New Data on the Stratigraphy and Pedology of the Clovis and Plainview Sites, Southern High Plains

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The well known Clovis and Plainview archaeological sites of New Mexico and Texas have yielded new data on regional late Quaternary geologic, paleoclimatic, and pedologic histories. Eolian sedimentation at the Clovis site from about 10,000 to less than 8500 yr B.P. was followed by the formation of a cumulic soil between 8500 and 5000 yr B.P. Episodic eolian and slope wash deposition then culminated in massive eolian sedimentation about 5000 yr B.P. after which a Haplustalf formed then was subsequently buried by part of a dune system within the last 1000 yr. At the Plainview site, a basal stream gravel contains Plainview cultural material (ca. 10,000 yr B.P.), which is followed by a localized early Holocene lacustrine deposit, two eolian deposits (the younger dating to about 5000 yr B.P.), and a marsh deposit which slowly accreted as an Argiustoll formed in the younger eolian unit. The data indicate that on the Southern High Plains (1) between 12,000 and 8500 yr B.P. sedimentation varied from site to site, (2) there was a regional climate change toward warming and drying in the early Holocene, (3) two episodes of severe drought apparently occurred in the middle Holocene (6500 to 4500 yr B.P.), (4) between 4500 yr B.P. and the present an essentially modern climate existed, but with several shifts toward aridity within the last 1000 yr, (5) argillic horizons have developed in late Holocene soils, (6) clay illuviation can occur in calcareous soils, and (7) long-distance correlation of Holocene stratigraphy in the region is possible, particularly with the aid of soil morphology.

INTRODUCTION

The Southern High Plains of northwest Texas and eastern New Mexico contain some of the best known Paleo-Indian sites in North America. Many are the type sites for Paleo-Indian projectile points and most have thick and multiple strata.

Geologic research has recently been carried out at some of these sites for several reasons. Most of the previous investigations focused on the stratigraphy and depositional environments of the Paleo-Indian-age deposits (greater than about 8000 yr B.P.) but these sites commonly contain younger sediments and soils. The paleoenvironments of the Southern High Plains for the past 8000 yr are poorly known, although a few sites, such as Lubbock Lake (Holliday et al., 1983), have provided information on this period, and there are indications of significant, regional climatic variations during the Holocene (Holliday, 1982a). The sites also commonly contain buried and nonburied soils that formed in the Holocene and allow investigation of the rates of development of Holocene soils. The significance or complexities of these soils have not always been recognized by previous investigators and the nature and rates of pedogenesis of soils formed in the Holocene are known only from a few specific sites such as Lubbock Lake (Holliday, 1982b, 1983) and one locality in the Sandhills region (Gile, 1979). An understanding of Holocene pedogenesis in the region can aid in making stratigraphic correlations and in dating Holocene sediments.

In this paper new sedimentological, geochronological, and pedological information from the Clovis and Plainview sites (Fig. 1) is assessed. The new data, combined with information previously published, are significant for reconstructing the late Quatern-
nary paleoenvironments of the localities and for building a regional late Quaternary history for the Southern High Plains.

Several subdivisions of the late Quaternary of the Southern High Plains are used in this paper. The late Quaternary, as used here, is divided into the latest Pleistocene (12,000 to 10,000 yr B.P.) and the Holocene (10,000 yr B.P. to the present). The Holocene is subdivided into early (10,000 to 6500 yr B.P.), middle (6500 to 4500 yr B.P.), and late (4500 yr B.P. to present).

REGIONAL SETTING

The Southern High Plains, or Llano Estacado, is an extensive plateau covering about 130,000 km². The area is an almost featureless plain. Thousands of small lake basins provide slight topographic relief in addition to several northwest- to southeast-trending drainages (with no permanent running water) and several large dune fields. The flat surface of the region is constructional, formed by deposition of extensive sheets of eolian sediment during the Pleistocene (Blackwater Draw Formation) (Fenneman, 1931; Hawley et al., 1976; Reeves, 1976).

