

CHAPTER 6. USTIPSAMMENTS AND HAPLUSTALFS  
OF THE MULESHOE, LONGVIEW AND BIRDWELL SURFACES

The soils occur in mapping units C and D (fig. 27).

ALFIC AND TYPIC USTIPSAMMENTS, AND PSAMMENTIC HAPLUSTALFS DOMINANT:  
MAPPING UNIT C, CIRCLEBACK COMPLEX

MAPPING UNIT COMPOSITION

<u>Series or variant</u>	<u>Subgroup</u>	<u>Particle-size family</u>	<u>Percentage of mapping unit</u>
CIRCLEBACK . . . . .	ALFIC USTIPSAMMENTS . . .	SANDY . . . . .	35
TIVOLI . . . . .	TYPIC USTIPSAMMENTS . . .	SANDY . . . . .	30
TEXICO . . . . .	PSAMMENTIC HAPLUSTALFS. .	SANDY . . . . .	25
Newell, sandy variant. . . . .	Aridic Argiustolls. . . .	Sandy . . . . .	5
Other inclusions . .	(Farwell, Keeney, Tivoli, thin variant #1). . . .		5

LOCATION, LANDSCAPE, SOIL OCCURRENCE, VEGETATION

Soils of unit C occur only in the northern part of the study area. Dune height ranges from low to some of the highest in the study area. Where dunes are highest, the terrain consists of elongate dunes and intervening troughs. Small, isolated blowouts also occur. Circleback soils occur both in dunes and depressions, but in places are discontinuously buried by Muleshoe sediments and Tivoli soils. Texico and Farwell soils occur in scattered areas of Birdwell sediments on sides of dunes and in depressions. Tivoli, thin variant #1, Newell, sandy variant, and Keeney soils occur in some of the depressions.

Vegetation observed in mapping unit C consists of shinnery oak (which dominates in most places), sumac, little bluestem, sand bluestem, snakeweed, sideoats grama, sand dropseed, prickly pear, three-awn, sand sagebrush, soapweed; blue grama and hairy grama occur in some of the depressions.

TYPICAL PEDONS AND RANGES IN SELECTED PROPERTIES

A typical pedon of Tivoli was given in mapping unit A. Pedon 21, at Site 21, is a typical pedon of Circleback, except that its C horizon is darker than typical. See tables 26 and 29 for characteristics of Pedon 21. Ranges in color and texture follow; underlined entries are typical.

The A horizon has hue of 7.5YR through 10YR, value of 5 through 6 dry, 3.5 through 4.5 (4) moist, and chroma of 3 through 4. It is fine sand or sand.

The B2&Bt horizon has hue of 2.5YR through 10YR (5YR), value of 5.5 through 6.5 (6) dry, 4.5 through 5.5 (5) moist, and chroma of 4 through 6. It is fine sand or sand.

The C horizon has hue of 5YR through 7.5 YR (6YR), value of 6 through 7 dry, 4.5 through 6 (5) moist, and chroma of 4 through 6. It is fine sand or sand.

A2 horizons are present in some pedons and have slightly lighter color than adjacent horizons. Clay bands are commonly slightly darker than other parts of the horizon; 5YR 5/4, dry, is a typical color.

Pedon 33a, at Site 33, is a typical pedon of Texico; see table 40 for its characteristics. Ranges in color and texture follow; underlined entries are typical.

The A horizon has hue of 5YR through 10YR (6YR), value of 4.5 through 5.5 (5) dry, 3 through 4 (3.5) moist, and chroma of 3 through 4. It is fine sand, sand, or loamy fine sand.

The B2t horizon has hue of 9YR through 2.5YR (4YR), value of 4.5 through 5.5 (5) dry, 3.5 through 4.5 (4) moist, and chroma of 4 through 6. It is loamy fine sand, fine sandy loam, fine sand or sand.

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

#### Site 18, episodic development of blowout and dune; oak-nonoak transition

Initial investigations at Site 18 (figs. 40, 54) were made in a short trench in the blowout and in the east crest of the blowout dune. These and subsequent study trenches comprise Sites 18a, 18b, and 18c.

#### Site 18a, blowout and south side of dune

Site 18a consists of a small east-west trench in the blowout and a connecting, later north-south trench extending from the blowout into the south side of the dune. Figure 55 shows the stratigraphy, soil occurrence, and slope and location of the sampled pedons. Table 23 gives characteristics of the soils.

Muleshoe sediments are at the surface for the full length of the trench. The western margin of the blowout (fig. 54) has a low area with a barren, sandy surface that is a site of present movement of windblown sand. Muleshoe sediments apparently moved through this low area also, as well as discontinuously along the bordering rim.

Blowout. Figure 56 shows Pedon 18a-1, in the first trench dug in the blowout. The upper 12 cm is slightly finer than below and is thought to reflect additions of silt and clay from dustfall and run-in after deposition of Muleshoe sediments. The A horizon is darker and thicker in the blowout than in the bordering dune. Coarse texture indicates that organic carbon is too low for a mollic epipedon. Finer texture at depth (table 23) indicates that organic carbon decreases irregularly with depth and that the soil is a Fluvent.

Two buried soils occur in Pedon 18a-1 (fig. 56, table 23). The Btb horizon of Longview age is thin and contains much more clay than adjacent horizons; it is similar in these respects to the Bt horizon in Longview

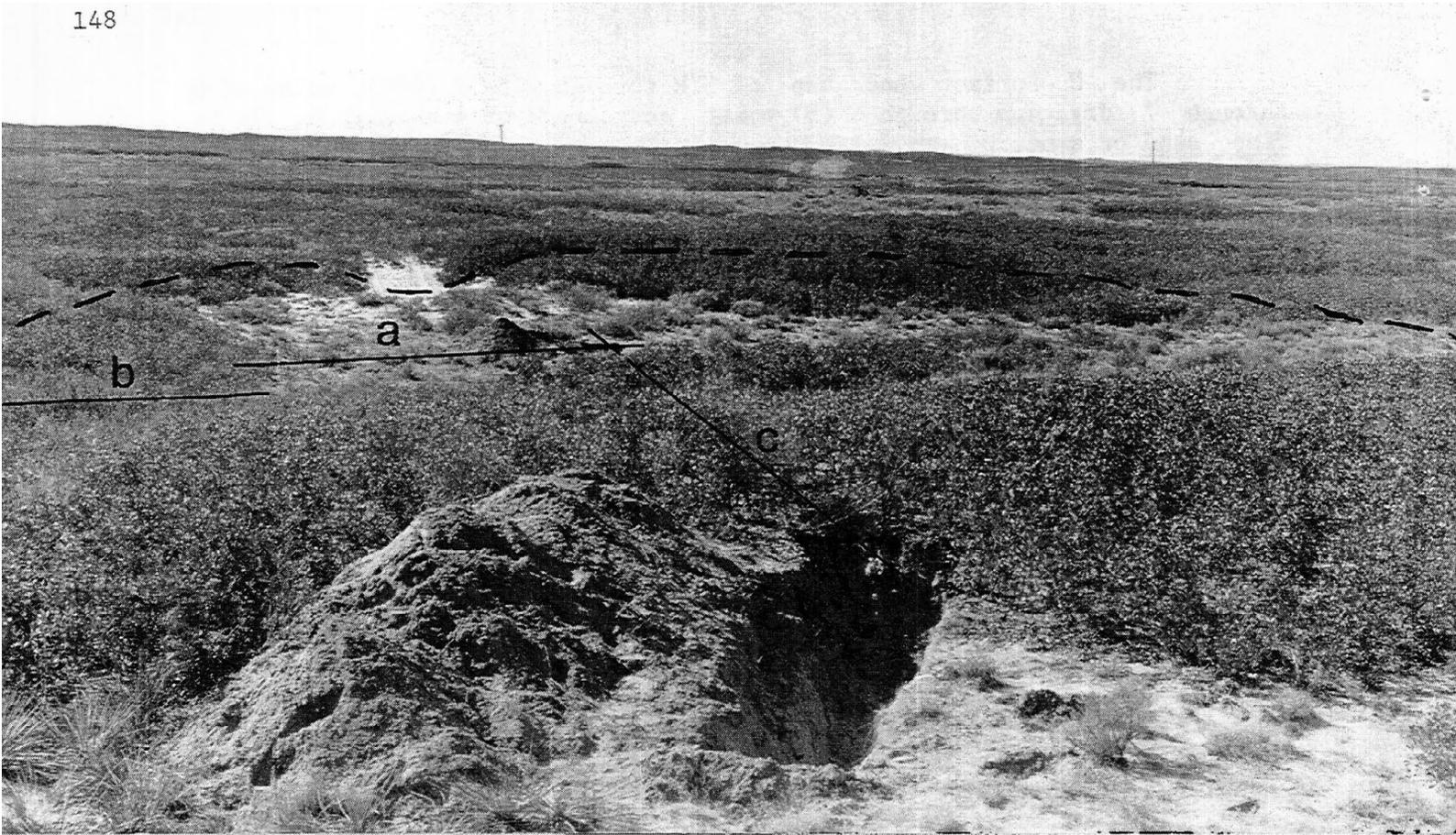
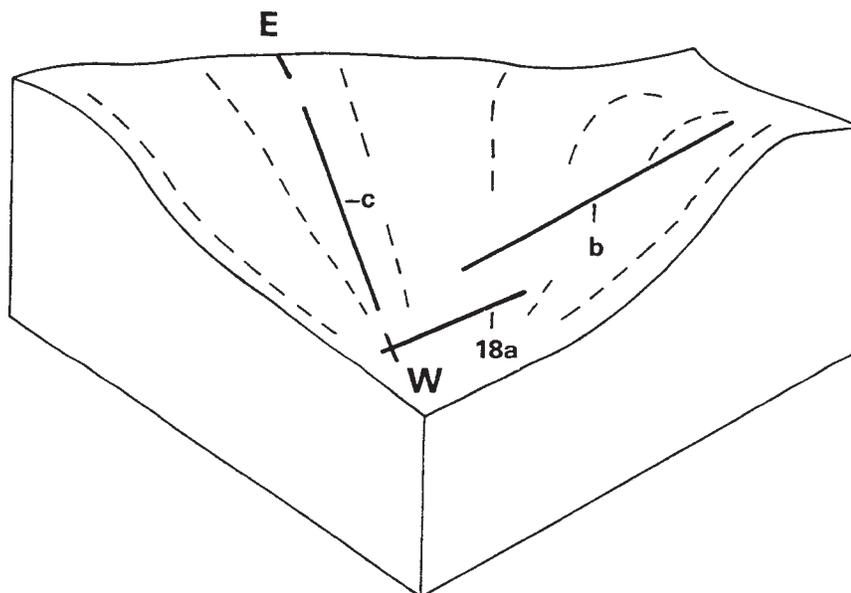


Figure 54. Sites 18a, 18b and 18c viewed from the east (photograph, above) and from the west (diagram, below). The two trenches shown in the photograph locate the initial investigations -- one in the east rim (foreground) and one in the blowout. Pedons 18c-4 and 18c-5 are located in the foreground trench, which was cut across the oak - nonoak boundary. Most of the studied area lies within the dashed lines. The south rim is beyond the left edge of the photograph.



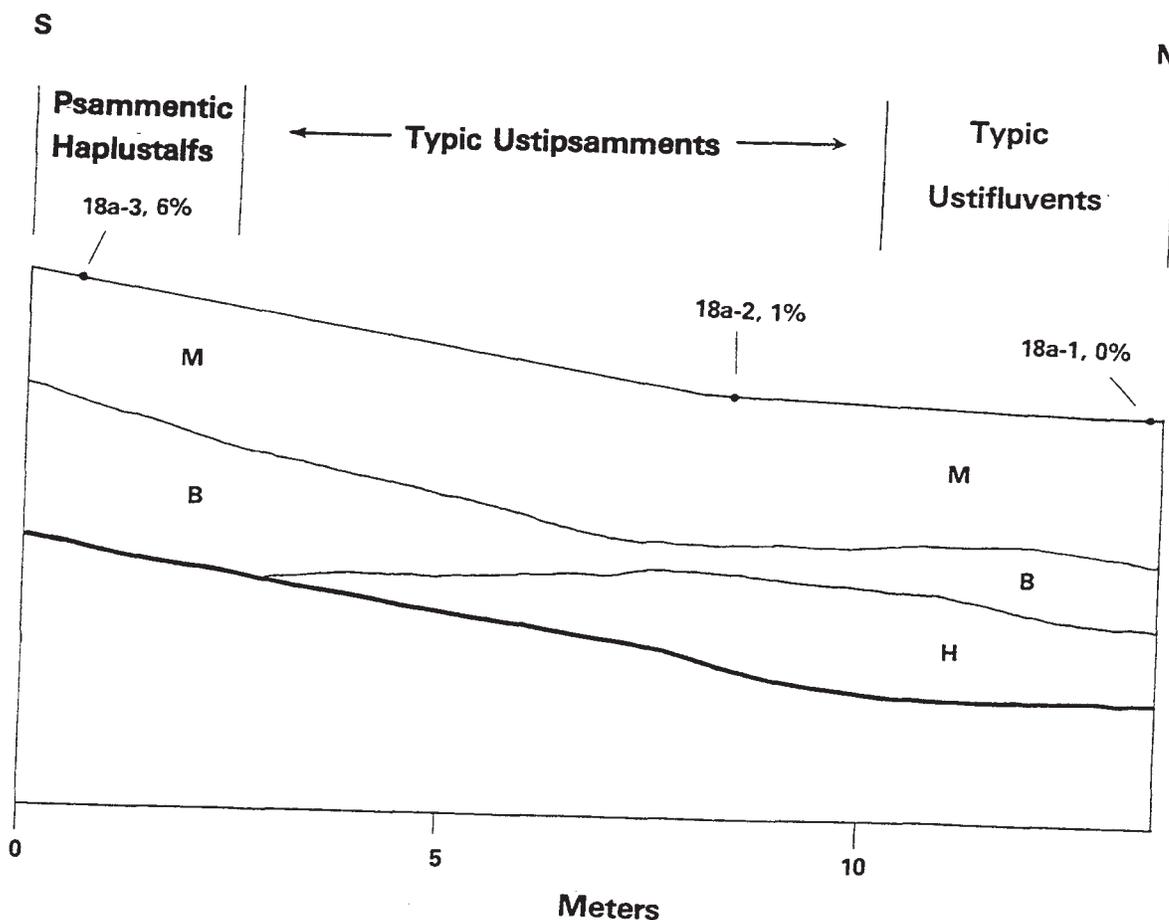


Figure 55. Diagram of the study trench at Site 18a, showing stratigraphy, subgroups, slope and location of the sampled pedons. M = Muleshoe, B = Birdwell, H = Hale. No vertical scale (see table 23 for thickness of sediments and horizons). The heavy lower line represents the bottom of the trench.

colluvium (see Sites 33-35 and 39). To study this further, a later trench was dug from the blowout into the adjacent dune (fig. 54). The lower buried soil has an A2 horizon and a reddish, high-chroma Bt horizon that descends below the bottom of the trench. Auger samples below the trench bottom showed that this Bt horizon is the typical thick one of Hale age.

Mottles in the buried soil of Hale age indicate a high water table at times in the past. The mottles are relict and no longer forming, since the water table is now at substantial depth due to irrigation (Cronin, 1969).

Side of dune. Sediments and soils in the blowout were traced upslope along the NS trench dug later (fig. 57). The thin Ab horizon of the upper buried soil at Pedon 18a-1 gradually thins and disappears upslope; it is not present in Pedon 18a-2 (table 23). The underlying thin Btb horizon at

Table 23. Characteristics of an Ustifluent, an Ustipsamment and a Haplustalf at Site 18a<sup>1/</sup>

Sediments	Horizon	Depth, cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	pH	Lower boundary
				Dry	Moist					
<u>Typic Ustifluent, Tivoli, thin variant #2, in blowout; Pedon 18a-1<sup>2/</sup></u>										
Muleshoe	A11	0-12	9YR	5/3	3/2	lfs	m,cr	s	6.4	cs
	A12	12-35	9YR	6/3	4/3	fs	m	s	6.8	cw
	A13	35-60	9YR	5/3	3/3	fs	m	s	7.0	cw
Birdwell	Alb	60-73	9YR	5/2.5	4/2	fs	m	sh	6.8	as
	B2tb	73-85	10YR	5.5/2	3.5/2	scl	lcsbk	eh	6.8	cs
Hale	A2b2	85-107	10YR	7/3	6/3	fs	lcsbk	vh	6.8	cs
	B2tb2	107-115	5YR	5/6	4/6	lfs	lcsbk	vh	6.8	
<u>Typic Ustipsamment, Tivoli, thin variant #1, on lower side of dune; Pedon 18a-2<sup>3/</sup></u>										
Muleshoe	A11	0-20	7.5YR	5/3	3.5/2	fs	m	s	6.8	cs
	A12	20-49	7.5YR	6/3	4/2	s	m	s	6.8	cw
	B	49-64	7.5YR	6/3	4/3	s	m	sh	6.8	as
Birdwell	Btb	64-79	10YR	6/2	4.5/2	ls	lcsbk	vh	7.0	as
Hale	Btb2	79-103	2.5YR	5/4	4/4	ls	lcsbk	vh	6.6	
<u>Psammentic Haplustalf, Texico, on side of dune; Pedon 18a-3<sup>4/</sup></u>										
Muleshoe	A1	0-12	7.5YR	5/3	3/2	s	m	s	7.0	cw
	A2	12-35	7.5YR	6/3	4/2	s	m	s,sh	6.6	cw
	B	35-49	7.5YR	6/4	3.5/4	s	m	sh	6.6	aw
Birdwell	B21tb	49-68	7.5YR	5.5/4	4/4	ls	lcsbk	vh	6.0	cw
	B22tb	68-93	5YR	6.5/6	5/6	s	m	h	6.2	cw
	B23tb	93-106	10YR	7/3	6/3	s	m	h	6.4	

<sup>1/</sup> Subordinate colors and other comments are footnoted to pertinent soils.

<sup>2/</sup> B2tb: parts 2.5YR 6/6, dry, and 7.5YR 7/4, dry; and dark stainings of organic carbon on prism faces. A2b2: has equal amount of 4YR 6/4, dry and small amount of 7.5YR 7/3, dry.

<sup>3/</sup> Btb2: parts 5YR 7/3, dry, and 5YR 6/3, dry.

<sup>4/</sup> B22tb: parts 10YR 8/3, dry. B23tb: parts 10YR 8/2, dry.

Pedon 18a-1 gradually becomes coarser-textured and lighter-colored upslope. It is still present in Pedon 18a-2 but grades out towards Pedon 18a-3. These morphological changes are typical of Bt horizons in Birdwell colluvium and show that the colluvium can occur in small blowouts and dunes as well as large ones. The three pedons illustrate the transition Ustifluvents-Ustipsamments-Haplustalfs as the buried horizons become coarser-textured and shallower upslope.

#### Site 18b, south side of dune and dune crest.

The study trench at Site 18b extends from the lower side of the dune southward to the crest of the dune (fig. 54). Figure 58 shows slope, stratigraphy, soil occurrence, and location of sampled pedons at Site 18b. Table 24 gives soil characteristics. A thin deposit of Muleshoe age overlies Longview sediments on the dune crest (fig. 58), but Longview

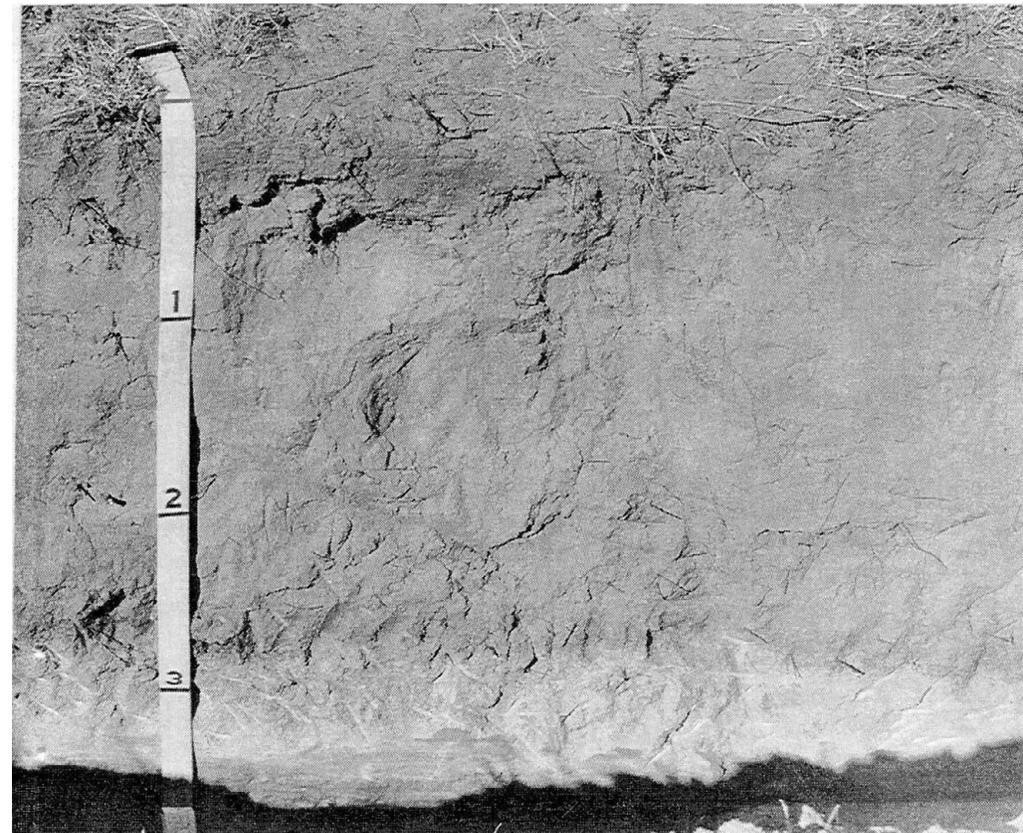


Figure 56. Top. Landscape of the Muleshoe surface in the blowout and bordering dune. The trench in the foreground is the initial east-west trench in the blowout.

Bottom. The Typic Ustifluent, Tivoli, thin variant #2, Pedon 18a-1. Scale is in feet.

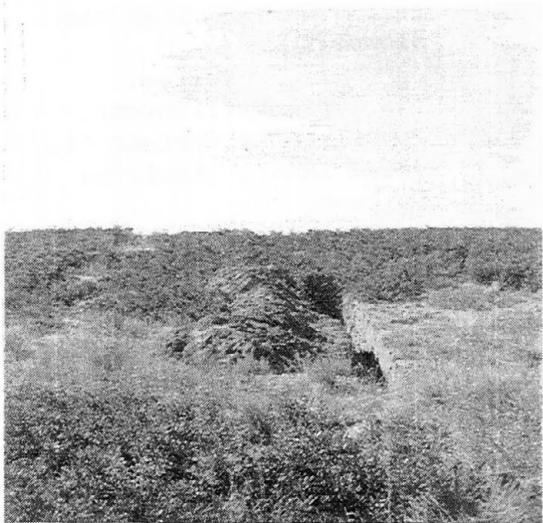


Figure 57. At left. Landscape of the trench at Site 18a. The filled-in trench at Site 18b may be seen at left. The view is south. Photographed November 1977.

