GUIDEBOOK

FIRST GEOARCHAEOLOGY FIELD COURSE:

MESCALERO SANDS, SOUTHEASTERN NEW MEXICO

November 2-3, 2002
Carlsbad, New Mexico

Stephen A. Hall

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GUIDEBOOK, FIRST GEOARCHAEOLOGY FIELD COURSE: MESCALERO SANDS, SOUTHEASTERN NEW MEXICO

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By

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and

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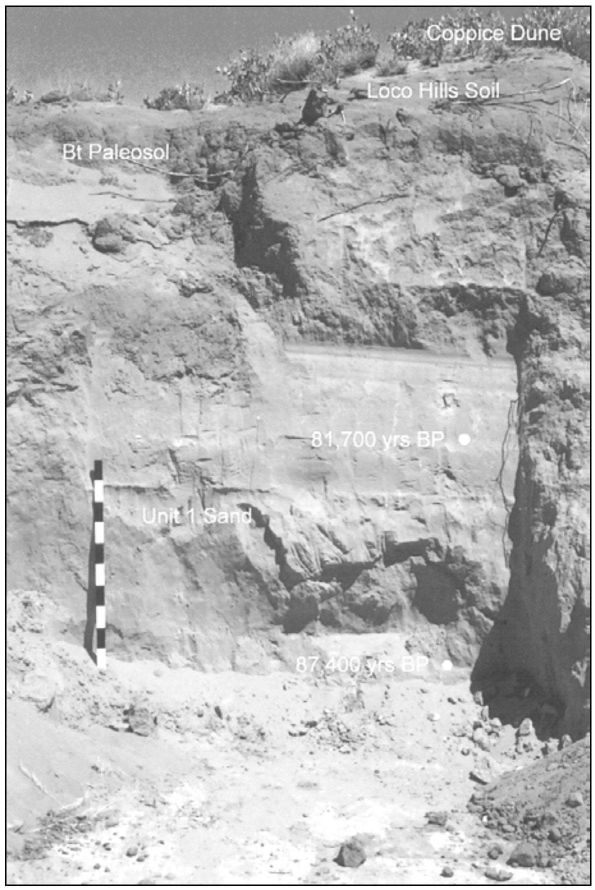
The ***Guidebook*** includes a brief description of the Localities visited in the Mescalero Sands, northeastern Eddy Co., in southeastern New Mexico during the two-day **First Geoarchaeology Field Course**. The New Mexico Bureau of Land Management and State of New Mexico Historic Preservation Division are gratefully acknowledged for their support of the **Field Course** and for providing funding for the preparation and production of the ***Guidebook***. All of the descriptions and illustrations in the ***Guidebook*** are taken from the more comprehensive *Field Guide to the Geoarchaeology of the Mescalero Sands, Southeastern New Mexico* by S. A. Hall (2002). Stratigraphic measurements are in centimeters; colors are from Munsell Soil Color Charts.

Stop 1. Valley Gas Rd. sand pit, state land; 0.8 mi. south of US Hwy. 82 on Valley Gas Rd. (Eddy Co. 212), west side of road at junction with side road; OSL samples from unit 1 sand collected here [State of New Mexico land]; *Field Guide* loc. 1.



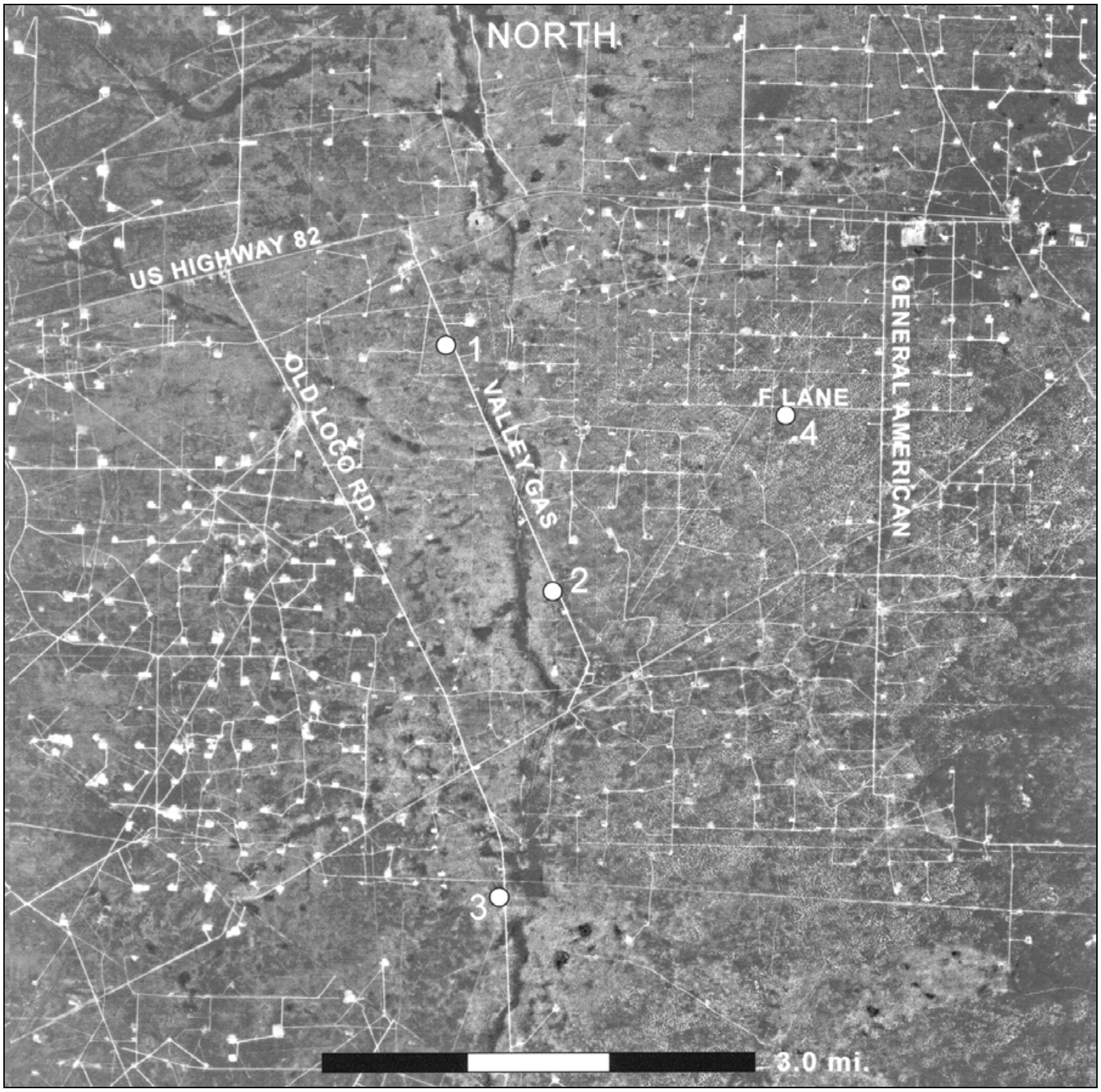
Stop 1

Fig. 1. Unit 1 sand is the oldest eolian sand body of the Mescalero Sands. It was deposited about 90,000 to 70,000 years ago directly on top of the eroded surface of the Mescalero paleosol. Before unit 1 sand was deposited, the Mescalero Sands did not exist. The sand source for unit 1 is local alluvium in small drainages that head in the Caprock escarpment that is formed by the Ogallala Formation. The upper part of the Ogallala in this region is wind-deposited fine-very fine sand; the texture of unit 1 fine-very fine sand is similar to that of the Ogallala).

<u>Stratigraphy</u>

0-40	Unit 2, yellowish red fine sand, darker-colored Loco Hills soil A horizon at top; mesquite coppice dunes resting directly on Loco Hills soil
40-110	Unit 1, red Bt paleosol in fine sand
110-350	Unit 1, red to yellowish red fine sand, massive, carbonate filaments; OSL samples taken at 200 cm (81,700 $\pm$ 3600 yrs) and 320 cm depth (87,400 $\pm$ 4500 yrs)
350-370+	Btk Mescalero paleosol, carbonate nodules in dark red clay; Bt horizon present here although it is eroded and missing elsewhere

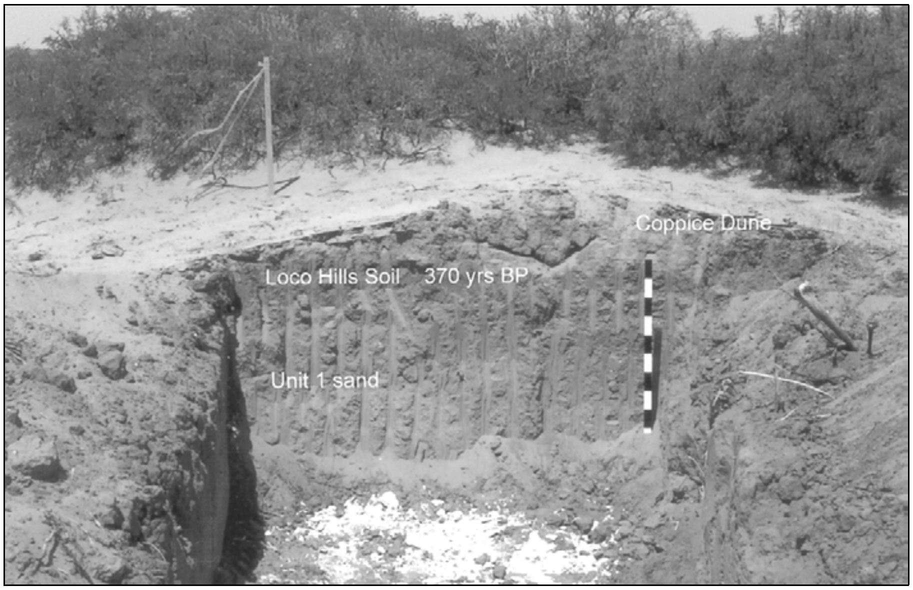
Fig. 2. Color infrared aerial photograph, altered to grayscale; centered over Bear Grass Draw west of Loco Hills community (just off the eastern edge of the image along US Highway 82); the numbered localities are documented stratigraphic and geomorphic study sites and soil pits (from S. A. Hall, 2002, *Field Guide*); dark areas along drainages are moist ground and dense grasses; the apparently featureless plain on the western half of the image is thin eolian sand cover with low mesquite coppice dunes underlain by late Pleistocene caliche; the rough-appearing surface east of Bear Grass Draw is composed of small parabolic dunes and shin oak vegetation; small white squares are oil-well pad sites connected by caliche-paved roads; image taken 6-30-83; **Stop 1**=loc.1, **Stop 2**=loc. 3.



