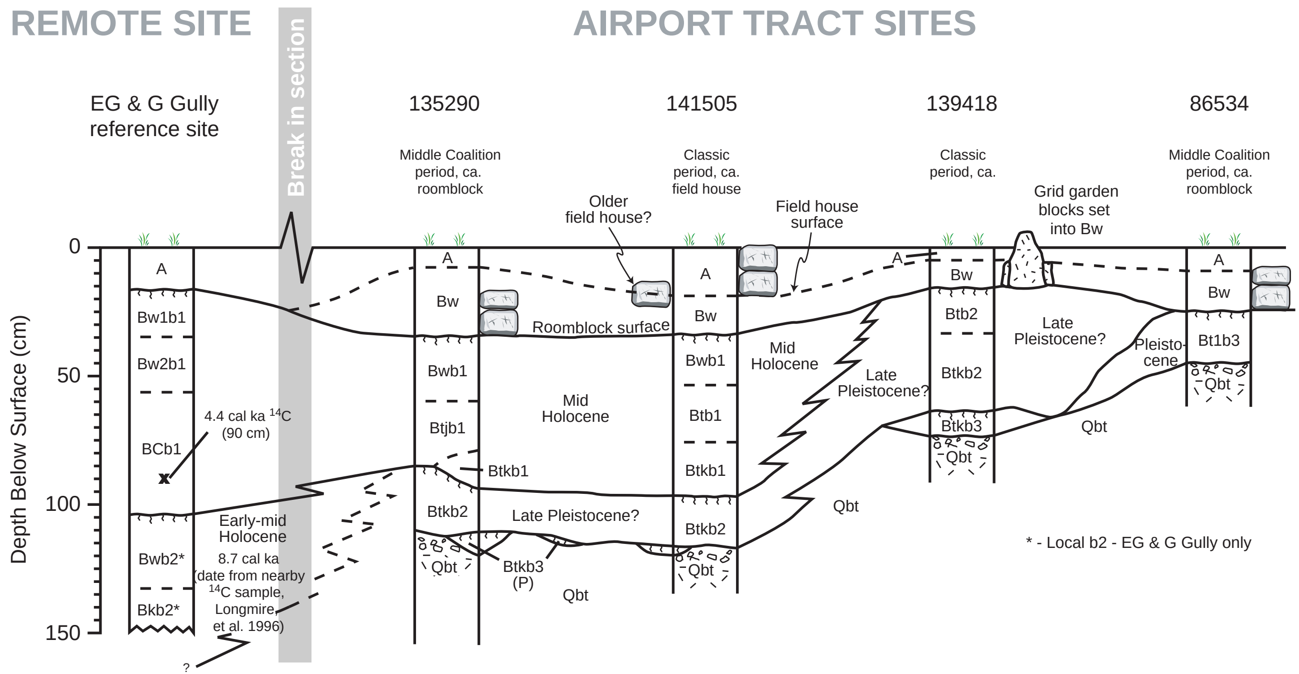
SURFICIAL UNITS AND PROCESSES ASSOCIATED WITH ARCHAEOLOGICAL SITES IN SELECTED LAND CONVEYANCE PARCELS, LOS ALAMOS NATIONAL LABORATORY, VOLUME II

2003 Field Season Investigations: Rendija Canyon and Airport Tract Sites



Stratigraphic correlation of Airport Tract sites.

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GLORIETA GEOSCIENCE, INC.

Los Alamos NATIONAL LABORATORY

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INTRODUCTION

Geomorphic studies were conducted in selected land conveyance parcels at Los Alamos National Laboratory in support of archaeological investigations preceding transfer of these tracts from the Department of Energy to Los Alamos County, San Ildefonso Pueblo, or the New Mexico Highway Department. This work included mapping and description of surficial geologic units to help define the geomorphic context of archaeological sites. This investigation also focused on identification of surficial processes associated with potential erosion or burial of cultural features. Fieldwork was conducted during the 2003 field season in support of excavations at five sites in the Rendija Canyon tract and at three sites within the Airport tract.

GEOMORPHIC SETTING

Los Alamos National Laboratory is located on the Pajarito Plateau and includes a variety of landforms including gently sloping mesa tops, steep canyon walls, and canyon bottoms. This area has a complex geomorphic history over the last 10 to 15 thousand years, the time scale relevant to archaeological investigations (e.g., Reneau and McDonald, 1996; Reneau et al., 1996). At various times, large parts of the landscape experienced deposition of alluvial, colluvial, or eolian sediments, with an associated potential to bury and help preserve archaeological sites. The landscape has also experienced significant erosion, with the associated potential to erode archaeological sites.

METHODS

Surficial geologic maps of selected land transfer tracts were prepared at a scale of 1:1200. The Airport tract geologic map was completed during the 2002 field season (Drakos and Reneau, 2003). The Rendija Canyon tract geologic map was completed during the 2003 field season, and included an area mapped previously by Reneau (Reneau and McDonald, 1996, p. 102). The mapping focused on units with potential archaeological significance. Soil descriptions were made at profiles both inside and outside of identified archaeological sites following methods discussed in Birkeland (1999). Carbonate stage for soils follows nomenclature developed by Gile et al. (1965, 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 ^{14}C dates were obtained. Small charcoal samples were collected for ^{14}C analysis from soil profiles at sites LA 85859, LA 99396, and LA 99397 in Rendija Canyon, and from Airport tract site LA 135290 (Appendix D). A ca. 4.0 ka ^{14}C (4.4 cal ka) (cal = calibrated ^{14}C age; ka = thousands of years before present) valley fill deposit in "EG&G Gully" on the mesa east of the Airport tract sites (Longmire et al., 1996, p. 48-49), at the same general elevation as the Airport tract, was used as a key reference site for the degree of soil development in a mid-Holocene unit on that part of the plateau (Figure 1). 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. The presence of buried mid-Holocene and late Pleistocene soils underlying the Airport tract roomblock (LA 135290) provided a clear boundary between deposits with Puebloan cultural materials and older deposits. 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, also provided a clear demarcation of cultural-versus-archaeologically sterile sediments.

Preliminary age estimates for soils in Rendija Canyon are based on comparison with a chronosequence of Pleistocene and Holocene soils developed on a terrace sequence in Rendija Canyon (Reneau and McDonald, 1996; McDonald et al., 1996; Phillips et al., 1998). Age constraints for the Rendija Canyon fluvial terraces are provided by 13 radiocarbon dates for Holocene terraces, two radiocarbon dates for Pleistocene terraces, and cosmogenic ^{21}Ne age estimates for three terraces. Additional data for Rendija Canyon soil age estimates are based on comparison with soils described in paleoseismic trenches in Chupaderos Canyon, northwest of the Rendija tract (Gardner et al., 2003).

The hillslope profile at LA 85859 was surveyed using a hand level, tape measure, and stadia rod.

AIRPORT TRACT

Surficial Geologic Units

The Airport land transfer tract includes a gently sloping mesa between a tributary to Pueblo Canyon on the north and DP Canyon, a tributary to Los Alamos Canyon, on the south. Bedrock beneath the mesa consists of the Tshirege Member of the Bandelier Tuff (unit Qbt). In this report, Bandelier Tuff is designated as Qbt, undifferentiated. At the Airport site location, the Bandelier Tuff has been mapped as unit Qbt-3 by Goff (1995). The mesa is capped by colluvium that thins to exposed bedrock near the mesa edge (Figure 2), overlain by fine-grained soils that likely constitute either eolian sediments or locally reworked eolian sediments. Recent (Holocene) soils and sediments unconformably overly thin Pleistocene soils. A tributary drainage to Pueblo Canyon that heads in the tract is shallowly 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. Geologic maps of this area have been prepared by Griggs (1964), Smith et al. (1970), Goff (1995), and Rogers (1995).

LA 86533 (Archaic lithic scatter)

LA 86533 is a Late Archaic period site consisting of a dispersed lithic scatter. LA 86533 is situated on top of shallow soils in a highly eroded area with exposed bedrock near the mesa edge (Figure 2). Sparse artifacts are part of a thin colluvial cover overlying

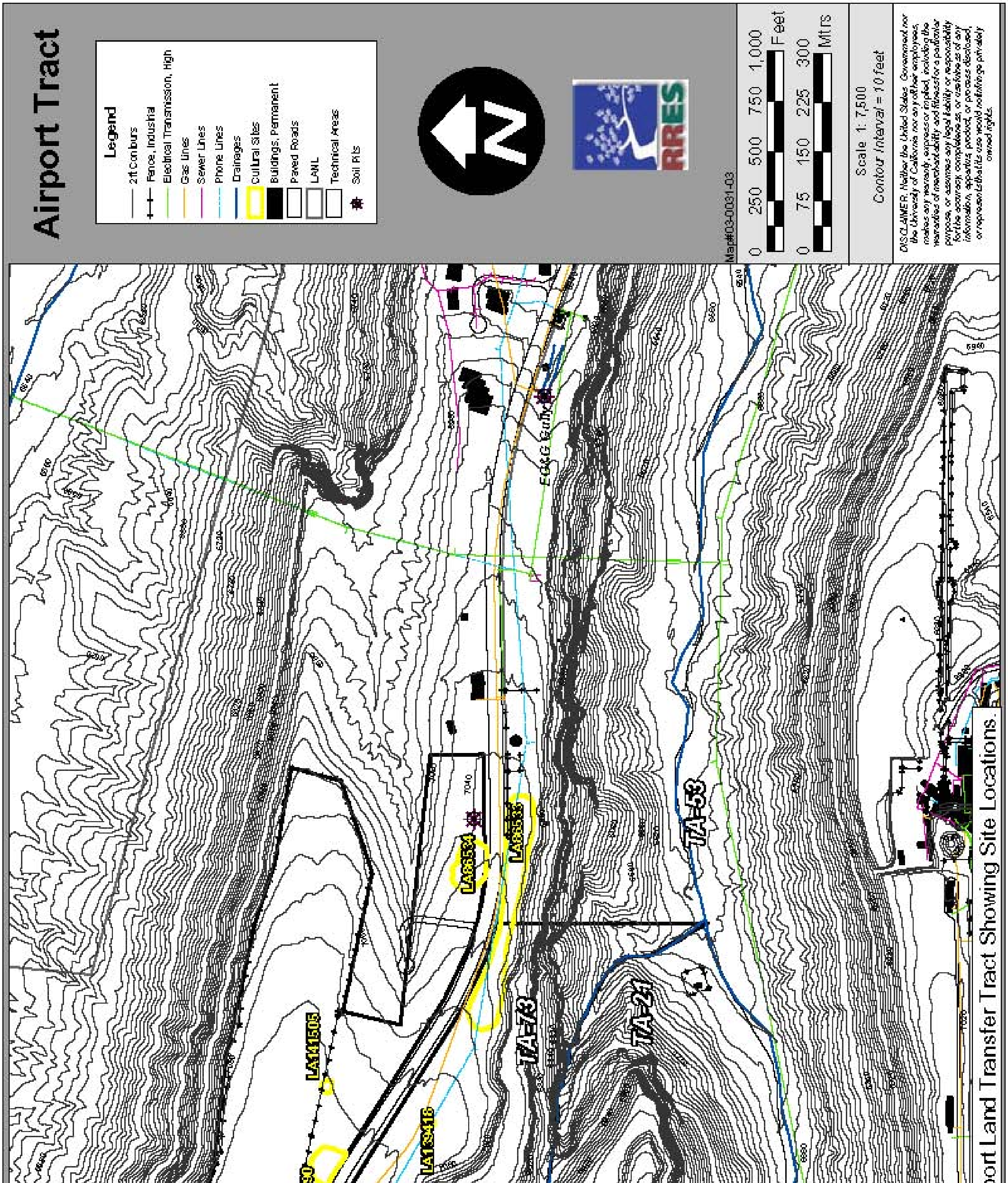


Figure 1. Airport Land Transfer Tract Showing Site Locations.

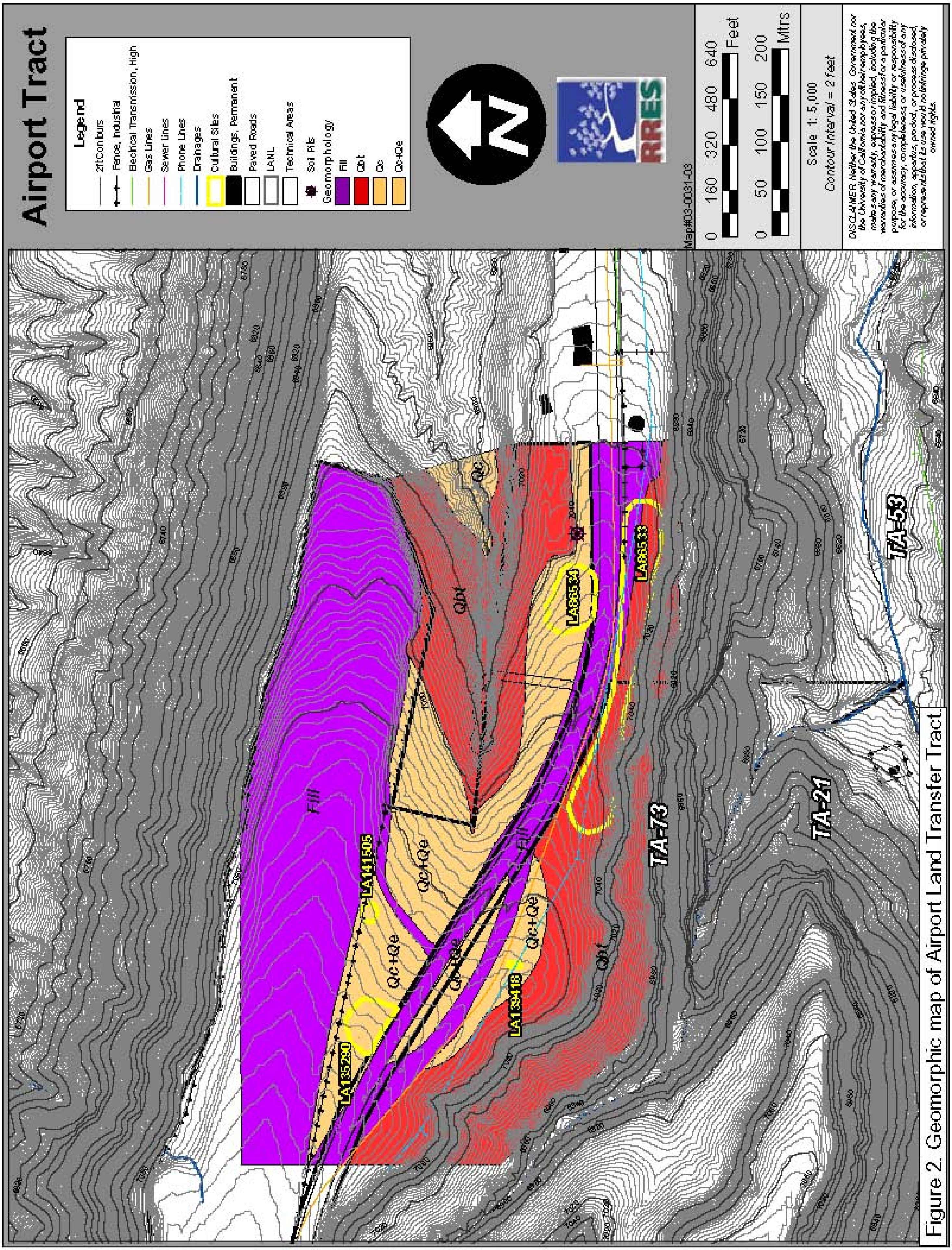


Figure 2. Geomorphic map of Airport Land Transfer Tract.

Bandelier Tuff bedrock. Archaeological context is poor, and the lithics appear to represent a lag deposit.

LA 135290 (Puebloan roomblock)

LA 135290 is an ancestral Puebloan roomblock on the mesa top that may date to the Middle Coalition period, ca. 1200-1300 AD. The site is underlain by a sequence of stacked Holocene and Pleistocene soils (Figure 3; Table 1). The older (b2 and b3) soils of inferred Pleistocene age are present as remnant soils that were eroded and subsequently buried by swale fill and/or eolian deposits (Figure 3). Thickness of buried Pleistocene deposits ranges from 0 to approximately 35 cm (Figure 3; Table 1). The inferred mid Holocene (b1) soil formed in fine-grained silty deposits of likely eolian origin (Table 1). An increase in gravel percentage from less than 2% in the overlying b1 soil to approximately 5% in the underlying b2 soil is suggestive of a stone line or erosion of the underlying bedrock by biological or slopewash processes during the late Pleistocene.

Burial of an undulating Bandelier Tuff surface and alternating periods of erosion and deposition have resulted in variable thicknesses of Pleistocene and Holocene sediments underlying the site (Figures 4a and 4b). A buried swale trends west-northwest to east-southeast, east of the roomblock (Figure 4b). Pleistocene soils are discontinuously preserved, indicating extensive erosion of the mesa top between the late Pleistocene and the mid Holocene (Figures 3, 4a and 4b). The 40 to 90-cm thick mid Holocene eolian deposit comprising the b1 soil was partially stripped (truncated) prior to occupation of LA 135290. Pleistocene and possibly Holocene soils are likely reworked and deposited as a swale fill sequence in the vicinity of profile 4 (Figure 3). The top of the mid Holocene eolian deposit and the upper surface of Holocene swale fill deposits comprises the occupation surface for LA 135290. The mid Holocene deposits are overlain by mixed colluvium derived from the roomblock and eolian deposits less than 700 to 800 years old. In this report, these post-occupation deposits are referred to as POD.

Age estimates for soils underlying the roomblock are based on correlation with soils on the Pajarito Plateau for which age control is available. In addition, three charcoal samples were collected from soils underlying the occupation surface (Figure 3; Appendix D), and soil age estimates may be revised based on ^{14}C analyses of these samples. Based on the estimated age of the roomblock, the A-Bw post-occupational deposit (POD) is less than 700 to 800 years old. The buried soil (b1) underlying POD includes Bw, incipiently developed Btj, and Btk horizons with stage I carbonate (Figure 3; Table 1, profiles 135290-3,4,5, and 6). The b1 soil has an inferred mid-Holocene age (4 to 6 ka BP), based on correlation with profile EG&G-1, described in "EG&G gully" east of the Airport tract sites (Figure 1; Table 1; Longmire et al., 1996). EG&G-1 has Bw1 and Bw2 horizons developed in a ca. 4.4 cal ka deposit, and a Bk horizon with stage I carbonate developed in an underlying 8.7 cal ka deposit (Figure 5, Table 1). The mid Holocene b1 soil is underlain at some locations by a Btkb2 soil of inferred late Pleistocene age, based on the age of the overlying soil and the additional time required to develop a Bt (argillic) horizon with 7.5YR color and common, moderately thick clay films. The Btkb2 soil exhibits clay films and color similar to the Rendija Canyon Qt4 soil that has an estimated age of 63 ± 8 ka based on ^{21}Ne analyses and 68-78 ka based on soils (McDonald et al., 1996; Reneau and McDonald, 1996; Phillips et al., 1998). The underlying thin (0 to 8 cm thick) Pleistocene Btkb3 horizon is inferred

