

CHAPTER 5. USTIPSAMMENTS AND USTIFLUENTS OF THE MULESHOE SURFACE

The soils occur in mapping units A and B (fig. 27).

TYPIC USTIPSAMMENTS DOMINANT: MAPPING UNIT A, TIVOLI FINE SAND

MAPPING UNIT COMPOSITION

<u>Series or variant</u>	<u>Subgroup</u>	<u>Particle-size family</u>	<u>Percentage of mapping unit</u>
TIVOLI	TYPIC USTIPSAMMENTS	SANDY	80
Circleback	Alfic Ustipsamments	Sandy	10
Texico	Psammentic Haplustalfs.	Sandy	5
Other inclusions (Tivoli, thin variants #1 and 2, Farwell; Keeney)			5

LOCATION, LANDSCAPE, SOIL OCCURRENCE, VEGETATION

Soils of unit A occur only in the northern part of the study area. The landscape is undulating, with common small blowouts and associated dunes. Minor areas of the unit are in troughs and on the sides of high dunes. Tivoli soils are dominant; all are of Muleshoe age. Circleback soils are in the few deposits of Longview age and also occur discontinuously in minor areas of Muleshoe sediments. Minor areas of Texico soils occur in the few deposits of Birdwell sediments. Very minor areas of Tivoli, thin variants #1 and #2; Farwell; and Keeney occur in depressions.

Vegetation observed in unit A consists of sumac, soapweed, dropseed, sand sagebrush, three-awn, prickly pear, hairy grama, little bluestem, sand bluestem, sandreed, queen's delight, and shinnery oak. The shinnery oak occurs in the western part of the unit; as noted in Chapter 1, in aerial photographs the oak appears as dark, roughly rounded areas. Sumac occurs primarily in the eastern part of the unit, and in aerial photographs shows as isolated dark spots that not only locate the sumac but that are useful for precise location in the field.

TYPICAL PEDON AND RANGES IN SELECTED PROPERTIES

Pedon 12b is a typical pedon for Tivoli, except that the A horizon is usually less red, and many pedons lack strata that occur in the lower part of the B horizon. See table 20 for characteristics of Pedon 12b. Ranges in color and texture follow; underlined entries are typical.

The A1 horizon has hue of 6YR through 10YR (7.5YR), value of 5 through 6 dry, 3 through 4.5 (4) moist, and chroma of 2 through 4 (3). It is a fine sand, except for thin (a few cm) surface horizons of loamy fine sand that occur in some depressions. If an A12 horizon is present, commonly it is 1/2 or 1 chip lighter in color than the A11. A2 horizons are present in some pedons.

The B2 horizon has hue of 5YR through 10YR, value of 5 through 7 (6) dry, 4 through 5 (4.5) moist, and chroma of 4 through 6. It is fine sand or sand.

The C horizon has hue of 5YR through 7.5YR, value of 6 through 7 (6.5) dry, 4 through 6 (5) moist, and chroma of 4 through 6. It is fine sand or sand.

These soils are always noncalcareous throughout. B horizons are weak or absent. C horizons are lacking in thin deposits with B horizons. Some pedons consist entirely of C horizon material (e.g., Site 1a).

STUDY SITES

Sites 4-7, summary

Soils of the Muleshoe surface occur in a wide variety of landscape positions as discussed in Chapter 2, but all have the youthful morphology typical of soils of Muleshoe age. All are Typic Ustipsamments except for a very few Alfic Ustipsamments (e.g., Site 6), in which there is sporadic development of enough clay bands to qualify as Alfic Ustipsamments.

The Ustipsamments at Sites 4-7 (table 14) were studied in trenches dug for sampling by the National Soil Survey Laboratory. All four pedons have a high percentage of fine sand and have A1 and A2 horizons. The A1 horizons contain more organic carbon and are darker than horizons below. The A1 horizons also contain slightly more clay than horizons of the same age beneath (table 14). This may be due to origin of the clay from dust storms, as postulated by Dan et al. (1969) for dunes in Israel. Thus some of the clay brought to earth in dry dustfall and in precipitation may be accumulating in A1 horizons faster than it can move into deeper horizons. All A1 horizons contain substantially more silt than the horizons beneath, and some of this silt may also have been derived from dustfall (Dan et al., 1969). The A1 horizons under oak also contain more very fine sand than horizons beneath, suggesting effectiveness of the mulch of oak leaves and twigs in trapping very fine sand in the dustfall.

The A2 horizons are typically lighter-colored and contain less clay than adjacent horizons, and are not as red as the underlying B horizons. The A2 horizons under oak have less clay than the A2 horizon under nonoak vegetation (table 14), suggesting that clay movement under oak may be greater than under nonoak vegetation. In the study area as a whole, A2 horizons are best developed and most common in Holocene soils that have oak vegetation. The pH values for most A2 horizons are lower than those of adjacent horizons. All four pedons have buried soils of Pleistocene age (table 14). The Bt horizons of these buried soils tend to have maximum values for bulk density and hardness (table 14). This is thought to be due to the scarcity of soil biota at the greater depths.

The pH tends to be higher in soils of middle and late Holocene age than in older soils (table 14). Apparently, leaching was more rigorous at times in the Pleistocene and in the early Holocene than at present (see also Sites 14-17). These times are thought to be associated with times of greater effective moisture than at present.

Table 15 summarizes sand and clay mineralogy for Sites 4-7 and 22. For sand mineralogy, the siliceous mineralogy class has in the 0.02 to 2 mm fraction, more than 90 percent by weight of silica minerals (quartz, chalcedony, or opal) and other extremely durable minerals that are resistant to weathering (Soil Survey Staff, 1975). All soils shown in table 15 are

Table 14. Characteristics of Ustipsamments at Sites 4-7^{1/}

Sedi- ment	Horizon	Depth cm	Particle size distribution, mm								Or- ganic C	Ext. Fe	Bulk den- sity g/cc	pH	Tex- tural class	Domi- nant dry color
			Sand					Silt	Clay	% g/cc						
			2-1	1-0.5	0.5- 0.25	0.25- 0.1	0.1- 0.05	0.05- 0.002	< 0.002							
<u>Typic Ustipsamment, Tivoli, S75TX-17-8, on side of dune: Pedon 4</u>																
M	A1	0-12	0.3	5.9	23.6	49.6	12.5	3.9	4.2	0.44	0.2	7.1	fs	7.5YR 5/4		
	A2	12-31	0.1	5.9	24.0	49.9	14.5	1.7	3.9	0.24	0.2	6.8	fs	7.5YR 6/4		
	B21	31-61	tr	7.5	26.0	50.2	11.6	0.8	3.9	0.16	0.2	7.1	fs	5YR 5.5/6		
	B22	61-84	tr	5.6	24.4	51.9	14.4	1.6	2.1	0.10	0.2	6.9	fs	5YR 6/6		
	B31	84-112	tr	4.2	22.7	53.9	15.7	1.3	2.2	0.07	0.2	6.6	fs	6YR 6/6		
	B32	112-151	tr	3.1	19.1	55.3	17.5	3.0	2.0	0.04	0.2	7.0	fs	6YR 6/6		
B	B1b	151-168	tr	3.4	22.3	55.0	14.5	3.0	1.8	0.04	0.2	6.9	fs	5YR 6/4		
	B21tb	168-182	0.0	2.6	14.4	46.6	16.7	5.9	13.8	0.13	0.4	6.9	fs1	5YR 5/4		
	B22tb	182-206	tr	2.9	15.1	45.0	19.5	7.6	9.9	0.07	0.3	6.1	lfs	9YR 5/4		
<u>Typic Ustipsamment, Tivoli, S75TX-17-4, on side of dune: Pedon 5</u>																
M	A1	0-11	tr	2.1	14.5	53.8	20.4	5.2	4.0	0.97	0.2	7.5	fs	10YR 4.5/2		
	A2	11-20	tr	3.4	20.1	59.0	14.0	1.6	1.9	0.29	0.1	7.4	fs	9YR 5/4		
	B1	20-33	tr	4.2	22.9	57.1	12.8	1.0	2.0	0.15	0.1	7.2	fs	7.5YR 6/4		
	B21&Bt	33-52	0.0	2.9	23.6	59.3	11.4	1.0	1.8	0.10	0.1	6.9	fs	7.5YR 6/4		
	B22&Bt	52-82	tr	3.0	22.6	59.1	12.8	0.9	1.6	0.06	0.1	7.2	fs	6YR 6/4		
	B31	82-109	tr	4.8	24.2	56.1	12.0	1.2	1.7	0.08	0.1	7.1	fs	6YR 6/4		
	B32	109-137	0.1	6.2	25.9	51.9	12.8	1.8	1.3	0.08	0.2	7.2	fs	6YR 6/4		
L	B1b	137-165	0.0	6.2	26.7	53.1	10.1	1.4	2.5	0.07	0.2	1.69	7.3	fs	5YR 6/4	
	B2b&Bt	165-198	0.1	4.9	22.7	55.4	11.1	2.3	3.5	0.06	0.2	1.71	7.5	fs	5YR 6/4	
<u>Alfic Ustipsamment, Circleback, S75TX-17-5, in trough: Pedon 6</u>																
M	A1	0-13	0.1	7.1	20.3	46.2	16.9	6.2	3.2	0.66	0.2	7.0	s	10YR 5/3		
	A2	13-39	0.1	8.4	24.1	50.5	13.3	2.5	1.1	0.13	0.1	6.9	fs	9YR 6.5/3		
	B21&Bt	39-56	tr	7.0	22.6	50.9	15.0	2.6	1.9	0.08	0.1	7.3	fs	6YR 6/4		
	B22&Bt	56-82	0.1	7.2	23.4	51.6	12.8	2.4	2.5	0.07	0.2	1.63	7.8	fs	6YR 6/4	
	B31	82-109	0.1	5.8	20.4	50.2	17.0	3.6	2.9	0.09	0.2	1.68	7.8	fs	6YR 6/4	
	B32&Bt	109-139	0.1	7.6	23.2	48.2	12.9	4.6	3.4	0.06	0.2	1.68	7.8	s	6YR 6/4	
	C	139-181	tr	6.5	21.7	48.9	13.0	6.0	3.9	0.06	0.2	1.69	7.2	s	7.5YR 6/4	
B	B11tb	181-208	0.1	6.3	22.7	48.8	10.7	7.1	4.3	0.14	0.2	1.71	7.3	s	10YR 6.5/3	
	B12tb	208-226	0.1	5.3	22.0	45.3	10.7	8.5	4.1	0.03	0.2	1.73	7.0	s	10YR 6.5/3	
	B2tb	226-247	0.2	5.7	20.4	43.6	8.9	10.7	10.7	0.07	0.4	1.84	7.2	fs1	5Y 6/1	
<u>Typic Ustipsamment, Tivoli, S75TX-17-7, on gently undulating plain: Pedon 7</u>																
M	A1	0-11	0.2	8.1	23.5	49.2	11.9	3.8	3.3	0.52	0.2	7.0	s	10YR 5/2		
	A2	11-34	0.3	9.9	25.9	50.1	11.1	1.0	1.7	0.51	0.1	7.2	fs	10YR 6.5/2		
	B1	34-53	0.3	8.9	24.9	51.4	11.6	0.6	2.3	0.08	0.1	7.4	fs	10YR 7/4		
	B21&Bt	53-81	0.4	8.9	25.0	50.8	10.9	1.7	2.3	0.06	0.1	7.4	fs	7.5YR 7/4		
	B22	81-111	0.2	8.1	23.6	50.9	10.9	2.8	3.5	0.06	0.2	7.4	fs	7.5YR 6/4		
L	B2b&Bt	111-143	0.3	10.5	27.4	49.8	7.6	1.2	3.2	0.05	0.1	7.1	s	9YR 7/4		
	C1b&Bt	143-164	0.3	9.9	26.5	52.7	7.7	0.8	2.1	0.00	0.1	6.3	fs	10YR 7/3		
	C2b	164-191	0.2	6.8	22.1	55.1	12.8	1.4	1.6	0.00	0.1	6.2	fs	10YR 8/3		
B	Btb2	191-221	0.1	7.0	19.8	43.9	10.8	1.7	16.7	0.01	0.3	1.92	6.4	fs1	2.5Y 6/2	

^{1/} Particle-size distribution is by method 3A1 (Soil Conservation Service, 1972); organic carbon, method 5A1a; extractable Fe, method 6C2b; bulk density, method 4A1h; pH, method 8C1a (1:1H₂O). M = Muleshoe, L = Longview, B = Birdwell.