Stop 2. Old Loco Rd. soil pit; 0.9 mi. south of Hagerman Cutoff (Eddy Co. 217) on Old Loco Rd. (Eddy Co. 210), west side of road; radiocarbon age of Loco Hills soil obtained here; *Field Guide* loc. 3.

<u>Stratigraphy</u>

0-15	Loco Hills soil A horizon, reddish brown fine sand, bioturbated; mesquite coppice dunes rest directly on soil; radiocarbon ages from A horizon are 370 $\pm$ 40 BP and modern
15-102	Unit 1, red sand, calcareous throughout, indurated, massive, lower 40 cm slightly redder with more carbonate films; sharp basal contact
102-115+	Bk Mescalero paleosol, moderately hard massive carbonates cementing sand grains



Stop 2

Fig. 3. The sand sheet is generally thin in the Bear Grass Draw drainage. At stop 2, the older unit 1 sand is about 1 meter thick and rests on the eroded Mescalero paleosol. Unit 2 is missing from this site. The Loco Hills soil (radiocarbon age here 370 ± 40 ^{14}C yrs BP) is developed directly on top of unit 1 sand. A low coppice dune occurs on top of the A horizon soil.

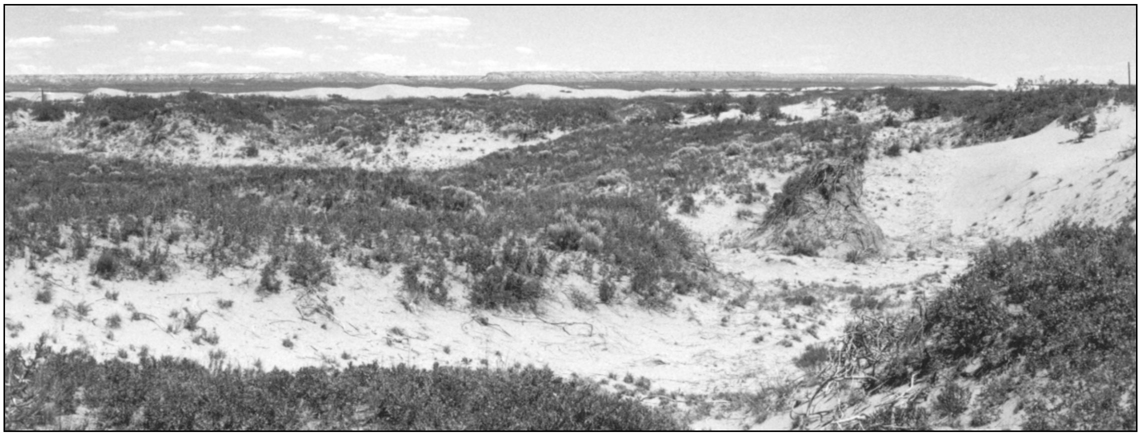
Stop 3. Hagerman Cutoff caliche pit; 4.4 mi. north of US Hwy. 82 at Loco Hills on Hagerman Cutoff (Eddy Co. 217), east side of paved road; numerous mesquite coppice dunes; *Field Guide* loc. 5; soft shoulder.

<u>Stratigraphy</u>

0-65	Unit 2 reddish yellow sand with Loco Hills soil mantling unit 2 sand
65-125	Unit 1 red sand, strongly turbated with numerous small burrow fills; red sand fills burrows and pipes in underlying caliche
125-275+	Bk Mescalero paleosol, dense but not strongly indurated carbonate-cemented sand, absence of laminar structures; voids in upper 40 cm filled with yellowish red sand, voids 40-60 cm below top of caliche filled with red sand; upper surface of caliche pitted by solution; solution pipes extend through caliche and are filled with red sand; inside surface of pipes coated with secondary carbonates

No photograph available of this stop. Caliche pit provides good exposures of the Mescalero paleosol overlain by bioturbated unit 1 red sand and unit 2 yellow sand with Loco Hills soil on top of unit 2. Numerous coppice dunes.

Stop 4. Booger Langston Rd. sand dunes; 3.0 mi. east of Hagerman Cutoff on Booger Langston Rd. (Eddy Co. 256), at right-angle turn from east to north, walk eastward towards high dunes; small area of active dunes in shinnery parabolic dune area. Stratigraphy not measured. Good exposure of unit 2 sand with **clay bands** and Loco Hills soil A horizon covered by recent dune sand. A small archaeological site is eroding out of the upper part of unit 2; *Field Guide* loc. 7; looking east, the Caprock escarpment is in the distance.



Stop 4

Fig. 4. Unit 2 sand is exceptionally thick in this central portion of the sand sheet; clay bands occur in the sand that serve as a marker for thick unit 2 sand; clay bands do not occur in unit 1 sand. The clay bands are secondary, forming though time by the downward washing of clays. The bands are generally about 5 mm thick and are about 6% clay. Clay bands occur in most sand sheets on the High Plains; older sand usually has more and thicker clay bands than does younger sand. Unit 2 sand accumulation ended about 5000 years ago, the clay bands formed since then.

Stop 5. Booger Langston Rd. sand dunes and spring deposits; 4.4 mi. east of Hagerman Cutoff on Booger Langston Rd. (Eddy Co. 256), just around corner SE of oil tanks on west side of road, walk east from road past abandoned well and oil spill towards the eastern edge of the active dunes which is the eastern margin of the study locality; shinnery parabolic dunes; site of 2 OSL ages from unit 2 sand and modern radiocarbon age from Loco Hills A horizon soil; *Field Guide* loc. 8.

Stop 5

Fig. 5. Although an occasional chert flake occurs here and there in the blowout, an archaeological site has not been found in this immediate area. If a site did occur here, following the pattern throughout the sand sheet, it would be above the clay bands in the upper part of unit 2 sand.