Above. The Muleshoe surface and upper part of study trench at Site 13a. The Psammentic Haplustalf Texico, Pedon 18a-3, is at left. Note increase in roots under oak vegetation. Scale is in feet.

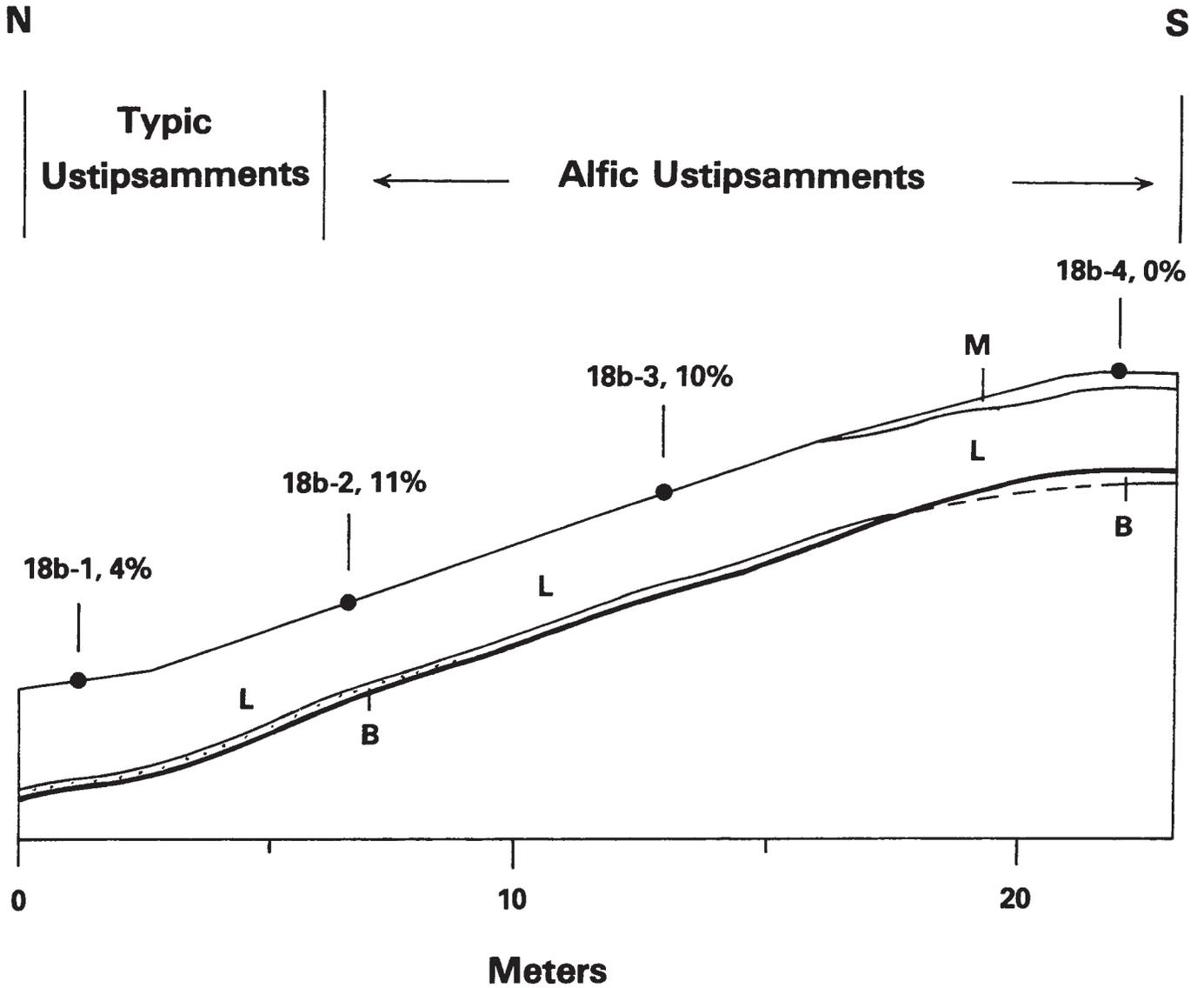


Figure 58. Diagram of the study trench at Site 18b, showing stratigraphy, subgroups, slope and location of the sampled pedons. M = Muleshoe, L = Longview, B = Birdwell. Black dots just below the top of the Birdwell sediments locate the top of a yellowish mottled zone. South of about 8 m the Btb horizon descends below the bottom of the trench. No vertical scale (see table 24 for thickness of sediments and horizons). The heavy lower line represents the bottom of the trench.

sediments are at the surface over the remainder of the exposure.

Pedon 18b-1 has a buried argillic horizon with texture of fine sand from 50 to 100 cm depth (Btb horizon, table 24), and is the Typic Ustipsamment Tivoli, thin variant #1. All other soils have clay bands and are Alfic Ustipsamments (fig. 58). All soils exposed in the trench have distinct A1 horizons, but horizons beneath differ markedly. In the lower part of the dune, a zone of yellowish mottles is in the buried Bt horizon of Birdwell age (fig. 58).

Lower side of dune. A2 horizon variation; clay band obliteration; mottles; past water tables. Important morphological changes take place on the lower side of the dune, in the vicinity of Pedons 18b-1 and 18b-2 (fig. 58, table 24). Both A2 horizon material and clay bands are discontinuous in Pedon 18b-1 (table 24). Upslope the B&A2 horizon changes to a thick A2 horizon in Pedon 18b-2 (table 24); in addition, volumes of light-colored A2 horizon material descend through the B horizon and join with the buried A2 horizon of Birdwell age.

That the A2b horizon in Pedon 18b-2 is in fact a buried A2 horizon is indicated by its light-colored, leached appearance; its continuity along the trench; and by the fact that upper horizons in protected situations can be buried with little or no erosion (see also Sites 18b-4, 33, 38, and 39). The occasional joining of land-surface and buried A2 horizons suggests that the soil is deeply leached at times under the present climate.

Mottles in the buried soil of Birdwell age (fig. 58) and hydrological data (Cronin, 1969) indicate that a water table must have been present at times during soil development, probably during minor pluvials of the early Holocene. Lateral movement from surface water can be augmented by lateral movement of the water table (Gile, 1958); effectiveness of this lateral movement should be enhanced if the materials differ in texture (Miller, 1963), as these do. Thus lateral movement of soil moisture would be expected at times in the buried A2 horizon because it overlies a Bt horizon that contains more clay and that is less pervious.

In Pedon 18b-2, two clay bands occur in the B&Bt horizon at 50-59 cm depth. Soil characteristics between Pedons 18b-1 and 18b-2 suggest an explanation for the disappearance of the two bands downslope towards Pedon 18b-1. Downslope the upper band comes closer to the surface, thins and then disappears within a distance of 1 m from Pedon 18b-2. Due to surface proximity the band did not form (see also Sites 1, 3, and 27).

Another mechanism appears to have been involved in disappearance of the lower of the two clay bands at Pedon 18b-2. As the upper band disappears towards Pedon 18b-1, the lower band drops to the top of the buried soil. At that point, the buried A2 horizon becomes browner, contains fewer light-colored A2 zones, and 1 1/2 m towards 18b-1 the light-colored zones above the buried soil stop altogether. This zone, which is quite uniformly brownish, apparently is a zone of clay accumulation related to lateral leaching along the buried A2 horizon upslope. At the point where the buried A2 horizon grades out, the slope is less than just south, being about 5 or 6 percent vs. 11 percent; this, together with the nearly level area just downslope, apparently cause clay accumulation rather than clay eluviation.

Table 24. Characteristics of Ustipsamments at Site 18b<sup>1/</sup>

Sediment	Horizon	Depth cm	Hue	Value/chroma		Texture	Structure	Dry consistency	pH	Lower boundary
				Dry	Moist					
<u>Typic Ustipsamment, Tivoli, thin variant #1, on lower side of dune; Pedon 18b-1<sup>2/</sup></u>										
Longview	A11	0-8	7.5YR	5/3	3/2	fs	m	sh	6.8	cw
	A12	8-15	10YR	6/3	3.5/2	fs	m	s	7.0	cw
	B&A2	15-38	7.5YR	6/2	4/2	fs	m	s,sh	7.0	cw
	B1	38-63	9YR	6.5/3	4.5/3	fs	m	sh,h	7.0	
	B2&Bt	63-80	9YR	6/4	4.5/4	s	m	sh,h	6.8	
Birdwell	Btb	80-102	9YR	6/4	5/4	ls	m	h	6.0	
<u>Alfic Ustipsamment, Circleback, on side of dune; Pedon 18b-2<sup>3/</sup></u>										
Longview	A1	0-10	10YR	5/2	2.5/2	lfs	m	s	7.0	cw
	A21	10-23	9YR	6.5/3	4/3	fs	m	s	6.8	cw
	A22	23-39	9YR	7/3	5/3	fs	m	sh	6.8	cw
	A2&B	39-50	9YR	7/3	5/3	fs	m	h	6.8	as
	B&Bt	50-59	9YR	7/4	5/4	fs	m	h,vh	6.8	as
Birdwell	A2b&B	59-73	10YR	8/3	6.5/3	fs	m	h,vh	6.6	aw
	Btb	73-94	7.5YR	7/4	6/4	fs	lcsbk	vh	6.0	
<u>Alfic Ustipsamment, Circleback, on side of dune; Pedon 18b-3<sup>4/</sup></u>										
Longview	A1	0-10	7.5YR	5/2	3/2	ls	m	s	7.2	cs
	A2	10-21	10YR	6/3	4/3	s	m	s	6.8	cs
	B1	21-34	7.5YR	6/4	4.5/4	s	lmsbk	sh	6.8	aw
	B21&Bt	34-52	7.5YR	6/5	4/5	s	lmsbk	sh,h	7.4	aw
	B22	52-94	7.5YR	6.5/4	5/4	s	m	sh,h	7.4	cw
	B3&Bt	94-118	7.5YR	7/5	5/4	s	m	sh	7.2	cw
Birdwell	A2b	118-137	10YR	8/4	6/4	s	m	sh	6.6	as
	Btb	137-147	7.5YR	6.5/4	5/4	s	lcsbk	vh	6.0	
<u>Alfic Ustipsamment, Circleback, on south rim; Pedon 18b-4<sup>5/</sup></u>										
Muleshoe	A1	0-11	10YR	5/3	3/2	fs	m	s	7.2	cs
	A2	11-26	10YR	7/3	5/2	fs	m	s	7.0	cs
Longview	A1b	26-34	10YR	7/3	5/2	fs	m	s	6.8	cs
	A2b	34-50	10YR	7/3	5/2	fs	m	s	7.0	cw
	B1b	50-71	7.5YR	6.5/4	5/4	fs	m	sh,h	7.0	as
	B21&Bt	71-96	7.5YR	6.5/5	5/4	fs	m	h,vh	6.4	as
	B22b&Bt	96-135	7.5YR	7/6	6/5	s	m	h,vh	6.6	as
	B3b&Bt	135-180	7.5YR	7/5	6/5	s	m	sh	6.6	
Birdwell	A2b2	195-210	10YR	8/3	6/3	fs			6.6	

1/ Subordinate colors and other comments are footnoted to pertinent soils.

2/ All: horizon also has lighter-colored parts. B&A2: parts 10YR 7/3, dry. B2&Bt: a few very discontinuous clay bands that appear to be in the process of disintegration. Btb: mottles of 7.5YR 6/8 and 10YR 7/3, dry, and occasional browner colors that may reflect accumulation of silicate clay.

3/ A1: some parts lighter-colored. A22: parts 9YR 6/3, dry. A2&B: occasional brownish volumes that appear to reflect accumulation of silicate clay. B&Bt: clay bands, 5YR 6/4, dry, ranging from 2 to 4 mm thick. (A2)&B: parts 10YR 7/3, dry. Btb: irregularly-shaped volumes 5YR 6/4, dry, which appear to be zones of greater clay accumulation. A few parts of 10YR 8/3 and 10YR 7/6, dry, are also present as irregular streaks one to several mm wide.

4/ A2: some parts slightly lighter and slightly darker than the given color. B21&Bt: clay bands 5YR 5/4, dry.

5/ Alb: parts 10YR 6/2, dry, and a few bits of 10YR 5/2, dry. A2b: a few slightly darker parts. B1b: parts 7/5YR 6.4, dry and 7.5YR 8/4, dry. B21&Bt: clay bands, 5YR 5/4, dry. B22b&Bt: clay bands, 5YR 5/4 and 5/6, dry. A2: sampled by auger below the bottom of the trench.

Central side of dune. Longview deposits are thicker at Pedon 18b-3, which has a thinner A2 horizon and a thicker, redder B horizon than does Pedon 18b-2. Pedon 18b-3 lacks the thick A2 horizon that deeply extends into the B horizon just north, and marks the point of disappearance of this feature; the B&Bt horizon is mostly reddish brown throughout. Thus the combined deeply penetrating plus lateral movement appears to be much less at Pedon 18b-3. Greater depth to the buried B horizon and higher position on the slope (resulting perhaps in less lateral leaching) may be factors in the different expression of these horizons. But the prominent buried A2 horizon of Birdwell age is still present.

There are two continuous clay bands, and one discontinuous band in the B21&Bt horizon. The bands are 2-3 mm thick. Clay bands, not present in the B22 horizon of Pedon 18b-3, do appear laterally in this horizon. Two bands, about 2 mm thick, are present in the B3&Bt horizon but in places are absent laterally.

The mottled zone occurs continuously along the top of the buried Bt horizon (fig. 58). Just south of Pedon 18b-2, part of the yellow color changes to brown, suggesting improved drainage, but substantial yellow is still present at about 8 m along the trench (fig. 58).

Towards Pedon 18b-4 upslope, the Longview sediments and soil are buried by Muleshoe sediments (fig. 58). The buried A horizon could be readily and continuously traced along the exposure. North of the boundary between Muleshoe and Longview sediments, the soil surface is covered with oak leaves. South of the boundary, both sand and oak leaves are at the surface.

Dune crest. Pedon 18b-4 (fig. 59) occurs on the level south crest, where a thin Muleshoe deposit, with A1 and A2 horizons, buries the Longview sediments and soil. Because the Muleshoe deposit lacks diagnostic horizons and is <50 cm thick, soil classification is based on the buried soil, which is the Alfic Ustipsamment, Circleback. The Muleshoe deposit and buried soil of Longview age continue southward to at least the end of the trench (fig. 58).

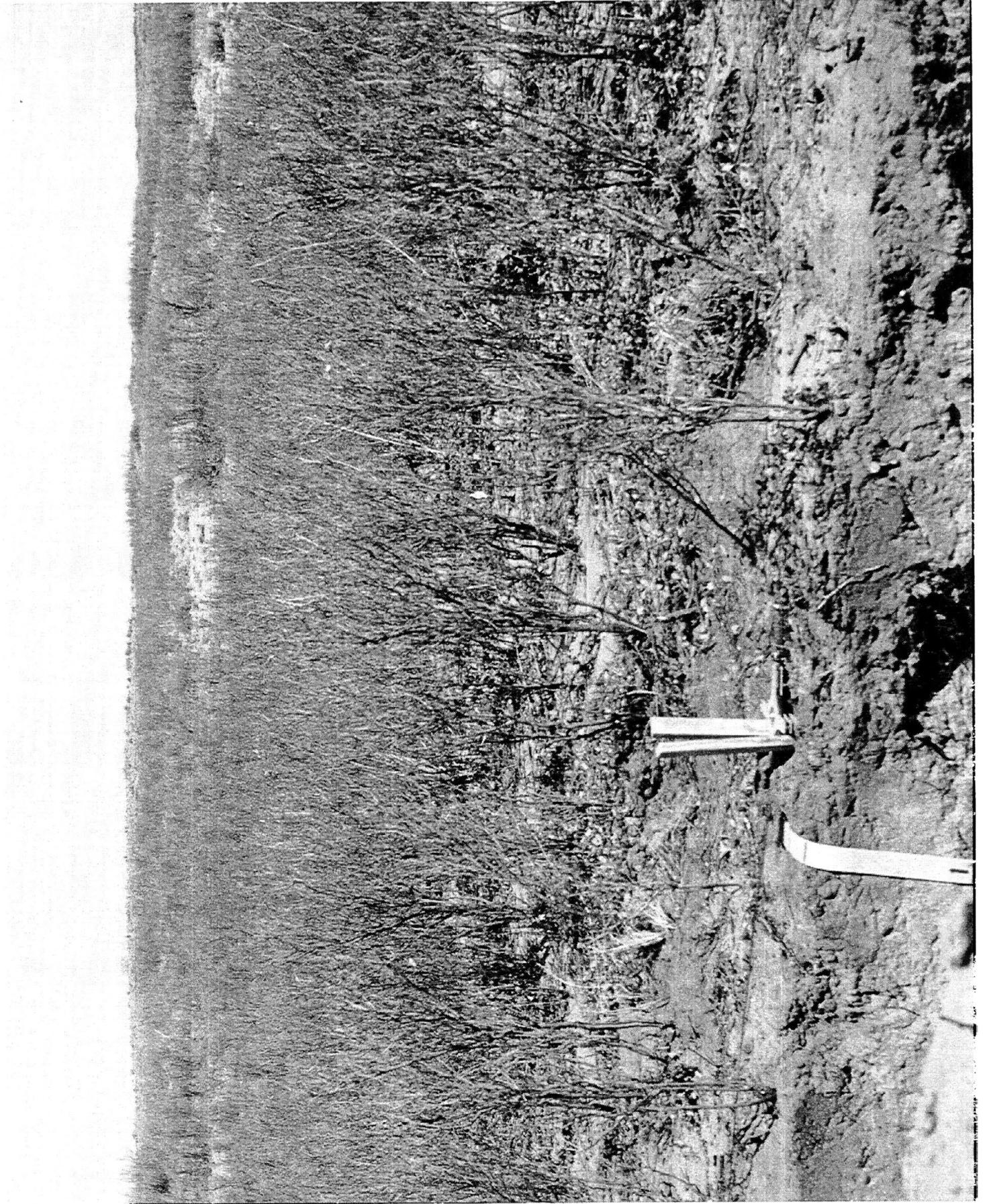
Longview sediments are at their maximum thickness at the dune crest. Three continuous clay bands occur in the B21&Bt horizon; the upper and middle ones are about 2 mm thick and the lower one is about 5 mm thick. Four continuous bands occur in the B22&Bt horizon. The upper three are 2 mm thick and the lower one is 2-5 mm thick. The bands are from 6-10 cm apart. The B3b&Bt horizon has only a few very thin bands.

Clay band development is much more prominent at the dune crest than on the dune side below. This is attributed to lack of strong lateral leaching on the dune crest, and greater depth to the buried soil. This contrasts to other sites where clay bands become thicker and more numerous with increasing distance down the side of the dune (see Sites 3 and 32). Subsurface leaching, as previously discussed, is thought to be responsible for the decrease in clay band expression downslope.

#### Site 18c, east side of dune and dune crest

Figure 60 shows slope, stratigraphy, soil occurrence, and location of the sampled pedons at Site 18c. Characteristics of the sampled pedons are in table 25.





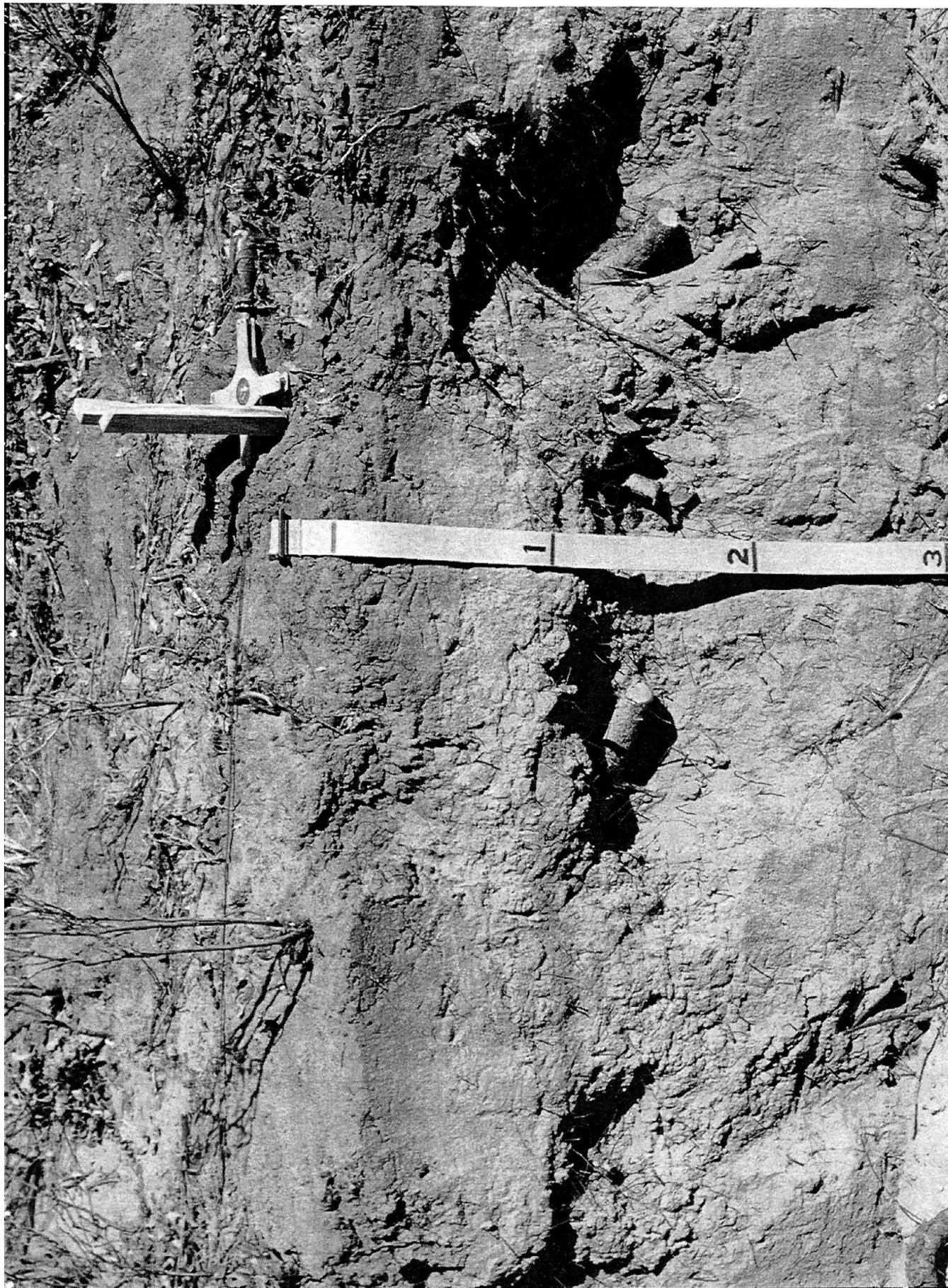


Figure 59. Upper. Landscape along south rim of dune at Site 18b. The view is east. Photographed November 1977.