Table 15. Sand and clay mineralogy,
and resistant minerals of Pedons 4-7 and 22

	Sand ^{1/}				Percent resistant minerals ^{2/}	Clay ^{3/}
	Fine		Very fine			
	QZ	FD	QZ	FD		
<u>Pedon 4 (S75TX-17-8)</u>						
B21, 31-61 cm	94	6	85	11	93.2	MI 3, KK 2, MM 1
B21tb, 168-182 cm			83	14		MM 3, MI 3, KK 3
<u>Pedon 5 (S75TX-17-4)</u>						
B21&Bt, 33-52 cm	95	5	84	14	93.8	MI 3, MM 2, KK 2
B2b&Bt, 165-198 cm			90	7		MI 3, MM 2, KK 2
<u>Pedon 6 (S75TX-17-5)</u>						
B22&Bt, 56-82 cm	96	4	85	13	94.6	
B2tb, 226-247 cm			87	10		MM3, MI 3, KK 2, MC 1
<u>Pedon 7 (S75TX-17-7)</u>						
B22, 81-111 cm	93	7	85	12	92.3	MI 3, MM 2, KK 2
B2b&Bt, 111-143 cm			84	14		
Btb2, 191-221 cm			88	10		MI 3, MM 3, KK 2, MC 1
<u>Pedon 22 (S75TX-17-6)</u>						
B2&Bt, 66-92 cm	94	6	87	11	93.6	MI 3, MM 2, KK 2, MC 1
B32tb, 205-235			88	8		MI 3, MM 2, KK 2

1/ QZ = quartz (includes some chalcedony), FD = feldspar.

2/ Weighted average resistant minerals in .02-2 mm fraction. Assume resistant minerals in medium and coarser fractions are the same as in the fine sand; resistant minerals in coarse silt are the same as in the very fine sands.

3/ MI = mica, MT = montmorillonite, MM = montmorillonite-mica, MC = montmorillonite-chlorite, KK = kaolinite. Relative amounts are indicated as 3 = moderate, 2 = small, 1 = trace.

easily in the siliceous class. Some series used in this study are defined as having mixed mineralogy (table 4), but this will be corrected after enough data are obtained to be certain about occurrence of the mineralogy classes.

Clay mineralogy is very similar at Sites 4-7 and 22 (table 15). All soils have moderate or small amounts of montmorillonite-mica, mica, and kaolinite. A trace of montmorillonite-chlorite was found at Sites 6 and 7.

Site 4, east-facing side of dune

Figure 40 locates Sites 1-4, 10-21, and 27-31. The general area from the vicinity of Site 4 to the southern boundary of figure 40 represents a body of Muleshoe sediments derived from higher, pre-Muleshoe dunes just east of Farm Road 1731.

Site 4 (fig. 41) occurs on the side of a low dune just east of the high dune with Longview sediments at Site 30. The site occurs in the southernmost major body of Muleshoe deposits in the study area (fig. 19). The sampled pedon (S75TX-17-8), table 14) is in Soil Moisture Site 8 (Appendix).

Pedon 4 (fig. 41, table 14) illustrates one of the few A2 horizons found under nonoak vegetation. The A2 is only slightly lighter-colored than adjacent horizons. The pH is lower in the A2 than in adjacent horizons, as is typical of many A2 horizons in the study area.

The B horizon is slightly redder than adjacent horizons, and this is attributed to very slight accumulation of silicate clay. Although the color difference is small, it is genetically significant because it is a pedogenic feature related to soil age. The redder horizon is in the same general zone that, in some soils of Muleshoe age, is occupied by discontinuous clay bands. Distinct crotovinas are present at the right of the tape (fig. 41).

Although no clay bands were present in the sampled pedon, the sampling trench illustrates the sporadic development of clay bands that occurs in many soils of Muleshoe age. On the east end of the trench, discontinuous clay bands 1-2 mm thick occur at 41, 46, 51, and 53 cm depths; two thinner ones are at depths of 64 and 69 cm.

Site 5, north-facing side of dune

Site 5 (figs. 42, 43) is on the north-facing side of a high dune that, as shown in the roadcut just north, also contains sediments of Longview, Birdwell, and Hale age. The site occurs in a belt of Muleshoe sediments emplaced along the side (and discontinuously on the top) of the high dune complex just north. Slope at Site 5 is 3 percent to the south.

The sampled pedon (S75TX-17-4, table 14) is in a soil moisture enclosure at Soil Moisture Site 4 (Appendix). The B1 horizon has a mixed-appearing fabric, dominated by brownish material but also having lighter-colored crotovinas occurring as roughly circular to cylindrical shapes in cross section, and ranging from 2 to 10 cm in diameter. These are thought to represent former root channels, as discussed earlier at Site 1.

The B2&Bt horizon illustrates sporadic occurrence of discontinuous clay bands. The B21&Bt horizon has one discontinuous clay band, 5YR 6/6 dry,



Figure 40. Location of Sites 1-4, 10-21, and 27-31. Farm Road 1731 is at left. 1970 aerial photograph.



Figure 41. Upper. Landscape of the Muleshoe surface and Tivoli soils at Site 4. Farm Road 1731 is at left; the high dune at Site 1 is on the skyline at right center. The fenced enclosure for Soil Moisture Site 8 (Appendix) is in the foreground. The view is north. Photographed November 1975.

Lower. The Typic Ustipsamment, Tivoli, Pedon S75TX-17-8 (table 14; Appendix). Note crotovinas at right of tape. Scale is in feet.

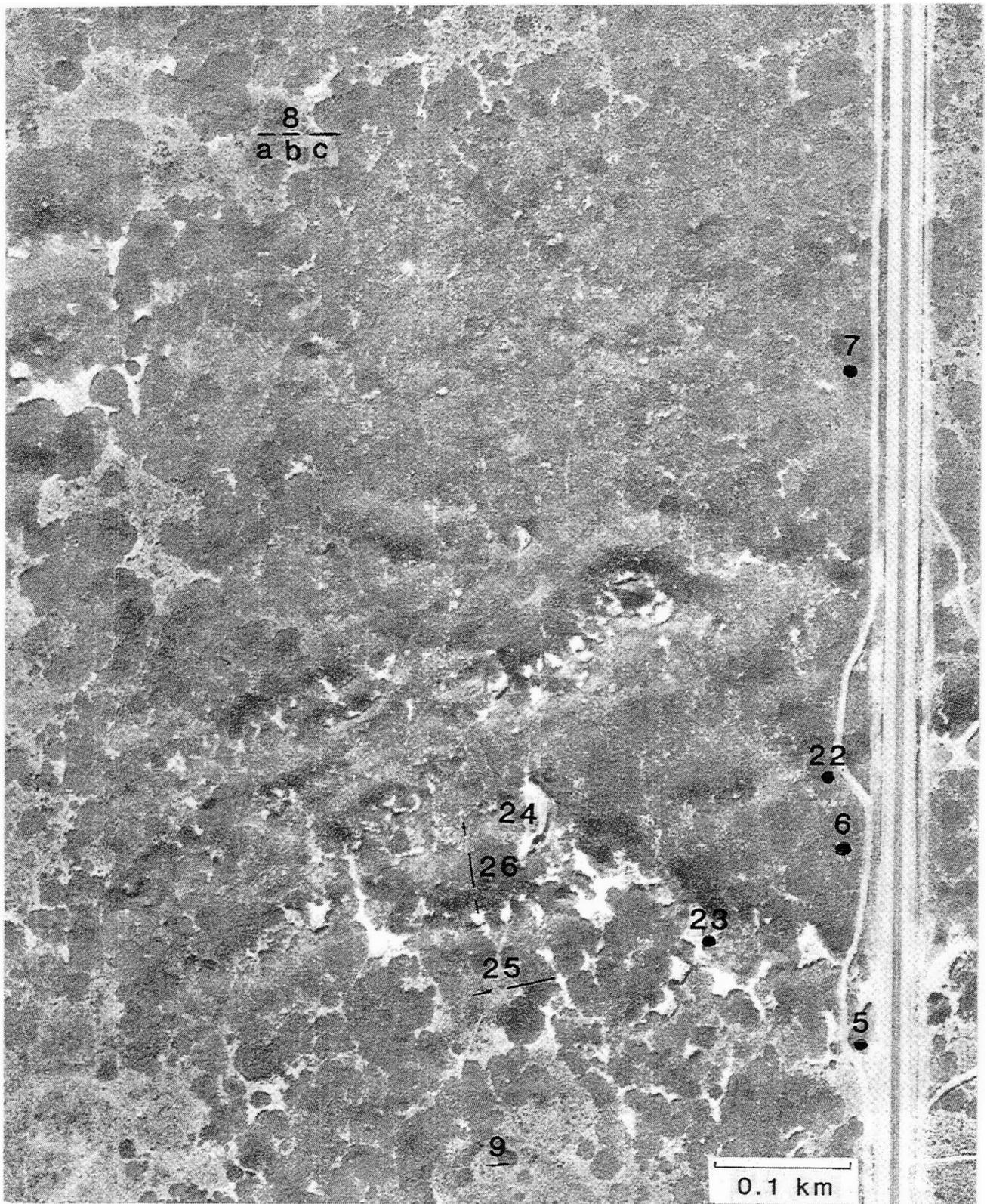


Figure 42. Location of Sites 5-9 and 22-26. Farm Road 1731 is at right. 1970 aerial photograph.



Figure 43. Landscape of the Muleshoe surface and Site 5. Arrow locates Site 5 and Soil Moisture Site 4 (Appendix). Farm Road 1731 is in the foreground. Photographed March 1981.

1 mm thick, that occurs for about 50 cm in the center of the horizon, then disappears. The B22&Bt horizon has two discontinuous clay bands about 1 mm thick and 3 to 4 mm apart. The B2b&Bt horizon, of Longview age, has six continuous clay bands, 5YR 5/6 dry, from 1 to 3 mm thick and 2 to 8 cm apart; the bands are thickest in the upper part of the horizon.

Beneath Muleshoe sediments, Pedon 5 has a buried soil of Longview age. A buried argillic horizon of Birdwell age was found with an auger at a depth of about 250 cm.

Site 6, trough

The soil and landscape at Site 6 has been illustrated (fig. 4 in Gile, 1979). Figure 44 shows the trough form of the linear depression in which Site 6 occurs.

The soil at Site 6 (table 14) has the same general stratigraphy as the soil at Site 5, but has enough continuous clay bands in Muleshoe sediments to qualify as an Alfic Ustipsamment. The B21&Bt horizon has two discontinuous and two continuous clay bands, 5YR 5/6 dry, 1 to 2 mm thick and 2 to 6 cm apart. The B22&Bt horizon has 4 to 6 clay bands, 5YR 5/6 dry, 1 to 3 mm thick and 2 to 4 cm apart.

The B32&Bt horizon has one discontinuous clay band, 5YR 5/6 dry, 1 mm thick. The individual clay bands have enough clay increase for an argillic horizon, but are too thin and too few (Soil Survey Staff, 1975) to qualify. The amount of clay for the B horizon as a whole is similar to that of the Typic Ustipsamments (table 14).

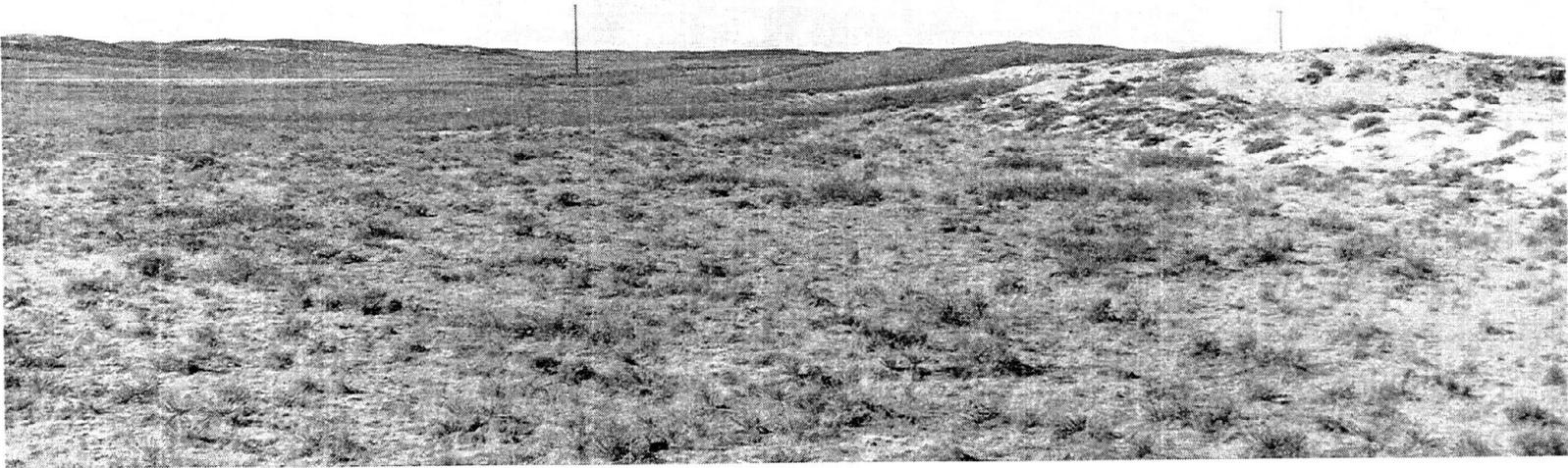


Figure 44. View of trough in which Site 6 is located. Site 6 occurs just to the left of, and beyond, the utility pole at left center. The view illustrates a typical trough between high dunes. The view is west. Photographed October 1974.

