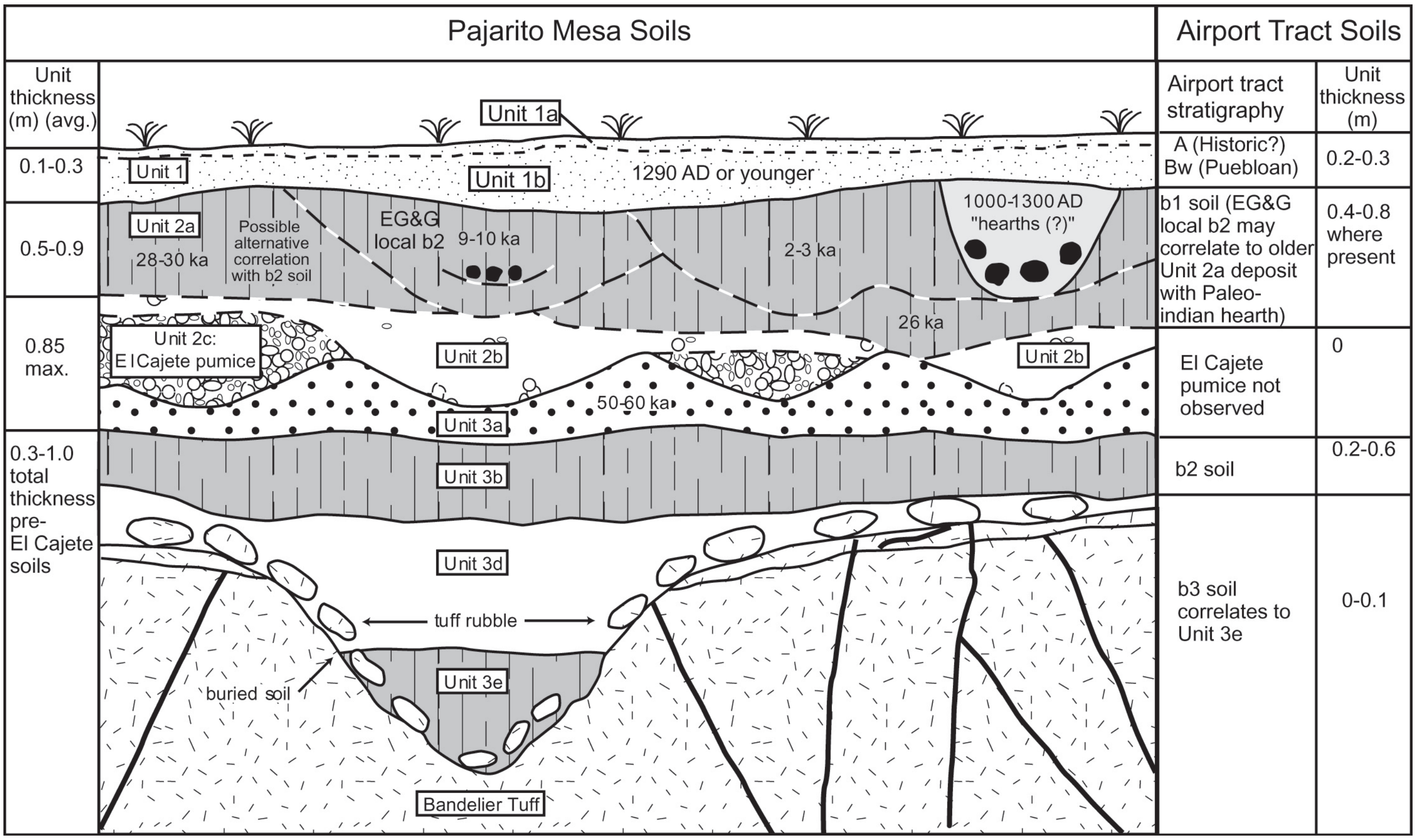

FIGURE 6. Correlation chart showing Pajarito Mesa and Airport tract stratigraphy. Modified from Reneau et al. (1995).

Puebloan and older sites. It is likely that many Pajarito Plateau mesa tops have experienced net deposition over this time period. Previous surveys of Pajarito Plateau archaeological sites, while not explicitly noting net deposition, did note that erosion on the mesa surfaces has been negligible since "pre-Columbian" occupation, and that sites are typically buried just below the "sod line" (Steen, 1977). The presence of latest Pleistocene/early Holocene eolian deposits on mesa tops may also result in the preservation of Paleoindian sites, whereas less extensive preservation of mid-Holocene deposits may result in less common preservation of Archaic sites.