Lower. The Alfic Ustipsamment, Circleback, Pedon 18b-4. Most of the buried A horizon (at about 1 ft, 0.3 m depth) has fallen in but parts remain at left. Scale is in feet.

Lower side of dune. Pedon 18c-1, on the lower side of the dune, is a Typic Ustipsamment (Tivoli, thin variant #1) since textures are sandy to a depth of more than 1 m. Upper horizons have the weak morphology typical of Muleshoe sediments. The B2b horizon has occasional clay bands and small volumes of irregular shape and may have been discontinuously impregnated with clay that moved laterally from upslope, as discussed previously at Site 18b.

Central side of dune. Mottles, past water tables. The Muleshoe sediments thin upslope and at Pedon 18c-2 (fig. 61) the buried argillic horizon is close enough to the surface (within 50 cm) to determine the classification. The argillic horizon averages sandy in the upper 50 cm and the pedon is a Psammentic Haplustalf (Texico series). A clay band horizon (A2b&Bt horizon, table 25) occurs beneath the argillic horizon. The interband zones have a whitish, leached appearance; clay is thought to have been moved downslope through these zones by laterally moving water, with some clay moving into underlying bands as the soil solution slowed and then dried.

Yellowish mottles, similar to those at Site 18b, deepen in upslope direction (fig. 60). The mottles are attributed to presence of a water table as discussed at Site 18b. In contrast to Site 18b, here the trench descends well below the top of Birdwell sediments, and the relation between depth of mottling and the soil of Birdwell age is apparent. Only the lower

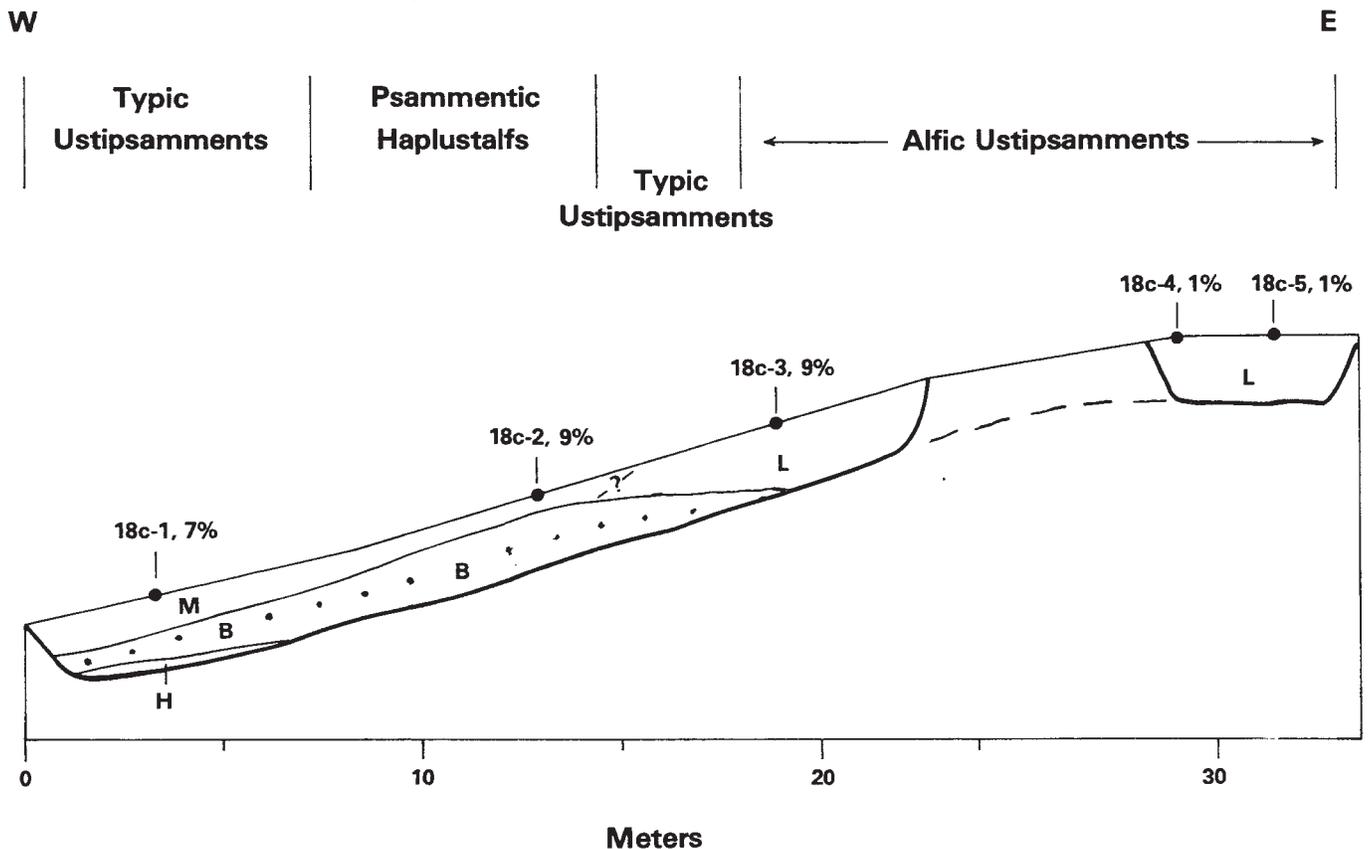


Figure 60. Diagram of the study trench at Site 18c, showing stratigraphy, sub-groups, slope and location of the sampled pedons. M = Muleshoe, B = Birdwell, L = Longview, H = Hale. Black dots represent the top of a yellowish, mottled zone. East of about 18 m, the mottled zone descends below the bottom of the trench. No vertical scale (see table 25 for thickness of sediments and horizons). The heavy lower line represents the bottom of the trench.

Table 25. Characteristics of Ustipsamments and a Haplustalf at Site 18c <sup>1/</sup>

Sediment	Horizon	Depth cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	pH	Lower boundary
				Dry	Moist					
<u>Typic Ustipsamment, Tivoli, thin variant #1, on lower side of dune; Pedon 18c-1<sup>2/</sup></u>										
Muleshoe	A11	0-10	7.5YR	5/3	3/3	s	m	s	6.8	cw
	A12	10-24	7.5YR	5/3	3/3	fs	m	s	7.0	cw
	B2	24-68	7.5YR	6/4	4/4	fs	m	s,sh	7.0	cs
Birdwell	Bb	68-87	10YR	6.5/3	5/3	ls	lcsbk	h	7.2	cs
	B21b	87-107	10YR	6.5/3	5/3	s	lcsbk	vh	7.0	cs
	B22b	107-118	7.5YR	6/4	5/4	s	lcsbk	vh	6.8	cs
Hale	Bb2	118-125	5YR	6/4	5/4	ls	lcsbk	vh	6.6	
<u>Psammentic Haplustalf, Texico, on side of dune; Pedon 18c-2<sup>3/</sup></u>										
Muleshoe	A11	0-11	7.5YR	5/3	3/2	fs	m	s	7.4	cw
	A12	11-31	10YR	6/3	4/3	fs	m	s	7.0	cw
	B1b	31-48	9YR	6.5/3	5/3	fs	m	sh	7.0	cw
Birdwell	B21tb	48-62	9YR	6.5/4	5/4	lfs	lcsbk	vh	6.2	cw
	B22tb	62-71	9YR	6.5/4	5/4	fs	lcsbk	vh	6.2	cw
	A21b	71-86	10YR	8/4	6/4	s	m	sh,h	6.4	cw
	A22b&Bt	86-130	10YR	8/3	6/4	s	m	h	6.2	as
	A23b	130-140	10YR	8/3	7/3	s	m	vh	6.6	
<u>Alfic Ustipsamment, Circleback, on side of dune; Pedon 18c-3<sup>4/</sup></u>										
Longview II	A1	0-9	10YR	6/4	4/3	s	m	s	7.2	cw
	B&A	9-30	10YR	7/6	5.5/4	s	m	s	7.0	cw
	B1	30-45	7.5YR	6/4	4.5/4	s	m	sh	7.0	as
	B2&Bt	45-56	7.5YR	7/4	5/4	s	m	sh	7.0	as
	B3&Bt	56-97	7.5YR	7/4	5/4	s	m	h	6.8	cw
	B21b&Bt	97-118	7.5YR	7/4	5/4	s	m	sh,h	6.8	
	B22b&Bt	118-127	7.5YR	7/4	5/4	s	m	sh,h		
<u>Alfic Ustipsamment, Circleback, on dune crest; Pedon 18c-4<sup>5/</sup></u>										
Longview		3-0	oak leaves and twigs							
	A1	0-15	9YR	5/3	3/3	s	m	s	7.0	cw
	A2	15-28	9YR	7/4	5/4	fs	m	s	6.4	cw
	B1	28-49	5YR	6/4	5/4	s	m	sh	6.8	aw
	B21&Bt	49-69	5YR	6/4	5/4	s	m	sh	6.8	as
	B22&Bt	69-94	6YR	6.5/4	5/4	fs	m	sh	6.8	as
	C	94-114	6YR	6.5/4	5/4	fs	m	sh	6.6	
<u>Alfic Ustipsamment, Circleback, on dune crest; Pedon 18c-5<sup>6/</sup></u>										
Longview	A11	0-14	7.5YR	5/3	3/3	fs	m	s	6.8	cw
	A12	14-30	7.5YR	6/4	4/3	fs	m	sh	6.8	cw
	B1	30-44	7.5YR	6.5/4	5/4	fs	m	sh	6.8	aw
	B21&Bt	44-65	7.5YR	6.5/5	5/4	fs	m	sh	6.8	aw
	B22&Bt	65-88	7.5YR	6.5/5	5/4	fs	m	sh	6.8	aw
	C	88-106	7.5YR	6.5/5	5/4	fs	m	s	6.6	

<sup>1/</sup> Subordinate colors and other comments are footnoted to the pertinent soils.

<sup>2/</sup> Bb: parts 7.5YR 5/3, dry. B21b: parts 10YR 8/2, dry, and 7.5YR 7/8, dry.  
Bb2: parts 2.5YR 5/3, dry, and 7.5YR 7/6, dry.

<sup>3/</sup> B22bt: parts with slightly higher value and parts with higher chroma. A22b&Bt: clay band, 5YR 5/4, dry.  
A23b: parts 10YR 7/6, dry.

<sup>4/</sup> B21b&Bt: clay bands that are thicker and more distinct than above.

<sup>5/</sup> A1, B1, B21&Bt, and B22&Bt: few parts with about the same color as the A2 horizon. A2: few parts with about the same color as the A1 horizon.

<sup>6/</sup> B2&Bt: clay bands, 5YR 5/4, dry.



Figure 61. View of the study trench at Site 18c. The tape is at Site 18c-2. Note that the Birdwell sediments, dark band this side of tape, dip downward upslope where they are buried by Longview sediments. The view is west. Photographed November 1976. Scale is in feet.

part of this soil is mottled near the dune crest that existed in Birdwell time, reflecting better drainage in the dune-crest position.

The Longview sediments thicken upslope. At 14.6 m (fig. 60) the top of the argillic horizon descends below 50 cm; classification is again based on the 0-50 cm zone and the soils are Psamments. This area must have been very near the dune crest in Birdwell time (fig. 61). Later the Birdwell sediments were buried by deposits of Longview age, resulting in the present, substantially higher dune crest.

At the point where the banded B horizon of Longview age becomes visible, the buried Bt horizon of Birdwell age descends and finally dips below the bottom of the trench. The Bt horizon of Birdwell age becomes progressively harder as it gradually descends further below the surface. As discussed at Sites 4-7, this increase in hardness is apparently due to less biotic activity at the greater depths.

Pedon 18c-3 (fig. 61, table 25) is an Alfic Ustipsamment in Longview II and I sediments. The banded B horizon from 97-127 cm is more prominent and is thought to be of Longview I age.

Dune crest. Alfic Ustipsamments in Longview sediments are on the crest of the dune (fig. 60). Pedons 18c-4 (oak vegetation) and 18c-5 (nonoak vegetation) are on the margin of the dune crest (fig. 62, table 25). The A1 horizon of Pedon 18c-4 has light-colored, circular parts in cross section that contrast with the darker adjacent material. The B horizon also has occasional light-colored zones, of irregular shape and 1 to 5 cm in diameter. These light-colored zones are interpreted as fillings of rodent burrows.

Pedon 18c-4 has an A2 horizon that is lighter in color than the analogous horizon under nonoak vegetation, and also has lower pH. The clay bands are generally similar under both types of vegetation, and there is also good gradation to C horizon material beneath the bands under both types. As usual there are more roots under the oak than under nonoak, although the roots here are not as prominent as in some oak patches.

In Pedon 18c-5, the B21&Bt horizon usually has two bands 1-2 mm thick but they disappear in places along the exposure. The B22&Bt horizon has the most bands, usually about five. They are about 2 mm thick in the upper part of the horizon and about 1 mm thick in the lower part.

#### Particle size distribution and pH for soils under oak and nonoak vegetation

Table 26 shows particle size distribution for Pedon 18c-4, under oak, and for Pedon 21, under nonoak vegetation. For Pedon 18c-4, percentages of silt and clay are slightly higher in the surface horizon than in underlying horizons, and are similar to soils of Muleshoe age in this respect (table 14). This higher percentage of silt and clay is particularly the case under oak vegetation, which, with its mulch of oak leaves and twigs, serves as a sort of "trap" for silt and clay in the dustfall. In contrast, the surface horizon of Pedon 21 contains less silt and clay than the underlying horizon. But the surface horizon of some older soils of dune crests and under nonoak vegetation do have more silt than underlying horizons (see Sites 28, 29, and 38).

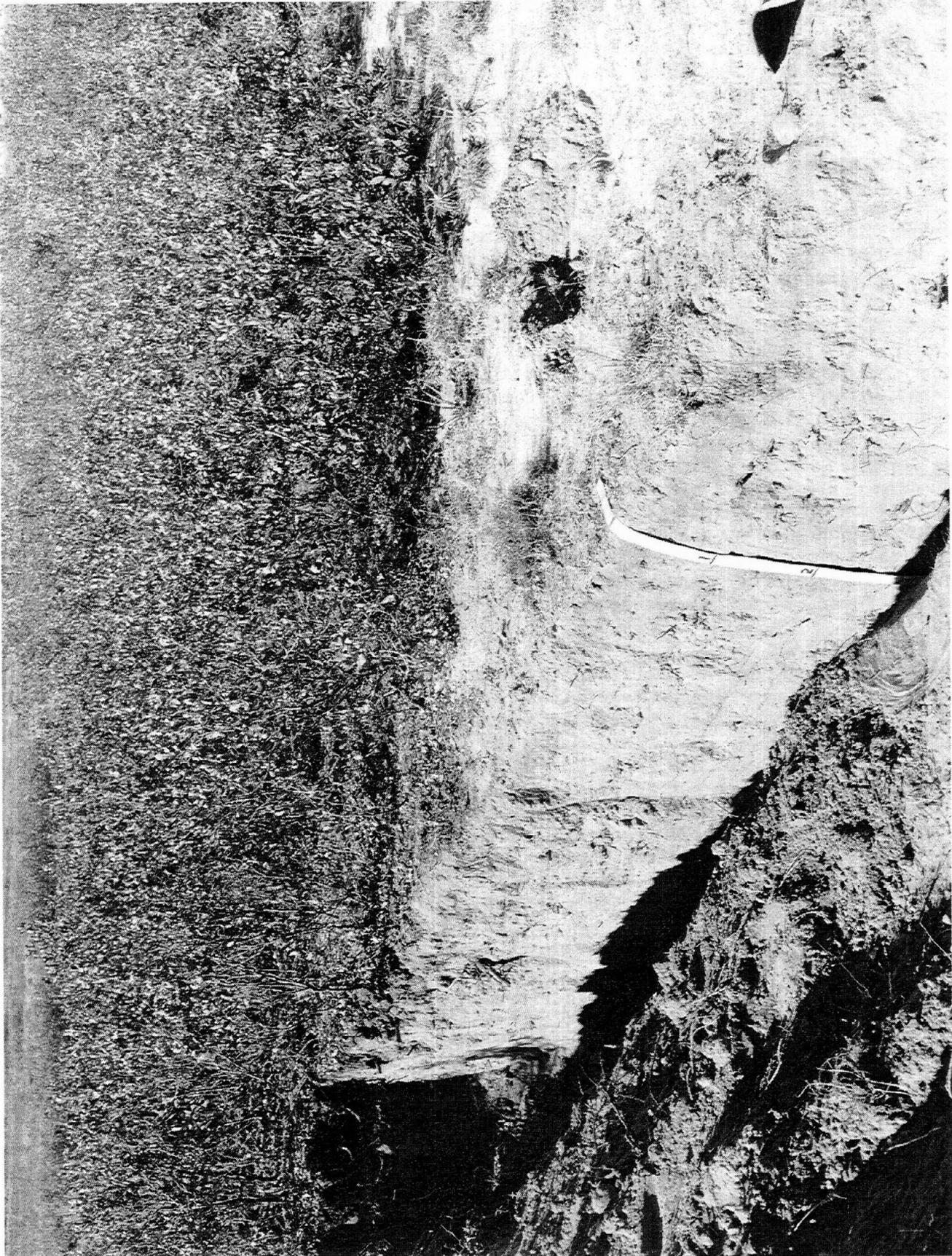


Figure 62. Landscape of the Longview surface at Sites 18c-4 and 18c-5. The trench is the initial one in the dune crest. Pedon 18c-4 is under the oak, at left, and Pedon 18c-5 is under nonoak vegetation by the tape at right. Photographed November 1976. Scale is in feet.

Table 26. Particle size distribution and pH for Alfic Ustipsamments (Circleback) under oak and nonoak vegetation<sup>1/</sup>

Horizon	Depth cm	Particle size distribution, mm							Textural class	pH
		Sand					Silt 0.05-0.002	Clay <0.002		
		2-1	1-0.5	0.5-0.25	0.25-0.1	0.1-0.05				
		%								
<u>Pedon 18c-4, S78TX-17-1, under oak vegetation<sup>2/</sup></u>										
A1	0-15	0.3	9.6	28.5	46.3	7.5	4.6	3.2	s	6.9
A2	15-28	0.2	8.7	27.1	52.5	7.3	1.8	2.4	fs	6.3
B1	28-49	--	7.7	34.1	48.3	5.8	1.3	2.8	s	6.7
B21&Bt	49-69	0.1	8.8	31.0	49.3	5.9	1.7	3.2	s	6.7
B22&Bt	69-94	0.1	9.3	27.3	50.0	8.7	2.6	2.0	fs	6.7
C	94-114	0.2	8.1	26.3	51.5	9.3	3.0	1.6	fs	6.4
<u>Pedon 21, S78TX-17-2, under nonoak vegetation<sup>3/</sup></u>										
A11	0-5	--	6.3	31.9	50.7	6.4	2.3	2.4	fs	7.0
A12	5-16	--	4.4	22.5	59.3	8.6	2.4	2.8	fs	6.9
B11	16-25	--	3.0	20.4	57.8	13.5	2.1	3.2	fs	6.7
B12	25-32	--	4.2	23.1	59.1	9.0	1.8	2.8	fs	6.7
B21&Bt	32-53	--	4.4	23.2	58.8	9.6	2.0	2.0	fs	6.7
B22&Bt	53-71	--	3.9	22.1	51.4	10.3	9.5	2.8	fs	6.7
B23&Bt	71-86	--	3.2	12.9	69.3	10.9	1.7	2.0	fs	6.9
B3&Bt	86-106	0.2	10.3	22.5	48.7	11.3	5.1	1.9	s	6.6
C	106-128	0.1	8.8	20.9	51.9	13.4	3.3	1.6	fs	6.2

<sup>1/</sup> Particle size distribution is by method 3A1; pH by method 8Cl<sub>a</sub> (1:1 H<sub>2</sub>O); (Soil Conservation Service, 1972).

<sup>2/</sup> The B21&Bt horizon usually has two discontinuous clay bands, 1 to 2 mm thick. The B22&Bt horizon has the most clay bands - usually about five - and they are continuous. In the upper part of the horizon the bands are about 2 mm thick but are thinner (about 1 mm thick) in the lower part.

<sup>3/</sup> The B2&Bt horizon has six continuous clay bands: two in the B21&Bt, three in the B22&Bt, and one in the B23&Bt horizon. The bands are 5YR 5/4, dry, and most are from 2 to 3 mm thick. The B3&Bt horizon has two discontinuous bands about 1 mm thick.

A slight maximum in silicate clay occurs in the clay band horizon of both pedons (table 26). In general, however, there is little difference in total clay content as compared to the soils of Muleshoe age (table 14). Although most clay bands are continuous and some are thicker than in soils of Muleshoe age, the bands do not contribute greatly to the total clay content of the horizon in which they occur. Clearly, clay bands are very sensitive morphological indicators of slight clay accumulation.

Both pedons contain high percentages of fine sand. Textures of all horizons are either fine sand, or sand that is near the margin to fine sand.

In upper horizons, pH is lower under oak than under nonoak vegetation, but for deeper horizons, pH is similar for both soils. The pH of the A2 horizon in the soil under oak is lower than pH of the horizon in the same position under nonoak vegetation.

#### Site 19, dune crest; oak-nonoak transition

The dune crest at Site 18c, discussed in the previous section, extends eastward as a long dune ridge at about the same elevation. All soils at Site 19 have formed in sediments of Longview age, and no evidence of post-Longview sediments can be seen.