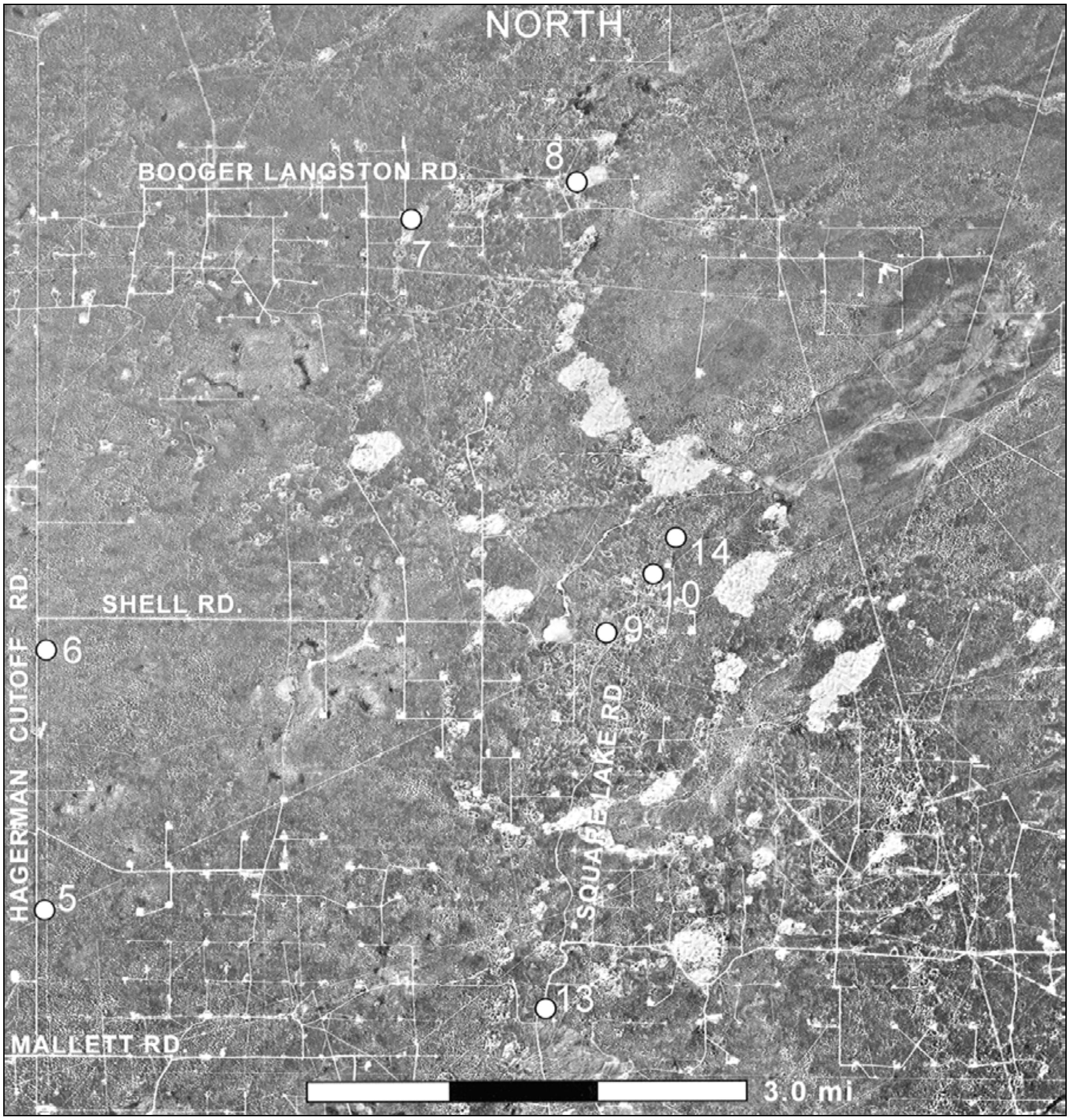
Stratigraphy

0-160	Unit 3, reddish yellow fine sand, subangular-subrounded, weak thin laminations, recent sand, eroded edge of parabolic dune covered by shin oak
160-175	Loco Hills soil A horizon, reddish yellow fine sand, slightly darker color in the field than overlying and underlying sand even though Munsell color is the same; soil appears to extend horizontally through the area of active dunes, indicating that the deflation and unit 3 dune deposition is recent eolian activity; radiocarbon age is modern
175-335	Unit 2, reddish yellow fine sand, massive, noncalcareous; OSL sample taken from 295 cm depth (6300 ± 200 yrs)
335-455	Unit 2, banded sand, bands are yellowish red fine sand, fine sand between bands is reddish yellow, bands and sand are noncalcareous, bands may be formed by iron-oxide accumulation which makes the bands redder and resistant to erosion, resulting in them standing out in relief upon deflation
455-620	Unit 2, reddish yellow fine sand, subrounded-rounded, massive, noncalcareous, strongly turbated as indicated by indurated burrow fills that stand out in relief upon abrasion of vertical sand face by wind; OSL sample taken from base of this zone at 615 cm depth (8900 ± 300 yrs); locally, a 25-cm thick zone of less red sand occurs at the base of unit 2 although this sand was not present at the section from which the lower OSL sample was collected; Unit 1 red sand is not present here although it occurs in a blowout just west of the study locality
620-650+	Spring deposits, calcareous sand, has the appearance of caliche; contains small shells of land and freshwater snails especially at the blowout at the oil spill closer to the road where the spring deposits are overlain by red sand; evidence for higher water table prior to formation of sand sheet

Stop 5

Fig. 6. Spring-cienega deposits, mostly carbonate-cemented sand, also contains small shells of aquatic and land snails and mammalian bone fragments. Radiocarbon age of shells elsewhere is about 19,000 yrs BP. The spring-cienega deposits are close in appearance to stage III carbonates of the Mescalero paleosol. The only sure way to distinguish between spring and paleosol carbonates at isolated exposures in the field is to look for snail shells...presence of snail shells indicates a spring deposit. Look closely; they are small.

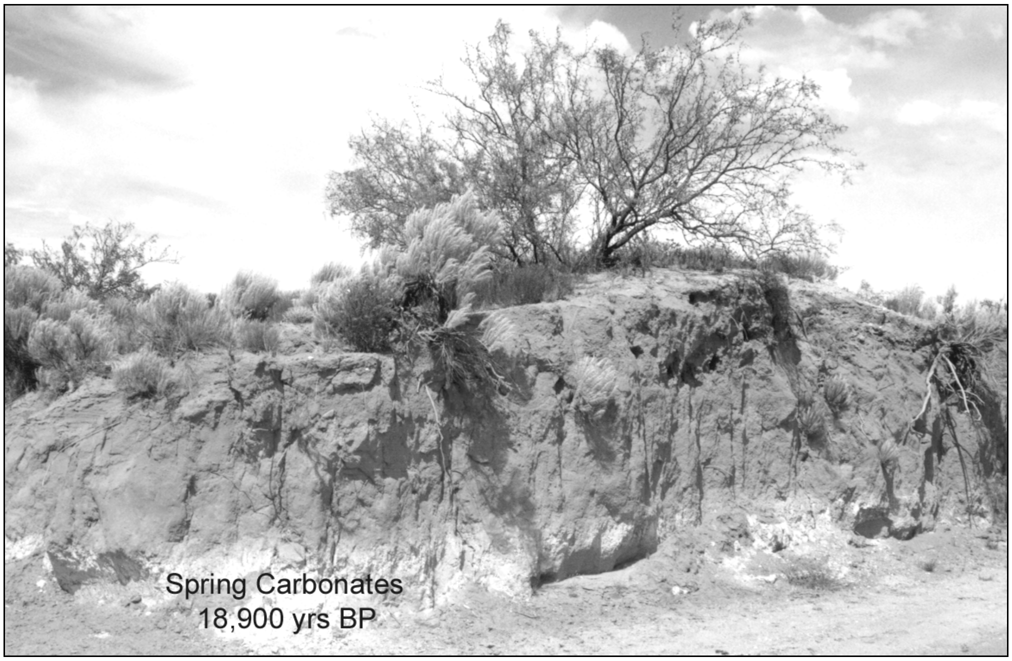
Fig. 7. Color infrared aerial photograph, converted to gray scale, of Mescalero Sands northeast of Loco Hills community; broad dark areas are shin oak-covered parabolic dunes (Peterson and Boyd, 1998); gray areas are thin eolian sand cover with scattered mesquite coppice dunes; white patches are active dune fields; small dark patches are depressions with dense plant cover; numbered localities are from S. A. Hall, 2002, *Field Guide*; image taken 9-25-83; **Stop 3**=loc. 5, **Stop 4**=loc. 7, **Stop 5**=loc. 8, **Stop 6**=loc. 14, **Stop 7**=loc. 13.



Stop 6. Square Lake Rd. spring-cienega deposit; 8.3 mi. north of US Hwy. 82 on Square Lake Rd. (Eddy Co. 220), or 1.5 mi. north on Square Lake Rd. from jct. with Shell Rd. (Eddy Co. 253), a low-water crossing of unnamed arroyo, east side of crossing; snail shells from this locality have a radiocarbon age of 18,900 ± 100 ^{14}C yrs BP; upper part of stratigraphy disturbed by road and culvert building; mesquite coppice dunes; this locality is a broad alluvial plain and, accordingly, the eolian geomorphology may not be representative of the sand sheet; the alluvial geology was not investigated; the following is a general stratigraphic sequence above the spring-cienega deposit; disturbed roadbed material, alluvium, and mesquite coppice dune sands overlie the sequence; *Field Guide* loc. 14.

Stratigraphy

0-54	Red sand, massive, noncalcareous, probably eolian in origin, may be eolian unit 2 but if it is this is the only locality where unit 2 sand is red
54-66	Bt paleosol, thin, indurated, may be developed in alluvium
66-81	Red sandy clay, carbonate films, indurated, may be thin bed of alluvium
81-166	Red sand, massive, carbonate films, not indurated, may be eolian unit 2
166-246	Spring-cienega deposit, pink, 40 to 80 cm thick, carbonate-coated sand, soft lacking induration, sharp upper contact with overlying red sand, strongly bioturbated with numerous burrow fills containing red sand derived from overlying unit, lower half of deposit with small carbonate nodules; shells of land and freshwater snails occur throughout deposit; shells are well-preserved with nacreous (pearly) luster; shell fragments from this locality provided an AMS radiocarbon age of 18,900 ± 100 ^{14}C yrs BP



Stop 6

Fig. 8. White zone at base of exposure is carbonate-coated sand of a spring deposit, the radiocarbon age of snail shells from the spring deposit is 18,900 ± 100 ^{14}C yrs BP; eolian sand with a possible thin red Bt paleosol overlies the spring deposit; eolian sand overlies red paleosol; mesquite coppice dune at top of section; the sediments may have a fluvial component and may not correlate with upland sand sheet deposits; overall, the stratigraphy here does not seem to correspond with the eolian sequence documented in the sand sheet.

The mollusks from the spring deposits indicate a cooler, moister climate than today for the area (Table 1). For example, one species of land snail (*Pupilla muscorum*) is found today at 8000 to 10,800 feet elevation on Sierra Blanca (Dillon and Metcalf, 1997); the elevation at Stop 6 is 3950 feet. Fossil pollen was not recovered from these deposits.

Table 1. Late Pleistocene mollusks from spring and cienega deposits, Mescalero Sands; preliminary list.

	Stop 8	Stop 6
AQUATIC		
Bakerilymnaea dalli		X
Fossaria modicella	X	X
Gyraulus circumstriatus		X
Lymnaea sp.		X
TERRESTRIAL		
Carychium exiguum	X	
Deroceras laeve	X	X
Gastrocopta sp.	X	X
Hawaiia miniscula	X	X
Pupilla blandi		X
Pupilla muscorum	X	X
Succinea sp.	X	X
Vallonia gracilicosta	X	X
Vertigo milium	X	X
Vertigo sp.	X	X

Other molluscan species from late Pleistocene spring deposits have been observed in the field, including the pill clam *Pisidium* sp.

Stop 7. Square Lake Rd. coppice dune; just north on Square Lake Rd. (Eddy Co. 220) from jct. with Mallet Rd. (Eddy Co. 257), or 3.6 mi. north of US Hwy. 82 on Square Lake Rd., road cut, east side; Square Lake Rd. is 2.8 mi. east of highway crossing at Loco Hills on US Hwy. 82; *Field Guide* loc. 13.

This coppice dune was chosen because of its well-preserved internal stratigraphy for pilot ^{210}Pb and ^{137}Cs analysis to test a 20th century origin of coppice dunes. A series of eight samples was collected from the 1-meter dune. The ^{137}Cs signature indicates the upper 22 cm of the dune accumulated since 1954. The ^{210}Pb signature from the upper- and lower-most samples, however, was too weak to interpret.