These marginal Alfic Ustipsamments in Muleshoe sediments occur in a complex pattern with the Typic Ustipsamments, with enough clay bands for qualification as Alfic in some spots but not in others. At Site 6, for example, clay bands were almost totally absent in the west end of the sampling trench. This contrasts with soils of Longview age, in which some clay bands are always continuous. Bulk density is highest in the buried soils of Pleistocene age, as is common in horizons of this texture that are largely below the zone of biotic mixing.

Site 7, gently undulating plain

The soil at Site 7 (figs. 42, 45; table 14) is on a gently undulating plain. Buried horizons of Longview and Birdwell age occur beneath Muleshoe sediments (table 14). Morphology of the soil of Muleshoe age is similar to the other soils of that age. The B2l&Bt horizon in Muleshoe sediments has one discontinuous clay band, 5YR 5/4, dry, from 1/2 to 1 mm thick; it occurs as segments a few cm in length, separated by much wider zones in which the clay band is absent. The B2b&Bt horizon in Longview sediments usually has about 4 clay bands, 5YR 5/6, dry; most bands are continuous and from 2 to 3 mm thick, with one being about 1/2 cm thick. The bands are usually 5 to 6 cm apart, ranging from 4 to 12 cm apart. The C1b&Bt horizon has two continuous clay bands, 5YR 5/4, dry, about 1 mm thick and from 5 to 10 cm apart.



Figure 45. Above. Landscape of the Muleshoe surface and Tivoli soils at Site 7. The fenced enclosure for Soil Moisture Site 7 (Appendix) is in the foreground. The view is west. Photographed March 1981.

Overleaf. The Typic Ustipsamment, Tivoli, Pedon S75TX-17-7 (table 14; Appendix). The clay bands below a depth of 4 ft (1.2 m) are bands of a buried soil of Longview age, overlain by Muleshoe sediments and soil. Scale is in feet.

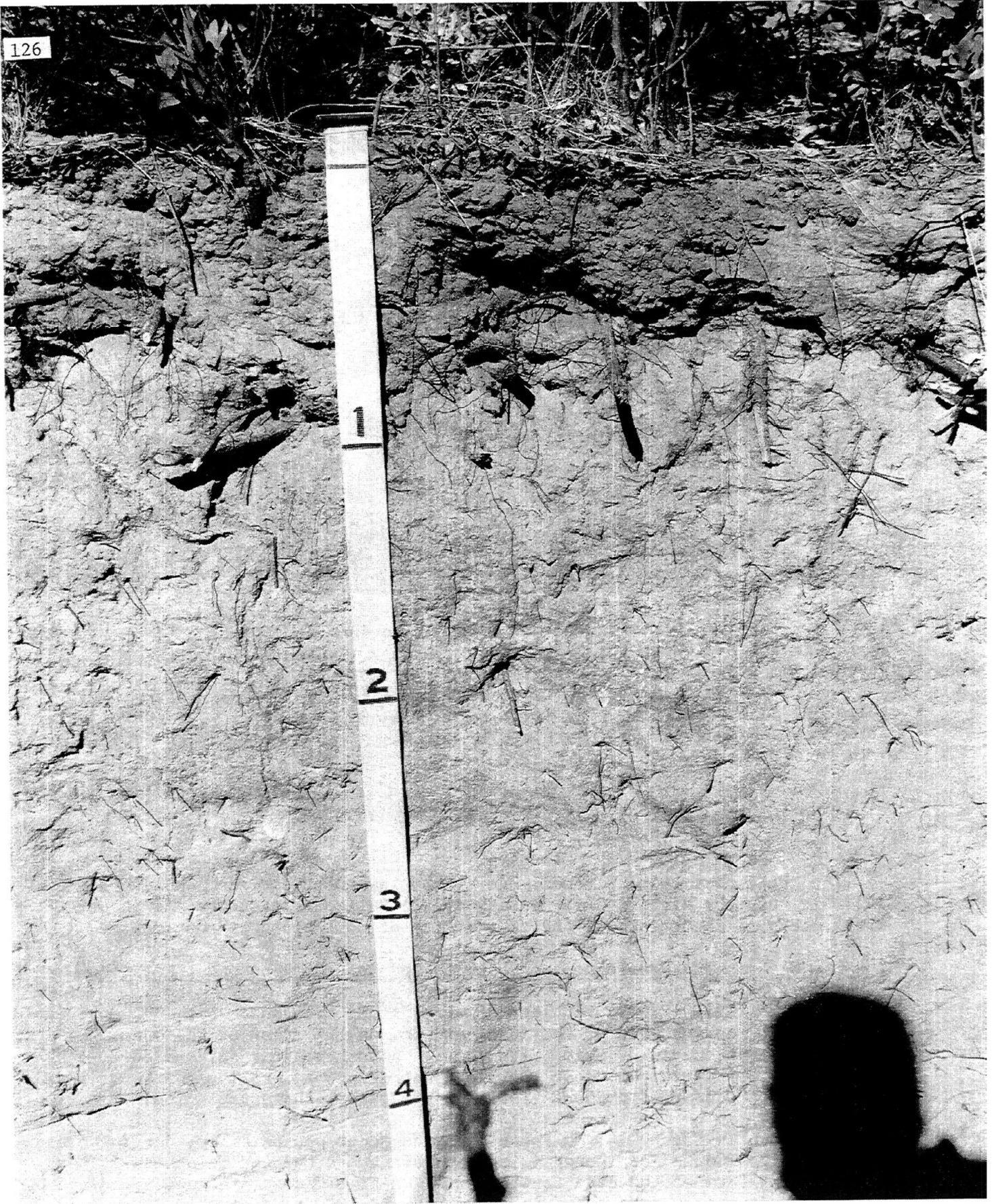
The Btb2 horizon of Birdwell age is the lowermost horizon sampled (table 14); it has the highest bulk density of all horizons measured. As at other sites, this is thought to be due to scarcity of soil biota at that depth.

Site 8, episodic development of blowout and dune; oak-nonoak transition

Site 8 (figs. 42, 46) consists of three study trenches: Site 8a, in the blowout; 8b, on the side of the dune; and 8c, on the crest of the dune. Site 8c is further divided into Site 8c-1, nonoak vegetation, and 8c-2, oak vegetation. Figure 46 shows the slope, stratigraphy, soil occurrence, and location of the sampled pedons. Table 16 gives soil characteristics.

As shown in figure 46, Muleshoe deposits occur sporadically, burying the Alfic Ustipsamments of Longview age in some areas but not in others. Thus the present form of the dune is the result of episodic sedimentation and not a single deposit. But the dune could have started to form before Longview time, as is the case at Site 18, discussed later. The sporadic burial resulted in an intricate pattern of Alfic and Typic Ustipsamments.

126



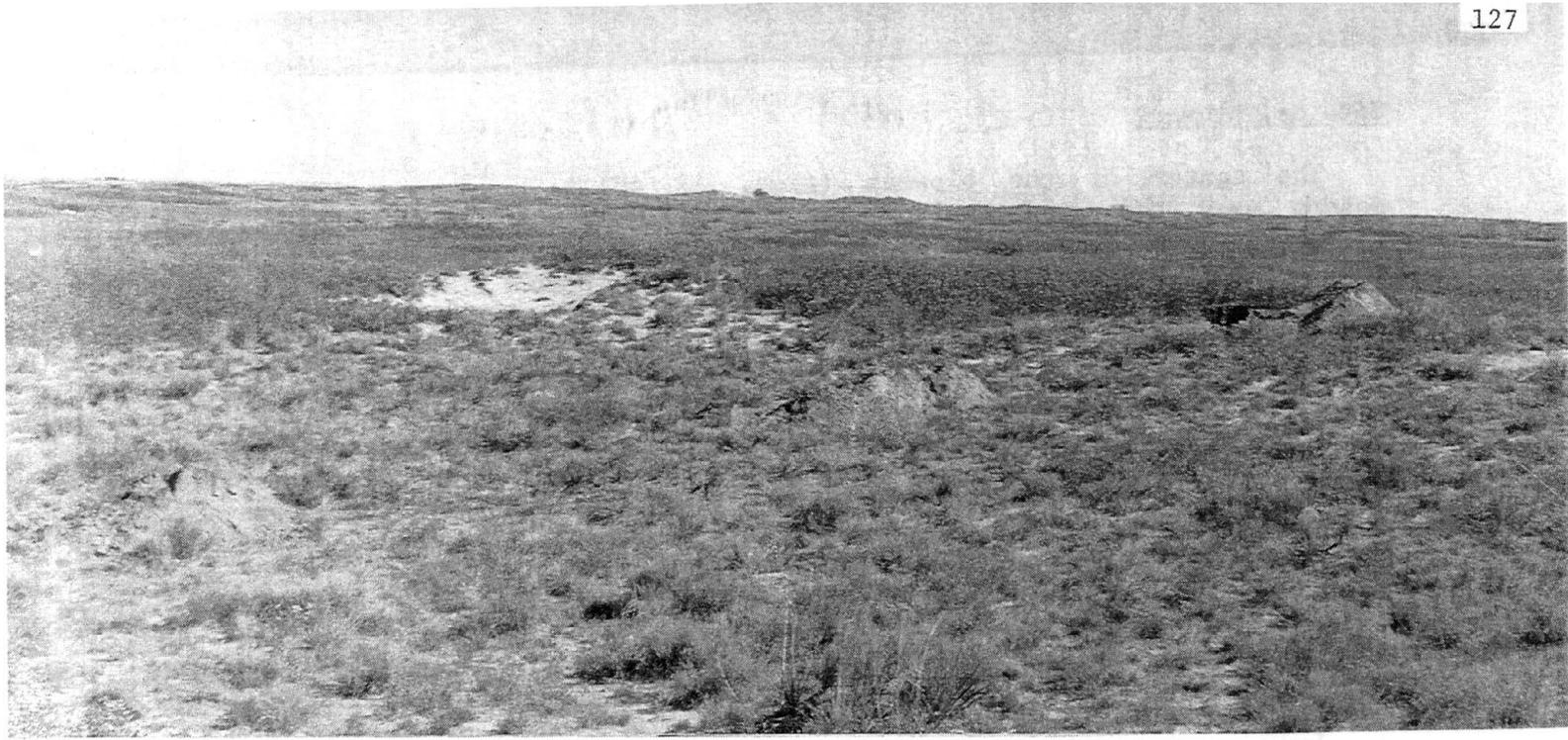
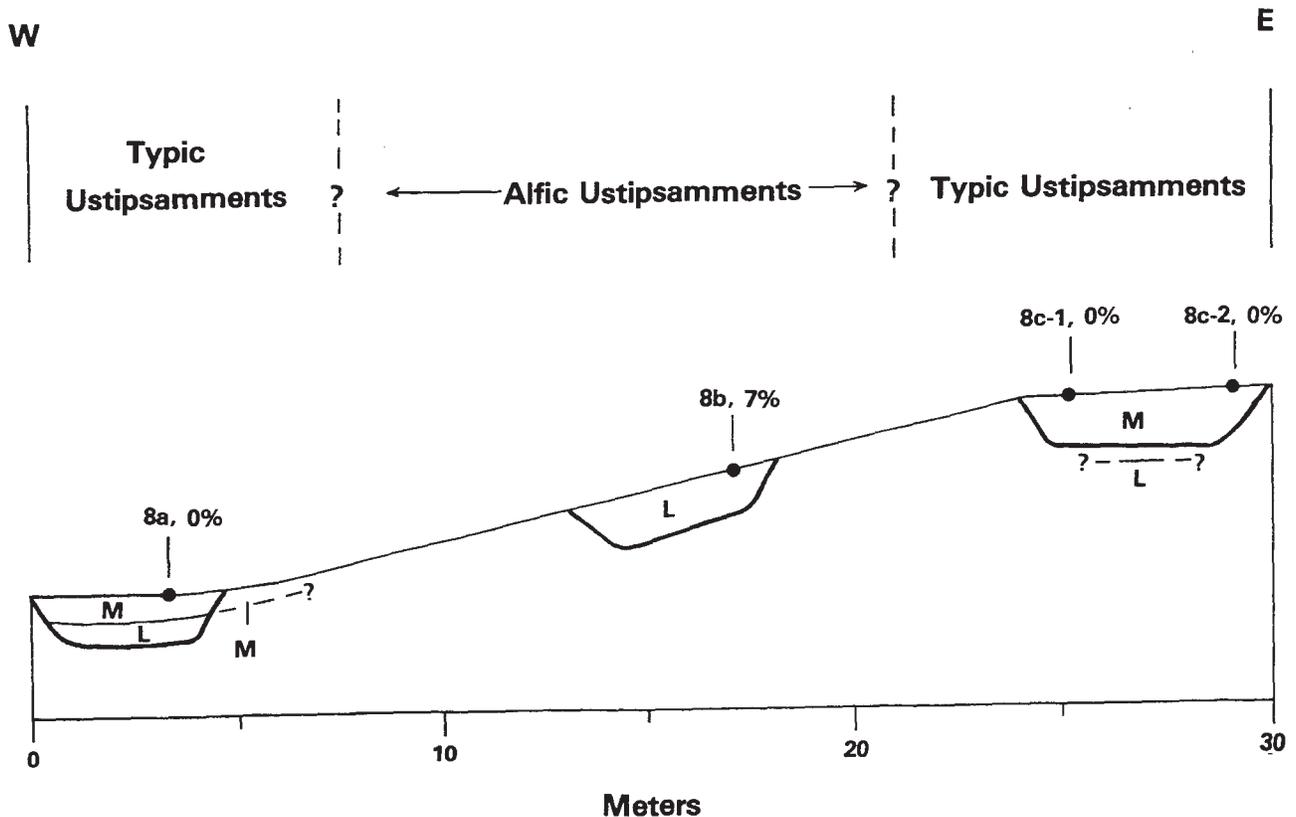