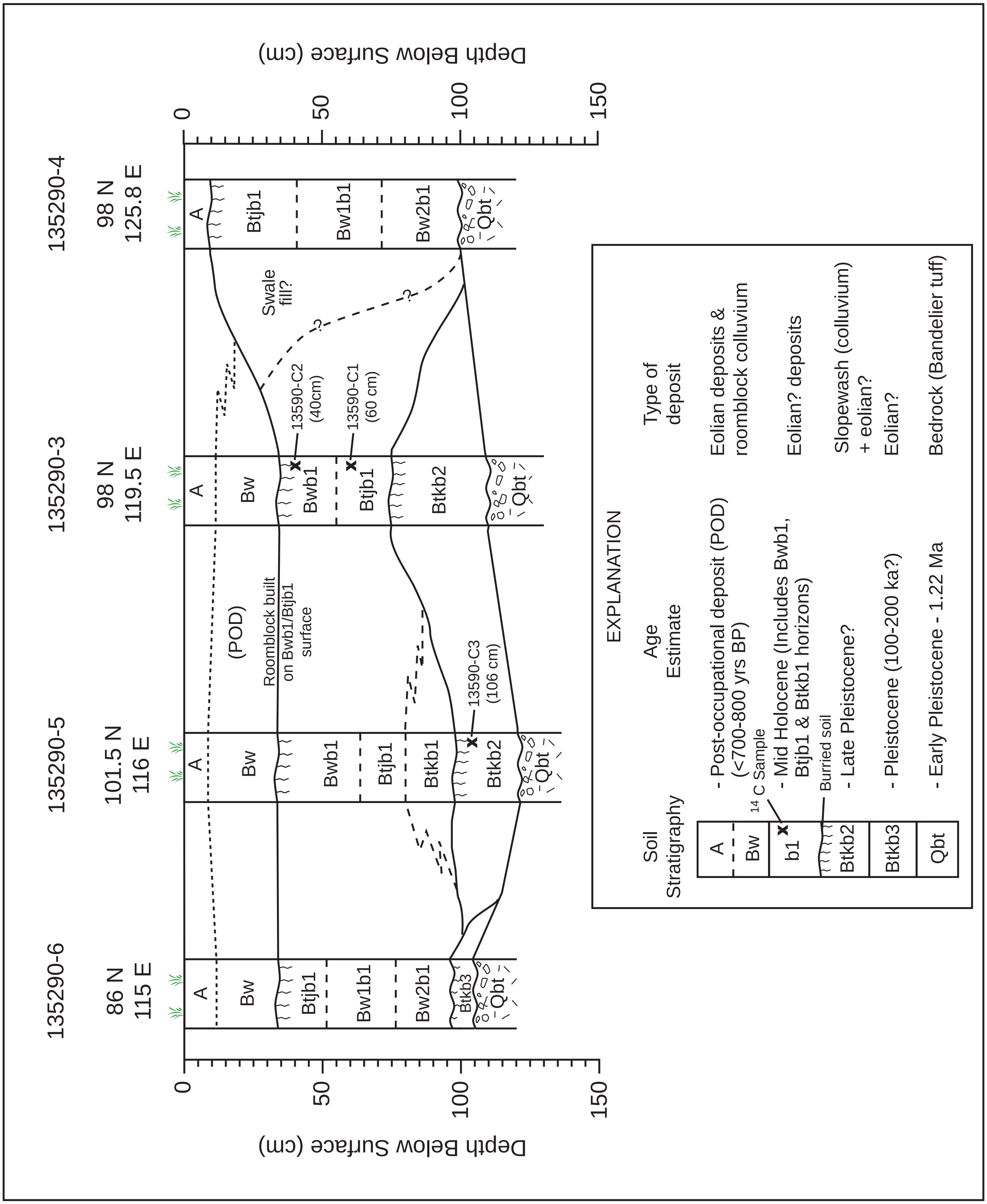


Figure 3. Correlation chart for Airport site LA 135290

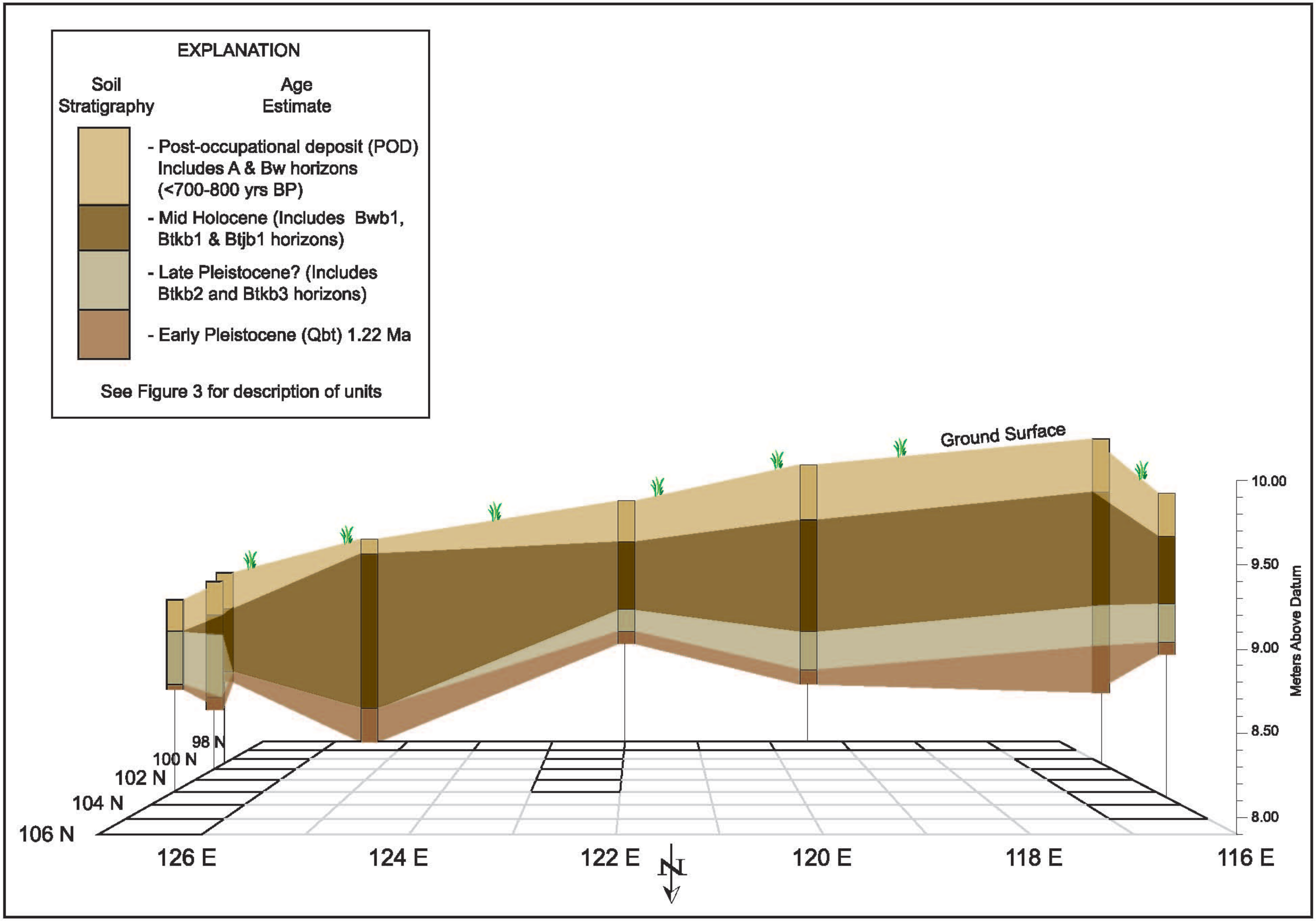


Figure 4a. LA 135290 soil profile fence diagram east of roomblock looking south

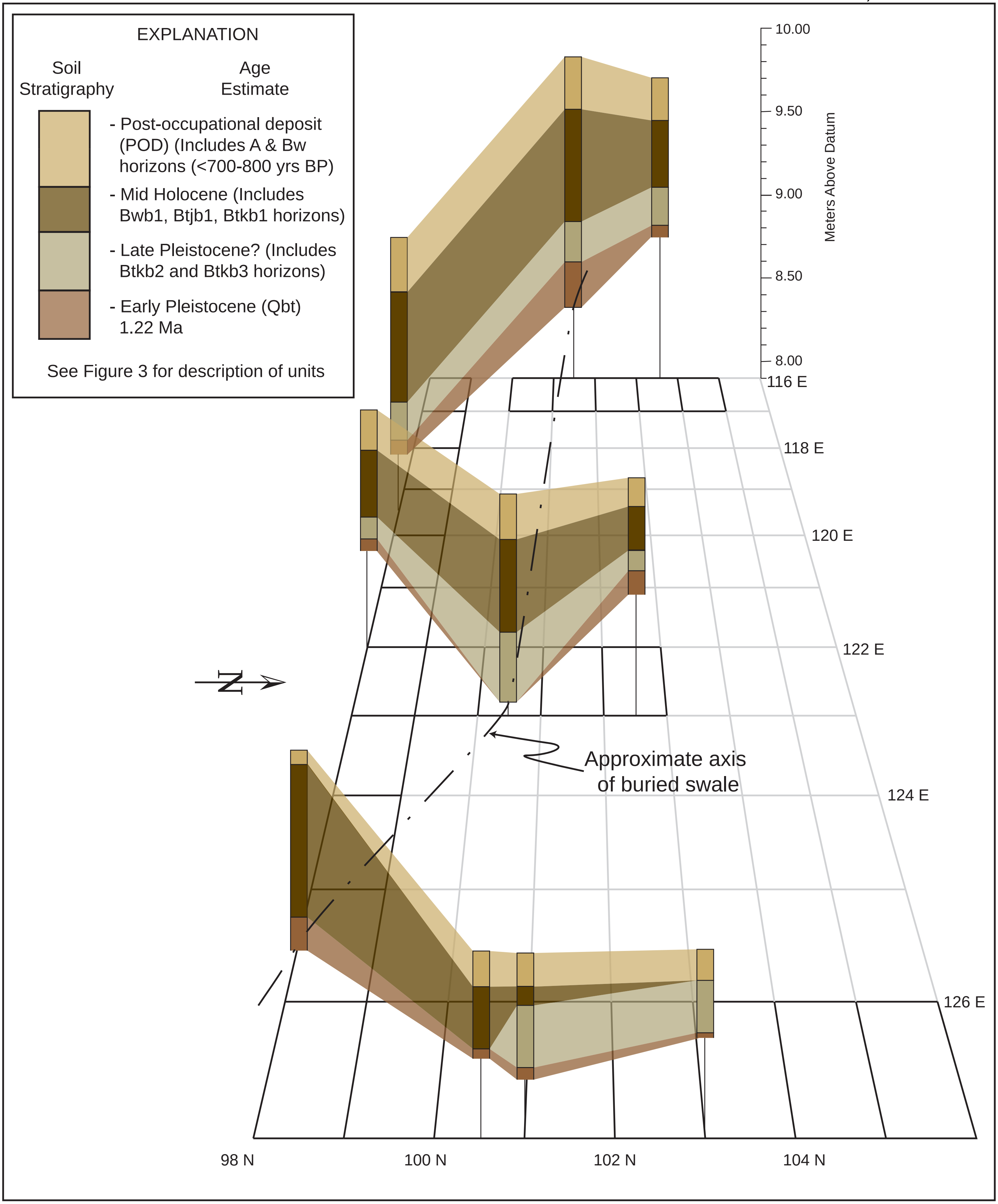


Figure 4b. LA 135290 soil profile fence diagram east of roomblock, looking west

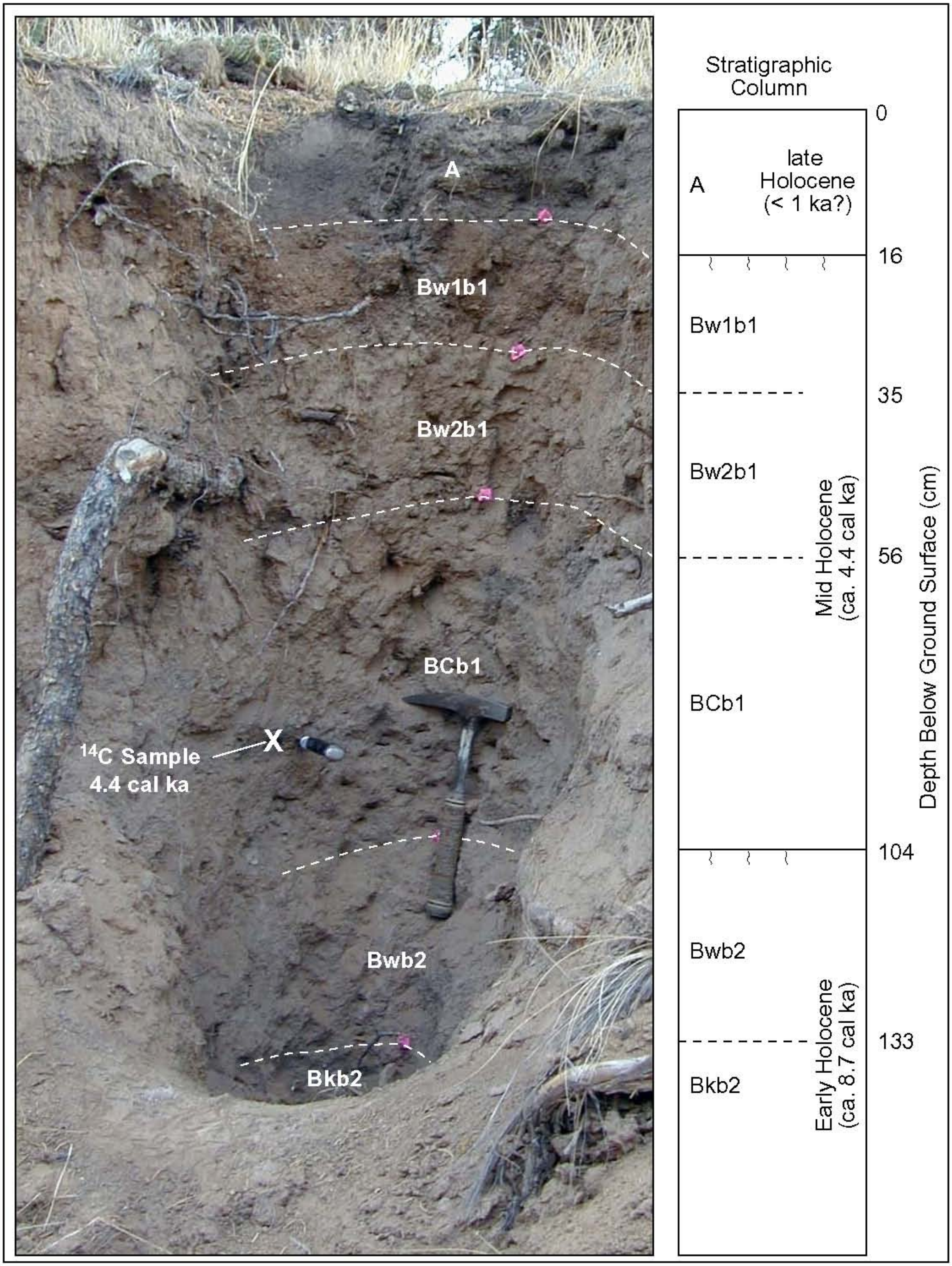


Figure 5. Soil stratigraphy and ^{14}C sample location, EG & G Gully site

Table 1. Summary of Soil Morphology at Airport Land Transfer Parcel Cultural Site LA 135290, Puebloan Roomblock (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA-135290, Profile 1, Airport roomblock, 98N, 111.5E, fill in roomblock; base of profile approx. 10 cm above floor (July 24, 2003)													**135290-1**		
A	0-10	<2	10YR5/3	10YR3/4	sl	1-2msbk	so	so.po	n.o.	none	-	cs		<700-800 yrs	
Bw1	10-22	5	10YR4/4	10YR3/3	sil	2msbk	so-sh	ss,ps	n.o.	none	-	cs			post-dates wall collapse to west
Bw2	22-57	5-10	10YR4/4	10YR3/4	si	2msbk	sh-h	ss,ps	n.o.	none	-	as			post-dates wall collapse to west
Bw3	57+														adobe melt with abundant charcoal + wall collapse
LA-135290, Profile 2, Airport roomblock, 94N, 110E, fill in roomblock; base of profile approx. 10 cm above floor (August 5, 2003)													**135290-2**		
A	0-6	20	10YR5/4	10YR4/3	sil	m	lo	so.po	n.o.	none	-	cs		<700-800 yrs	gravel from wall fall, + eolian material
Bw1	6-22	10-20	10YR4/3.5	10YR3/3	si	2msbk	so-sh	ss,ps	n.o.	none	-	gs			pure eolian deposit? + wall fall
Bw2	22-57+	5-10	10YR5/4	10YR3/3	sil	2m-csbk	sh-h	so,ps	n.o.	none	-	-			abundant charcoal; wall fall to east of profile
LA-135290, Profile 3, Airport roomblock, 98N, 119.5E, E-W trench to E. of roomblock (September 10, 2003)													**135290-3**		
A	0-12	10-20	10YR3/4 (damp)	10YR3/3	sl	1fsbk-m	so-lo	so.po	n.o.	none	-	gs		<700-800 yrs	described moist; gravelly colluvium derived from room block
Bw	12-34	10-20	10YR4/3	10YR3/3	sl	1msbk	so	so,ps	n.o.	none	-	aw			gravelly colluvium derived from room block
Bwb1	34-55	<2	10YR4/3	10YR3/3	si	2msbk	h	ss,ps	n.o.	none	-	gs		mid Holocene (4-5 ka?)	eolian deposit with cicada burrows
Btjb1	55-75	<2	8.75YR4/4	8.75YR4/3	si	2mabk	h	ss,ps	1npobr	none	-	as			slightly redder than Bwb1
Btkb2	75-110	<5	7.5YR5/4	7.5YR3/3	sicl	2m-csbk	h	ss,ps	2mkpobr	e-es	I	ci		late Pleistocene	thin CaCO3 filaments
R	110+													1.22 Ma	tuff rubble
LA-135290, Profile 4, Airport roomblock, 98N, 125.8E, E-W trench to E. of roomblock (September 10, 2003)													**135290-4**		
A	0-9	<5	10YR4/4 (damp)	10YR3/3	sil	1-2msbk	so	so.ps	n.o.	none	-	as		<700-800 yrs	distal post-puebloan colluvium
Btjb1	9-41	<2	7.5YR4/4	7.5YR3/3	csi	2m-csbk	h	ss,p	1npobr	none	-	gs		mid Holocene	clayey swale fill? Possibly 1npobr argillans?
Bw1b1	41-72	<2	8.75YR4/4	8.75YR4/3	si	2m-csbk	sh-h	ss,ps	n.o.	none	-	gs			some films appear to be siltans; slightly redder than 10YR
Bw2b1	72-100	<2	10YR4/4	10YR3/4	si	2msbk	sh	ss,ps	n.o.	none	-	ci			
R	100+													1.22 Ma	tuff rubble
LA-135290, Profile 5, Airport 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	
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 flaments 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 soil 100-200 ka)

Table 1. Summary of Soil Morphology at Airport Land Transfer Parcel Cultural Site LA 135290, Puebloan Roomblock (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA-135290, Profile 6, Airport roomblock, 86N, 115.8E, trench, south wall, E of roomblock (October 16, 2003)													**135290-5**		
A	0-11	5-10	10YR4/4	10YR3/3	sil	1msbk	so	so,po	n.o.	none	-	gs		<700-800 yrs	
Bw	11-34	<2	10YR4/3	10YR3/4	sil	1-2msbk	so	so,ps	n.o.	none	-	as			
Btjb1	34-51	<2	8.75YR4/4	8.75YR3/3	sicl	2msbk	h	ss,p	1nbrpo	none	-	cs		mid Holocene	
Bw1b1	51-76	<2	8.75YR5/4	8.75YR4/4	sil	2m-csbk	h	ss,ps	n.o.	none	-	gs			
Bw2b1	76-97	<2	10YR5/4	10YR4/3	sil	2msbk	sh-h	ss,ps	n.o.	none	-	as			
Btkb3	97-105	<2	5YR4/4	5YR4/6	sic	2-3fabk	sh-h	s,p	3-4mkcopobrpf	e	I-			100-200 ka	buried soil b3 relative to overall site stratigraphy; "big orange"?
R	105+													1.22 Ma	Qbt
LA-135290, Profile 7, Airport roomblock, 93N, 110E, description of soil below floor (November 4, 2003)													**135290-7**		
Bw	0-13	2-5	7.5YR5/4	7.5YR3/3	sil	1msbk	so	so,ps	n.o.	none	-	as		mid Holocene?	0 = base of floor, 90N, 110.4E; fill?
Bwb1	13-26+	<2	10YR4/4	10YR3/3	si	2fsbk	sh	ss,ps	n.o.	none	-	-			some siltans
LA-135290, Profile 8, Airport roomblock, 92.25N, 108E, description of soil below floor (November 4, 2003)													**135290-8**		0 = base of floor
Bw	0-11	<2	7.5YR4/4	7.5YR3/3	si	1-2msbk	so	so,ps	n.o.	none	-	as		mid Holocene?	
Bwb1	11-17+	<2	7.5YR5/4	7.5YR3/3	si	2msbk	sh-h	so,ps	n.o.	none	-	-			
LA-135290, Profile 9, Airport roomblock, 97N, 109E, description of soil below floor (November 5, 2003)													**135290-9**		0 = base of floor
Bw	0-14	<2	7.5YR5/4	7.5YR4/4	si	1-2msbk	so	so,ps	n.o.	none	-	ci		mid Holocene?	
Bwb1	14-21+	<2	8.75YR5/4	8.75YR3/3	si	2msbk	sh-h	so,ps	n.o.	none	-	-			
EG&G Gully, on mesa top east of Airport Site													**EG&G-1**		
A	0-16	2-5	10Yr4/3	10YR3/2	ls	1msbk	so	so,po	n.o.	none	-	as		Late Holocene (< 1 ka?)	
Bw1b1	16-35	5-10	7.5YR4/5	7.5YR3/4	sl	2msbk	sh	so,ps	n.o.	none	-	cs		Mid Holocene (ca. 4.4 ka)	predominently tuff gravel, different parent material; "unroofing" of Bt horizon upslope, but no clay films
Bw2b1	35-56	<2	10YR5/4	10YR4/3	sil	2msbk	so-sh	ss,ps	n.o.	none	-	gs			minor csbk structure; krotavinas near boundary
BCb1	56-104	5	10YR5/4	10YR4/3	l	1msbk-m	so-lo	so,po	n.o.	none	-	as			89cm = dated charcoal, ca. 4 ka BP (4.4 cal ka)
Bwb2	104-133	5	10YR4/4	10YR3/3	scl	2msbk	h	ss,ps	n.o.	none	-	cw		8.7 ka	possibly 1npo argillans
Bkb2	133-148+	2	10YR4/3	10YR3/3	sl	2msbk	sh	so,ps	n.o.	e	I	-			

Table 2. Summary of Soil Morphology at Airport Land Transfer Parcel Cultural Site LA 139418, Grid Garden (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consistence	Wet Consistence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 139418-1, Airport Land Transfer Parcel Grid Garden, E Wall, 85.5N, 106E (June 23, 2003)													**139418-1**		
AC	0-8	<2	10YR5/4	10YR3/4	sil	1-2msbk	so	so,ps	n.o.	none	-	as		<500 yrs?	scattered clasts along lower contact suggests strat break
Bw	8-19	5	10YR4/4	10YR3/4	sil	1-2msbk	sh	ss,ps	n.o.	none	-	cs		<700-800 yrs	b1 based on upper contact
Bt1b2	19-27	5-10	7.5YR4/5	7.5YR3/4	sicl	2fsbk	sh	ss,p	1nbrpo	none	-	as		late Pleistocene	
Bt2b2	27-39	<2	7.5YR4/6	7.5YR3/4	sic	2-3fabk	sh-h	s,p	3npobrpf	none	-	cs			decrease in gravel from overlying horizon - strat break?
Btkb2	39-50+	<2	7.5YR4/4	7.5YR3/4	sic	2-3msbk	h	s,p	3mkpobrpf	e	I	cs			few CaCO3 filaments
LA 139418-2, Airport Land Transfer Parcel Grid Garden, E Wall, 83.5N, 106E (June 23, 2003)													**139418-2**		
AC	0-9	<1	10YR4/4	10YR3/4	sil	1msbk	so	so,ps	n.o.	none	-	as		<500 yrs?	
Bw	9-21	2-5	10YR4/5	10YR3/4	sil	1-2msbk	so-sh	ss,ps	n.o.	none	-	cs		<700-800 yrs	large roots, close to junipers
Btb2	21-34	2	8.75YR4/4	8.75YR3/4	sicl	2fsbk	so	ss,p	2npobr	none	-	cs		late Pleistocene	large roots
Btkb2	34-42+	<2	7.5YR4/4	7.5YR4/4	sic	2-3fsbk	sh	s,p	3npobrpf	e	I				few CaCO3 filaments
LA 139418-3, Airport Land Transfer Parcel Grid Garden, E Wall, 80.5N, 106E, approx. 1 m S of grid garden (July 17, 2003)													**139418-3**		
AC	0-7	2	10YR4/4	10YR3/4	sil	1msbk	so	so,po	n.o.	none	-	as		<500 yrs?	4 cm pine litter, 1 m NW of Piñon trunk
Bw	7-15	5	10YR5/3	10YR4/3	sil	2msbk	so-sh	so,ps	n.o.	none	-	vas		<700-800 yrs	
Btb2	15-23+	<2	7.5YR3.5/4	7.5YR4/4	sic	2-3fabk	h	s,p	3npobrpf	none	-	-		late Pleistocene	
LA 139418-4, Airport Land Transfer Parcel 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		late Pleistocene	
Btk1b2	34-42	<2	7.5YR5/3	7.5YR4/3	sic	2msbk	h	ss,p	2npobrpf	es	I	cs			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

Table 3. Summary of Soil Morphology at Airport Land Transfer Parcel Cultural Site LA 141505, Field House (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 141505, Profile 1, Late coalition or Early Classic? field house, 110N, 107.3E (December 17, 2003)													**141505-1**		
A	0-5	5-10	10YR4/3	10YR2/2	sl	1msbk	so	so,po	n.o.	none	-	as		<600 to 800 yrs	1.5m from pinon stump, 30% organic matter, litter
Bw or Bwb1?	5-21+	<2	10YR4/4	10YR3/4	sil	2msbk	sh-h	so,ps	n.o.	none	-	-			tuff blocks imbedded into top of horizon
LA 141505, Profile 2, Late coalition or Early Classic? 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 pps equivalent?
Bwb1	34-54	<1	8.75YR4/3	8.75YR3/3	si	2f-msbk	h	ss,p	n.o.	none	-	cs		Mid Holocene (4-6 ka?)	abundant siltans; possible b1?
Btb1	54-76	<1	7.5YR5/4	7.5YR4/3	sic	2f-msbk	h	s.p	2nbrpo	none	-	cs			
Btkb1	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 fliaments; 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
Qbt	116+													1.22 Ma	Qbt rubble + remnant "big orange" (Btkb3)

to be 100-200 ka or older, based on correlation with soils described by McFadden et al. (1996). The Btkb3 horizon is a reddened (5YR) silty clay, likely of eolian origin, that is a potential clay source for making ceramics.

Roomblocks were apparently built on top of the b1 soil (either on top of the Bwb1 or Btjb1 horizon) (Figure 3). Soils formed in and surrounding the roomblock (POD) typically exhibit A-Bw1-Bw2 profiles developed in silty eolian sediment mixed with roomblock-derived colluvium (Figure 6, Table 1, profiles 135290-1 and 2). The A and Bw horizons include a variety of ceramic and lithic artifacts. Eolian or reworked eolian sediment is interpreted to largely comprise the A horizon that partially buries blocks of tuff derived from wall collapses. The different soil components are well mixed, which indicates extensive bioturbation of the post-occupational soil by burrowing and other processes.

The presence of pockets of reddened (7.5YR) soil with minor gravel immediately underneath the roomblock floor (e.g. 135290-7, 135290-8, and 135290-9; Table 1) suggests that the roomblock is underlain by imported fill at some locations. At locations 135290-7 and 135290-9, the 7.5YR soil immediately underneath the roomblock floor overlies a less reddened Bwb1 horizon, suggesting that an older, more reddened soil was used as fill material. The slight increase in gravel percentage in the Bw versus the Bwb1 horizon at 135290-7 suggests that some gravel was also utilized in the fill material, possibly picked up from the mesa edge, or that the soil used for the fill contained more gravel than the original soil at the site. The thickness of the fill below the roomblock floor in the three soil profiles where the fill material was observed ranges from 11 to 14 cm.

Total thickness of POD in the vicinity of the roomblocks ranges from 40 to 70 cm (Figure 7). The colluvial mound surrounding the roomblock (defined by the location of the 20 cm isopach) extends approximately 10 to 12 meters (m) east-southeast and approximately 4 m west and north of the roomblock (Figure 7), illustrating the transport of roomblock colluvium to the east-southeast by slopewash processes. Outside of the colluvial mound surrounding the roomblocks, post-occupational soil thickness ranges from 5 to 10 cm or more (Figure 7), to 16 cm on the south side of the mesa top near the LA 139418 grid garden (see profile 139418-4, Table 2). Non-cultural sediments post dating the Ancestral Puebloan sites within the Airport tract appear to be primarily eolian in origin, are up to 20 cm thick, and likely represent at least two separate eolian depositional events (discussed below). The thicker POD inside the roomblocks than outside is probably due to a combination of enhanced eolian deposition in the roomblock and contributions to the soil from adobe at the site.

LA 139418 (grid garden)

LA 139418 consists of a grid garden on the mesa top in an area of stripped Pleistocene soils overlain by thin, weakly-developed soils inferred to be less than 600 to 700 years old (Figure 8). Depth to Bandelier Tuff bedrock, observed 15 m east of the grid garden, was less than 1 m (0.7 m). The grid garden is located on a gently southeast-sloping area of the mesa that affords minimal surface runoff to the site.

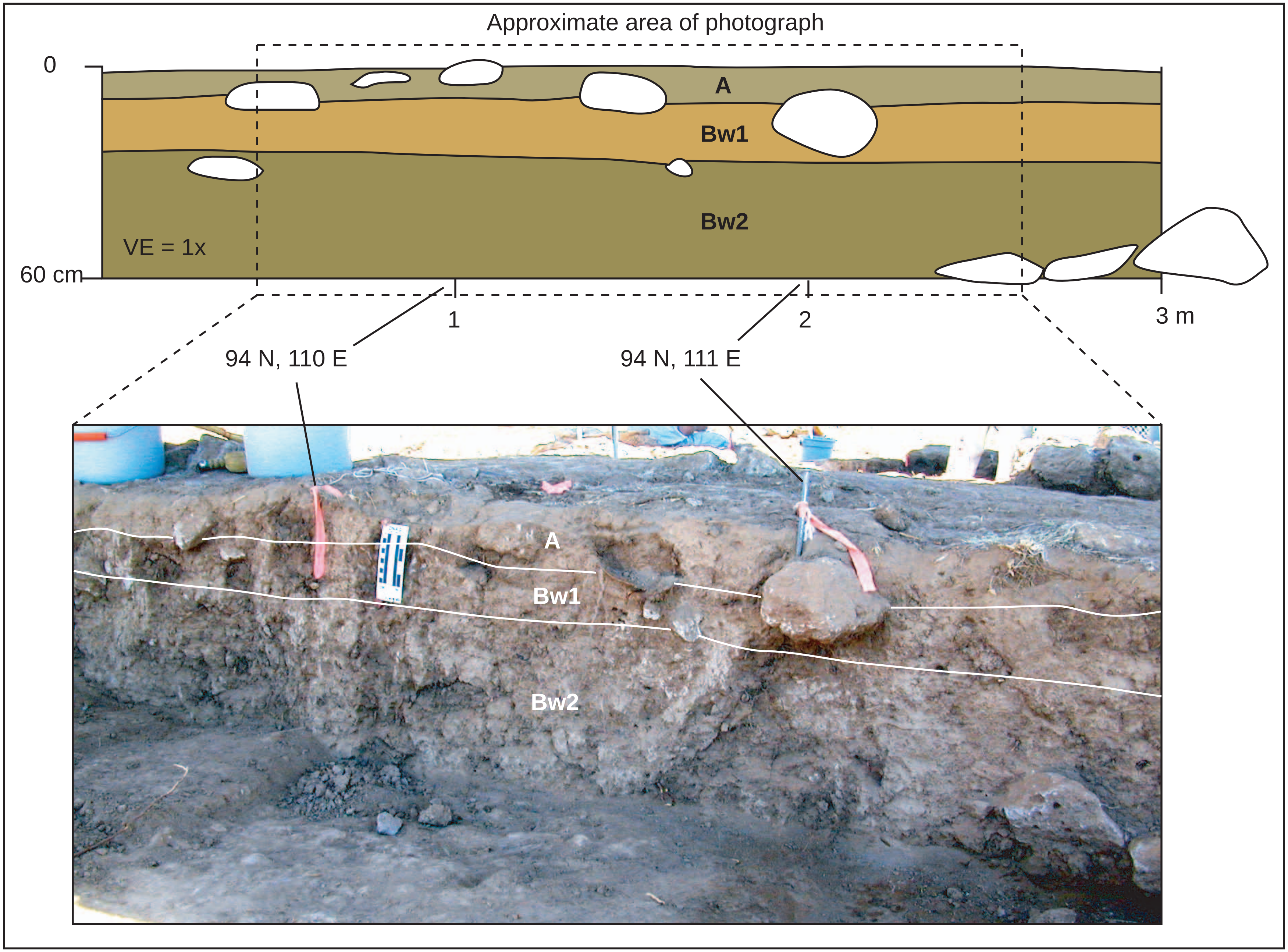


Figure 6. Photograph and sketch through LA 135290 roomblock showing soil developed in roomblock fill

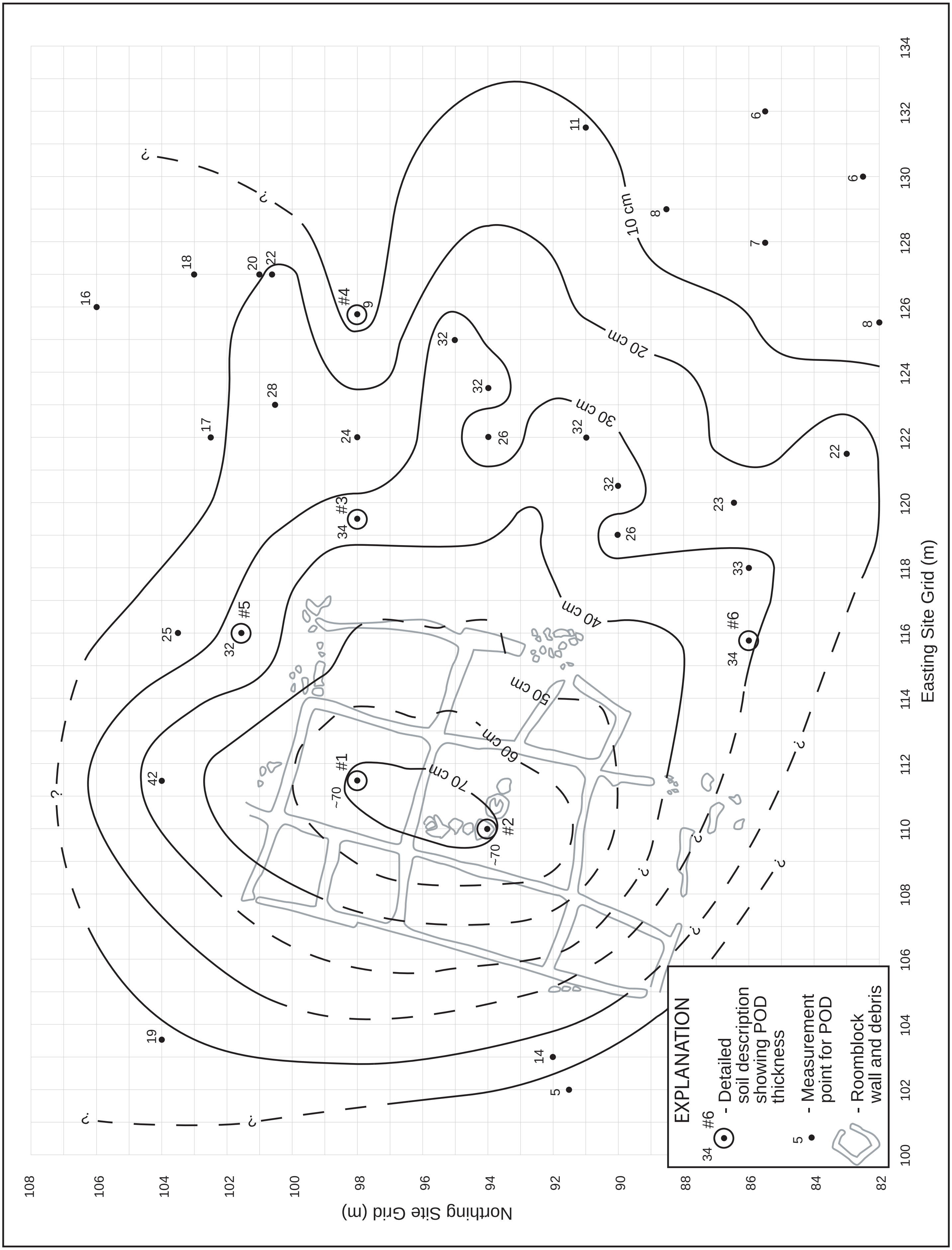


Figure 7. Isopach map showing thickness of post-occupational deposits (POD) at LA 135290

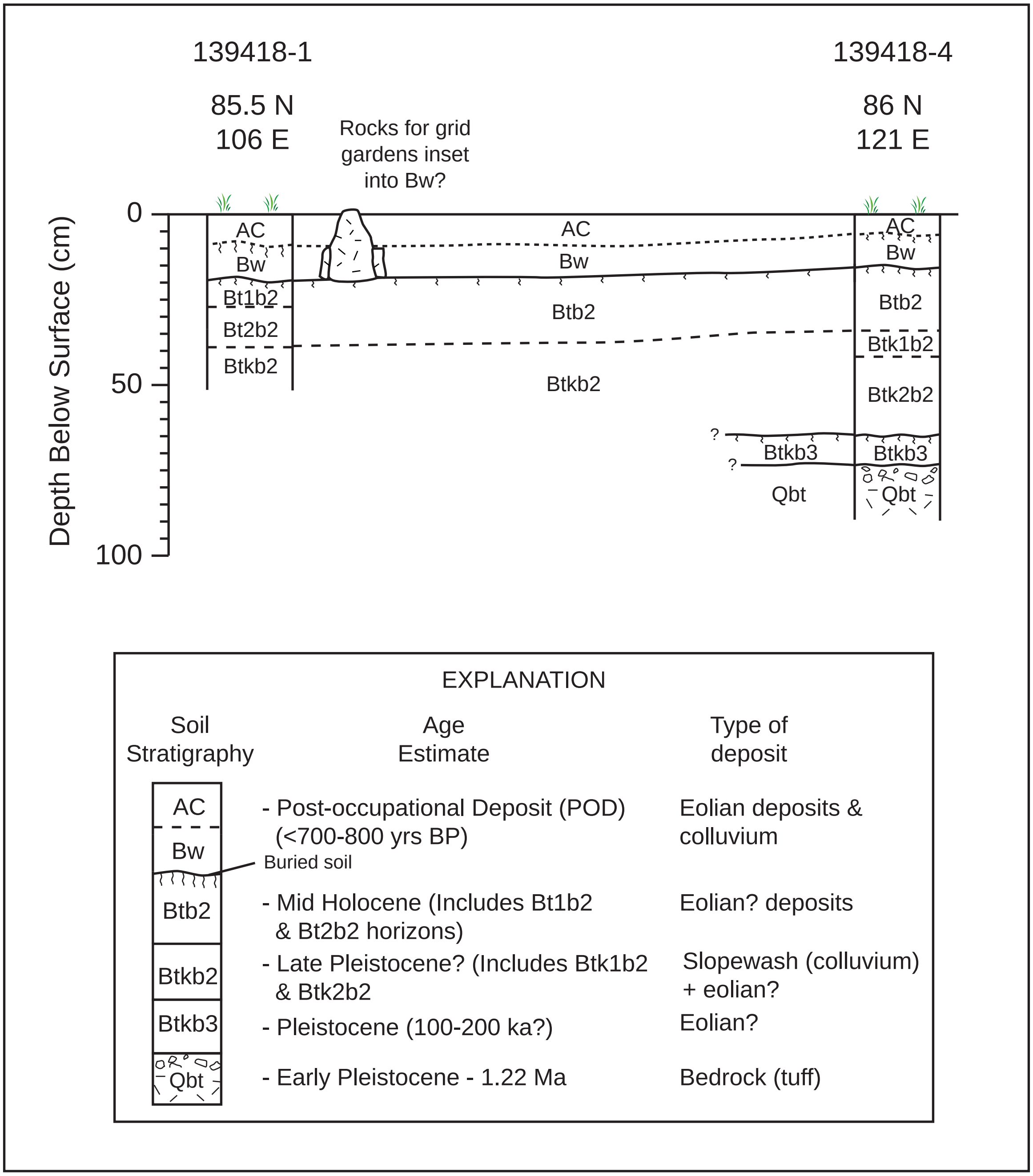


Figure 8. Site stratigraphy, airport site LA 139418 (grid garden)

Two soil profiles (139418-1 and 2) were described within the rock alignments forming the grid garden, one profile (139418-3) was described just outside, slightly downslope, and one profile (139418-4) was described well outside of the rock alignments (Figure 9). Rocks forming the grid garden appear to have been set into the Bw horizon, with the smaller rocks that faced larger rocks set to the top of the Bw horizon (Figures 8 and 9). Soils described inside and outside of the grid garden have similar texture, color, structure, and consistence (Table 2). AC horizons described inside the grid garden have a slightly greater thickness (1 to 3 cm) that do the AC horizons described outside the grid garden, suggesting that the rock alignments trapped some relatively minimal additional eolian silt, either acting as dust traps or by capturing some overland flow, relative to deposition outside the grid garden.