The coppice dune is associated with a broad colluvial-alluvial surface. The dune itself rests on a sharp contact with an underlying A horizon of the Loco Hills soil. The soil forms a low rise directly beneath the dune, suggesting that the mesquite that formed the dune also protected the underlying soil and its surface from erosion; other coppice dunes in the region also exhibit this character. The A horizon is about 20 cm thick and, immediately beneath the dune, is developed on 70-80 cm of eolian sand. The low mound of sand rests on a deposit of sand and gravel, the gravel consisting of caliche fragments. The entire deposit is exposed for some distance along Square Lake Rd. and is derived from hill slope wash. The Mescalero paleosol is exposed at a distant hilltop and is the likely source of the caliche gravel. The radiocarbon age of charcoal from the Loco Hills soil just beneath the coppice dune is 150 $\pm$ 40 ^{14}C yrs BP.

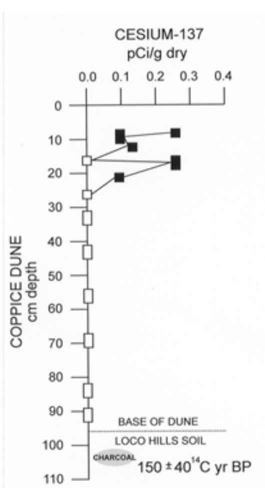
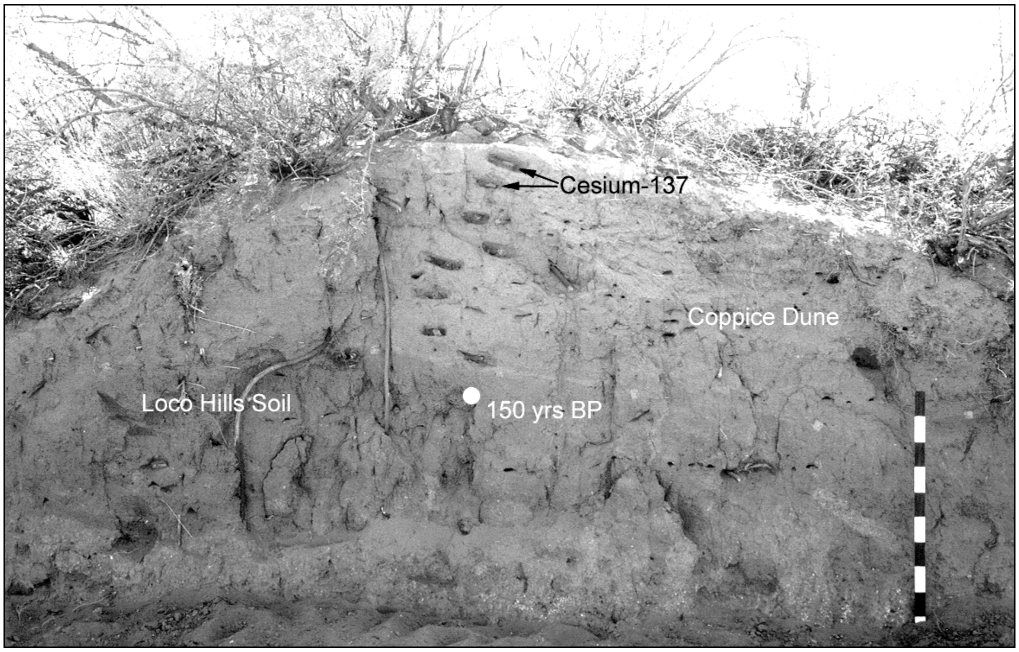


Fig. 9. Cesium-137 content vs. depth of coppice dune, Stop 7; presence of cesium-137 in upper 22 cm indicates eolian deposition accompanying atmospheric testing of atomic weapons since 1954 (Jeter, 2000).



Stop 7

Fig. 10. Torrey mesquite coppice dune; low dark zone represents Loco Hills soil A horizon; small shallow holes are locations of sediment samples for radioactive-isotope analysis; upper two samples shown here have cesium levels indicating that the upper 22 cm of the dune accumulated since 1954; 3 of 4 additional samples from the same zone also contain cesium-137; the radiocarbon age of charcoal in the Loco Hills soil just beneath the coppice dune is 150 $\pm$ 40 ^{14}C yrs BP; 10-cm increment 1-m scale.

Stop 8. Caprock Rd. spring and cienega deposits; less than 0.1 mi. south of jct. of Caprock Rd. (Eddy Co. 255) with Radio Rd. (Eddy Co. 254); white-light olive spring deposits are exposed along road cut on both sides of Caprock Rd. and extend south for about ½ mile; the exposure just south of the Radio-Caprock Rd. jct. is the highest preserved level of the 5+ meter thick deposits; *Field Guide* loc. 11.

Fig. 11, **Stop 8a**

Fig. 11. The spring-cienega deposits consist of white to light olive fine sand with carbonate matrix although soft and not indurated. The upper part of the deposit exposed along Caprock Rd. is eroded and weathered with numerous burrows and, especially below 40 cm, plant casts, and iron-oxide stains. Snail shells, mostly land and some aquatics, occur at the Caprock Rd. exposure (Table 1). Calcareous snail-bearing cienega deposits are also exposed in the small arroyo south of the road cuts. Cienega deposits are exposed in most of the small drainages in the adjacent area. Fragments of fossil mammalian bones occur sparsely in the cienega deposits. Although these deposits are not directly dated, they are late Pleistocene in age, likely correlating with the Square Lake Rd. spring deposit with a radiocarbon age 18,900 ± 100 ^{14}C yrs BP. The snail species that occur in these spring-cienega sediments are locally extinct, occurring today only in moister, cooler habitats in the central and northern New Mexico mountains.

Stop 8b

Fig. 12. Spring deposits exposed in arroyo west of Caprock Rd. locality 11; these deposits contain land and freshwater snails, pill clams, and bone fragments of mammals; late Holocene alluvium exposed on left bank.

Stop 9. Caprock Rd. alluvial section; 0.1 mi. south on Caprock Rd. (Eddy Co. 255) from jct. with Radio Rd. (Eddy Co. 254), west of Caprock Rd. in small unnamed arroyo about 200 feet, alluvial section on right bank of arroyo; this alluvial section was selected for analysis because of the prominent A horizon paleosol overlain by mesquite coppice dunes; the radiocarbon age of the A horizon is 330 ± 40 ^{14}C yrs BP; a single A horizon soil such as this one occurs towards the top of thin alluvial sequences in small drainages throughout the eastern half of the sand sheet and correlates with the Loco Hills soil that mantles eolian sand unit 2; *Field Guide* loc. 12.

Stratigraphy

0-56	Unit 3, light yellowish brown fine eolian sand, rounded, fine laminations; mesquite coppice dune
56-80	Light yellowish brown gravelly sand, subrounded-rounded, laminated in lower part, upper part turbated, caliche gravels, forms sharp erosional basal contact with underlying Loco Hills A horizon soil, small caliche gravels at contact; small gravel-filled scour trough 29 cm deep (109 cm depth) through underlying soil, gravels fine upwards, 5 cm dia. at base of trough; alluvium
80-105	Loco Hills soil, A horizon, dark brown, fine sand, upper contact sharp, erosional; lower contact gradational; soil developed in alluvium; AMS radiocarbon age is 330 ± 40 ^{14}C yrs BP
105-210+	Brown fine sand, subrounded, massive, occasional caliche gravel; alluvium; late Holocene alluvial fill inset into late Pleistocene spring-cienega deposits in this and other adjacent drainages

Stop 9

Fig. 13. Late Holocene alluvial fill with dark brown A horizon paleosol radiocarbon age 330 ± 40 ^{14}C yrs BP; young paleosol overlain by alluvium and coppice dunes.

GEOARCHAEOLOGY

We will visit some archaeological sites that exhibit various aspects of preservation and deflation and bioturbation. The following generalities apply to sites on the sand sheet.