The study trenches at Site 19 (fig. 40, table 27) are across an oak-nonoak contact (Pedon 19a and 19b) and in a nonoak area just east (Pedon 19c). Fine strata, about 1 mm thick, are apparent in much of the Bt

Table 27. Characteristics of Alfic Ustipsamments, Circleback, on the crest of a Longview dune at Site 19<sup>1/</sup>

Horizon	Depth cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	pH	Lower boundary
			Dry	Moist					
<u>Pedon 19a, oak<sup>2/</sup></u>									
A1	0-12	7.5YR	5/3	3.5/3	s	m	s	7.2	cs
A2	12-36	7.5YR	6/3	4.5/3	s	m	s	6.8	
A2&Bt	36-60	7.5YR	6.5/4	5/4	s	m	s	6.6	
B21&tb	60-71	5YR	6.5/4	5/4	s	m	sh	6.4	aw
B22&Bt	71-100	6YR	6.5/4	5/4	s	m	sh	6.6	as
B23&Bt	100-138	6YR	7/4	5.5/4	s	m	sh	6.6	as
C1&Bt	138-150	7.5YR	6/4	4.5/4	s	m	sh	6.6	cw
C2	150-168	7.5YR	6/4	4.5/4	s	m	s,sh	6.8	
<u>Pedon 19b, nonoak<sup>3/</sup></u>									
A1	0-20	7.5YR	5/3	3.5/3	s	m	s	7.0	cw
A2	20-37	7.5YR	6/3.5	4.5/3	s	m	s	7.0	as
A2&Bt	37-62	7.5YR	6/4	4/4	s		s	7.0	as
B21&Bt	62-77	5YR	6.5/4	5/4	s	m	s sh	6.8	aw
B22&Bt	77-101	6YR	6.5/4	5/4	s	m	s,sh	6.8	aw
B3&Bt	101-118	7.5YR	6.5/4	5/4	fs	m	sh	6.8	aw
C	118-148	7.5YR	6.5/4	5/4	fs	m	s,sh	6.8	
<u>Pedon 19c, nonoak<sup>4/</sup></u>									
A1	0-20	7.5YR	5/3	3.5/3	s	m	s	7.0	cw
A2	20-40	7.5YR	6.5/3.5	4.5/3.5	s	m	s	7.0	aw
A2&Bt	40-52	7.5YR	6.5/4	5/4	s	m	s,sh	6.8	as
B2&Bt	52-84	7.5YR	6.5/4	5/4	s	m	sh	6.8	as
B3&Bt	84-104	7.5YR	6.5/4	5/4	s	m	s,sh	6.8	as
C	104-141	7.5YR	6.5/4	5/4	s	m	s,sh	6.8	

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

<sup>2/</sup> A2&Bt and B2&Bt: clay bands 5YR 5/4, dry. B3&Bt: clay bands 6YR 6/4, dry.

<sup>3/</sup> A2&Bt and B&Bt: clay bands 5YR 5/4, dry.

<sup>4/</sup> A2&Bt and B2&Bt: clay bands are 5YR 5/4, dry. B3&Bt: clay bands 5YR 5.5/4, dry.

horizon of all three pedons. The strata are not apparent in the A1 and most of the A2 horizons, and in these horizons have apparently been obliterated by biotic mixing. Also present in all three pedons are volumes of light-colored material, one to several centimeters wide and roughly circular to elongate in the cross section. Some of these light-colored parts are isolated and occur in no particular pattern; others occur vertically and descend irregularly through the B horizon. These features are interpreted as fillings of former root channels and rodent burrows.

In soils of Muleshoe age, and at Site 18c discussed earlier, little or no difference in morphology and number of clay bands is apparent across oak-nonoak contacts. But at Site 19 distinct differences are apparent.

#### Pedon 19a, under oak.

The clay band horizon under oak is thicker and more prominent than the one under nonoak vegetation. Some of the individual clay bands are also thicker under oak. The A2 horizon of Pedon 19a is lighter-colored in part

and has lower pH than the soils under nonoak vegetation. Soils of Longview age under (long-standing?) oak vegetation have the most prominent A2 horizons in the study area; see Site 22 for a photograph of an example.

The A2&Bt horizon has clay bands that are thin and discontinuous. In the A2 material the sand is prominently light-colored, as though clay had been stripped from the grains. There are also a few light-colored zones in the B2&Bt horizon, suggesting some stripping of grains even there.

Because these morphological differences coincide with the oak-nonoak boundary, they are attributed to the differences in vegetation. The mulch of oak leaves and twigs should trap more clay from dustfall, and could explain the more prominent clay band horizon. The morphological differences suggest that the boundary between oak and nonoak has been stable for a substantial, but unknown period of time.

The distinctive morphological evidence of clay stripping has been observed in another soil of Longview age (Site 22) and in a number of soils of Pleistocene age (for an illustration and discussion, see Gile, 1981, p. 27, 28 and 41). In soils of middle and late Holocene age, the feature of clay stripping has been observed only in soils that are under oak vegetation and that have clay only in banded form.

Clay stripping in soils with continuous Bt material, as contrasted to clay bands, has been observed only in soils of early Holocene or Pleistocene age that have been preserved by burial. The weathering of the middle and late Holocene apparently has not been sufficiently rigorous for clay stripping in continuous Bt horizons. The converse appears to be true; the consistent occurrence of Bt material in the upper part of the Bt horizon of land-surface soils indicates clay illuviation (instead of clay stripping) in these Bt horizons. All this is additional evidence of a stronger leaching regime in the early Holocene and in the Pleistocene than exists today (see Site 14-17 for additional evidence).

The A2&Bt horizon (table 27) has three clay bands 1 mm thick near the center of the horizon. The B21&Bt horizon has two clay bands, the upper one being nearly 1 cm thick and the lower one several mm thick. The upper 11 cm of the B22&Bt horizon has no bands; a band about 1 cm thick is from 82-83 cm depth. From 83-98 cm there are two indistinct, discontinuous bands.

The B23&Bt horizon has six clay bands, ranging from 1 to 5 mm thick, at depths of 102, 106, 115, 119, 131, and 139 cm. The 4th and 5th bands are the thickest (4-5 mm). Clay bands of this zone become thinner and then disappear under the grass. The B3&Bt horizon has several bands, 1-2 mm thick, faintly expressed and not present under grass. The C horizon has no clay bands.

#### Pedon 19b, under nonoak vegetation

Although the A2 horizon extends from the oak into the nonoak, the clay bands tend to be thinner under grass than under oak, and also have more undulations. The lowermost clay bands under oak thin towards the grass and finally disappear.

The A2&Bt horizon (table 27) has three clay bands, about 2 mm thick. The B21&Bt horizon has three clay bands: two are  $\frac{1}{2}$  cm thick and one is 1-2 mm

thick. The B22&Bt horizon has four clay bands, 3-4 mm thick, at 77, 83, 97, and 100 cm depths; there are many undulations. The B3&Bt horizon has two clay bands, 1 mm thick, at 104 and 117 cm depths. No bands occur in the C horizon.

Pedon 19c, under nonoak vegetation

Pedon 19c is under nonoak vegetation and is about 6 m further east along the ridge crest. This pedon is similar to Pedon 19b, but the clay band horizon is thinner (table 27). A third study trench under nonoak vegetation, 25 m further east along the ridge crest, was not sampled, but the soil was very similar to the other two pedons under nonoak vegetation.

Sites 20-22, dune crests

Site 20

Site 20 (figs. 40, 63; table 28) occurs on a slight ridge of Birdwell sediments. There is no A2 horizon, and the present A1 horizon is not particularly low in clay. But it is thought that thicker, coarser horizons were once present, as they now are in younger soils at stable sites. The sand texture and surficial position of such A horizons would have made them susceptible to erosion. Thus post-Birdwell erosion could have stripped the original A horizon, leaving the finer-textured and more resistant B horizon at the surface. The present A1 horizon (so designated because of its position, color, and accumulation of organic carbon) may have formed in what was once a B horizon.

Table 28. Characteristics of a Psammentic Haplustalf, Texico, on the crest of a Birdwell dune at Site 20

Horizon	Depth cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	pH	Lower bound- ary
			Dry	Moist					
A1	0-4	9YR	5/3	3/3	lfs	m	s	7.0	as
B1t	4-18	7.5YR	5/4	3/3	lfs	m	sh	7.0	as
B2t	18-35	5YR	5.5/4	4/4	ls	lcsbk	h	7.2	as
B3t	35-59	6YR	6/4	4.5/4	s	lcsbk	sh	7.0	cw
C	59-73	7.5YR	6.5/5	5/5	s	m	sh	7.0	as
A1b	73-83	7.5YR	5.5/3	4/3	s	m	sh	6.8	cw
A2b	83-112	7.5YR	6.5/4	5/4	s	m	sh	7.0	as
B2tb2	112-125	5YR	5/4	4/4	scl	lcsbk	vh	6.8	

Development of the Bt horizon is most prominent in the level-transversely crest of the slight dune. The Bt horizon is continuous, though thin, and the soil as a whole is similar to soils of other dunes of Birdwell age (see Chapter 7). Clay bands in the Bt horizon are thin (2-3 mm) except for one at 22-23 cm depth, which is about 1 cm thick. A band at 31 cm is

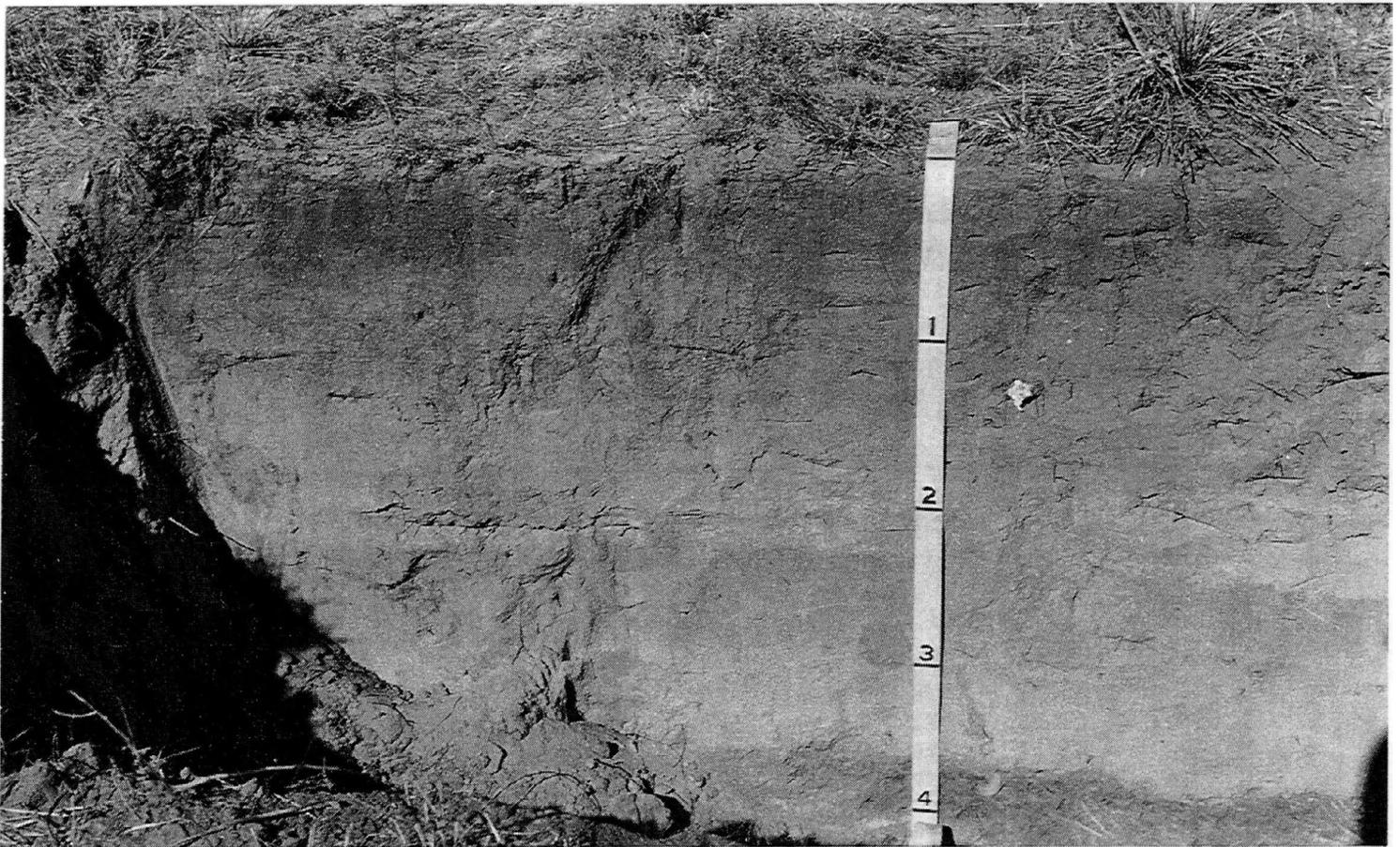
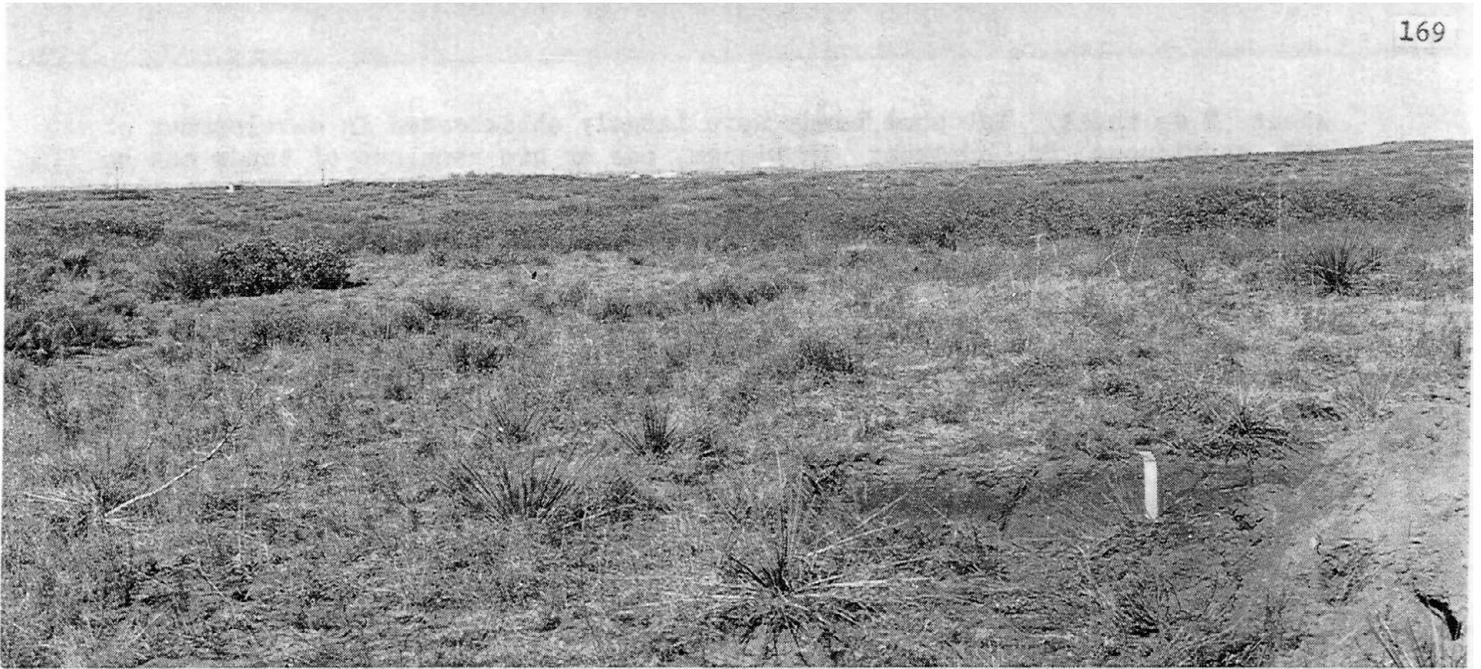


Figure 63. Upper. Landscape view of the low Birdwell dune at Site 20. The view is north. Photographed November 1976.

Lower. The Psammentic Haplustalf, Texico, at Site 20. Birdwell sediments extend to slightly below 2 ft (0.6 m) depth, and are underlain by an A horizon of apparent Hale age. Scale is in feet.

about 2 mm thick. But some bands were largely obliterated in development of the continuous Bt horizon; in places, one or two remnants of bands can be observed in the upper part of the Bt horizon. One clay band, about 1 mm thick and discontinuous, has formed along the contact between the B32 and the Alb horizon.

The buried Alb horizon appears to be a valid Al horizon associated with the soil of Hale age. A similar dark horizon was noted at Site 28. At first it seems surprising that such a coarse-textured surficial horizon was not removed by wind erosion; but broad crests of some dunes may be sites of little or no erosion prior to deposition (see Sites 1b and 18b).

Two crotovinas are apparent in the buried A2b horizon (fig. 63). One, about 9 cm diameter, is filled with brown, fine earth. Another, about the same size, is filled with reddish material similar in color to the Bt above. The buried Bt horizon is of Hale age and mottled in part but mostly reddish with some black (Mn, Fe?) spots. Augering below the base of the trenches showed the Btb horizon extends to at least 170 cm depth.

#### Site 21, dune crest

Site 21 (fig. 40) represents an area apart from the main area of Longview sediments, and illustrates their sporadic nature in the southern part of the area of occurrence.

Particle size distribution and pH for Pedon 21 were given in table 26; table 29 gives other characteristics.

Table 29. Characteristics of the Alfic Ustipsamment, Circleback,  
on crest of Longview dune at Site 21

Horizon	Depth cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	Lower bound- ary
			Dry	Moist				
A11	0-5	7.5YR	6/3	4/3	fs	m	s	as
A12	5-16	7.5YR	5/4	3.5/4	fs	m	s	cw
B11	16-25	5YR	6/4	4/4	fs	m	s	cw
B12	25-32	5YR	6/4	4/4	fs	m	sh	as
B21&Bt	32-53	5YR	6/4	5/4	fs	m	sh	as
B22&Bt	53-71	5YR	6/4	5/4	fs	m	sh	as
B23&Bt	71-86	5YR	6/4	5/4	fs	m	sh	aw
B3&Bt	86-106	6YR	6/4	4.5/4	s	m	sh	cw
C	106-128	6YR	6/4	4.5/4	fs	m	sh	

## Site 22

Site 22 (figs. 40 and 64; table 30) occurs on the crest of a blowout dune of Longview age. The sampled pedon (S75TX-17-6, table 30) is in Soil Moisture Site 6 (Appendix). A landscape view has been presented (Gile, 1979, p. 999). A buried soil of Birdwell age occurs in the lower part of Pedon 22; sedimentary strata are preserved in the overlying B3&Bt horizon.

Table 30. Characteristics of the Psammentic Haplustalf, Texico S75TX-17-6, on the crest of a Longview dune at Site 22<sup>1/</sup>

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								
			2-1	1-0.5	0.5- 0.25	0.25- 0.1	0.1- 0.05	0.05- 0.002	< 0.002								
L	A1	0-12	0.1	4.3	21.4	51.4	13.6	6.6	2.6	0.81	0.2		7.0	fs	10YR 5.5/3		
	A2	12-46	tr	5.9	25.9	56.3	9.1	2.4	0.4	0.13	0.2		6.8	fs	10YR 7/3		
	A2&Bt	46-66	tr	5.9	27.4	54.4	6.7	2.2	3.4	0.11	0.2		6.7	fs	10YR 7/3		
	B2&Bt	66-92	0.1	8.3	27.5	51.8	6.8	1.1	4.4	0.08	0.2	1.72	7.0	fs	5YR 6/4		
	B31&Bt	92-112	0.1	10.6	29.2	48.0	6.6	1.3	4/2	0.05	0.2	1.71	7.0	s	6YR 6/4		
	B32&Bt	112-131	0.2	7.2	26.9	50.6	9.4	1.7	4.0	0.09	0.2	1.72	6.5	fs	6YR 6/5		
B	Bltb	131-141	0.1	6.3	23.8	49.7	9.6	1.4	9.1	0.07	0.3	1.70	6.4	ls	5YR 6/4		
	B2tb	141-164	tr	6.3	21.7	47.5	7.8	2.8	13.9	0.11	0.4	1.78	6.1	fs1	2.5YR 5/6		
	B31tb	164-205	0.2	10.9	26.7	45.1	5.9	3.5	7.7	0.04	0.3	1.78	6.4	ls	5YR 6/6		
	B32tb	205-235	0.1	8.7	27.3	50.4	6.2	2.3	5.0	0.02	0.2	1.76	6.8	fs	5YR 6/6		

<sup>1/</sup> Particle-size distribution is by method 3A1 (Soil Conservation Service, 1972); organic carbon, method 6A1a; extractable Fe, method 6C2b; bulk density, method 4A1h; pH, method 8C1a (1 : 1H<sub>2</sub>O). L = Longview, B = Birdwell.

Most soils of Longview age do not meet the requirements of the argillic horizon, but this one does. Pedon 22 has the most prominent A2 horizon observed in the study area, with very little clay (table 30). Some of the clay bands are thicker than in other soils of Longview age. The B2&Bt horizon has four clay bands, 5YR 4.5/6 dry; the upper two are usually about 1 cm thick and the lower two from 1 to 4 mm thick. The bands are from 6 to 10 cm apart. The B31&Bt horizon has four to six clay bands from 1 to 3 mm thick and from 1 to 3 cm apart. The B32&Bt horizon has one discontinuous clay band about 1 mm thick. The data and field evidence illustrate the incipient nature of the argillic horizon in this soil of Longview age.

The A2 horizon is continuous along the exposure and in places descends into the reddish brown Bt material to form the A2&Bt horizon. The character of the A2&Bt horizon suggests downward encroachment of the A2 horizon into a clay band horizon that once had thicker bands. The Bt material occurs in two ways: in irregularly-shaped masses and as bands from 2 to 10 mm thick. In the latter case, the A2 material occurs horizontally between the bands. In the former case, the A2 material occurs as light-colored, irregular masses and as mottles in the redder, more clayey material. Thus the A2 material appears to reflect stripping of clay from former Bt parts of the horizon.