The relatively uniform climate of the Llano Estacado is a dry, midlatitude, semi-desert (Strahler and Strahler, 1983, Plate C2). Mean annual precipitation for Clovis (1305 m; 4280 ft) is 42.3 cm (16.67 in.) (NOAA, 1982a); for Plainview (1027 m; 3370 ft) it is 48.1 cm (18.93 in.) (NOAA, 1982b). However, interannual variability is high.

METHODS

Available exposures at the Clovis and Plainview sites were examined and one profile at each site was described and measured (Table 1). Samples from each profile were analyzed for particle-size distribution, sorting characteristics, CaCO₃ and organic-carbon content, and bulk density (Table 2). Variations in parent material were detected by calculating fine sand/very fine sand and very fine sand/silt ratios (Evans, 1978, p. 363) and an “index of similarity” (Buol et al., 1980, p. 14). Because variations in parent material were detected in many profiles, clay movement could be measured only between horizons with similar parent material. For any horizon that exhibited clay illuviation (suggested by this procedure), an examination of a thin section was used to confirm the presence of such clay. However, this approach could determine only minimal amounts of translocated clay. Clay minerals were identified for selected horizons using X-ray diffraction analysis. Thin sections were also prepared for selected horizons and described following the terminology of Brewer (1976).

THE CLOVIS SITE

Setting and Previous Work

The Clovis site (Roosevelt County, New Mexico), also known as Blackwater Draw locality 1, is one of the best known archaeological sites in North America. Its fame rests primarily on the abundant Paleo-Indian material it contains. In particular, it is the type site for the Clovis point and was the first site where the stratigraphic relationship of Clovis and Folsom cultures was documented (Wormington, 1957). The site, located between Clovis and Portales, lies in a small basin immediately north of and draining into Blackwater Draw (Fig. 2), a tributary of the Brazos River (Fig. 1).

The site was discovered during gravel mining operations. Hester (1972) has summarized all archaeological work through 1963, and Stevens (1973) has done so for 1963 through 1972. Mining has now destroyed most of the site (Fig. 2); however, a portion of the southwest part of the site remains (the “South Bank” of Stevens, 1973, and Agogino et al., 1976). The South Bank lies along the basin margin (Fig. 2) at about the interface between the basin sediments and dune sands on the uplands (part of the Sandhills, an east–west-trending belt of dunes that extends far into the Texas Panhandle; Figs. 1 and 3). The section ex-
TABLE I. FIELD DESCRIPTIONS OF THE CLOVIS AND PLAINVIEW SITES\(^a\)

<table>
<thead>
<tr>
<th>Unit</th>
<th>Horizon</th>
<th>Depth (cm)</th>
<th>Munsell color</th>
<th>Dry Texture</th>
<th>Moist Texture</th>
<th>Dry consistence</th>
<th>CaCO(_3)</th>
<th>Boundary</th>
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<td>G A</td>
<td>0–20</td>
<td>10YR 3/3</td>
<td>IS m</td>
<td>sh</td>
<td>non</td>
<td>cw</td>
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</tr>
<tr>
<td>C</td>
<td>20–48</td>
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<td>IS m</td>
<td>lo</td>
<td>non</td>
<td>cs</td>
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</tr>
<tr>
<td>F</td>
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<td>7.5YR 4/4</td>
<td>LJS 1smbk</td>
<td>sh</td>
<td>non</td>
<td>cs</td>
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</tr>
<tr>
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<td>7.5YR 4/5</td>
<td>LJS 1smbk</td>
<td>h</td>
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<td>A1b2</td>
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<td>FSL 1msbk &amp; 1cpr</td>
<td>sh</td>
<td>non</td>
<td>gw</td>
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<td>h</td>
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<td>cw</td>
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<td>vh</td>
<td>es</td>
<td>cw</td>
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<td>vh</td>
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<tr>
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<td>7.5YR 4/2</td>
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<td>vh</td>
<td>es</td>
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<tr>
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<td>10YR 3/4</td>
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<td>vh</td>
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<td>10YR 5/3</td>
<td>SCL 2mpr &amp; 1msbk</td>
<td>h</td>
<td>es</td>
<td>cs</td>
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<td>10YR 5/3</td>
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<td>h</td>
<td>es</td>
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**Clovis site**