Figure 46. Above. Landscape view of the blowout and dune at Site 8, and from left to right, the three study trenches at Sites 8a, 8b and 8c. A grassy, non-oak area is in the foreground. Vegetation in the middle ground and background is dominantly oak.

Below. Diagram showing stratigraphy, soil occurrence, and the location and slope of sampled pedons at Site 8. M = Muleshoe sediments; L = Longview sediments. The heavy lower lines represent the bottom of the trenches. No vertical scale (see table 16 for thickness of sediments and soil horizons).



Site 8a, blowout

The center of the blowout (figs. 47, 48) is level, but only several meters away the land surface rises in all directions to the crest of the bordering dune. To 51 cm depth the horizons are weakly expressed and have the typical youthful appearance of Muleshoe sediments. Since the Muleshoe deposit lacks diagnostic horizons and is more than 50 cm thick, classification is based on it instead of the buried soil. Textures are coarse and diagnostic horizons are lacking to a depth of more than 1 m, and the soil is the Typic Ustipsamment, Tivoli. The A horizon is darker and thicker in the blowout than in the surrounding dune, reflecting run-in from adjacent slopes and resultant thicker vegetation. However, the epipedon is not mollic because color values are too high. Also, textures are quite coarse and analyses for similar materials elsewhere (see Site 12a) indicate that the epipedon would have too little organic carbon for mollic.

The thin surficial horizon is a loamy fine sand in contrast to fine sand beneath (table 16). Finer texture at the surface is common in Muleshoe blowouts. Silt and clay apparently have accumulated in the blowout as a result of run-in and additions from dustfall. The pH of the surface horizon is lowest of any horizons in the four soils studied. This also may be due to run-in; relatively low pH values were also found in the blowout at Site 18.

The top of the B21b&Bt horizon is a clay band that is 1 to 2 cm thick at the sample site. The band becomes diffuse and thins westward to only 1 to 2 mm thick in the west 1 m of the pit. The lower band in the B21b&Bt horizon also becomes more diffuse westward. The B22b&Bt horizon has occasional yellowish mottles and streaks and is yellower than in soils of Longview age on dunes. These colors are attributed to the high water table that existed prior to extensive pumping for irrigation (Cronin, 1969).

Site 8b, side of dune

Longview sediments, buried in the blowout, rise to the surface on the side of the dune (fig. 49). The distinct clay band horizon is typical of soils of Longview age (see Unit C), and the soil is an Alfic Ustipsamment. The soil lacks the loamy fine sand surficial horizon of the blowout (table 16).

The described pedon (fig. 49, table 16) is just left of the tape. A light-colored A2 horizon is just above the banded zone. The A2 horizon has no continuous clay bands but does contain scattered bits of material colored 5YR 5/5, dry. These are interpreted as remnants of former clay bands that were once continuous with bands to the right of the tape, where the uppermost clay band is 1-3 mm thick and is at 36 cm depth. The band is nearly continuous on the east end of the pit but only occasional segments occur on the west end; the band appears to be slowly disintegrating by biotic action and movement of soil water. The next band is at 44 cm depth and is less broken than the one above. But it also is generally not present on the west end of the pit.

The main zone of clay bands starts at 61 cm. Most of the bands range from 1/2 to 1 cm thick. There are eight well-defined bands on the east end of the pit and several less on the west end, where the upper bands are generally more discontinuous. There are no bands in the B3 horizon, but



Figure 47. Above. Landscape view of Site 8a in the blowout and slopes leading to the rim on the skyline. The view is north. Scale is in feet. Photographed November 1976.

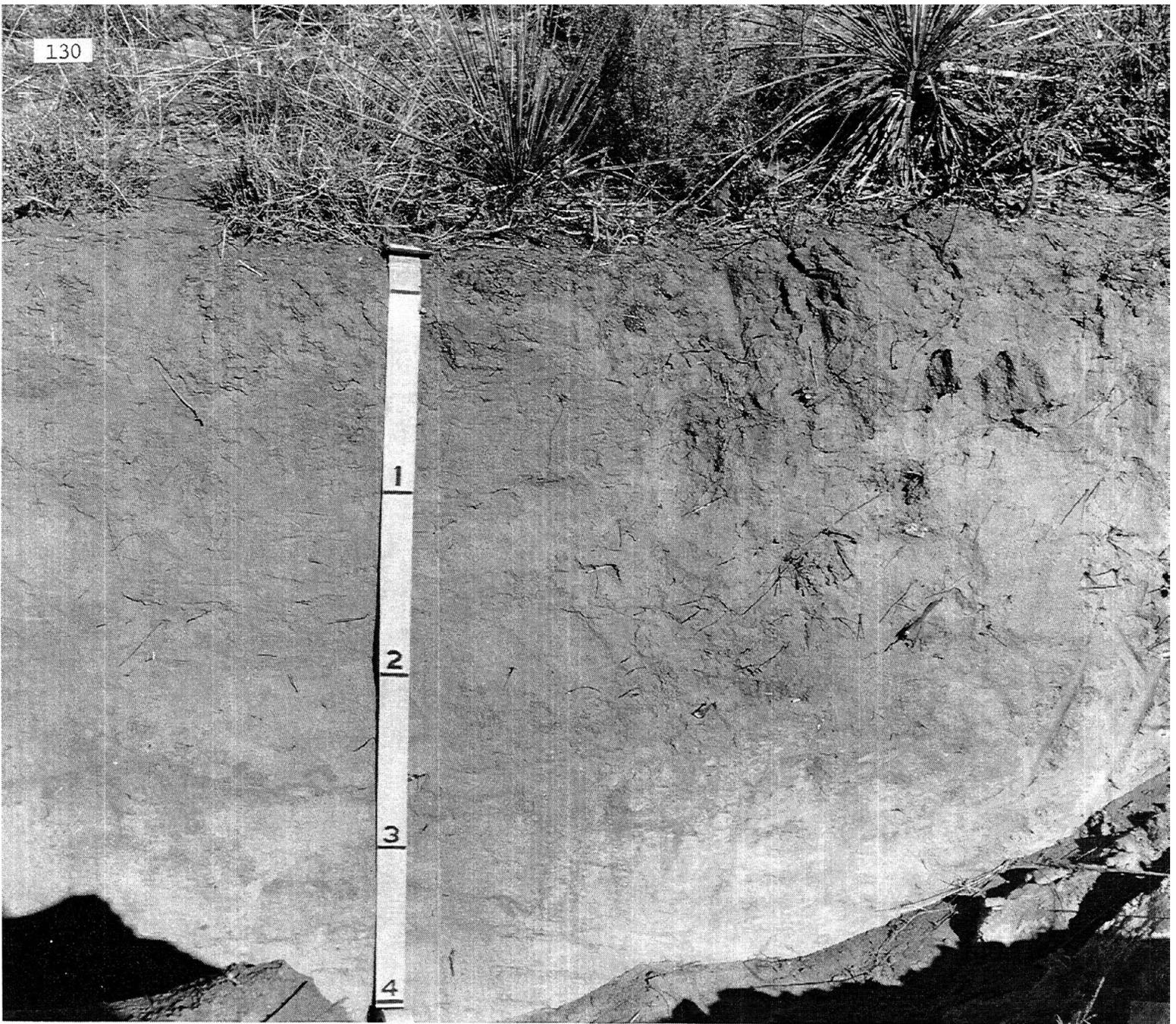


Figure 48. The Typic Ustipsamment, Tivoli, in the blowout. Muleshoe sediments extend to a depth of slightly less than 2 ft (0.6 m) and are underlain by Longview sediments with clay bands. Scale is in feet.

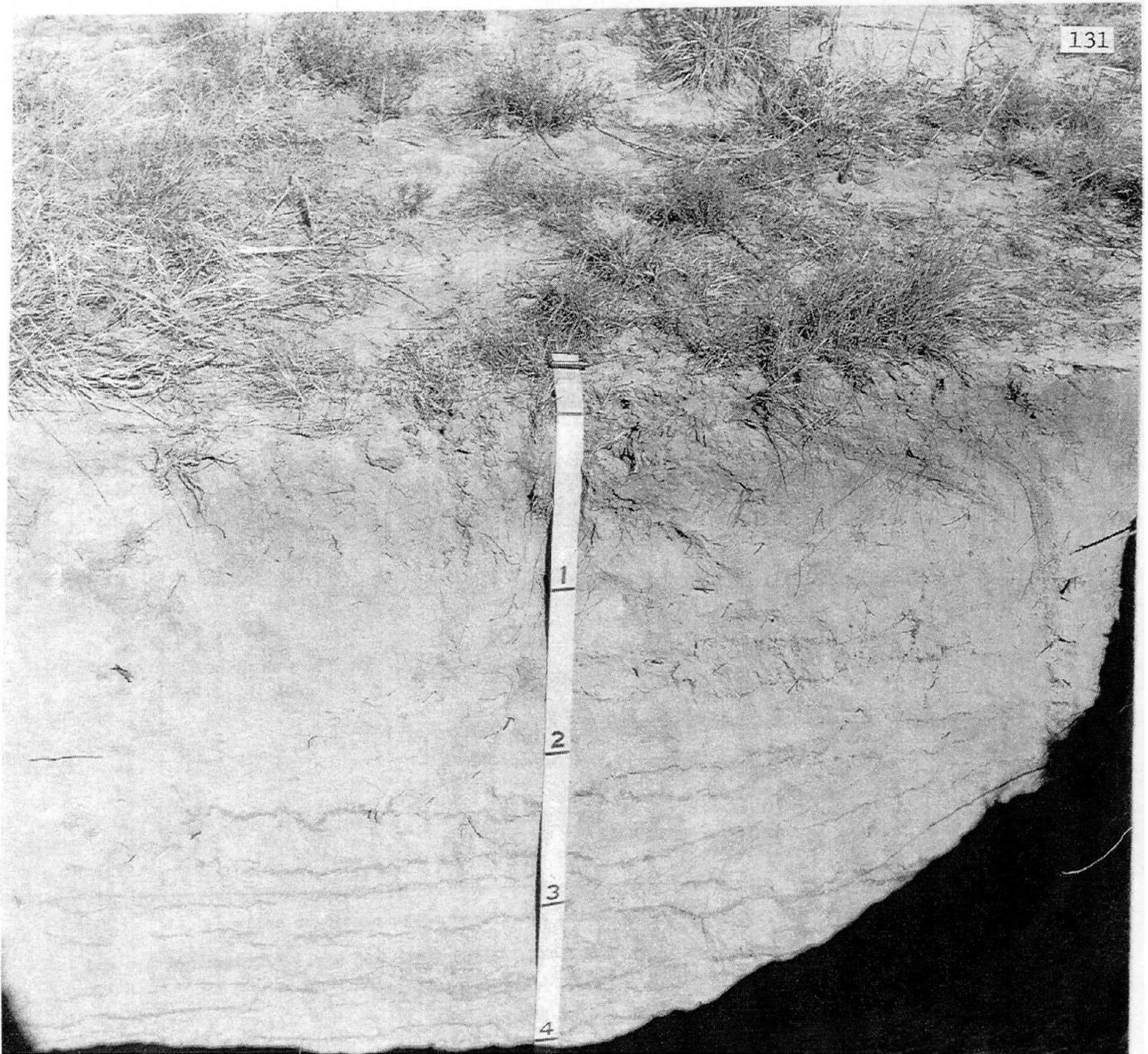


Figure 49. The Alfic Ustipsamment, Circleback. Sediments of Longview age, buried at Sites 8a and 8c, are at the surface here at Site 8b. Scale is in feet. Photographed November 1976.

