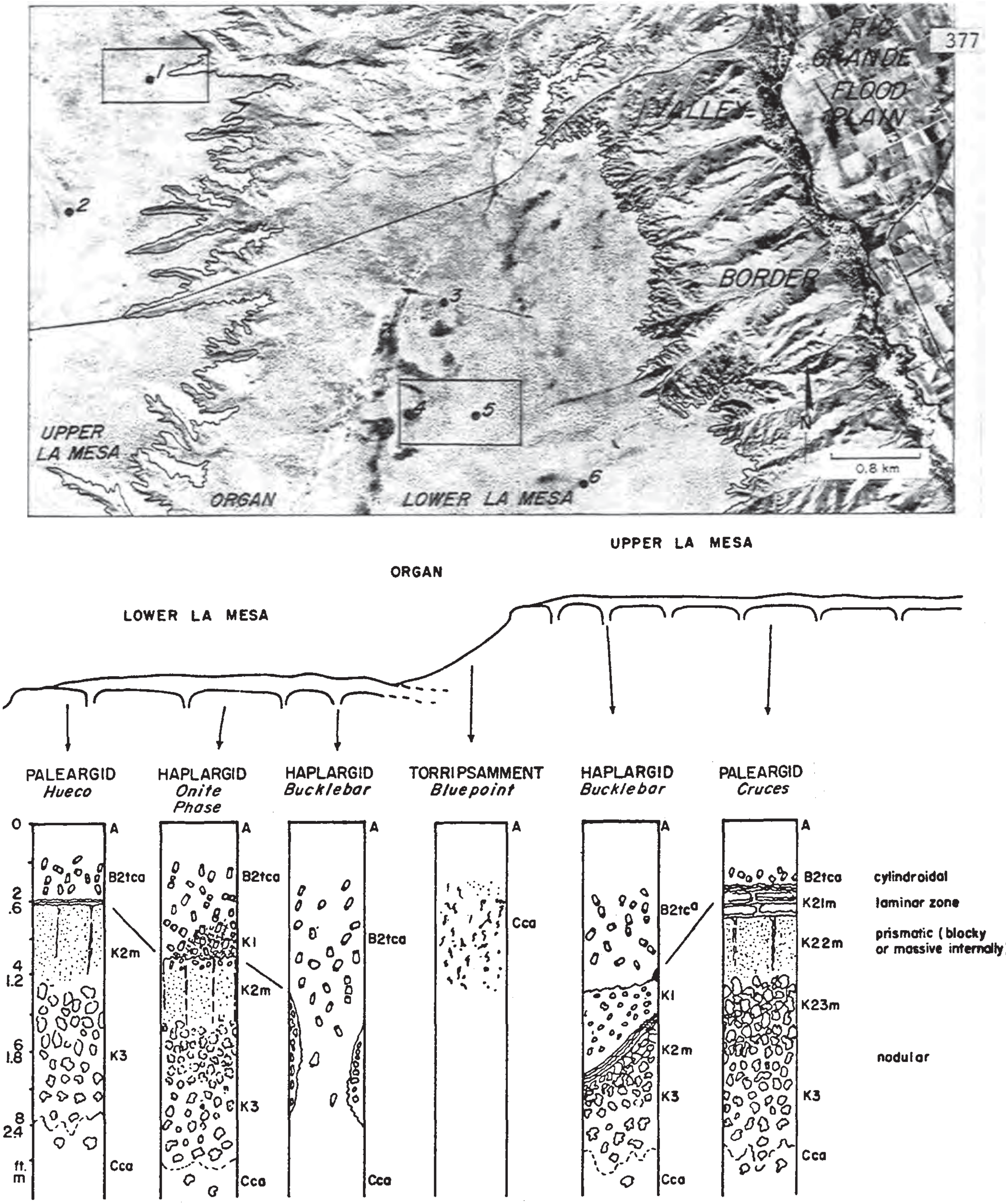


Figure 100. Upper. Location of sampled pedons and soil maps on lower and upper La Mesa. 1 = 61-7 and 68-8; 2 = 66-12; 3 = 72-2 and 72-3; 4 = 68-2; 5 = 61-8; 6 = 72-1.

Lower. Morphological features of some of the soils of lower La Mesa, Organ, and upper La Mesa surfaces. Note the thickness and morphological variety of soils of mid-Pleistocene age (upper and lower La Mesa) as compared to soils of Holocene age (Organ).

in figure 100 ranges from about 4400 to 4450 ft. The two levels are separated physiographically by a prominent scarp, which approximately coincides with a southward extension of the Robledo Fault (Ruhe, 1962, 1967; Hawley and Kottlowski, 1969). However, the surficial sediments (the materials in which the soils have formed) of the two levels may be of different ages; the fault may have occurred before the surficial sediments of lower La Mesa were deposited. Upper La Mesa is part of Lee's "high terrace" (Lee, 1907) and Dunham's "first erosion surface" (Dunham, 1935). La Mesa surface may have member surfaces of at least two ages (Hawley, 1965). This possible age difference could be an important factor in pedogenic history and soil morphology on upper and lower La Mesa.

Figure 101. View of upper La Mesa from lower La Mesa. Note barren areas between coppice dunes.

149. ONITE - PINTURA COMPLEX (15P)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ONITE, DEEP PETROCALCIC PHASE	TYPIC HAPLARGIDS	COARSE-LOAMY	45
PINTURA	TYPIC TORRIPSAMMENTS		20
Bucklebar	Typic Haplargids	Fine-loamy	10
Pintura, thin variant	Typic Torrifluvents	Coarse-loamy	10
Sonoita	Typic Haplargids	Coarse-loamy	5
Other inclusions (Paleargids, Paleorthids)			10

LOCATION, LANDSCAPE, VEGETATION

There is one large delineation of this mapping unit; it is located on lower La Mesa, west of the Rio Grande Valley and south of Picacho Mountain. Most soils have formed in mid-Pleistocene river alluvium; others are in the youthful deposits of coppice dunes. Elevation is about 4200 feet.

Lower La Mesa is nearly level and is undissected except along a scarp at the northern and eastern borders. There are scattered small (commonly a few tens of m in diameter), roughly circular to slightly elongate depressions. The depressions are shallow -- generally not more than several m lower than adjacent areas -- and the bordering slopes are very gentle. Coppice dunes dominate the microrelief in most areas between the depressions.

Dunes usually have a dense cover of vegetation, mainly mesquite; a few four-wing saltbush also occur on some dunes. Interdune areas are generally barren or have a few scattered snakeweed. Creosotebush is common near the scarp. The depressions have quite a dense cover of mesquite, probably a reflection of more favorable moisture caused by runoff from adjacent areas. The dense mesquite causes the darker color of the depressions as shown in aerial photographs. There is no grass except for a very few clumps around the mesquite in some of the depressions.

TYPICAL PEDONS, PROPERTIES AND RANGES

The A horizon has been truncated between many dunes and the B horizon is at the surface. In places the upper few cm between dunes is younger than the thick, old horizons beneath (see "Other studies").

Onite, deep petrocalcic phase

These soils are of mid-Pleistocene age and have a thick late stage III carbonate horizon, thus differ from most Onite soils of the study area, which are of Holocene age and have stage I carbonate horizons.

A typical pedon of Onite, deep petrocalcic phase is described in the Appendix (pedon 61-8). Figure 102 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

Table 120. Typical (underlined) and range in selected properties for major horizons of Onite, deep petrocalcic phase.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-13	ls,s sl	0-15	5YR-7.5YR	5-7	3-5 4	2-4
B2t	23-56	sl scl	0-15	5YR-7.5YR 6YR	5-7 6	4-6	4-6
K2m	117-203	--	--	7.5YR-10YR	6-9 8	5-8 7	2-4
Clca	267-287	s,sl ls	0-75	7.5YR-10YR	6,7	4,5 4,5	2-4
Control section		< 18% clay	0-15				

Other. Depth to the deep petrocalcic horizon ranges from 1 to 1 1/2 m. Above the K2m horizon there is prominent interpenetration of reddish brown Bt material and light-colored carbonate nodules. In many places, this zone of interpenetration rests directly on the K2m horizon. Intermittently, however, this zone overlies a K1 horizon that rests in turn on the K2m horizon.

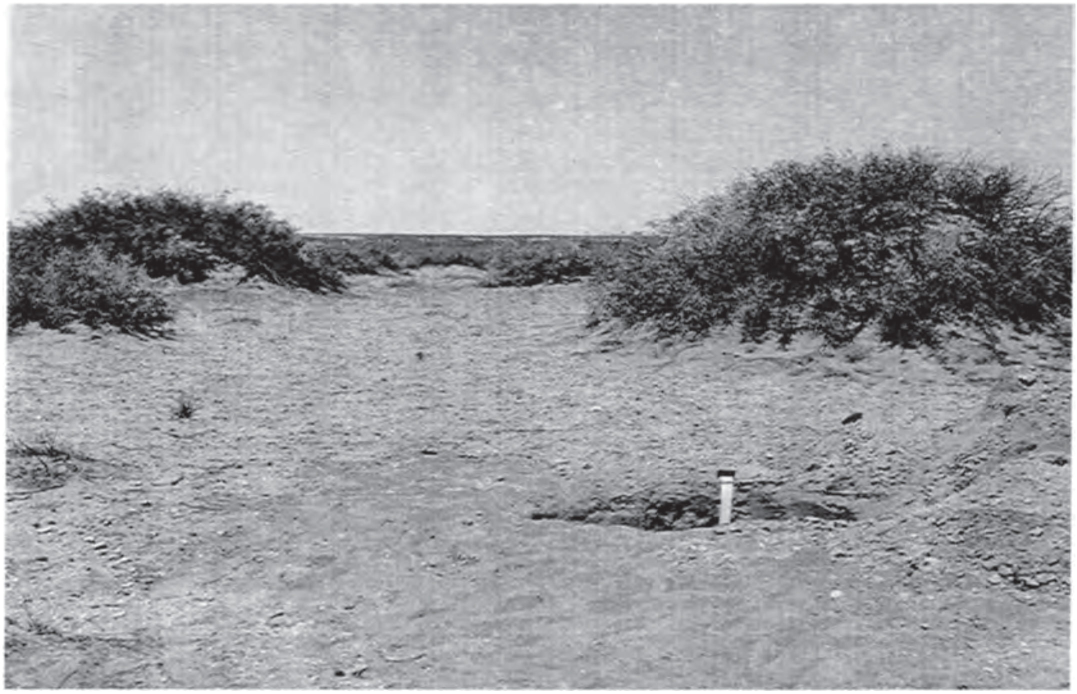
Pintura

A typical pedon of Pintura is described below. The location is the SE 1/4 SW 1/4 Sec. 31, T23S, R1E, 0.2 mile west of road. Elevation is 4200 feet. Figure 103 is a photograph of the pedon and its landscape.

C1 0-61 cm. Reddish brown (5YR 5/4, dry) or reddish brown (5YR 4/4, moist) loamy fine sand; weak thin platy structure, with some parts massive; soft; common fine roots; evident strata, about 1 mm to several cm thick, partially disrupted by fine roots and insect burrows; generally noncalcareous, with very few thin strata that are slightly calcareous in spots; clear wavy boundary.

C2 61-130 cm. Reddish brown (5YR 5/4, dry) or reddish brown (5YR 4/4, moist) loamy fine sand; weak thin platy structure, with some parts massive; soft, few coarse roots; stratification as above; scattered rodent burrows, about 5 to 20 cm in diameter, some of which are filled or nearly filled with loose sand; generally noncalcareous, a few spots effervesce weakly; abrupt smooth boundary.

Bb 130-163 cm. Reddish brown (5YR 5/4, dry) or reddish brown (5YR 4/4,



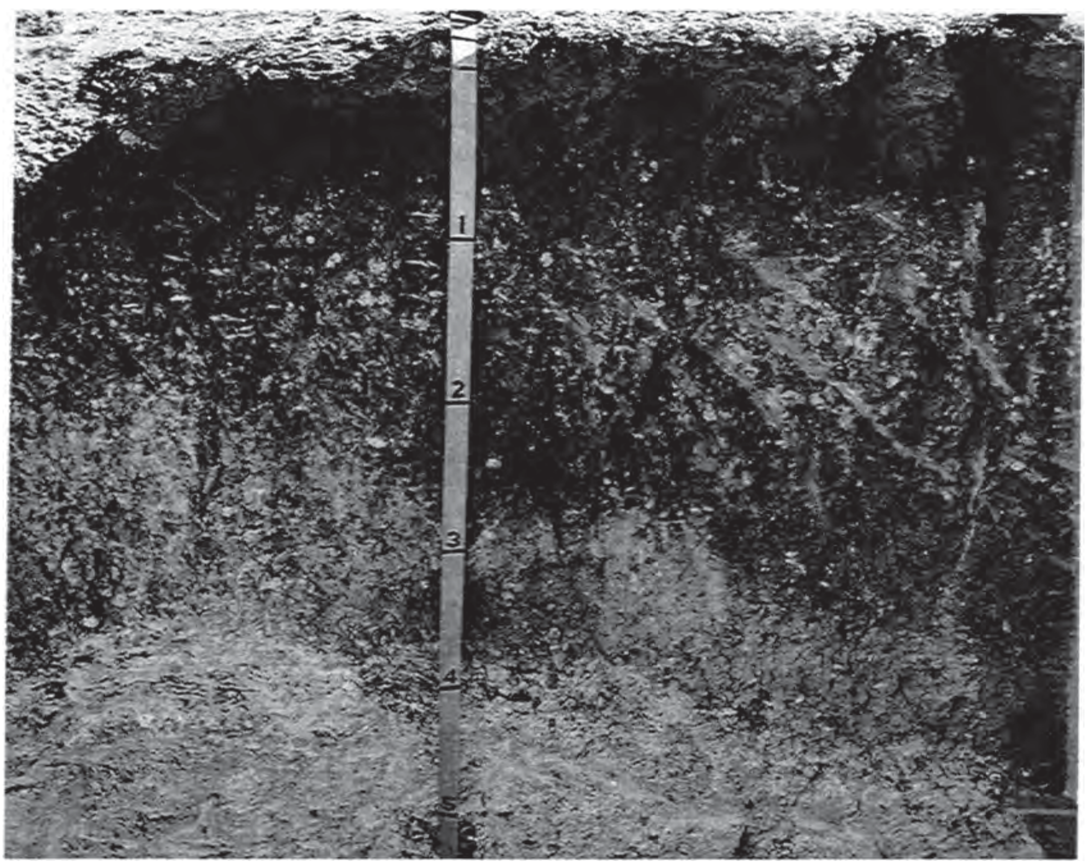


Figure 102. Upper. Landscape of the Typic Haplargid, Onite phase 61-8, on lower La Mesa surface. Mesquite is dominant on the coppice dunes; there are a few four-wing saltbush. Interdune areas are barren. The area is nearly level. Lower. Onite, deep petrocalcic phase 61-8. Scale is in feet.