- Unit G: Described as part of this study is at the South Bank (Fig. 2).
- Haynes and Agogino (1966) and Haynes (1975) present the most recent and comprehensive review of the stratigraphy of the Clovis site (Fig. 3) and discuss most of the reported radiocarbon ages. Hester (1972) provides a brief review of all previously reported radiocarbon ages from the site. The following summary of the stratigraphy and geochronology of the site follows the descriptions and radiocarbon ages of these investigators and the terminology of Haynes (1975).
- Extensive erosion occurred in the basin prior to about 11,000 yr B.P. Deposition of spring sediments (Unit C) occurred during Clovis time (11,500 to 11,000 yr B.P.) and was followed by deposition of diatomaceous lacustrine sediments (Unit D) from 11,000 to 10,000 yr B.P. Some soil formation in and erosion of Unit D occurred about 10,000 yr B.P. Silty, carbonaceous lacustrine sediments were deposited in the basin, along with the accumulation of sandy, eolian sediments along the basin margin (Unit E), from about 10,000 to sometime after 8500 yr B.P. Soil formation and extensive erosion began sometime after 8500 yr B.P. and ended prior to about 5000 yr B.P.

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**Plainview site**

- South Bank, Roosevelt County, New Mexico.
- Profile 1, Pit 2, Hale County, Texas.
<table>
<thead>
<tr>
<th>Unit</th>
<th>Horizon</th>
<th>Very coarse</th>
<th>Coarse</th>
<th>Medium</th>
<th>Fine</th>
<th>Very fine</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
<th>% Organic carbon</th>
<th>% CaCO₃</th>
<th>Bulk density (g/cm³)</th>
<th>Sorting</th>
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<td>2.1</td>
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<td>27.6</td>
<td>94.6</td>
<td>3.0</td>
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<tr>
<td></td>
<td>C</td>
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<td>11.0</td>
<td>58.5</td>
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<td>F</td>
<td>Ab1</td>
<td>3.2</td>
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<td>45.3</td>
<td>25.7</td>
<td>84.3</td>
<td>9.8</td>
<td>5.9</td>
<td>0.2</td>
<td>1.74</td>
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<td></td>
<td>Btb1</td>
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<td>14.7</td>
<td>37.3</td>
<td>18.7</td>
<td>77.0</td>
<td>13.2</td>
<td>9.8</td>
<td>0.2</td>
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<td>1.05</td>
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<td></td>
<td>Ab2</td>
<td>6.0</td>
<td>15.2</td>
<td>30.8</td>
<td>19.7</td>
<td>71.7</td>
<td>19.3</td>
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<td></td>
<td>A2b2</td>
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<td>13.1</td>
<td>15.7</td>
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<td>10.9</td>
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<td>12.0</td>
<td>36.8</td>
<td>14.0</td>
<td>73.7</td>
<td>17.3</td>
<td>9.0</td>
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<td>A</td>
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<tr>
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<td>0.5</td>
</tr>
<tr>
<td>A2</td>
<td>1.4</td>
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<tr>
<td>A3</td>
<td>1.1</td>
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<tr>
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<td>4Ch1</td>
<td>-</td>
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<tr>
<td>4C2b1</td>
<td>0.8</td>
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</table>

a Silt and clay by pipet (Day, 1965) on organic matter- and CaCO₃-free basis; sands separated by wet sieving then dry sieved.
b Walkley-Black technique (Allison, 1965).
c By Chittick apparatus as described by Dreimanis (1962) and modified by Bachman and Machette (1977).
d Clod method (Blake, 1965).
* Sorting characteristics following Inman (1952) and Folk (1974).
* South Bank.
* Profile 1, Pit 2.

yr B.P. Eolian sand (Unit F) was deposited about 5000 yr B.P. A soil formed in Unit F in the late Holocene and was followed by deposition of more eolian sand (Unit G) and development of a weak soil in that sand.

