Late Pleistocene and Holocene stratigraphy, Southern High Plains of Texas

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LOCATION

Begin in Crosbyton, Texas (Fig. 1). Take U.S. 82 west 35 mi (56 km) to Lubbock. On the northeast side of Lubbock at the intersection of U.S. 82 (which is also U.S. 62 along this stretch of the road) and Loop 289, turn right (north) off of U.S. 82 and follow Loop 289 to the north and west. Cross over I-27/U.S. 84, and take the University Avenue exit. Stay on the frontage road and continue west, parallel to the loop. Cross University Avenue and continue west with the large Texas Instruments (TI) plant to the north (right). Just past the TI plant the road drops into Yellowhouse Draw. The Lubbock Lake site, is in the trees to the northwest, about 300 ft (100 m) away. On the floor of the draw, take the only paved road north (right). Follow it for 0.3 mi (500 m) as it curves to the left along the edge of the draw. A chain-link fence enclosing most of the trees becomes visible. This is Lubbock Lake.

SIGNIFICANCE

Excellent examples of Pleistocene and Holocene stratigraphy are exposed in the east-central part of the Southern High Plains of Texas.

A trip from Crosbyton to Lubbock, which is well into the High Plains proper, allows excellent views of the generally flat, featureless topography of the region. The route also passes examples of landforms that provide the little topographic relief there is in the region, including numerous playas, a few dunes, and several draws. The highway goes near or through a number of shallow basins with ephemeral lakes or playas. There are thousands of these basins on the Southern High Plains, probably resulting mostly from wind deflation in late Pleistocene and Holocene time (Reeves, 1966; Holliday, 1985a). Typically, lacustrine sediment several meters thick is found on the floors of the playas (Holliday, 1985a). Along the highway, in the area of Lorenzo and Idalou (17 and 26 mi; 27 and 42 km west of Crosbyton, respectively), are some large dunes on the lee (east) side of the playas. These dunes are silty, calcareous deposits derived from adjacent playas that had calcareous lacustrine sediments (Holliday, 1985a). Late Pleistocene and Holocene valley fills, commonly found in ephemeral drainages or draws of the region, are exposed at the Lubbock Lake archaeological site (Fig. 1).

Lubbock Lake is the most intensively studied late Quaternary site on the High Plains (Johnson, 1987). The stratigraphy at the site is generally representative of that for all draws in the central part of the Southern High Plains.