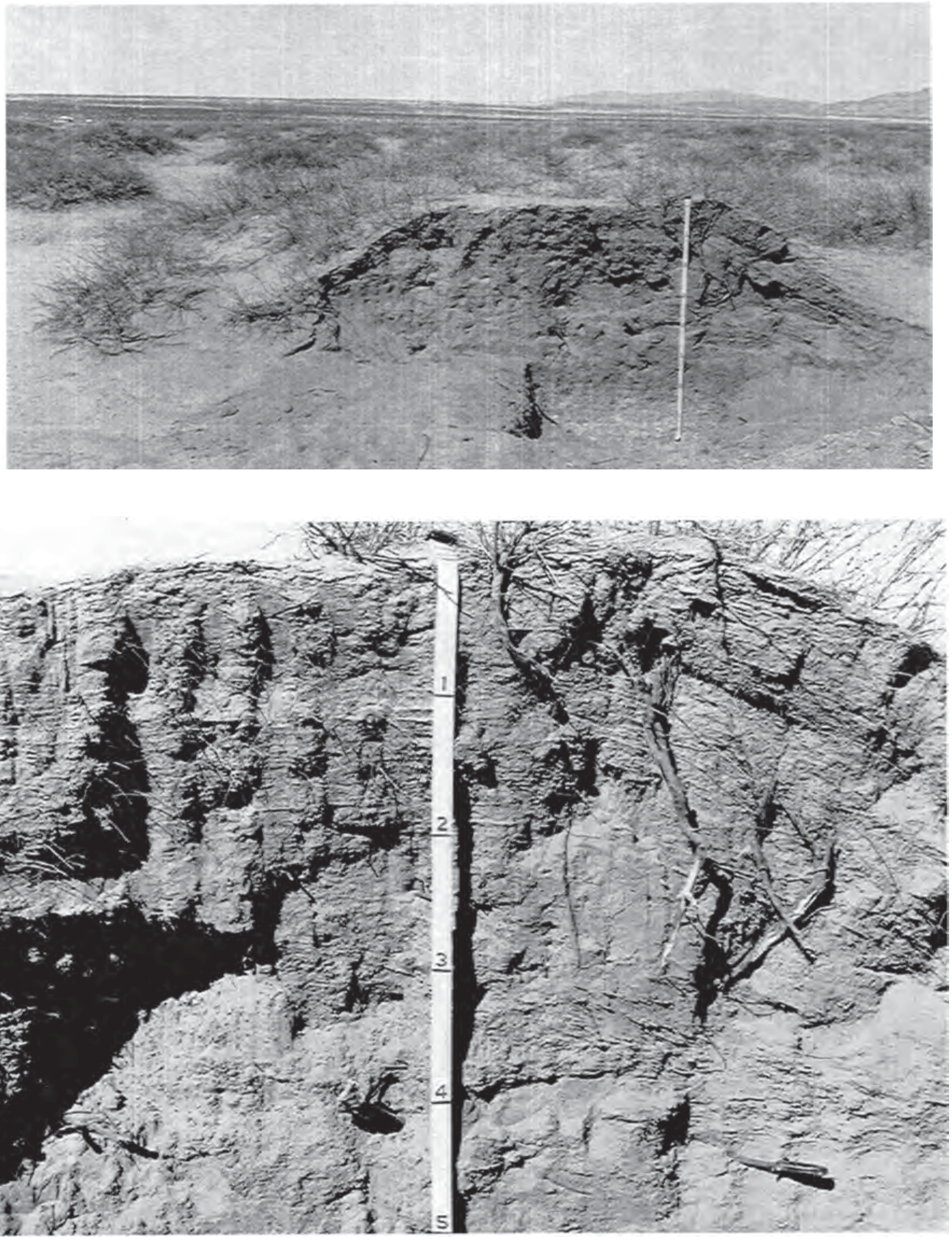


Figure 103. Upper. Landscape, Pintura-Onite complex, and cross section of dune. Vegetation on dunes is mesquite; the photograph was taken in the winter when the leaves were off. Areas between dunes are essentially barren of vegetation. The C horizon material of the foreground dune is nearly 5 ft thick. Dominant wind movement is from the southwest, left to right.

Lower. Closeup of C horizon material in foreground dune. Wind-blasted face shows distinct layering, especially in the upper part. Each layer marks a former crusted surface of the dune, which has built upward mainly during spring dust storms. Roots and burrow fillings indicate mixing. Scale is in feet.

moist) loamy fine sand; massive; slightly hard; few roots; noncalcareous; clear, wavy boundary.

Bcab2 163-183 cm. Reddish brown (5YR 5/4, dry) or reddish brown (5YR 4/4, moist) light sandy loam; massive; slightly hard; few roots; few carbonate filaments; effervesces strongly.

Table 121. Typical (underlined) and range in selected properties for major horizons of Pintura

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
C	0-61	lfs fs	0	5YR- 7.5YR	5,6	4,5	4-6
Control section		lfs, fs	0				

Other. Most dunes range from 1 to 2 m in height and 2 to 10 m in width: many are elliptical in shape. The surfaces of most dunes are calcareous but material within is largely noncalcareous. There is no evidence of horizon development in the dune materials. Many sandy layers, some as thin as 1 mm, appear little disturbed except for the activity of roots and soil fauna.

SOIL OCCURRENCE

The occurrence of soils in this unit is determined by dunes, depressions, pipes, distance from scarps, and occasional slight ridges. Soils of this unit illustrate initial development of the stage IV carbonate horizon in low-gravel materials.

Haplargids. ONITE, DEEP PETROCALCIC PHASE is the dominant soil between dunes. The fine-loamy Bucklebar soils occur in depressions and in a few pipes. The coarse-loamy Sonoita soils occur in most of the pipes. Location of pipes cannot be predicted from surface observation, since the surface blends smoothly into that of soils adjacent to the pipes.

Torripsamments. PINTURA soils are in coppice dunes. These soils have sandy particle size to a depth of at least one m. They overlie Onite, deep petrocalcic phase and other older soils of the mapping unit.

Torrifluvents. Some dunes are 50 to 100 cm thick and overlie buried horizons that contain more organic carbon. This results in an irregular decrease in organic carbon with depth. These Torrifluvents are designated Pintura, thin variant.

Paleargids. The coarse-loamy, moderately deep Hueco soils and the loamy, shallow Cruces soils occur near scarps and on several slight ridges in the southern part of the area. Depth to the petrocalcic horizon is less than 50 cm in the Cruces soils and 50 to 100 cm in the Hueco soils.

Paleorthids. The shallow, loamy Simona soils occur primarily around the periphery of the La Mesa remnant where the argillic horizon has been obliterated by soil truncation, carbonate engulfment and/or biotic activity.

SOIL BOUNDARIES

Table 122 gives information about boundaries to major adjacent units. Some of the boundaries are illustrated in figure 104.

Table 122. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Tencee complex, eroded (10C)	The boundary has been caused by landscape dissection. The A and B horizons of the 15P soils have been truncated in unit 10C and the petrocalcic horizon (commonly with its once-continuous upper horizons now broken and quite loose) is at or near the surface. Topographically the boundary is approximately parallel to the scarp between the edge of La Mesa and the slopes of the Rio Grande Valley below.
Adelino clay loam (13P)	The boundary has been caused by a younger geomorphic surface and associated alluvium in unit 13P. The area is small and has no formal designation, but may be earliest Holocene. The 15P soils, analogues of which are buried in unit 13P, emerge at the surface on the 15P side of the boundary. Topographically the boundary is marked by the margin of a slight, elongate depression in which unit 13P occurs.
Bluepoint complex (13X)	Landscape dissection has caused the boundary. Dissection has exhumed gravel formerly beneath soils of unit 15P. The topographic boundary is distinct, occurring along the scarp between the nearly level basin floor (unit 15P) and steep ridges (unit 13X). Vegetation is much less dense on the steep ridges of unit 13X.
Bluepoint sand (13Y)	The boundary has been caused by a younger geomorphic surface (Organ) in unit 13Y. The 15P soils, analogues of which are buried in unit 13Y, emerge at the surface on the 15P side of the boundary. Topographically the boundary is marked by an increase in slope from level or nearly level 15P to slopes of 2 to 3 percent (13Y).

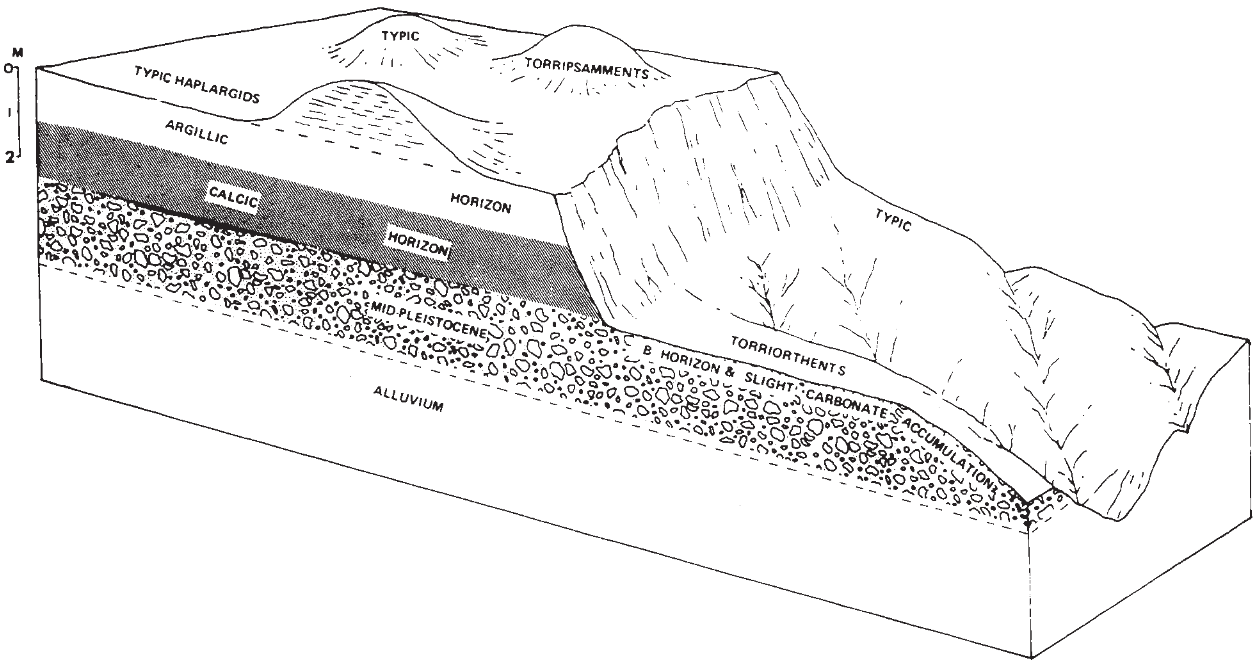


Figure 104. Character of the soil boundary between Onite-Pintura complex and Bluepoint complex. Typic Haplargids dominate the basin floor and are overlain in places by the much younger Torripsamments of coppice dunes. Landscape dissection along the scarp has exhumed horizons above the gravel, forming a structural bench in which the Torriorthents occur. Bluepoint soils occur on sides of the ridges and on ridge crests downslope from the area shown.

OTHER STUDIES

The studies will be considered in three groups: sodium and salt accumulation; polygenesis in soils of mid-Pleistocene age; and coppice dunes. Figure 100 locates the detailed map and sampled pedons.

Sodium and salt accumulation in Haplargids of a relict basin floor.

Five pedons of this mapping unit were analyzed (figs. 100, 105; table 123). Onite phase 61-8, 72-1 and 72-2 occur in nearly level areas between dunes; Bucklebar 68-2 is in a depression (figs. 105, 106); and Sonoita 72-3 occurs in a large pipe adjacent to Onite phase 72-2.

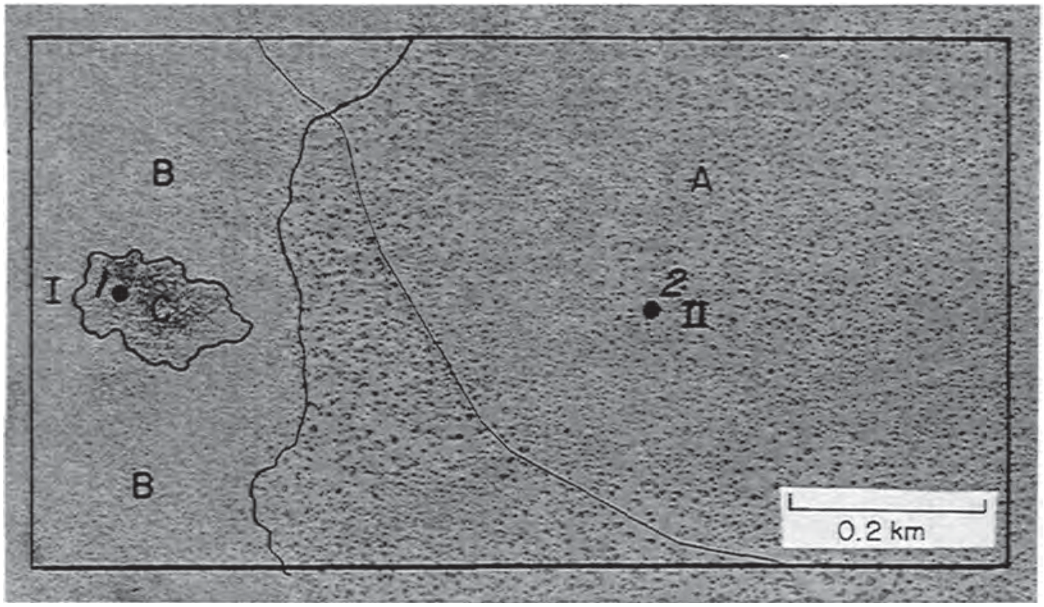
Upper horizons of pedons 72-1, 72-2 and 72-3 were sampled to assess the chemical character of these ancient soils with respect to the possibility of atmospheric additions of sodium in addition to carbonate. Since sodium is also in the precipitation, sodium should be found in at least some of the soils.