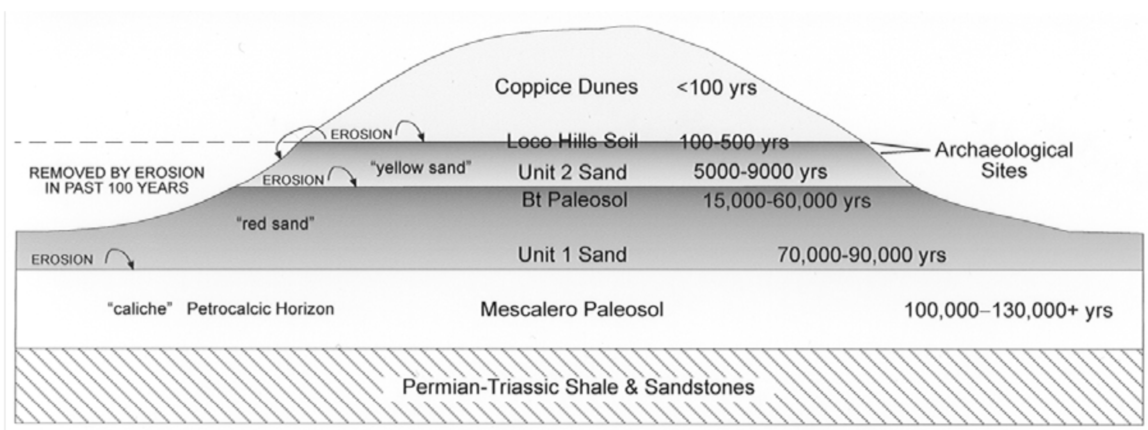
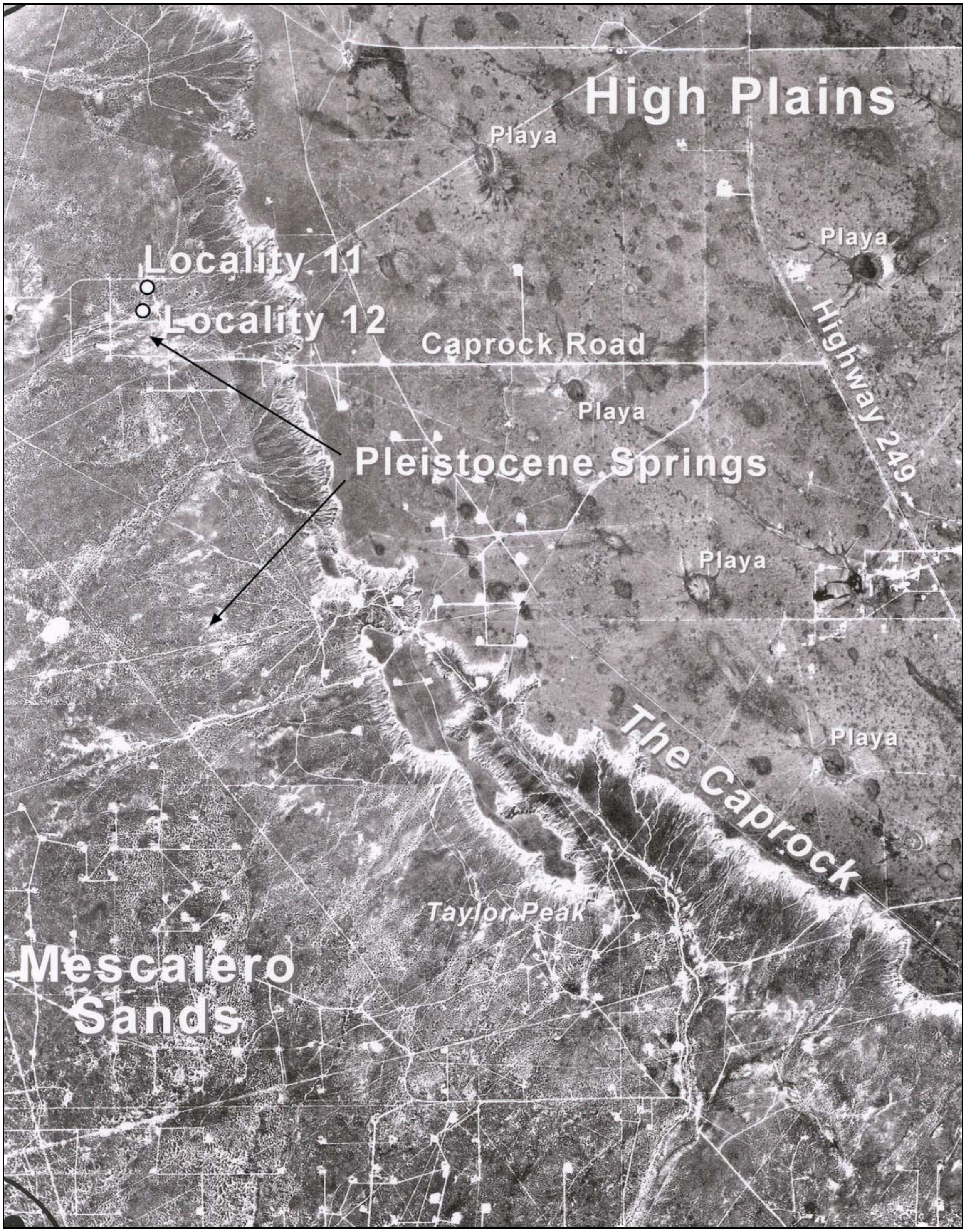


Fig. 14. A geomorphic-geoarchaeological summary of eroded areas of coppice dunes in the Mescalero Sands, indicating the stratigraphic position at the top of unit 2 sand where most archaeological sites will occur; artifacts from the top of unit 2 sand are commonly deflated from sites and are resting atop the eroded red sand.

Fig. 15. Color infrared aerial photograph, converted to grayscale, of the western Caprock escarpment north of US Highway 82 (off of image), Eddy-Lea county, New Mexico; late Pleistocene spring and cienega deposits are visible as a white band; numerous playas on the High Plains surface are visible as round features darker in color than the surrounding area due to fine-textured soils, greater soil moisture, and denser vegetation in the playa basins; some of the basins have small drainages leading to them; west of the Caprock, several streams drain westward into the present-day Mescalero sand sheet; 4.8 mi. across; image taken 9-18-83; from S. A. Hall, 2002, *Field Guide*; **Stop 8**=loc. 11, **Stop 9**=loc. 12.



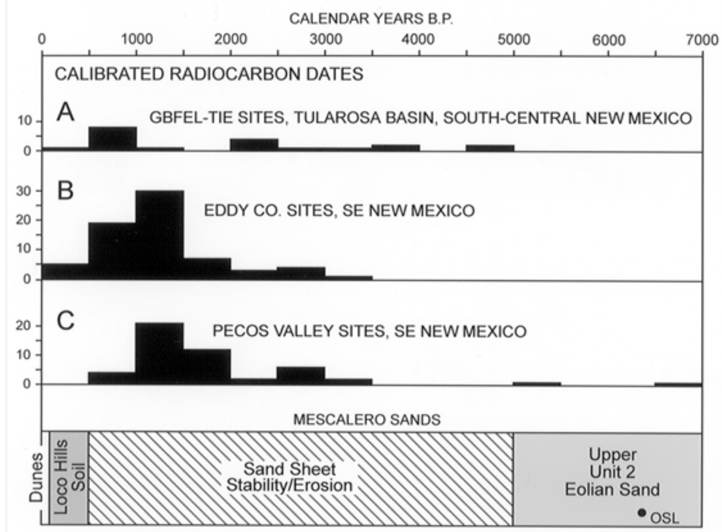


Fig. 16. Frequency of radiocarbon ages from archaeological sites in the (A) GBFEL-TIE project, Tularosa basin (Swift, 1991), (B) from sites in Eddy Co., New Mexico (calibrated ages in Katz and Katz, 2000, excluding sites listed by Sebastian, 1989), and (C) from sites in the Pecos Valley region of the Roswell district (Sebastian, 1989); radiocarbon ages are converted to calendar years (Calib 4.1 program, Stuiver and Reimer, 1993, Stuiver et al., 1998).

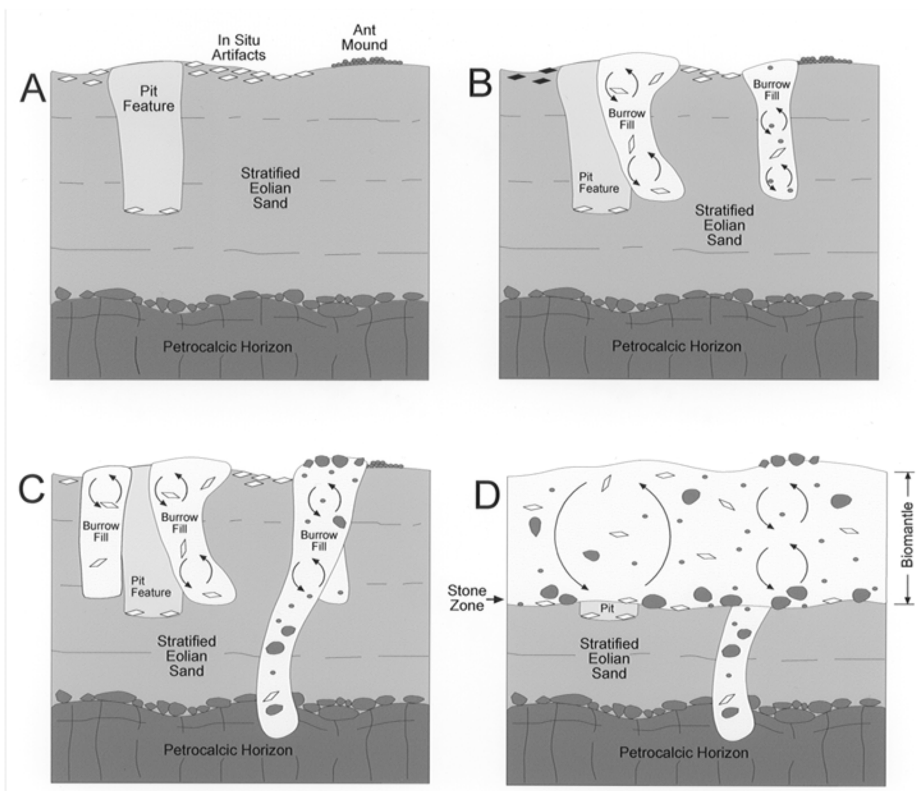


Fig. 17. The bioturbation of an archaeological site at the surface of stratified eolian sand, with time resulting in a thoroughly mixed zone (biomantle) and the development of a stone zone at its base (Johnson 1989); the prehistoric cultural levels may appear to extend to some depth; the presence of caliche pebbles scattered throughout the biomantle is evidence of bioturbation; this degree of bioturbation and biomantle development has been documented in alluvial fan deposits in the Tularosa basin (Johnson, 1997).

TESTING FOR TURBATION

The disturbance of surface sediments and soils by burrowing animals can be especially severe in the soft sandy substrate of a sand sheet. The absence of stratification can indeed be evidence for bioturbation. It may be justified to assume that bioturbation has occurred and to look for evidence against it, instead of the other way around.

In the Mescalero Sands, mesquite coppice dunes occur where both unit 1 and unit 2 sands are thin. The soft thin unit 2 sand and the thin Loco Hills A horizon soil that mantles unit 2 sand are readily eroded, exposing the underlying unit 1 red sand. The late Pleistocene red sand is harder than the yellow sand due to secondary precipitation of iron oxides and clays originating through late Pleistocene pedogenesis. Consequently, burrowing animals focus on the softer dune sand and can completely destroy a dune's internal stratigraphy. Burrowing activity commonly extends down into the underlying Loco Hills soil and unit 2 sand, thereby disturbing archaeological sites that may be present. So, even though remnant patches of sites may be preserved beneath coppice dunes in eroded areas, they may be severely disturbed by bioturbation.