Table 16. Characteristics of Ustipsamments at Site 8^{1/}

Sediment	Horizon	Depth cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	pH	Lower boundary
				Dry	Moist					
<u>Typic Ustipsamment, Tivoli, in blowout; Pedon 8a^{2/}</u>										
Muleshoe	A11	0-5	10YR	5/2	3/2	lfs	m	s	6.2	as
	A12	5-16	10YR	5.5/2	3.5/2	fs	m	s	6.8	cw
	A13	16-39	9YR	6/4	4.5/4	fs	m	s	6.8	cw
	A14	39-59	9YR	6/3	4.5/3	fs	m	sh	6.8	cw
Longview	B1b	59-78	7.5YR	6/5	4.5/5	fs	m	sh	6.8	aw
	B21b&Bt	78-110	7.5YR	6/5	4.5/5	fs	m	sh	6.8	aw
	B22b&Bt	110-122	10YR	7/4	6/4	fs	m	h	6.8	
<u>Alfic Ustipsamment, Circleback, on side of blowout dune; Pedon 8b^{3/}</u>										
Longview	A11	0-18	9YR	6/4	4/4	fs	m	s	6.8	cw
	A12	18-44	7.5YR	6/4	4.5/4	fs	m	sh	6.8	aw
	A2	44-61	7.5YR	7/4	5/4	fs	m	s	6.8	aw
	B21&Bt	61-88	7.5YR	6.5/4	4.5/4	s	m	sh	6.8	aw
	B22&Bt	88-118	7.5YR	6/4	4.5/4	s	m	sh	6.8	aw
	B3&Bt	118-130	7.5YR	7/4	6/4	s	m	sh,s	6.8	
<u>Typic Ustipsamment, Tivoli, on crest of blowout dune; Pedon 8c-1 (nonoak)</u>										
Muleshoe	A1	0-22	7.5YR	6/4	4.5/4	fs	m	s	6.8	cw
	B1	22-38	7.5YR	6/5	4.5/4	fs	m	sh	7.2	cw
	B21	38-63	7.5YR	6/5	4.5/5	fs	m	sh	6.8	cw
	B22	63-85	7.5YR	6/5	4.5/5	fs	m	sh	6.8	cw
	C	85-112	7.5YR	6.5/5	5/5	fs	m	s	6.8	cw
<u>Typic Ustipsamment, Tivoli, on crest of blowout dune; Pedon 8c-2 (oak)</u>										
Fairview	A1	0-11	9YR	6/4	4/4	fs	m	s	7.0	cw
Muleshoe	A1b	11-24	9YR	6/4	4.5/3	fs	m	s	6.6	cw
	A2b	24-40	8YR	6/4	4.5/4	fs	m	s	6.6	cw
	B1b	40-61	7.5YR	6/4	4.5/4	fs	m	s	6.8	cw
	B21b	61-89	7.5YR	6/5	4.5/5	fs	m	s	6.6	cw
	B22b	89-127	7.5YR	6/5	4.5/5	fs	m	sh	6.6	cw
	Cb	127-144	7.5YR	6.5/5	5/5	fs	m	sh	6.6	cw

^{1/} Subordinate colors and other characteristics are footnoted to pertinent soils.

^{2/} B21b&Bt: mottles and streaks of 7.5YR 5/4, 10YR 7/4 and 10YR 7/6, dry. B22b&Bt: mottles and streaks of 10YR 7/6, dry and clay bands 7.5YR 5/4, dry.

^{3/} B22&Bt: clay bands 5YR 5/4, dry. B3&Bt: also 9YR 8/2, dry.

only about 15 cm of this horizon was exposed above the bottom of the trench.

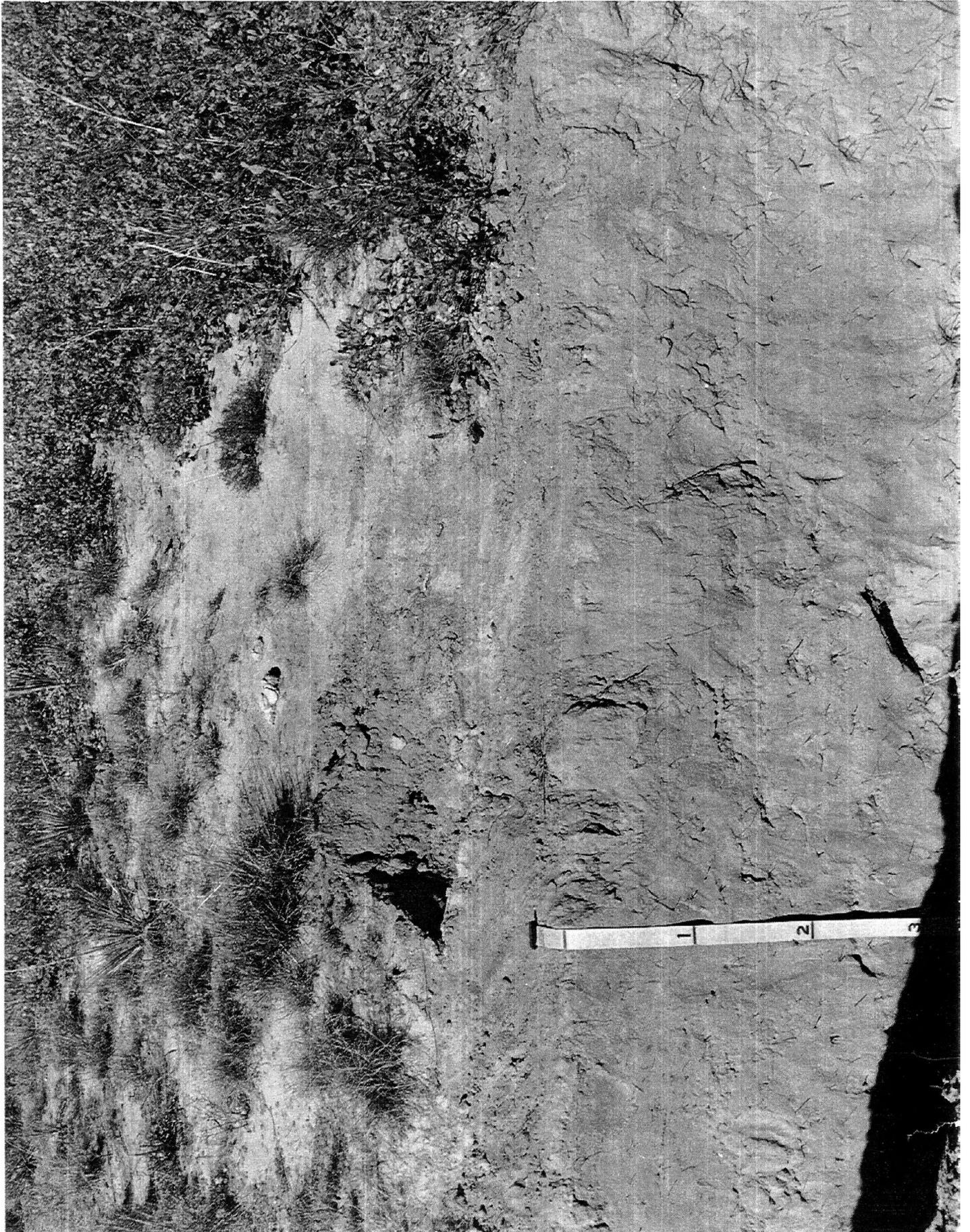
Site 8c, crest of dune

This site (fig. 50) is on the nearly level crest of the dune, where the Muleshoe sediments are thicker than in the blowout. The trench extends from a nonoak area into oak (fig. 50). All soils exposed in the trench are Typic Ustipsamments (Tivoli). The soils lack continuous clay bands and thus contrast with the Alfic Ustipsamment of Longview age only a short distance downslope (fig. 49). Augering below the trench bottom showed the Longview clay bands to be present at a depth of about 185 cm.

Pedon 8c-1 is under nonoak vegetation and has a weak B horizon, which is very slightly harder and darker than the C horizon. The B horizon also has zones that differ in color: scattered small volumes of material are slightly yellower and lighter-colored than the horizon as a whole, apparently due to faunal mixing. There is one discontinuous clay band.



Figure 50. Above. The Typic Ustipsamment, Tivoli, at Site 8c-2. A thin deposit of Fairview age is indicated by burial of oak clumps at left of tape, but not at right of tape. Overleaf. The Typic Ustipsamment, Tivoli, under nonoak vegetation at Site 8c-1, and the oak-nonoak contact. Scale is in feet. Photographed November 1976.



Pedon 8c-2 is under oak vegetation. Although Fairview sediments bury portions of oak trunks, unburied grass clumps are rooted in the deposits. This suggests stability for at least several years. Oaks appear to be advancing into the area once barren or occupied by grass, since a number of small oak plants, only a few cm high, mark the western edge of the oak patch. The nonoak area has common barren spots and would be more susceptible to erosion than the oak, which should resist erosion because of the mulch of oak leaves and twigs on the surface. Roots are larger and more prominent under the oak than under the adjacent nonoak vegetation.

Only slight differences are apparent in the soil under oak as compared to nonoak vegetation. Reaction values are slightly lower under oak. In places the A1 horizon in Fairview sediments has been slightly darkened by organic carbon. The A2b horizon has the lightest color and is beneath the former ground level, as indicated by the buried oak branches. The A2b horizon is very slightly lighter in color than adjacent horizons although not enough to show on the color chips.

The expression of pedogenesis in the Bb horizon is similar to that under nonoak vegetation except that the Bb horizon is not quite as hard and is easier to remove than the Cb horizon, possibly because of numerous oak roots. A discontinuous clay band, 1 mm thick, occurs in the lower part of the B21b horizon. Another discontinuous clay band, 1 mm thick, is at 107 cm depth. It occurs in segments 5 to 10 cm in length, separated by longer intervals in which the band is absent. The bands are indistinct and difficult to see in shadow, and could easily be missed in all but direct sunlight.

Site 9, crest of blowout dune; oak-nonoak transition

Site 9 (fig. 42, table 17) extends from an oak into a nonoak area on a dune crest that is west of a small blowout. Along the western margin of the oak patch, burial of oak trunks indicates that about 12 cm of Fairview sediments have been added since Muleshoe time. The sediments were apparently derived primarily from the nonoak area just west, which contains many barren spots.

Table 17. Characteristics of Typic Ustipsamments (Tivoli series) on dune crest at Site 9.

Sediment	Horizon	Depth cm	Hue	Value/chroma		Texture	Structure	Dry consis- tence	pH	Lower boundary
				Dry	Moist					
<u>Pedon 9a, nonoak</u>										
Muleshoe	A11	0-10	7.5YR	5/4	3.5/4	fs	m	s	6.6	cw
	A12	10-37	7.5YR	6/4	4.5/4	fs	m	s	6.6	cw
	B21	37-71	5YR	6/6	4.5/6	fs	m	sh	7.0	cw
	B22	71-99	5YR	6/6	4/5/6	fs	m	sh	7.0	cw
Longview	Bb&Bt	99-110	5YR	6/6	4.5/6	s	m	sh	7.4	
<u>Pedon 9b, oak</u>										
Muleshoe	A11	0-16	8YR	6/3	4/3	fs	m	s	6.6	cw
	A12	16-35	7.5YR	5.5/4	4/6	fs	m	s	6.6	cw
	B21	35-55	5YR	6/6	4/6	fs	m	s	6.8	cw
	B22	55-92	5YR	6/6	4/6	fs	m	sh	6.8	cw
Longview	Bb&Bt	(similar to the Bb&Bt horizon of Pedon 9a)								

There is little difference between the soils under oak, vs. nonoak vegetation. Both appear slightly weaker than other soils of Muleshoe age. The pH is slightly lower under oak than under nonoak vegetation, as is common. The only clay band evident in Muleshoe sediments is in the west (nonoak) end of the trench. The band is at about 50 cm depth and extends for a lateral distance of about 1 m.