Laboratory data (table 123) suggest the entrapment of sodium and soluble salts, as well as carbonate in the precipitation, in the latter part of the history of these ancient soils. Several features may be responsible for the accumulations. The area is level and prior to the recent development of coppice dunes, surface horizons apparently had coarse textures. These features should provide optimum conditions for infiltration of precipitation and the ions in it. Plugged or near-plugged horizons, after their development, should serve as a sort of "trap" for the retention of ions in the soil solution and should prevent them from moving to greater depths. Also, depth to the plugged horizon is commonly substantial (nearly 1 m or somewhat more than 1 m) so that the zone is thick enough to permit the accumulation (shallow depth to petrocalcic horizons could result in lateral movement of the sodium and soluble salts into and through pipes).

The chemical data (table 123) show a distinct increase with depth in exchangeable sodium in all pedons, but with a greater depth to appreciable sodium for the two pedons occurring in situations indicating deeper penetration of moisture (Bucklebar 68-2 in a depression; Sonoita 72-3 in a pipe). The K horizons of all pedons have an ESP above 15 percent. The major portion of the B2t horizons have an ESP below 15 percent. Onite 61-8, Onite 72-1, and Onite 72-2 meet the chemical criteria for a natric horizon but not the morphological requirements.

Polygenesis in soils of mid-Pleistocene age.

The soils of La Mesa are much older than other soils of the valley-border stepped sequence and their polygenetic character is more complicated. The argillic horizon is thick, reddish brown in part and contains common carbonate nodules and cylindroids. In places the argillic horizon rests abruptly on the partially indurated K2 horizon and in others it rests on a weaker carbonate horizon that rests in turn on the partially indurated one. At its upper margin the K2 horizon contains scattered volumes of weakly calcareous or noncalcareous, reddish brown Bt material. This suggests incomplete engulfment of



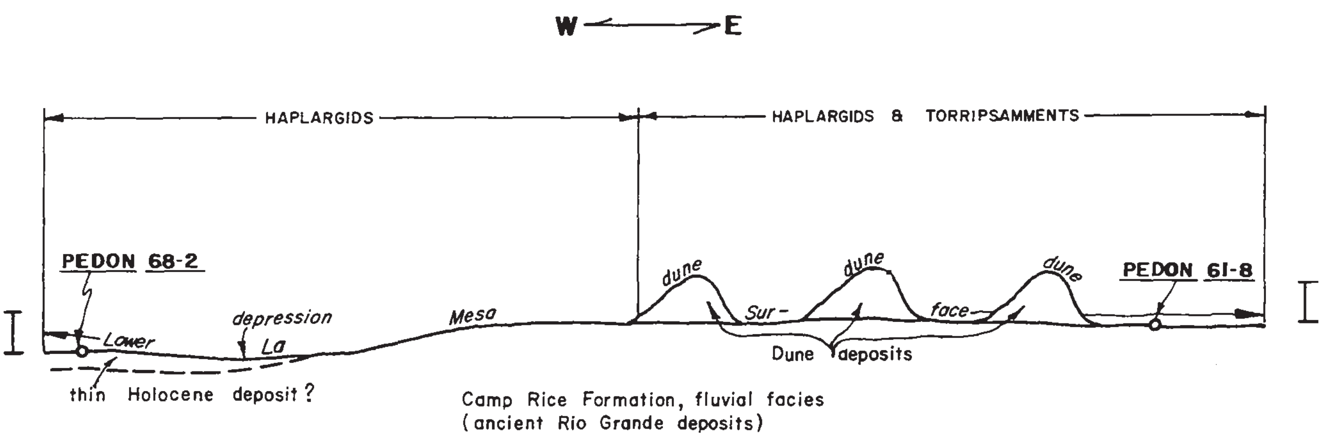


Figure 105. Upper. Map of soils in the vicinity of pedons 68-2 and 61-8, lower La Mesa. A = Onite-Pintura complex (lower La Mesa surface and dunes). B = Onite, deep petrocalcic phase (lower La Mesa). C = Bucklebar, overflow phase (depression in lower La Mesa). 1 = Bucklebar 68-2; 2 = Onite phase 61-8. I to II locates cross section.

Lower. Cross section from points I to II on the soil map.

Table 123. Laboratory data for Typic Haplargids on lower La Mesa surface.

Horizon	Depth	Sand 1/	Silt 1/	Clay 1/	Organic carbon	Car- bonate	Exchange- able sodium Percentage (ESP)	Elec- trical conduc- tivity	2/
	cm	pct	pct	pct	pct	pct	pct	mmhos/cm	
Onite phase 61-8									
A	0-5	87	5	8	0.2	2		0.4	
A3	5-13	87	5	8	0.2	3		0.4	
B1t	13-23	85	5	10	0.2	4		0.5	
B21tca	23-41	80	5	15	0.2	12		0.7	
B22tca	41-56	82	4	14	0.2	12	13	2	1.1
B22tca	56-71	82	4	14	0.09	10		6	
K11	71-99	84	4	12	0.08	11		7	
K12	99-117	85	5	10		15	15	9	0.7
2K21m	117-145	80	7	13		40		9	
2K22m	145-170	80	7	13		51	29	8	0.3
2K23m	170-203	72	7	22		44			
2K31	203-236	74	9	17		41			
2K32	236-267	73	10	17		31			
3C1ca	267-287	78	8	15		19			
3C2ca	287-318	84	6	10		11			
3C3	318-340	96	1	2		2			
Organic carbon: 2.2 kg/m² to 99 cm									
Onite phase 72-1									
A	0-5	83	7	10	0.05	3	3	0.5	2.6
B21t	5-26	81	7	12	0.1	4	3	0.5	2.1
K & Bt	26-40	74	7	19	0.2	17	7	0.6	1.3
K11	40-61	77	6	17	0.08	13	17	0.8	0.7
K12	61-86	81	5	15	0.04	9	17	3	0.3
K13	86-111	82	4	14	0.14	11	25	5	0.4
K2 & K2m	111-118	76	5	18	0.1	38	36	6	0.02
Onite phase 72-2									
A	0-4	77	9	13	0.3	1	2	0.7	4.6
B1ca	4-20	79	9	13	0.2	3	2	0.5	4.9
B21tca	20-46	76	8	15	0.2	5	5	0.7	2.9
B22tca	46-65	75	7	18	0.2	7	11	2	2.2
K11	65-89	79	6	16	0.1	12	18	3	1.0
K12	89-121	84	4	12	0.08	8	24	4	0.6
K2 & K2m	121-130	84	4	12	0.2	36	24	5	0.5
Sonoita 72-3 (in pipe)									
A	0-4	81	6	13	0.2	tr	2	0.8	6.0
B11tca	4-23	79	7	13	0.3	tr	2	0.6	6.0
B12tca	23-57	81	9	11	0.2	1	2	2	5.7
B13tca	57-82	85	7	9	0.1	2	3	3	3.5
B14tca	82-104	80	6	14	0.05	1	5	2	2.6
B21tca	104-131	75	5	21		3	7	1	1.8
B22tca	131-154	80	4	16		1	9	1	1.5
B3tca	154-186	84	4	13		tr	15	2	1.3
Bucklebar 68-2 (in depression)									
A2	0-5	62	19	19	0.5	tr			
B1t	5-15	65	13	23	0.4	tr			
B2t	15-33	73	9	18	0.3	tr			
B21tcab	33-58	74	9	17	0.2	2			
B22tcab	58-79	82	4	14	0.2	3			
B23tcab	79-99	83	4	13	0.1	3			
K11b	99-127	85	3	12		11			
K12b	127-157	86	3	12		11			
K13b	157-183	88	2	10		13			
K14b	183-190	88	3	9		10			
K2b	190-218	80	6	14		17			
Organic carbon: 3.3 kg/m² to 99 cm									

1/ Carbonate removed.

2/ To approximate the ratio of exchangeable calcium over sodium plus magnesium, $\frac{\text{CEC} - (\text{exch K + Mg + Na})}{\text{exch (Na + Mg)}}$, where CEC is cation exchange capacity by method 5A6a (Soil Survey Staff, 1972).

Bt horizon peds by upward-encroaching carbonate. The silicate clay content (carbonate-free basis) of the upper part of K horizon is about the same as that of the overlying lower Btca, supporting the interpretation of engulfment.

The morphology of Onite phase 61-8 and associated soils together with the morphology of younger soils suggest the following generalized sequence of events in soil development. Pedogenesis commenced following deposition of the alluvium and abandonment of the area by the ancestral Rio Grande as downcutting of the valley was initiated. Pleistocene pluvials led to the development of fairly thick B horizons with underlying horizons of carbonate accumulation. Probably most of the carbonate in the middle and lower part of the K horizon was emplaced in the mid-Pleistocene. Carbonate in upper horizons apparently accumulated in the upper part of the K2 and above it during the late-Pleistocene and in the Holocene. The depth to and degree of carbonate accumulation was influenced not only by change in climate, but also by landscape position as it determines whether an area receives water and whether the soils have been subject to truncation or accretion. Thus in the depression the depth to the K horizon is greater and the upper part of the argillic horizon is free of carbonate (Bucklebar 68-2, table 123), both because of additions of water by run-in and a net accretion rather than a removal of sediment. In contrast, Onite phase 61-8 has been subject to runoff and truncation, both processes leading to more carbonate at shallower depths.

Truncation increases the complexity of these ancient soils. Onite phase 61-8 has not reached stage IV, in which a laminar horizon forms. In places, however, the soils have laminar horizons resulting from truncation that brought the plugged horizon within reach of more frequent wetting. On several slight ridges and in places around the periphery of this lower La Mesa remnant the plugged K horizon is within 1/2 to 3/4 m depth and is capped by a thin laminar horizon.

Young coppice dunes on the mid-Pleistocene basin floor

Coppice dunes are common on lower La Mesa. Land survey notes (Bureau of Land Management, Santa Fe, N. M.) were made in 1857, 1885, and 1922 and suggest the time of dune formation. At the corner of sections 5, 6, 31, and 32, Range 1 East, and on the line between Townships 23 and 24, the following comments were made in 1857: "Land level sandy plain, some mesquite bushes, grama grass good." The 1885 notes indicate that lower La Mesa had changed little by 1885; grass was present and ranged from poor to good. In 1922, the area was variously described as rolling, or nearly level, with a scattering of mesquite and other shrubs; grass was not mentioned. The occasional mention of rolling topography suggests that formation of distinct dunes might have started on lower La Mesa by 1922. Dunes are prominent in the 1936 aerial photographs and must have formed before then.

The present topography and vegetation on lower La Mesa differ markedly from descriptions of the 1857 and 1885 land surveys. Coppice dunes range from about 1 to 8 ft in height and 5 to 40 ft in width. There is no grass. Mesquite is dominant on coppice dunes, with a few four-wing saltbush. In 1857 to 1885, coppice dunes were apparently absent or very small in lower La Mesa. Field notes of the early land surveys and present conditions strongly suggest that most of the dune materials on lower La Mesa accumulated between 1885 and 1922.

The dunes overlie and have preserved upper horizons of buried soils. The preserved horizons show the surficial character of soils at the land surface as the dunes started to form. Between the dunes and the soils of mid-Pleistocene age there is a thin, apparent eolian deposit (fig. 103; description). This material lacks the layering of the overlying dune sediments and has evidence of weak soil formation. The Bb horizon (fig. 103) is a weak "color B" and has a slight accumualtion of filamentary carbonate. This weak soil apparently was at the land surface during the 1857 land surveys.

At first glance it might seem that the Bb horizon could be upper part of a bisequum. However, the general lack of pebbles, and similarity in thickness over substantial areas of nearly level lower La Mesa suggest an eolian deposit above the mid-Pleistocene alluvium. The deposit could be an eolian accumulation of Altithermal age, derived from the scarp area below upper La Mesa to the west. Soil development is similar to that known to be of Holocene age.

Exposed roots of dead mesquite occur between dunes in the general vicinity of figure 103. Elevation of the exposed roots suggests a former ground level that accorded with the surface of the thin buried soil beneath the dunes. Hence, this thin soil may have occurred continuously on lower La Mesa prior to development of coppice dunes.

The significance of this deposit to soils of interdune areas is shown by the variable nature of their upper horizons. Some deposits of loose sand are stratified and obviously only a few years old. In other places the Bt horizon of Onite phase is at the surface and is readily identified. However, other thin (a few cm) horizons are of less certain origin on cursory examination. Stratigraphic relationships show that at least in some cases, these thin upper horizons are actually former Bb (or Ab) horizons, thus are much younger than the mid-Pleistocene sediments in which the thick soils of lower La Mesa formed.

No photographs of the pre-dune character of the landscape are available. Figure 106a is a drawing based on the 1857 land survey notes, showing mostly grass and a few mesquite. Figure 106b depicts the area as it was in 1966.