Based on soil characteristics, the AC-Bw horizons at LA 139418 are interpreted to be correlative with POD at LA 135290. It is inferred from the site stratigraphy that approximately 10 cm of sediment was deposited after occupation of the LA 135290 roomblock but prior to construction of the LA 139418 grid garden. Based on stratigraphic relationships, LA 139418 is a more recent site than is LA 135290 (Figure 10). Soils burying LA 139418 are very weakly developed, have developed only an AC horizon and apparently lack development of Bw horizons observed in Coalition period soils. The soils and related stratigraphy are therefore consistent with LA 135418 being a Classic period feature.

LA 141505 (field house)

LA 141505 includes two partially overlapping field house structures (rooms 1 and 2) and associated large tuff blocks grouped into features 2, 3, 4, and 5 on the mesa top east of LA 135290 (Figures 1 and 11). Soils were described in two test pits at the site. Site stratigraphy is similar to that observed at LA 135290, and includes POD overlying a sequence of buried mid Holocene and stripped late Pleistocene soils (Figures 10 and 12; Table 3). Depth to Bandelier Tuff bedrock, observed below the west wall of the structure, is approximately 1.2 m (Figure 12).

Blocks for the southeastern one-room structure (Room 2) are set into the Bw horizon, whereas blocks for the northwestern one-room structure (Room 1) are set on top of the Bw horizon. Tuff clasts inferred to be derived from Room 2 also lie underneath Room 1 (Figure 11). The soil-stratigraphic relations therefore indicate that Room 2 is older than Room 1. Soil-stratigraphic relationships also indicate that features 2 through 5 are associated with the later construction of Room 1. In addition, based on their stratigraphic position set into or on top of the Bw horizon, which is inferred to be correlative with POD, the LA 141505 field houses are more recent features than the LA 135290 roomblock (Figure 10). It is inferred from the soil stratigraphy that Room 1 is roughly correlative with the LA 139418 grid garden, and that Room 2 may be slightly older than the grid garden. Thin, weakly-developed soils burying features at LA 141505, including an A horizon at profile 141505-2 comprising 80-90% tuff blocks with minor eolian sediment, are consistent with a Classic period site.

It is inferred that most of the recent eolian deposition observed at the three Airport tract sites investigated during the 2003 field season occurred after abandonment of the Middle Coalition (?) period roomblock at LA 135290, but prior to construction of the most recent field house structure at LA 141505. This eolian deposition is represented by the Bw horizon in Figure 10, and likely

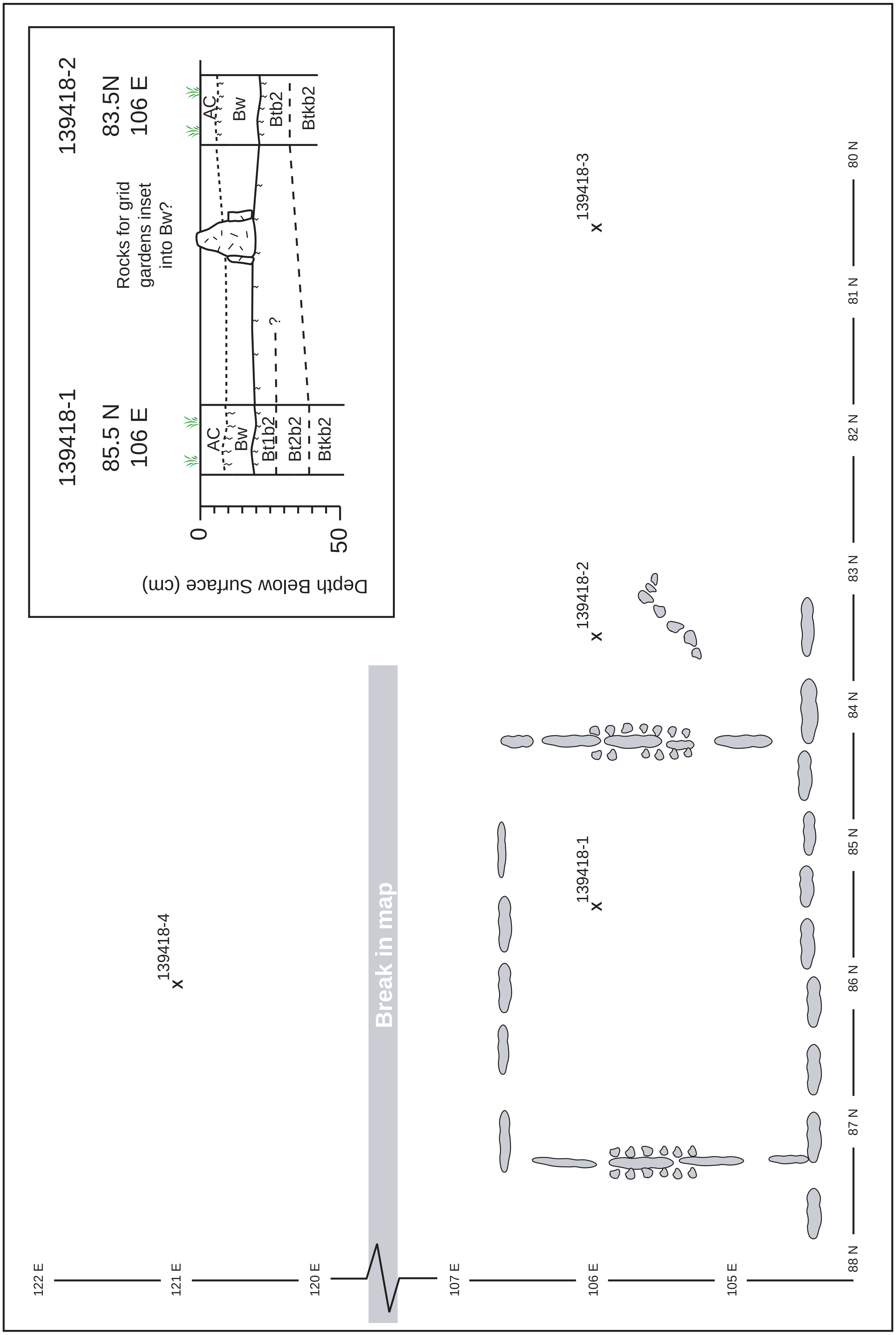


Figure 9. Grid garden sketch map and cross section, Airport tract site LA 139418. See Figure 3 for unit descriptions.

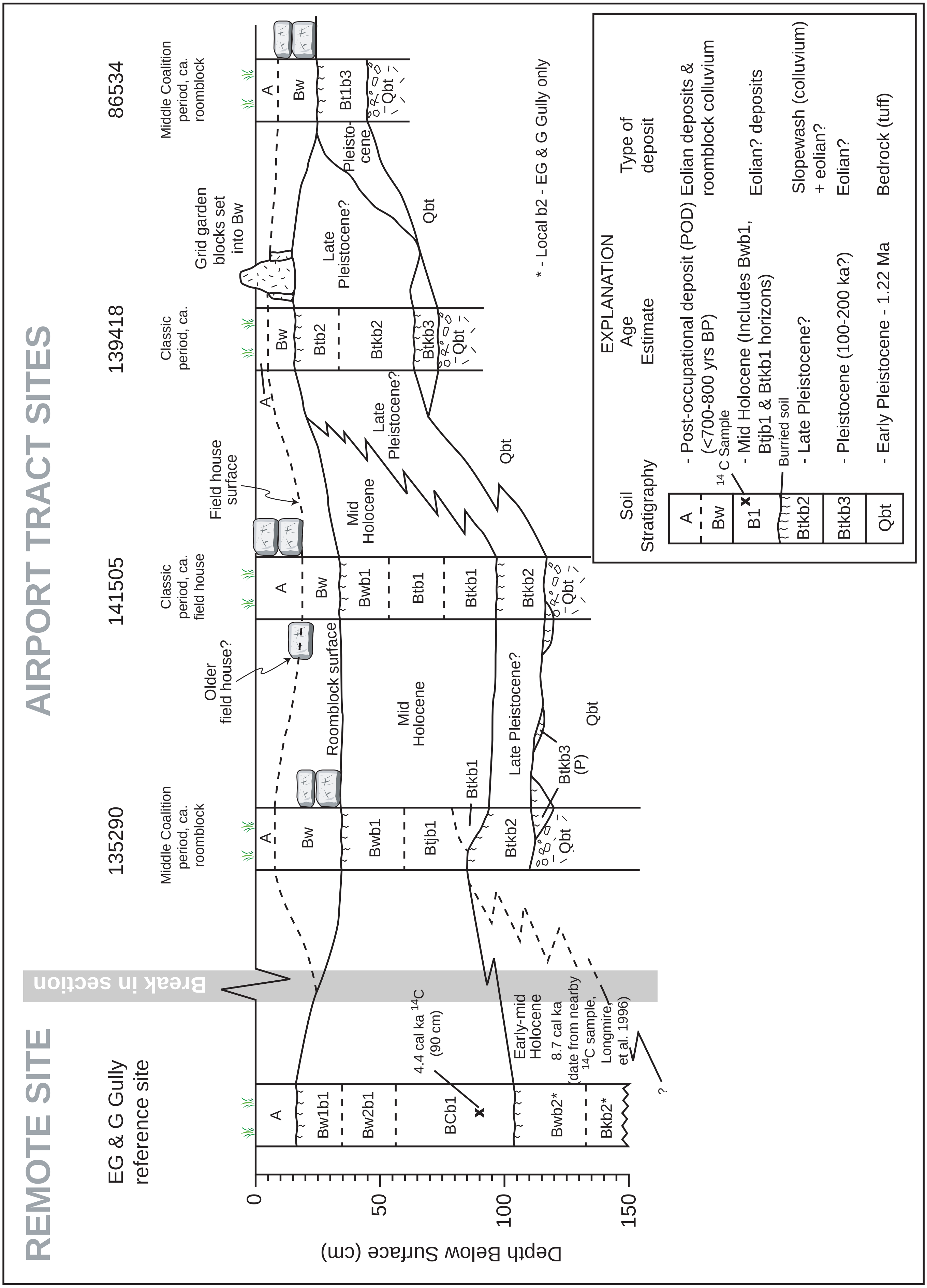


Figure 10. Stratigraphic correlation of Airport tract sites. See Figure 1 for site locations.

occurred sometime after the Middle Coalition period but prior to the Classic period, e.g. during the Late Coalition period (ca. 1250 to 1325 AD). This is consistent with results of the 2002 field season investigation, which also indicated that eolian deposition in the White Rock tract occurred during the Late Coalition period (Drakos and Reneau, 2003). Where it has not been eroded, the Late Coalition period eolian deposit is approximately 15 to 20 cm thick. A second, more recent eolian event, occurred after abandonment of the Early Classic (?) period sites, resulting in deposition of an additional 5 to 10 cm of fine-grained sediment across the mesa top.

Tract Summary

A total of four Coalition period to Classic period Ancestral Puebloan sites and one Late Archaic dispersed artifact scatter were investigated within the Airport tract during the 2002 and 2003 field seasons. Soils were also described in a ca. 4.4 cal ka valley fill deposit overlying a ca. 8.7 cal ka deposit in "EG&G Gully" east of the Airport tract sites (Figure 5). The sites are situated on a Bandelier Tuff mesa top north of Los Alamos Canyon. Results of the site investigations show that Airport tract Ancestral Puebloan sites are partially buried, primarily by recent (less than 700 to 800 year old) eolian deposits and are underlain by less than 1.5 m of Pleistocene and Holocene deposits overlying 1.22 Ma Bandelier Tuff bedrock (Figure 10).

The Late Archaic site (LA 86533) is a dispersed artifact scatter situated in a highly eroded area with thin soils and exposed bedrock near the mesa edge. Archaeological context is poor, and the lithics appear to represent a lag deposit.

The Airport tract sites include two Coalition period roomblocks (LA 86534 and LA 135290), a Classic period (?) field house (LA 141505), and a Classic period (?) grid garden site (LA 139428). The roomblock sites are buried by colluvium, derived in part from erosion of the roomblock, and eolian sediment. The field house and grid garden sites are partially buried by eolian sediment. All four sites are in generally good archaeological context, with the exception of scattered tuff blocks located west and north of the LA 86534 roomblock that represent surface disturbance that may have occurred during highway construction.

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") (Figure 10). Locally, relatively thick gully fill deposits include an early Holocene stratigraphic record (e.g., the 4 m thick early Holocene deposit at EG&G gully; see Longmire et al., 1996, p. 49). The thickness of deposits is likely controlled 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 mesa top (e.g., LA 86534 and LA 139428). The presence of mid Holocene deposits in several areas of the Airport tract indicates that there is potential for the preservation of buried Archaic sites in this area.

Stratigraphic relationships indicate that LA 141505 and LA 139418 are more recent sites than LA 135290 and LA 86534 (Figure 10). LA 141505 and LA 139418 are constructed on top of the lower section (Bw horizon) of POD, which buries LA 135290 and LA 86534 (Figure 10). Soils burying LA 141505 and LA 139418 are very weakly developed, exhibiting thin A or AC horizons but apparently lacking development of Bw horizons observed in Coalition period soils. It is therefore inferred that LA 135418 and LA 141505 are likely Classic period sites. In contrast, Coalition period sites LA 135290 and LA 86534 are built on mid Holocene to Pleistocene soils, or directly on Bandelier Tuff, and are buried by a thicker soil with an A-Bw profile (Figure 10).

It is inferred that the recent eolian deposition observed at the Airport tract sites occurred sometime after the Middle Coalition period but prior to the Classic period; e.g. during the Late Coalition period (ca. 1250 to 1325 AD). This corresponds to "The Great Drought" of 1276-1299 and a locally drier period around 1250-1255 AD, inferred from tree ring data and a major regional event associated with the abandonment of Mesa Verde (Rose et al., 1981). Where it has not been eroded, the Late Coalition period eolian deposit is approximately 15 to 20 cm thick. A second, more recent eolian event, occurred after abandonment of the Early Classic (?) period sites, resulting in deposition of an additional 5 to 10 cm of fine-grained sediment across the mesa top since approximately 1500 AD. Eolian deposits are thicker inside and next to roomblocks than elsewhere on the mesa, which is due to the greater trapping efficiency at these sites. Animal burrowing also seems to be more active in the abandoned roomblocks, which results in mixing of material at these sites.

RENDIJA CANYON TRACT

Surficial Geologic Units

The Rendija Canyon land transfer tract is located within the Rendija Canyon watershed and includes part of the active stream channel and adjacent floodplains, tributary drainages, fluvial terraces, colluvial slopes, ridge crests and mesitas (Figure 13). The eastern half of the Rendija Canyon land transfer tract was the focus of the 2003 field season investigation. Bedrock units beneath the Rendija Canyon tract include, from oldest to youngest, Tschicoma Formation dacite lavas (unit Tt); Puye Formation (unit Tp), an alluvial fan complex derived from the Tschicoma highlands that includes abundant Tschicoma dacite cobbles; Cerro Toledo interval (unit Qct) pumice beds and dacite rich alluvium with minor obsidian pebbles; the Tshirege Member of the Bandelier Tuff (unit Qbt), and Older Alluvium (unit Qoa). Unit Qoa is stratified alluvium deposited on top of the Bandelier Tuff generally prior to incision of the modern canyons (Kempter and Kelley, 2002), possibly within 100,000 years of eruption of Qbt (Reneau and McDonald, 1996; Reneau et al., 2002) (Figure 14). Unit Qct may include the Guaje Pumice Bed of the Otowi Member, Bandelier Tuff (Qbog). Bedrock on hillslopes and ridge tops beneath most of the eastern half of the tract is pumice and alluvium of the Cerro Toledo interval. Puye Formation gravels crop out in Rendija Canyon and along tributary drainages incised below the Cerro Toledo interval deposits (Figure 13). The Tshirege Member of the Bandelier Tuff crops out near the top of an isolated mesa near the western edge of the eastern part of the Rendija Canyon tract, and along the base of the mesa escarpment along the southern boundary of the tract (Figure 13). Remnants of unit Qoa are present on top of the isolated Bandelier Tuff mesa, and may cap other ridges in the tract but could not be unequivocally identified. Large parts of the tract are covered by locally derived colluvial or slopewash deposits of a variety of ages. Fluvial terraces are locally preserved near the canyon bottom and are inset into or interfinger with colluvial deposits on north-facing slopes south of the Rendija Canyon drainage (Figure 13).

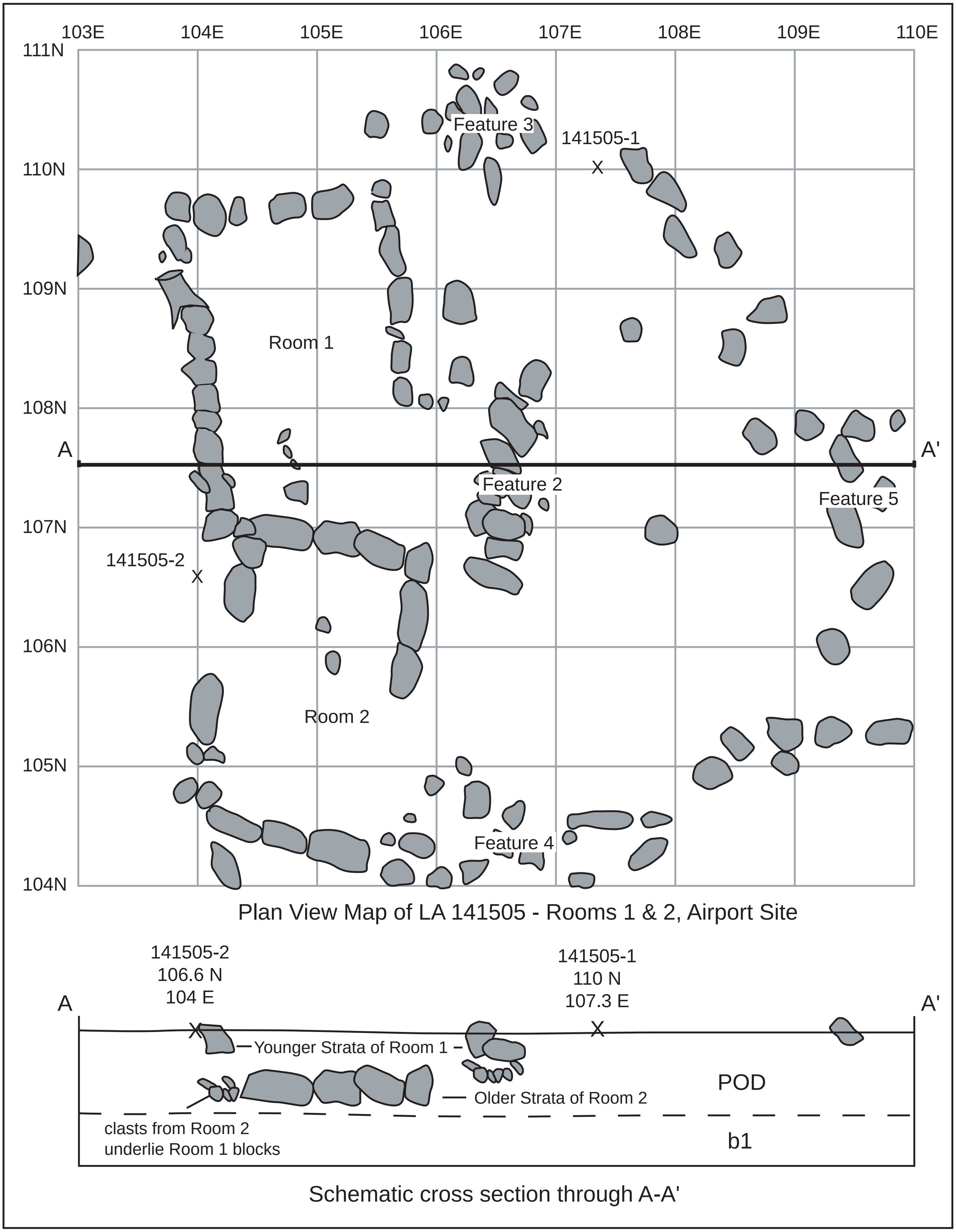


Figure 11. Site map and schematic cross section of Airport Tract field house, LA 141505

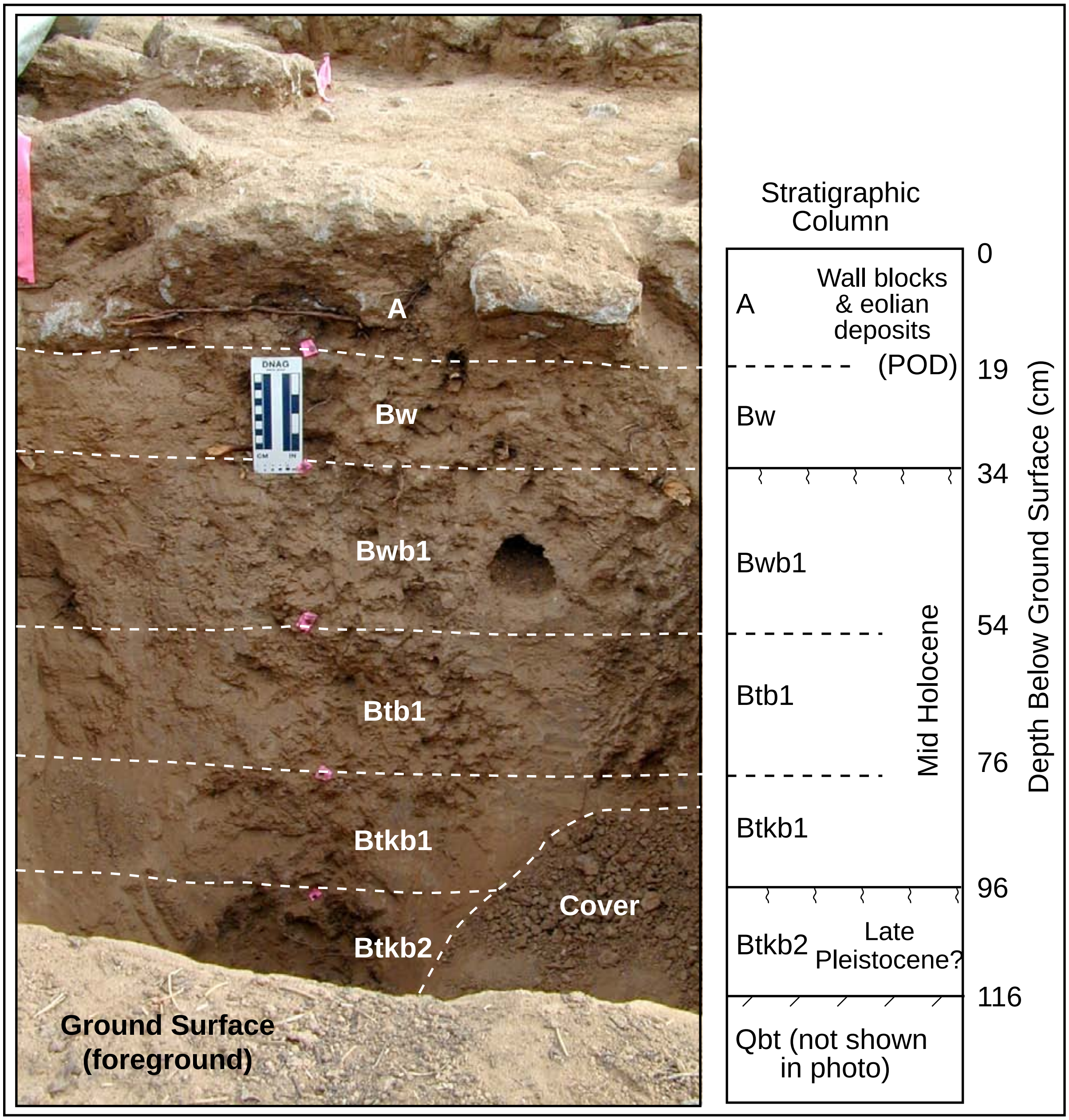


Figure 12. Site stratigraphy and wall blocks, LA 141505

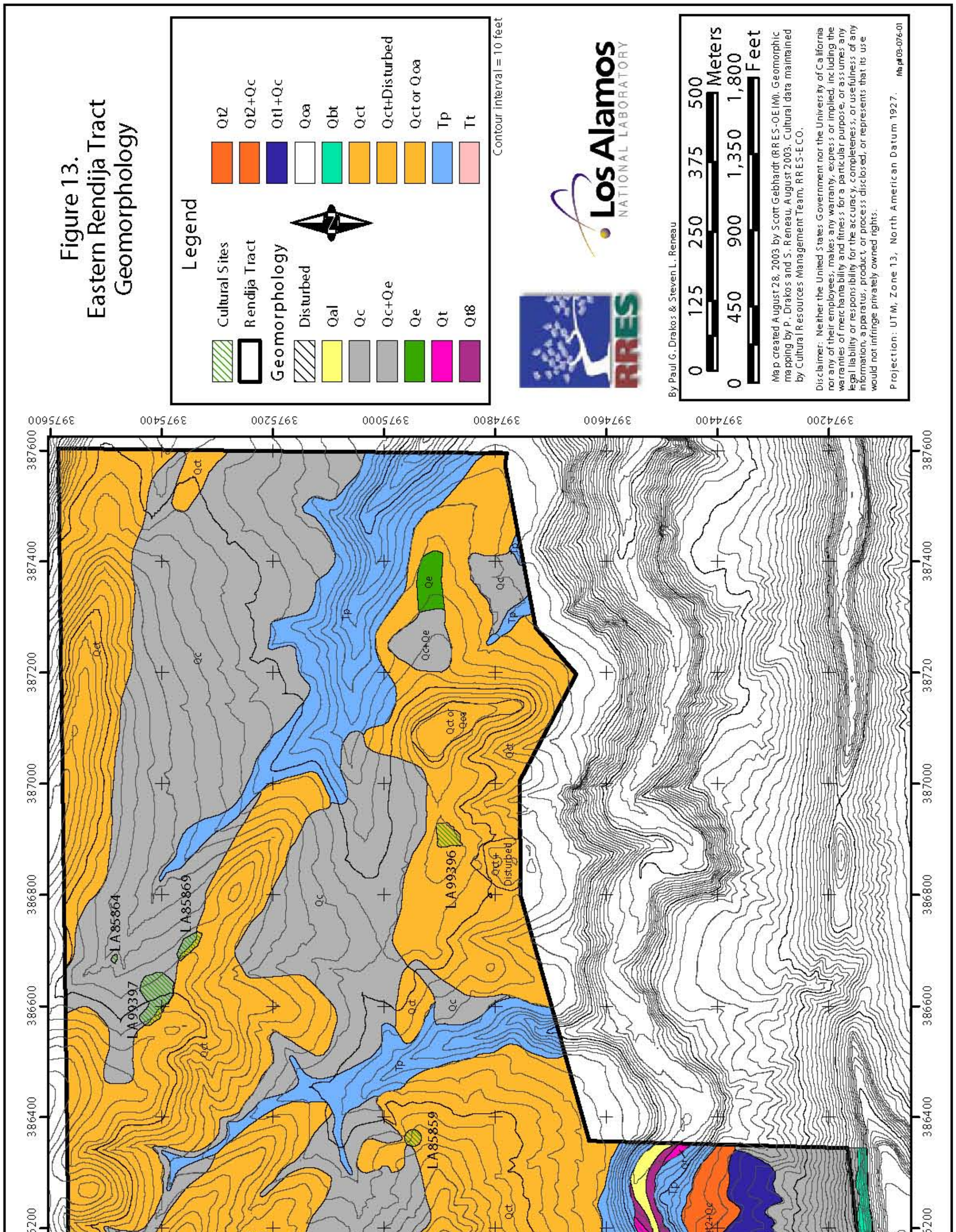
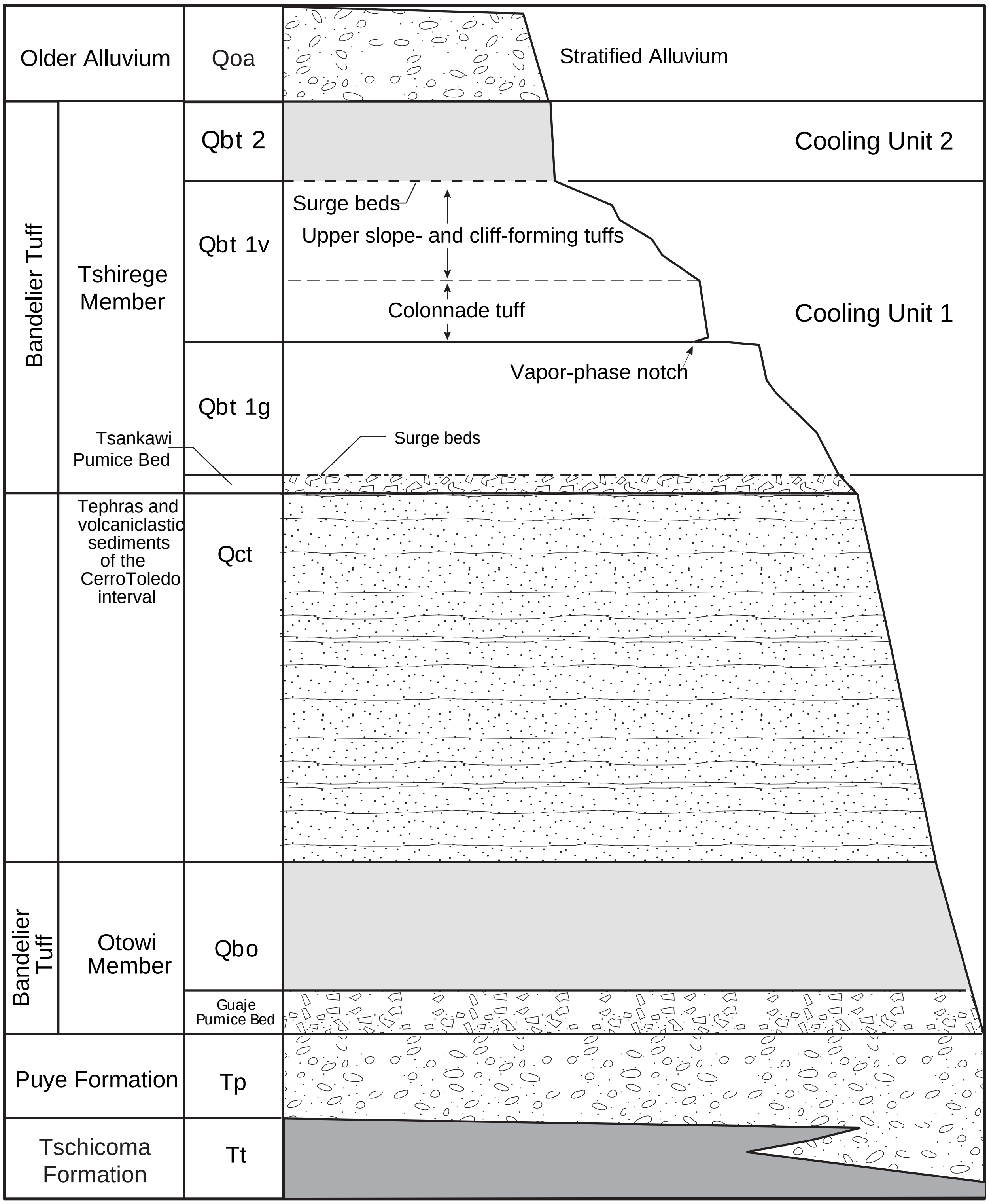