**New Results**

The work at the South Bank was in upper Unit E and Units F and G (Fig. 3). Upper Unit E has a thick, cumulic A horizon whose texture varies from fine sandy loam to loam (Table 1), suggesting that the surface of the unit was slowly aggrading with variations in sedimentation. Unit E in the South Bank is moderately to poorly sorted (Table 2). This, and the proximity of the section to the edge of the basin, suggests that reworking, by slope wash, of the valley-margin eolian facies of Unit E and probably eolian sedimentation were part of the aggradation process. Unit E is also calcareous with a distinct zone of secondary CaCO₃ in the Aklb3 and Ak2b3 horizons.

A radiocarbon sample from the top of the A horizon in upper Unit E yielded an age of 4855 ± 90 yr B.P. (SI-4585; NaOH-insoluble fraction). This suggests that pedogenesis in and some erosion of Unit E occurred between 8500 and 5000 yr B.P. and that Unit F was deposited around 5000 yr B.P. This is also indicated by Haynes (1975, p. 64), who notes a "strongly developed pedocalcic paleosol" in Unit E and that "along the north rim this paleosol contains the strongest development of calcium carbonate of any observed in the younger group of sediments (Units B to G)." The soil in Unit E at the South Bank is not as
FIG. 1. The Llano Estacado (Southern High Plains) showing the locations of the Clovis site (BWD-1), the Plainview site, and other localities and physiographic features referred to in the text.

well developed because of cumulization of the profile.

The transition from Unit E to F is marked by a weak cumulic soil, indicating a continuation of the episodic sedimentation of Unit E. There is a clay bulge in the A2b2 horizon (Fig. 5), but its position within the A horizon and the lack of field evidence for a B horizon indicates that the clay may not be illuvial. Alternatively, it may be that dust-derived clay was mechanically infiltrated into the soil as the surface aggraded, then clay translocation was halted upon burial.

This process occurs elsewhere in the region (Holliday, 1982b). As in Unit E, the sorting of the sand fraction in the transition zone is moderate to poor, suggestive of slope wash additions (Table 2).

Unit F is considered to be principally eolian, as interpreted by Haynes (1975), although it is not particularly well sorted (Table 2). An eolian origin is indicated by the position of the South Bank profile high on the valley wall, the absence of coarse clastics in the South Bank, or any exposures described by Haynes (1975), and the
FIG. 2. Map of the Clovis site showing the topography of the original (premining) basin, approximate extent of the gravel quarry, and the location of the South Bank section (contours approximate). The elongate, topographic low in the south-central portion of the map is the upper end of the drainageway into Blackwater Draw (ca. 2 km south of the South Bank). The inset shows the location of the site relative to the draw and the city of Portales, New Mexico. Based on Evans (1951, Fig. 1); Hester (1972, Fig. 15), and Haynes (1975, Fig. 4-2).

units blanket-like distribution mantling the lowlands and uplands, based on Haynes (1975). There were probably some slope wash additions, again a function of the proximity of the profile to the basin margin.

Lower Unit F has produced a radiocarbon age of 4950 ± 150 yr B.P. (0–157; Brannon et al., 1957; Haynes, 1968, 1975). Haynes (1968, p. 621) suggests that this age may be too young because of the nature of the material dated, which was charred bison bone. However, the new radiocarbon age from the top of Unit E indicates that 0–157 is reliable.

Unit F exhibits the best expressed buried soil (b1) at the South Bank and it is classified as a Haplustalf. The soil has an ochric epipedon and structure in the B horizon is weakly developed. Haynes (1975, pp. 64–65) suggests stronger structural development in the soil in other exposures at the site and mentions that "At most exposures
Fig. 3. Stratigraphy of the Clovis site. Top. Sketch of the section described at the South Bank, including locations of new radiocarbon ages from the mid-Holocene units reported in the text and correlation of soils and stratigraphic units with previous investigations. Bottom. Generalized north-south geologic cross section of the site, based on Haynes (1975, Figs. 4-3, 4-4, 4-7; 1983, personal communication).

this sand, Unit F, contains a coarse, irregular, blocky structure that is responsible for its being referred to as the ‘jointed sands’ and ‘Along the north rim . . . the soil profile developed in Unit F is more strongly developed than elsewhere at the site. Here it contains a brownish-red zone grading into a reddish-brown zone of fine to medium, irregular, blocky structure in the lower half. The unit is weakly cemented by secondary carbonate . . . . ’

Several thin sections were taken from the b1 soil. The Btb1 horizon has argillasepic fabric with common free grain argillans and occasional embedded grain argillans; outer boundaries of argillans are usually sharp. Distribution is intertextic to granular, with very common interconnected vugs (simple packing voids). Orientation is flecked to moderately striated (Fig. 4). The thin sections and particle-size distribution (Fig. 5) demonstrate that sufficient illuvial clay is present to qualify the B horizons as argillic.