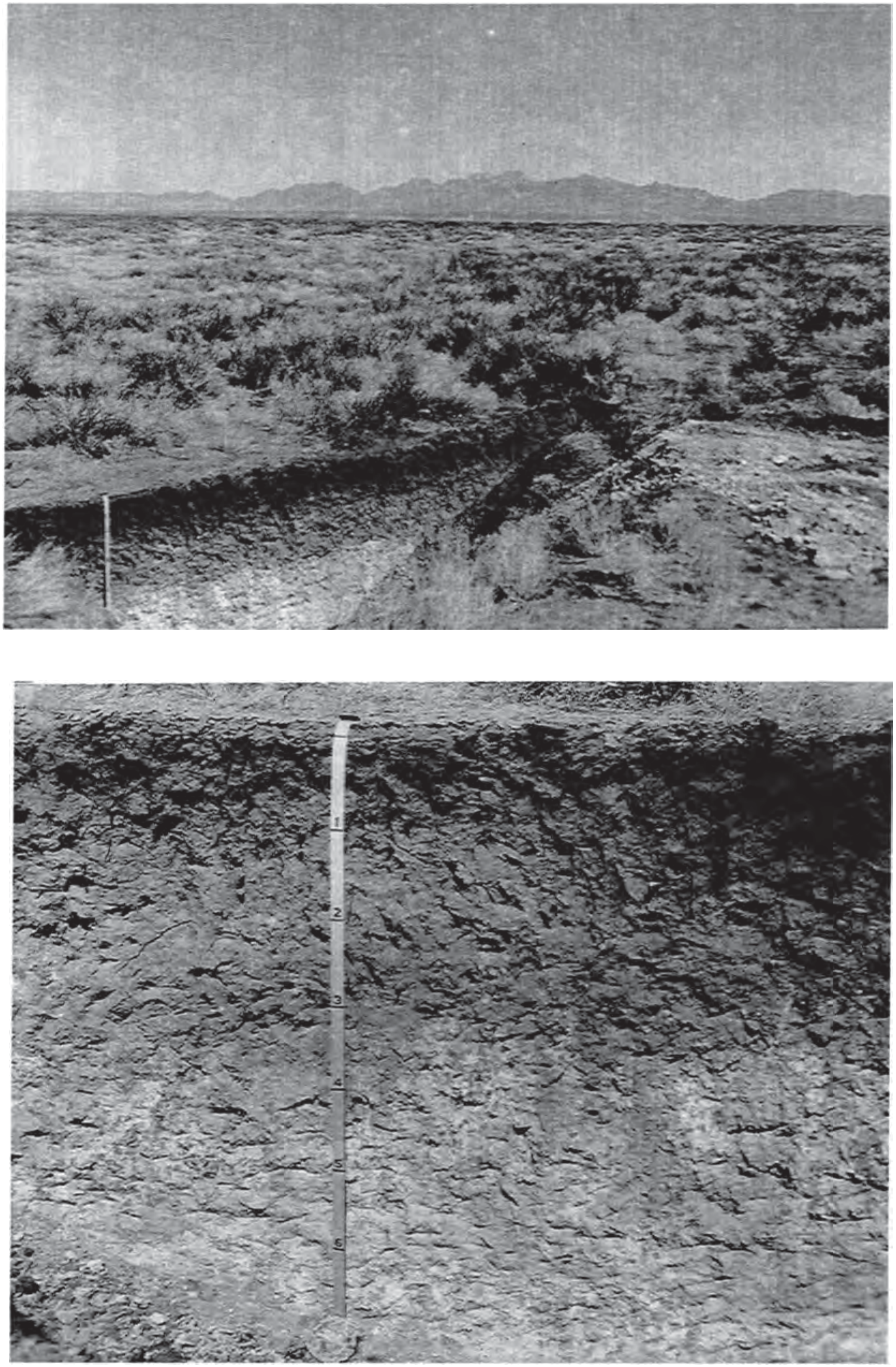
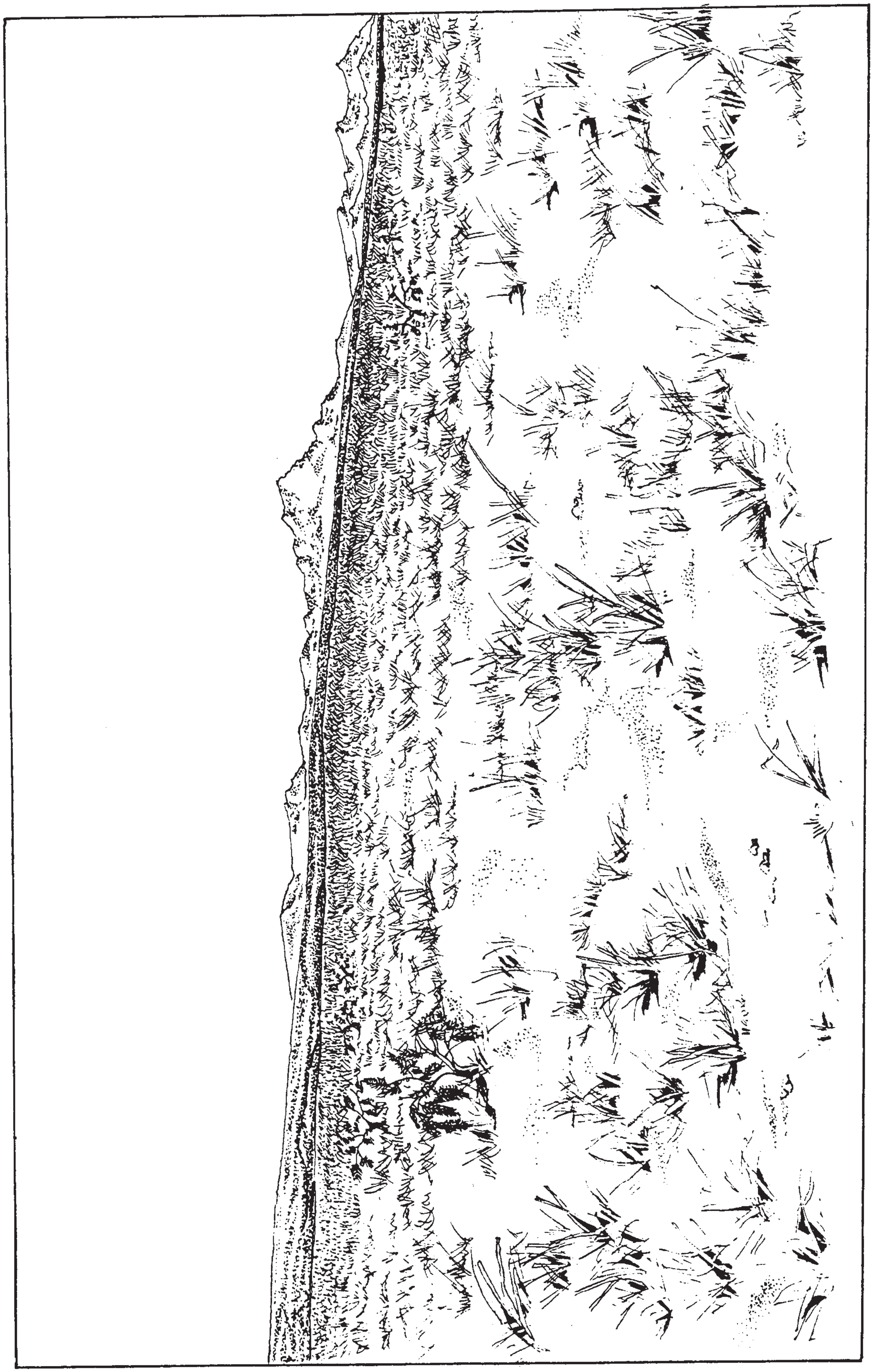


Figure 106. Upper. Landscape of a Typic Haplargid, Bucklebar 68-2, in a slight depression on lower La Mesa. Mesquite are thicker in the depression and dunes are absent or very low.

Lower. Bucklebar 68-2. Scale is in feet.



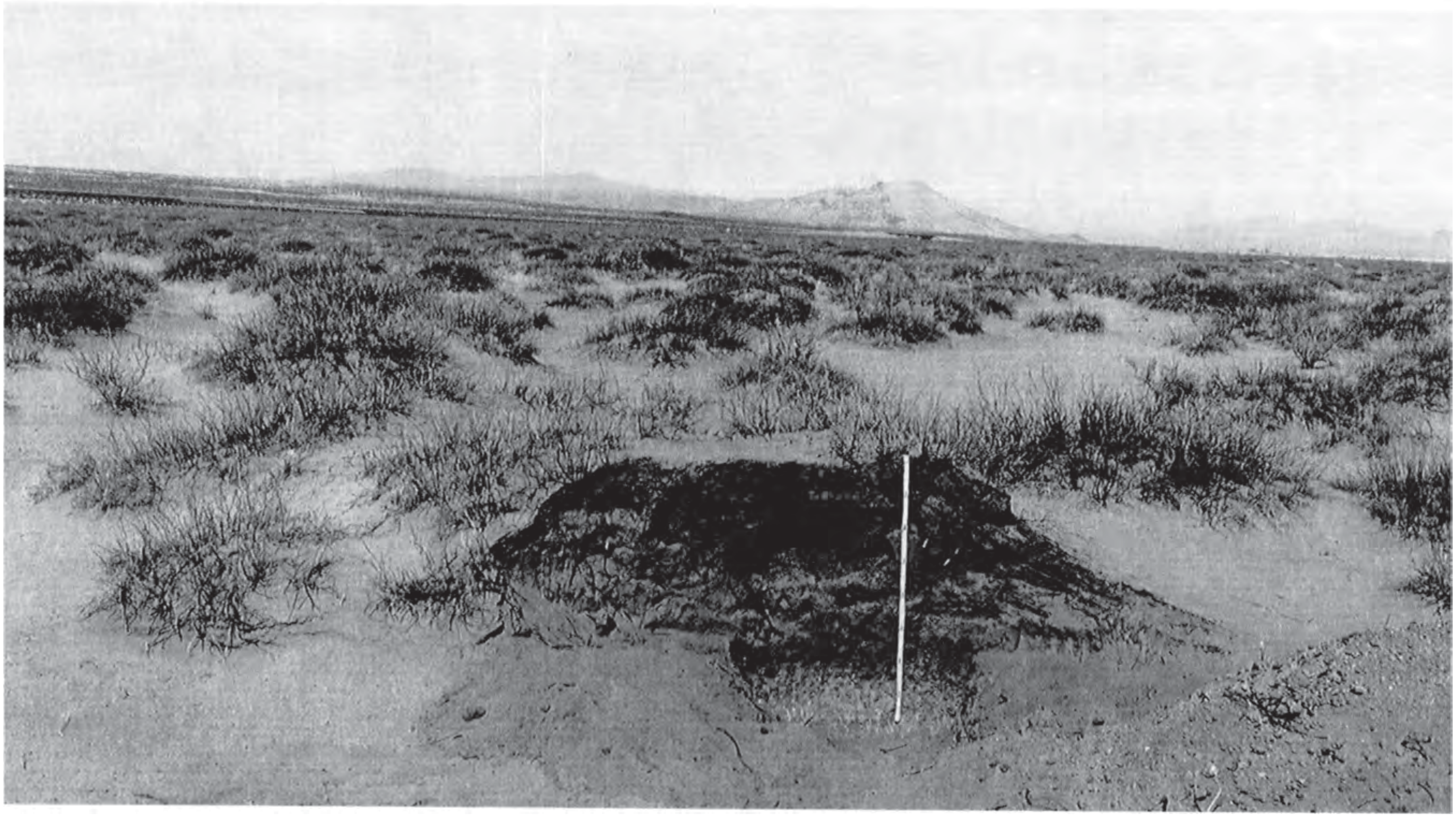


Figure 106a. Upper. Drawing of lower La Mesa as it may have appeared in 1885, when the area was described by land surveyors as a level plain; grass was present and ranged from poor to good. Mesquite shrubs were mentioned only occasionally. The Robledo Mountains are in the left background. Picacho Mountain is the peak in the center. The Dona Ana Mountains are in the right background. The drawing represents an area in the southwestern part of Township 23 South, Range 1 East. Drawing by Debbie Birkinshaw.

Lower. Photograph of the lower La Mesa landscape taken in 1966. Coppice dunes are prominent and the vegetation is nearly all mesquite (*Prosopis juliflora*). Areas between dunes are essentially barren of vegetation and there is no grass. In 1922 the presence of mesquite was consistently noted and grass was not mentioned; the area was variously described as rolling and nearly level. This suggests that the development of coppice dunes may have started by 1922. The dunes were present and well developed by 1936 since they are prominent in aerial photographs taken then. A spectacular change in relief and vegetation must have taken place, primarily between 1885 and 1922.

150. ADELINO CLAY LOAM (13P)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ADELINO CLAY LOAM	TYPIC CAMBORTHIDS	FINE-LOAMY	90
Onite, deep, partially indurated phase	Typic Haplargids	Coarse-loamy	10

LOCATION, LANDSCAPE, VEGETATION

There is one delineation of this mapping unit and it occurs along the border between the nearly level slopes of lower La Mesa and steeper slopes that grade to the scarp zone of upper La Mesa to the west. Adelino soils overlie soils with Bt horizons similar to Bt horizons of Onite, deep, partially indurated phase. These relationships indicate that the deposit in which Adelino soils have formed represents a localized period of sedimentation that is younger than La Mesa. The younger sediments must have been derived primarily from or below the scarp zone of upper La Mesa, since they are directly downslope and are confined to a belt that parallels the scarp zone. Elevation is about 4200 feet.

The soils occur in an elongate depression that is level or nearly level. Drainage from Organ sediments and the scarp zone of upper La Mesa westward periodically spreads into parts of the depression, and in places has formed small fans along its western edge. There are a few small coppice dunes.

Vegetation consists of creosotebush, mesquite, tarbush, snakeweed and patches of burro grass. There are many barren areas.

TYPICAL PEDON, PROPERTIES AND RANGES

These soils are strongly calcareous throughout and are underlain by buried soils.

Adelino

A typical pedon of Adelino is described below. The location is the NW 1/4 Sec. 30, T23S, R1E, just west of road. Figure 107 is a photograph of the pedon and its landscape. A table of properties and ranges follows the description.

Soil surface. The soil surface is cracked into plates, 2 to 5 cm diameter and about 2 mm thick, that are readily displaced. A few (5 to 10%) of fine, rounded pebbles are scattered over the surface.