White Rock tract mesa top multicomponent site

LA 12587 includes a multicomponent Ancestral Puebloan roomblock site situated on a small isolated Bandelier Tuff mesa in Cañada del Buey, approximately 0.75 km west of the town of White Rock (Fig. 1; Drakos et al., this volume, fig. 2). The site includes two probable Late Coalition period roomblocks (roomblocks 1 and 3) and an overlying Classic period field house (roomblock 2) and associated rock alignment that is a possible Classic period agricultural feature (Fig. 7; Drakos and Reneau, 2003). The Coalition period roomblocks are built either directly on Bandelier Tuff or on remnants of Pleistocene soils preserved in depressions in the undulating tuff surface (Fig. 8). Some sections of the younger Coalition period roomblock (roomblock 3) are built on colluvium derived from roomblock 1 (Fig. 8). The Coalition period roomblocks are overlain by soils formed in eolian or reworked eolian sediment plus colluvium derived in part from the roomblocks. The post-Coalition period soils exhibit A-Bw, A-Bw1-Bw2, or A-Bwk profiles (Table 1; carbonate in these young soils is inferred to be derived from the mortar used in wall construction). Data from ^{14}C analyses and archaeomagnetic dating indicate that roomblock 1 most likely dates to ca. 1270-1300 AD, or late Coalition time (B.J. Vierra, unpubl., 2007).

The rock alignments located north of the field house (roomblock 2) are built on top of the Bw horizon that buries the Coalition period roomblocks (Fig. 8). Based on ceramics found at the site, the field house and rock alignments are inferred to most likely date to the early 1400s, although they could date to the late 1400s or early 1500s (B.J. Vierra, unpubl., 2007). The presence of a 16 to 23 cm-thick Bw horizon formed in a deposit composed predominantly of eolian or reworked eolian sediment underlying the possible agricultural rock alignments is evidence for significant eolian deposition during the late Coalition or early Classic period (between approximately 1270-1300 AD and the early 1400s). Whereas eroding roomblocks provided a source for coarse colluvium, the predominantly fine-grained nature of the <2 mm fraction of upper Bw horizons indicates an eolian source for most of the sediment burying the roomblocks. Additional, thinner (9 to 15 cm) sediment partially buries the rock alignments, indicating smaller inputs of eolian sediment or reworked eolian

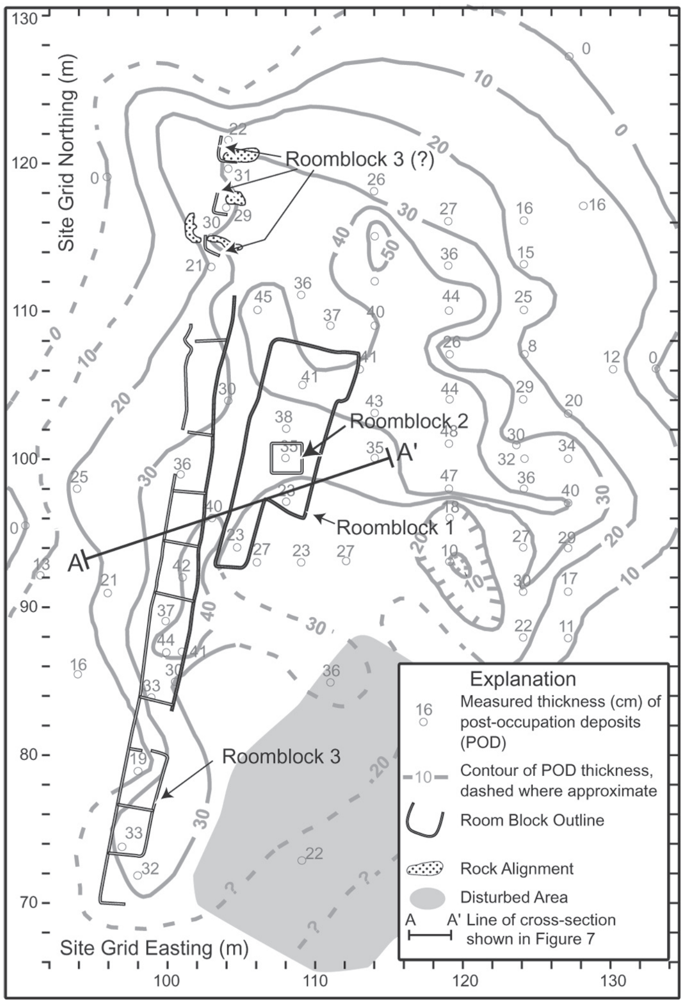

FIGURE 7. LA 12587 site map showing room blocks, rock alignments, and thickness of post-occupational deposits.

sediment following their emplacement. This later episode of sediment deposition dates to the mid-1400s or later.