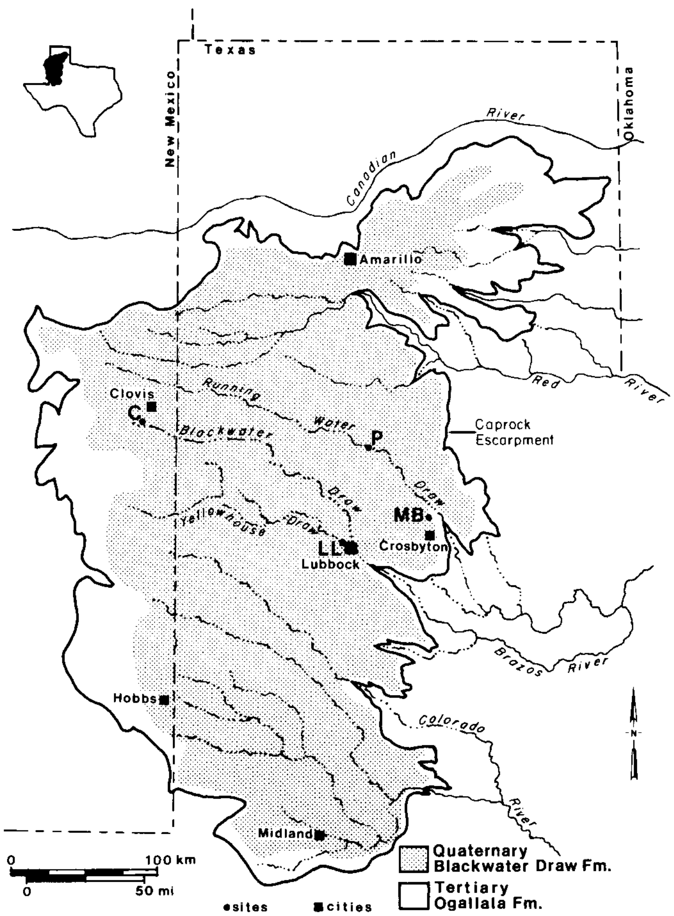

Figure 1. Map of Southern High Plains with principal regional surficial geologic units (Ogallala and Blackwater Draw Formations) and principal physiographic and cultural features, including those mentioned in text. (Key to sites: LL = Lubbock Lake; P = Plainview; C = Clovis)

LUBBOCK LAKE

Lubbock Lake (Figs. 1, 2) (33°31′13.5″N, 101°53′31.5″W; Lubbock West 7½-minute Quadrangle) is a well-stratified archaeological site composed of a thick sequence of sediments set in an entrenched meander of Yellowhouse Draw, a tributary of the Brazos River. The site, a State Archaeological Site and National Historic Landmark, covers 300 acres (120 ha) and contains a virtually complete geological, biological, and cultural record spanning the last 11,000 yr. It is owned by the city of Lubbock,