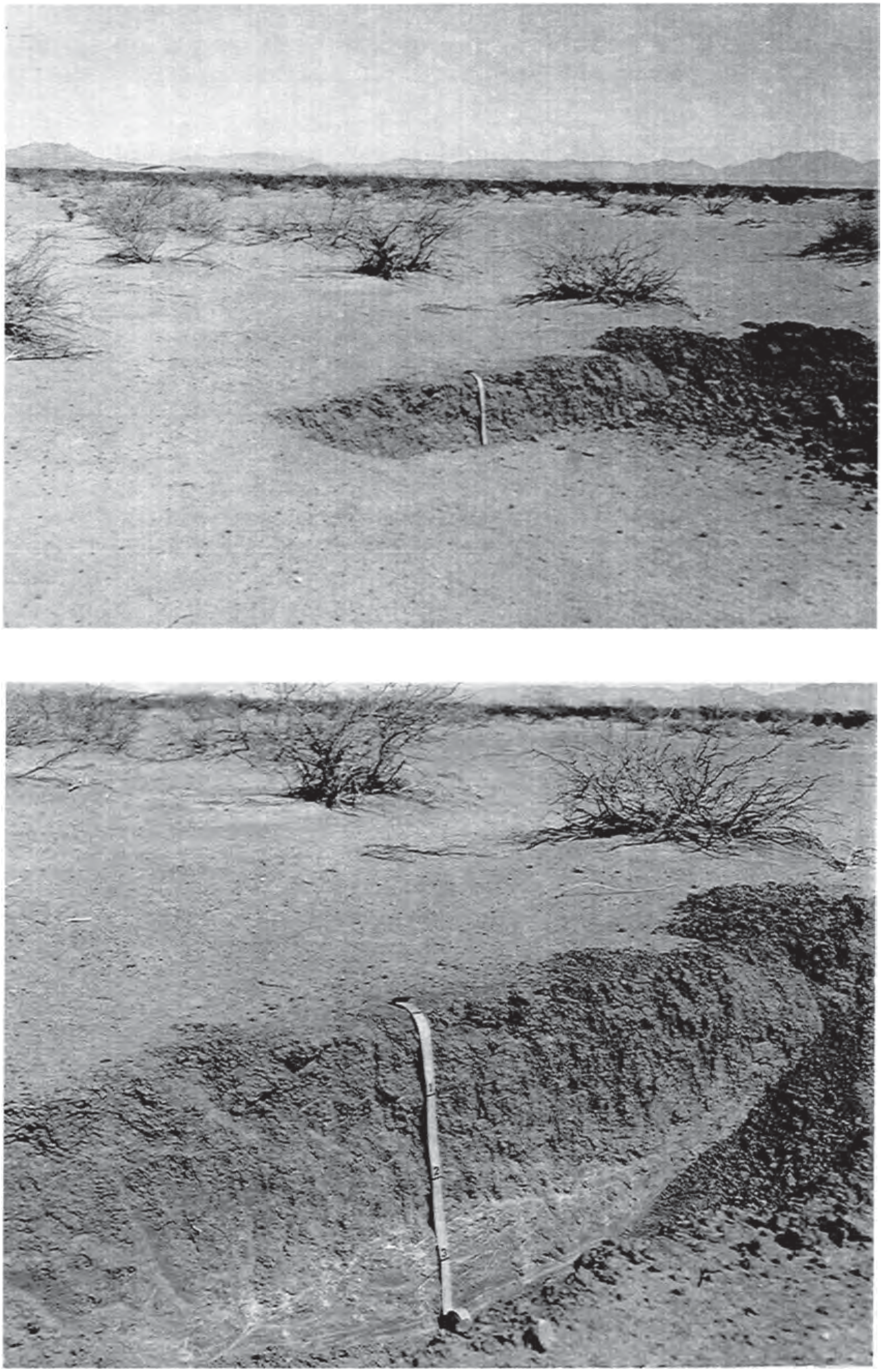


Figure 107. Upper. Landscape of a Typic Camborthid, Adelino clay loam. Vegetation consists of a few mesquite. The area is level.
Lower. Adelino clay loam. Scale is in feet.

A 0-3 cm. Pinkish gray (7.5YR 6/2, dry) or dark brown (7.5YR 4/2, moist) light clay loam; moderate medium and fine platy; soft; no roots; effervesces strongly; abrupt smooth boundary.

B21 3-18 cm. Light brown (7.5YR 6/3, dry) or dark brown (7.5YR 4/3, moist) clay loam; weak medium prismatic, breaking to moderate medium subangular blocky; hard; few roots; few very fine tubular pores; a few insect burrows, 4 to 5 mm diameter, some empty, some partially filled with loose fine earth; a very few fine carbonate filaments; effervesces strongly; clear wavy boundary.

B22ca 18-48 cm. Light brown (7.5YR 6/3, dry) or dark brown (7.5YR 4/3, moist) clay loam; weak medium prismatic, breaking to moderate medium subangular blocky; hard; few roots; few fine and very fine tubular pores; few carbonate filaments and a few fine (1 to 2 mm diameter) carbonate nodules; few insect burrow fillings, 4 to 5 mm diameter, filled or partially filled with dark fine earth; effervesces strongly; clear wavy boundary.

B23ca 48-79 cm. Light brown (7.5YR 6/3, dry) or dark brown (7.5YR 4/3, moist) light clay loam; moderate medium subangular blocky; hard; few roots; few fine and very fine tubular pores; common carbonate filaments and a few fine nodules; effervesces strongly; clear smooth boundary.

B1cab 79-99 cm. Reddish brown (6YR 5.5/4, dry, 6YR 4/4, moist) with few parts of slightly redder hue; heavy sandy loam; very weak, medium and coarse subangular blocky; hard; no roots; few carbonate filaments; some peds partially carbonate-coated; effervesces strongly; clear smooth boundary.

B2tcab 99-120 cm. Yellowish red (5YR 5/6, dry, 5YR 4/6, moist) sandy loam; massive; hard; no roots; sand grains weakly stained with reddish clay; few carbonate filaments; effervesces weakly.

Table 124. Typical (underlined) and range in selected properties for major horizons of Adelino.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-3	sl l,<u>cl</u>	0-5	<u>7.5YR</u>	<u>6</u>,7	<u>4</u>,5	<u>2</u>,4
B2	3-79	<u>cl</u>,scl hv.sl	0-5	<u>7.5YR</u>	<u>6</u>,7	<u>4</u>,5	<u>3</u>,4
Bb	79-120	<u>sl</u>	0-5	<u>5YR</u>	<u>5</u>,6	<u>4</u>,5	<u>4</u>,6
Control section		scl,sl	0-5				

Other. The A horizon has been truncated in many places and the B horizon is at the surface. Thickness of the younger deposit generally ranges from about 1/2 to 1 m; the B horizon rests abruptly on the B horizon of the buried soil. The horizon of carbonate accumulation is dominantly filamentary although in places there are a very few small (2 to 3 mm diameter) carbonate nodules.

SOIL OCCURRENCE

Adelino soils occupy nearly all the depression. Onite, deep petrocalcic phase occurs only in places--mainly along margins of the mapping unit where the deposit is so thin that classification is based on the underlying soil.

SOIL BOUNDARIES

Table 125 gives information about boundaries to adjacent major units. Figure 108 shows boundaries and stratigraphy of some of the units.

Table 125. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Bluepoint sand (13Y)	The boundary has been caused by a younger geomorphic surface and associated alluvium along the western edge of the depression. The 13P soils, analogues of which are buried beneath soils of unit 13Y, emerge at the surface on the 13P side of the boundary. Topographically the boundary is marked by an increase in slope, from level in unit 13P, to 2 or 3 percent in unit 13Y.
Onite-Pintura complex (15P)	The boundary has been caused by a younger geomorphic surface and associated alluvium in unit 13P. The 15P soils, analogues of which are buried in unit 13P, emerge at the surface on the 15P side of the boundary. Topographically the boundary is marked by the edge of the slight depression in which the 13P soils occur.

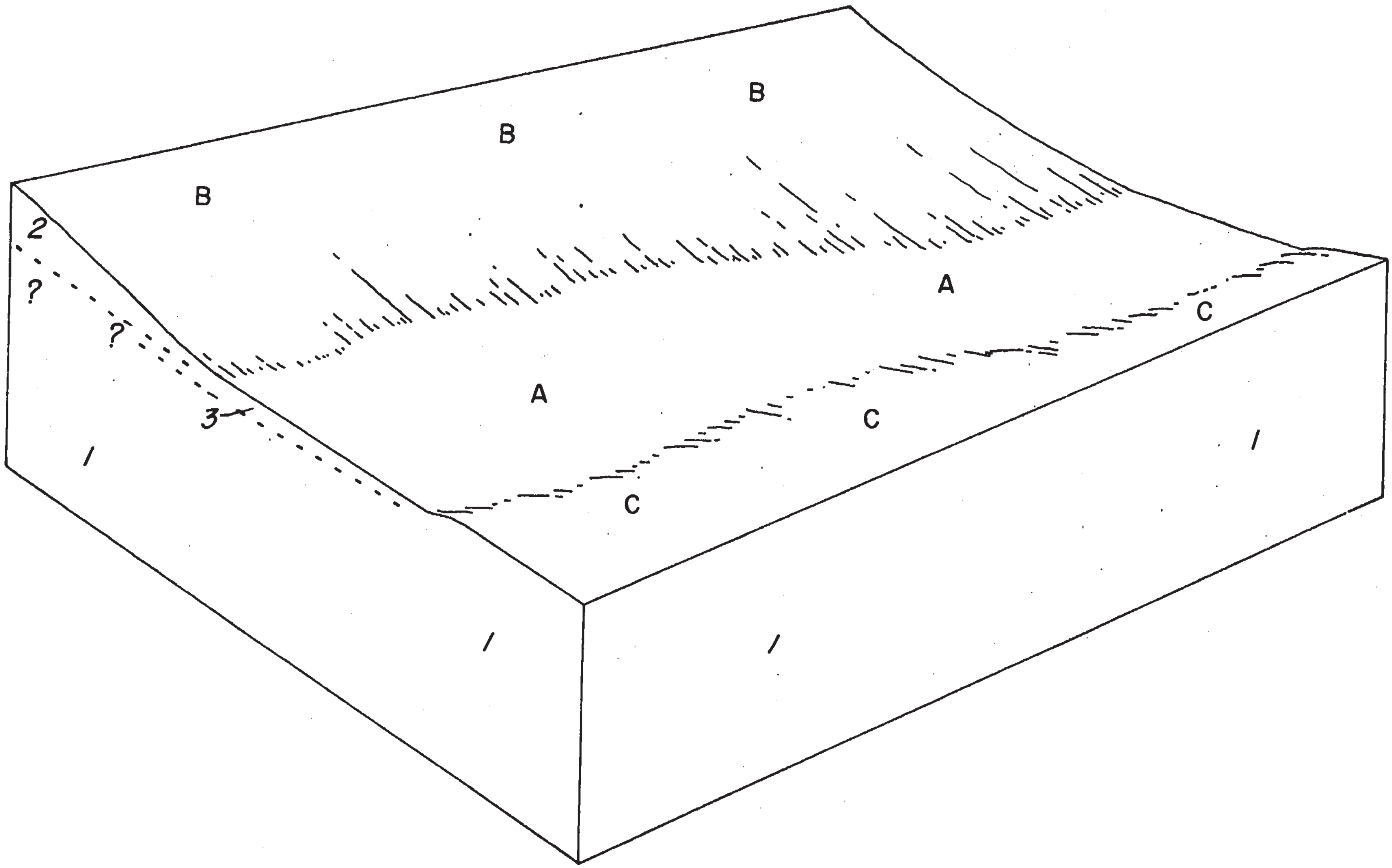


Figure 108. Block diagram of soil-landscape relations and soil stratigraphy in an area of Adelino clay loam, Bluepoint sand, and Onite-Pintura complex. A = Adelino clay loam. B = Bluepoint sand. C = Onite-Pintura complex.
1 = Upper Camp Rice Formation, fluvial facies (ancient river alluvium) and soils. 2 = Organ alluvium and soils. 3 = Unnamed Holocene deposit and soils.

151. TENCEE COMPLEX, ERODED (10C)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
JAL	TYPIC CALCIORTHIDS	COARSE-LOAMY, CARBONATIC	35
TENCEE	TYPIC PALEORTHIDS	LOAMY-SKELETAL, CARBONATIC, SHALLOW	45
Bluepoint	Typic Torripsamments		10
Tencee, eroded	Typic Paleorthids	Shallow	5
Tonuco	Typic Paleorthids	Sandy, shallow	5

LOCATION, LANDSCAPE, VEGETATION

These soils occur along and below scarps cut in the soils of the La Mesa surface south of Picacho and Goat Mountain and north of Fort Selden. The soils have formed in sandy, noncalcareous sediments of the upper Camp Rice Formation. Elevations range from about 4200 to 4500 feet.

The soils occur in digitating pattern between the nearly level basin floor and steeper slopes that descend to the flood plain or to lower La Mesa (fig. 100). Small arroyos have impinged soils along the scarp, and the resultant landscape consists of discontinuous ridges with the prominent, light-colored K horizon very near and in places at the surface. Slopes along the ridge crests range from 1 to 5 percent. Slopes of ridge sides range from about 10 to 40 percent.

Vegetation on Tencee soils consists mainly of scattered creosotebush, and, in places, a few ratany. Strongly eroded areas, where the petrocalcic horizon is at the surface, are commonly barren of vegetation or have only a very few small creosotebush. Such areas are extremely arid. Vegetation is thicker around and below edges of the scarps with creosotebush and tarbush being dominant. Where the petrocalcic horizon has been truncated, dropseed may also be found.

TYPICAL PEDONS, PROPERTIES AND RANGES

Most soils are strongly calcareous throughout. In most places there is no bedrock within many scores of m of the surface. Gravel is common beneath the soils of lower La Mesa; in upper La Mesa and in other areas of this mapping unit there is commonly little or no gravel to the depths of many m.

Jal

A description of Jal is in the Appendix (pedon 65-6).

Tencee

A typical pedon of Tencee is described below. The location is the SE 1/4 Sec. 14, T23S, R1W, along edge of scarp, 45 m east of road. Figures 109 and 110 are photographs of the soil and its landscape. Table 126 follows the description and gives properties and ranges.