The only way to know the extent of bioturbation is by careful excavation. Nevertheless, some field observations can be made prior to excavation that will provide preliminary insights on site integrity. If the following observations are negative, the potential for bioturbation and serious disturbance of sites is diminished.

LOOK FOR THESE
1. Rodent burrows at margins of coppice dune
2. Caliche pebbles (non-cultural) on sand
3. Scattered caliche pebbles within the sand column
4. Zones of caliche pebbles in the a sand column

DO THIS
3. Brush near-vertical face for faint outlines of burrow fills, fecal pellets
4. Trowel a clean face for outline of large burrow fills, caliche pebbles
5. Brush a freshly troweled face for faint outlines of smaller burrows
6. Leave a fresh face exposed to wind for a week or more; sandblasting can reveal burrows and other subtle turbation features

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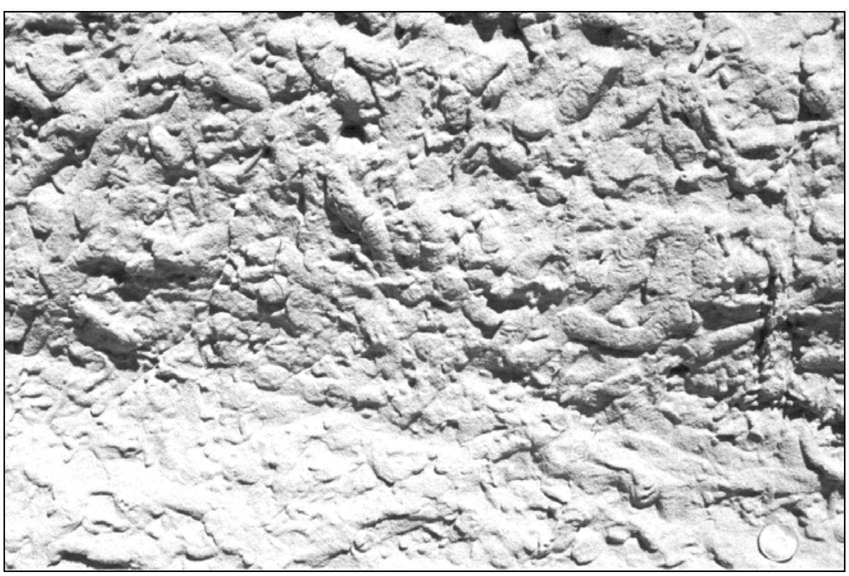

Fig. 18. Burrow fills, probably cicada insects, in lower unit 2 sand, Stop 5; burrow fills are visible in micro-relief on this vertical face due to differential hardness of the individual burrows and surrounding sand; in this example, burrows overlap and turbate other burrows; upon excavation of a clean surface, the visibility of the burrow fills is lost; penny lower right for scale.

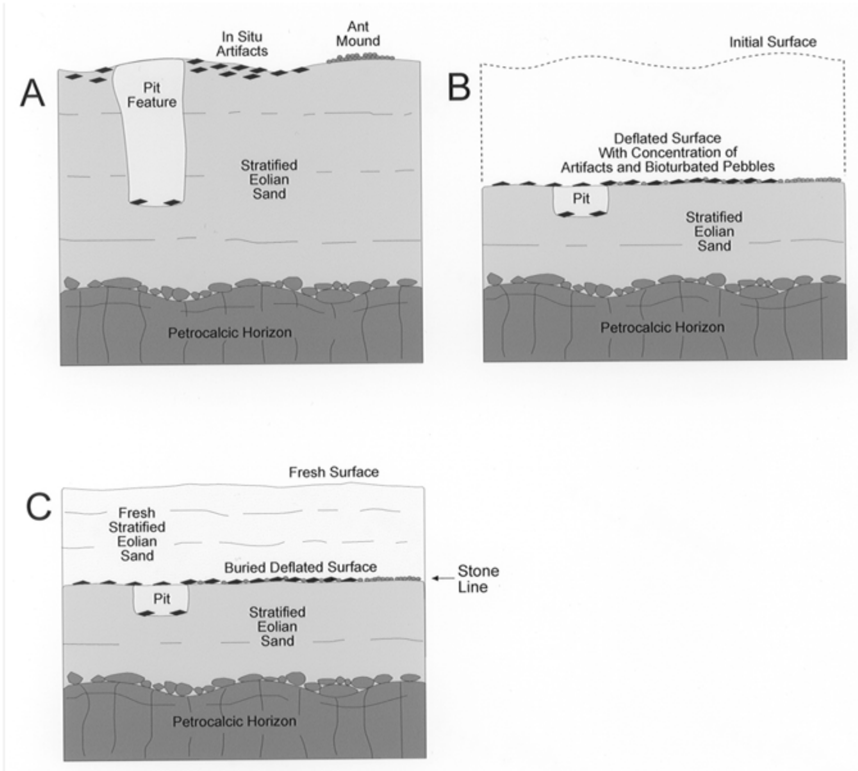

Fig. 19. (A) An *in situ* site of the stable surface of the sand sheet, (B) erosion and concentration of artifacts on an erosional surface, and (C) subsequent burial of artifact-strewn surface can result in (1) the appearance of an *in situ* cultural living floor and (2) that the age of the stratified eolian sand is incorrectly equated with the age of the artifacts.

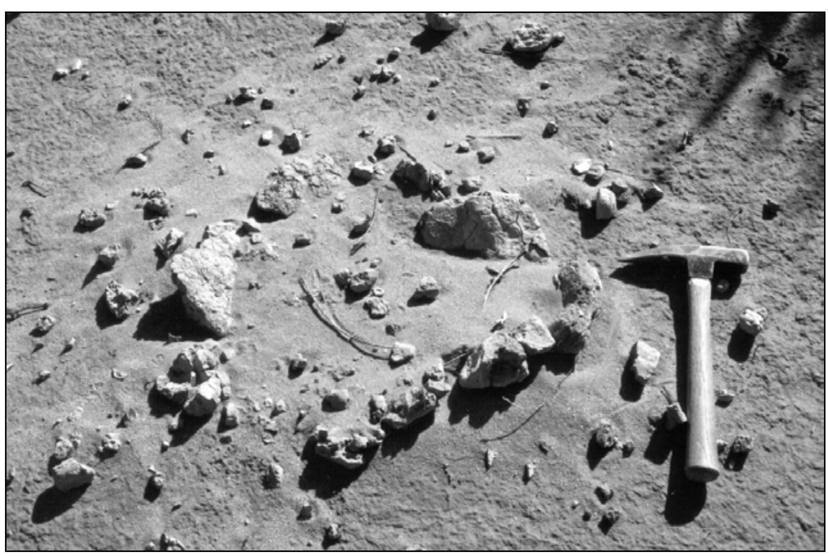

Fig. 21. Caliche-lined hearth is intrusive into older red sand (unit 1); original prehistoric surface of the site has been removed by erosion, and artifacts and caliche pebbles have been lowered onto the erosion surface; loose, recent wind-deposited sand fills the depression of the prehistoric hearth; if this feature and associated artifacts and pebbles on the eroded surface were to be buried by fresh sand, the buried surface would be a stone line and have the appearance of a prehistoric living floor.

FIELD TESTS TO IDENTIFY SAND UNITS

One of the goals of the Field Course is to identify means by which Mescalero sand units and paleosols can be recognized in the field. It is anticipated that this information can be used for determining the potential occurrence of archaeological sites. The following criteria cover commonly-encountered field situations although exceptions are to be expected.

Table 2. Field observations that can aid the identification of sand units and the likelihood of the occurrence of archaeological sites.

1. COLOR

The sands are color coded, old sands generally redder that young sands; white color generally means carbonates; tested with Munsell Soil Color Charts

Reddish yellow (5YR 6/6) .... ♦ Unit 2
Yellowish red to red (5YR 5/5-8 to 2.5YR 4-5/8) .... ⊗ Unit 1
White or pink (5YR 7-8/1-4) .... ⊗ caliche, or spring deposit

2. DUNES

Index to thickness of eolian sands

Coppice dunes .... ⊗ thin sands
Parabolic dunes .... ⊗ thin or thick sands

3. CARBONATES

Index to calcic soils or spring deposits; tested with 10% HCl

No reaction to HCl .... ♦ either Unit 1 or Unit 2
Positive reaction to HCl .... ⊗ caliche, or spring deposit

4. STRATIGRAPHY

Sequence of sand layers; sites are associated with Loco Hills soil and upper Unit 2 sand

TOP of stratigraphic sequence

Dune .... ⊗ coppice or parabolic
Dark yellow sand (or darker than other sand), thin .... ♦ Loco Hills soil
Yellow sand .... ♦ Unit 2
    No bands .... ♦ thin Unit 2 sand
    Bands .... ⊗ thick Unit 2 sand
Red sand .... ⊗ Unit 1, with Bt paleosol*
White sand .... ⊗ caliche, or spring deposit

BOTTOM of stratigraphic sequence

* Erosion commonly exposes red sand at surface, and artifacts that have been eroded out of younger yellow sands may occur on the eroded surface of the red sand

5. CLAY BANDS

Observed in the middle of thick unit 2 sand; sites may occur *above* clay bands

Above clay bands .... ♦ upper Unit 2
In clay bands .... ⊗ middle Unit 2
Below clay bands .... ⊗ lower Unit 2

♦ High potential for the presence of archaeological sites
⊗ Low potential for the presence of sites, or No potential for sites