Figure 13.
Eastern Rendija Tract
Geomorphology
Legend
Cultural Sites
Rendija Tract
Geomorphology
Disturbed
Qal
Qc
Qc+Qe
Qe
Qt
Qt8
Qt2
Qt2+Qc
Qt1+Qc
Qoa
Qbt
Qct
Qct+Disturbed
Qct or Qoa
Tp
Tt
Contour interval = 10 feet
Los Alamos
NATIONAL LABORATORY
RRES
By Paul G. Drakos & Steven L. Reneau
0 125 250 375 500 Meters
0 450 900 1,350 1,800 Feet
Map created August 28, 2003 by Scott Gebhardt (RRES-OEIM). Geomorphic mapping by P. Drakos and S. Reneau, August 2003. Cultural data maintained by Cultural Resources Management Team, RRES-ECO.
Disclaimer: Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, including the warranties of merchantability and fitness for a particular purpose, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.
Projection: UTM, Zone 13, North American Datum 1927.
Map#03-076-01
LA99397
LA85864
LA85869
LA99396
LA85859



Modified from Broxton and Reneau, 1995

Figure 14. Generalized stratigraphic column for the Rendija Canyon area

Rendija Canyon possesses what may be the most extensive and best preserved set of stream terraces on the Pajarito Plateau, locally including at least five Pleistocene surfaces and four Holocene surfaces (Reneau and McDonald, 1996; McDonald et al., 1996). Geologic maps of this area have been prepared by Griggs (1964), Smith et al. (1970), and Kempter and Kelley (2002). A detailed geomorphic map of the western part of the tract was previously prepared by Reneau (Reneau and McDonald, 1996, p. 102). The Rendija Canyon terrace sequence was first examined by Gonzalez and Gardner (1990) and later by Wong et al. (1995). In this investigation, a 1:3000 scale surficial geologic map was prepared that encompasses the eastern half of the Rendija Canyon land transfer tract, focused on units with potential archaeological significance (Figure 13).

Unit Qal consists of young alluvium in the main stream channel of Rendija Canyon. Sediment sources for Rendija Canyon alluvium include Bandelier Tuff and Cerro Toledo beds that provide sand and pumice, and Puye Formation beds and Tschicoma Formation dacite outcrops that provide the majority of the pebble to boulder-size gravel (McDonald et al., 1996).

Unit Qt includes several stream terraces flanking the Rendija Canyon stream channel. Stream terraces are labeled Qt1 through Qt8, from oldest to youngest. The Holocene terraces (Qt5 through Qt8) are typically strath terraces, with 0.5 to 2 m channel deposits overlain by fine-grained floodplain sediments (Reneau and McDonald, 1996). Pleistocene terraces (Qt1 through Qt4) are typically overlain by more significant aggradational sequences consisting of 4 to 10 m of gravelly deposits. Terraces are in part overlain by colluvium (unit Qc). The older, higher terraces are more extensively buried by colluvium, and many of the Qt1 terraces are completely buried (Figure 13).

Unit Qc includes a mixture of gravelly and fine-grained (fine to very fine sand and silt) slopewash colluvium deposited by overland flow, and also includes rocky colluvium on hillslopes below mesas and ridge crests. Qc includes valley-filling colluvial deposits that were locally reworked by fluvial processes, and eolian deposits and/or locally reworked eolian sediment. Qc includes deposits with a wide age range, and typically has buried soils that indicate pauses in deposition, in part accompanied by local erosion. However, two relatively widespread episodes of colluvial deposition are inferred from an examination of soil profiles at the Rendija Canyon sites. At sites LA 85859, LA 85869, LA 99396, and LA 99397, Qct is overlain by colluvium of inferred late Pleistocene or early Holocene age, typically less than 1.5 m thick (Tables 4, 6, 7, and 8). Late Pleistocene or early Holocene soil profiles are truncated, indicating erosion of these colluvial deposits. Late Pleistocene or early Holocene colluvium is typically overlain by a late Holocene colluvial deposit less than 25 cm thick. Local swale-fill and gully-fill deposits preserve relatively thick (greater than 1 m) early to mid Holocene colluvial deposits that are buried by late Holocene deposits (e.g. profiles 85864-2, 99397-5, 99397-7; Figure 15). The early to mid Holocene deposits could potentially contain buried Archaic or Paleoindian sites, although no buried sites were observed in gullies that cross many parts of this unit.

Age estimates for colluvial deposits are based on comparison with a chronosequence of Pleistocene and Holocene soils developed on a terrace sequence in Rendija Canyon (Reneau and McDonald, 1996; McDonald et al., 1996; Phillips et al., 1998). A late Pleistocene age for the lower colluvial deposits at LA 85859, LA 85869, LA 99396, and LA 99397 is inferred based on the presence of moderately-developed Bt horizons with many, moderately thick clay films and

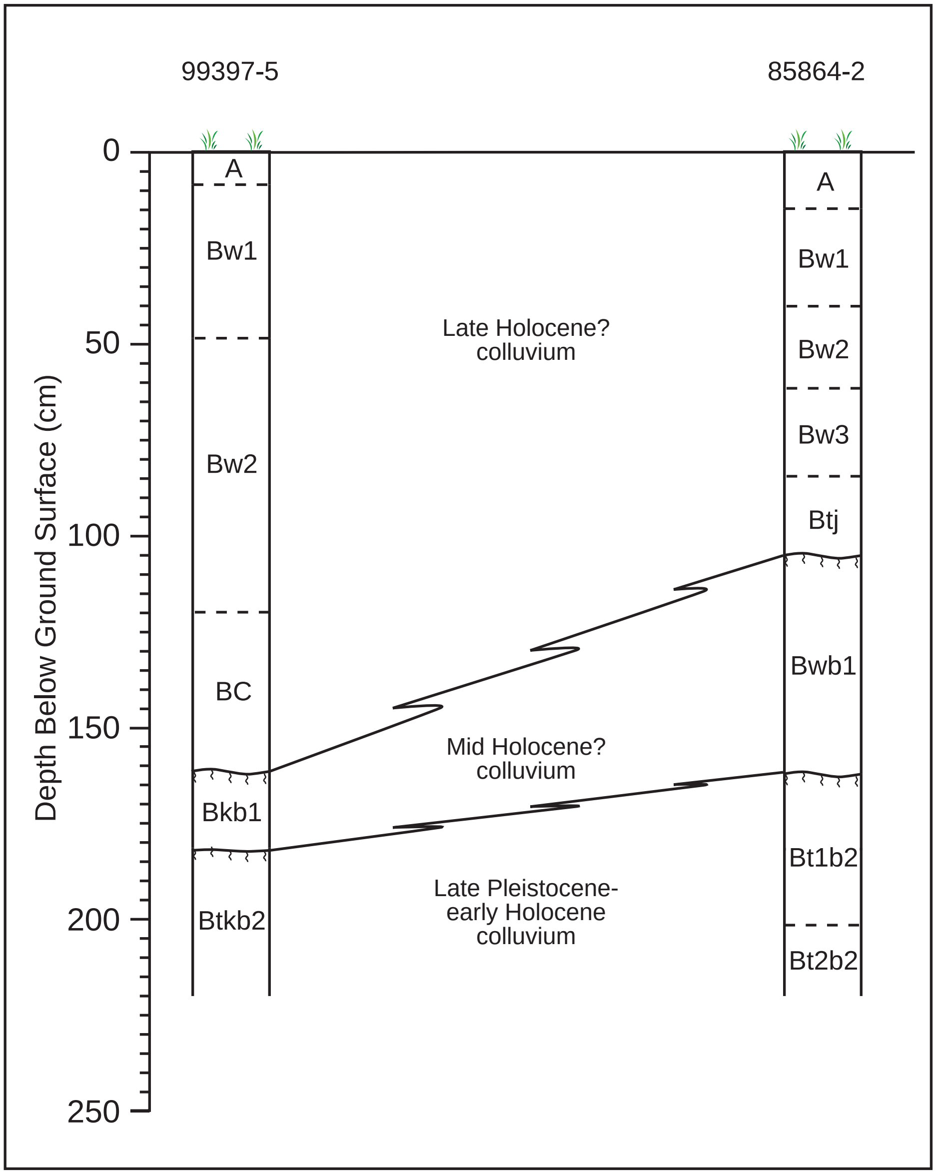


Fig 15. Holocene and late Pleistocene stratigraphy exposed in gullies near sites LA 99397 and LA 85864

7.5 YR color (Tables 4, 6, 7, and 8). These characteristics are roughly comparable with the Rendija Canyon Qt4 soil Bt horizons, although the Qt4 soil has a much greater thickness, and hence greater age (McDonald et al., 1996). The Qt4 soil has an estimated age of 63 ± 8 ka based on ^{21}Ne analyses and 68-78 ka based on soils (Phillips et al., 1998). The inferred late Pleistocene colluvial deposits at LA 85859, LA 85869, LA 99396, and LA 99397 may be correlative with Rendija Canyon colluvial deposits described in Phillips et al. (1998), which are dated at 12.6 to 16.8 cal ka based on ^{14}C analysis of three charcoal samples. The inferred late Pleistocene colluvial soil exhibits much better soil development than the mid Holocene (5.3 to 7.0 ka) Rendija Canyon Qt6 soil, which has 64 to 99 cm thick Bw horizons, but lacks development of Bt horizons. The upper, inferred late Holocene colluvial deposit has an A-Bw horizon profile and exhibits weak to moderate subangular blocky structure. The degree of soil development in this profile is roughly comparable to the soil development observed in Airport tract POD soils, and the Rendija Canyon Qt8 (0.5 to 1.0 ka) and Qt7 (3.2 ka) soils (McDonald et al., 1996). Parent material for colluvial soils likely includes sediment derived from erosion of older soils that may contain clay-rich horizons. This may lead to more rapid soil development than observed for soils developed in fluvial terrace deposits with lower initial clay contents.

Some preliminary age estimates have been obtained from two charcoal samples collected from the upper part of the Bt1b1 horizon at LA 85859. These samples give calibrated ^{14}C ages of ca. 6.8 cal ka (Hoagland sample), and ca. 7.25 cal ka (sample 85859-c3) (Appendix D), which are younger than age estimates based on soil development. It is possible that this discrepancy is due to either overestimates of soil age or underestimates of age based on the ^{14}C analyses. Several factors may explain this discrepancy. 1) Soil development on these colluvial slopes could possibly occur more rapidly than has been observed on fluvial terraces, due to reworking of clay from older Pleistocene soils, resulting in an overestimate of soil age. However, such older soils were not found in soil pits dug upslope of LA 85859, and therefore no local source for clay was observed. 2) The dated charcoal could represent burned material that postdates colluvial deposition, such as fragments of burned roots or charcoal that was transported down animal holes from the surface, resulting in underestimates of deposit age. Although no evidence for burned roots or burrows was observed at the specific charcoal sample sites, abundant evidence for bioturbation was observed at LA 85859, and burned roots were also observed, and the introduction of young charcoal into older deposits is therefore possible at this site. A third charcoal sample from LA 85859 that yielded a date of 0.55 cal ka (Appendix D) represents such introduction of young charcoal into an older soil. Pervasive bioturbation at LA 85859 is indicated by the absence of recognizable stratigraphy in the b1 soil, and by the dispersed occurrences of obsidian flakes through this soil and the overlying surface soil. These ^{14}C dates should therefore be considered as minimum limiting age estimates, indicating that the b1 soil is ≥ ca. 7 cal ka. Because of the discrepancy between age estimates from soils and ^{14}C analyses, this unit is provisionally considered to be late Pleistocene or early Holocene in age in this report. Additional ^{14}C analyses of charcoal samples collected from LA 85859 and from colluvial deposits of a variety of ages at other sites (Appendix D) may help better constrain the age of soils, archaeological sites, and colluvial deposits in the Rendija Canyon tract.

Unit Qe is restricted to one small ridge top area near the eastern boundary of the Rendija Canyon tract (Figure 13). Unit Qe is situated east of, and presumably on the leeward side of a hill capped by Qct gravels or Qoa. Unit Qe appears to be a relatively young deposit, and has the potential to have preserved buried archaeological sites.

LA 85859 (Archaic lithic scatter)

LA 85859 is an Archaic lithic scatter on a northeast-facing hillslope underlain by Qct pumice and thin colluvial deposits (Figures 13 and 16). Qct is overlain by a buried soil in colluvium (b1), up to 80 cm thick, that has an inferred age of late Pleistocene based on the degree of soil development and early to mid Holocene, ≥ ca. 6.8-7.3 cal ka, based on two ^{14}C analyses, as discussed above (Table 4, Figure 16). The late Pleistocene or early Holocene soil profiles are truncated, and are overlain by a late Holocene colluvial deposit less than 25 cm thick. Soils described at LA 85859 represent a catena, wherein a series of soil profiles developed in the same parent material that have a similar age, exhibit lateral variability in soil properties that is related to hillslope position. The term catena was proposed by Milne (1935a, 1935b), who emphasized that each soil on a slope bears a relationship to the soils above and below it. See Birkeland (1999) for a discussion of catenas. At LA 85859, the hillslope includes an upper hillslope with thin (less than 25 cm thick) late Holocene colluvium overlying Qct (profiles 85859-6 and 7), and a lower hillslope with thin Holocene colluvium overlying up to 81 cm of late Pleistocene or early Holocene colluvium and Qct (profiles 85859-2, 3, 4, 5, and 8; Figures 16 and 17; Table 4). The upper and lower hillslopes are separated by an area with bedrock at or near the surface (85859-1; Figure 16).

It is inferred from the site stratigraphy that the upper hillslope was eroded during late Pleistocene or early Holocene time, and that colluvium derived from Qct bedrock and/or Qct soils was deposited on the concave part of the hillslope below 85859-1. The base of this colluvial unit includes common dacite clasts, up to small boulder size, that represents a lag left after almost complete erosion of an older alluvial unit (Qoa or a gravel layer within Qct). A second period of erosion likely occurred sometime during the mid or late Holocene, during which the upper hillslope was stripped to bedrock and the late Pleistocene or early Holocene soils on the lower hillslope were truncated. The stripped Qct on the upper hillslope and truncated late Pleistocene or early Holocene soils on the lower hillslope were then buried by a thin late Holocene colluvial deposit.

Artifacts are found in both the late Pleistocene or early Holocene colluvium and the late Holocene colluvium at LA 85859 (Figure 16; Table E-1 in Appendix E; it is assumed that more than one artifact must be found in a given horizon to confirm artifact occurrence in a particular stratigraphic unit). The maximum artifact concentration at the site was found in the vicinity of 85859-5, and the highest artifact concentration near 85859-5 was in the Bt1b1 horizon. Artifacts were found in the Bt horizons near profiles 85859-2 and 4, downslope from 85859-5, but not near 85859-3, located 3 m upslope from 85859-5 (Figure 15; Table E-1). Artifacts were also found in the late Holocene colluvium near profiles 85859-2, 4, and 5, with the highest density also near 85859-5. This artifact distribution suggests that the occupation surface was within the upper part of the late Pleistocene or early Holocene colluvium, and that the artifacts found in the late Holocene colluvium were supplied from local bioturbation of the underlying b1 soils. The absence of artifacts upslope near 85859-3 provides evidence that the artifacts found near 85859-5 were not transported from upslope, but that the main occupation area was near 85859-5

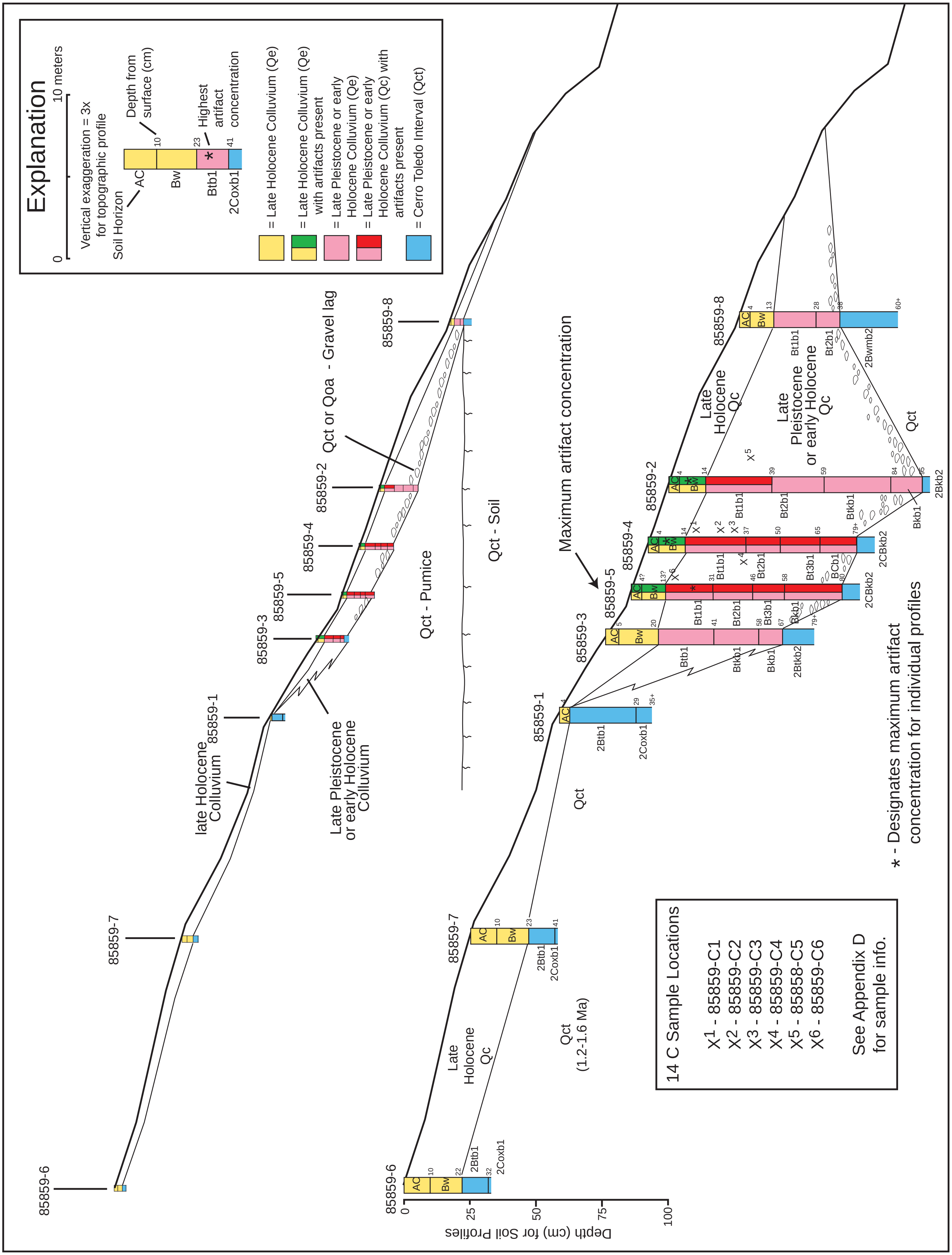
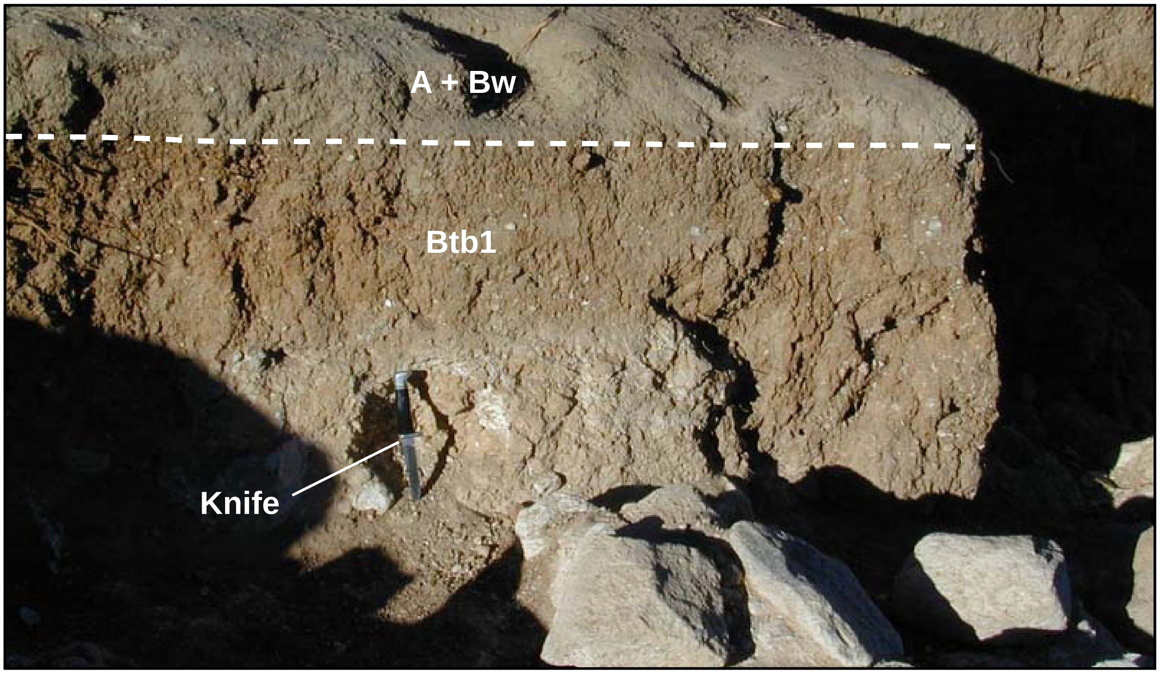


Figure 16. Hillslope profile and catena showing artifact distribution at LA 85859



Opposite side of trench wall showing A & Bw horizons (late Holocene colluvium) overlying Btb1 horizon. Dacite gravel lag at base. Knife (length = 22 cm) for scale.

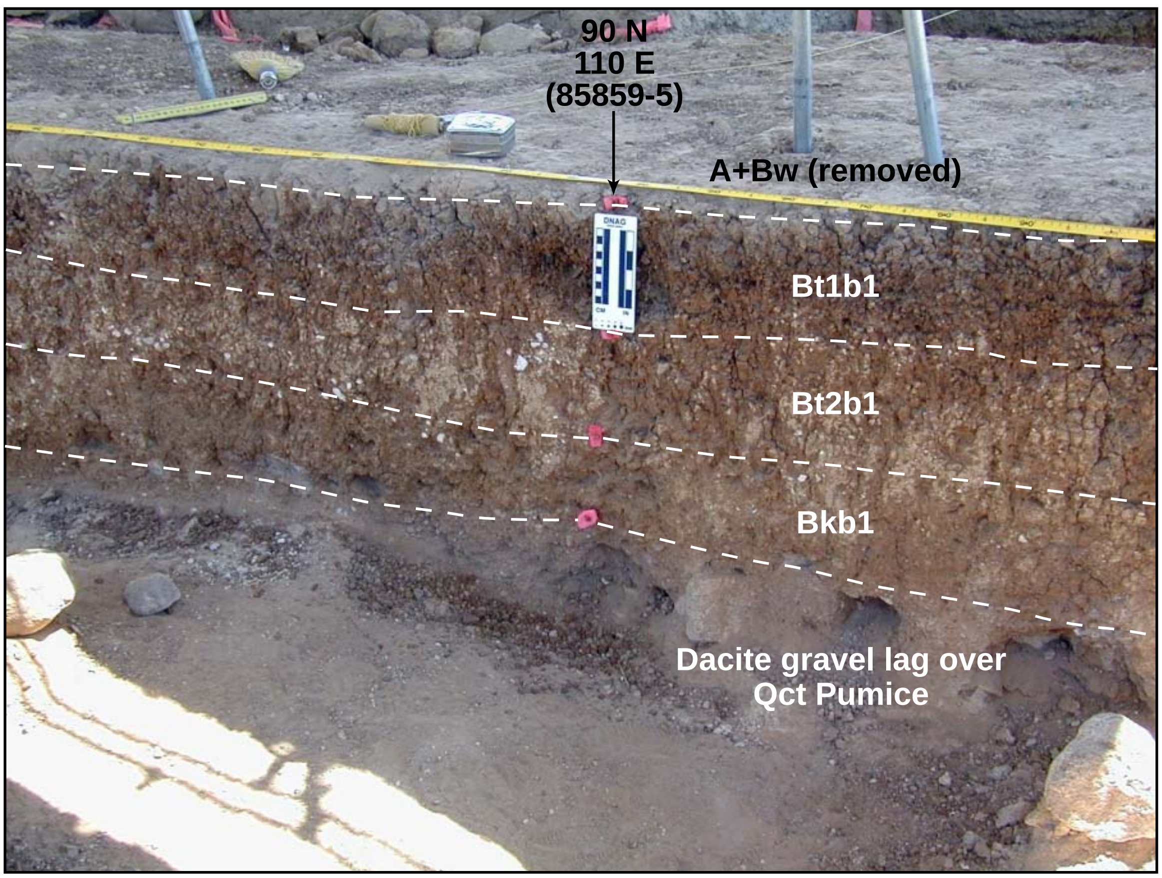


Figure 17. Trench wall showing soil horizons at LA 85859. Greatest artifact concentration (obsidian flakes) found in Bt1b1.