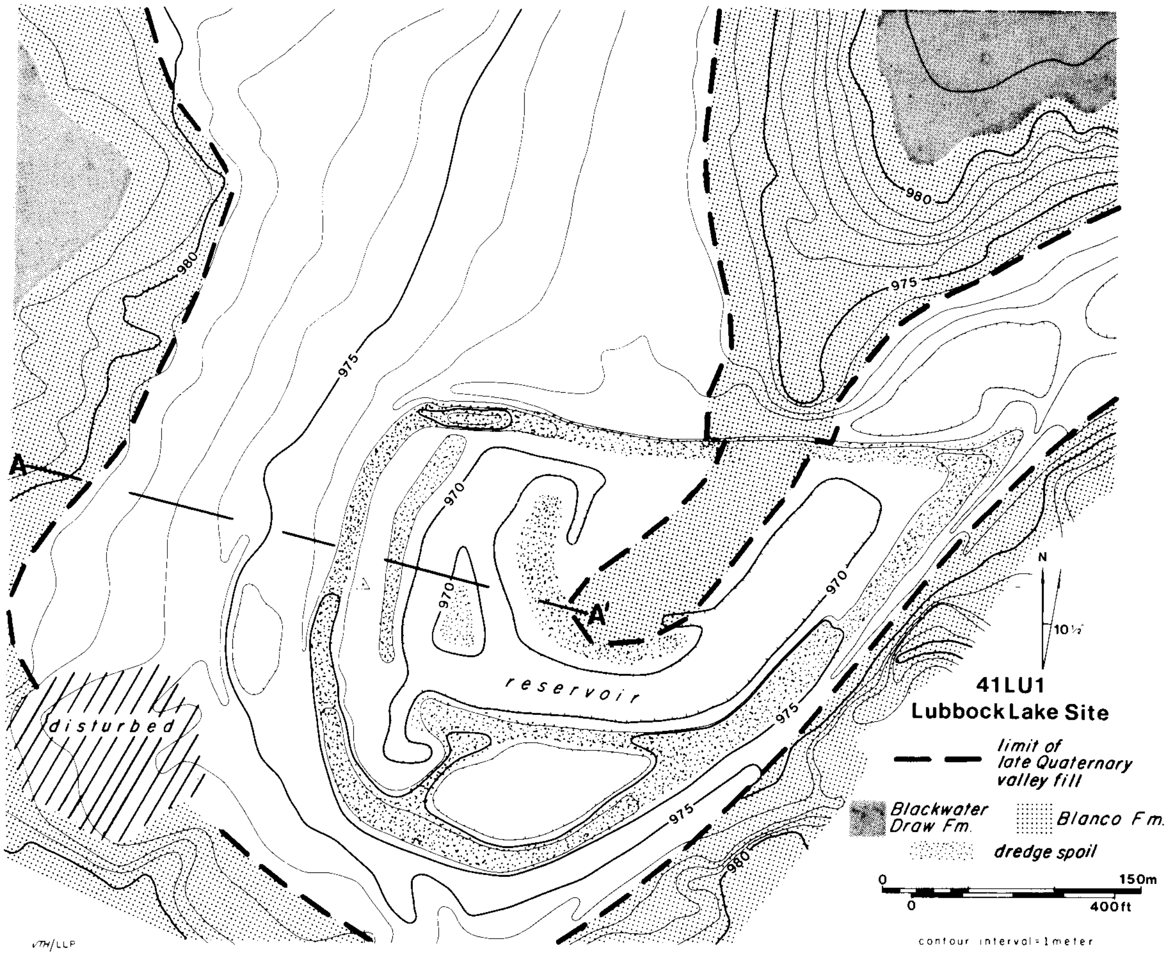

Figure 2. Topographic and geologic map of Lubbock Lake area in Yellowhouse Draw, with line-of-secton for Figure 4.

and is leased and managed by Texas Tech University. Tours of the site are given during the summer excavation season.

The site was discovered in 1936 during excavation of a U-shaped reservoir along the inside of the meander (Fig. 2). The excavations exposed the late Quaternary valley fill of Yellowhouse Draw that contains abundant debris of human occupation. Archaeological investigations were conducted intermittently at the site beginning shortly after its discovery. In 1972 the Lubbock Lake Project began, under the auspices of The Museum of Texas Tech University, which is continuing research at the site and other localities in the region. The results of much of the research are presented by Johnson (1987). The stratigraphy, soils, and geochronology of the site are described by Holliday (1985b-d) and Holliday and others (1983, 1985).

The local bedrock in the area of the site is weakly consolidated sandstone and dolimitic marl of the Blanco Formation. At the top of the unit is a Stage IV–V pedogenic calcrete, similar to that exposed at Mt. Blanco. These Blanco sediments were deposited in a basin that was separate from the basin in the Mt. Blanco area. The Blanco beds are well exposed immediately north of the entrance gate to the main excavation area of the site and along the paved road leading to the fence along the east side of the draw (Fig. 2). The Blanco outcrops on the east side of the draw were heavily quarried for road metal in the 1950s.

Yellowhouse Draw cut through the Blackwater Draw Formation and into the Blanco Formation in the late Pleistocene. One stage of this downcutting is indicated by a strath terrace cut on the Blanco Formation in the area of the entrance gate to Lubbock Lake (Fig. 2). Aggradation along the draw began at the end of the Pleistocene and continued intermittently throughout

TABLE 1. GENERALIZED DESCRIPTIONS OF STRATA 1 THROUGH 5 AT LUBBOCK LAKE*

Stratum	Valley Axis Facies	Valley Margin Facies
5	Substratum 5Bℓ: up to 1 m thick; gray to very dark gray (5YR5/1 to 3/1, dry); clay; weakly stratified. Substratum 5Aℓ: same as 5B.	Substratum 5B: 10-25 cm thick; brown (e.g., 7.5YR5/3, dry); sandy clay loam to sandy loam, interbedded with common sand and gravel lenses. Substratum 5A: 30-75 cm thick; brown (e.g., 7.5YR5/3, dry); sandy clay loam to sandy loam interbedded with few sand and gravel lenses.
4	Substratum 4Bℓ: same as 5B Substratum 4A: less than 1 m thick; olive gray (2.5YR hues); laminated to massive, often cross-bedded, well-sorted, loamy fine sand to sandy clay loam interbedded with blocky to granular, somewhat more organic clay to clay loam.	Substratum 4B: 1-3+ m thick; brown (e.g., 7.5YR5/4, dry); sandy clay loam to sandy loam. No valley margin equivalent of 4A.
3	Substratum 3ℓ: 30-100+ cm thick; white (10YR7/1, dry); massive to platy, friable, silty clay to silty clay loam.	Substratum 3e: 30-100+ cm thick; light brown (7.5YR7/3, dry); sandy loam.
2	Substratum 2F: up to 30 cm thick; light gray (e.g., 2.5YR7/2, dry); sandy loam. Substratum 2B: 30-80 cm thick; gray (e.g., 10YR5/1, dry); loam to silty clay loam to clay; locally abundant silicified roots; few lenses of diatomite. Substratum 2A: 3-100 cm thick; light gray (10YR7/1, dry) diatomite interbedded with gray (e.g., 10YR5/1, dry) silt to clay.	No facies variation noted in 2F. Substratum 2s (facies of 2A and 2B): up to 2 m thick; gray (e.g., 2.5Y7/2, dry); silty clay interbedded with light gray (E.g., 2.5Y7/2, dry) sandy clay. Substratum 2e (facies of 2A and 2B); up to 2 m thick; pale brown (e.g., 10YR6/3, dry); sandy clay loam.
1	Highly variable, stratigraphic subdivisions reflect local lithologic changes and can occur individually or in various combinations. Substratum 1C: up to 50 cm thick; light gray (e.g., 2.5YR7/2, dry), massive sandy clay to clay. Substratum 1B: up to 1 m thick; light gray (e.g., 2.5Y7/2, dry) loose, cross-bedded, sand to loamy sand, with lenses of carbonate gravel (with clasts up to 2 cm in diameter). Substratum 1A: up to 1.5 m thick; massive carbonate gravel with clasts up to 5 cm in diameter and lenses of cross-bedded sand to loamy sand.	