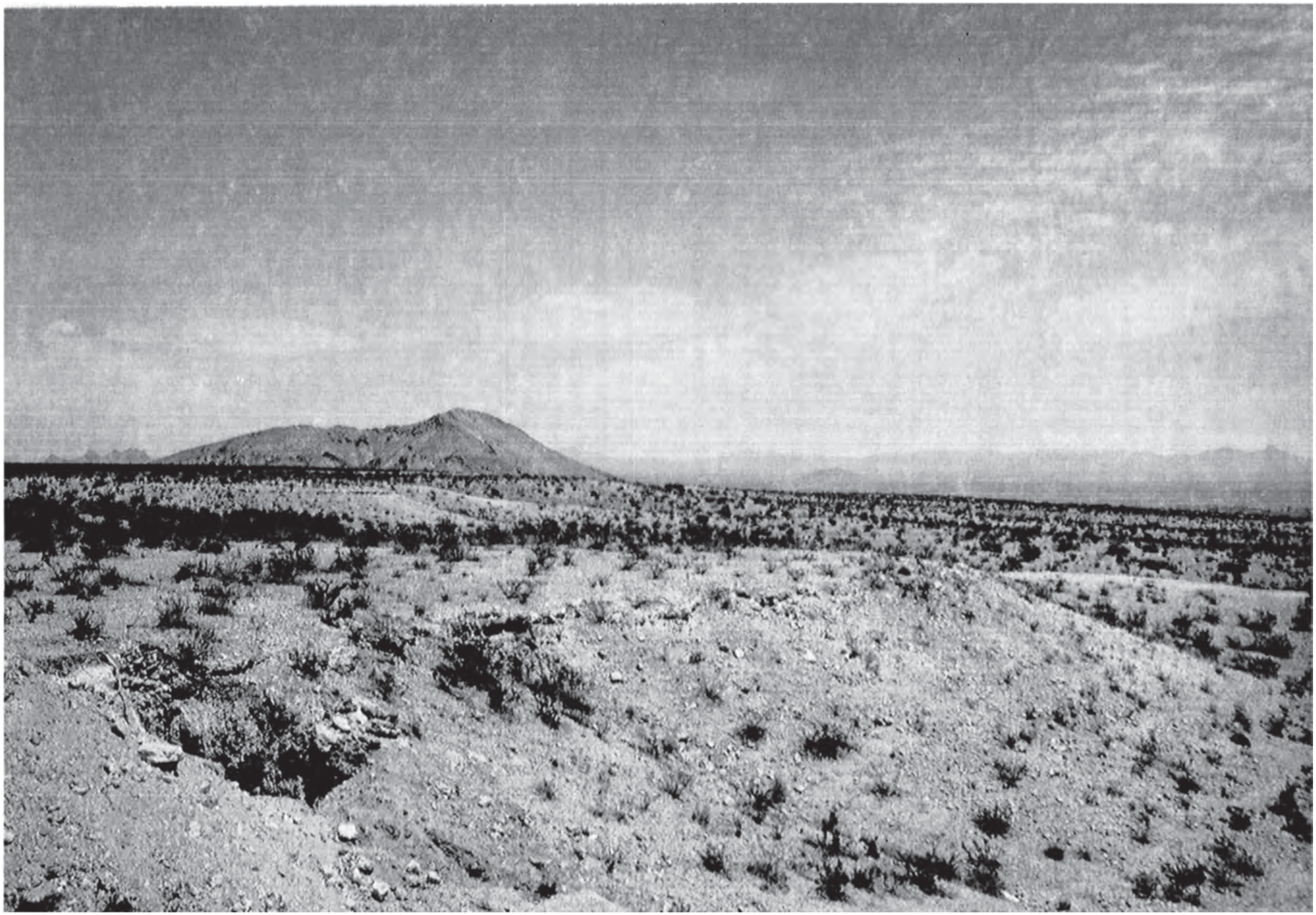


Figure 109. Landscape of Tencee soils along scarp of upper La Mesa. Pit in Tencee is at left. Vegetation consists of a few small creosotebush. The area is very nearly level. Picacho Mountain is on the skyline at the left.

Figure 110. A Typic Paleorthid, Tencee very gravelly sandy loam. Scale is in feet.

Soil surface. About 75 percent covered with coarse fragments of indurated, carbonate-cemented material. The fragments are commonly rounded and are etched and pitted on their surfaces. Most range from 1/2 to 4 cm in diameter, with a few up to 8 cm diameter. There are a few fine, rounded pebbles of quartz and mixed igneous rocks. The surface is weakly crusted and cracked into polygons 2 to 5 cm across, and breaks out as smooth-topped plates 1 to 4 mm thick.

Aca 0-4 cm. Pinkish gray (7.5YR 6/2, dry) or dark brown (7.5YR 4/2, moist) gravelly fine sandy loam; upper 1 to 4 mm weak thin and medium platy, below is weak very fine crumb; soft; very few roots; gravel consists of rounded, carbonate-cemented fragments, extremely hard and indurated; thin carbonate coatings on the fragments; effervesces strongly; abrupt smooth boundary.

K1 4-20 cm. Brown (7.5YR 5/4, dry) or dark brown (7.5YR 4/4, moist) very gravelly fine sandy loam; weak very fine crumb, loose; fine roots common; gravel consists of carbonate-cemented fragments--colored pink (7.5YR 9/4, dry, 7.5YR 8/4, moist) and some very pale brown (10YR 9/4, dry, 10YR 8/4, moist); all gravel fragments are indurated and extremely hard; effervesces strongly; abrupt wavy boundary.

K21m 20-54 cm. Dominantly very pale brown (10YR 9/3, dry, 10YR 8/3, moist) and (10YR 8/3, dry, 10YR 9/3, moist) carbonate-cemented material; weak very coarse prismatic, with prisms 25 to 75 cm across; extremely hard, indurated; no roots except for some fine roots between prisms; breaks out with backhoe as grossly platy units, ranging from 3 to 10 cm thick; most plates thinly capped with laminar horizon which is harder than material beneath; the laminar capping ranges from 1 to 15 mm thick, being thickest in upper part of horizon; prisms thinly (1 to 2 mm) lined with white laminar carbonate; effervesces strongly; clear wavy boundary.

K22m 54-90 cm. Dominantly very pale brown (10YR 9/3, dry, 10YR 8/3, moist) carbonate-cemented material; weak very coarse prismatic, prisms 25 to 75 cm across, are very tightly fitted, and thinly (1 to 2 mm) coated with carbonate; extremely hard; a few fine roots occur along parts of the prism faces; some parts fracture into blocks with smooth, carbonate-coated surfaces; in places, breaks into grossly platy units from 2 to 10 cm thick; sand grains widely separated by carbonate; effervesces strongly; clear irregular boundary.

K31 90-142 cm. Dominantly pinkish white (7.5YR 8/2, dry) or pink (7.5YR 7/4, moist) fine sandy loam; compound weak very coarse prismatic and moderate medium and coarse subangular blocky; most parts very hard and firm, some parts extremely hard and indurated; no roots; many of the subangular blocks occur as rounded nodules and cylindroids, 1 to 6 cm diameter, that have smooth surfaces and are easily removed from horizon; effervesces strongly; clear wavy boundary.

K32 142-190 cm. Very pale brown (10YR 9/3, dry, 10YR 7/3, moist); heavy fine sandy loam; compound weak very coarse prismatic and weak coarse subangular blocky; very hard, firm; no roots; a few parts colored 10YR 9/4, dry, 10YR 8/4, moist; sand grains separated by carbonate; laterally there are vertically oriented zones, 5 to 10 cm across, of indurated, extremely hard nodules, 1 to 2 cm across, that may be picked out with fingers and have loose fine earth between them; nodules same colors as above, but some have discontinuous black coatings, and most have smooth carbonate coatings; most of horizon takes water readily; few very fine tubular pores; effervesces strongly; clear wavy boundary.

K33 190-246 cm. Dominantly pink (7.5YR 8/4, dry, 7.5YR 7/4, moist) heavy fine sandy loam; compound weak very coarse prismatic and moderate medium subangular blocky; very hard, firm; no roots; common carbonate nodules and vertical cylindroids, 1 to 5 cm diameter, colored very pale brown (10YR 9/4, dry, 10YR 8/4, moist); sand grains coated with carbonate; a few discontinuous black stains on some peds; effervesces strongly; clear wavy boundary.

C1ca 246-294 cm. Pink (7.5YR 8/4, dry) or light brown (7.5YR 6/4, moist) loamy sand; massive; slightly hard; no roots; sand grains thinly and discontinuously coated with carbonate; a few extremely hard carbonate nodules, 1 to 6 cm diameter; a few tubes, 6 to 8 mm diameter 1 to 5 cm long commonly filled with sand; effervesce strongly; clear wavy boundary.

C2ca 294-320 cm. Very pale brown (10YR 7/3, dry) or brown (10YR 5/3, moist) sand with about 5 percent fine rounded pebbles of mixed origin; massive; soft; no roots; some sand grains are discontinuously coated with carbonate; a few vertical tubes, 4 to 8 mm diameter, 5 to 10 cm long, calcareous, some empty and some filled with sand; a few carbonate nodules, extremely hard, 1 to 2 cm diameter; most parts are noncalcareous or effervesce weakly, some parts effervesce strongly; clear wavy boundary.

C3 320-334 cm. Light gray (10YR 7/2, dry) or brown (10YR 5/3, moist) fine sand; massive and single grain; soft and loose; no roots; noncalcareous.

Remarks. The Tencee soils have at least one loamy-skeletal horizon above the petrocalcic horizon.

Table 126. Typical (underlined) and range in selected properties for major horizons of Tencee.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-4	sl	0-75	7.5YR-10YR	5-7, 6	3-5, 4	2-4
K1	4-20	sl	35-75	7.5YR-10YR	5,6	3-5, 4	3,4
K2m	20-90	--	--	7.5YR-10YR	6-9	5-8	2-4, 3
C1ca	246-294	s,ls sl	0-75	7.5YR-10YR	6-8	5-7	3,4
Control section		sl	> 35				

Other. Depth to the petrocalcic horizon (the K2m horizon in the description) is usually 15 to 30 cm, ranging from 5 to 50 cm. Essentially all of the coarse fragments consist of carbonate-cemented nodules or plates.

SOIL OCCURRENCE

Occurrence of specific soils depends on degree of dissection and soil truncation. The petrocalcic horizon is preserved in stablest areas (where Paleorthids are dominant) but has commonly been truncated in dissected terrain below the scarp (where Calciorthids and Torripsamments are dominant).

Paleorthids. The loamy-skeletal Tencee soils are dominant on the remnants of La Mesa surface. In places they grade to truncated Paleorthids in which the petrocalcic horizon is at the surface, with no horizon containing fine earth above it. These soils are not classified from the standpoint of texture and mineralogy families because horizons with fine earth are not present. Tonuco soils occur in a few places where textures are sandy.

Calciorthids. Jal soils occur in dissected areas where the petrocalcic horizon has been truncated, leaving a calcic horizon. These soils also occur in places where a calcic, but not quite a petrocalcic horizon has formed.

Torripsamments. The sandy Bluepoint soils occur in small areas just below the scarp, where both petrocalcic and calcic horizons have been truncated.

SOIL BOUNDARIES

Table 127 gives information about boundaries to adjacent major units. Figure 111 shows boundaries and stratigraphy of some of the units.

Table 127. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Cruces fine sandy loam (12P)	The boundary has been caused by landscape dissection and occurs where erosion has gradually removed horizons once overlying the petrocalcic horizon. This causes the upper part of the petrocalcic horizon to fracture (section 74), giving rise to the skeletal Tencee soils, in which the coarse fragments are composed of broken-up parts of the petrocalcic horizon. The topographic boundary between the 10C and 12P units is less apparent than between the 10C and 13Y units; both commonly occur on about the same slope. Usually, however, the boundary does approximately parallel the scarp. Although there is no distinct topographic boundary, the approximate boundary is commonly marked by a vegetation change from mesquite, *Condalia* spp. and fourwing saltbush (unit 12P) to dominantly creosotebush (unit 10C).
Bluepoint sand (13Y)	The boundary has been caused by landscape dissection. The boundary occurs where the petrocalcic horizon of the dominant 10C soils has been truncated and the sands (in which the 13Y soils have formed) once beneath it are at the surface. The topographic boundary between the 10C and 13Y units is usually distinct and irregular, following the dissection patterns of arroyos and drainageways. Where the scarp is prominent--as it is in most places--the boundary occurs on steep slopes a few m below the rim, where the sand crops out.

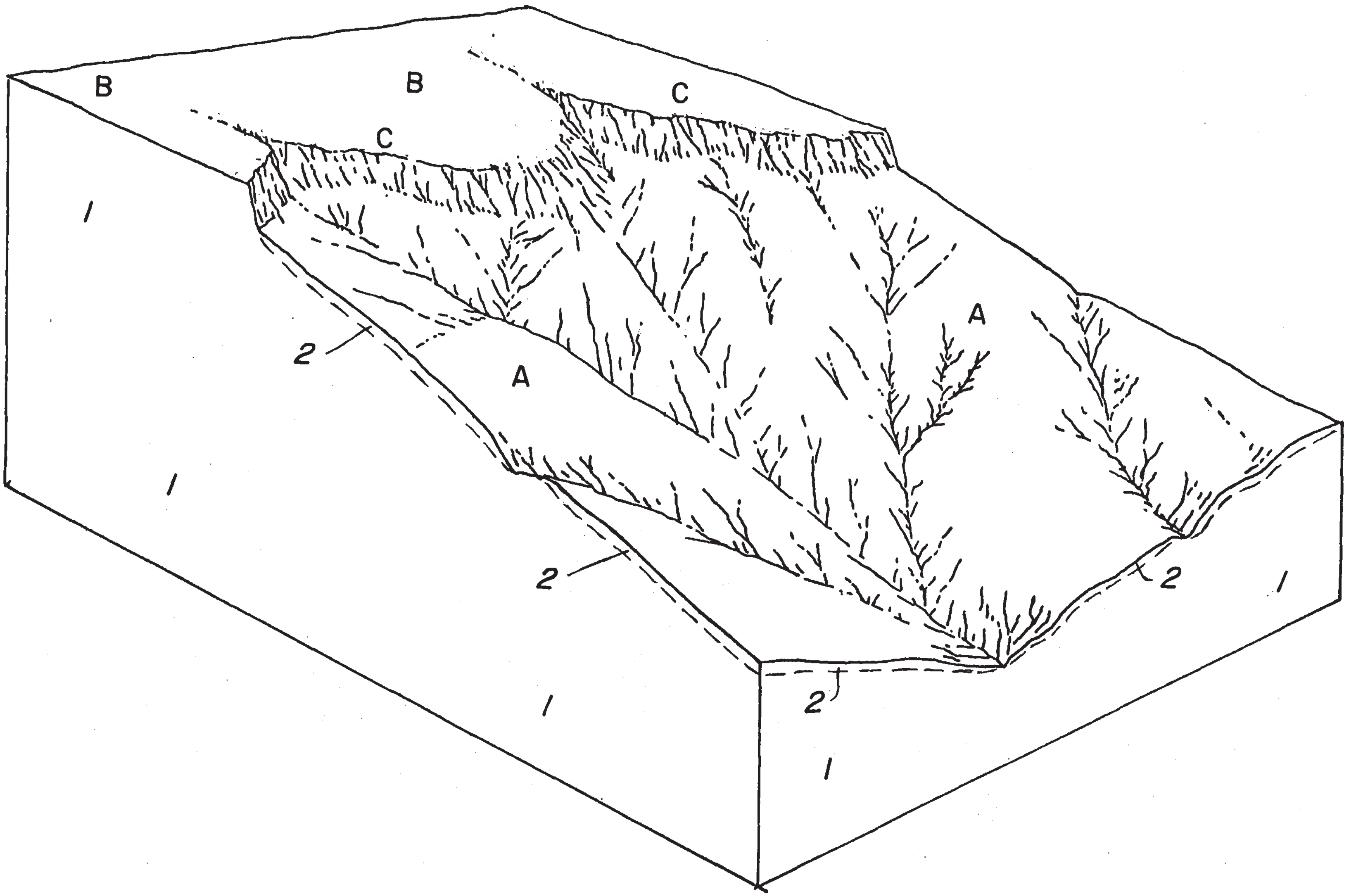


Figure 111. Block diagram of soil-landscape relations in an area of Cruces fine sandy loam, Tencee complex, eroded, and Bluepoint sand. A = Bluepoint sand (Fort Selden surface). B = Cruces fine sandy loam (upper La Mesa surface). C = Tencee complex, eroded (upper La Mesa surface).
1 = Upper Camp Rice Formation, fluvial facies (ancient river alluvium) and soils. 2 = Fillmore and Fort Selden colluvium and alluvium and soils.