Table 4. Summary of Soil Morphology at Rendija Canyon Land Transfer Parcel Archaic Site LA 85859 (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 85859-1, Rendija Canyon Land Transfer Parcel, W. wall of excavation grid, SW corner = 90N, 101E, upslope pit in transect (June 10,													**85859-1**		**Aspect: ESE-facing hillslope**
AC	0-4	30	10YR5/3	10YR3/3	sl	sg	lo	so,po	n.o.	none	-	as		< 1000 yrs?	young colluvium
2Btb1	4-29	60-70	7.5YR5/3	7.5YR3/3	scl	2fsbk	so-sh	ss,ps	2ncobr	none	-	gs		1.2 - 1.6 Ma (Ma = million years)	clasts
2Coxb1	29-35+	90	7.5YR5/3-5/4	7.5YR4/3	s	sg	lo	so,po	n.o.	e	-	-			Qct(?) pumice deposit; 7.5YR7/6 on oxidized clasts; white on inside
LA 85859-2, Rendija Canyon Land Transfer Parcel, N. wall of excavation grid, SW corner = 90N, 118E, downslope pit in transect (June 1													**85859-2**		**Aspect: ESE-facing hillslope**
A	0-4	30-40	10YR5/3	10YR3/3	sl	sg	lo	so,po	n.o.	none	-	as		Late Holocene (<1000 yrs?)	young colluvium
Bw	4-14	30	8.75YR 5/3	7.5YR4/3	sl	2msbk	sh	so,ps	n.o.	none	-	cs			
Bt1b1	14-39	20	6.25YR4/3	6.25YR4/3	sc	2fabk	sh	s,p	3-4mkcopobrpf	none	-	gs			
Bt2b1	39-59	20-30	7.5YR5/4	7.5YR4/4	scl	2-3fsbk	sh	ss,p	2ncopobr	none	-	gs		Late Pleistocene	
Btkb1	59-84	10	7.5YR6/4	7.5YR4/4	sl	2msbk	sh-h	so,ps	1npo	es	I	ci			marginal argillans; pumice gravel
Bkb1	84-95	30	7.5YR6/3	7.5YR4/6	ls	2msbk	sh	so,po	n.o.	ev	II-	ai			gravel lag horizon
2Bkb2	95+										III?			1.2 - 1.6 Ma	carbonate cemented pumice
LA 85859-3, Rendija Canyon Land Transfer Parcel, S. end of W. wall of excavation grid, SW corner = 90N, 107E (June 13, 2003)													**85859-3**		**Aspect: ESE-facing hillslope**
A	0-5	40	10YR5/3	10YR3/3	sl	sg	lo	so,po	n.o.	none	-	as		Late Holocene (<1000 yrs?)	young colluvium
Bw	5-20	30	10YR5/2	10YR3/3	sl	1-2msbk	so-sh	so,ps		none	-	aw			variable thickness, local swale, min = 9 cm, max = 17 cm
Btb1	20-41	20	7.5YR4/6	7.5YR3/4	sc	2-3fabk	sh	s,p	3mkcopobr	none	-	gs			
Btkb1	41-58	30	7.5YR4/6	7.5YR3/4	scl	2msbk	so-sh	ss,ps	1npobr	e-es	I	cw		Late Pleistocene	
Bkb1	58-67	30-40	10YR4/4	10YR3/4	scl	1msbk	so-sh	ss,ps	n.o.	es	I	cw			
2Btkb2	67-79+	80-90	7.5YR5/3	7.5YR5/4	scl	m	lo	ss,ps	1-2nkco	ev	II			1.2 - 1.6 Ma	pumice clasts Qct(?); colloidal stains and continuous CaCO3 coatings on clasts; clay coatings predominant in upper 4 cm, CaCO3 below this
LA 85859-4, Rendija Canyon Land Transfer Parcel, W. wall of excavation grid, SW corner = 90N, 114E (June 19, 2003)													**85859-4**		**Aspect: ESE-facing hillslope**
A	0-4	20	10YR5/3	10YR3/3	sl	sg	lo	so,po	n.o.	none	-	as		Late Holocene (<1000 yrs?)	few lithics
Bw	4-14	20-30	10YR5/3	10YR3/3	sl	2msbk	so-sh	so,po	n.o.	none	-	aw			relatively high density of lithics (10-12)
Bt1b1	14-37	10-20	7.5YR4/3	7.5YR4/3	sc	2-3fsbk	sh-h	s,p	3mkcopobr	none	-	cs			highest density of lithics in top 10 cm
Bt2b1	37-50	40-50	7.5YR4/4	7.5YR3/4	sc	2msbk	sh-h	s,p	2ncopobr	none	-	cs			diminishing density of lithics
Bt3b1	50-65	20	7.5YR5/4	7.5YR4/3	scl	2msbk	sh-h	ss,ps	1ncopobr	none	-	aw		Late Pleistocene	base = top of stone line
BCb1	65-79	50-60	7.5YR5/4	7.5YR4/5	scl	1-2msbk	so	ss,ps	n.o.	none	-	aw			clasts with discontinuous CaCO3 coatings, < 1 mm thick, some on tops and sides (reworked clasts)
2CBkb2	79+	90+	7.5YR8/2	7.5YR7/2	s	m	lo	so,po	n.o.	es	I	-		1.2 - 1.6 Ma	Qct(?) pumice bed, thin discontinuous CaCO3 coatings on clasts
LA 85859-5, Rendija Canyon Land Transfer Parcel, S. wall of excavation grid, SW corner = 90N, 110E (June 20, 2003)													**85859-5**		**Aspect: ESE-facing hillslope**
A	0-4?													Late Holocene (<1000 yrs?)	estimated 10 cm stripped by archaeologists
Bw	4-13?														
Bt1b1	13-31	30	7.5YR4/4	7.5YR3/4	sic	2-3fsbk	h	s,p	3mkcopobrpf	none	-	cs			some peds = abk; most sbk
Bt2b1	31-46	20-30	7.5YR4/6	7.5YR3/4	sic	2msbk	sh-h	s,p	2ncopobr	e-	-	cs			few thin discontinuous coatings on clasts and on peds
Bt3b1	46-58	20-30	7.5YR4/6	7.5YR4/4	sil	2f-msbk	sh	ss,ps	1ncobr	none	-	cs		Late Pleistocene	few thin discontinuous coatings on clasts and on peds
Bkb1	58-80	50	7.5YR5/4	7.5YR3/4	scl	1msbk	so	ss,ps	n.o.	es	I	aw			dacite clasts 4 cm below top of horizon with discontinuous CaCO3 coatings, < 1 mm thick, some on tops and sides (reworked clasts); obsidian microflake with discontinuous CaCO3 coating in horizon
2CBkb2	80+	100	white		g	m	lo	-	n.o.	ev	II	-		1.2 - 1.6 Ma	Qct(?) pumice bed, continuous CaCO3 coatings on clasts

Table 4. Summary of Soil Morphology at Rendija Canyon Land Transfer Parcel Archaic Site LA 85859 (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 85859-6, Rendija Canyon Land Transfer Parcel, 0 m pt. on topographic profile, on ridgecrest (June 20, 2003)													**85859-6**		**Aspect: N-sloping ridgecrest**
A	0-10	20	10YR3/3	10YR2/2	sl	sg	lo	so,po	n.o.	none	-	as		Late Holocene (<1000 yrs?)	pumice gravel
Bw	10-22	20	10YR4/4	10YR3/4	sl	1-2msbk	so	so,po	n.o.	none	-	aw			
2Btb1	22-32	40	7.5YR4/3	7.5YR3/3	sl	1msbk-m	so-lo	ss,po	3nco (on clasts)	none	-	cw		1.2 - 1.6 Ma	extensively bioturbated; colloidal stains common on pumice clasts
2Coxb1	32+	80-90	7.5YR6/2	7.5YR5/2	s	m	lo	so,po	n.o.	none	-	-			Qct(?) pumice deposit
LA 85859-7, Rendija Canyon Land Transfer Parcel, 18 m pt. on topographic profile (June 20, 2003)													**85859-7**		**Aspect: ESE-facing hillslope**
A	0-10	30-40	10YR4/3	10YR3/3	sl	m	lo	so,po	n.o.	none	-	as		Late Holocene (<1000 yrs?)	
Bw	10-23	20-30	10YR4/4	10YR3/4	scl	1-2msbk	so	ss,ps	n.o./1ncobr	none	-	as			from lower horizons by bioturbation (?) (sparse)
2Btb1	23-41	70	7.5YR4/4	7.5YR3/4	sl	m	lo	ss,po	2nco	e	-	cs		1.2 - 1.6 Ma	extensively bioturbated; colloidal stains common on pumice clasts
2Coxb1	41+	90	7.5YR6/3	7.5YR4/3	s	m	lo	so,po	n.o.	es	I	-			Qct(?) pumice bed, thin discontinuous CaCO3 coatings on clasts
LA 85859-8, Rendija Canyon Land Transfer Parcel, 64 m pt on profile, lower slope (June 20, 2003)													**85859-8**		**Aspect: ESE-facing hillslope**
AC	0-4	30	10YR3/3	10YR3/2	sl	sg	lo	so,po	n.o.	none	-	cs		Late Holocene (<1000 yrs?)	includes Cerro Grande burn layer; pumice gravel
Bw	4-13	20	10YR4/4	10YR3/4	sil	1msbk	so	so,po	1nco	none	-	as			argillans possibly reworked
Bt1b1	13-28	40-50	7.5YR4/5	7.5YR4/4	sc	2fsbk	so-sh	s,p	2ncopobr	none	-	cs		Late Pleistocene	clasts pumice + dacite (1 large)
Bt2b1	28-38	40-50	7.5YR5/6	7.5YR4/6	scl	2fabk	sh	ss,ps	3ncopobr	none	-	cs			Pleistocene colluvium or Qct soil?
2Bwmb2	38-60+	30-40	7.5YR6/4	7.5YR4/6	sl	3m-cabk	h	so,po	n.o.	e	-			1.2 - 1.6 Ma	Qct soil? Silica cement?, well cemented, CaCO3 filaments on some clasts

Some artifacts were also observed in deeper horizons, and immediately above the Qct pumice. Evidence of extensive burrowing was observed immediately above the Qct contact, and these artifacts are therefore interpreted to have been transported to deeper soil horizons by animal burrowing (e.g., the Bkb1 horizon at 85859-5 and the BCb1 horizon at 85859-4; note the occurrence of a rodent bone in the Bkb1 horizon at 85859-5; see Table E-1). Additional downward movement of artifacts into other horizons from bioturbation is also inferred to have occurred after site abandonment (e.g., the decrease from 282 artifacts in the Bt1b1 to 3 artifacts in the Bt3b1 at 85859-5). The dispersion of artifacts through the entire thickness of the soil profile near 85859-4 and 85859-5 provides evidence for substantial bioturbation and vertical transport of artifacts since site abandonment. The precise depth of the occupation surface is therefore not well constrained, but may occur somewhere in the Bt1b1 horizon, at a depth of 13 to 31 cm, where artifact concentrations are highest. The fact that the maximum artifact density occurs in the best-developed soil horizon (Bt1b1) suggests that most of the bioturbation occurred relatively soon after deposition of the colluvium and site abandonment, prior to development of these soil horizons. Because the peak artifact density occurs in the upper part of the b1 soil, site occupation also apparently occurred late in the period of deposition of this unit.

As discussed above, the b1 soil at LA 85859 is inferred to be late Pleistocene in age based on comparison with a chronosequence of Pleistocene and Holocene soils developed on a terrace sequence in Rendija Canyon (Reneau and McDonald, 1996; McDonald et al., 1996). However, ^{14}C analyses of two charcoal samples collected from Btb1 and Bt1b1 horizons, provided calibrated ^{14}C dates of ca. 6.8 and 7.25 cal ka (Appendix D), which are younger than age estimates based on soil development. The ^{14}C dates are consistent with the age estimates for two diagnostic points found on the ground surface in the vicinity of LA 85859, but not at the site (S. Hoagland, personal communication), providing supporting but not conclusive evidence for the ca. 7 cal ka ^{14}C age estimates. Because of the evidence for bioturbation and vertical mixing of material at the site, the charcoal samples may or may not be contemporaneous with the artifacts, but could possibly have been mixed into the soil after site abandonment. Several additional charcoal samples have been collected for ^{14}C analysis from Btb1 horizons at this site (Appendix D). These additional charcoal samples could help determine if LA 85859 is a potential late Pleistocene site, or if rates of soil development are instead more rapid on this northeast-facing colluvial hillslope than have been observed in Rendija Canyon terrace deposits.

LA 85864 (Apache tipi ring site)

LA 85864 is a tipi ring outlined by dacite cobbles located on a gullied Qc valley bottom. The tipi ring is situated on a preserved valley bottom remnant between two 2-3 m deep southeast-sloping gullies (Figure 13). Soil stratigraphy at the tipi ring includes an A horizon from 0 to 9 cm overlying an Ab1 horizon (Table 5, profile 85864-1). Tipi ring rocks are set on top of or into the Ab1 horizon. The occupation surface may have been on top of the Ab1 horizon, or may have been on top of the underlying Bwb1 horizon. The thickness of the A horizon indicates approximately 9 cm of deposition that post-dates construction of the tipi ring during the mid to late 1800s. The deep gully incision in the area apparently post-dates the tipi ring site.

The gullies adjacent to LA 85864 and LA 99397 (discussed below) preserve 1.5 to 2 m thick mid to late Holocene colluvial deposits (Figure 15). The Holocene colluvium buries late Pleistocene

Table 5. Summary of Soil Morphology at Rendija Canyon Land Transfer Parcel Tipi Ring Cultural Site LA 85864 (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 85864; Profile 1; lower tipi ring site in gullied area; 101N, 104.7E (December 23, 2003)															
A	0-9	<1	10YR4/4	10YR3/3	sil	1fsbk	so	so,po	n.o.	none	-	as	**85864-1**	Late Holocene	post-Apache
Ab1	9-14+	<1	10YR3/4	10YR3/2	sicl	2msbk	so-sh	s,p	n.o.	none	-				siltans in pores
LA-85864; Profile 2, gully wall; approximately 10m SW of tipi ring (December 23, 2003)													**85864-2**		
A	0-15	<5	10YR4/3	10YR3/3	sil	1 msbk-m	so-lo	ss,ps	n.o.	none	-	cw		Late Holocene	eroded upper surface; possible lumping of multiple horizons (A-Bw?, A-Ab1?)
Bw1	15-40	<2	10YR4/3	10YR3/3	sil	2 msbk	so-sh	ss,ps	n.o.	none	-	as		Mid to Late Holocene	charcoal at 38 cm; siltans
Bw2	40-61	2-5	10YR4/3.5	10YR3/3	sicl	2csbk	h	ss,ps	n.o.	none	-	gs			siltans, possible buried soil (Bwb1?), possibly not
Bw3	61-85	2	8.75YR5/3	8.75YR3/3	sicl	2mpr } 2csbk	h	ss,ps	n.o.	none	-	cs			
Btj	85-104	2	7.5YR5/4	7.5YR4/3	sicl	2mpr }2-3 csbk	h	ss,ps	1nbr	none	-	as			
Bwb1	104-163	5	8.75YR4/4	8.75YR3/3	sicl	2 mpr	h	s,p	n.o.	none	-	as		Mid Holocene?	
Bt1b2	163-201	<2	7.5YR6/3	7.5YR4/3	sicl	2 csbk	h	ss,ps	1ncopo	none	-	as		Late Pleistocene	
Bt2b2	201-213+	<2	7.5YR5/3	7.5YR4/3	sic	2 f-mabk	h	s,p	2ncopobr	none	-	-			

to early Holocene colluvium that is exposed near the base of gully walls. The Holocene section exposed in gullies has excellent potential for preservation of Archaic or older sites, but none were observed during mapping or stratigraphic descriptions during the 2003 field season.

LA 85869 (Apache tipi ring site)

LA 85869 includes a two tipi rings (Features 2 and 4) defined by dacite cobbles situated on the north shoulder of a northwest to southeast-trending ridge, adjacent to the ridge top (Figures 13, 18). Soil stratigraphy at the tipi ring includes an A horizon from 0 to 4 cm that contains beads, chipped stone, ceramics, and metal artifacts overlying a Bw horizon (Figure 18; Table 6). Tipi ring rocks are set on top of the Bw horizon. The occupation surface was likely the top of the Bw horizon. The thin A horizon that post-dates construction of the tipi ring indicates minimal deposition has occurred at this site since the mid to late 1800s. Based on the deposition of very young sediment on top of the Bw horizon, the Bw could be considered a buried soil. The Bw horizon overlies a Btb1 horizon with common to continuous moderately thick clay films. The Btb1 soil is of inferred Pleistocene age. The total thickness of late Holocene deposits in the vicinity of LA 85869 is less than 20 cm (Figure 18; Table 6).

LA 99396 (Multicomponent Archaic lithic scatter and Ancestral Puebloan structure)

LA 99396 includes an Archaic lithic scatter and a one-room Ancestral Puebloan structure with a hearth and an artifact scatter that includes sherds. The site is situated on a broad, low-relief approximately east-west trending ridge crest and on the south-facing hillslope below the ridge, and is located just west of a saddle (Figures 13 and 19). LA 99396 is underlain by thin eolian and colluvial deposits that overlie Qct or Qbog pumice (Figures 20 and 21). Many of the soil horizons at the site are fine-grained, silty deposits with less than 2% gravel, indicating a significant component of eolian deposition (Table 7; Figure 21).

Site stratigraphy includes late Holocene or slopewash deposits generally less than 15 cm thick outside the Feature 2 structure overlying late Pleistocene or early Holocene eolian deposits (99396-1, 99396-4, 99396-5), mid to late Holocene swale fill deposits (99396-2), or Qct/Qbog pumice (99396-3) (Figures 20 and 21; Table 7). The maximum thickness of late Pleistocene or early Holocene eolian deposits observed at LA 99396 was 113 cm at 99396-4, and likely represents a cumulic soil profile. Note that although the degree of soil development in these deposits suggests a late Pleistocene age, the soils are similar to soils described at LA 85859 and these deposits may be correlative. Therefore it is considered possible that the deposits are early Holocene in age. The late Pleistocene or early Holocene soils are truncated, indicating erosion of the area in the vicinity of LA 99396 sometime during the Holocene, prior to deposition of the late Holocene eolian and colluvial deposits. The development of shallow drainages and their subsequent filling is recorded by the mid to late Holocene swale fill deposit at 99396-2 (Figure 20). The swale fill deposits are reddened, exhibiting 8.75YR to 7.5YR color, but lack clay films (Table 7). From these soil properties it is inferred that the swale fill deposits are derived from reworking of older soils upslope.

Table 6. Summary of Soil Morphology at Rendija Canyon Land Transfer Parcel Tipi Ring Cultural Site LA 85869 (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 85869, Profile 1, Upper Tipi Ring site, 100.4N, 132E; N. shoulder of ridge; (December 9, 2003)													**85869-1**		
A	0-3	20-30	10YR3/4	10YR2/2	sl	m-sg	lo	so,po	n.o.	none	-	as		Late Holocene	includes Cerro Grande ash
Bw	3-9	5	10YR4/3	10YR3/3	scl	1f-msbk	so-lo	ss,ps	n.o.	none	-	as			
Bt1b1	9-22+	10	7.5YR4/4	7.5YR3/4	sic	3fsbk	h	s,p	3-4mkcopobrpf	none	-			Pleistocene	
LA 85869, Profile 2. Upper Tipi Ring site, 78N, 158E; inside Feature 2 (Tipi Ring) near ridge crest; (December 23, 2003)													**85869-2**		
A	0-4	40	10YR4/3	10YR3/3	ls	m	lo	so,po	n.o.	none	-	as		Late Holocene	
Bw	4-15	20-30	10YR5/3	10YR3/3	sl	2msbk	so-sh	so,po	n.o.	none	-	aw			tipi ring rocks set on or on top of Bw
Btb1	15+													Pleistocene	see profile #1 for Btb1 description

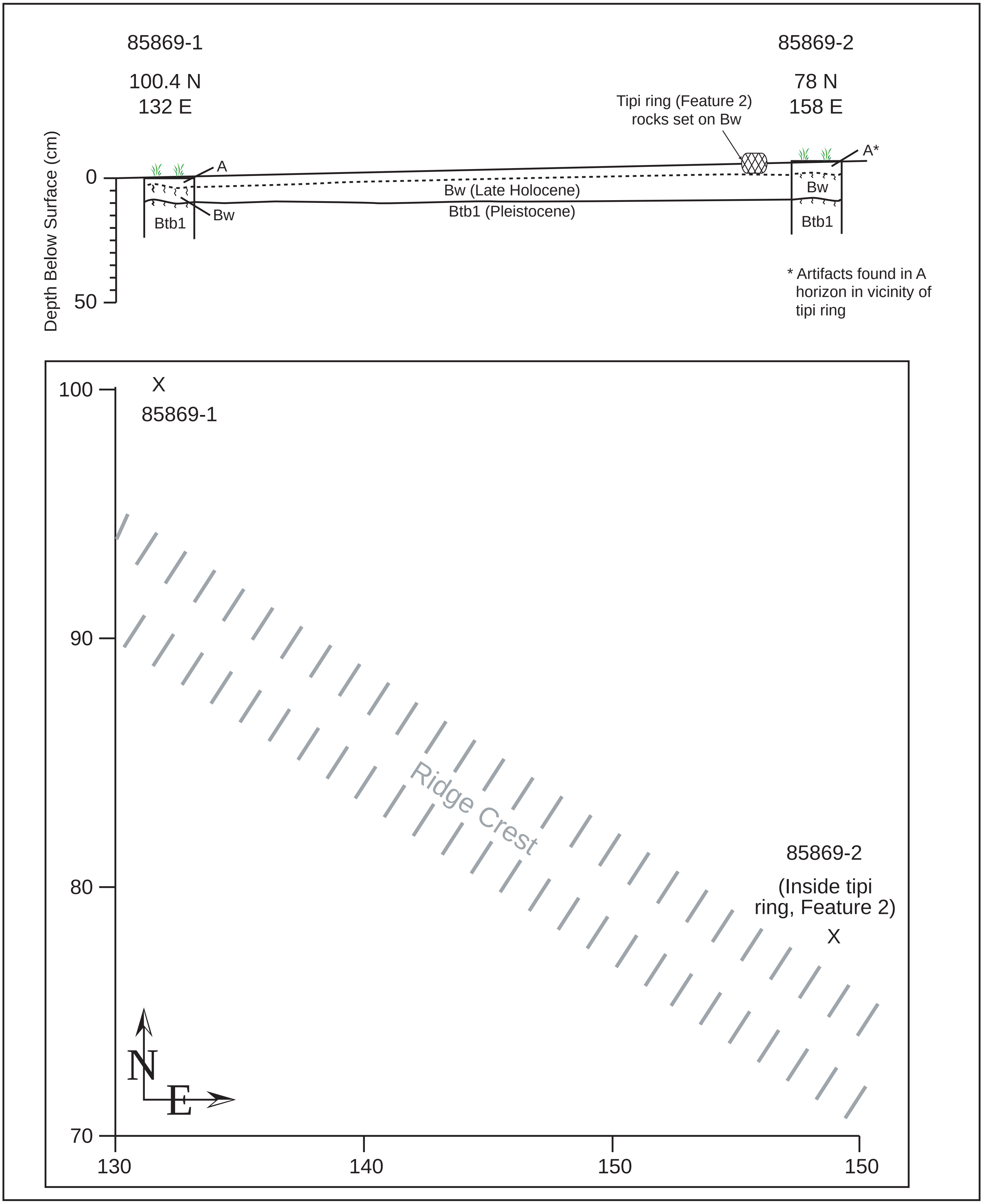


Figure 18. Site stratigraphy and sketch map, LA 85869 (Tipi Ring, Feature 2)

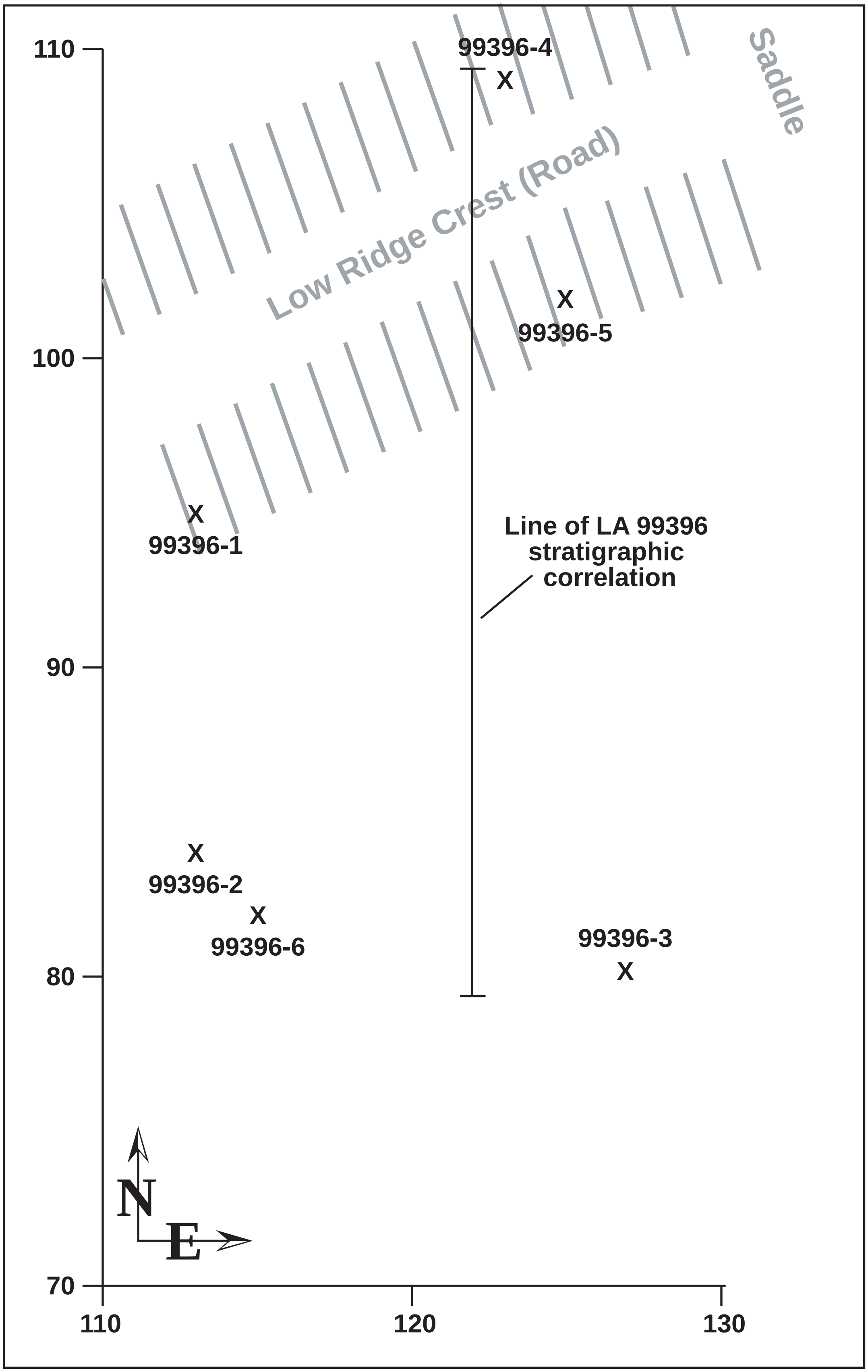
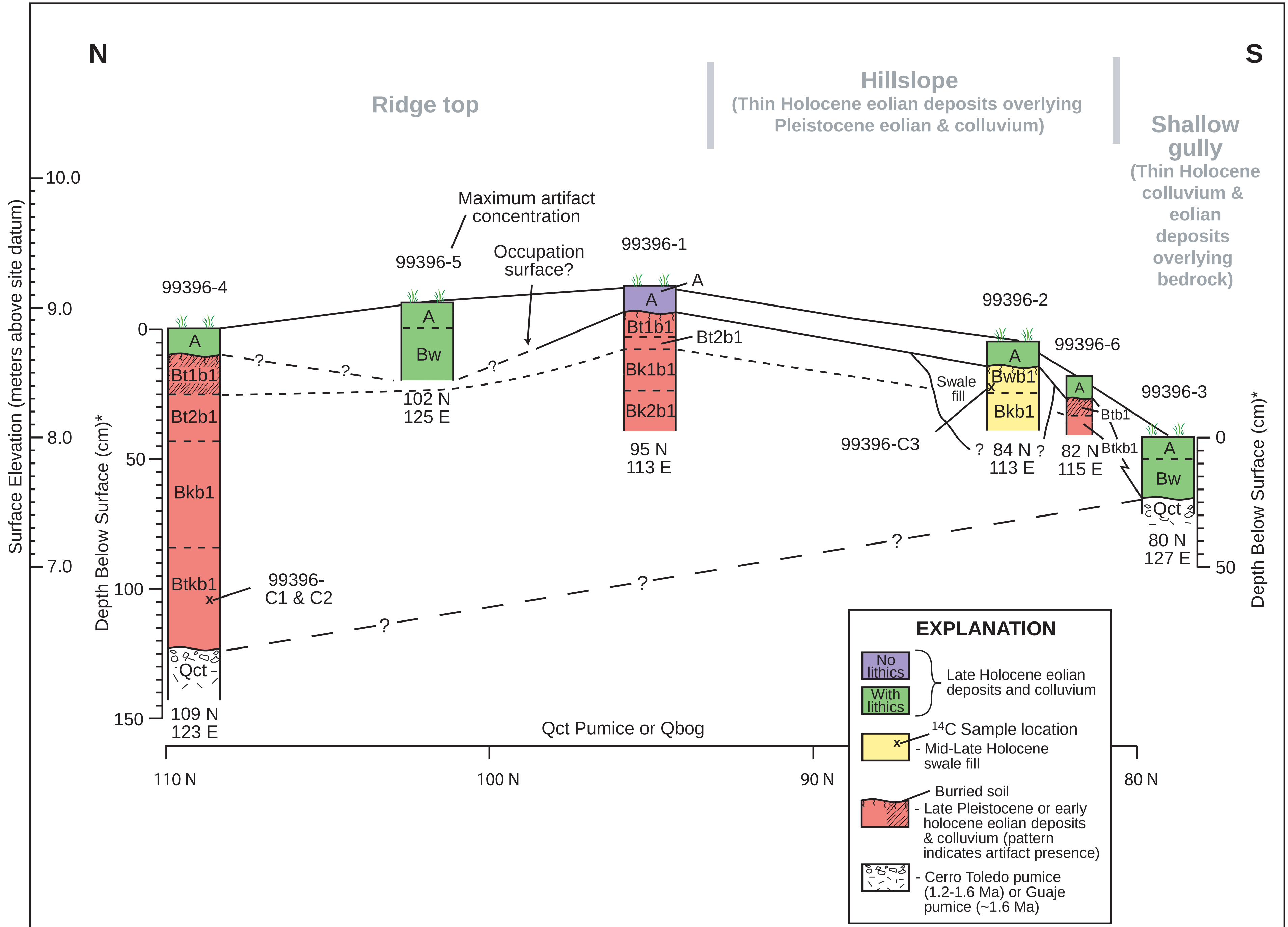
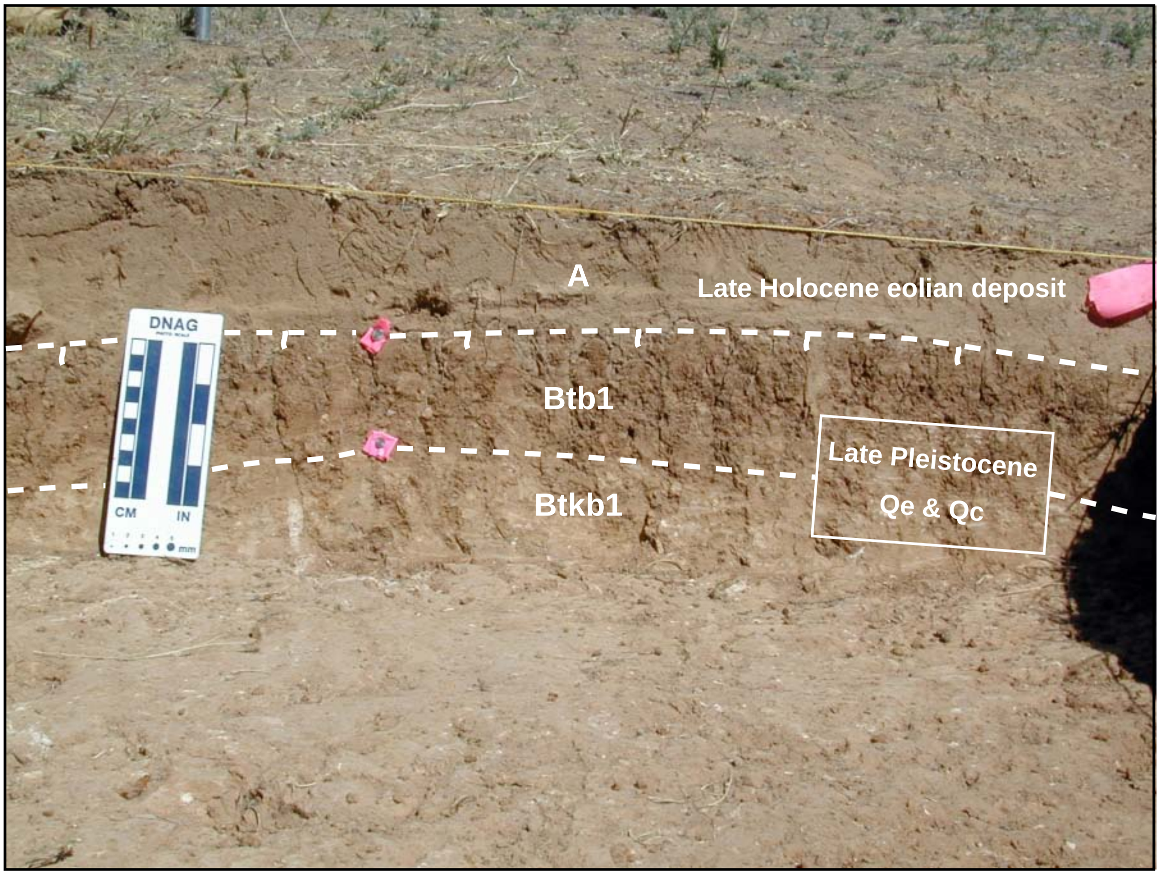


Figure 19. Site map showing location of soil pits at LA 99396



* - All profiles are depth below ground surface. Surface profile is VE = 4x

Figure 20. LA 99396 Stratigraphic correlation, geomorphic setting, and artifact occurrence



Late Holocene eolian deposit (Qe) over truncated late Pleistocene Btb1 horizon.