No evidence of a light-colored A2 horizon is apparent in the soil under oak. This contrasts with other soils under oak previously discussed, all of which had A2 horizons. Lack of an A2 horizon is attributed to youthfulness of the oak clump, which may only be a few decades old. The clump was smaller in 1941, as shown by comparison of 1941 and 1981 airphotos (figs. 13-17).

At about 1 m depth all along the exposure there is a buried B horizon of Longview age, with prominent clay bands. The contact between Muleshoe and Longview sediments is thought to occur at the top of the banded B horizon. This horizon is the most erosion-resistant horizon in soils of Longview age, and is currently at the surface in some of the small active blowouts in mapping unit C (fig. 27). Morphology of materials above the banded B horizon is typical of soils of Muleshoe age, and the area occurs in a belt of Muleshoe sediments (fig. 19).

Site 10, dune crest; oak-nonoak transition

Site 10 (fig. 40) is on the nearly level crest of an elongate blowout dune. Two pedons were sampled (table 18), one in the oak (west) part of the trench, and the other in the nonoak (east) part. The study trench illustrates sporadic development of clay bands that is typical of many soils of Muleshoe age. Most soils exposed in the trench are Typic Ustipsamments.

Table 13. Characteristics of Ustipsamments on dune crest at Site 10

Horizon	Depth, cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	pH	Lower boundary
			Dry	Moist					
<u>Typic Ustipsamment, Tivoli: Pedon 10a, oak</u>									
A1	0-9	7.5YR	5/3	3/3	fs	m	s,1	7.0	aw
A2	9-25	7.5YR	6.5/3	5/3	fs	m	s,1	6.4	cw
B1	25-41	7.5YR	6.5/4	5/4	fs	m	s,sh	6.6	cw
B21	41-62	7.5YR	6.5/4	5/4	fs	m	sh	6.6	cw
B22	62-88	7.5YR	6.5/4	5/4	fs	m	sh	6.8	cw
B23&Bt	88-120	7.5YR	6.5/5	5/5	fs	m	sh	6.6	cw
B3	120-141	7.5YR	6.5/5	5/5	fs	m	sh	7.0	cw
C	141-148	7.5YR	6.5/5	5/5	fs	m	sh	7.0	
<u>Alfic Ustipsamment, Circleback: Pedon 10b, nonoak</u>									
A1	0-12	7.5YR	5/3	3.5/3	fs	m	s,1	7.0	cw
A2	12-25	7.5YR	6/4	4/4	fs	m	s	7.2	cw
B1	25-46	7.5YR	6/5	4/5	fs	m	s	7.2	cw
B21&Bt	46-71	7.5YR	6/5	4/5	fs	m	sh	7.0	as
B22&Bt	71-88	7.5YR	6/5	4/5	fs	m	sh	6.8	cw
B3	88-106	7.5YR	6.5/6	5/5	fs	m	s	6.8	cw
C	106-129	7.5YR	6.5/5	5/5	fs	m	s	6.8	

The soil under nonoak vegetation is an Alfic Ustipsamment, but only on the north side of the trench, where the pedon was sampled; less than two continuous clay bands are present on the south side. The B21&Bt horizon has one continuous and one discontinuous clay band, about 1 mm thick. The B22&Bt horizon has one continuous and one discontinuous band in the center of the horizon and also in the lower 5 cm.

A clay band at 71 cm depth extends continuously from the soil under nonoak vegetation into the soil under oak, where the band gradually deepens and is discontinuous. Several other discontinuous bands, about 1 mm thick, are also present. At the sample site in oak, the only clay band present is at about 92 cm depth. Except for the surface horizon, pH of upper horizons is lower under oak than under grass.

Site 11, blowout

Muleshoe deposits are usually quite thin in blowouts. Site 11 (fig. 40, table 19) illustrates a thicker deposit of Muleshoe sediments in a blowout. The A horizon has been darkened by organic carbon. No clay bands and no reddening occur in the B horizon. The A1 horizon, biotic mixing in the B horizon and slight increase of consistence with depth reflect slight pedogenic change from the parent materials. The abrupt smooth boundary at the base of the Muleshoe sediments appears to reflect an erosional contact to the older sediments beneath.

Table 19. Characteristics of the Typic Ustipsamment,
Tivoli, in blowout at Site 11 ^{1/}

Hori- zon	Depth cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	Lower pH bound- ary
			Dry	Moist				
A11	0-9	7.5YR	5/3	3/3	fsl	m	h, sh	6.4 as
A12	9-26	9YR	5.5/3	3.5/3	fs	m	s	6.2 cw
B21	26-48	9YR	6/3	4/3	s	m	s	6.6 cw
B22	48-64	9YR	6.5/3	4.5/3	s	m	s, sh	6.8 cw
B23	64-104	9YR	6.5/3	4.5/3	s	m	sh	6.8 cw
B24	104-138	9YR	6.5/4	4.5/3	s	m	sh	6.8 as
Bb	138-143	10YR	7/3	6/3	s	m	h, vh	6.8

^{1/} Bb: parts 10YR 6/2, dry. Muleshoe sediments occur from 0-138 cm. Sediments from 138-143 not identified.

Site 12, side and crest of blowout dune

Site 12 (figs. 21, 40) consists of a study trench in a blowout and one in the adjacent blowout dune. Site 12a illustrates a soil that occurs in some of the small blowouts. The epipedon does not quite qualify as mollic; upper horizons are not quite dark enough, and organic carbon is too low (table 20). Since the Muleshoe deposit is thinner than 50 cm and lacks diagnostic horizons, classification is based on the buried soil beneath, which is the Psammentic Haplustalf, Texico.

Table 20. Characteristics of an Ustipsamment and a Haplustalf at Site 12^{1/}

Sediment	Horizon	Depth cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	pH	Lower bound- ary	Organic C
				Dry	Moist						
Psammentic Haplustalf, Texico, on side of blowout dune, near bottom; Pedon 12a ^{2/}											
Muleshoe	A11	0-9	7.5YR	5/3	3/3	lfs		s	6.8	cs	1.35
	A12	9-28	7.5YR	5/3	3.5/3	fs	m	s	6.8	cw	0.34
	A13	28-44	7.5YR	5.5/3	4/3	fs	m	s	7.0	cw	0.32
Birdwell	B1tb	44-53	7.5YR	5/4	3/4	fs	m	h	7.0	cs	0.28
	B21tb	53-65	7.5YR	6/4	5/4	lfs	lmsbk	vh	7.0	cw	0.28
			5YR	5/4	4/4						
	B22tb	65-80	7.5YR	5/4	3.5/4						
			5YR	7/4	6/4	fs	lcsbk	vh	7.4		0.16
			5YR	6/4	5/4						
Typic Ustipsamment, Tivoli, on crest of blowout dune; Pedon 12b ^{3/}											
Muleshoe	A11	0-13	6YR	5/3	3.5/3	fs	m	s	6.8	cw	
	A12	13-26	5YR	5.5/4	4/4	fs	m	s	6.8	cw	
	B21	26-56	5YR	6.5/4	5/4	fs	m	s	7.0	cw	
	B22	56-73	5YR	6.5/4	5/4	fs	m	s,sh	7.0	as	
	B23&Bt	73-114	5YR	6.5/4	5/4	fs	m	sh	7.0	as	
	C	114-120	5YR	6.5/4	5/4	s	m	s,sh	7.0		

1/ Subordinate colors and additional characteristics are footnoted to pertinent soils.

2/ B21tb: approximately equal amounts of given colors occur in irregular masses 1-10 cm diameter; also, about 5% of coarse mottles, 1-5 mm diameter, 5YR 6/6, dry, occur throughout. B22: 10% irregular zones of 10YR 8/3, dry, and 5% mottles, 5YR 6/8, dry, 1-3 mm diameter.

3/ B23&Bt: several discontinuous clay bands, about 1 mm thick.

Site 12b (fig. 21) is on the south rim of the dune and illustrates incipient clay band development in Muleshoe sediments. Sedimentary strata are well preserved in the lower part of the pedon (fig. 21). In most places, distinct strata are not apparent in Muleshoe sediments.

Site 13, blowout dune; oak-nonoak transition

At site 13 (figs. 40, 51) a trench was dug across an oak-nonoak boundary on the east-facing side of a blowout dune. Pedon 13a was sampled under oak, and Pedon 3b under nonoak vegetation (table 21). A weak A2 horizon occurs under oak but not under nonoak vegetation. A discontinuous clay band, about 1 mm thick, occurs in the B2 horizon of Pedon 13b. The band could be traced into the soil under oak, where it is also discontinuous. Over the exposure as a whole, the single clay band was similarly developed under both oak and nonoak vegetation.

Work with the auger and backhoe indicates a continuous Muleshoe deposit in the dune at Site 13 (fig. 51). An exploratory trench was also dug in the crest of the dune (fig. 51). A pit 130 cm deep and 3 m wide showed the soil of Muleshoe age to have a weak A1 horizon; no A2 horizon, despite being under oak; no clay bands; and only a very slight reddening in the B horizon.

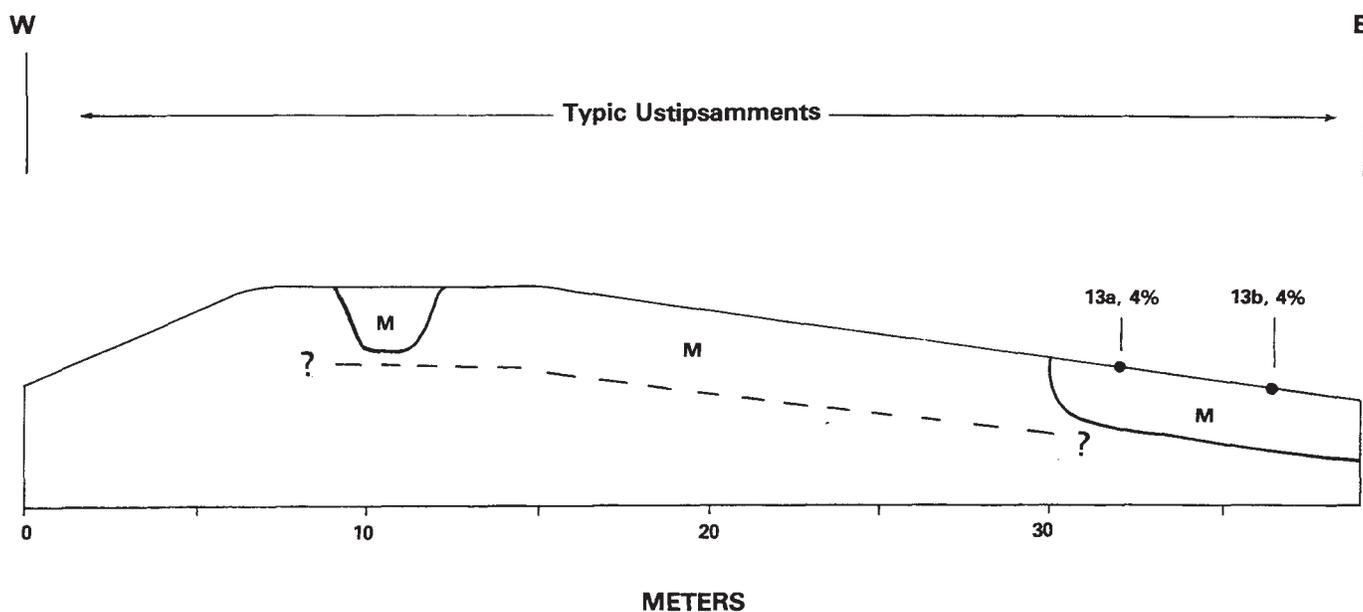


Figure 51. Diagram showing study trenches, stratigraphy, subgroups, and slope and location of sampled pedons at Site 13. M = Muleshoe sediments. No vertical scale (see table 21 for thickness of soil horizons). The heavy lower line represents the bottom of the trenches.