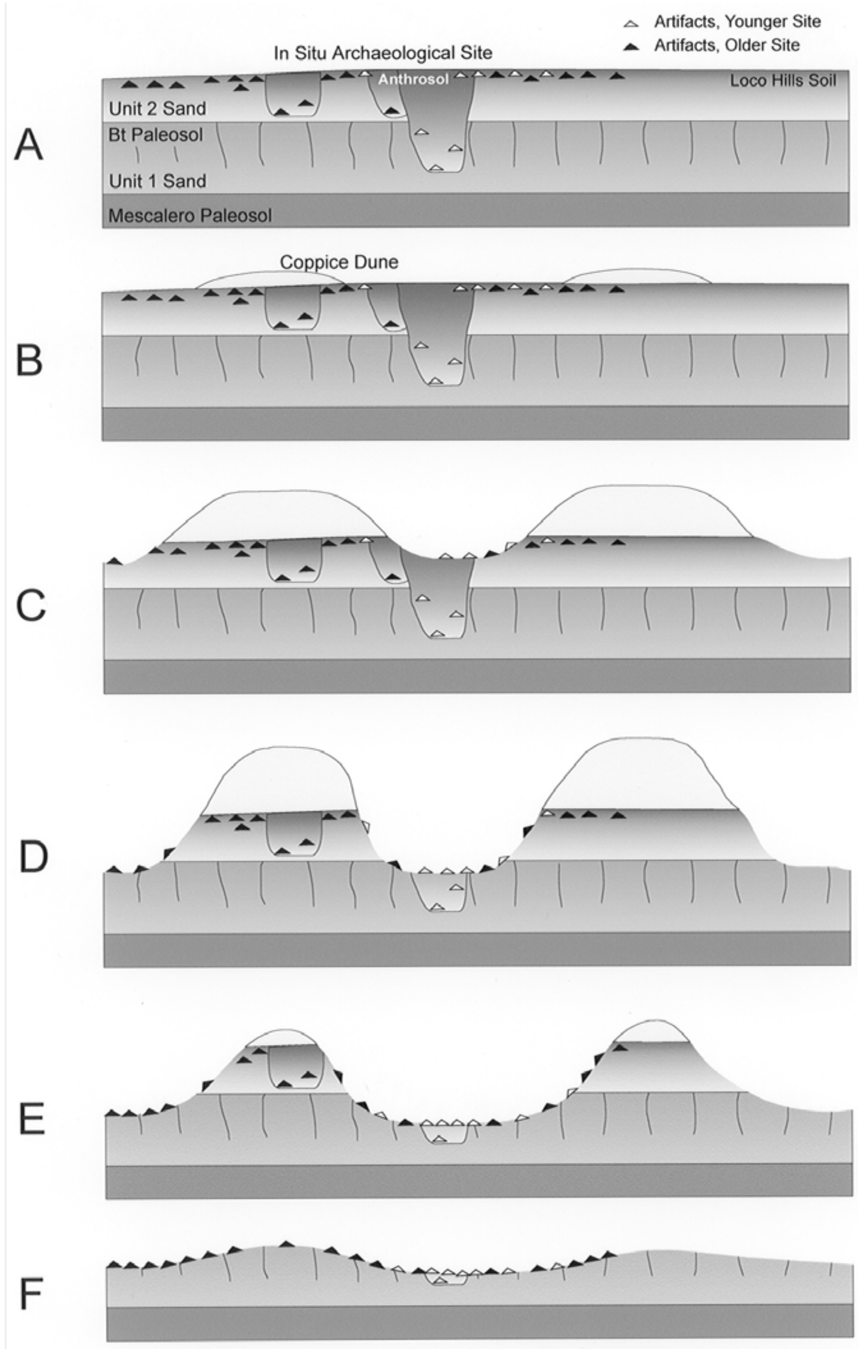

Fig. 21. Origin, development, and erosion of coppice dunes and the effects on archaeological sites, Mescalero Sands, southeastern New Mexico; explanation of each panel follows below.

A = Stable desert grassland landscape, development of Loco Hills soil about 100 to 500 years ago; archaeological sites are intact and little disturbed by erosion; Loco Hills soil mantles and blends with older A horizon anthrosols (formed by human occupation) at archaeological sites; black triangles are artifacts from an older occupation and white triangles are artifacts from a younger occupation at the same locality.

B = Destabilization of local desert grassland landscape; expansion of Torrey mesquite (*Prosopis glandulosa torreyana*) into grasslands; decrease in ground cover results in soil drying and deflation of sand that is transported by wind and accumulates around the base of shrubs, especially Torrey mesquite; the destabilization of the desert grassland probably occurred in the late 19th century due to changes in local land-use, land use changes that may be part of a regional pattern

C = Accelerated deflation in the 20th century results in loss of Loco Hills soil and underlying sand and marks the beginning of erosion of archaeological sites at the top of sand unit 2 and the lowering and mixing of artifacts onto an erosional surface; coppice dunes become wider and higher as sand is eroded from interdunal areas and accumulates around shrubs; many areas of coppice dunes in the Mescalero Sands are at this stage

D = Continued deflation in the late 20th century results in deflation of archaeological sites and lowering of artifacts onto the older, more indurated red sand (unit 1); coppice dunes become higher as additional sand accumulates around shrubs; however, at a later stage of development as more sand is removed from interdunal areas, the margins of the coppice dunes are eroded, becoming steep and collapsing, thereby reducing dune width; the rate of dune growth may decline because of less saltating sand reaching the accumulation surface; erosion rates in the interdunal areas may slow because of the greater resistance of the indurated argillic Bt paleosol at the top of the unit 2 red sand; artifacts from old and young archaeological sites are mixed; intact portions of sites are preserved beneath coppice dunes, although mesquite roots can damage site stratigraphy; also, burrowing animals are attracted to the mounds of loose sand that makeup the coppice dunes, further mixing site stratigraphy and artifact distribution beneath the dunes; some areas of coppice dunes in the Mescalero Sands are at this stage of development

E = Further erosion and loss of the coppice dune sand; the dune landform is predominantly erosional at this stage instead of depositional, and as a consequence, in situ archaeology occurs “high” in the “dune;” note that in situ younger artifacts occur lower in elevation than do in situ older artifacts; young and old artifacts become mixed during erosion; artifact concentration is greater on an erosional surface plane than in their original stratigraphic position where they may be dispersed over several decimeters of sand; this stage of advanced erosion is infrequent in the Mescalero Sands, occurring at present where sand loss is accentuated by overland flow and sheet erosion

F = Terminal stage of coppice dune erosion where all the dune landforms have been removed by erosion down to the resistant argillic Bt soil in unit 1 sand; this stage has not been reached yet in the Mescalero Sands area, but it is estimated that, at the present rate of development, the coppice dunes will be largely destroyed by erosion within the next 100 years; most of the in situ archaeology will be lost as well except for cultural features that are intrusive into older deposits

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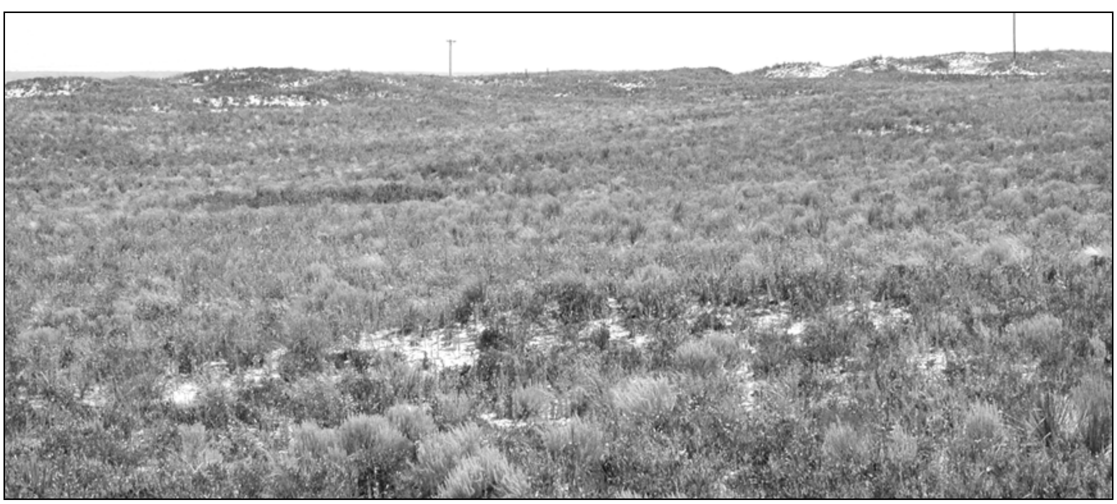

Fig. 22. Area of quasi-stable sand sheet south of the study area east of Carlsbad; small, low relief parabolic dunes in fore- and middle-ground with higher dunes in background; shin oaks, grasses, yucca, sand sage, absence of mesquite; ca. 80% ground cover; absence of A horizon soil; except for the fences and utility lines, this may be what the Mescalero Sands looked like during the late Holocene, 5000 to 500 years ago, when the sand sheet was inhabited by prehistoric people.