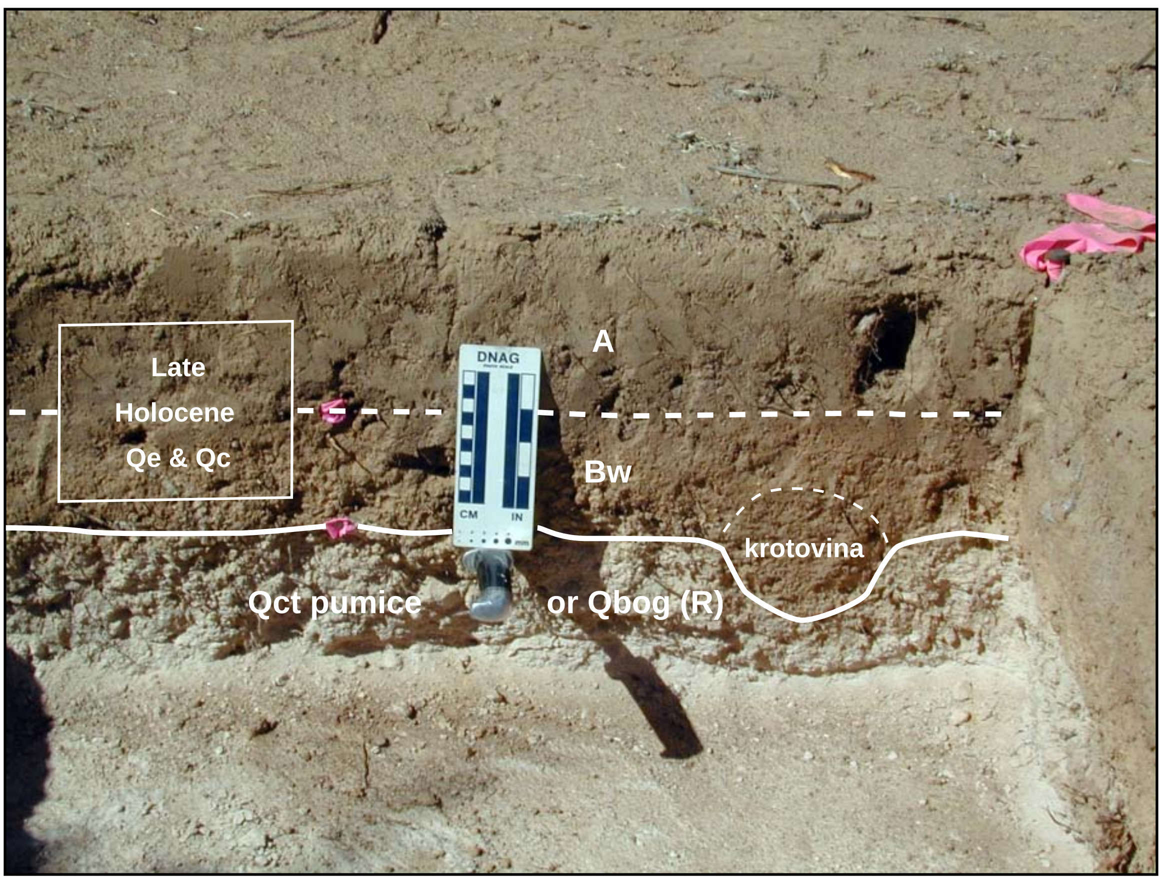


Fig 21. Thin soils at LA 99396. Late Holocene eolian (Qe) and slopewash colluvium (Qc) over bedrock (Qct or Qbog pumice) at profile 99396-3 (bottom).

Table 7. Summary of Soil Morphology at Rendija Canyon Land Transfer Parcel Multicomponent Archaic and Ancestral Puebloan Site LA 99396 (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 99396-1, Archaic (?) site, lithic scatter, 95N, 113E; north wall (October 1, 2003)													**99396-1**		
A	0-10	5	10YR4/4	10YR3/4	sl	1-2msbk	so	so,po	n.o.	none	-	as		< 1000 yrs	late Holocene eolian deposit + gravel lag following erosion
Bt1b1	10-19	<2	6.25YR4/3	6.25YR3/3	sic	3mpr } abk	sh-h	s,p	4n-mkpobrpf	none	-	cs			prismatic structure breaking to abk
Bt2b1	19-27	<2	7.5YR4/4	7.5YR3/3	sic	2msbk	h	ss,p	2-3npobrpf	e	-	cs			
Bk1b1	27-40	10-20	8.75YR5/3	8.75YR4/3	sl	2msbk	sh-h	so,ps	n.o.	ev	II	cs		Late Pleistocene?	very abundant filaments
Bk2b1	40-56+	10-20	8.75YR5/3	8.75YR3/3	sl	2m-csbk	h	so,po	n.o.	es	I	-			filaments; irregular surface on weathered Qct soil exposed on other walls
LA 99396-2, Archaic (?) site, lithic scatter, S. slope of Qc/Qct or Qbog ridge; 84N, 113E; north wall (October 16, 2003)													**99396-2**		
A	0-10	2-5	8.75YR4/4	8.75YR3/4	sl	1-2fsbk	so	so,po	n.o.	none	-	as		Late Holocene (< 1000 yrs?)	late Holocene Qc (+/- Qe), derived from reworking older soils up slope?
Bwb1	10-23	2-5	7.5YR4/4	7.5YR3/4	scl	2msbk	sh-h	ss,ps	n.o.	none	-	as		Mid to Late Holocene	verging on Btj?; 14C sample LA 99396-c3 collected from @ 22 cm, 84.7N, 114E
Bkb1	23-35+	<5	7.5YR5/3	7.5YR4/3	sl	2mabk	h	so,ps	n.o.	e	I	-			discontinuous CaCO3 coatings on ped faces
LA 99396-3, Archaic (?) site, lithic scatter, 80N, 127E; farther down south slope, eroded area (October 16, 2003)													**99396-3**		
A	0-13	5	8.75YR5/4	8.75YR3/4	ls	1msbk	so-lo	so,po	n.o.	none	-	cs		Late Holocene	late holocene slope wash (Qc)
Bw	13-23	20-30	7.5YR5/4	7.5YR4/4	ls	2msbk	so-sh	so,po	n.o.	none	-	vas			Holocene Qc
R	23-36+	-	7.5YR7/2.5									-		1.2 - 1.6 Ma	Qct pumice or Qbog
LA 99396-4, Archaic (?) site, lithic scatter, 109N, 123E; North wall, slightly north of low ridgecrest (October 16 and November 6, 2003)													**99396-4**		
A	0-10	<2	10YR5/3	10YR4/3	sil	1msbk	so	so,ps	n.o.	none	-	cs		< 1000 yrs?	eolian
Bt1b1	10-25	<2	8.75YR4/3	8.75YR3/3	sicl	2fsbk	sh-h	ss,p	1nbrco	none	-	cs		Late Pleistocene to Early Holocene	8.75YR color
Bt2b1	25-43	<2	7.5YR4/3	7.5YR3/3	sicl	2msbk	h	s,p	2-3nbrpf	none	-	aw			
Bkb1	43-84	<2	7.5YR5/3	7.5YR3/3	sil	2mpr } 2m-csbk	h	so,ps	n.o.	es	II-	cw			
Btkb1	84-123	<2	8.75YR5/3	8.75YR3/3	sil	2csbk	h	so,ps	1nbr	es	-	cs			some subordinate f-mpr structure; CaCO3 in fine matrix, no filaments
2Btb2	123-143+	50	7.5YR4/4	7.5YR3/4	scl	2msbk	h	ss,ps	2mkpobr	none	-	-		1.2 - 1.6 Ma	Qct or Qbog pumice gravel, abundant quartz crystals
LA 99396-5, Inside one-room structure, above occupation surface, 102N, 125E = upper horizon, 102N, 126E = lower horizon (November 4, 2003)													**99396-5**		
A	0-10	2-5	10YR5/4	10YR3/4	sl	1-2fsbk	so	so,po	n.o.	none	-	-		Late Holocene	very fine sandy loam
Bw	10-29+	2-5	10YR5/4	10YR3/4	sl	2msbk	sh	so,po	n.o.	none	-	-			
LA 99396-6, Archaic (?) site, lithic scatter, S. slope of Qc/Qct or Qbog ridge; 82N, 115E (October 16, 2003)													**99396-6**		
A	0-8													Late Holocene	
Btb1	8-15								3ncopobrpf					Late Pleistocene?	
Btkb1	15-23+														

Artifacts were found in both the late Holocene deposits and in the upper horizon (Bt1b1) of the late Pleistocene or early Holocene soil at LA 99396 (Figure 20; Table E-2 in Appendix E; it is assumed that more than one artifact must be found in a given horizon to confirm artifact occurrence). The maximum subsurface artifact concentration at the site was observed in the vicinity of 99396-4 and 99396-5, on the ridge crest and within the one-room structure. Artifacts were observed in the Btlb1 horizon at 99396-4 and in the Btb1 horizon of 99396-6 (Figure 20; Table E-2 in Appendix E), indicating an Archaic component to the site. Artifacts were observed in the late Holocene deposits in several profiles where soils were described, including 99396-2, 99396-3, 99396-4, 99396-5, and 99396-6. These include locations on the ridge crest and on the slopes both to the north and the south. With the exception of one obsidian flake recovered from the Bt1b1 horizon, artifacts were not observed at 99396-1, located west of 99396-5, in a slightly upslope direction (Figure 19). The presence of Feature 2, a one-room structure, with a concentration of artifacts including a shard in the Bw horizon of 99396-5, indicates an Ancestral Puebloan component to the site. The weakly developed soils with thin A-Bw horizons that bury the LA 99396 occupation surface, and within which artifacts occur, is consistent with an Ancestral Puebloan age for Feature 2.

The subsurface artifact distribution at LA 99396 suggests that the Ancestral Puebloan occupation surface was on top of the late Pleistocene eolian deposits, and that the site was centered in the vicinity of the one-room structure and LA 99395-5. Artifacts have been transported in late Holocene slopewash colluvium, and are concentrated in the shallow gully examined at 99396-3. The site likely extended northward to the vicinity of 99396-4.

The subsurface distribution of artifacts suggests that Archaic usage was likely centered in the vicinity of 99396-4 and possibly also near 99396-6 (Figures 19 and 20). However, surface lithic density is highest in the vicinity of the shallow gully near 99396-3. These data suggest that much of the Archaic site component has been eroded, with the artifacts transported down slope and concentrated in the shallow gully near 99396-3. In contrast, ceramics associated with Feature 2 are located in close proximity to the Ancestral Puebloan structure, both on the surface and in the subsurface, indicating less erosion and down slope transport than for the Archaic components. The concentration of artifacts in the Bt1b1 horizon at 99396-4 and in the Btb1 horizon at 99396-6, near the top of the b1 soil profile, suggests that the Archaic occupation surface was in the upper part of the b1 soil, and that the Archaic site was buried by late Holocene eolian deposits.

The b1 soil at LA 99396 (including Bt, Bk, and Btk horizons) is similar to the b1 soil at LA 85859 and is inferred to be late Pleistocene in age, based on comparison with a chronosequence of Pleistocene and Holocene soils developed on a terrace sequence in Rendija Canyon (Reneau and McDonald, 1996; McDonald et al., 1996). The stage II or II- carbonate horizon observed at 99396-1 and 99396-4, indicates a minimum early Holocene age for these deposits, based on the development of stage I carbonate in 4 to 8 ka deposits at the Fence Canyon site and the development of stage II+ carbonate in a greater than 50-60 ka colluvial deposit on the White Rock tract, Location 6 (Reneau and McDonald, 1996; Drakos and Reneau, 2002). Stage II carbonate horizons in semiarid climates typically indicate a latest Pleistocene age for the soil (Machette, 1985). However, as discussed above, ^{14}C ages from LA 85859 suggest an age of ca. 7 ka, which is younger than age estimates based on relative soil development, and an age of either late Pleistocene or early Holocene is considered possible for the b1 soil at LA 99396 based on available data. Samples LA-99396-c1 and c2 have been collected for ^{14}C analysis from the Btkb1 horizon at LA 99396 (Figure 20; Appendix D). An additional charcoal sample, LA-99396-c3, was collected from the Bwb1 horizon of the mid to late Holocene swale fill deposit (Figure 20; Appendix D). Radiocarbon analyses of these additional samples could help constrain rates of soil development in Rendija Canyon eolian and colluvial deposits, and could help provide better age constraint for site LA 99396.

With the exception of the site disturbance related to creation of the two-track road through the site, the Ancestral Puebloan Feature 2 structure and artifacts in its vicinity are in reasonably good context. It is also possible that the Archaic artifacts in the Btb1 horizon at LA 99396 are in somewhat close proximity to their original location. However, it is likely that the occupation surface has eroded away leaving only a few artifacts in the Btb1 horizon that are not in their precise original location. While not in good archaeological context, the artifacts in the Btb1 horizon are in considerably closer proximity to their original context than are those in the late Holocene slopewash colluvium and eolian deposits.

LA 99397 (Archaic lithic scatter)

LA 99397 is situated on a northeast-facing hillslope that forms the shoulder of a generally southeast-to-northwest trending ridge crest, slightly northwest of LA 85869 and southwest of LA 85864 (Figures 13 and 22). A field house (LA 85411) is located just upslope from LA 99397. LA 99397 is underlain by a thin late Holocene colluvial and eolian deposit that overlies Pleistocene colluvium and Qct gravel (Figure 23; Table 8). Several areas of the site exhibit a surface gravel cap or weak desert pavement, discontinuous Av (vesicular A) horizon, and rubification (reddening) of the underside of surface clasts, all of which indicate a late Holocene eolian influx leading to the formation of a weak desert pavement (Table 8, 99397-1, 99397-3, 99397-4, and 99397-6; Figure 23; see McFadden et al. (1987) for a discussion of eolian dust influx and the formation of desert pavements). Some of the late Pleistocene and Holocene soil horizons at the site are fine-grained, silty deposits with 5% or less gravel, indicating a significant eolian component to the colluvium (Table 8).

Site stratigraphy includes thin late Holocene colluvial and eolian deposits less than 25 cm thick overlying late Pleistocene or early Holocene colluvial deposits or mid to late Holocene swale fill deposits (99397-7) (Figures 23 and 24; Table 8). Late Pleistocene or early Holocene colluvial deposits observed at LA 99397 range in thickness from approximately 15 cm to greater than 114 cm, with deposit thickness generally increasing down slope (Figure 23; Table 8). The late Pleistocene or early Holocene soils are truncated, indicating erosion of the area in the vicinity of LA 99397 sometime during the Holocene, prior to deposition of the late Holocene colluvium. The development of shallow drainages and their subsequent filling is recorded by the mid to late Holocene swale fill deposit at 99397-7 (Figure 21). The A-Bw-Bwb1-Bwb2 profile at 99397-7 represents episodic deposition in a swale.

Artifacts including lithics and rare sherds were found concentrated in the late Holocene deposits and locally in the underlying late Pleistocene or early Holocene Btb1 horizon at LA 99397 (Figure 23; Table E-3 in Appendix E). The maximum artifact concentration at the site was observed in the vicinity of 99397-6, where several artifacts were also found in the Btb1 horizon.

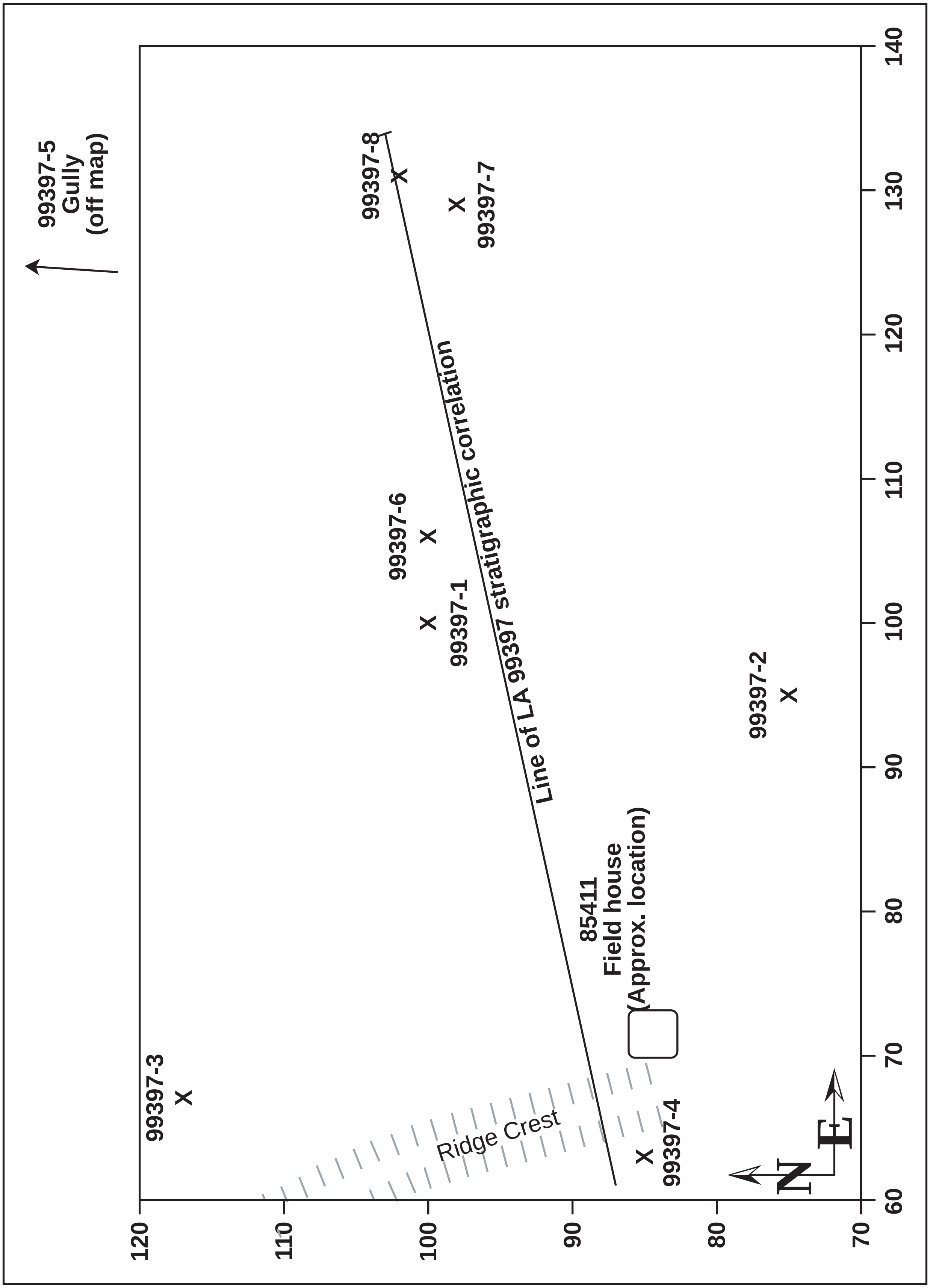


Figure 22. Site map showing location of soil pits, LA 99397

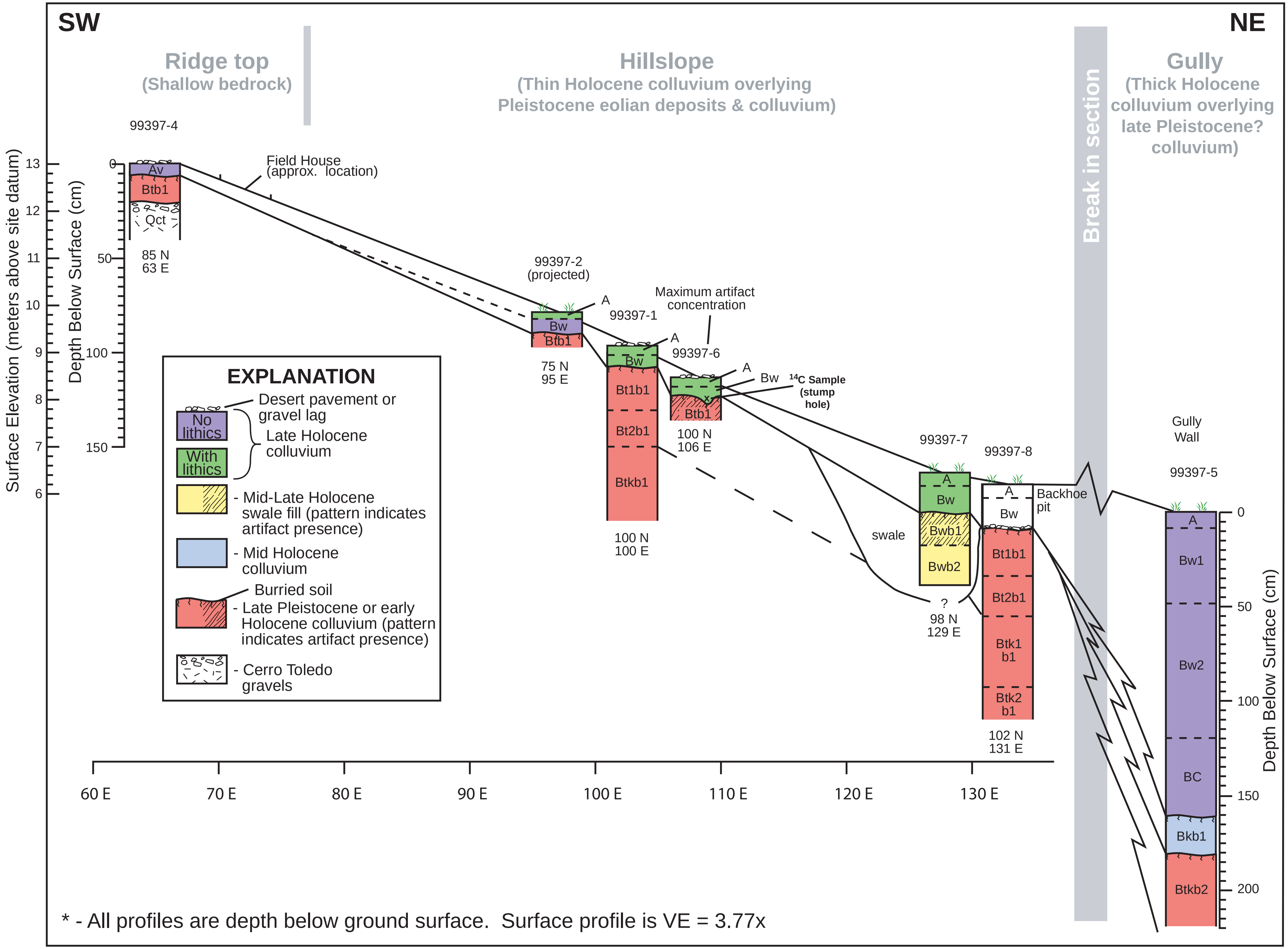


Figure 23. LA 99397 Stratigraphic correlation, geomorphic setting, and artifact occurrence

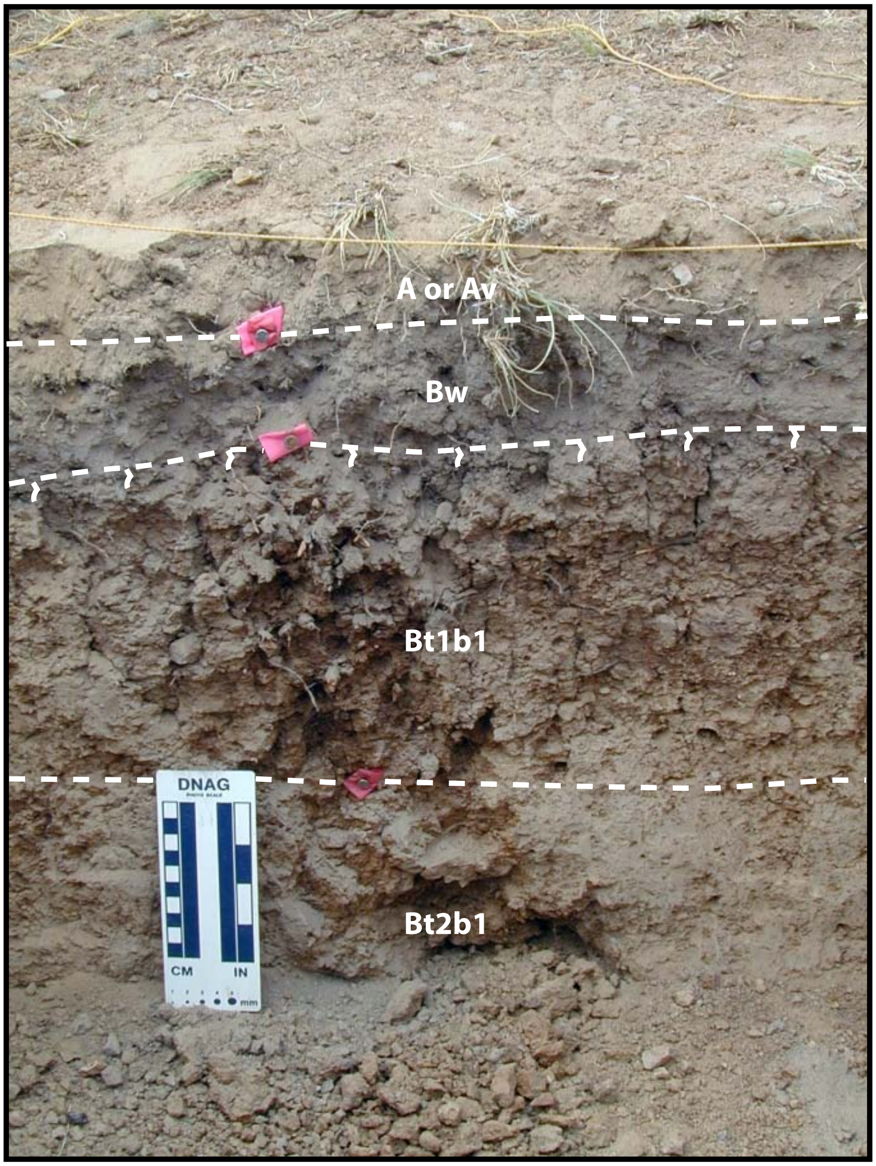


Figure 24. Soil profile #1 at LA 99397. Av-Bw horizons formed in late Holocene colluvium and eolian deposits overlying buried Bt horizons developed in late Pleistocene colluvium.