Total thickness of post-occupational deposits in the vicinity of the roomblocks ranges from 10 to 54 cm (Fig. 7). Greater sediment thickness corresponds in general to the roomblock locations and the colluvial mound northeast of roomblock 1. Outside of the colluvial mound surrounding the roomblocks, post-occupational deposit thickness ranges from 0 cm on stripped bedrock surfaces east, north, and west of the roomblocks (Fig. 7), to a maximum eolian deposit thickness of 17 to 24 cm at SP21 and SP21A on the edge of the mesa top north of the site (Drakos et al., this volume, fig. 4).

The discontinuous Pleistocene (b3) soil underlying LA 12587 consists of an eroded Btk horizon with 5YR hue and Stage I carbonate and is inferred to be 100-200 ka or older, based on correlation with soils described by McFadden et al. (1996) and Reneau et al. (1995). Pleistocene soil thickness in the site vicinity ranges from 0 to 16 cm. The Pleistocene soil at LA 12587 is a polygenetic soil in which the Bt horizon formed during the Pleistocene, and the Stage I carbonate formed later, probably during the Holocene.

In summary, the isolated mesa top on which LA 12587 was constructed is characterized by Bandelier Tuff bedrock overlain by thin, discontinuous remnant Pleistocene soils and recent eolian or reworked eolian deposits typically less than 30 cm thick, of which approximately 15 to 20 cm was deposited after construction of the late Coalition period roomblock but prior to Classic period features (Figs. 7, 8). Similar thin, discontinuous deposits were noted during archaeological excavations on the Mesita del Buey mesa top approximately 1 km west of LA 12587 (Steen, 1982). Prior to the Coalition period, mesa top surfaces in this area were characterized by stripped surfaces with remnant eroded Pleistocene (b3) soils and exposed bedrock. Although erosion and some colluvial transport has occurred across mesa top surfaces, roomblocks and associated artifacts are in relatively good archaeological context. Roomblocks were an effective trap for eolian sediment, and the eroding walls were a local source of coarse colluvium after site abandonment. Two eolian events are recorded in the site vicinity. The older, Coalition period roomblocks are buried by eolian deposits with Bw horizon development, whereas Classic period rock alignments are constructed on top of the Bw horizon (Fig. 8). Classic period features are partially buried by a younger eolian deposit. The earlier eolian event likely occurred during late Coalition or early Classic time (between approximately 1270-1300 AD and the early 1400s), and the latter eolian event dates to the mid 1400s or later, within the Classic period or the historic period.

DISCUSSION – ANCESTRAL PUEBLOAN EOLIAN EVENTS

Based on the mesa top stratigraphic correlations and the timing of Ancestral Puebloan site occupations, we infer that 15 to 20 cm of eolian deposition occurred sometime after occupation of Coalition period sites but prior to occupation of Classic period sites in the study areas. Age constraints from cultural sites in the White Rock tract suggest deposition sometime between ca. 1270-1300 AD and the early 1400s, essentially identical to radiocarbon analyses from Pajarito Mesa eolian deposits of ca. 1290-1410 AD. Age constraints from the Airport tract are less precise, but are consistent with eolian deposition during this period. This eolian event apparently began near the end a series of droughts that occupied much of the 1200s (e.g., Allen, 2004, fig. 2.6), suggesting drought-induced destabilization of the landscape. Based on recent observations, we infer that the source of the eolian sediment may have been young, non-vegetated fine-grained sediment deposits on floodplains and fans in canyon bottoms, in turn suggesting extensive erosion and flooding in local canyons at this time. A second, more recent eolian event occurred after abandonment of Classic period sites in the Airport and White Rock tracts, resulting in net deposition of an additional 5 to 10 cm of fine-grained sediment on mesa tops since the early 1400s. These later deposits may originally have been thicker, being partially removed by erosion.