Several factors may be responsible for increased development of the A2 and clay band horizons at Site 22. A long-time cover of oak would tend to promote development of the A2 horizon and the associated eluviation of clay,

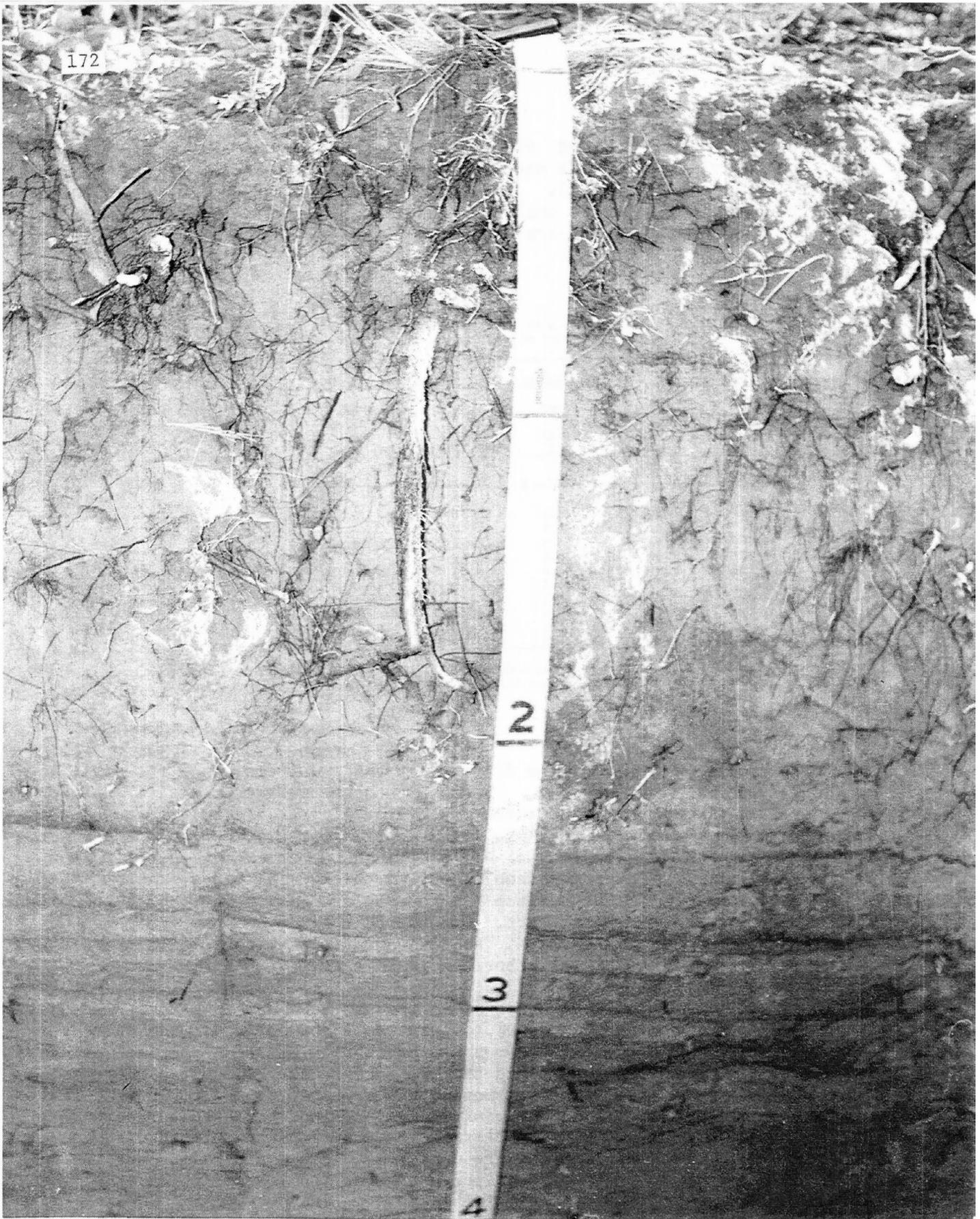


Figure 64. The Psammentic Haplustalf, Texico, S75TX-17-6, formed in sediments of Longview age at Site 22. This pedon has the most prominent A2 horizon observed in the study area. Photographed October 1975. Scale is in feet.

because increased development of the A2 horizon due to oak vegetation has been seen in some of the younger soils of Muleshoe age. The oak mulch of leaves and twigs tends to protect the soil from erosion; in addition, it should trap more dust than nonoak vegetation. The soil may be of Longview I age instead of Longview II. Finally, the buried argillic horizon at shallow depth (table 30) could also be a factor because the buried horizon would tend to slow downward movement of the wetting front and confine the clay accumulation in the overlying sediments to a thinner zone.

#### Sites 23 and 24, active small blowouts and dunes

Small active blowouts and steep slopes are fairly common in oak, because oak can grow thickly on steep slopes and protect them from erosion. In places, small vertical scarps have formed along the eastern margin of the blowouts. This is illustrated in the vicinity of Site 23 (figs. 42, 65) where the topography is very irregular; steep hummocks alternate with small blowouts and occasional vertical scarps. In aerial photographs the blowouts show as light-colored areas of irregular shape (fig. 42).

Site 23 consists of a thin deposit of Fairview sediments and underlying Longview sediments exposed in a scarp. The soil of Longview age has a distinct A2 horizon, a thick A2 horizon, and a banded B horizon underlain by a C horizon (table 31).

Table 31. Characteristics of an Alfic Ustipsamment, Circleback, on the crest of a Longview dune at Site 23<sup>1/</sup>

Sediment	Horizon	Depth cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	pH	Lower boundary
				Dry	Moist					
Fairview	C1	0-16	6YR	6/4	4.5/4	fs	m	s	6.8	cw
	C2	16-34	6YR	6/4	4.5/4	fs	m	s,sh	6.8	cw
Longview	A11b	34-47	6YR	6/4	4.5/4	fs	m	sh	6.8	cw
	A12b	47-65	6YR	6/4	4.5/4	fs	m	sh	7.0	cw
	A21b	65-78	7.5YR	6.5/4	4.5/4	fs	m	sh	7.2	ci
	A22b	78-102	7.5YR	6.5/4	5/4	s	m	sh	7.0	ci
	B1b	102-126	5YR	6/4	4.5/4	s	m	sh	6.8	cw
	B21&Btb	126-138	5YR	6/5	5/5	fs	m	sh,h	6.8	as
	B22&Btb	138-147	5YR	6/5	5/5	fs	m	sh,h	6.6	as
	B23&Btb	147-158	5YR	6/5	5/5	fs	m	sh,h	6.4	as
	B31&Btb	158-179	5YR	6/4	4.5/4	s	m	sh	6.6	as
	B32&Btb	179-206	5YR	6/4	4.5/4	s	m	sh	6.6	cw
	B33b	206-236	5YR	6.5/4	5/4	s	m	sh	6.6	cw
	Cb	236-260	7.5YR	6.5/4	5/4	s	m	s,sh	6.6	

<sup>1/</sup> Subordinate colors and additional characteristics follow. Alb: parts 5YR 5/3, dry, and 7.5YR 7/3, dry, occur throughout. A21b: parts 7.5YR 7/3, dry, occur throughout. A22b: parts 5YR 5/4, dry, occur throughout; few parts 7.5YR 7/4, dry. B1b: very few parts 7.5YR 7/4, dry. B21&Btb: two clay bands from 2 to 4 mm thick. B22&Btb: two continuous bands from 3 to 5 mm thick. B23&Btb: three bands 2 mm thick and 3 bands 1 mm thick. Most bands are continuous but they bifurcate in places. B31&Btb: three continuous bands, about 1 mm thick, and three discontinuous bands less than 1 mm thick. B32&Btb: several very discontinuous bands.

On the north margin of the dune, Fairview deposits are absent and the buried A horizon of Longview age has been truncated by wind erosion (fig. 65, lower, at left). The B21tb horizon has two distinct, continuous clay bands that crop out on the beveled surface, which is littered with dead oak branches. The 1941 airphoto (but not the 1953 airphoto) shows the oak

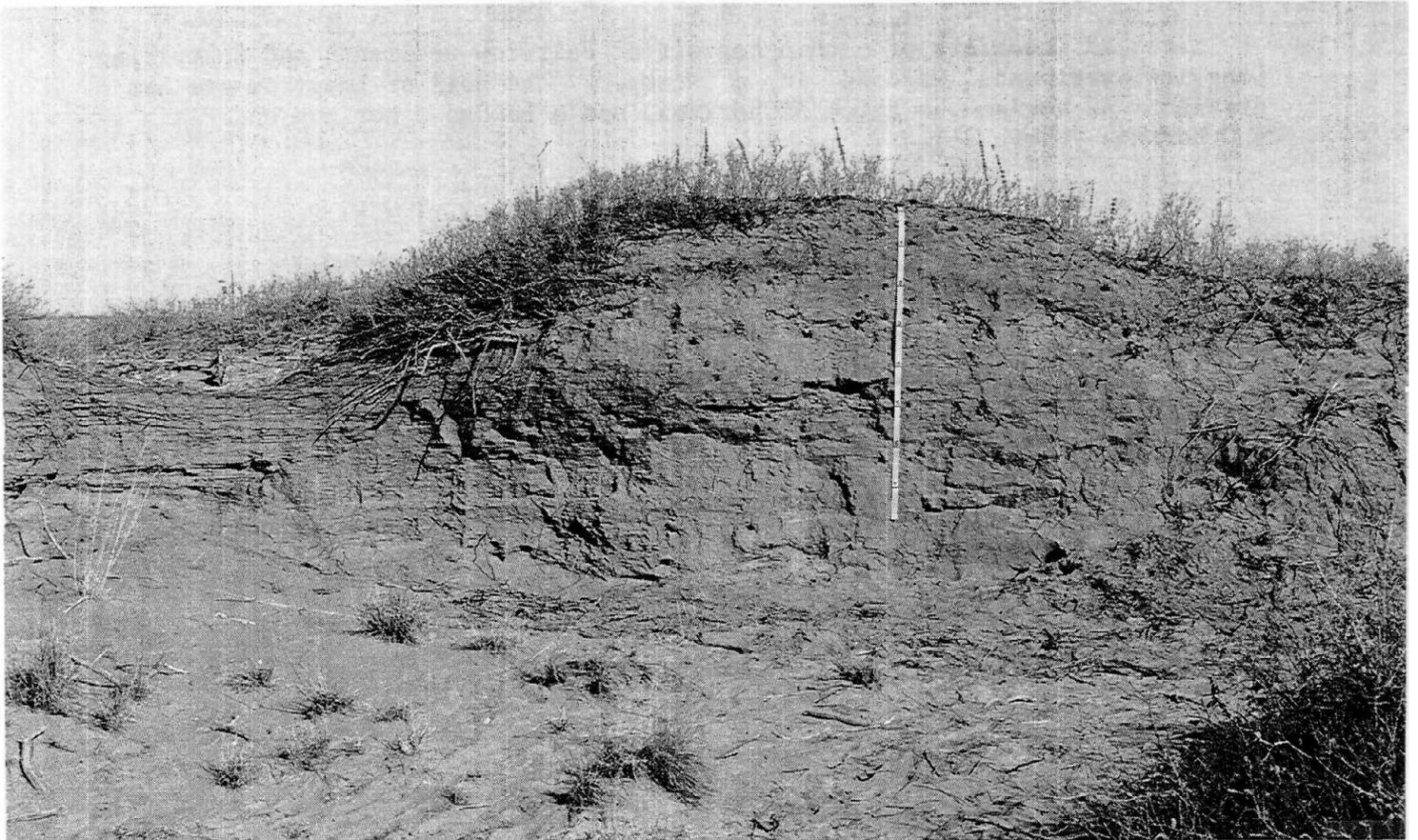
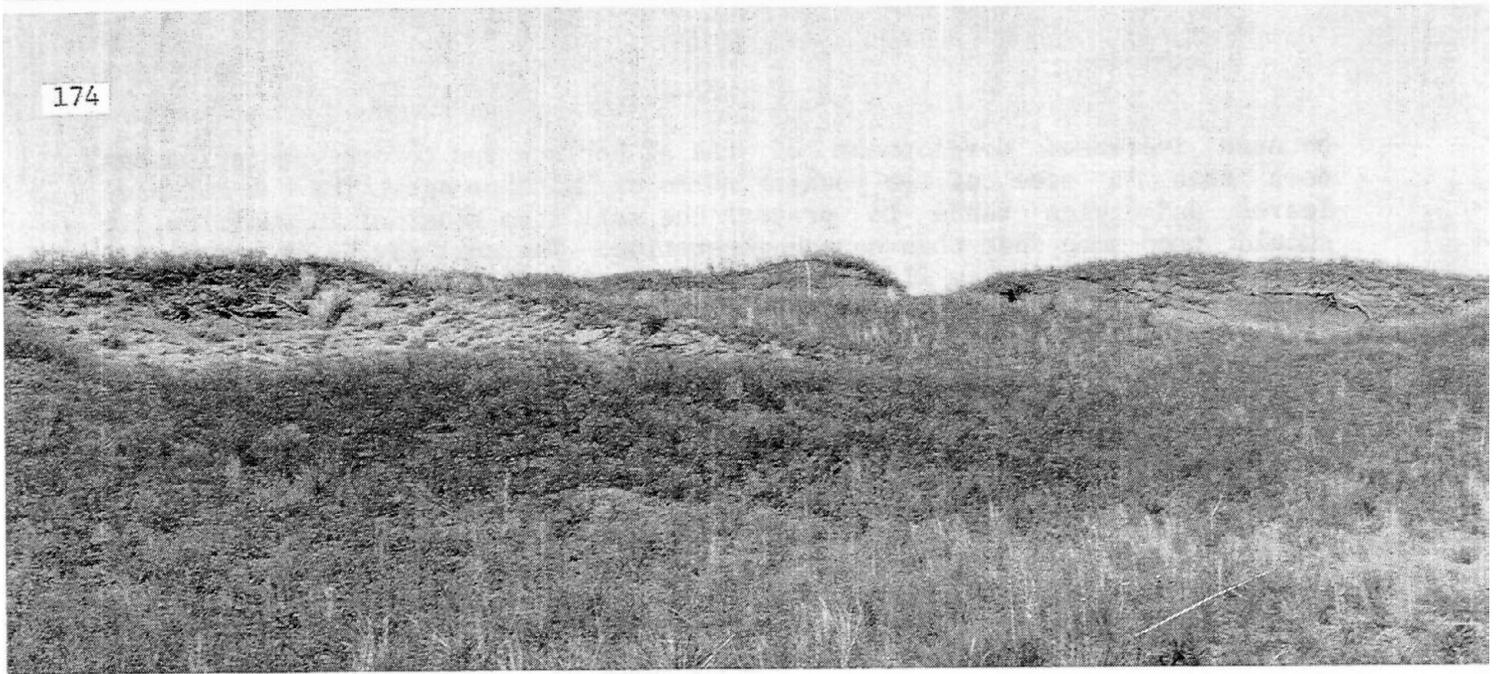


Figure 65. Upper. Landscape of a complex of Muleshoe and Longview surfaces in the vicinity of Site 23. Steep slopes are common in the oak-dominated terrain. The view is east. Photographed March 1978.

Lower. Site 23 and the Alfic Ustipsamment, Circleback, exposed on eastern margin of small active blowout (foreground) and buried by a thin deposit of Fairview age. Note the sloping relief on the buried A1 horizon of Longview age. Scale is in feet.

continuing across to the dune just north. Thus much of the erosion must have taken place between 1941 and 1953.

The surface topography of the Alb horizon is slightly rounded and denotes the land surface before it was buried by overlying sediments. The soil of Longview age must have been truncated before the Al horizon developed. The prominent A2 horizon suggests long-time occurrence of oak in this area (few A2 horizons have been found under grass except near the oak).

Site 24 (fig. 42), not sampled, illustrates gradual enlargement of a small, linear blowout in oak vegetation (figs. 13-17). The blowout is barren and has a scattering of dead oak branches and roots. In the 1941 aerial photograph, faint traces of a trail may be seen north of the blowout. By 1953 the blowout had enlarged and a trail may also be seen south of the blowout. But faintness of the trail suggests that the part played by cattle in initial development of the blowout was slight, as does the occurrence of nearby blowouts that have enlarged where no evidence of a trail can be seen.

Tivoli soils are in the upper sediments of the west-facing, near-vertical face along the western edge of the blowout. The general stratigraphy, similar to that at Site 3a, is as follows. A few centimeters of Fairview sediments are at the surface. Muleshoe sediments underlie Fairview and extend to about 120 cm depth. Below the Muleshoe sediments are these generalized horizons in Longview II sediments: A2b2, 120-150 cm; B1b2 and B2b2, 150-200 cm; B3b2, 200-260 cm; Cb2, 260-288 cm. From 288-328 cm is a horizon like the buried A horizon in Longview I sediments at Site 3b. The typical clay bands occur in the soil of Longview age.

Site 24 and vicinity illustrate typical occurrence of Tivoli and Circleback in mapping unit C. Although Circleback soils are buried here, elsewhere in unit C they are at the land surface and Muleshoe deposits are absent.

PSAMMENTIC HAPLUSTALFS AND ALFIC USTIPSAMMENTS: MAPPING UNIT D,  
TEXICO-CIRCLEBACK COMPLEX

MAPPING UNIT COMPOSITION

<u>Series or variant</u>	<u>Subgroup</u>	<u>Particle-size family</u>	<u>Percentage of mapping unit</u>
TEXICO . . . . .	PSAMMENTIC HAPLUSTALFS . . . . .	.SANDY . . . . .	45
CIRCLEBACK . . . . .	ALFIC USTIPSAMMENTS. . . . .	.SANDY . . . . .	40
Tivoli, thin variant #1 . . . . .	Typic Ustipsamments. . . . .	.Sandy . . . . .	5
Tivoli . . . . .	Typic Ustipsamments. . . . .	.Sandy . . . . .	10

LOCATION, LANDSCAPE, SOIL OCCURRENCE, VEGETATION

Soils of unit D occur on dunes in the central part of the study area. Texico soils occur on crests and upper sides of dunes. Circleback soils occur in areas of Longview sediments, on ridge crests (mainly in the north-central part of the area) and on sides of some dunes. Tivoli, thin variant #1 occurs in depressions; Tivoli occurs on lower sides of some dunes.

Vegetation observed in mapping unit D consists of sand sagebrush, soapweed, sumac, dropseed, hairy grama, three-awn, catclaw, snakeweed, and queen's delight.

#### TYPICAL PEDONS AND RANGES IN SELECTED PROPERTIES

See mapping unit C for typical pedons and ranges for Texico and Circleback.

#### STUDY SITES

##### Site 25, episodic development of dune; west aspect

Site 25 (figs. 42 and 66, table 32) is on the west-facing side of a blowout dune. The long trenches at Sites 25 and 26, dug October 1977, are visible in the 1981 aerial photograph (fig. 17). On the ground in October, 1982, the trench sites were visible in faint linear pattern with less vegetation than adjacent areas. Small oak had started to grow in the disturbed area, reflecting the speed of oak growth and advance in sandy sediments (see also Site 13).

Originally it was thought that Birdwell sediments consisted of only one major sediment. However, evidence at Site 25 and at Site 38, to be discussed, illustrates two ages for the sediments concerned -- that is, sediments older than Longview and younger than Roosevelt. Site 25 illustrates a dune of Birdwell II age, and episodic upbuilding of a dune from Birdwell I through Longview time.

Site 25 consists of a short east-west trench near the blowout and a longer east-west trench up the side of the blowout dune (fig. 66). All soils at Site 25 are Psammentic Haplustalfs except for Alfic Ustipsamments on the dune crest. Pedons 25a and 25b are under nonoak vegetation; Pedons 25c and 25d are under oak. Figure 66 shows the stratigraphy, soil occurrence, and slope and location of the sampled pedons. Table 32 gives soil characteristics.

##### Lower side of dune

Pedon 25a (fig. 66, table 32) is in the short east-west trench. The A horizon is thick and may have originated partly by colluviation from slopes to the east. Evidence to be presented in the following section indicates that Pedon 25a actually consists of soils of two ages: a thin land-surface soil in Birdwell II sediments, and an underlying buried soil in Birdwell I sediments. The Birdwell II deposit is so thin that no C horizon has been preserved, and any boundary between the two sediments has been masked by pedogenesis.

Pedon 25b (figs. 66 and 67, table 32) is of Birdwell II age in the upper part and of Birdwell I age in the lower part. In this trench the horizon and sediments were traced eastward to where the B horizons are separated by C horizon material as the Birdwell II sediments thicken upslope (fig. 66).

##### Central side of dune

Upslope from Pedon 25b, the expression of clay bands shows the effect of slope position on their development because they become thinner and less

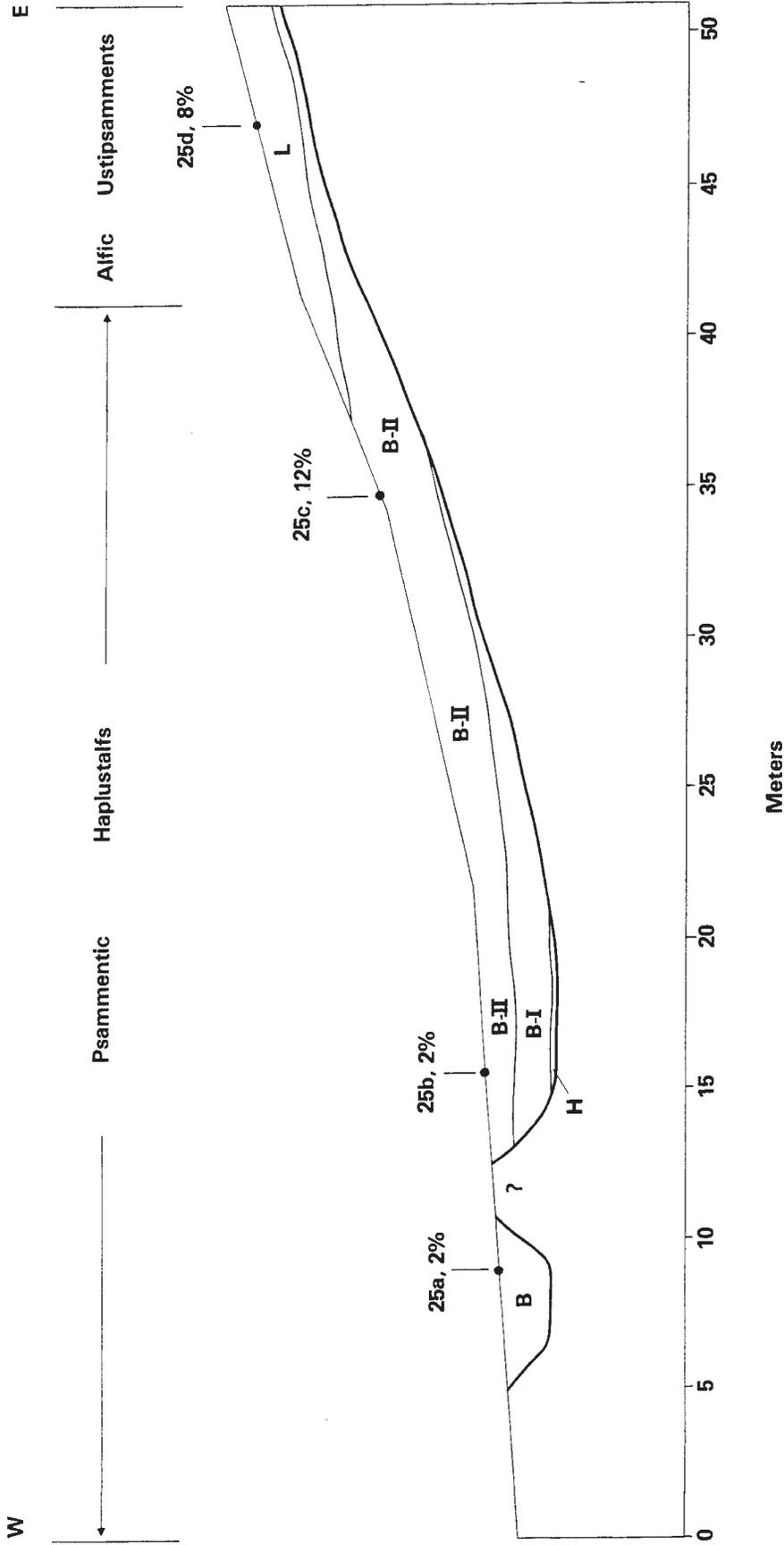


Figure 66. Diagram of study trenches at Site 25, showing stratigraphy, subgroups, and slope and location of sampled pedons. L = Longview, B-II = Birdwell II, B-I = Birdwell I, Hale = Hale. No vertical scale (see table 32 for the thickness of sediments and horizons). The heavy lower line represents the bottom of the trench.