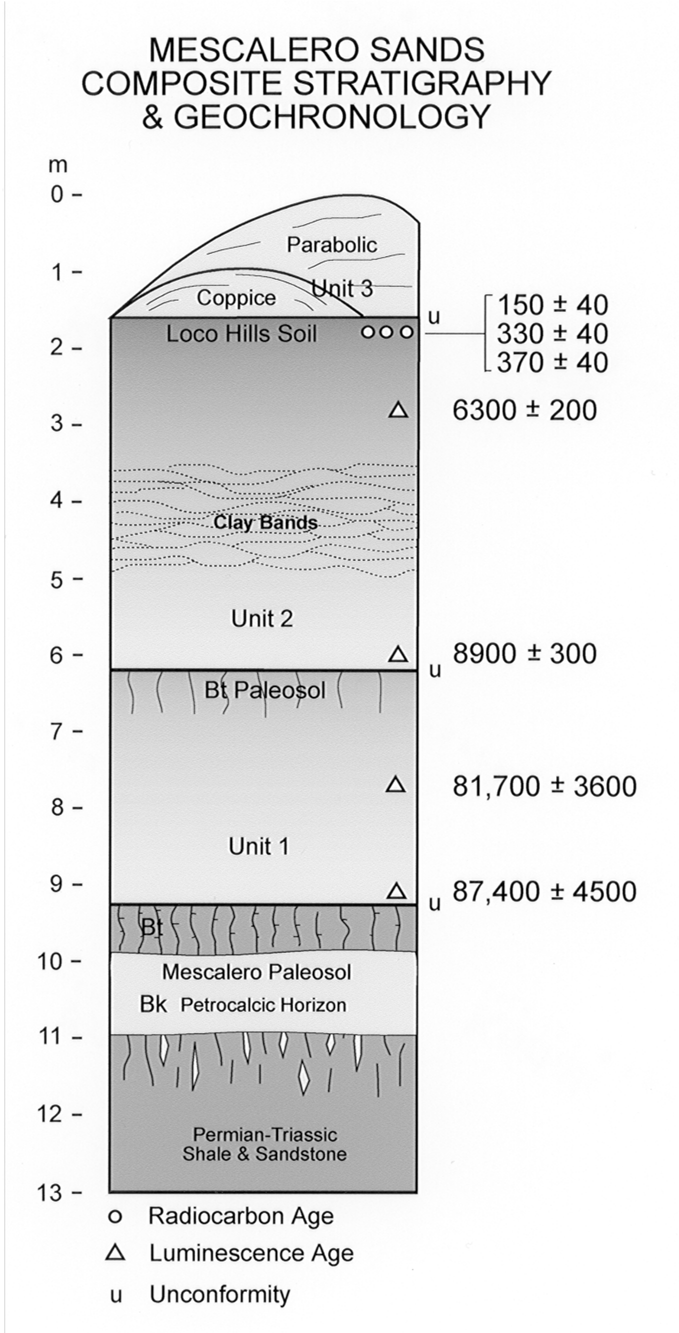

Fig. 22. Composite stratigraphy of the Mescalero Sands; maximum thickness of eolian units; no single location exhibits the entire stratigraphic sequence; radiocarbon ages are in radiocarbon years BP; OSL ages in calendar years BP.

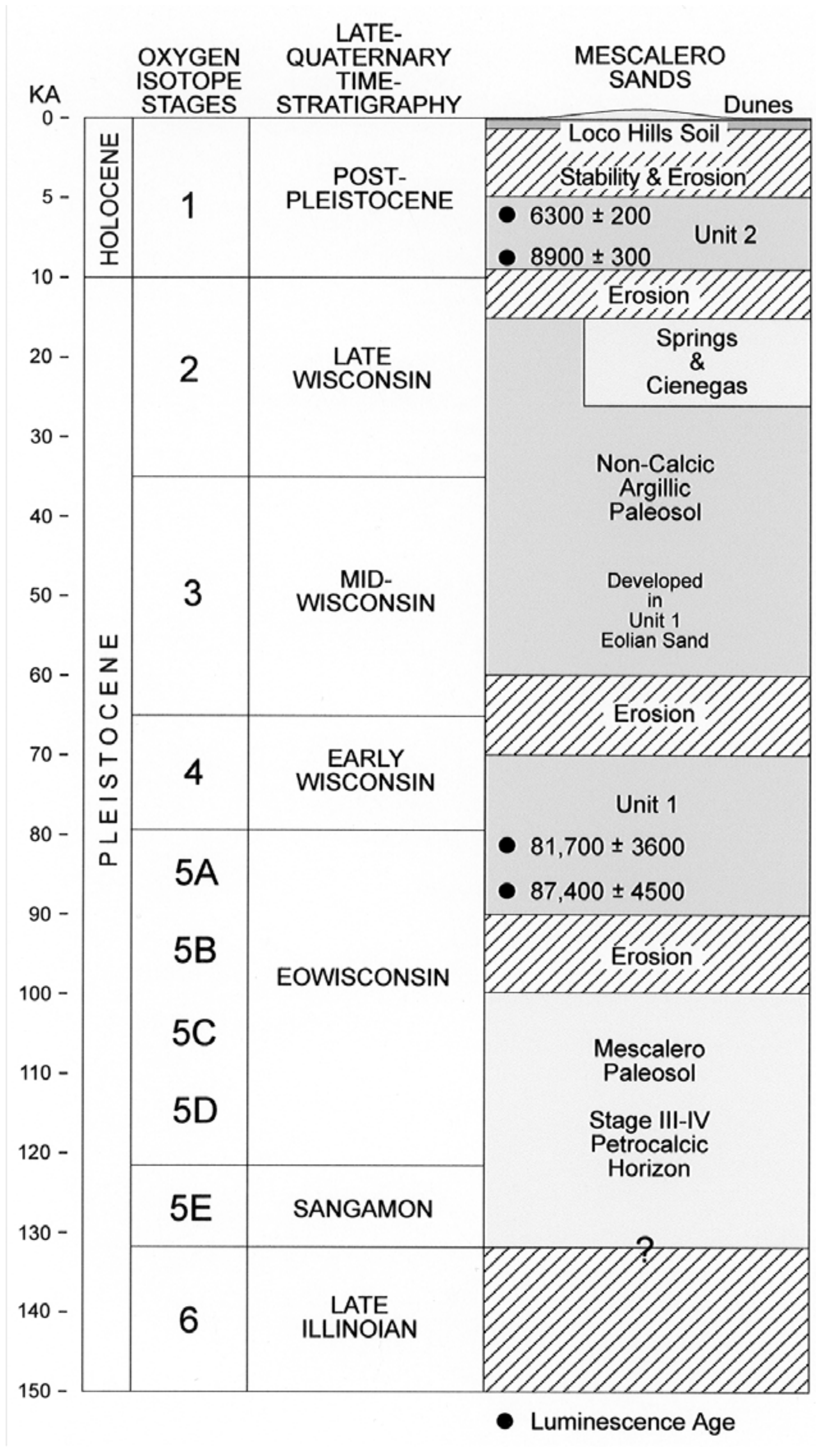

Fig. 23. Late-Quaternary time-stratigraphy of the Mescalero Sands, with OSL ages; Late-Quaternary time-stratigraphy and oxygen isotope stages from Richmond and Fullerton (1986); change in scale at 10 ka; the age of the Mescalero paleosol is uncertain and might include Sangamon and/or pre-Sangamonian periods of formation.

Table 3. Summary of the geomorphology, geoarchaeology, and paleoenvironments of the Mescalero Sands, NE Eddy Co., southeastern New Mexico (from S. A. Hall, 2002, *Field Guide*)

YEARS AGO	STRATIGRAPHY	PROCESSES	ENVIRONMENTS	GEOARCHAEOLOGY
0-100	Unit 3 coppice & parabolic dunes; unconformity with Loco Hills soil & Unit 2 sand	Deposition of coppice & parabolic dunes; severe deflation of Unit 1 & 2 sands & red Bt paleosol	Land use changes, disturbance of desert grasslands, decrease in grass cover, expansion of Torrey mesquite & shin oak	Active erosion of sites by wind & slope processes; burial of sites by coppice & parabolic dunes
100-500	Loco Hills soil, A horizon	Soil A horizon development on stable landscape, mantles Unit 1 & 2 sand & late Holocene alluvium	Desert grassland & shin oak vegetation	Site surfaces are stabilized by Loco Hills soil; sites subject to disturbance by bioturbation
500-5000	Unconformity	Sand sheet quasi-stability of Unit 2 sand	Desert grassland, shrub grassland, with shin oaks	Archaeological sites date to this period, indicating prehistoric occupation coinciding with sand sheet quasi-stability
5000-9000	Unit 2 eolian sand	Deposition of eolian sand Unit 2	Early Holocene, strong winds; desert grassland	Early Archaic sites are absent from sand sheet
9000-15,000	Unconformity	Erosion of red Bt paleosol at top of Unit 1 sand; erosion of cienega alluvial and spring deposits	Drying climate, lowering of water table, cienegas and springs begin to dry up	Margins of remnant cienegas and springs may have been Paleoindian campsites
15,000-25,000+	Cienega and spring deposits	Deposition of alluvium and spring-related deposits with land and freshwater snails	High water table, dewatering of Ogallala aquifer; last glacial maximum vegetation is a sagebrush grassland	
15,000-60,000	Noncalcic red Bt paleosol	Weathering of Unit 1 eolian sand, development of noncalcic argillic paleosol	Wisconsinan glacial-age climate, wetter than today; shrub grassland vegetation	
70,000-90,000	Unit 1 eolian sand	Deposition of eolian sand Unit 1	Late Eowisconsin-Early Wisconsin, oxygen isotope stage 5A-4	

90,000-100,000	Unconformity	Erosion of calcic Mescalero paleosol	Cooler oxygen isotope stage 5B	
100,000-130,000 or earlier (<400,000)	Mescalero paleosol, stage III-weak stage IV petrocalcic horizon	Calcic soil development on Permian-Triassic shale and sandstones	Dry climate, oxygen isotope stage 5E-5C, warm Sangamon Interglaciation and late Eowisconsin	

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Fig. 24. Fire-burned caliche and caliche pebbles concentrated on a deflated surface of red sand (unit 1), Mescalero Sands.

Title-Page Photograph: Caliche pebbles deflated to an eroded surface of red sand (unit 1); absence of artifacts and fire-blackened caliche; Torrey mesquite coppice dunes, Mescalero Sands, southeastern New Mexico.