*Facies are not necessarily time equivalents. Modified from Holliday (1985b).

the Holocene. Five principal strata (numbered 1 through 5, oldest to youngest, Figs. 3, 4; Table 1) and five soils (named) are identified at the site.

The oldest valley fill at the site is stratum 1, a deposit of gravel, sand, and clay exposed low in the walls of the reservoir cut. These sediments were laid down by a meandering stream under somewhat cooler and more moist conditions than today. The beginning date of this alluviation is not known, but it terminated about 11 ka. The earliest cultural remains at the site are found in stratum 1. About 11.1 ka (Clovis cultural age), the local inhabitants butchered a variety of extinct mammals along point bars of the stream. The animals include extinct bison (*Bison antiquus*), mammoth (*Mammuthus columbi*), camel (*Camelops hesternus*), horse (*Equus francisi* and *Equus mexicanus*), short-faced bear (*Arctodus simus*), and giant armadillo (*Holmesina septentrionale*). The latter two finds are the first documented in association with humans and the youngest reported in the paleontological literature.

Conformably above stratum 1 are lake and marsh deposits of stratum 2. The bedded diatomite in the lower portion of the unit is a distinct marker bed in the walls of the reservoir. Stratum 2 accumulated from 11 to about 8.5 ka. A marsh soil (Firstview Soil) then developed in the top of the deposit from 8.5 to about 6.4 ka. Most of the Paleoindian occupation of the site took place during stratum 2 sedimentation, including the Folsom culture (10.5 to 10.2 ka), for which the site is best known. Most of the cultural features are composed of the butchered remains of *Bison antiquus* with associated stone tools and projectile points. The early Archaic cultural period occurred during formation of the Firstview Soil.

Stratum 3 conformably overlies stratum 2. This deposit is composed of highly calcareous lacustrine sediment along the valley axis, and sandy eolian material along the valley margin. Stratum 3 was deposited between 6.4 and about 5.5 ka and represents the first of two significant episodes of warm, dry climate for the region. Formation of the Yellowhouse Soil (5.5 to