Table 32. Characteristics of Haplustalfs and an Ustipsamment at Site 25 <sup>1/</sup>

Sedi- ment	Horizon	Depth, cm	Hue	Value/chroma		Struc- ture	Dry consis- tence	pH	Lower bound- ary	Tex- tural class	Sand 2.0- 0.05 mm	Silt 0.05- 0.002 mm	Clay < 0.002 mm
				Dry	Moist								
<u>Psammentic Haplustalf, Texico, on lower side of dune; Pedon 25a<sup>2/</sup></u>													
B-I, II	A11	0-10	7.5YR	4.5/3	3/3	m	s	6.8	aw	lfs			
	A12	10-35	5YR	5/3	4/3	m	s	6.8	cw	fs			
	B1t	35-54	5YR	5/3	4/3	m	sh	7.4	aw	fs			
	B2tb	54-70	5YR	5/4	4/4	lmsbk	vh	7.2	as	lfs			
	B3&Btb	70-94	5YR	6/6	4.5/6	m	h	7.2	aw	lfs			
	Cb	94-106	5YR	6/6	4.5/6	m	sh,h	7.2		fs			
<u>Psammentic Haplustalf, Texico, on lower side of dune; Pedon 25b<sup>3/</sup></u>													
B-II	A11	0-9	7.5YR	5/3	3.5/3		s	7.0		lfs	88.1	5.1	6.8
	A12	9-23	7.5YR	5.5/3.5	5.4/3.5	m	sh	7.2		fs	92.4	2.3	5.3
	B1t	23-36	7.5YR	5.5/3.5	5.4/3.5	m	sh	7.2		lfs	84.5	9.2	6.3
	B21t	36-44	5YR	5/4	4/4	lcsbk	h	7.2		lfs	88.1	1.5	11.4
	B22t	44-52	5YR	5/5	4/5	lcsbk	h	7.0		lfs	84.5	2.6	12.9
B-I	B1tb	52-62	5YR	5/5	4/5	lcsbk	h,vh	7.0		lfs	83.6	3.5	12.9
	B2tb	62-79	5YR	5.5/5	4/5	lcsbk	vh	7.0		fs1	81.3	5.3	13.4
	B31tb	79-102	5YR	5/4	4/4	lcsbk	h	7.0		lfs	87.9	3.8	8.3
	B32tb	102-119	5YR	6.5/4	5/4	m	sh	7.2		fs	90.5	3.2	6.3
	Cb	119-134	6YR	7/4	5.5/4	m	sh	7.2		fs	90.6	3.6	5.8
H	Btb2	134-144	2.5YR	5/6	4/6	lmsbk	h,vh	7.4		scl	73.8	3.0	23.2
<u>Psammentic Haplustalf, Texico, central side of dune; Pedon 25c<sup>4/</sup></u>													
B-II	A1	0-9	7.5YR	5/3	3.5/3		s	7.4	cw	lfs			
	A2	9-28	7.5YR	6/3	4.5/3	m	sh	7.0	cw	fs			
	B1	28-42	7.5YR	6/4	4.5/4	lmsbk	sh,h	7.0	as	fs			
	B21t	42-56	5YR	5.5/4	4.5/4	lcsbk	vh	6.6	as	lfs			
	B21t	56-66	4YR	5/5	3.5/5	lcsbk	h,vh	6.6	as	fs			
	B3t	66-77	5YR	6.5/6	5/6	m	sh	6.4	cw	fs			
	C&Bt	77-90+	7.5YR	5.5/5	4/5	m	sh	6.4		fs			
<u>Alfic Ustipsamment, Circleback, on upper side of dune; Pedon 25d<sup>5/</sup></u>													
L	A1	0-7	7.5YR	4.5/3	3/3		s,sh	7.0	as	lfs			
	B&A2	7-18	5YR	5.5/4	4/4	lcsbk	h	7.0	as	fs			
	B2&Bt	18-39	5YR	5.5/5	4/5	lcsbk	h	7.0	cw	s			
	B3&Bt	39-72	5YR	6/4	5/4	m	sh	6.8	cw	s			
	C	72-90	5YR	6/4	4.5/4	m	sh	6.6		fs			

<sup>1/</sup> Subordinate colors and additional characteristics are footnoted to pertinent soils. Sediments identified as: B-II = Birdwell II, B-I = Birdwell I, H = Hale, L = Longview.

<sup>2/</sup> B3&Btb: clay bands are 5YR 5/6, dry.

<sup>3/</sup> B21t: parts 7.5YR 5.5/4, dry. B1tb: parts 5YR 4/2, dry. B3tb: this horizon dominated by eight clay bands ranging from ½ to 5 cm thick and from 5YR 5/4 to 5YR 6/4, dry.

<sup>4/</sup> B21t: parts 4YR 5/5, dry. B22t: parts 5YR 5.5/4, dry. C&Bt: few discontinuous bands and spots of 5YR 5/4, dry.

<sup>5/</sup> B&A2: parts 7.5YR 7/3, dry; 10YR 7/2, dry; and 7.5YR 4/2, dry. B2&Bt: clay bands colored 5YR 4/4, dry. B3&Bt: clay bands colored 5YR 5/4, dry.

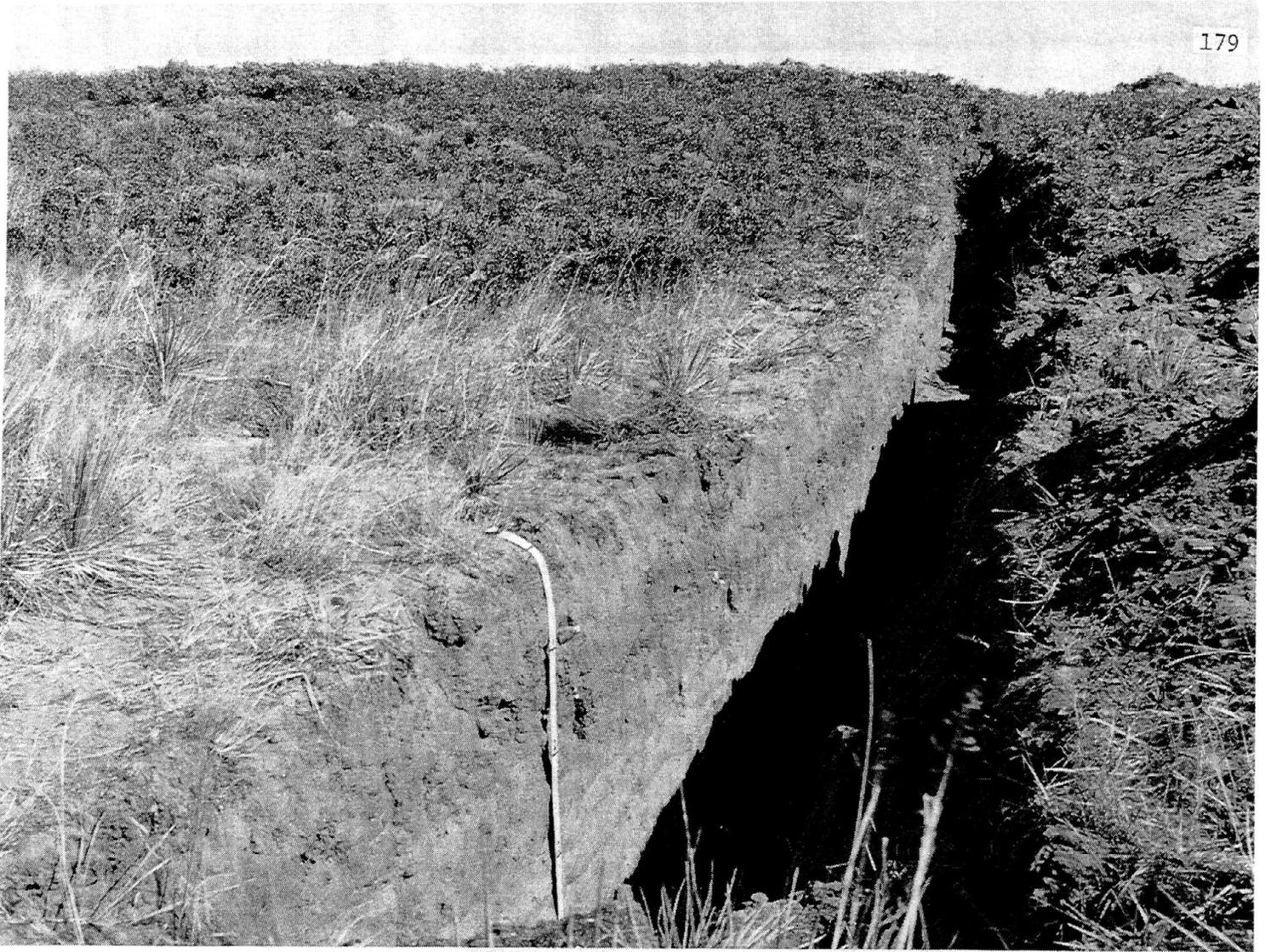


Figure 67. View of study trench and Psammentic Haplustalfs at Sites 25b and 25c. The Birdwell surface is in the foreground and middle ground, and the Longview surface is on the skyline. Horizons of two ages are present in Pedon 25b, at the tape. Birdwell II sediments extend to a depth of slightly less than 2 ft (0.6 m). The Birdwell II deposit is so thin that no C horizon occurs between it and underlying Birdwell I sediments. The thick clay bands (at and below 3 ft, 0.6 m depth) occur in many Birdwell pedons. Scale is in feet.

numerous upslope (see also Sites 1, 3, 32, and 36). Also upslope from Pedon 25b, the soils of Birdwell II and I are separated by C horizon material as Birdwell II sediments become thicker (fig. 66, table 32). This C horizon material contains only a few visible sedimentary strata, whereas the overlying B horizon has developed primarily in sediments that are distinctly stratified. Deposition of the C horizon material is thought to have taken place during a minor erosive episode prior to the main period of erosion and deposition, which is marked by the distinct strata in which the B horizon has formed.

Only a very few thin clay bands descend below the lowermost thick band, which marks the base of the stratified sediments and the boundary between the B and C horizons. The B horizon is remarkably thin for some distance due to the nature of the sedimentary contact: sand grains above the contact are slightly coarser than those below it and would tend to enhance the lateral movement of clay-carrying water downslope.

Post-Birdwell erosion may be another factor involved in thinness of the B horizon. Longview sediments are present at the top of the slope (fig. 66), and may have been partly derived from the side of the dune. The original soil in Birdwell II sediments may have been thicker before the start of Longview erosion.

At Pedon 25b, clay bands are barely visible in the soil of Birdwell II because they have been largely obscured by clay accumulation. One band at 43 cm depth is about 2 mm thick and another at 49 cm depth is 1 cm thick. In contrast, prominent clay bands are in the B3tb horizon of the buried soil in Birdwell I sediments (table 32, fig. 67). West of Pedon 25b, in the west end of the trench (fig. 66) the B3tb horizon has three bands ranging from about 1 to 5 cm thick. The bands split eastward and at Pedon 25b there are eight separate bands ranging from 1/2 to 5 cm thick. The bands are separated by light-colored, less red material with less clay.

Although the colluvium typical of many Birdwell dunes was not found at Site 25, a discontinuous zone of finer texture did occur in the B horizon from about 20 to 21 m along the north bank of the trench (fig. 66). This zone occurred from about 50 to 60 cm depth and is a fine sandy loam, as compared to a loamy fine sand of adjacent material at the same depth. Origin of this finer-textured zone is not known. It could be a remnant of Birdwell colluvium that was eroded elsewhere.

Pedon 25c (fig. 68, table 32) is under oak vegetation and has an A2 horizon, as is common under oak. Tracing downslope into the nonoak vegetation there is little change for about a meter and then the A2 horizon gradually darkens to an A1 horizon.

In contrast to Pedon 25a and 25b, Pedon 25c has formed entirely in sediments of Birdwell II; C horizon material separates the land-surface soil from the buried soil, the top of which occurs at 186 cm depth. The top of the B2lt horizon is marked by a clay band 2 cm thick, and the bottom by a band 1 cm thick. The lower part of the B22t horizon also has a zone, 2 to 3 cm thick, in which thinner clay bands have accumulated. This is a zone of relatively coarse sand, which should expedite lateral movement of soil solution and development of clay bands.

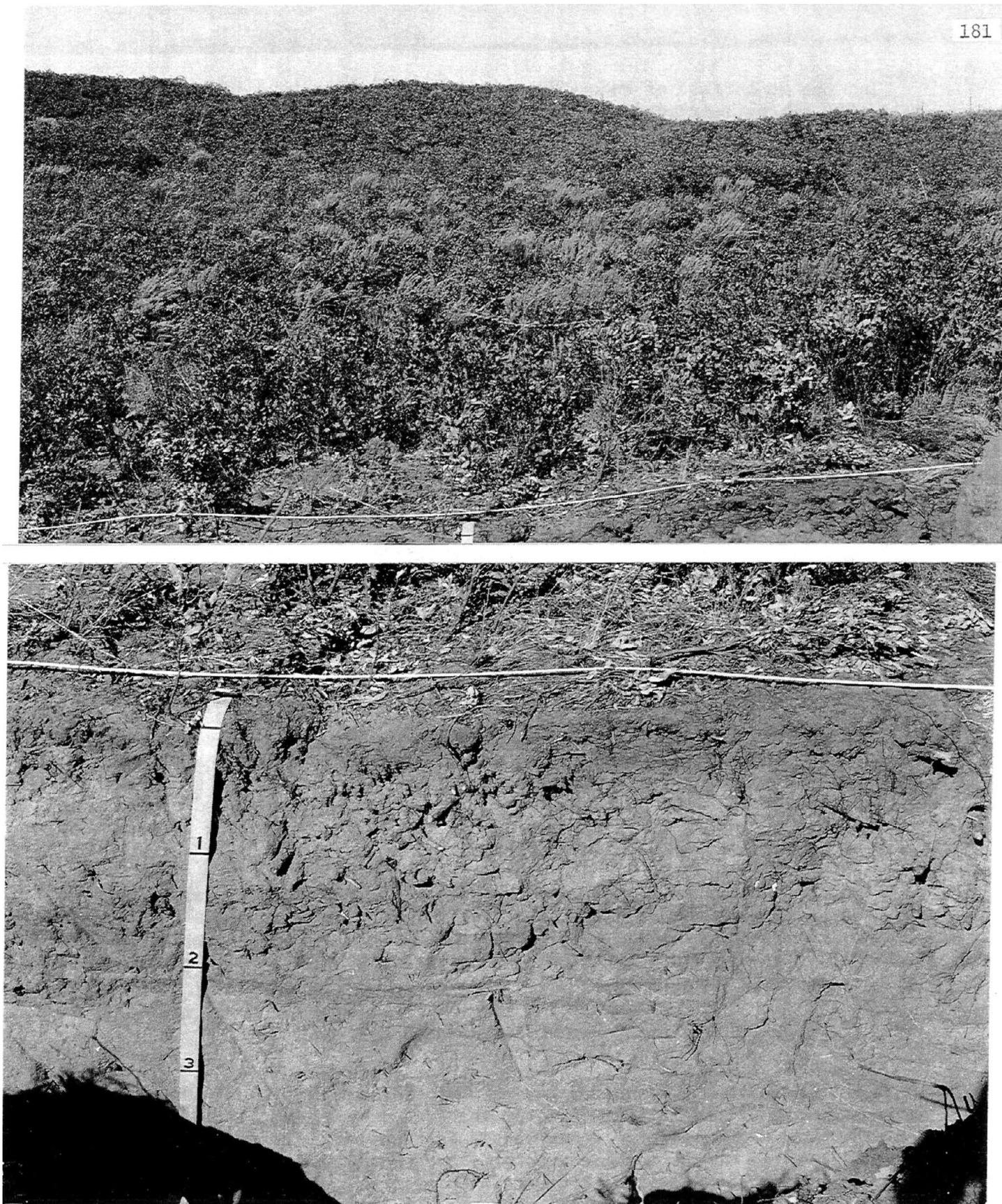


Figure 68. Upper. Landscape view of oak-covered Birdwell surface in foreground. The view is north. Photographed October 1977.

Lower. The Psammentic Haplustalf, Texico, at Site 25c. In the vicinity of the tape, the clay band just below 2 ft (0.6 m) depth marks the contact between prominently and weakly stratified sediments. At center and right, note that clay bands have started to deepen in the soil. This marks the start of burial of Birdwell II sediments by Longview sediments (fig. 66).

In the Bt horizon of Pedon 25c, the lowermost clay band is at a depth of only 65 cm; but eastward the band deepens, splits and a lower band drops to a depth of 1 m at the east end of the original trench. Here, this lower band is actually part of a buried soil as discussed in the following section.

#### Upper side of dune

The original trench did not extend to Pedon 25d, but to be certain of the stratigraphy, the two trenches were connected before they were filled. The connecting trench showed that Longview sediments on the dune crest bury the soil of Birdwell II. The dune crest must have been substantially lower in Birdwell time; deposition of Longview sediments made the dune higher and steeper. The present land surface does not suggest a younger deposit because the slope grades smoothly across the contact between the Birdwell and Longview sediments.

Pedon 25d (fig. 66, table 32) has a thin A1 horizon, a thin A2 horizon and a distinct clay band horizon. Clay bands occur at depths of 32, 46, 56, 60 cm; all are 2-3 mm thick. C horizon material occurs beneath the banded B horizon, and the buried Bt horizon of Birdwell age is at a depth of about 125 cm. The soil is steepest at the west end of the trench; soil truncation there is indicated by partial engulfment of B horizon material by a downward-encroaching A horizon, and by thinness of the B horizon. The B horizon is thicker and there are more clay bands toward the east end of the trench, where the soil nears the dune crest and is not as steep.

#### Site 26, trough and adjacent north and south aspects

Figure 42 locates Site 26, which shows the character of soils on north and south aspects of high dunes, and in the trough between them. Site 26 consists of one short east-west trench in the trough and three trenches that extend northward from a dune crest, down into the trough, and up the dune north of the trough. Two segments of the transect were not dug because they were too steep for the backhoe to operate.

Two pedons were sampled, one in the short trench in the trough, and one in the side of the adjacent dune (table 33). Figure 69 shows the stratigraphy, soil occurrence, and slope and location of the sampled pedons. Table 33 gives characteristics of the soils. Figure 70 gives a general view of the landscape and trenches.

#### Dune crest and small active blowout, south end

Muleshoe sediments are in the narrow crest of the dune. These thin Muleshoe deposits are quite common but do not represent a part of an extensive sheet of Muleshoe age. Instead, they constitute isolated deposits on the crest and sides of dunes and in depressions. The dune crest has oak vegetation, is at the south edge of the transect (0 mark in fig. 69), and is the steepest part of the transect. Some of the active blowouts are quite small, only a few meters in diameter, and range in shape from roughly circular to linear and curved. They show as white spots in aerial photographs; many of them are not near cattle trails and appear to have formed naturally. For example, the small blowout just north of the crest (fig. 70) can be seen in both the 1941 and 1981 photographs and appears

Table 33. Characteristics of Psammentic Haplustalfs, Texico, at Site 26<sup>1/</sup>

Sediment	Horizon	Depth cm	Hue	Value/chroma		Tex- ture	Struc- ture	Dry consis- tence	pH	Lower boundary
				Dry	Moist					
<u>In trough; Pedon 26a<sup>2/</sup></u>										
Fairview	C	0-7	7.5YR	5.5/3	3.5/3	fs	m	s	7.0	as
Birdwell	A1	7-18	7.5YR	5/3	3/3	fs	m	s	7.0	cw
	A2	18-35	7.5YR	6/3	4/3	fs	m	s	7.2	cw
	B11	35-50	6YR	6/4	4/4	fs	m	sh	7.4	cw
	B12	50-60	5YR	6/4	4.5/4	fs	lcsbk	sh	7.2	as
	B2t	60-70	5YR	6/4	4.5/4	lfs	lcsbk	h	7.4	as
	B3t	70-95	5YR	6/4	4.5/4	lfs	m	sh,h	7.4	aw
Hale	B2tb	95-113	2.5YR	5/6	3.5/6	scl	lcsbk	vh	6.0	
<u>On lower side of dune; Pedon 26b<sup>3/</sup></u>										
Birdwell	A11	0-6	7.5YR	5/3	3/3	fs		s	7.0	
	A12	6-20	7.5YR	5.5/3	3.5/3	fs	m	s	7.2	
	A2	20-34	7.5YR	6/4	4.5/4	fs	m	sh	7.2	
	B1	34-48	5YR	6/4	4.5/4	fs	m	sh	7.2	
	B21t	48-62	4YR	5/6	4/6	lfs	lm,csbk	h, vh	7.4	
	B22t	62-90	4YR	5/6	4/6	lfs	lm,csbk	h, vh	7.4	
	B31t	90-104	2.5YR	5/6	4/6	fs	m	sh	7.2	
	B32t	104-124	5YR	5.5/6	4/6	fs	m	sh	6.8	

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

2/ B2t: clay bands and other zones of higher clay content are 5YR 5/4, dry.

3/ B31t: parts 5YR 5.5/4, dry. B32t: parts 4YR 5/5, dry.

about the same size in both. Commonly these small blowouts are nearly barren of vegetation, and this causes the white color on the airphotos.

The top of the banded B horizon is very near the surface in the small blowout, and this is the common situation in blowouts formed in Longview dunes. The sandy A horizon, which is generally quite thick in these soils at stable sites, erodes readily where not protected by vegetation, so that the more resistant clay band horizon is at, or very near the soil surface.

### Small eolian lobe

The north-facing upper side of the dune gives the impression of occasional small lobes of youthful eolian sediments emplaced on older deposits. A study trench across a small dune just north of the blowout showed the typical Longview clay bands all along the exposure, just above the trench bottom. Muleshoe deposits are present above the Longview sediments, as indicated by thin, discontinuous clay bands in a zone well above the Longview clay bands.