Table 21. Characteristics of Typic Ustipsamments, Tivoli, of the blowout dune at Site 13^{1/}

Sediment	Horizon	Depth cm	Hue	Value/chroma		Texture	Structure	Dry consis- tence	pH	Lower boundary
				Dry	Moist					
<u>Pedon 13a, oak</u>										
Muleshoe	A1	0-12	6YR	5/3	3.5/3	fs	m,sg, lfer	s,l	6.8	cw
	A2	12-28	6YR	5.5/3	4/3	fs	m	s,sl	6.8	cw
	B1	28-43	5YR	5.5/4	4/4	fs	m	s,sh	7.0	cw
	B21	43-74	5YR	6/5	4.5/5	fs	m	sh	7.0	cw
	B22	74-119	5YR	6/5	4.5/5	fs	m	sh,s	7.0	
<u>Pedon 13b, nonoak</u>										
Muleshoe	A11	0-10	8YR	5.5/4	4/3	fs	m,sg, lfer	s,l	7.0	cw
	A12	10-21	8YR	5.5/4	4/3	fs	m	s	7.0	cw
	B1	21-43	6YR	6/4	4.5/4	fs	m	s	7.0	cw
	B21	43-72	5YR	6/4	4/4	fs	m	sh	7.0	cw
	B22&Bt	72-92	5YR	6/4	4/4	fs	m	sh,s	7.0	as
	B3	92-117	5YR	6.5/4	4.5/4	fs	m	sh,s	7.0	aw
Longview?	Bb	117-134	5YR	6/4	4/4	fs	m	sh	7.0	

^{1/} One clay band occurs discontinuously in the lower part of the B22&Bt horizon of Pedon 13b.

The oak-nonoak contact at Site 13 showed no visible evidence suggesting oak advance or retreat. However, the sandy road west of the dune crest demonstrates the speed of oak movement into sandy sediments that lack vegetation. Aerial photographs (figs. 15, 16) show that road was present in 1962 but not in 1953. The road appears fresh in the 1962 photograph, with no evidence of oak. But the 1970 photograph shows darkening across the road west of the study trenches. The oak plants were seen on the ground by the author in 1974. The evidence suggests that much of the oak crossing of the sandy road could have been accomplished in a period of less than about 8 years.

TYPIC USTIFLUVENTS AND USTIPSAMMENTS DOMINANT:

MAPPING UNIT B, TIVOLI VARIANTS

MAPPING UNIT COMPOSITION

<u>Series or variant</u>	<u>Subgroup</u>	<u>Particle-size family</u>	<u>Percentage of mapping unit</u>
TIVOLI, THIN			
VARIANT #2	TYPIC USTIFLUVENTS . . .	(SANDY, COARSE-LOAMY) . . .	45
TIVOLI, THIN			
VARIANT #1	TYPIC USTIPSAMMENTS . . .	SANDY	30
Circleback	Alfic Ustipsamments . . .	Sandy	10
Texico	Psammentic Hapulstalfs .	Sandy	10
Other inclusions . .	(Farwell, Keeney)		5

LOCATION, LANDSCAPE, SOIL OCCURRENCE, VEGETATION

Soils of unit B occur only in broad topographic lows in the northern part of the study area. There are slight undulations and, in places, blowouts 1 to 2 m deep. Muleshoe sediments are thinner in mapping unit B than in unit A, and buried argillic horizons occur between 50 and 100 cm depth. Organic carbon tends to be higher in the buried argillic horizons than in overlying coarser-textured materials because of the close relation of organic carbon to clay content. Thus organic carbon decreases irregularly with depth and if the argillic horizon is finer than loamy very fine sand, the soil is the Typic Ustifluent Tivoli, thin variant #2. If some subhorizon of the argillic horizon is not finer than loamy very fine sand, the soil is the Typic Ustipsamment Tivoli, thin variant #1. Tivoli, thin variant #2 dominates the unit as a whole, being most extensive in lowest parts of the broad depression (see Site 15). Otherwise, occurrence of the two thin variants is difficult to predict, and depends on texture of the buried Bt horizon. Circleback soils occur in scattered places where Longview sediments are at the surface. Texico and Farwell soils occur in a few areas where soils of Birdwell age, usually buried in unit B, are at the surface.

Vegetation observed in mapping unit B consists of sumac, shinnery oak, soapweed, hairy grama, sideoats grama, sand sagebrush, three-awn, dropseed, little bluestem, prickly pear, lovegrass, and queen's delight.

TYPICAL PEDONS AND RANGES IN SELECTED PROPERTIES

Pedon 14, at Site 14, is a typical pedon for Tivoli, thin variant #1. See table 22 for characteristics of Pedon 14. Ranges in color and texture follow; underlined entries are typical. Two underlined entries indicate that it is typical for both entries to occur in the stated horizons.

The A1 horizon has hue of 7.5YR through 10YR, value of 5 through 6 dry, 3 through 4 moist, and chroma of 2 through 4 (3). It is fine sand, sand or loamy fine sand. If an A12 horizon is present it is commonly 1/2 or 1 chip lighter than the A11 horizon.

The B2 horizon has hue of 5YR, value of 5.5 through 6.5 (6) dry, 3.5 through 4.5 (4) moist, and chroma of 4. It is fine sand or sand.

The B2tb horizon has hue of 2.5YR through 5YR (4YR), value of 5 through 6 dry, 4 through 5 moist, and chroma of 4 through 6. It is loamy fine sand or sand. The pH values tend to decrease slightly in lower horizons. Other soil properties also change as the buried soil is encountered; texture becomes finer and dry consistence becomes harder.

Pedon 15 may be considered a typical pedon of Tivoli, thin variant #2, except that texture of fine sandy loam may be more common than sandy clay loam in the buried Bt horizon, and both sandy and coarse-loamy pedons are included. See table 22 for characteristics of Pedon 15. Ranges in color and texture follow; underlined entries are typical.

The A horizon has hue of 7.5YR through 10YR, value of 4 through 6 (5) dry, 3 through 4 moist, and chroma of 3 through 4. It is fine sand, sand, or loamy fine sand.

The B2 horizon has hue of 5YR, value of 5.5 through 6.5 (6) dry, 3.5 through 4.5 (4) moist, and chroma of 4. It is fine sand or sand.

The B2tb horizon has hue of 2.5YR through 10YR, value of 4 through 5 (4.5) dry, 3.5 through 4.5 (4) moist, and chroma of 2 through 6. It is fine sandy loam or sandy clay loam.

The B2 horizon is not present in pedons of Fairview age.

STUDY SITES

Sites 14-17, broad topographic low; the Ustipsamment-Ustifluvent transition

The Muleshoe deposits are thinner in mapping unit B than in unit A and as a result, buried argillic horizons are nearer the surface in most places. Since the mantle of younger deposits is more than 50 cm thick, classification is based on the mantle. In Tivoli, thin variants #1 and #2, a buried argillic horizon occurs from 50 to 100 cm depth. Table 22 gives soil characteristics.

Site 14 (fig. 52) illustrates the Typic Ustipsamment Tivoli, thin variant #1. The pedon is near the west edge of a broad, gently undulating depression. The Muleshoe sediments extend to 77 cm depth, where they overlie Birdwell sediments with a buried argillic horizon. Although organic carbon decreases irregularly with depth (table 22), texture between 25 and

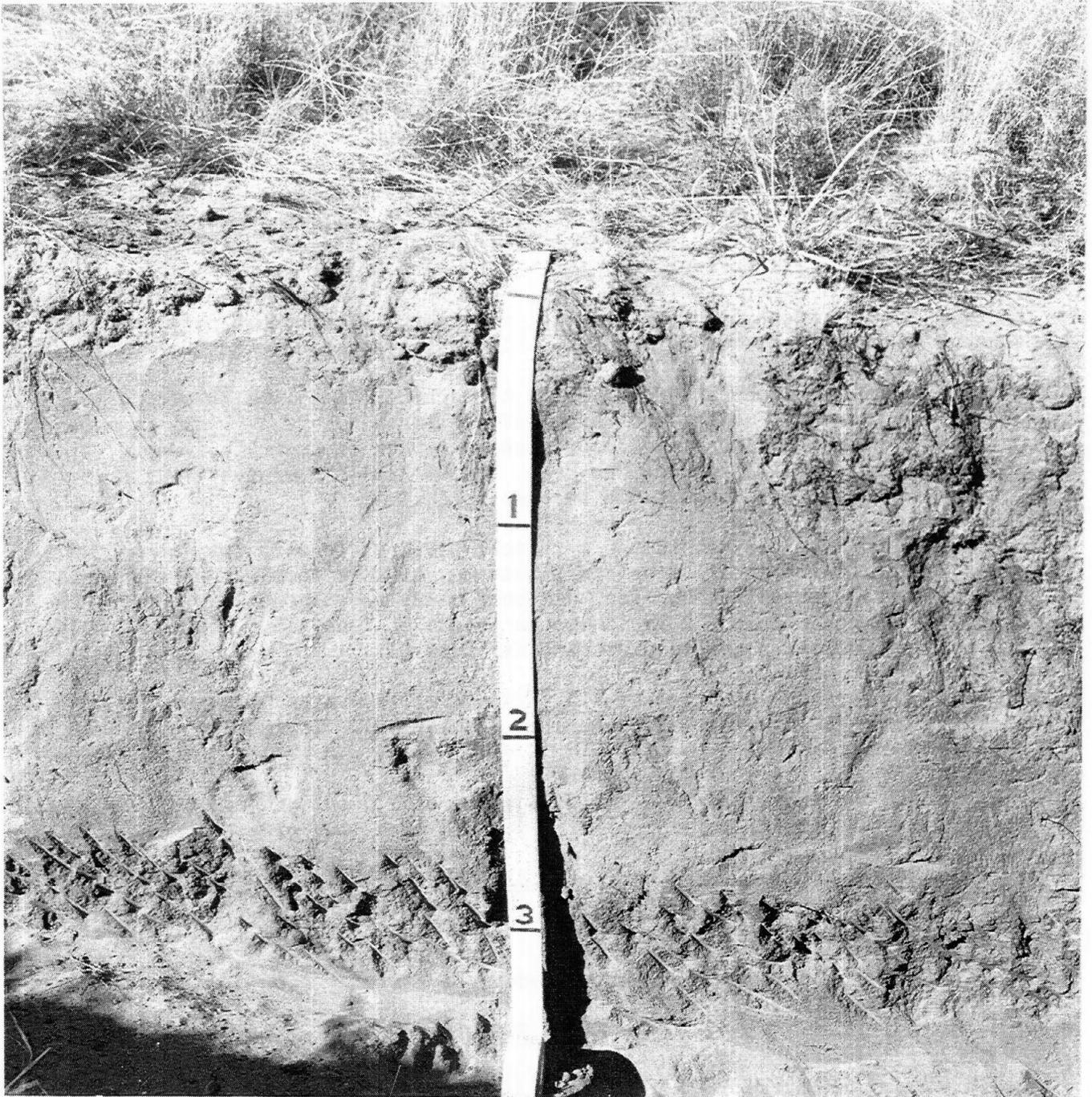


Figure 52. The Typic Torripsammit Tivoli, thin variant #1, at Site 14. The top of the buried argillic horizon of Birdwell age is at a depth of about $2\frac{1}{2}$ ft (0.8 m). The overlying sediments are of Muleshoe age. Scale is in feet.