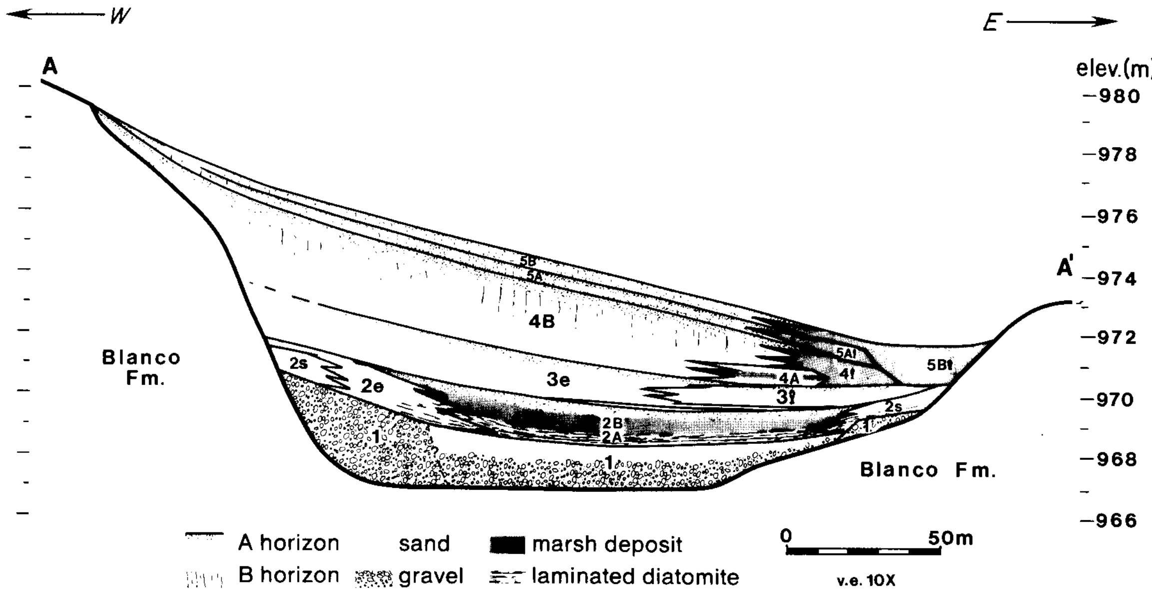

Figure 3. Late Quaternary stratigraphy of Yellowhouse Draw at Lubbock Lake (modified from Holliday, 1985b). Subdivisions of strata indicate either vertical sequence (such as A, B) or facies (s = shore, e = eolian, *l* = lacustrine).