### Lower sides of dune and the trough

The study in the north aspect of the dune showed that sediments in the upper part of the section have the distinctive youthful appearance of

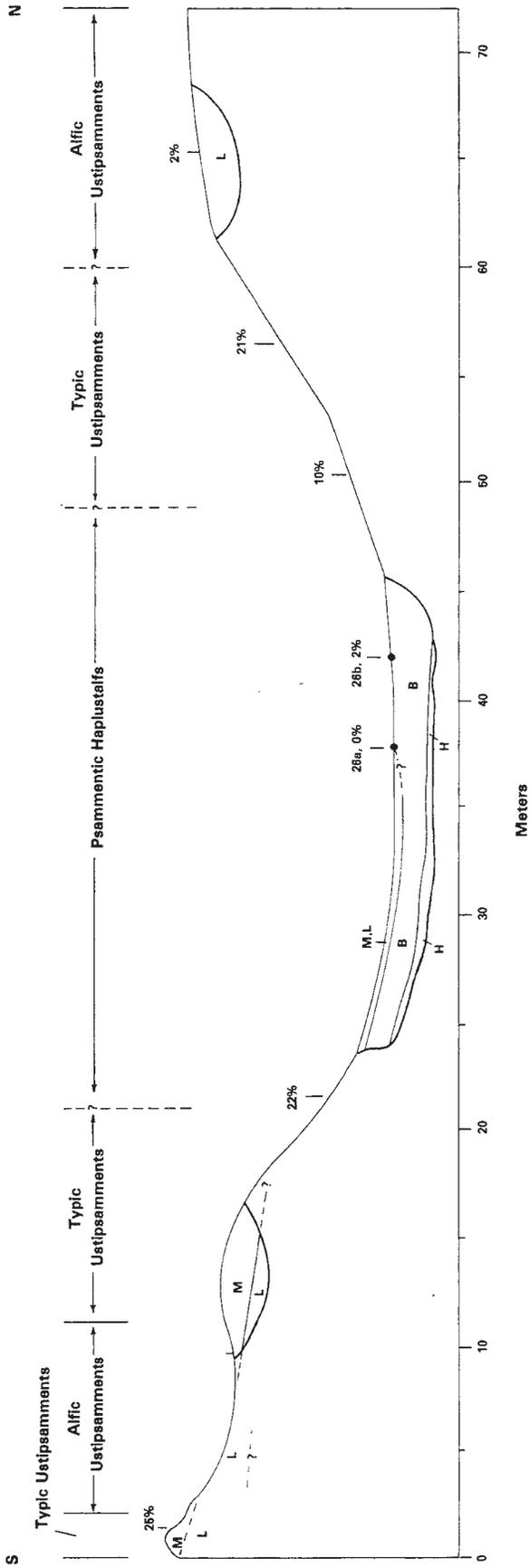


Figure 69. Diagram of study trenches at Site 26, showing stratigraphy, subgroups, and slope and location of sampled pedons. M = Muleshoe, L = Longview, B = Birdwell, H = Hale. No vertical scale (see table 33 for thickness of sediments and horizons). The heavy line represents the bottom of the trenches.



Figure 70. Landscape view of study trenches at Site 26. A small, active, nearly barren blowout is in the foreground. The Longview surface and Circleback soils are in the small blowout; the Muleshoe surface and Tivoli soils are in the small dune at the tape; the Birdwell surface and Texico soils dominate the trough; and the Longview surface and Circleback soils are on the dune crest beyond the trough. Photographed October 1977.

Muleshoe sediments. They bury the Birdwell sediments and its soil, which rest in turn on the thick, red Bt horizon of Hale age. The Muleshoe deposits thin to the north and are very thin or absent on the north side of the blowout (fig. 69).

The distinctive soil in colluvium that occurs on the lower side of many Birdwell dunes is not apparent here in either the north or south aspects. Absence of the colluvium may be due to sporadic erosion and deposition of post-Birdwell sediments. In addition, the mulch of oak twigs and leaves should tend to reduce runoff, though duration of oak cover is not known.

At 25 m (fig. 69) the Muleshoe sediments extend from 0-40cm; Birdwell sediments, from 40-116 cm; and Hale sediments, from 111-132 cm, the bottom of the trench. An A1 and a B horizon has formed in the Muleshoe sediments and an A, B1, B25, and B3 horizon has formed in the buried Birdwell sediments. But the Muleshoe sediments have been in place long enough for a distinct A1 horizon to form. Presumably, the A horizon of Birdwell age was eroded to form the Longview deposits to the east.

The characteristic red, prominent Bt horizon is in Hale sediments along the bottom of the trench. The Birdwell and Hale sediments are continuously exposed in the trench (fig. 69), but Muleshoe sediments are not apparent north of the 35 m mark in the study trench (fig. 69). A few centimeters of Muleshoe sediments could be mixed with surficial Birdwell sediments, however. The clay bands in Birdwell sediments are distinct, discrete, and are similar to those in Birdwell I at the west end of Site 25.

#### Dune crest, north end

The northern segment of Site 26 is a short north-south trench in Longview sediments on the dune crest. This is an Alfic Ustipsamment that shows effect of post-Longview erosion. At the north end of the trench, depth to the banded B is only 26 cm; at the south end, the depth to the banded B is about double that. Over the north 2/3 of the exposure the soil has a distinct, though thin A2 horizon. Thus both of the high dunes at Site 26 are capped by a deposit of Longview age, but these deposits do not occur in the trough. These relationships at Site 26 indicate erosion of sediment from troughs, blowouts and sides of dunes in Longview time and deposition of this sediment to the leeward. Subsequently, Muleshoe erosion removed upper horizons of pre-Muleshoe deposits at various places and sporadically buried the Longview sediments.

#### Site 27, dune crest and east aspect

Site 27 (fig. 40) consists of Site 27a, a trench in the dune crest and adjacent east-facing dune side, and Site 27b, a trench in the east-facing dune side about 12 m northeast of Site 27a.

#### Site 27a, dune crest and upper side of dune

The crest of the blowout dune is several meters higher than the blowout just west. The study trench extended from the center of the dune crest 8 m down the east-facing dune side. Soil characteristics are in table 34.

Table 34. Characteristics of a Psammentic Haplustalf, Texico, on crest of Birdwell dune at Site 27a

Horizon	Depth, cm	Hue	Value/chroma		Struc- ture	Dry consis- tence	pH	Lower bound- ary	Tex- tural class	Sand	Silt	Clay
			Dry	Moist						2.0- 0.05 mm	0.05- 0.002 mm	< 0.002 mm
A1	0-10	7.5YR	5/3	3.5/3	m,sg,cr	s	6.8	as	s	89.2	6.2	4.6
B1t	10-18	6YR	5.5/4	3.5/4	m	s	6.8	as	fs	90.8	3.5	5.7
B2t	18-34	5YR	6/5	5/5	m	sh	7.0	as	fs	89.9	2.2	7.9
B31t	34-56	5YR	6/6	4.5/6	m	sh	7.0	as	fs	91.9	2.1	6.0
B32t	56-78	5YR	6/6	4.5/6	m	sh	7.2		fs	92.3	2.0	5.7
C	78-101	7.5YR	7.5/5	6/5	m	s	6.8		fs	97.0	2.3	0.7

Pedon 27a (fig. 71, table 34) is in the center of the dune crest. The pedon has a thin A horizon and a relatively thin Bt horizon. Particle size analyses (table 34) show the silicate clay bulge to be small but distinct, and enough for an argillic horizon. The exposure shows excellent gradation to C horizon material, and striking coincidence of the clay band horizon with the horizon of clay accumulation as a whole. The coincidence indicates pedogenic origin of clay between the bands as well as in them. Distinct clay bands have not yet been obliterated by the mixing process of soil formation, however (fig. 71). The B2t horizon has the main concentration of bands. Once there may have been a clay band at the top of this horizon, as suggested by occasional spots of darker and redder color that occur at the same depth along the exposure. There are two main clay bands, 2 to 3 mm thick, at 31 and 34 cm depths. They have been obliterated in a few places but are generally continuous. Two clay bands occur about in the center of the B31t horizon and one at the base of the horizon; all are 1 to 2 mm thick and quite continuous. Several thin bands occur in the center of the B32t horizon and a discontinuous one occurs in the C horizon, at a depth of about 98 cm. Augering below the trench bottom showed that the sandy C horizon extends to at least 210 cm depth.

The Bt horizon of Pedon 27a illustrates the minimal end of the Texico series. Although the Bt horizon is distinct (fig. 71, table 34) it is markedly lower in clay content and is much less hard than other Texico Bt horizons.

The C horizon contains almost no clay (table 34), contrasting with other C horizons of Birdwell age, particularly to the south (e.g., see Sites 32-39). The low clay content may be due to the considerable thickness of sandy C horizon material of Hale age in this general area (see stop 5, Gile 1981).

A trench was dug 8 m down the east-facing side of the dune to see if evidence of a younger eolian deposit could be found just east of the crest (see Site 38 for a Birdwell II eolian deposit on the east-facing side of a

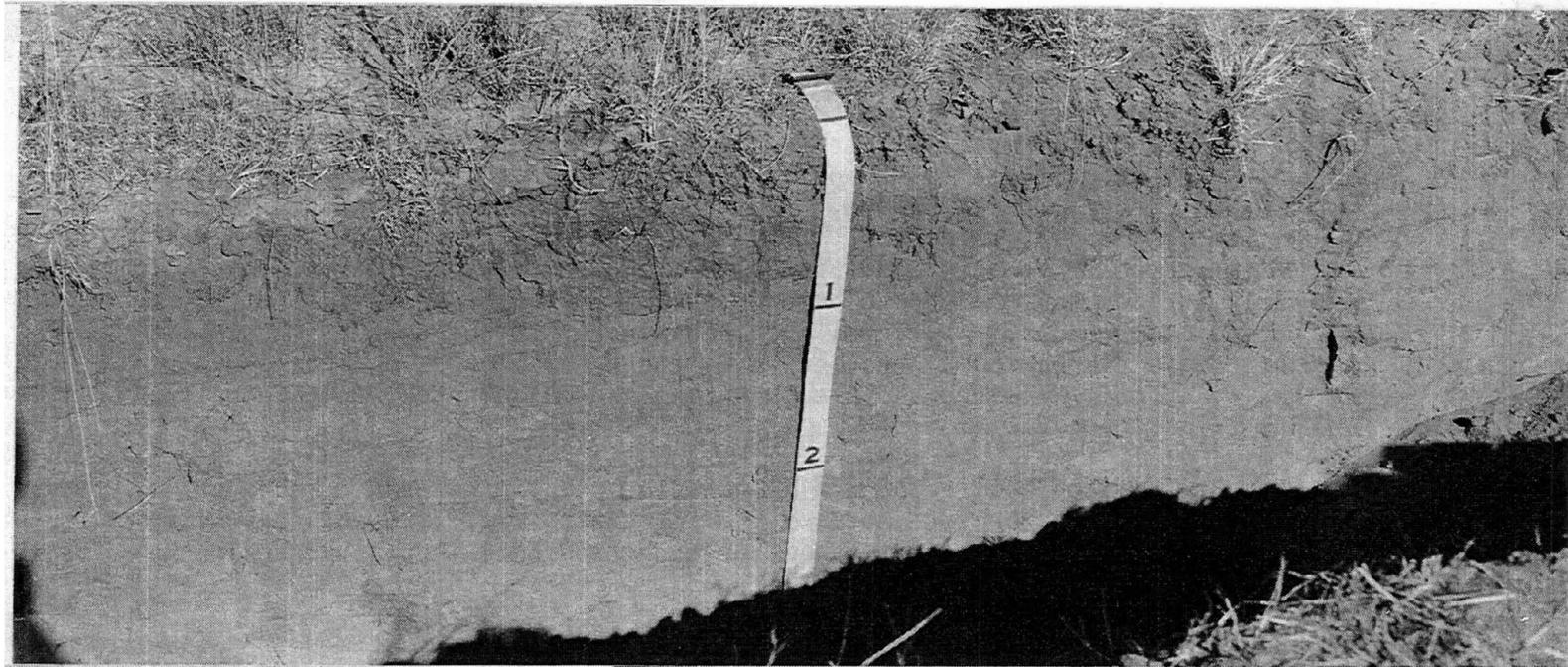
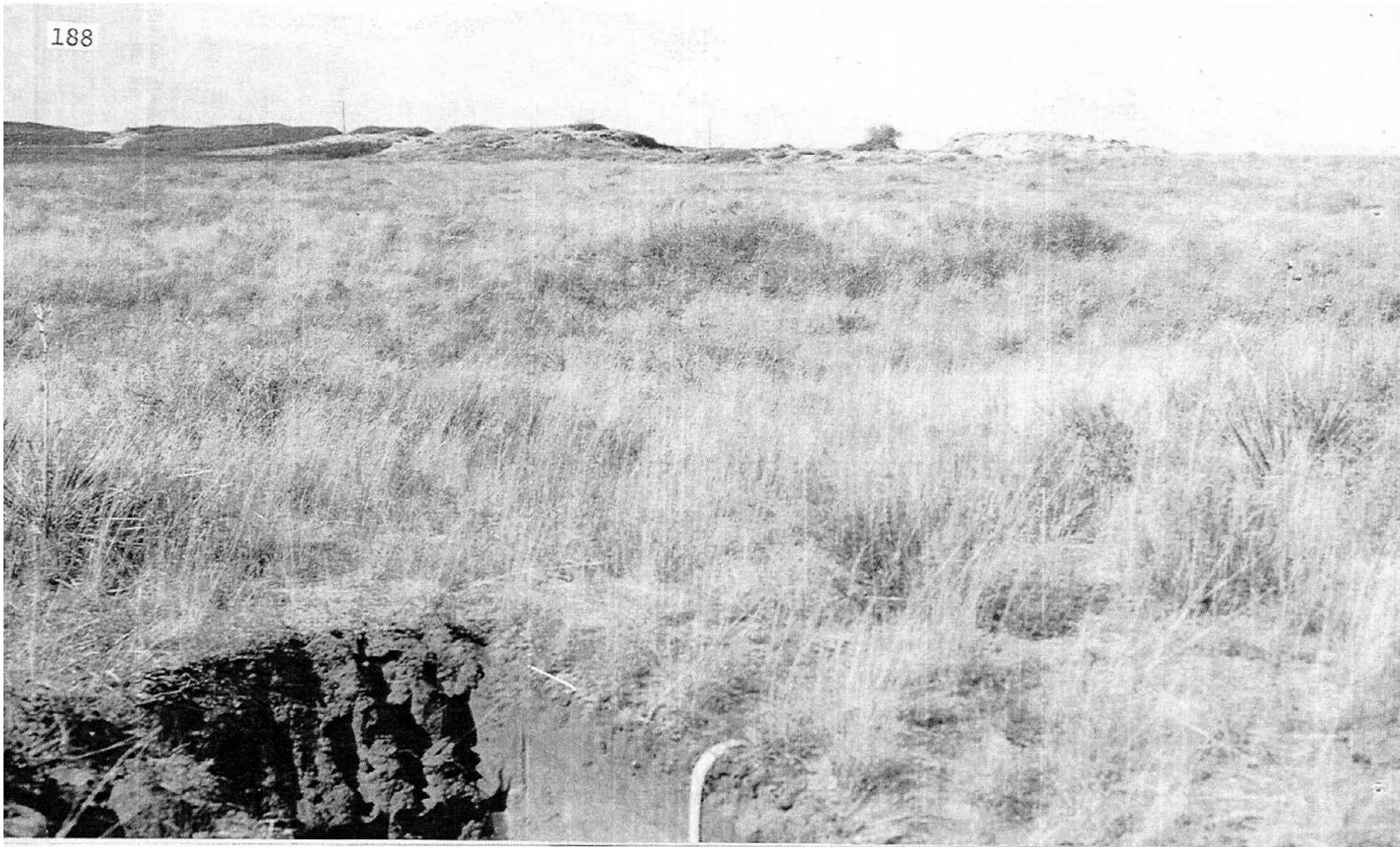


Figure 71. Upper. Landscape view of the Birdwell surface, on dune crest in the foreground. On the skyline at left are oak-covered dunes of the Muleshoe and Longview surfaces; at right is the high dune at Site 1. The view is north. Photographed November 1975.

Lower. The Psammentic Haplustalf, Texico, at Site 27a. The argillic horizon is very near the surface due to erosion. Scale is in feet.

Birdwell dune). The Psammentic Haplustalf in Birdwell sediments was found to extend continuously across the dune crest and down the east-facing dune side. Only a thin deposit with an A horizon was found on the dune side. Depth to the Bt horizon is only 10 cm on the ridge crest (table 34), but on the dune side, depth to the Bt horizon is about 35 cm. The thin deposit with the A horizon buries the A horizon of Birdwell age, and is attributed to eolian sedimentation in Muleshoe and Longview time. Similar thicknesses of eolian sediments were found in post-Birdwell II deposits elsewhere (see Site 38). The sand is eroded from the west-facing side of the dune and from the dune crest, and accumulates on the lee side of the dune. Since no Birdwell II deposit was found east of this dune, the Birdwell sediments of the dune crest are considered to be of Birdwell II age.

Thicknesses of the A and Bt horizons and depth to the C horizon were remarkably similar all along the trench. Auger samples east of the trench showed the Bt horizon to become weaker downslope, and it disappeared altogether 20 m east of the ridge crest. Details of the morphological change could not be determined by auger.

#### Site 27b, side of dune

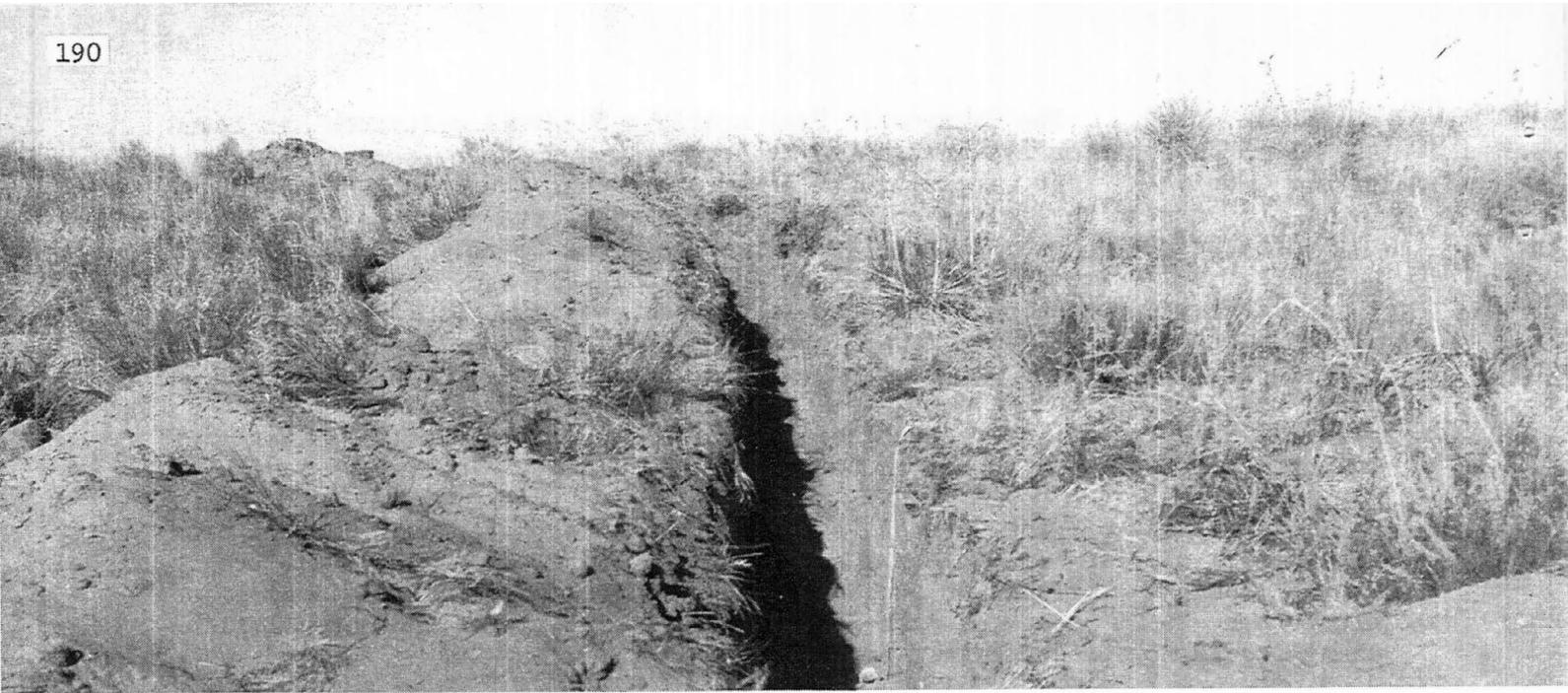
Another trench was dug about 12 m northeast of the first, to study the east aspect in another place. Figure 72 is a photograph and diagram of the study trench. The trench shows the gradation from Psammentic Haplustalfs on the upper side of the dune to Typic Ustipsamments on the lower side of the dune. Table 35 gives soil characteristics.

Pedon 27b-1 is on the upper side of the dune (fig. 72). As on the east aspect at Site 27a, a thin post-Birdwell deposit occurs at the surface. The A horizon material just above the B horizon is lighter-colored than adjacent

Table 35. Characteristics of soils at Site 27b<sup>1/</sup>

Sedi- ment	Horizon	Depth, cm	Hue	Value/chroma		Struc- ture	Dry consis- tence	pH	Lower bound- ary	Tex- tural class	Sand 2.0- 0.05 mm	Silt 0.05- 0.002 mm	Clay < 0.002 mm
				Dry	Moist								
<u>Psammentic Haplustalf, Texico, on upper side of dune; Pedon 27b-1</u>													
M, L	A11	0-12	7.5YR	5/3	3.5/3	m,sg,cr	s	7.0	aw	fs	91.9	2.8	5.3
	A12	12-25	7.5YR	5/4	3/4	m	s	7.2	aw	fs	92.3	3.6	4.1
B	A2b	25-41	7.5YR	6/4	4/4	m	s	7.4	cw	fs	93.7	0.0	7.4
	B21tb	41-59	5YR	5.5/4	4/4	m	sh	7.0	cw	fs	91.7	0.9	7.4
	B22tb	59-76	5YR	6/4	4/4	m	sh	7.2	cw	fs	92.1	0.4	7.5
	Cb	76-93	7.5YR	7/4	5/4	m	s	7.0	fs	fs	96.1	0.0	5.0
<u>Typic Ustipsamment, Tivoli, on lower side of dune; Pedon 27b-2</u>													
M	A1	0-12	7.5YR	5/3	3/3	m,sg,cr	sl	7.4	as	fs			
	B1	12-36	7.5YR	5.5/4	3.5/4	m	s	7.4	cw	fs			
	B21&Bt	36-60	7.5YR	6/4	4/4	m	s	7.2	cw	fs			
	B22	60-78	6YR	6.5/4	5/4	m	s	7.2	cw	fs			
	C	78-109	7.5YR	6.5/4	5/4	m	s	7.4		fs			

<sup>1/</sup> Sediments identified as: M = Muleshoe, L = Longview, B = Birdwell.