Table 8. Summary of Soil Morphology at Rendija Canyon Land Transfer Parcel Archaic Site LA 99397 (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 99397-1, Archaic (?) site, lithic scatter, 100N, 100.4E (August 25, 2003); Btkb1 described @ 99.8N, 98E, on November 17, 2003													**99397-1**		
A or Av	0-5	20-25	10YR5/3	10YR3/3	ls	1msbk-pl-sg	so-lo	so,po	n.o.	none	-	as		Late Holocene (<1000 yrs?)	contains vessicular peds
Bw	5-11	5	10YR5/3	10YR3/3	ls	2msbk	so	so,po	n.o.	none	-	aw			
Bt1b1	11-34	<2	7.5YR4/3	7.5YR3/3	sic	2mpr} 2-3msbk	h	s,p	3mkcopobr	none	-	cs			2pr breaking to 2-3msbk
Bt2b1	34-54	<2	7.5YR4/4	7.5YR3/3	sic	2msbk	h	s,p	2npobr	none	-	cw		Late Pleistocene	
Btkb1	54-93+	5	7.5YR5/3	7.5YR4/3	sl	2cabk	h	so,ps	1npo	es	II-	-			generally continuous CaCO3 ped face coatings, plus filaments; very rare clay films
LA 99397-2, Archaic (?) site, lithic scatter below fieldhouse, 75N, 95E (SW corner); thin Qc over Qct? (September 3, 2003)													**99397-2**		
A	0-4	30-40	10YR5/3	10YR3/3	ls	1msbk	so-lo	so,po	n.o.	none	-	cs		Late Holocene (<1000 yrs?)	Young gravelly colluvium, pebbles to small boulders; few artifacts
Bw	4-11	50	10YR5/3	10YR3/3	sl	1-2msbk	so	ss,ps	n.o.	none	-	aw			Young gravelly colluvium, pebbles to small boulders; few artifacts
Btb1	11-18+	10-20	7.5YR4/4	10YR3/3	sc	2msbk	h	s,p	2-3mkcopobr	none	-	-		Late Pleistocene?	Gravel mostly finer than above; no artifacts
LA 99397-3, Archaic (?) site, lithic scatter, 117.1N, 67.3E; 5-10 m N of ridgecrest, no artifacts (September 3, 2003)													**99397-3**		
AC	0-4	20	10YR3/2	10YR2/1	ls	sg	lo	so,po	n.o.	none	-	vas		Late Holocene (<1000 yrs?)	post Cerro Grande fire deposit; pumice + abundant charcoal
A	4-14	10-20	10YR5/2	10YR3/2	ls	1msbk	so	so,po	n.o.	none	-	cs			possible rubification on undersides of clasts
Bw	14-24	30-40	10YR5/3	10YR4/3	s	1msbk	so-lo	so,po	n.o.	none	-	aw			
R	24+		7YR6/6											1.2 - 1.6 Ma	Qct, fine gravel, cemented granules
LA 99397-4, 85N, 63E; On ridge crest, 7 m W of field house, young eolian over bioturbated Qct + eolian w/old soil (September 3, 2003)													**99397-4**		
Av?	0-6	10-20	10YR6/2	10YR3/3	sl	1msbk	so-lo	so,po	n.o.	none	-	vas		< 1000 yrs	discontinuous gravel cap, primarily at surface, with vessicular peds; rubification on some clasts
Btb1	6-20+	5-10	5YR4/4	5YR4/3	sc	2-3msbk	h	s,p	3-4mkcopobrpf	none	-	-		Pleistocene; 100-200 ka?	parent material inferred to be bioturbated Qct + eolian fines; color from ped interiors
LA 99397-5, Gully to northeast of site, west wall, thick Holocene Qc (September 10, 2003)													**99397-5**		
A	0-9	10	10YR5/3	10YR3/3	sl	m	lo	so,po	n.o.	none	-	as			moist
Bw1	9-49	5	10YR4/4	10YR3/4	sl	2msbk	sh	so,ps	n.o.	none	-	gs		Mid to Late Holocene?	cicada burrows are hard
Bw2	49-120	10	10YR4/4	10YR3/3	ls	1csbk	so	so,po	n.o.	none	-	gs			fine gravel
BC	120-162	10-20	10YR4/3	10YR3/3	sl	1msbk-m	so	so,po	n.o.	none	-	gs			coluvium
Bkb1	162-182	<5	10YR5/4	10YR3/3	ls	2m-csbk	h	ss,ps	n.o.	e	I-	as		Mid Holocene?	some sparse CaCO3 on ped faces, some filaments possible clay films?
Btkb1 or b2?	182-222+	<5	8.75YR5/4	8.75YR4/4	sil	2-3msbk	h	ss,ps	1-2npobr	e	I-			Late Pleistocene to early Holocene?	late Pleistocene (?) or early Holocene Qc
LA 99397-6, Archaic (?) site, lithic scatter, 100N, 106E; burned stump location (September 11, 2003)													**99397-6**		
A	0-4	20-30	10YR5/3	10YR3/3	ls	1-2fsbk	so	so,po	n.o.	none	-	as		Late Holocene (<1000 yrs?)	areas with vesicular A
Bw	4-9	5-10	10YR5/3	10YR3/3	sl	1-2msbk	so	so,ps	n.o.	none	-	as			
Btb1	9-23+	<2	7.5YR4/4	7.5YR4/3	sic	2-3msbk	h	s,p	3npobrpf	none	-	-		Late Pleistocene?	
LA 99397-7, Archaic (?) site, lithic scatter, 98N, 129E; swale fill deposit(?) (October 1, 2003)													**99397-7**		
A	0-7	<5	10YR4/3	10YR3/2	l	1fsbk	so-lo	so,po	n.o.	none	-	cs		Late Holocene (<1000 yrs?)	young colluvium
Bw	7-21	20-30	10YR4/3	10YR3/3	ls	1-2msbk	so	so,po	n.o.	none	-	aw			contains obsidian flakes, siltan coatings on flakes, highest % in section
Bwb1	21-38	10-20	10YR4/3	10YR3/3	sil	2fsbk	sh-h	ss,ps	n.o.	none	-	aw		Mid to Late Holocene	slightly reddened horizon; abruptness of contact suggests buried soil; no artifacts in this horizon
Bwb2	38-60+	<2	10YR4/3	10YR3/2	sil	2msbk	h	ss,ps	n.o.	none	-	-		Mid to Late Holocene	bioturbated at upper boundary

Table 8. Summary of Soil Morphology at Rendija Canyon Land Transfer Parcel Archaic Site LA 99397 (described by Paul Drakos and Steven Reneau)

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	$CaCO_3$	$CaCO_3$ Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 99397-8, Archaic (?) site, lithic scatter, 102N, 131.3E; backhoe pit (November 6, 2003)													**99397-8**		
A	0-7	5	10YR4/4	10YR3/4	sl	1mgr-m	so-lo	so,po	n.o.	none	-	as		Late Holocene (<1000 yrs?)	Qc
Bw	7-23	30	10YR4/3	10YR3/3	sl	2msbk	so-sh	so,po	n.o.	none	-	cs			gravel lag; b1?
Bt1b1	23-48	<2	7.5YR4/3	7.5YR3/3	csi	2-3mabk	h	ss,ps	2nbrpfpo	none	-	gs		Early Holocene?	some subordinate fpr structure
Bt2b1	48-70	5	7.5YR5/4	7.5YR4/3	csi	2csbk	h	ss,ps	1nbr	none	-	cw			discontinuous CaCO3 coatings on sparse gravel; matrix does not effervesce
Btk1b1	70-105	2	7.5YR5.5/3	7.5YR4/3	sicl	2f-mpr	h	ss,ps	1brpo	ev	II-	cw			CaCO3 filaments and discontinuous coatings on ped faces
Btk2b1	105-127+	2	8.75YR4/3	8.75YR3/3	sl	2csbk	h	so,ps	1-2nbrpo	e-	I-	-			b2? Suggested by increase in argillans ; eff weakly on ped faces, matrix non-eff; few filaments on ped faces

Artifacts were observed in the A and Bw horizons in 99397-1, 99397-6, and 99397-7, and in the A horizon only in 99397-2. Artifacts were not observed in 99397-3 or 99397-4, located upslope from both the field house and the artifact concentration at LA 99397. The artifact distribution at LA 99397 suggests that the occupation surface was within or on top of the late Pleistocene or early Holocene colluvial deposits, and that usage was centered in the vicinity 99397-6. Artifacts have been transported in late Holocene slopewash colluvium downslope from the vicinity of 99397-6, and are also concentrated in the upper swale fill deposit at 99397-7 (Figure 23; Table E-3). Artifacts found in the A horizon only at 99397-2 are inferred to have been transported downslope from the field house (LA 85411).

Several of the b1 soils at LA 99397 (including Bt and Btk horizons) are similar to the b1 soil at LA 85859 and LA 99396 and are also inferred to be late Pleistocene in age, based on relative soil development in Rendija Canyon (Reneau and McDonald, 1996; McDonald et al., 1996). The stage II- carbonate horizon observed at 99397-1 and 99396-8, suggests an early Holocene age for these deposits, based on the development of stage I carbonate in 4 to 8 ka deposits at the Fence Canyon site and the development of stage II+ carbonate in a greater than 50-60 ka colluvial deposit on the White Rock tract, Location 6 (Reneau and McDonald, 1996; Drakos and Reneau, 2002), and on carbonate soils described in Machette (1985). However, as discussed above, ^{14}C ages from LA 85859 suggest an age of ca. 7 ka, which is younger than age estimates based on relative soil development, and an age of either late Pleistocene or early Holocene is considered possible for the b1 soil at LA 99397 based on available data. Samples have been collected for ^{14}C analysis from LA 85859 and LA 99396, and from the burned stump location at 99397-6 (Figure 25; Appendix D). These additional ^{14}C samples could help constrain rates of soil development in Rendija Canyon eolian and colluvial deposits, and could help provide better age constraint for LA 99397.

The remnant truncated mid Pleistocene (?) soil with 5YR color and continuous, moderately thick clay films on the ridge crest at 99397-4 indicates that older, clay-rich soils are present in locations above LA 99397 where they could have been sources for clay in downslope colluvial deposits. Deposition of clay derived from the erosion of old soils with clay-rich Bt horizons could possibly result in accelerated Bt horizon development in the b1 soil underlying the site.

Most of the artifacts at LA 99397 appear to have been reworked into the late Holocene colluvium and mid to late Holocene swale fill deposits, and are not in good archaeological context. It is possible that the Archaic artifacts in the Btb1 horizon at LA 99397 are in somewhat close proximity to their original location. However, it is likely that the occupation surface has eroded away leaving only a few artifacts in the Btb1 horizon that are not in their precise original location. While not in good archaeological context, the artifacts in the Btb1 horizon are in considerably closer proximity to their original context than are those in the late Holocene slopewash colluvium and eolian deposits. Artifacts found in the A horizon only at 99397-2 are inferred to have been transported downslope from the field house (LA 85411), and are not in good context.

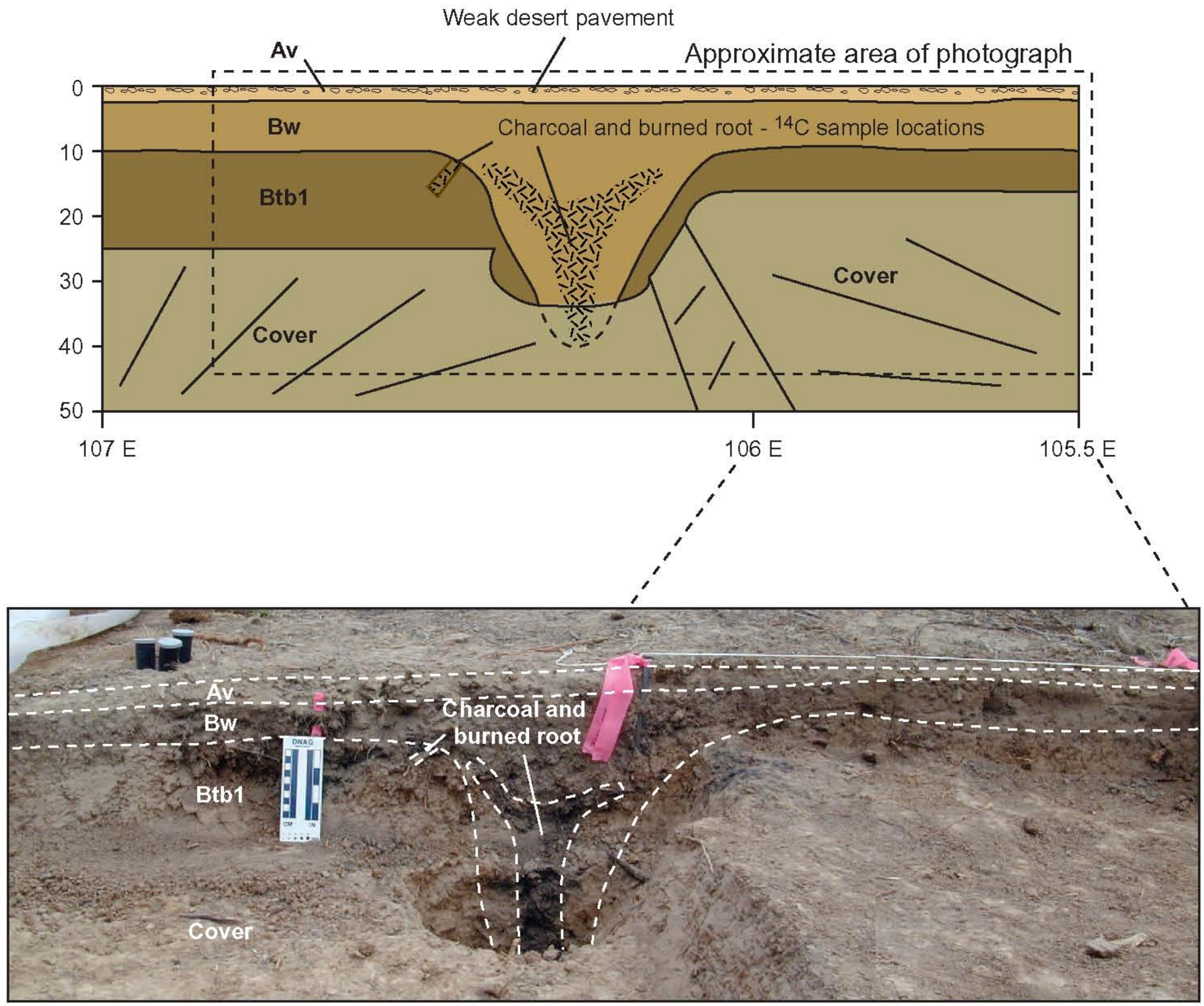


Figure 25. Photograph and sketch showing stump hole with ^{14}C sample location and soil horizons, 99397-6 (Av and Bw).

Tract Summary

Sites investigated within the Rendija Canyon tract include three Archaic or multicomponent sites on hillslopes and ridge top settings with generally thin colluvium and eolian deposits overlying Qct or Qbog pumice or Qct gravel   Two tipi ring sites were investigated, one on a ridge top and one in a valley bottom setting. Site stratigraphy for hillslope or ridge top sites includes thin late Holocene colluvial and eolian deposits less than 25 cm thick overlying late Pleistocene or early Holocene colluvial and eolian deposits or mid to late Holocene swale fill deposits less than 1.5 m thick. Late Pleistocene or early Holocene soils are truncated, indicating erosion sometime during the Holocene, prior to deposition of the late Holocene colluvium. The development of shallow drainages and their subsequent filling is recorded by the mid to late Holocene swale fill deposits. Valley bottoms preserve 1.5 to 2 m thick mid to late Holocene colluvial deposits and an unknown thickness of underlying early Holocene and/or late Pleistocene deposits (see Figure 15). The Holocene and Pleistocene sections exposed in gullies have excellent potential for preservation of Archaic or older sites, although no buried sites were observed in this setting during mapping or stratigraphic descriptions during the 2003 field season.

Three Archaic sites were investigated, one of which is a multicomponent site that included an Ancestral Puebloan one-room structure. LA 85859 is an Archaic site situated on a northeast-facing hillslope that has numerous artifacts within a reddened Bt horizon that are likely displaced from their original location due to vertical mixing of material by burrowing animals. LA 85859 also included artifacts that had been reworked into late Holocene colluvium that are not in good archaeological context. LA 99396 is a multicomponent site, with sparse artifacts in the Bt1b1 horizon, indicating an Archaic component to the site, and an Ancestral Puebloan structure with additional artifacts in the A and Bw horizons. The Ancestral Puebloan component of LA 99396 is in good archaeological context. Archaic artifacts in the Btb1 horizon at LA 99396, while not in good archaeological context, are in considerably closer proximity to their original context than are those in the late Holocene slopewash colluvium and eolian deposits. Artifacts in the Btb1 horizon may have been largely subject to vertical mixing, as inferred at LA 85859. The site is situated on a broad, low-relief ridge crest, trending approximately east-west, and the south-facing hillslope below the ridge. Artifacts derived from both the Archaic and Ancestral Puebloan site components at LA 99396 have been reworked into the late Holocene colluvium downslope from the main artifact concentration and are not in good archaeological context. LA 99397 is an Archaic site situated on a northeast-facing hillslope, with a sparse artifact concentration in the Btb1 horizon and more abundant artifacts in overlying late Holocene colluvium (A and Bw horizons). As with LA 99396, it is inferred that the artifacts observed in the Btb1 horizon are in considerably closer proximity to their original context than are those in the late Holocene slopewash colluvium. The artifacts observed in the overlying A and Bw horizons have been reworked from the Btb1 horizon or transported downslope from a nearby field house and are in relatively poor archaeological context. The Btb1 horizon and most of the associated artifacts may have been largely eroded, affecting site integrity.

Two tipi ring sites were investigated during the 2003 field season. LA 85864 includes a tipi ring outlined by dacite cobbles situated on a gullied Qc valley bottom remnant between two 2-3 m deep southeast-sloping gullies (Figure 13). Valley-bottom sediments partially bury the tipi ring, and therefore the deep gully incision in the area apparently post-dates occupation, occurring sometime after the mid to late 1800s. LA 85869 includes a tipi ring outlined by dacite cobbles situated near a ridge crest. The ridge top site has experienced 0-4 cm of eolian deposition since occupation in the mid to late 1800s.

The degree of soil development suggests that the buried soils within which the Archaic artifacts are found at LA 85859, LA 99396 and LA 99397 are late Pleistocene in age. However, ^{14}C dates and diagnostic points collected from the ground surface in the vicinity of LA 85859 suggest an age of ca. 7 ka, which is younger than age estimates based on the degree of soil development. Because of uncertainties in the rates of soil development and in the context of the dated charcoal and the diagnostic points, available evidence suggests that these buried soils may be either late Pleistocene or early Holocene in age. Additional ^{14}C analyses of charcoal samples collected from a variety of soil horizons at LA 85859, LA 99396 and LA 99397 could help better constrain rates of soil development in Rendija Canyon eolian and colluvial deposits, and could help provide better age constraint for the sites.

CONCLUSIONS

Archaeological sites discussed in this report are located on mesa tops, colluvial slopes, valley bottom, and ridge top settings. An examination of sites located in these different settings indicates that mesa top sites have the best potential for preservation of an intact archaeological record. In contrast, sites on colluvial slopes and eroded ridge tops include some artifacts in good archaeological context, but also a significant portion of artifacts in relatively poor archaeological context due to erosion. The Archaic sites investigated within the Rendija Canyon tract include one site (LA 85859) with many of the artifacts situated in a soil horizon that likely included the former occupation surface (a buried reddened soil with an argillic horizon), and a subset of artifacts reworked into late Holocene colluvium. However, significant vertical mixing of material has occurred at this site due to animal burrowing, obscuring the occupation surface and potentially affecting the reliability of dated charcoal samples. The other two Rendija Canyon Archaic sites contain a few artifacts situated in relatively close proximity to the inferred former occupation surface, located within a buried reddened soil with argillic horizons, but includes a majority of artifacts reworked into late Holocene colluvium. At these sites most of the buried soils and associated artifacts may have been removed by erosion.

The Airport tract sites are situated within a mesa top setting. Results of the site investigations show that Airport tract Ancestral Puebloan sites are partially buried, primarily by recent (less than 700 to 800 year old) eolian deposits, and are underlain by less than 1.5 m of Pleistocene and Holocene deposits overlying Bandelier Tuff bedrock. The Ancestral Puebloan 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") (Figure 10). Locally, relatively thick valley fill deposits include an early Holocene stratigraphic record. The thickness of deposits is likely controlled by geomorphic position, with thicker deposits filling mesa top swales and shallow valleys (e.g., LA 135290 and EG&G gully) and thinner deposits and stripped surfaces located near the mesa edges or mesa top (e.g., LA 86534 and LA 139428). LA 86533, a Late Archaic lithic scatter, is a dispersed artifact scatter situated in an area of thin soils and exposed bedrock near the mesa edge, wherein the lithics appear to represent a lag deposit. The presence of mid Holocene deposits in several areas of the Airport tract indicates that there is the potential for the preservation of buried Archaic sites.

It is inferred that the recent eolian deposition observed at the Airport tract sites likely occurred sometime after the Middle Coalition period but prior to the Classic period; i.e., during the Late Coalition period (ca. 1250 to 1325 AD). Where it has not been eroded, the Late Coalition period eolian deposit is approximately 15 to 20 cm thick. A second, more recent eolian event occurred after abandonment of the Early Classic (?) period sites, resulting in deposition of an additional 5 to 10 cm of fine-grained sediment across the mesa top since approximately 1500 AD. Eolian deposits are thicker inside and next to roomblocks than elsewhere on the mesa, which is due to the greater trapping efficiency at these sites. Animal burrowing also seems to be more active in the abandoned roomblocks, which results in mixing of material at these sites.

Rendija Canyon sites investigated during the 2003 field season are situated on hillslopes, ridge tops, and valley bottoms. Results of the site investigations indicate that two widespread episodes of colluvial deposition have occurred that overlie Qct bedrock in the area. Colluvial deposits in the area appear to contain a significant component of eolian or reworked eolian sediment. The colluvial deposits include thin late Holocene deposits less than 25 cm thick overlying late Pleistocene or early Holocene deposits or mid to late Holocene swale fill deposits less than 1.5 m thick. Late Pleistocene or early Holocene soils are truncated, indicating erosion sometime during the Holocene, prior to deposition of the late Holocene colluvium. The development of shallow drainages and their subsequent filling is recorded by mid to late Holocene swale fill deposits. Valley bottoms preserve 1.5 to 2 m thick mid to late Holocene colluvial deposits and an unknown thickness of underlying early Holocene and/or late Pleistocene deposits. The Holocene and Pleistocene sections exposed in gullies have excellent potential for preservation of Archaic or older sites. The deep gully incision in the area apparently post-dates an Apache tipi ring site, and therefore occurred sometime after the mid to late 1800s.

Relative soil development suggests that the buried soils within which the Archaic artifacts are found at LA 85859, LA 99396 and LA 99397 are late Pleistocene in age. However, ^{14}C dates and diagnostic points collected from the ground surface in the vicinity of LA 85859 suggest an age of ca. 7 ka, which is younger than age estimates based on the degree of soil development. Because of uncertainties in the rates of soil development and in the context of the dated charcoal and the diagnostic points, available evidence suggests that these buried soils may be either late Pleistocene or early Holocene in age. Additional ^{14}C analyses of charcoal samples collected from a variety of soil horizons at LA 85859, LA 99396 and LA 99397 could help constrain rates of soil development in Rendija Canyon eolian and colluvial deposits, and could help provide better age constraint for the sites.

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APPENDIX A

SOIL HORIZON NOMENCLATURE

APPENDIX A: SOIL HORIZON NOMENCLATURE

From Birkeland, 1999

DESCRIPTION OF MASTER HORIZON, HORIZON, AND SUBHORIZONS

O horizon—Surface accumulations of mainly organic material; may or may not be, or has been, saturated with water. Subdivided on the degree of decomposition as measured by the fiber content after the material is rubbed between the fingers.

Oi horizon—Least decomposed organic materials; rubbed fiber content is greater than 40% by volume.

Oe horizon—Intermediate degree of decomposition; rubbed fiber content is between 17 and 40% by volume.

Oa horizon—Most decomposed organic material; rubbed fiber content is les that 17% by volume.

A horizon—Accumulation of humified organic matter mixed with mineral fraction; the latter is dominant. Occurs at the surface or below an O horizon; Ap is used for those horizons disturbed by cultivation.

E horizon—Usually underlies an O or A horizon, and can be used for eluvial horizons within or between parts of the B horizon (e.g., common above fragipan, x). Characterized by less organic matter and/or fewer sesquioxides (compounds or iron and aluminum) and/or less clay than the underlying horizon. Many are marked by a concentration of sand and silt. Horizon is light colored due mainly to the color of the primary mineral grains because secondary coatings on the grains are absent; relative to the underlying horizon, color value will be higher or chroma will be lower.

B horizon—Underlies an O, A, or E horizon, and shows little or no evidence of the original sediment or rock structure. Several kinds of B horizons are recognized, some based on the kinds of materials illuviated into them, others on residual concentrations of materials.

Subdivisions are:

Bh horizon—Illuvial accumulation of amorphous organic matter-sesquioxide complexes that either coat grains or form sufficient coatings and pore fillings to cement the horizon.

Bhs horizon—Illuvial accumulation of amorphous organic matter-sesquioxide complexes, and sesquioxide component is significant; both color value and chroma are three or less.

Bk horizon—Illuvial accumulation of alkaline earth carbonates, mainly calcium carbonate; the properties do not meet those for the K horizon.

Bl horizon—Illuvial concentrations primarily of silt (Formal and Miller, 1984). Used when silt cap development reaches stages 5 and 6.

Bo horizon—Residual concentration of sesquioxides, the more soluble materials having been removed.

Bq horizon—Accumulation of secondary silica.

Bs horizon—Illuvial accumulation of amorphous organic matter-sesquioxide complexes if both color value and chroma are greater than three.

Bt horizon—Accumulation of silicate clay that has either formed in situ or is illuvial (clay translocated either within the horizon or into the horizon); hence it will have more clay than the assumed parent material and/or the overlying horizon. Illuvial clay can be recognized as grain coatings, bridges between grains, coatings on ped or grain surfaces or in pores, or thin, single or multiple near-horizontal descrete accumulation layers of pedogenic origin (clay bands or lamellae). In places, subsequent pedogenesis can destroy evidence of illuviaiton. Although Soil Survey Division Staff (1993) does not include this, clay accumulation that lacks evidence for illumiation is included (could have been formed in situ, for example).

Bw horizon—Development of color (redder hue or higher chroma relative to C) or structure, or both, with little or no apparent illuvial accumulation of material.

By horizon—Accumulation of secondary gypsum.

Bz horizon—Accumulation of salts more soluble than gypsum.

K horizon. A subsurface horizon so impregnated with carbonate that its morphology is determined by the carbonate (Gile and others, 1965). Authigenic carbonate coates or engulfs nearly all primary grains in a continuous medium. The uppermost part of a strongly developed horizon is laminated, brecciated, and/or pisolithic (Machette, 1985). The cemented horizon corresponds to some caliches and calcretes.

C horizon—A subsurface horizon, excluding R, like or unlike materials from which the soil formed, or is presumed to have formed. Lacks properties of A and B horizons, but includes materials in various stages of weathering.

Cox and Cu horizons—In many unconsolidated deposits, the C horizon consists of oxidized material overlying seemingly unweathered C. The oxidized C does not meet the requirement of the Bw horizon. In stratigraphy, it is important to differentiate between these two kinds of C horizons. Here Cox is used for oxidized C horizons and Cu for unweathered C horizons. Cu is from the nomenclature of England and Wales (Hodson, 1976). Alternatively the Cox can be termed BC or CB.

Cr horizon—In soils formed on bedrock, there commonly will be a zone of weathered rock between the soil and the underlying rock. If it can be shown that the weathered rock has formed in place, and has not been transported, it is designated Cr. Such material is the saprolite of geologist; in situ formation is demonstrated by preservation of original rock features, such as grain-to-grain texture, layering, or dikes. If such material has been moved, however, the original structural features of the rock are lost, and the transported material may be the C horizon for the overlying soil. Those Cr horizons with translocated clay, as shown by clay films, are termed Crt.

R horizon—Consolidated bedrock underlying soil.

Selected Subordinate Departures

Lower-case letters follow the master horizon designation. Those that are mainly specific to a particular master horizon are give above. Some can be found in a variety of horizons; they are listed below.

b Buried soil horizon with major features formed prior to burial. May be deeply buried and not affected by subsequent pedogenesis; if shallow, they can be part of a younger soil profile.

c Concretion or nodules cemented by accumulations of iron, aluminum, magnaneses, or titanium.

f Horizon cemented by permanent ice. Seasonally frozen horizons are not included, nor is dry permafrost material (material that lacks ice but is colder than 0ºC).

g Horizon in which gleying is a dominant process, that is, either iron has been removed during soil formation or saturation with stagnant water has preserved a reduced state. Common to these soils are neutral colors, with or without mottling. Most have chromas of 2 or less and many have redox concentrations. Strong gleying is indicated by chromas of one or less, and hues bluer than 10Y. Much of the above color is due to the color of reduced iron, or the color of uncoated grains from which iron pigment has been removed. Bg is used for horizons with pedogenic features in addition to gleying; however, if gleying is the only pedogenic feature, the horizon is designated Cg.

j Used in combination with other horizon designation (Btj, Ej) to denote incipient development of that particular feature or property (National Soil Survey Committee of Canada, 1974). A rule for some designations would be to use it for those horizons that do not meet criteria for diagnostic horizons (e.g., Ej for an eluvial horizon that does not meet the criteria of the albic horizon).

k Accumulation of alkaline earth carbonates, commonly $CaCO_3$.

m Horizon that is more than 90% commented. Denote the cementing material (Km, carbonate; qm, silica; Kqm, carbonate and silica; etc.).

n Accumulation of exchangeable sodium.

ss Presence of slickensides.

v Has two uses. (1) One is plinthite, iron-rich, humus-poor, reddish material that hardens irreversibly when dried. (2) If A horizons in arid environments have a vesicular structure (round voids), they are designated Av (McFadden, 1988).

x Subsurface horizon characterized commonly by a bulk density greater than that of the adjacent horizons, firmness and brittleness, and very coarse prismatic structure with bleached vertical faces (fragipan character). An E horizon may oerlie the fragipan horizon at depth as well as between the A and Bt horizons higher in the profile. If the E-horizon nomenclature designations are identical, and both are pedogenic, a prime is applied to the lower E horizon. In this example, the profile would be A/E/Bt/E'/Bx/Cox.

y accumulation of gypsum.

z Accumulation of salts more soluble that gypsum (e.g., NaCl).