In the South Bank section the b1 soil and most of the section is noncalcareous. Clay minerals are illite, some mixed-layer illite-smectite clays, and minor amounts of kaolinite. The sand fractions of the soil are almost entirely quartz.

Unit G overlies Unit F, and is a noncalcareous sand representing dune sediments of the Sandhills. At some localities around the Clovis site, Haynes (1975) subdivided Unit G into G1 (older) and G2 (younger), based on stratigraphic, sedimentological, and pedological characteristics. At the South Bank exposure only one deposit was apparent.
Fig. 4. Photomicrographs of thin sections (under crossed Nicols) from the Clovis (a, Btbl) and Plainview sites (b, 3Btk3bl). Free- and embedded-grain argillans (e.g., arrows) are common and distinct, coating quartz grains in (a). Embedded grain argillans (e.g., arrows) are common, though less distinct in (b), as is some secondary CaCO₃ (SC). The bar is 10 μm.

The soil formed in Unit G is the local surface soil. It is weakly developed with an ochric epipedon and no diagnostic subsurface horizons. There is some suggestion of translocated clay in the C horizon (Fig. 5), but the difference in clay content between the A and C horizons may be less than the analytical error. The soil in Unit G is classified as an Ustipsamment.

Stratigraphy, pedology, and the new radiocarbon age, discussed above and those discussed by Haynes (1975) and Hester (1972), suggest that Units E and F represent a period of episodic eolian deposition. This period began perhaps 10,000 yr B.P. and terminated by 4500 to 4000 yr B.P.

Soil formation in Unit F and deposition of and soil formation in Unit G are poorly dated. A radiocarbon sample was taken from the top of the buried A horizon in Unit
Plainview, Hale County, Texas (Fig. 1), in Running Water Draw. The site was discovered during caliche quarrying along the south margin of the draw and consisted of an extensive bone bed of extinct bison (Bison antiquus) associated with lithic material (Sellards et al., 1947; Guffee, 1979). The locality is the type site for the Plainview point. Continued quarrying resulted in the excavation of three deep pits (Fig. 6). The pit with the bone bed (Pit 1, Fig. 6) is now filled but the other two pits provide long, continuous exposures of the fill in Running Water Draw. The section discussed in this paper (Fig. 7) is located toward the center of the valley (Fig. 6) and is representative of the valley-axis stratigraphy.

Running Water Draw has cut through the Blackwater Draw Formation and onto the Pliocene Ogallala Formation (the Panhandle Formation of Sellards et al., 1947). Bedded carbonate gravel and sand (Unit 1), varying from a few centimeters to more than 1 m thick, comprise the basal late Quaternary fill. The Plainview bone bed rested on top of Unit 1. Discussion of the site stratigraphy by Sellards et al. (1947) and Guffee (1979) and an examination of blocks from the bone bed indicate that the kill took place in an abandoned meander channel and the bones were quickly buried by sandy loam fluvial deposits. The age of Plainview points is about 10,000 yr B.P. (Johnson and Holliday, 1980; Holliday and Johnson 1981), providing an age for the end of Unit 1 deposition.

New Results

In the described section (Table 1), Unit 1 is very thin and the sandy loam that buried the bone bed is missing. An organic-rich, lacustrine clay (Unit 2) overlies Unit 1 in some exposures. Unit 2 is not present at the described section. There, Unit 1 is buried by almost 1.5 m of sandy sediment (Units 3 and 4). The lower 50 cm (Unit 3) and the upper 1 m (Unit 4) are both sandy loams, but the particle-size data indicate a
FIG. 6. Geologic sketch map of the area of the Plainview site in Running Water Draw (no adequate topographic base is available) showing the locations of the caliche pit that contains the archaeological remains (Pit 1, now filled in), the present-day caliche pits (2 and 3), the profile studied as part of this investigation, and the cross section for Figure 7 (A–A'). Based on Sellards et al. (1947, Fig. 2) and Blakely and Koos (1974, sheets 19, 26, and 27).