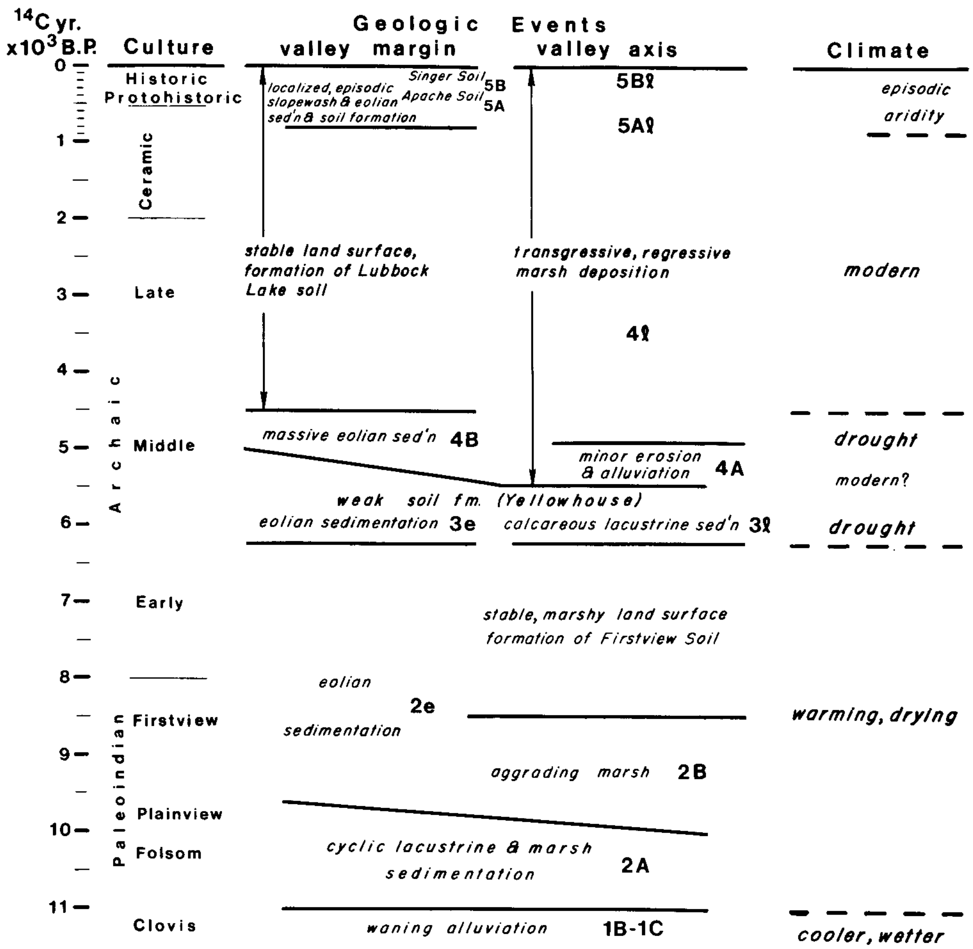

Figure 4. Cultural, geological, and climatic sequence at Lubbock Lake (modified from Holliday, 1985b).

5 ka in upper stratum 3 marks a brief, relatively cooler, wetter respite during the mid-Holocene dry interval.

Stratum 4 is an extensive deposit of sandy eolian material overlying stratum 3 and denoting the culmination of middle Holocene drough between 5.0 and 4.5 ka. Relatively more moist and cooler conditions prevailed beginning about 4.5 ka and represented by the Lubbock Lake soil, which is well developed in upper stratum 4 with a distinct A horizon and calcic horizon. Along much of the draw, stratum 4 is the most recent valley fill, and the Lubbock Lake Soil is the modern surface soil. Marsh clays were deposited along the valley axis during deposition of stratum 4 and formation of the Lubbock Lake Soil, indicating that the draw was never dry in this reach during middle and late Holocene time. Middle Archaic cultures occupied the site throughout the middle Holocene drought, and late Archaic cultures followed during the period of Lubbock Lake Soil pedogenesis. Most of the Archaic occupation features are accumulations of camping debris and butchered remains of modern bison (*Bison bison*).

Locally, stratum 4 is covered by stratum 5, which accumulated intermittently over the past 1,000 yr. Stratum 5 is composed of slopewash sand and gravel and eolian sand along the valley margin and marsh clay along the valley axis. The Apache and Singer Soils developed in stratum 5 and denote short-lived periods of nondeposition. The youngest of the stratum 5 marsh clays are probably related to a spring-fed lake that existed at the site throughout Historic times (it was noted by the early Spanish explorers), but disappeared in the early part of this century because of mining of the ground water. There are considerable accumulations of camping debris and butchered bison bone in stratum 5, the result of intense occupation during the late Ceramic, Protohistoric, and Historic cultural periods. The Apache were the Protohistoric and early Historic occupants of the region, replaced by the Comanche in the 18th century. Anglo-American settlements around the site in the 1880s mark the founding of Lubbock.

The sedimentology, invertebrate, and vertebrate paleontology, and paleobotany of Lubbock Lake provide an excellent record of late Quaternary climate change (Fig. 4). Furthermore, the stratigraphy and geochronology of the valley fill at Lubbock Lake is similar to that reported from other draw localities in the region (Fig. 5). Therefore, the record of late Quaternary climatic change at Lubbock appears to reflect regional climatic change.