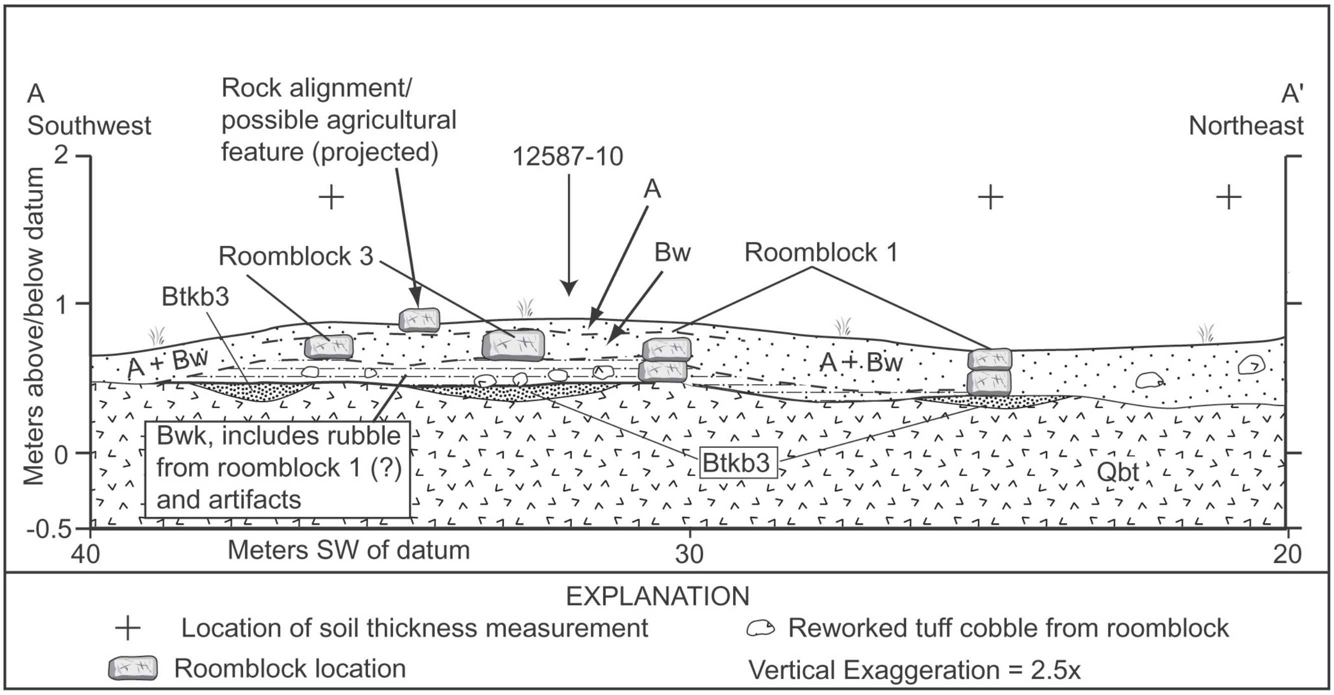

FIGURE 8. Cross section A-A' through LA 12587. Line of section shown on Figure 7.

CONCLUSIONS

Preliminary correlations of eolian stratigraphic units have been developed during investigation of cultural sites located on mesa tops in the Airport and White Rock tracts and in trenches on Pajarito Mesa. Post occupation eolian deposits are present in each of the mesa top locations, and Ancestral Puebloan sites are typically buried and are generally in good archaeological context. One eolian event occurred between the late 1200s and the early 1400s, and apparently followed a series of droughts that occupied much of the 1200s. A second, more recent eolian event occurred after abandonment of Classic period sites in the study areas. The total thickness of these eolian deposits is approximately 20-30 cm, of which 15-20 cm is the thickness of the earlier eolian deposit.

In many cases Coalition and Classic period sites can be differentiated based on soil stratigraphic relationships. Where they are not built on bedrock, Coalition period sites sit on a buried soil, and Classic period sites sit on young eolian deposits. Coalition period sites are typically buried by a greater thickness of deposits that have A-Bw soil profiles, whereas deposits burying Classic period sites typically have thinner A or AC profiles only.

Post-middle Coalition period deposits typically are underlain by 0-2.5 m of Pleistocene and Holocene deposits overlying the early Pleistocene Bandelier Tuff, recording a sequence of discontinuous, truncated late Pleistocene through middle to late Holocene soils that represent episodic eolian deposition and soil formation followed by erosion. Widespread eolian deposits with buried soils are inferred to date to the mid-Holocene, latest Pleistocene to early Holocene, the mid- to late Pleistocene, and the middle Pleistocene. The thickness of deposits is affected by geomorphic position, with thicker deposits filling mesa top swales and shallow valleys, and stripped surfaces located near the mesa edges or on narrow mesa tops. The presence of late Pleistocene to early Holocene eolian deposits in mesa top settings preserves a record of Paleoindian occupation on the Pajarito Plateau, as shown by Paleoindian sites exposed on Pajarito Mesa, and Archaic sites may also be locally preserved.

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