152. CRUCES FINE SANDY LOAM (12P)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
CRUCES	PETROCALCIC PALEARGIDS	LOAMY, SHALLOW	50
Bucklebar	Typic Haplargids	Fine-loamy	5
Cacique	Petrocalcic Paleargids	Fine-loamy	10
Hueco	Petrocalcic Paleargids	Coarse-loamy	10
Pintura	Typic Torripsamments		5
Tencee	Typic Paleorthids	Loamy-skeletal, carbonatic, shallow	5
Tonuco	Typic Paleorthids	Sandy, shallow	10
Other inclusions (Paleargids, Paleorthids, Haplargids)			5

LOCATION, LANDSCAPE, VEGETATION

These soils occur southwest of Picacho Mountain; north of Fort Selden; and near Goat Mountain. The soils have formed mainly in noncalcareous sand (with a few rounded pebbles) of the Upper Camp Rice Formation. Elevations range from about 4300 to 4500 feet.

These areas are generally undissected except along the scarp next to the valley; there are no arroyos or gullies. The surface is very gently undulating with broad, very slight depressions between very slight ridges. On the La Mesa surface southwest of Picacho Mountain, slopes increase near the scarp and range from about 1 to 3 percent. Coppice dunes are common in places, especially in the southern part of the area and near the scarp. North of Fort Selden the soils are level adjacent to the scarp; north of the scarp, slopes increase and range from 2 to 5 percent.

Snakeweed and mesquite occur over much of the area. Mesquite is dominant on coppice dunes; four-wing saltbush also occur on some dunes. Buckthorn, tarbush, and creosotebush occur less frequently, mainly adjacent to scarps. Barren areas are common. A few areas have discontinuous stands of black grama or tobosa; these are best developed in the area fenced in by the Las Cruces Municipal Airport.

TYPICAL PEDON, PROPERTIES AND RANGES

These soils have formed in thick sediments and no bedrock occurs within a depth of many m.

Cruces

A typical pedon of Cruces is described below. The location is the south bank of trench, 800 ft east of northeast taxiway, Las Cruces Munucipal Airport, in the NE 1/4, Sec. 23, T23S, R1W. Cruces 61-7 (see "other studies") is about 1 m to the east. Its petrocalcic horizon is deeper (48 cm). Figures 112 and 113 are photographs of Cruces 61-7 and its landscape. A table of properties and ranges follows the description.

Figure 112. Upper. The airport trenches of upper La Mesa, and landscape, looking west. Sleeping Lady Hills are in the background. Pedons 61-7 and 68-8 are in the right hand trench (see below).

Lower. Cruces 61-7 (indentation at left), with spoil bank above. The typical pedon for this mapping unit, and the type locality for the Cruces series is about 1 m west of pedon 61-7. Pedon 68-8 is to the east and is not shown.

Figure 113. A Petrocalcic Paleargid, Cruces 61-7. The top of the tape, and not the 0 mark, is at the soil surface (spoil is above).

Soil surface: The soil surface is covered by a spoil pile, but elsewhere a few fine pebbles of mixed lithology are scattered over the surface. There is a discontinuous layer of loose sand 1 to 2 mm thick.

A1 0-5 cm. Reddish brown (5YR 5/4, dry) or reddish brown (5YR 4/4, moist) loamy sand; massive and weak medium platy; soft; few roots; noncalcareous; abrupt smooth boundary.

B1t 5-18 cm. Reddish brown (5YR 5/4, dry) or reddish brown (5YR 4/4, moist) fine sandy loam; weak very coarse prismatic; slightly hard, firm; few roots; sand grains coated with silicate clay; noncalcareous; clear wavy boundary.

B21t 1 -31 cm. Red (3.5YR 5/6, dry) or dark red (3.5YR 3/6, moist) heavy fine sandy loam; compound weak very coarse prismatic structure and weak medium subangular blocky; slightly hard, firm; few roots; sand grains coated with silicate clay; noncalcareous; clear smooth boundary.

B22tca 31-36 cm. Red (3.5YR 4/6, dry) or dark red (3.5YR 3/6, moist) sandy clay loam; compound weak very coarse prismatic and weak medium subangular blocky; hard, firm; few roots; sand grains coated with silicate clay; few carbonate filaments; in places there are scattered extremely hard, subangular and rounded, carbonate-cemented fragments about 2 mm to 5 cm in diameter; most parts calcareous, a few parts noncalcareous; abrupt smooth boundary.

K21m 36-64 cm. Pinkish white (7.5YR 8/2 and 9/2, dry) or pink (7.5YR 8/4, and 7/4, moist), alternating layers of laminar carbonate and massively carbonate-cemented material; extremely hard; no roots; reddish brown and red stains along cracks; effervesces strongly; clear wavy boundary.

K22m 64-120 cm. White (10YR 8/1) and pinkish white (7.5YR 8/2, dry) or light gray (10YR 7/2) and pinkish gray (7.5YR 7/2, moist) carbonate-cemented material; massive; extremely hard; sand grains separated by carbonate; effervesces strongly; gradual wavy and irregular boundary.

C3ca 120-230 cm. White (10YR 8/1, dry) or very pale brown (10YR 7/3, moist) sandy loam; matrix is massive and soft; many indurated, extremely hard carbonate nodules; carbonate coatings on nodules and sand grains; calcareous; effervesces strongly; gradual wavy boundary.

C4ca 230-315 cm. Light gray (10YR 7/2, dry) or yellowish brown (10YR 5/4, moist) sandy loam; matrix is massive and soft; few indurated carbonate nodules; carbonate coatings on nodules and sand grains; effervesces strongly; gradual wavy boundary.

C5 315-356 cm. Light brownish gray (10YR 6/2, dry) or yellowish brown (10YR 4.5/4, moist) sand; single grain and massive; loose and soft; noncalcareous.

Table 128. Typical (underlined) and range in selected properties for major horizons of Cruces.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	<u>ls</u>,s	0-10	<u>5YR-</u> 7.5YR	<u>5</u>,6	<u>4</u>,5	3,<u>4</u>
B2t	18-36	sl scl <u>fsl</u>	0-35	2.5YR- 5YR <u>3.5YR</u>	4,<u>5</u>	<u>3</u>,4	4-<u>6</u>
K2m	36-120	--	--	7.5YR- <u>10YR</u>	6-9 <u>8</u>	5-8 <u>7</u>	1-4 <u>2</u>
C1ca	230-315	s ls	0-10	7.5YR- <u>10YR</u>	5-7 <u>8</u>	4-6 <u>7</u>	<u>2</u>-4
Control section		sl,scl	0-15				

Other. Depth to the petrocalcic horizon (the K2m horizon in the description) is usually about 25 to 40 cm, ranging from 15 to 50 cm. The A horizon has been eroded in many places and the Bt horizon is at the surface. These soils are typically noncalcareous to depths of from 20 to 40 cm but in a few places the Bt horizon is calcareous throughout. Noncemented, nodular carbonate occurs at depths of from about 40 to 50 cm. The K horizon is continuous except where penetrated by pipes. A multiple laminar horizon is common at the top of the Km horizon. The C horizon consists of a few to many m of sand, which is commonly noncalcareous. Usually there are only a few pebbles but more gravelly zones do occur in places at a depth of several m.

SOIL OCCURRENCE

Paleargids. The loamy, shallow Cruces soils are most common near scarps and on or near a very few slight ridges. The coarse-loamy Hueco soils and fine-loamy Cacique soils occur primarily away from scarps and in broad areas between ridges. They also occur along the edges of pipes where depth to the petrocalcic horizon ranges from 50 to 100 cm. Fine Paleargids (SND-5) occur only in several very small spots on upper La Mesa. These areas are 5 to 10 m in diameter and occur away from scarps.

Haplargids. The fine-loamy Bucklebar soils occur in pipes. The pipes cannot be predicted from landscape position since the slopes blend smoothly with those of adjacent soils. Observations in trenches indicate that these pipes are intermittently present over the whole area. Small areas of Dona Ana, deep petrocalcic phase (with a petrocalcic horizon deeper than one m) are also present.

Paleorthids. The sandy Tonuco soils, the loamy Simona soils and the loamy-skeletal Tencee soils occur on slight ridges.

Torripsamments. Pintura soils occur in dunes which occur mostly adjacent to scarps.

SOIL BOUNDARIES

Table 129 gives information about boundaries to major adjacent units.

Table 129. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Tencee complex, eroded (10C)	The boundary has been caused by landscape dissection, and occurs where soil truncation has gradually removed horizons above the petrocalcic horizon. This causes the upper part of the petrocalcic horizon to fracture (see section 74), giving rise to the skeletal Tencee soils, in which the coarser fragments are derived from fracture of the upper part of a preexisting petrocalcic horizon. The topographic boundary between the 10C and 12P units is not distinct because both units commonly occur on about the same slope. However, the boundary does approximately parallel the scarp. The approximate boundary is commonly marked by a vegetation change from mesquite, *Condalia spp*. and four-wing saltbush (unit 12P) to dominantly creosotebush (unit 10C).
Bluepoint sand (13Y)	The boundary has been caused by landscape dissection. Soils of unit 12P have been truncated along the boundary; downslope from the boundary, soils of unit 13Y have formed in sandy sediments (once beneath the 12P soils) which have been exposed by truncation. Topographically the boundary is marked by a shift from the level or nearly level basin floor (unit 12P) to the 5 to 10 percent slopes of unit 13Y.

OTHER STUDIES

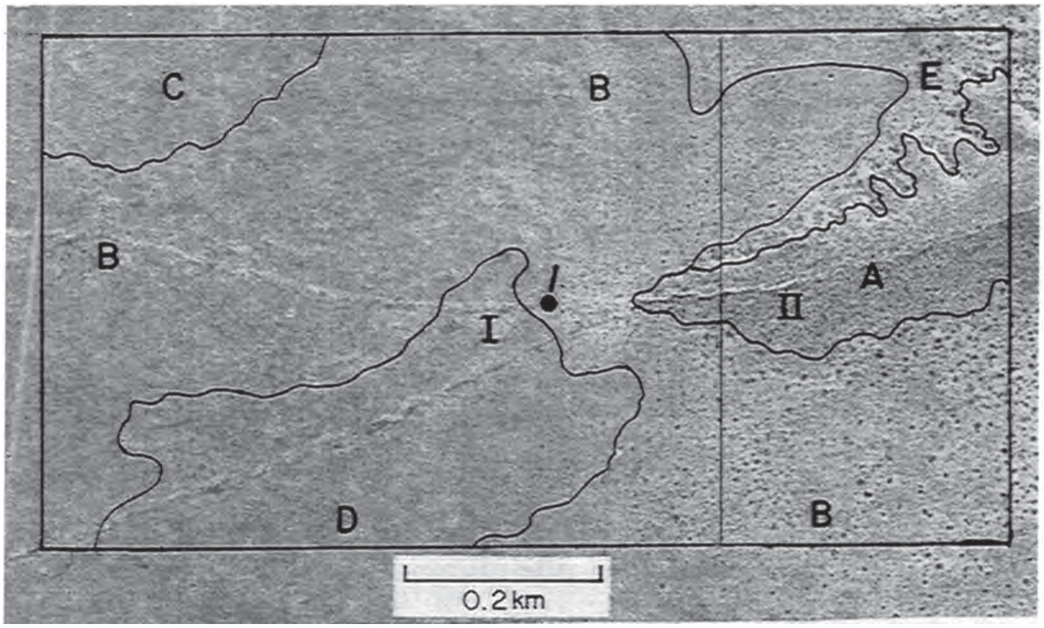
The soils of upper La Mesa are considered to be older than soils of lower La Mesa and may be the oldest soils in the study area. The K horizons are thick and complex, but are thought to have formed the same way as in the younger soils--by long-continued carbonate accumulation. The greater complexity of the K horizon is attributed to their greater age. Three pedons were sampled in this mapping unit--Cruces 61-7, Cruces 66-12, and Bucklebar 68-8. Pintura 66-13, in a dune, was sampled a short distance to the west (Appendix).

Two soils of upper La Mesa will be considered here--a Typic Haplargid (Bucklebar 68-8) in a pipe, and a Petrocalcic Paleargid (Cruces 61-7) adjacent to the pipe. Their location is shown in figures 113 and 114. Laboratory data are in table 130.

A Petrocalcic Paleargid of upper La Mesa.

The argillic horizon of Cruces 61-7 (fig. 115) is discussed in section 81; characteristics of its laminar horizon are in section 73; and physical properties are discussed in sections 96 to 98. Figure 114 shows the pipe and the horizon sequences along the airport trench exposure where Cruces 61-7 and Bucklebar 68-8 were sampled.

Despite the great age of this soil, the argillic horizon contains about 40 percent of weatherable minerals and there is little change with depth. This indicates lack of rigorous weathering during soil development.