Subtle lithologic break between the two units (Table 2). In other exposures, the Unit 3 sandy loam interfaces with a highly calcareous, apparently lacustrine deposit of marl. Unit 3, especially the marl facies, occasionally exhibits a weak soil at the top. The sand fraction of Units 3 and 4 is only moderately sorted (Table 2), which is not particularly indicative of eolian sedimentation. An eolian origin is indicated by the massive nature of both units throughout the area of the site, the complete absence of coarse clasts, and the blanket-like distribution of both units across the draw. The lack of sorting of Units 3 and 4 may be due to a short transportation distance for the sediments; they were derived from the Blackwater Draw Formation immediately adjacent to the draw.

The eolian sediments are buried by an organic-rich, clayey, lowland marsh deposit (Unit 5), which is the present surficial deposit in the draw in the site area. In the described section Unit 5 exhibits subtle lithologic variation (Table 2) and in exposures near the valley margin a sandy, eolian
A well-developed soil formed in Units 4 and 5. The surface horizons qualify as pachic, mollic epipedons. The mollic colors extend into the 2Btk1b1 horizon but the organic carbon content there is below 0.6%. The 2Btk1b1 horizon is considerably finer grained than the lower B and C horizons and probably represents the initial Unit 5 sediments and original A horizon of the soil. However, the entire B horizon has a well-developed structure. Secondary CaCO₃ accumulation occurs in the lower A horizon and upper and middle B horizon as films, threads, and coatings on ped faces. This zone of CaCO₃ accumulation is Stage 1 of Gile et al. (1966), but does not qualify as a calcic horizon (Soil Survey Staff, 1975). The soil is classified as an Argiustoll.

The micromorphology of the soil at Plainview is generally uniform throughout. Fabric is argillasepic with common, thin, embedded-gran argillans and occasional free-grain argillans, which usually have sharp outer boundaries. Distribution is agglomeroplasmic to intertextic. Vugs are common and occasionally interconnected with occasional, thin, calcitans along their sides (Fig. 4b). The fabric in the zone of secondary carbonate accumulation is probably crustic. Orientation is flecked to weakly striated. The micromorphology and particle-size distribution (Fig. 5) indicate the presence of significant amounts of illuvial silicate clay. The B horizon, then, qualifies as argillic.

Clay minerals of the Plainview soil are illite and mixed-layer illite–smectite and some kaolinite. Sand-size minerals in the soil are almost entirely quartz with some feldspars.
The evidence indicates that the profile is a composite. The A horizon aggraded as fine-grained lacustrine sediment (Unit 5) slowly filled the draw. Pedogenesis in the underlying, sandier material began at this time. Eventually the A horizon aggraded to the point that the B horizon began to develop in the bottom of what was the original A horizon (102–130 cm). This same phenomenon has been observed along Yellowhouse Draw to the south (Holliday, 1982b, 1983).

CONCLUSIONS

The data from the Clovis and Plainview sites provide additional and significant information to the growing body of data on the late Quaternary geology, paleoclimates, and pedology of the Southern High Plains. At Clovis, Haynes and Agogino (1966) and Haynes (1975) show that spring discharge produced localized alluviation between 11,500 and 11,000 yr B.P. Between 11,000 and 10,000 yr B.P. the springs fed ponds, producing diatomaceous lacustrine sediments. At Plainview, however, alluviation continued until 10,000 yr B.P. These different sedimentation histories are probably related to fluctuation in or the presence or absence of spring discharge and the change in climate toward less effective moisture at about 11,000 yr B.P. documented throughout the southern Great Plains (e.g., Johnson, 1976; Lundelius, 1974; Lundelius et al., 1983). Wind may have reworked alluvium on the floors of the draws and dammed the relatively sinuous and narrow reaches of upper Blackwater Draw (with the Clovis site) and lower Yellowhouse Draw (with Lubbock Lake). The broader and less sinuous reaches of middle Running Water Draw (with the Plainview site) remained open (Holliday, 1984).