Table 22. Characteristics of Ustipsamments and an Ustifluent at Sites 14-17^{1/}

Sedi- ment	Horizon	Depth, cm	Hue	Value/chroma		Struc- ture	Dry consis- tence	pH	Lower bound- ary	Organic C, %	Tex- tural class	Sand 2.0 0.05 mm	Silt 0.05- 0.002 mm	Clay < 0.002 mm
				Dry	Moist									
<u>Typic Ustipsamment, Tivoli, thin variant #1, on eastern edge of broad topographic low; Pedon 14</u>														
M	A11	0-9	7.5YR	5/3	3.5/3	m	s,l	7.0	cw	0.59	fs			
	A12	9-26	7.5YR	6/4	4/3	m	s	7.0	cw	0.29	fs			
	B21	26-51	7.5YR	6/4	4/4	m	sh	7.0	as	0.29	fs			
	B22	51-77	5YR	6/4	4.5/4	m	sh	7.0	as	0.23	fs			
B	B1tb	77-83	5YR	5/4	4/4	lmsbk	vh	7.2	as	0.38	lfs			
	B2tb	83-98	4YR	5/4	4/4	lmsbk	vh	6.8	cw	0.32	lfs			
	B3tb	98-115	4YR	6/5	5/5	m	h	7.0		0.36	fs			
<u>Typic Ustifluent, Tivoli, thin variant #2, in broad topographic low; Pedon 15</u>														
M	A1	0-9	7.5YR	5/4	3/4	m	s,l	7.0	aw	0.56	fs	90.2	7.0	2.8
	B1	9-29	7.5YR	5.5/3.5	3.5/4	m	s	7.0	cw	0.15	fs	94.9	2.8	3.8
	B21	29-50	5YR	6/4	4/4	m	sh	7.0	cw	0.19	fs	94.3	2.9	2.8
	B22	50-63	5YR	6/4	4/4	lmsbk	h	7.0	as	0.13	fs	92.0	2.4	5.6
H	B21tb	63-74	4YR	4.5/5	4/5	lcsbk	eh	7.0	cw	0.46	scl	65.7	12.7	21.6
	B22tb	74-98	2.5YR	4.5/6	4/6	lcsbk	eh	6.6		0.28	scl	61.5	12.7	25.8
<u>Typic Ustipsamment, Tivoli, thin variant #1, in broad topographic low; Pedon 16</u>														
M	A11	0-12	10YR	5/3	3/3	m	s	7.6	cw		lfs			
	A12	12-28	7.5YR	6/3	4.5/3	m	s	7.6	cw		fs			
	B21	28-46	7.5YR	6/4	4.5/4	m	sh	7.6	cw		fs			
	B22	46-64	5YR	6/4	4.5/4	m	sh	7.6	as		fs			
B	B2tb	64-85	4YR	6/5	5/5	lcsbk	vh	6.0			lfs			
	B3tb	85-97	6YR	5/4	4/4	lcsbk	vh	6.2			fs			
<u>Alfic Ustipsamment, Circleback, on slight dune in broad topographic low; Pedon 17^{2/}</u>														
L	A11	0-10	9YR	5/4	3/4	m	s	7.0	cw		fs			
	A12	10-28	9YR	6/4	4/4	m	s	7.2	cw		s			
	B1	28-42	7.5YR	6/4	4/4	m	sh	7.2	cs		s			
	B2&Bt	42-59	6YR	6/4	4/4	m	sh	7.0	as		s			
	B3	59-74	7.5YR	7/4	5/4	m	sh	6.8	cs		s			
	C	74-89	7.5YR	8/4	6/4	m	sh	6.8	as		s			
B	Btb	89-97	5YR	5.5/6	5/6		vh	6.8			ls			

^{1/} Subordinate colors and other comments are footnoted to pertinent soils. Sediments are identified as: M = Muleshoe, L = Longview, B = Birdwell, H = Hale.

^{2/} B2&Bt: one clay band is 1 cm thick and 5YR 5/4, dry. Four thinner bands are also present. Btb: also parts 7.5YR 7/4, dry, occurring as pore fillings and as irregularly shaped volumes ½ - 2 cm diameter.

100 cm depth is too coarse for the Fluvents and the pedon is a Psamment. The buried argillic horizon grades to sandy C horizon material beneath the bottom of the study trench.

The transition from Ustipsamments to Ustifluvents occurs where the buried argillic horizon has texture of loamy very fine sand or finer in some subhorizon between 50 to 100 cm depth. This happens further east in the broad depression in Hale sediments and in some sediments of Birdwell age. Pedon 15 (fig. 53) illustrates the Typic Ustifluent Tivoli, thin variant #2. It has a buried argillic horizon of Hale age. The overlying Muleshoe sediments have the characteristic weak morphology. One clay band, 1 mm thick and 5 cm long, is at a depth of 40 cm in the center of the exposure. Another band of about the same size is in the east end. The buried Bt horizon, a sandy clay loam, is distinctly finer than the Bt horizon at Site 14 (table 22), and the pedon is coarse-loamy; Tivoli, thin variant #2

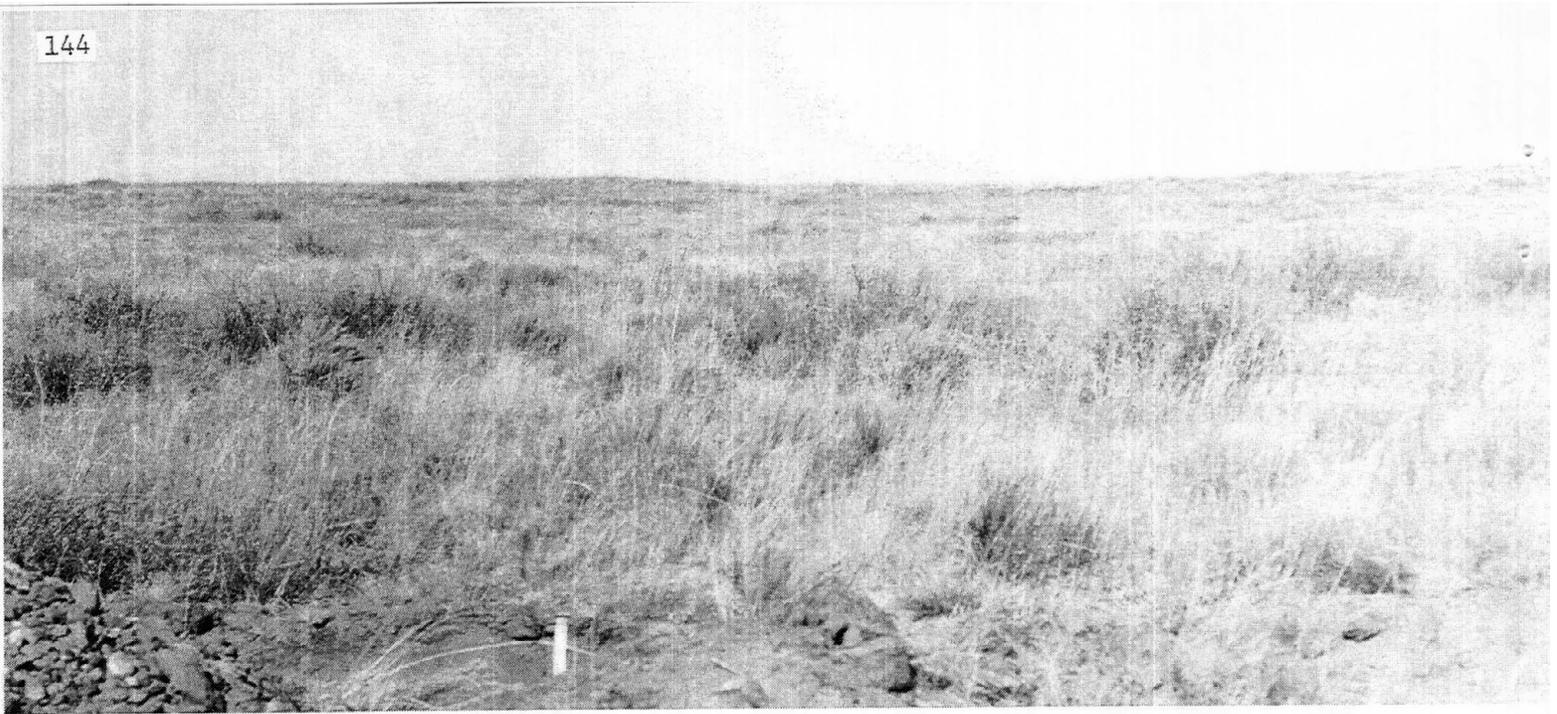
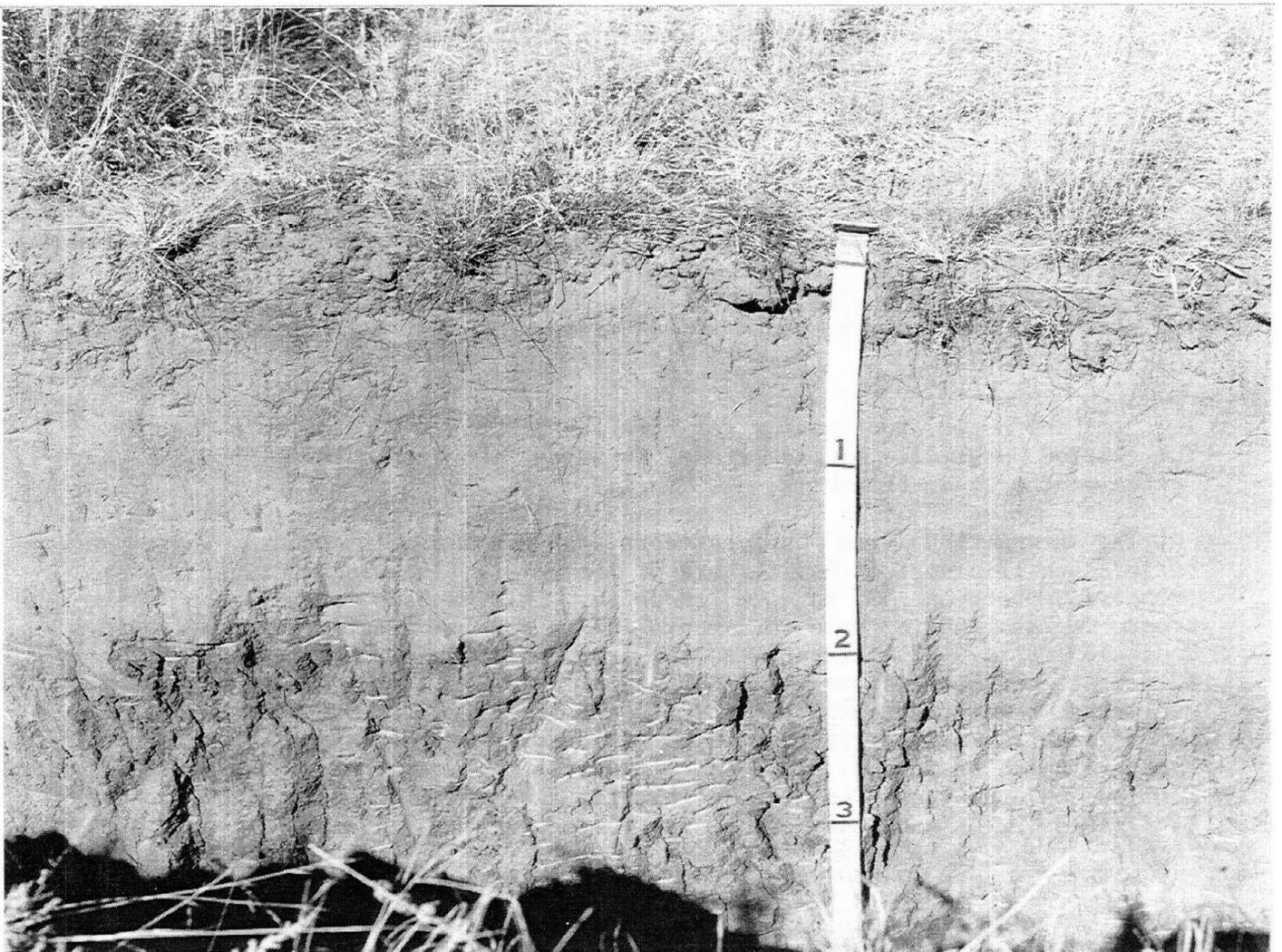


Figure 53. Above. Landscape of the Muleshoe surface at Site 15, in the topographic low in the foreground and middle ground. A Birdwell dune occupies most of the skyline. Photographed November 1975.

Below. The Typic Ustifluvent, Tivoli, thin variant #2. A buried argillic horizon of Hale age is at a depth of about 2 ft (0.6 m). The overlying sediments are of Muleshoe age. Scale is in feet.



includes both sandy and coarse-loamy pedons (table 4). Organic carbon decreases irregularly with depth (0.46 percent in the B2ltb vs 0.13 percent in the overlying B22 horizon) and the pedon is a Fluvent.

Augering below the bottom of the trench showed that clay gradually decreases to a light sandy clay loam, then to a noncalcareous fine sandy loam. Clay then increases again to a sandy clay loam, and a K horizon of Bailey age occurs at about 205 cm depth. At about 235 cm depth the K horizon grades into a noncalcareous loamy sand. At 280 cm there is a fine sandy loam with scattered carbonate accumulations, and 305 cm depth there is a calcareous sandy clay loam with a minor amount of carbonate.

Auger samples nearby Site 15 showed nodular carbonate accumulations at depths less than 1 m. Their significance is not known, but they may represent soils of Bailey age that once occupied minor topographic highs in the depressions. More work is needed on such depressions because their present smooth topography may mask important evidence of a pedogenic and geomorphic history more complex than suggested by their appearance.

Site 16 (table 22) is on the edge of an oak patch. The pit is in a very slight ridge in the broad depression, a few cm higher than some of the adjacent highs, and level with others. Weak morphology and lack of clay bands above the Bt horizon (table 22) fits Muleshoe age. The thin B2tb horizon is characteristic of Birdwell sediments.

Site 17 (table 22) is on a slight ridge that constitutes the back rim and western edge of a blowout. Pedon 17, an Alfic Ustipsamment, illustrates an inclusion of Longview age in a unit dominated by soils of Muleshoe age. A Btb horizon of Birdwell age is the lowermost horizon sampled (table 22).