NW

SE

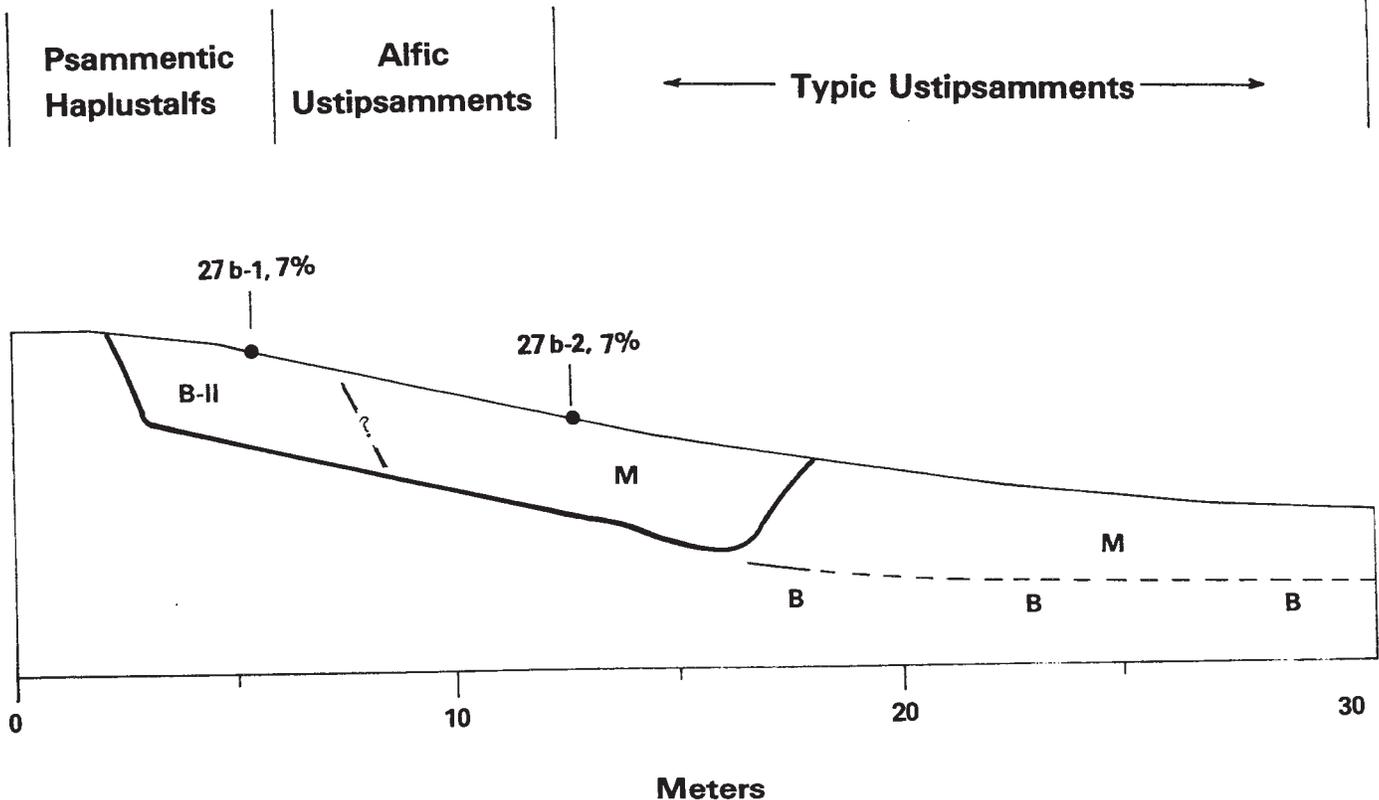


Figure 72. Upper. View of study trench at Site 27b. The Birdwell dune crest is on the skyline, but downslope at the tape the sediments are of Muleshoe age.

Lower. Diagram of study trench at Site 27b, showing stratigraphy, subgroup, slope and location of sampled pedons. M = Muleshoe, B-II = Birdwell II, B = Birdwell. Minor thickness of Muleshoe and Longview sediments at surface in the upper part not shown. No vertical scale (see table 35 for thickness of sediments and horizons). The heavy lower line represents the bottom of the trench.

horizons and is considered to be an A2 horizon, although its present clay content is similar to the Bt horizon beneath (table 35). The Bt horizon is reddish and barely has enough clay increase for an argillic horizon.

Downslope, the post-Birdwell deposit gradually thins and at Pedon 27b-2 cannot be distinguished. Also downslope, clay decreases and the reddish zone that characterizes the Bt horizon gradually disappears; the clay bands persist, however, and Alfic Ustipsamments are present (fig. 72). Still further downslope, the banded zone comes closer to the surface, its top being about 40 cm from the surface where the bands disappear. The bands grade from two continuous, and two discontinuous bands in the west end of the trench to two continuous bands, then one, and finally none on the east end of the trench. The boundary between the Typic and Alfic Ustipsamments occurs where less than two clay bands are present, and is quite sharp at the lower end of the trench, occurring within a distance of about 1/2 m. The zone in which the clay bands occur also becomes less red. The upper two bands -- the most prominent ones -- are 1-2 mm thick and disappear abruptly. The lowermost band extends almost continuously into the Typic Ustipsamment. Pedon 27b-2 illustrates the Typic Ustipsamments.

Although there is gradation from Birdwell sediments in the upper side of the dune to Muleshoe sediments downslope, the exact location of the contact is not apparent because of mixing by soil biota and by percolating soil water. The original Birdwell dune side is thought to have been removed by post-Birdwell slump and erosion associated with the large blowout just to the east. The contact is thought to be located approximately as shown in Figure 72, where the continuous Bt horizon disappears. The smooth slopes that cross the boundary between sediments of different ages is common as discussed previously. This is a major reason why soil occurrence is difficult to predict. Predictions can be made with somewhat more assurance in the high Birdwell dunes to the south (see Sites 33-39).

The surficial sandy horizons in Pedon 27b-2 are thinner than upslope and the soil as a whole is not as red (table 35). There are two discontinuous bands in the B2t&Bt horizon; they are about 5 cm apart and about 1 mm thick.

To determine the character of the boundary between the Alfic and Typic Ustipsamments in another place, a study trench was also examined about 1 m north of Pedon 27b-2. Here also the boundary between the Alfic and Typic Ustipsamments was marked by the disappearance of two continuous clay bands. Thus, this kind of boundary is not an isolated case.

#### Sites 28 and 29, dune crests

Sites 28 and 29 (fig. 40, table 36) illustrate soil development on small dune crests of Birdwell age. Pedons at both sites are similar to Pedon 27a, on the dune crest at Site 27, in several respects. Particle-size data indicate an accumulation of silt, and possibly some clay, from dustfall in the surface horizon. Both pedons have distinct, although slight, accumulations of silicate clay in Bt horizons that are underlain by C horizons (table 36). The Bt material occurs continuously in a Bt horizon, instead of occurring only in bands as is the case in soils of Longview age. Clay bands are still plainly visible in the Bt horizon, however.

In Pedon 28, the B2t horizon has the maximum development of clay bands, approximately 1 cm thick and usually two in number, one at the top and one

Table 36. Characteristics of a Haplustalf and an Ustipsamment on crests of Birdwell dunes, Sites 28 and 29

Horizon	Depth, cm	Hue	Value/chroma		Struc- ture	Dry consis- tence	pH	Lower bound- ary	Tex- tural class	Sand	Silt	Clay
			Dry	Moist						2.0- 0.05 mm	0.05- 0.002 mm	< 0.002 mm
<u>Psammentic Haplustalf, Texico; Pedon 28</u>												
A11	0-12	6YR	5/3	3.5/3	m,sg, lfcr	s	6.8	as	s	88.5	5.5	6.0
A12	12-25	5YR	5/3.5	4/3.5	m	sh	6.8	cw	s	92.1	0.9	7.0
B1t	25-35	5YR	5/4	3.5/4	m	sh	7.0	as	s	90.0	2.5	7.5
B2t	35-47	5YR	5/4	3.5/4	lcpr-m	h	7.0	as	ls	85.7	2.9	11.4
B3t	47-61	5YR	5.5/5	4/5	lcsbk	sh	7.0	cw	lfs	89.0	0.5	10.5
C	61-77	5YR	6/4	5/4	m	s,sh	7.2	as	s	94.6	0.9	4.5
B1b	77-102	5YR	5.5/4	4.5/4	m	sh	7.2		s	93.4	1.0	5.6
<u>Alfic Ustipsamment, Circleback; Pedon 29</u>												
A11	0-7	7.5YR	5/3	3.5/3	m	s	7.0	aw	s	90.3	3.7	6.0
A12	7-17	7.5YR	5.5/3.5	4/3.5	m	s	7.0	cw	fs	95.5	0.0	4.5
B1t	17-30	5YR	5/4	3.5/4	m	s,sh	7.0	as	s	94.3	0.6	5.1
B21t	30-47	5YR	5.5/5	4/5	m	sh	7.0	as	s	93.4	0.0	6.9
B22t	47-64	5YR	6/5	4.5/5	m	sh	7.0	as	s	93.9	0.5	5.6
B3t	64-97	5YR	6/5	4.5/5	m	sh	7.0		fs	93.1	0.5	6.4
C	97-121	5YR	6.5/5	5/5	m	s	7.0		s	94.6	0.0	5.4

at the bottom of the horizon. The B3t horizon has a crotovina, 8 cm in diameter, filled with material like that of the A12 horizon. Pedon 28 has a buried horizon in its lower part (table 36). A thin, discontinuous Alb horizon, slightly darker than the B1b horizon, occurs above the B1b horizon but was not sampled.

Augering below the bottom of the trench showed a loamy fine sand B2t horizon that grades to sandy C horizon material at a depth of about 185 cm. This buried soil is thought to be Birdwell I.

Pedon 29 occurs on the crest of a high dune of Birdwell age. The pedon illustrates the occurrence of Alfic Ustipsamments on a very narrow ridge crest of Birdwell age. In this situation the clay increase required for the argillic horizon is not met (table 36). The low clay at this site, as compared to Site 28, may be related to its landscape position, on the very crest of this high dune. Less clay would be expected to move into such soils because runoff should be greater (and infiltration less) on narrow ridges as compared to broader, stabler sites such as Site 28. The B2t horizon has the most prominent clay bands, which are about 1/2 cm thick and quite continuous across the exposure.

#### Site 30, southernmost major deposit of Longview age

Site 30 (fig. 40, table 37) occurs on the crest of a dune with Longview deposits. This dune is the southernmost major deposit of Longview age in the study area (see fig. 19). Occasional thin deposits have been observed on the lee side of Birdwell ridges and will be discussed later.

Table 37. Characteristics of the Alfic Ustipsamment, Circleback, on the crest of a Longview dune at Site 30 <sup>1/</sup>

Horizon	Depth, cm	Hue	Value/chroma		Texture	Structure	Dry consistency	pH	Lower boundary
			Dry	Moist					
A1	0-21	7.5YR	5.5/4	3.5/4	fs	m	s	7.0	cw
B11	21-42	7.5YR	6/4	4/4	fs	m	s	7.0	cw
B12	42-63	7.5YR	6.5/4	5/4	fs	m	sh	7.0	aw
B21&Bt	63-91	5YR	6.5/4	5/4	fs	m	sh	7.0	aw
B22&Bt	91-123	5YR	6.5/4	5/4	fs	m	sh	6.8	cw
B3&Bt	123-160	7.5YR	6/4	4.5/4	fs	m	sh	6.8	aw
C&Bt	160-206	4YR	5/5	4/5	fs	m	sh	6.6	aw
Btb	206-218	2.5YR	5/5	4/5	fs	m	sh	6.6	

<sup>1/</sup> Subordinate colors and other characteristics follow. B21&Bt: clay bands range up to 5 mm thick, and are 2.5YR 4/5, dry. C&Bt: parts are lighter and less red. Longview sediments occur from 0-206 cm; Birdwell sediments from 206-218 cm.

The two most prominent clay bands are continuous, are in the B21&Bt horizon and range from 1/2 to 1 cm thick. Bands beneath are generally 1-3 mm diameter; there are eight to ten of these, some discontinuous, to the top of the C&Bt horizon.

The soil at Site 30 is thicker than many soils of Longview age. Sedimentation could encompass all of the Longview I and II time. Thickness of the banded zone; apparent pedogenic clay in the C horizon; and a fairly thick zone (tens of centimeters) without bands in the B3&Bt horizon all suggest the possibility of a halt during deposition of Longview sediments -- possibly at about 1 m depth -- followed by a time of stability and soil formation. Then sedimentation could have continued to the top of the present land surface, followed by stability and subsequent development of the most prominent zone of clay bands.

Some stratification is visible in the B3&Bt horizon. The C&Bt horizon is clearly stratified, has some clay bands that could be pedogenic, and has occasional lenses of whitish grains. The buried Bt horizon becomes less red and less clayey with depth and C-like material was found with the auger at 250 cm depth. This continues to at least 325 cm depth where color of the C horizon is 5YR 5.5/4, dry and texture is fine sand.

#### Site 31, blowout and dune

Site 31 (figs. 40, 73, 74) consist of a study trench in a blowout and in the crest of a blowout dune to the east. Figure 73 shows slope, stratigraphy, soil occurrence and location of the sampled pedons. Table 38 gives soil characteristics.

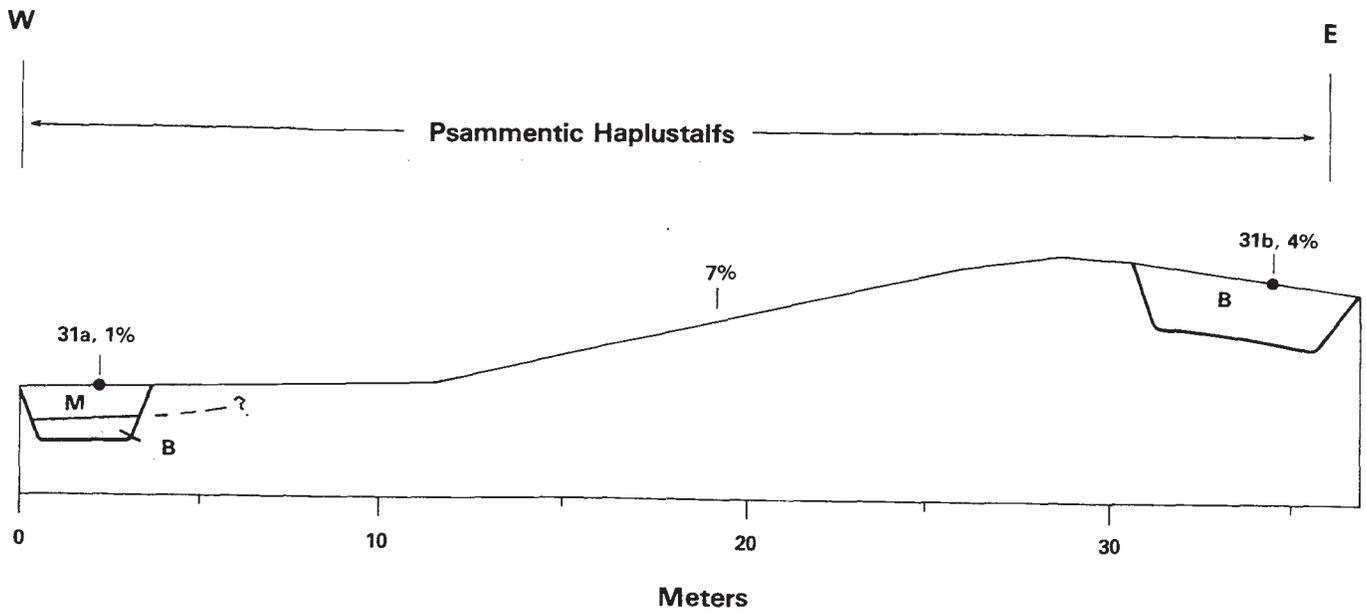


Figure 73. Upper. Landscape view of the blowout and dune at Site 31. Site 31a is in the blowout, foreground, and Site 31b is in the dune in the middle ground. The high dune at Site 32, to be discussed next, is on the skyline at center. The view is east. Photographed March 1976.

Lower. Diagram of study trenches at Site 31, showing stratigraphy, subgroup, slope and location of sampled pedons. M = Muleshoe, B = Birdwell. No vertical scale (see table 38 for thickness of sediments and horizons). The heavy line represents the bottom of the trenches.

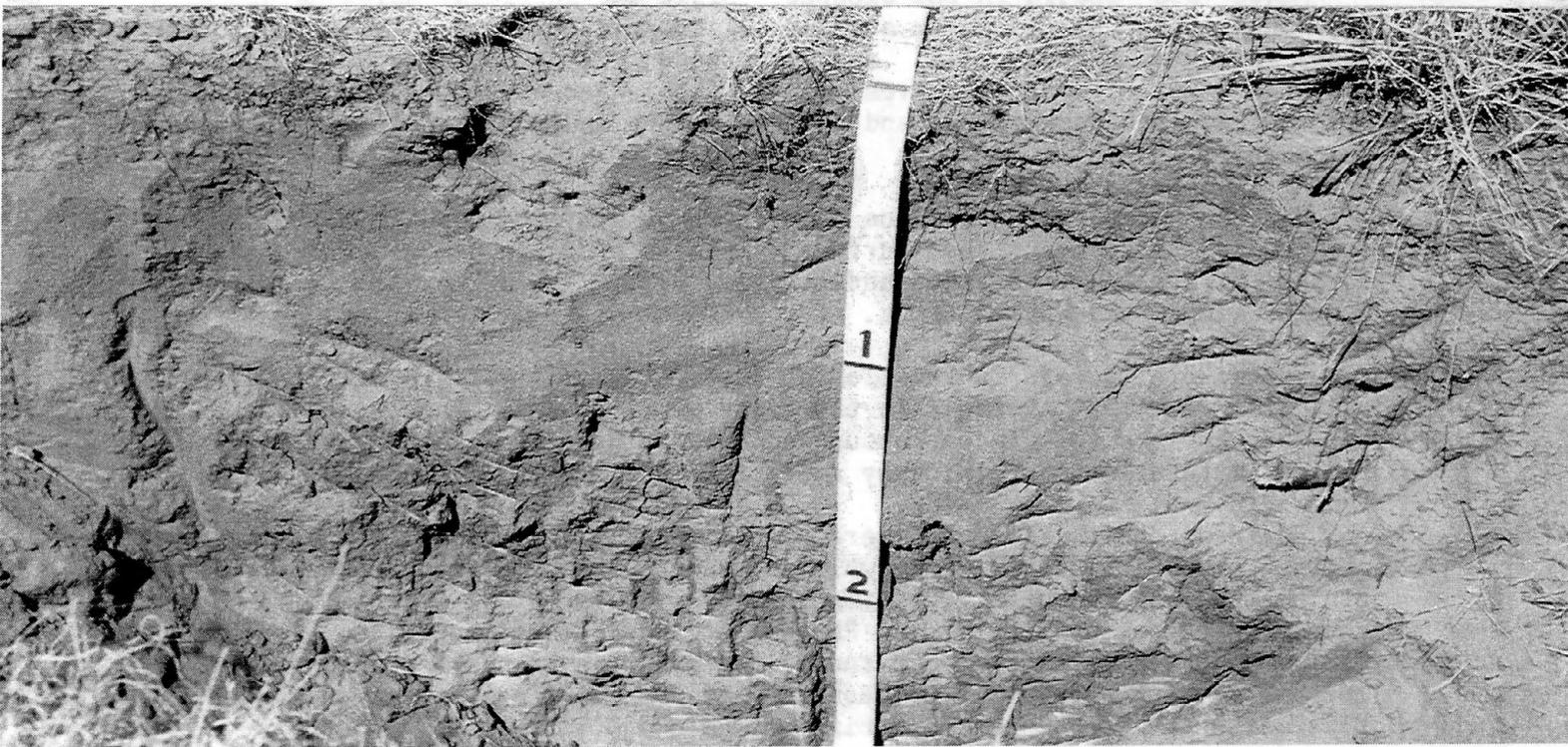


Figure 74. Upper. The Psammentic Haplustalf, Texico, at Site 31a, on the dune crest. The boundary to Roosevelt sediments is just below the 5 ft (1.5 m) level. Scale is in feet. Photographed March, 1976.

Lower. The Psammentic Haplustalf, Texico, at Site 31b, in the blowout. Muleshoe sediments extend to below the 1 ft (0.3 m) mark, and are underlain by Birdwell sediments. Scale is in feet.

Table 38. Characteristics of Psammentic Haplustalfs, Texico, at Site 31

Sedi- ment <sup>1/</sup>	Horizon	Depth, cm	Hue	Value/chroma		Struc- ture	Dry consis- tence	pH	Lower bound- ary	Tex- tural class	Sand	Silt	Clay
				Dry	Moist						2.0- 0.05 mm	0.05- 0.002 mm	< 0.002 mm
<u>In blowout; Pedon 31a</u>													
M	A11	0-3	7.5YR	5/3	3.5/3	lmp1	sh	7.4	as	lfs			
	A12	3-15	7.5YR	5/3	3.5/3	m	s	7.4	as	fs			
	B2	15-34	7.5YR	5/3	3.5/3	m	sh	7.2	as	fs			
B	B1tb	34-52	6YR	5/3	3.5/3	m	h,sh	7.2	as	lfs			
	B2tb	52-72	2.5YR	4.5/6	4/6	lcpr- lcsbk	vh	7.2	as	fs1			
	B3b	72-83	2.5YR	5/6	4/6	lcpr	h,vh	7.0		lfs			
<u>Near crest of blowout dune; Pedon 31b</u>													
B	A1	0-8	6YR	5/3.5	4/3.5	m,sg lfc	s	7.0	as	s	91.1	3.8	5.1
	B1t	8-23	5YR	5/4	4/4	m	a	7.0	as	fs	91.5	2.6	5.9
	B2t	23-42	4YR	5/6	4/4	m	sh,h	7.0	as	fs	85.8	3.4	10.8
	B31t	42-65	4YR	5/4	4/4	m	sh	7.0	as	fs	87.9	3.2	8.9
	B32t	65-94	5YR	5.5/4	4/4	m	sh	7.0	as	s	93.6	0.8	5.6
	C	94-106	7YR	6.5/4	5/4	m	s,sh	7.0		s	97.0	0.1	1.9

<sup>1/</sup> M = Muleshoe, B = Birdwell

Pedon 31a occurs in the blowout. Since the surficial Muleshoe deposits are less than 50 cm thick and lack diagnostic horizons, classification is based on the buried soil, and the pedon is a Psammentic Haplustalf. Although the blowout receives run-in from adjacent slopes, upper horizons are not quite dark enough and organic carbon would be too low for a mollic epipedon.

Up the side of the dune towards Pedon 31b, the reddish Bt horizon of Texico is very near the surface. This is probably due to strong erosion during Birdwell II, Muleshoe and Longview time. The Bt horizon is deeper on gentler slopes near the blowout.

Pedon 31b occurs in the blowout dune. The soil has a distinct bulge in silicate clay that averages in the sandy particle-size class. Clay bands in the Bt horizon are discontinuous and only faintly visible because of large-scale obliteration and mixing by soil biota and by percolating soil water.

Horizons below 106 cm were not sampled. At 160 cm depth there is an abrupt smooth boundary from whitish sand in the C horizon to the prominent Bt horizon in Roosevelt sediments (see stops 5 and 6 in Gile, 1981 for characteristics of soils in Roosevelt and Hale sediments along Farm Road 1731, just west). The Bt horizon in Roosevelt sediments becomes coarser and less red with depth. At about 230 cm the color again becomes redder and this marks the top of the Bt horizon of Hale age.