Lacustrine sediments were deposited at Clovis and Plainview in the early Holocene. Extensive and continuous lacustrine sedimentation occurred until at least 8500 yr B.P. in settings where alluviation halted at 11,000 yr B.P. (Clovis and Lubbock Lake). Lacustrine sedimentation was discontinuous and considerably less extensive where alluviation continued until about 10,000 yr B.P. (Plainview).

Increased eolian sedimentation and precipitation of CaCO₃ followed noncalcareous lacustrine deposition. At Clovis this occurred sometime after 8500 yr B.P. At Plainview the event is not dated, but a similar change in similar stratigraphic position occurred around 6500 yr B.P. at Lubbock Lake (Holliday et al., 1983). At Lubbock Lake, Holliday (in press) suggests that increased temperature produced calcareous sediments and reduced effective moisture led to increased eolian deposition. The data suggest a regional trend toward warming and drying.

The middle Holocene records at Clovis and Plainview document two cycles of eolian activity separated by a brief interval of nondeposition and formation of weakly developed soil. Similar records are reported from Lubbock Lake (Holliday et al., 1983) and the Sandhills east of Clovis (Fig. 1) (Gile, 1979, 1983). These correlations (Fig. 8) suggest two periods of prolonged, severe drought throughout at least the central Llano Estacado, resulting in loss of soil moisture, reduction in vegetation cover, and deflation by wind. A similar two-drought Atlithermal has been suggested by Benedict and Olson (1978) and Benedict (1979) for the Central Plains and by Gaylord (1982) for dune fields in south-central Wyoming.

The late Holocene at Clovis and Plainview is primarily a period of landscape stability, also documented in the Sandhills (Gile 1979, 1983) and at Lubbock Lake (Holliday et al., 1983). Minor eolian activity occurred at all of these sites within the last 1000 yr (Fig. 8). Because conditions of landscape stability prevail today, the late Holocene climate of the region is interpreted as having been essentially like that of today with minor shifts toward aridity within the past 1000 yr. It is possible that climatic changes toward increased moisture
occurred (as suggested by Hall (1982) for the period 2000 to 1000 yr B.P.) but these events are not evident in the geologic record.

The pedologic comparisons for the two sites are between the soil in Unit F at Clovis and throughout Units 4 and 5 at Plainview. Both soils formed at about the same time and, although there are some variations in setting and parent material texture and carbonate content, they both exhibit similar development. This is best seen in the amount of translocated clay in the B horizon in the thin section and from laboratory data. This soil development is comparable to that in middle Holocene eolian sediments (Stratum 4) at the Lubbock Lake site (Holliday, 1982b).

The co-occurrence of illuvial clay with secondary CaCO\textsubscript{3} at Plainview (2Btk1b1, 3Btk2b1, and 3Btk3b1 horizons, Fig. 7) is significant. In other situations where this is documented (e.g., Allen and Goss, 1974), it has been demonstrated or suggested that the argillic horizons formed in decalcified material and were subsequently recalcified. There are no data from any locality in the region that indicate that this process occurred in the late Holocene. On the contrary, data from Lubbock Lake (Holliday, in press), a site near Amarillo (Fig. 1) (Goss et al., 1973), and other regions (Aguilar et al., 1983), clearly demonstrate that clay can be translocated into a calcareous medium. The data from the Plainview site further support these conclusions.

The above information suggests that the timing and nature of Holocene deposition on the Southern High Plains were similar. This allows for making long-distance correlations through the area with some degree of confidence. Additionally, the data demonstrate that soil morphology (macro- and micro-) is a useful tool for correlating Holocene sediments in the region and that many of the sites can provide significant information concerning the formation of Holocene soils in a semiarid environment. 

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**Fig. 8.** Correlation of late Quaternary depositional and pedological events at the Clovis and Plainview sites (as described in this paper) with events at the Lubbock Lake site (Holliday et al., 1983) and the Sandhills (Gile, 1979, 1983) and an interpretation of general climatic trends for the Southern High Plains, relative to the modern climate.
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