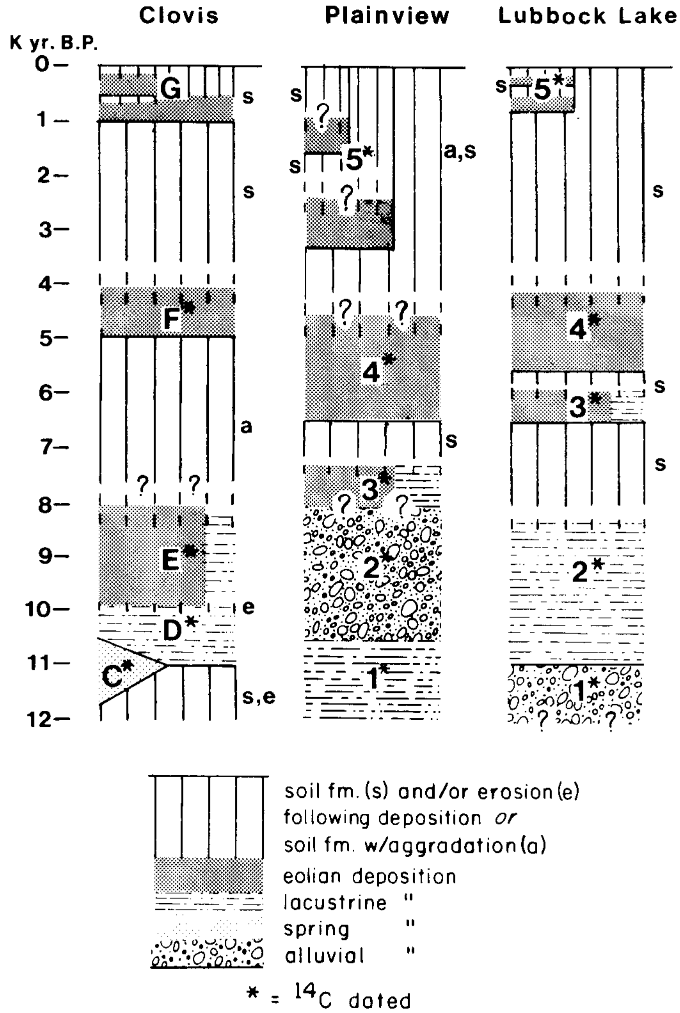

Figure 5. Stratigraphy at Lubbock Lake compared with that reported from Plainview Site in middle Running Water Draw (Fig. 1) (Holliday, 1985e, 1986) and Clovis site (Blackwater Draw Locality 1) in upper Blackwater Draw (Fig. 1) (Haynes and Agogino, 1966; Haynes, 1975; Holliday, 1985e).

REFERENCES CITED

Haynes, C. V., Jr., 1975, Pleistocene and Recent stratigraphy, *in* Wendorf, F., and Hester, J. J., eds., Late Pleistocene environments of the Southern High Plains: Publication of the Ft. Burgwin Research Center, v. 9, p. 57–96.

Haynes, C. V., Jr., and Agogino, G. A., 1966, Prehistoric springs and geochronology of the Clovis site, New Mexico: American Antiquity, v. 31, p. 812–821.

Holliday, V. T., 1985a, Holocene soil-geomorphological relations in a semiarid environment; The Southern High Plains of Texas, *in* Boardman, J., ed., Soils and Quaternary landscape evolution: Chichester, United Kingdom, John Wiley & Sons, p. 325–357.

——, 1985b, Archaeological geology of the Lubbock Lake site, Southern High Plains of Texas: Geological Society of America Bulletin, v. 96, p. 1483–1492.

——, 1985c, Early Holocene soils at the Lubbock Lake archaeological site, Texas: Catena, v. 12, p. 61–78.

——, 1985d, Morphology of late Holocene soils at the Lubbock Lake archaeological site, Texas: Soil Science Society of America Journal, v. 49,

p. 938–946.
——, 1985e, New data on the stratigraphy and pedology of the Clovis and Plainview sites, Southern High Plains: Quaternary Research, v. 23, p. 388–402.
——, 1986, Late Quaternary stratigraphy of the Plainview site and middle Running Water Draw, *in* Holliday, V. T., ed., Guidebook to the archaeological geology of classic Paleoindian sites on the Southern High Plains, Texas, and New Mexico: Geological Society of America Guidebook, Department of Geography, Texas A&M University, p. 60–70.
Holliday, V. T., Johnson, E., Haas, H., and Stuckenrath, R., 1983, Radiocarbon ages from the Lubbock Lake site, 1950–1980; Framework for cultural and ecological change on the Southern High Plains: Plains Anthropologist, v. 28, p. 165–182.
——, 1985, Radiocarbon ages from the Lubbock Lake site, 1981–1984: Plains Anthropologist, v. 30, p. 227–291.
Johnson, E., ed., 1987, Lubbock Lake; Late Quaternary Studies on the High Plains of Texas: College Station, Texas A&M University Press (in press).
Reeves, C. C., Jr., 1966, Pluvial lake basins of west Texas: Journal of Geology, v. 74, p. 269–291.

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