APPENDIX B

Key to symbols used in descriptions of soil morphology

APPENDIX B: Key to symbols used in descriptions of soil morphology (from Birkeland (1984) and McDonald (1996))

Structure

Grade	Size	Type	Other
1 = weak	vc = very coarse	sbk = subangular blocky	: = parting to (e.g. pr:pf)
2 = moderate	c = coarse	abk = angular blocky	
3 = strong	m = medium	pr = prismatic	
	f = fine	pl = platy	
		sg = single grain	
		m = massive	

Consistence

Dry	Moist	Wet - Stickiness	Wet - Plasticity
lo = loose	lo = loose	so = non sticky	po = non-plastic
so = soft	vfr = very friable	vss = very slightly sticky	vps = very slightly plastic
sh = slightly hard	fr = friable	ss = sticky	ps = slightly plastic
h = hard	fi = firm	s = sticky	p = plastic
vh = very hard	vfi = very firm		

Cutans

Abundance	Thickness/(Distinctness)	Location/Type	Type
n.o. = none observed	n = thin (faint)	po = along pores	man = mangans
v1 = very few (< 5%)	mk = moderately thick (distinct)	co = coating gravel, ped faces	skel = skeletons
1 = few (2 - 25%)	k = thick (prominent)	br = bridging grains	si = silans
2 = common (25 - 50%)		pf = along ped faces (as co + br)	
3 = many (50 - 75%)		pr:pf along prismatic ped faces	
4=near continuous (75+%)		bk:pf on blocky ped faces	
		Lam = lamellae	
		Non-lam = interspace between lamellae	
		PI: ped interior	
		prfc: pressure faces	
		irg = irregular shape	

Horizon Boundary

Thickness	Topography	Carbonate effervescence in HCl
a =abrupt (< 2.5cm)	s = smooth	none = non-effervescent
c = clear (2.5 - 6cm)	w = wavy	e = slightly effervescent
g = gradual (6-12.5cm)	i = irregular	es = strongly effervescent
d = diffuse (> 12.5 cm)	b = broken	ev = violently effervescent
		e- = very slightly effervescent

Texture

s = sand	sil = silt loam
ls = loamy sand	scl = sandy clay loam
sl = sandy loam	sicl = silty clay loam
l = loam	cl = clay loam

APPENDIX C

Soil properties utilized in field descriptions

From Birkeland (1999), Appendix A, and Table 1.3

Structure

Describe type, grade, and structure size. If the structure is not apparent, take a spade full of the soil and tap it horizontally on the ground and look for repeating patterns.

Type of Structure: Use Table 1.3 to define the type of soil structure.

Grade:

m—massive. Enough aggregation to maintain a vertical face but no formation of structure type (structureless).

sg—single grain. No aggregation (structureless). Loose grains of a sand dune are a good example.

1—weak. Peds barely observable in place, and, when disturbed, few entire peds are observed; much of the material is unaggregated.

2—moderate. Peds easily observable in place. When disturbed, there is a mixture of whole peds, broken peds, and some material not organized into peds.

3—strong. Peds are distinctly visible in place, and, when disturbed, nearly the entire mass consists of whole peds.

Size: Size differs with the kind of structure as shown in Table A1.4. Smaller structural units may be held together in such a way as to form larger units. For example, small subangular blocky units may combine in such a way to form larger prismatic units. The dominant structure is the primary structure when calculating PDI values, and the subordinate structure is the secondary structure.

Table 1.3 Description and Probable Origin of Soil Structure

Type	Sketch[a] and Description		Probable Origin[b]	Usual Associated Soil Horizon
Granular		Spheroidally shaped aggregates with faces that do not accommodate adjoining ped faces	Colloids, mainly organic, bind the particles together; clay and Fe and Al hydroxides may be responsible for some binding, and flocculating capacity of some ions, such as Ca^{2+}, may be helpful; periodic dehydration helps form more stable aggregates	A
Angular blocky		Approximately equidimensional blocks with planar faces that are accommodated to adjoining ped faces; face intersections are sharp with angular blocky, rounded with subangular blocky	Many faces may be intersecting shear planes developed during swelling and shrinkage that accompany changes in soil moisture	Bt
Subangular blocky				
Prismatic		Particles are arranged about a vertical line, and ped is bounded by planar vertical faces that accommodate adjoining faces; prismatic has a flat top, and columnar a rounded top.	Faces develop as a result of tensional forces during times of dehydration; rounded column tops may be due to some combination of erosion by percolating water and greater amounts of upward swelling of column centers on wetting	Bt
Columnar				Bn
Platy		Particles are arranged about a inherited horizontal plane	May be related to particle size orientation from parent material or induced by freeze–thaw processes	E, or those with fragipan
			May be related to layering in cementing material, induced during its precipitation(carbonate, silica, Fe hydroxides)	Km, Bqm, Bs

[a]Taken from Soil Survey Staff (1975).

[b]From Baver (1956), Black (1957), Rode (1962), and White (1966).

Gravel Content

Estimate volume percentage occupied by gravel (>2 mm). Weight percentage can be determined in the field with a screen (one can use an inexpensive 3-mm door screen) and a hand-held portable scale. Be watchful for shape and lithologic changes during the screening process, as they may indicate parent materials of more than one origin.

Consistence

Consistence is a measure of the adherence of the soil particles to the fingers, the cohesion of soil particles to one another, and the resistance of the soil mass to deformation. Soil Survey Division Staff (1993) has changed some of the terms, but the older terms are kept here as PDI values are based on them. Because this property varies with moisture content, it is taken when the soil is dry, moist, and wet. The wet consistence (natural or artificial wetness) is useful in determining texture classes in the field.

Dry Consistence (naturally dry in exposure):

lo—loose. Noncoherent, such as grains of a sand dune.
so—soft. Easily fails to powder or single grain, with very slight force between thumb and forefinger.
sh—slightly hard. Easily fails under slight force between thumb and forefinger.
h—hard. Fails in the hands without difficulty; requires strong force to fail between thumb and forefinger.
vh—very hard. Fails in hands with difficulty, but not between thumb and forefinger.
eh—extremely hard. Cannot be failed in hands.

Moist Consistence (usual moisture when one digs back into exposure):

lo—loose. Noncoherent.
vfr—very friable. Easily fails to powder or single grain, with very slight force between thumb and forefinger.
fr—friable. Fails under slight force between thumb and forefinger.
fi—firm. Fails under moderate force between thumb and forefinger.
vfi—very firm. Fails under strong force between thumb and forefinger.
efi—extremely firm. Fails under very strong force between hands but cannot be crushed between thumb and forefinger.

Wet Consistence (usually wetted artificially, but not so much the mass flows):

Stickiness is measured by pressing the wet soil between the thumb and forefinger and noting its adherence.

so—nonsticky. Practically no adherence to thumb and forefinger when pressure released.
ss—slightly sticky. After release of pressure, soil adheres to both thumb and forefinger but comes off one or the other rather cleanly. Does not appreciably stretch.
s—sticky. After release of pressure, soil adheres to both thumb and forefinger and tends to stretch somewhat before pulling apart from either digit.
vs—very sticky. After release of pressure, soil adheres strongly to both digits and is markedly stretched when they are separated.

Table A1.4 Classes of Soil Structure

0 20 40

Scale (in mm)

Size Class	Diameter of Granules (mm)	Thickness of Plates (mm)	Diameter of Blocks (mm)	Diameter of Prisms (mm)
vf—very fine	<1	<1	<5	<10
f—fine	1–2	1–2	5–10	10–20
m—medium	2–5	2–5	10–20	20–50
c—coarse	5—10	5–10	20–50	50–100
vc—very coarse	>10	>10	>50	>100

Plasticity is measured by rolling the wet soil between the thumb and forefinger and observing whether a roll can be formed and maintained.

po—nonplastic. No roll can be formed.
ps—slightly plastic. A roll 4 cm long and 6 mm thick can be formed and, if held on end, will support its own weight. A 4-mm-thick roll will not support its own weight. The roll is easily deformed and broken.
p—plastic. A roll 4 cm long and 4 mm thick can be formed and support its own weight. A 2-mm-thick roll will not support its own weight.
vp—very plastic. A roll 4 cm long and 2 mm thick can be formed and support its own weight. The roll is readily bent into a half or full circle.

Texture

Use established names from the textural triangle (Fig. A1.3). Screen out gravels and determine the textural class of the <2-mm fraction by noting the grittiness and wet consistence as shown in Fig. A1.4 (see also useful table of properties in Foss and others, 1975). Broad guidelines are given in the figure, but for more accuracy one should calibrate one's fingers by texturing samples with known particle-size distribution.

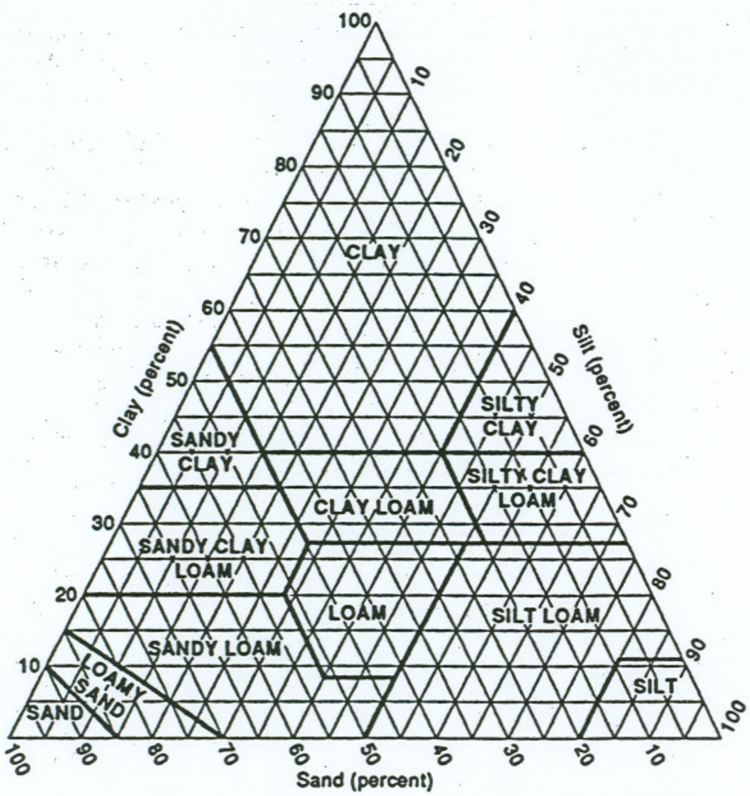

Figure A1.3 Textural names and abbreviations of names versus sand–silt–clay contents. *(Redrawn from Soil Survey Division Staff, 1993, Fig. 3.16.)*

TEXTURAL ABBREVIATIONS:				MODIFIER ABBREVIATIONS:	
C	Clay	SCL	Sandy Clay Loam	vf	very fine
CL	Clay Loam	SL	Sandy Loam	f	fine
L	Loam	Si	Silt	co	coarse
LS	Loamy Sand	SiC	Silty Clay	vco	very coarse
S	Sand	SiCL	Silty Clay Loam	g	gravelly
SC	Sandy Clay	SiL	Silt Loam		

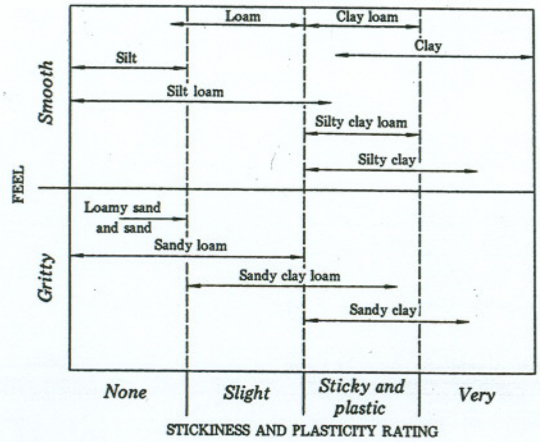

Figure A1.4 Approximate relations between texture class, grittiness, and wet consistence.

Clay Films

Clay films are thin layers of oriented clay and are described by recording their amount, distinctness, and locations. Study the peds with a hand lens in the field, or with a binocular microscope in the laboratory.

Amount:

v1—very few. Occupies less than 5% of the total area of the kind of surface described.
1—few. Occupies 5–25% of the total area of the kind of surface described.
2—common. Occupies 25–50% of the total area of the kind of surface described.
3—many. Occupies more than 50% of the total area of the kind of surface described.

The same classes are used to describe the amount of bridges connecting particles of structureless soil bodies. The amount is judged on the basis of the percentage of particles of the size designated that are joined to adjacent particles of similar size by bridges at contact points.

Distinctness: Distinctness refers to the ease and degree of certainty with which a surface feature can be identified. Distinctness is related to thickness, color contrast with the adjacent material, and other properties, but is not itself a measure of any one of them. Some thick films, for example, are faint, whereas some thin ones are prominent. The distinctness of some surface features changes markedly as the amount of moisture changes; therefore, the soil-water state might be specified. Clay films are difficult to recognize in wet soils. If classifying films on ped faces, compare features on a ped face with those on a nonstructural face broken across the ped. Three distinctness classes are used.

f—faint. Evident only on close examination with 10× magnification and cannot be identified positively in all places without greater magnification. The contrast with the adjacent material in color, texture, and other properties is small.
d—distinct. Can be detected without magnification, although magnification or tests may be needed for positive identification. The feature contrasts enough with the adjacent material that a difference in color, texture, or other properties is evident.
p—prominent. Conspicuous without magnification when compared with a surface broken through the soil. Color, texture, or some other property or combination of properties contrasts sharply with properties of the adjacent material, or the feature is thick enough to be conspicuous.

Location of Clay Films: Oriented clay is present as films on peds, inside of pores, or as bridges between grains and coats on grains. If films are preferential to some orientation (horizontal vs vertical), this should be noted.

pf—clay films occur on ped faces. Where the structure grade is weak or the soil is structureless, ped faces are indistinct or absent. It is probable that only when the structure grade is moderate or strong are the clay films on ped faces discernible.
po—clay films line tubular or interstitial pores.
br—oriented clay occurs as bridges holding mineral grains together. This is probably an initial step that occurs before clay films coat grains and is best observed in coarse-textured soils.
co—colloid coats mineral grains.
cobr—coats and bridges are present. This is probably more common than coats or bridges alone.

In describing clay films, care must be exercised not to confuse pressure faces with clay films. The former are common in soils with high clay content (Vertisols; shrink–swell clay such as smectite is best), and seasonal wetting and drying. Pressure faces arise when swelling pushes structural aggregates together and makes their sides smooth and, in places, reflective. At times these are difficult to differentiate from clay films, but some clay films can also be partly pressure faces. Slickensides are produced in the same manner, but are better developed, being polished and striated, and usually at >50 cm depth. Where slickensides are prominent, they are extensive and oriented at 20–30° from the horizontal to form wedges (Ahmad, 1983). If the shrinking and swelling that produce slickensides are extensive enough, wide and deep ground cracks will form during the dry season.

Examples of Clay-Film Descriptions:

3d po—many distinct clay films in pores.
2f pf and po—common faint clay films on peds and in pores.
3p pf, 2f po—many prominent clay films on ped faces, common faint clay films in pores.

It is important to record clay films because their presence is strong evidence for pedogenically illuviated clay. However, be warned that in places clay films can be original depositional (parent material) features. Waters charged with fine sediment that infiltrate a flood plain can produce clay films at depth (Walker and others, 1978), as can similar waters infiltrating till at the base of a glacier. If these latter parent-material films are present below the main soil-forming zone, their color will be closer to that of the parent material than to that of the soil.

Horizon Boundaries

Describe the lower boundary of each horizon, indicating distinctness and general topography.

Distinctness:

a—abrupt. Transition is less than 2 cm.
c—clear. Transition is 2–5 cm thick.
g—gradual. Transition is 5–15 cm thick.
d—diffuse. Transition is more than 15 cm thick.

Topography: Topography refers to the nature of the surface that separates the horizons. The modifiers sl (slightly) and v (very) may be used in combination with the following abbreviations.

s—smooth. Boundary is planar or parallel to the geomorphic surface.
w—wavy. Undulating surface with pockets wider than they are deep.
i—irregular. If pockets are deeper than their width.
b—broken. If one or both of the horizons separated by the boundary are discontinuous, so that boundary is interrupted.

Stages of Carbonate Morphology

Describe the stage of morphology (Fig. A1.5, Tables A1.5 and A1.6). In some places, there may not be stage II morphology in a sequence of nongravelly soils; rather, filaments of stage I become so common that the horizon meets the approximate percentage requirements for stage II. Holliday (1982) suggests that these latter occurrences be termed IIf to indicate their filamentous morphology.

I want to inject a word of caution on the recognition of carbonate morphological stages. In places, carbonate can be deposited on vertical faces by laterally seeping waters and thereby mask the pedogenic carbonate morphology (Lattman, 1973). In addition, M.N. Machette and R.E. Anderson (personal communication, 1991) have observed strong lateral (on contour) variations in carbonate morphology and accumulation along natural arroyos in arid parts of the eastern Great Basin. Hence, to study the morphology of pedogenic carbonate and avoid surficial cementation, one may have to dig back a meter or more.

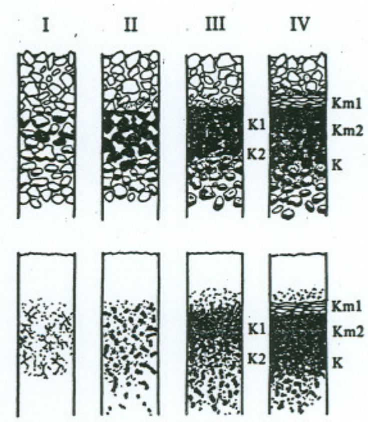

Figure A1.5 Sketch of carbonate buildup stages (I, II, III, IV) for gravelley (top) and nongravelley (bottom) parent materials. Machette (1985) added two more stages beyond stage IV (Table A1.5). In general, the stage morphologies merge to a common form at about stage III. *(Redrawn and modified from Gile and others, 1966, © 1966, The Williams & Wilkins Co., Baltimore.)*

Table A1.5 Stages of Carbonate Morphology

Stage	Gravelly Parent Material	Nongravelly Parent Material
I	Thin discontinuous clast coatings; some filaments; matrix can be calcareous next to stones; about 4% $CaCO_3$	Few filaments or coatings on sand grains; <10% $CaCO_3$
I+	Many or all clast coatings are thin and continuous	Filaments are common
II	Continuous clast coatings; local cementation of few to several clasts; matrix is loose and calcareous enough to give somewhat whitened appearance	Few to common nodules; matrix between nodules is slightly whitened by carbonate (15–50% by area), and the latter occurs in veinlets and as filaments; some matrix can be noncalcareous; about 10–15% $CaCO_3$ in whole sample, 15–75% in nodules
II+	Same as stage II, except carbonate in matrix is more pervasive	Common nodules; 50–90% of matrix is whitened; about 15% $CaCO_3$ in whole sample
Continuity of fabric high in carbonate		
III	Horizon has 50–90% K fabric with carbonate forming an essentially continuous medium; color mostly white; carbonate-rich layers more common in upper part; about 20–25% $CaCO_3$	Many nodules, and carbonate coats so many grains that over 90% of horizon is white; carbonate-rich layers more common in upper part; about 20% $CaCO_3$
III+	Most clasts have thick carbonate coats; matrix particles continuously coated with carbonate or pores plugged by carbonate; cementation more or less continuous; >40% $CaCO_3$	Most grains coated with carbonate; most pores plugged; >40% $CaCO_3$
Partly or entirely cemented		
IV	Upper part of K horizon is nearly pure cemented carbonate (75–90% $CaCO_3$) and has a weak platy structure due to the weakly expressed laminar depositional layers of carbonate; the rest of the horizon is plugged with carbonate (50–75% $CaCO_3$)	
V	Laminar layer and platy structure are strongly expressed; incipient brecciation and pisolith (thin, multiple layers of carbonate surrounding particles) formation	
VI	Brecciation and recementation, as well as pisoliths, are common	

Taken from Gile and others (1981) and Machette (1985), with further modification by R.R. Shroba (written communication, 1982).

Carbonate Effervescence

If dilute HCl (use a 1:10 ratio of concentrated HCl:water) is added to a soil containing $CaCO_3$, it will effervesce. The classes of effervescence are generally related to the amount of carbonate as well as to particle size (more rapid with smaller size) and mineralogy (slight with dolomite). Four classes are recognized:

Very slightly effervescent—few bubbles seen.
Slightly effervescent—bubbles readily seen.
Strongly effervescent—bubbles form low foam.
Violently effervescent—thick foam forms quickly.

For most geomorphic purposes, carbonate morphology stage is more useful than the classification of effervescence.

Salts and Silica Development

Pedogenic gypsum and silica have developmental stages that are similar to the stages of carbonate morphology (Table A1.7). One could devise a similar scheme for halite or any other accumulation of interest.

Cementation

Cementation refers to the brittle, hard consistence caused by some cementing agent, such as silica or $CaCO_3$, which, unlike clay, does not deform under pressure.

cw—weakly cemented. Mass is brittle and hard, but can be broken in hands.

APPENDIX D

^{14}C samples collected from soil profiles at Airport tract and Rendija Canyon tract sites

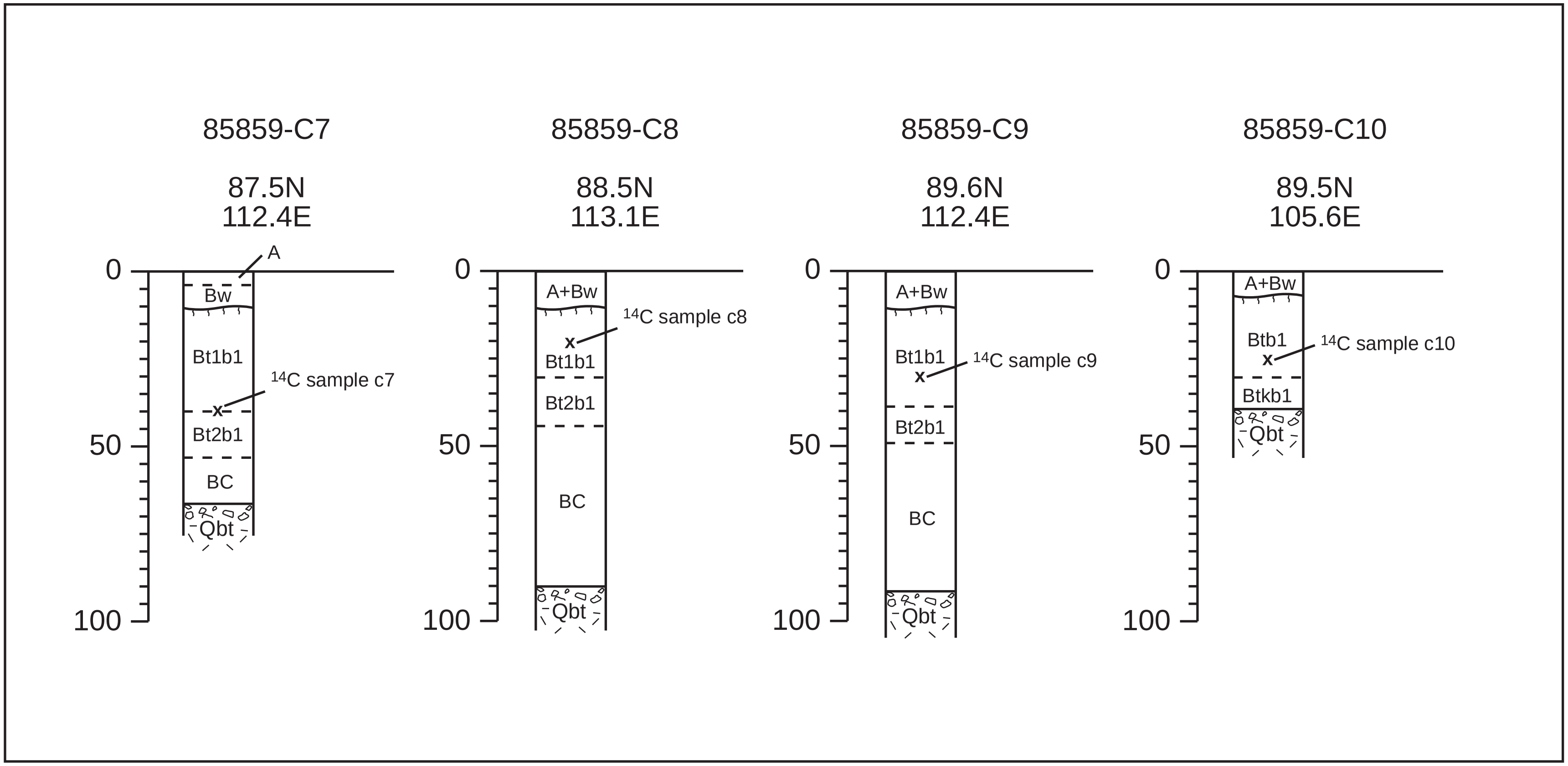

Figure D-1. ^{14}C Sample locations LA 85859 c6-c10

APPENDIX E

Artifact occurrence by soil horizon, Rendija Canyon sites LA 85859, LA 99396, and LA 99397

Table E-1. Artifact density vs. soil horizon, Rendija Canyon site LA 85859

Horizon	Depth (cm)	Artifacts (chipped stone unless otherwise noted)	
85859-1			
AC	0-4	None	
2Btb1	4 to 29	None	
2Coxb1	29-35+	None	
85859-2			
A	0-4		
Bw	4 to 14	21	
Bt1b1	14-39	6	
Bt2b1	39-59	None	
Btkb1	59-84	None	
Bkb1	84-95	None	
2Bk	95+	None	
85859-3			
A	0-5	None	
Bw	5 to 20	None	
Btb1	20-41	None	
Btkb1	41-58	1	
Bkb1	58-67	None	
2Btkb2	67-79+	None	
85859-4			
A	0-4	10 plus 1 sherd	
Bw	4 to 14	26	
Bt1b1	14-37	18	
Bt2b1	37-50	8	
Bt3b1	50-65	9	
BCb1	65-79	2	
2CBkb2	79+	None	
85859-5			
A	0-4?	123	
Bw	4-13?		
Bt1b1	13-31	282	
Bt2b1	31-46	142	28 additional artifacts in either
Bt3b1	46-58	3	Bt2b1 or Bt3b1
Bkb1	58-80	26 plus 1 possible groundstone fragment and 1 rodent bone	
2CBkb2	80+	None	
85859-6			
A	0-10	Geomorphology/soil description pit outside site; no artifacts observed	
Bw	10 to 22		
2Btb1	22-32		
2Coxb1	32+		
85859-7			
A	0-10	Geomorphology/soil description pit outside site; no artifacts observed	
Bw	10 to 23		
2Btb1	23-41		
2Coxb1	41+		
85859-8			
AC	0-4	Geomorphology/soil description pit outside site; no artifacts observed	
Bw	4 to 13		
Bt1b1	13-28		
Bt2b1	28-38		
2Bwmb2	38-60+		

Table E-2. Artifact density vs. soil horizon, Rendija Canyon site LA 99396

Horizon	Depth (cm)	Artifacts (chipped stone unless otherwise noted)
99396-1		
A	0-10	None
Bt1b1	10 to 19	1
Bt2b1	19-27	None
Bk1b1	27-40	None
Bk2b1	40-56+	None
99396-2		
A	0-10	2
Bwb1	10 to 23	None
Bkb1	23-35+	None
99396-3		
A	0-13	16
Bw	13-23	10
R	23-36+	None
99396-4		
A	0-10	5 plus: 25 additional artifacts likely in A horizon
Bt1b1	10 to 25	3
Bt2b1	25-43	Soil pit deepened by backhoe
Bkb1	43-84	excavation for soil
Btkb1	84-123	description/geomoprhology
2Btb2	123-143+	investiation; no artifacts noted
99396-5		
A	0-10	9 (0 to 3 cm)
Bw	10-29+	20?

** Note from S. Hoagland: Again our strat.s don't blend well, our strat 2 has 15 chipped stone and 1 sherd from 3 to 15 cm with strat 2 being 1 cm thick along the north end and 12 cm thick along the south end of the 1 by 1 m unit we also have 4 chipped stone from 15 cm plus

Horizon	Depth (cm)	Artifacts (chipped stone unless otherwise noted)
99396-6		
A	0-8	9
Btb1	8-15	11
Btkb1	15-23+	None

Table E-3. Artifact density vs. soil horizon, Rendija Canyon site LA 99397

Horizon	Depth (cm)	Artifacts (chipped stone unless otherwise noted)
99397-1		
A or Av	0-5	11
Bw	5 to 11	7
Bt1b1	11 to 34	None
Bt2b1	34-54	None
Btkb1	54-93+	None
99397-2		
A	0-4	1 chipped stone, 1 sherd
Bw	4 to 11	None
Btb1	11-18+	None
99397-3		
AC	0-4	None
A	4 to 14	None
Bw	14-24	None
R	24+	None
99397-4		
Av?	0-6	None
Btb1	6-20+	None
99397-5		
A	0-9	no data
Bw1	9 to 49	no data
Bw2	49-120	no data
BC	120-162	no data
Bkb1	162-182	no data
Btkb1 or b2?	182-222+	no data
LA-99397-6		
A	0-4	46
Bw	4 to 9	6
Btb1	9-23+	8
LA-99397-7		
A	0-7	11
Bw	7 to 21	23 from @ 7 to 35 cm
Bwb1	21-38	
Bwb2	38-60+	None
99397-8		
A	0-7	no data
Bw	7 to 23	no data
Bt1b1	23-48	no data
Bt2b1	48-70	no data
Btk1b1	70-105	no data
Btk2b1	105-127+	no data