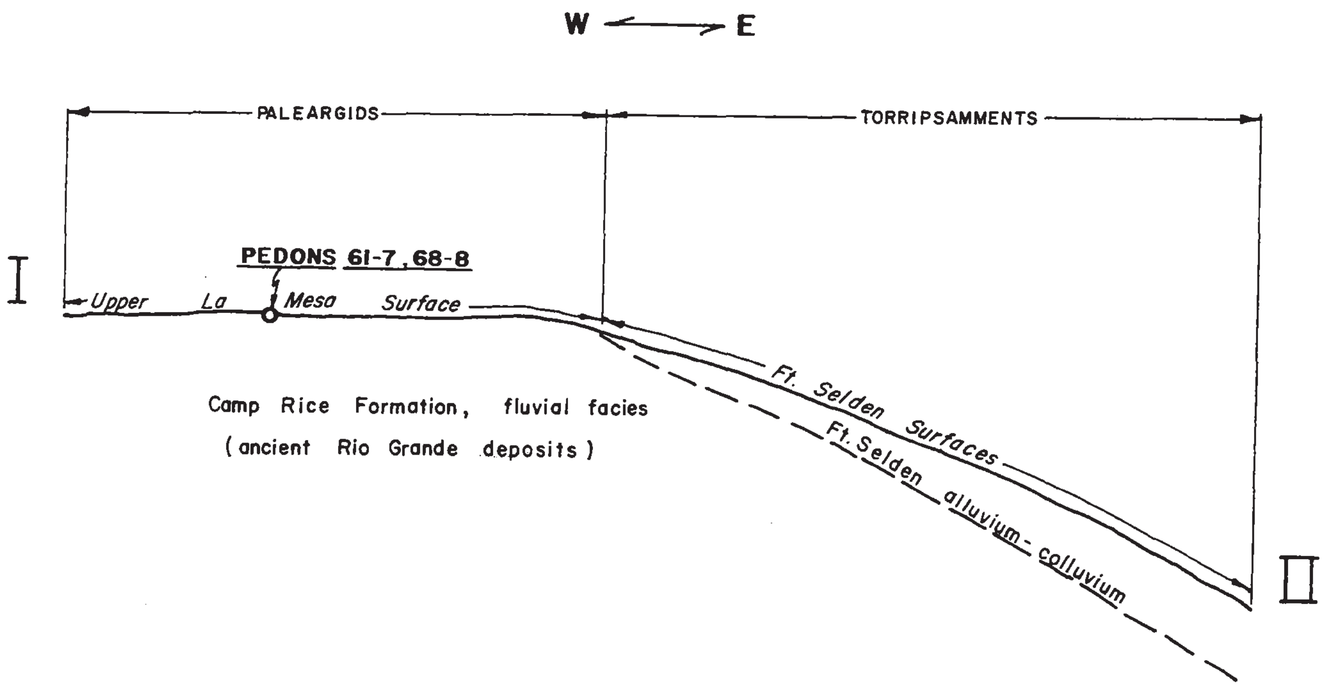


Figure 114. Upper. Soil map in the vicinity of the airport trench and pedons 61-7 and 68-8. A = Bluepoint sand (Fort Selden surface). B = Cruces fine sandy loam (La Mesa surface). C = Cruces-Hueco complex (La Mesa surface). D = Cruces-Cacique complex (La Mesa surface). 1 = pedons 61-7, 68-8. I to II locates cross section.

Lower. Cross section from points I to II, soil map.

Table 130. Laboratory data for two Argids of upper La Mesa.

Horizon	Depth	Sand 1/	Silt 1/	Clay 1/	$CaCO_3$ Equiv.	Organic Carbon
	cm	pct	pct	pct	pct	pct
Typic Haplargid (Bucklebar 68-8) in pipe						
A	0-5	76	6	18	tr(s)	0.23
B1t	5-30	73	7	20	2	0.19
B21tca	30-48	78	4	18	6	0.11
B22tca	48-79	82	4	14	3	0.04
B23tca	79-114	78	8	14	10	0.04
K&B	114-157	82	8	10	10	0.02
Petrocalcic Paleargid (Cruces 61-7) near the pipe						
A	0-5	85	5	10		0.25
B1t	5-18	87	4	9		0.13
B1t	18-25	81	6	13		0.17
B21t	25-36	80	5	15	1	0.14
B22tca	36-48	77	6	17	16	0.24
K21m	48-74	68	9	23	75	0.15
K22m	74-102	71	11	18	65	0.05
K23m	102-150	75	6	19	51	0.06
K31 2/	150-185				52	
K32 2/	185-236				41	
C1ca	236-272	89	6	5	13	
C2	272-353	91	4	5	2	

1/ Carbonate-free basis.

2/ Earthy nodules were abundant after carbonate removal. They resisted disaggregation in the particle size procedure and made particle size distribution data misleading.

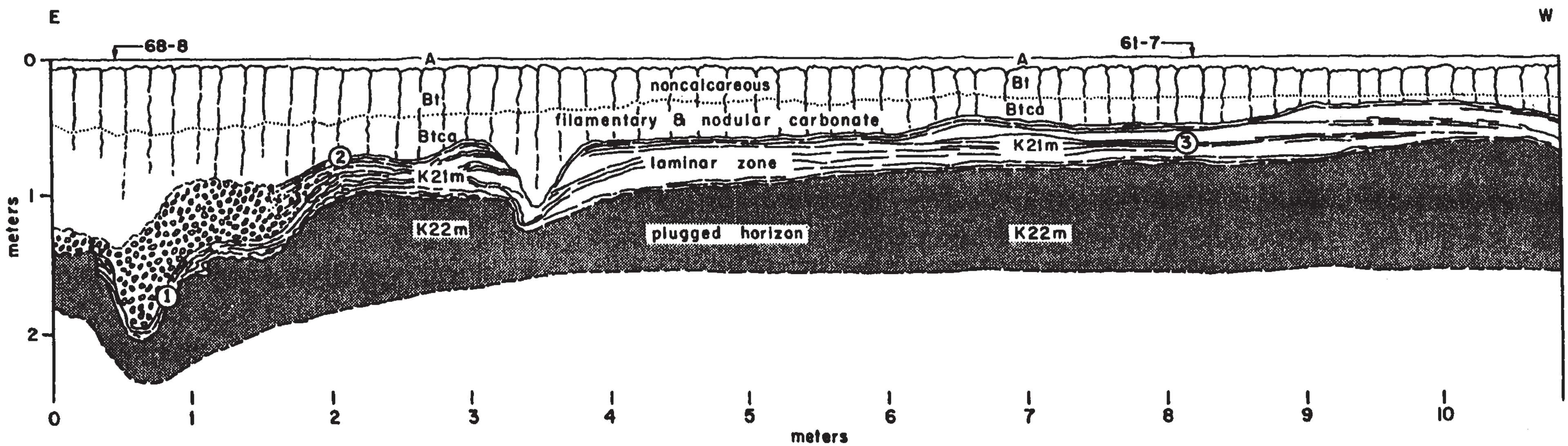


Figure 115. Cross section of airport trench in vicinity of pedons 61-7 and 68-8. 1, 2, 3 locate horizons dated by radiocarbon (see table 131).

The mineralogy of Cruces 61-7 was studied by Vanden Heuvel (1966) and the data given in the Appendix were drawn largely from his work. Attapulgite and sepiolite occur in the middle and lower K horizon, with the attapulgite concentrated above the sepiolite. The maxima in both occur below the silicate clay bulge, which is in the uppermost K horizon. The regional occurrence of these minerals in the Southern Great Plains is reviewed by McLean et al. (1972). Frye et al. (1974) discuss the occurrence in caliche of central-eastern New Mexico. Attapulgite and sepiolite contain structural magnesium. Total analyses confirm a bulge in magnesium in the zone (K22m-K32) where attapulgite and sepiolite are concentrated. Based on allocation of the magnesium to assumed structural formulas, the K22m contains about 10 percent attapulgite and the K32 horizon contains 25 percent sepiolite on a carbonate-containing basis. These percentages set the maximum values for the pedon. Total analysis data on the clay from the K32 horizon are consistent with an aluminous sepiolite. The CO_2 values are significant; the number of moles of CO_2 and of CaO are nearly equal. This is strong evidence for the predominance of calcite and a very low proportion or absence of dolomite. X-ray observations also failed to show the presence of a significant proportion of dolomite. In passing, the greater proportion of mica in horizons above the K horizon is consistent with observations on other soils of the project.

Thin sections show that the sepiolite and attapulgite in the K horizon occur as aggregates and coatings concentrated in channels, and also as a network of fiber-like particles in the matrix. In the C horizon, much of the attapulgite occurs as coatings on sand grains. From these observations Vanden Heuvel concludes:

> ...the sepiolite and attapulgite crystallized in the soil during the period of caliche formation.... Then, during period of higher rainfall when the caliche was partially dissolved along solution channels, the sepiolite, attapulgite, quartz, feldspar and other mineral grains were concentrated, the sepiolite and attapulgite forming aggregates and coatings.... During subsequent drier periods, fresh calcite then crystallized in the solution channels, but in some cases at least, only partially filled them.

Alternatively, much of the attapulgite and sepiolite may have been emplaced prior to appreciable carbonate accumulation, which could have filled between and pushed apart the aggregates and fiber-like bodies to form a network in the matrix. The channels mentioned in which these minerals are concentrated may be parts with lower initial carbonate accumulation. For example, they could represent former root channels that existed early in the history of the soil and that never completely filled with fine earth after the overlying horizons were carbonate-plugged.

Attapulgite and sepiolite form under saline, lacustrine conditions (Parry and Reeves, 1968; McLean, Allen and Craig, 1972). Dolomite is commonly associated with the sepiolite. Dolomite is present in only trace amounts if at all in clay from the zone in which sepiolite is common in pedon 61-7. This lends support to the alternative hypothesis that attapulgite and sepiolite were emplaced after the carbonate. The attapulgite and sepiolite may have an eolian origin. Evaporation of nearby small lakes on La Mesa may have resulted in an eolian source. In addition, the attapulgite and sepiolite may have formed under conditions of high water tables prior to entrenchment of the Rio Grande. Such an origin raises the question of the lack of appreciable dolomite in the K horizon. Whatever the origin of the attapulgite and sepiolite, their accumulation apparently predates the development of the large pipe in which Bucklebar 68-8 occurs. No attapulgite or sepiolite was found in this pedon.

The genesis of Cruces 61-7 may have been along the following lines. An early feature of development appears to have been the formation of a thick B horizon and an underlying horizon of carbonate accumulation; the relatively high effective moisture associated with pluvial climates of the Pleistocene and the sandy parent materials should have resulted in thick zones of leaching. In places, sepiolite and attapulgite--possibly deposited in small ponds on La Mesa, prior to downcutting of the Rio Grande--may have been redistributed and pushed apart by carbonate accumulation. Subsequent carbonate accumulation apparently engulfed the lowermost part of the B horizon (probably in the position presently occupied by the K23m or K22m horizons), finally plugging these horizons and causing the formation of the lowermost laminar horizon of the laminar zone. Carbonate-plugging and laminar horizon formation probably proceeded most rapidly during the Pleistocene pluvials, since more moisture would have been available for carbonate movement. Such rapid development is indicated by the similar C-14 ages (both inorganic and organic) for the upper and lower parts of the middle laminar horizon of pedon 61-7 (table 131). The organic carbon date of 21 kyrs for the hard laminar zone of 61-7 falls within the full-glacial maximum of 17,000-23,000 years B.P. (Martin, 1964). This fits genetic ideas of the laminar horizon discussed earlier (section 73) since free water should have been more abundant in the pluvial.

Table 131. Carbon-14 ages of inorganic and organic carbon from pedon 61-7 and edge of pipe

Horizon	Morphology of dated carbonate	C-14 age Inorganic	C-14 age Organic
		kyrs	kyrs
Pedon 61-7 (#3, fig. 114)			
K21m	Upper hard part of laminar horizon from the middle of the laminar zone.	29	21
	Lower hard part of laminar horizon from the middle of the laminar zone.	30	21
K22m	Upper part of the plugged horizon.	28	
Edge of pipe (#1, 2, figs. 114, 117)			
	Upper laminar horizon (#2)	21	
	Laminar horizon in lower part of pipe (#1).	32	

A Typic Haplargid in a pipe.

Bucklebar 68-8 (fig. 116) is in the large funnel-shaped pipe at about the 1-m station (fig. 114). Viewed frontally, since the section is cut to the near side of the central axis of the pipe, only about half its depth is shown and the apparent bottom is actually the pipe wall. A smaller pipe is located just to the right. Its funnel shape and flared upper orifice are apparent. The bowed structure immediately to the right of the smaller pipe consists of the laminar carbonate lining of the pipe wall.

The A horizon and noncalcareous upper Bt horizon continue across the pipe without change. The underlying Btca horizon, which contains common carbonate nodules and is in stage II of carbonate accumulation, also extends across all horizon sequences of the section, but it is much thicker inside the pipe. Outside the pipe, it rests abruptly on the laminar horizon (K21m). Inside the pipe, it grades across a clear boundary to a K1 horizon consisting of a carbonate-whitened matrix enclosing numerous spheroidal masses of reddish brown, slightly calcareous to noncalcareous, sticky Bt-horizon material. These inclusions lend a cellular appearance and suggest engulfment by carbonate of a pre-existing Bt horizon. Laterally, the upper part of the cellular horizon merges with the upper part of the multiple laminar horizon. With increasing depth the cellular horizon either rests abruptly against a laminar horizon (the lining of the pipe) or grades to a carbonate-plugged K horizon (inside the pipe). Weathered exposures of the underlying carbonate-plugged K horizon show faint spheroids, suggesting that it passed through a cellular stage.

Continuity of the Btca horizon across all horizon sequences suggests that its carbonate is younger than the carbonate in horizons below. Lateral merging of the cellular horizon with the upper part of the multiple laminar horizon shows that the two were formed contemporaneously. It also indicates, since the multiple laminar horizon forms from the bottom upward (section 73), that the cellular horizon is younger than the lower portion of the multiple laminar horizon. Continuity of the lower part of the multiple laminar horizon down into the pipes demonstrates that the pipe preceded the lower laminar horizon.

The presence of Bt horizon material in the cellular horizon and the extension of the laminar horizon into the pipes beneath the cellular zone both suggest that the pipes were once free of carbonate and must have been regularly flushed by water. The occurrence of the cellular and Btca horizons in the pipes indicates that there might have been at least two progressive changes to a drier soil moisture regimen, probably due to changes in climate.

The control exercised on formation of the laminar horizon by depth to the carbonate-plugged horizon is discussed in section 149. A similar example on a small scale is shown in the pipe (figs. 114, 117). Inside the pipe (at about the 2-m station) a cellular horizon has formed. Outside the pipe, where depth to the carbonate-plugged horizon is shallower, a laminar horizon has formed instead of the cellular horizon.

Figure 116. A Typic Haplargid, Bucklebar 68-8, in pipe shown in figure 115. See figure 117 for closeup of margin of pipe. Scale is in feet.

Figure 117. Margin of the pipe shown in figure 116. Upper laminar horizon disappears towards the left, concurrent with an increase in depth to indurated material. Area of laminar horizon disappearance is marked by the jackknife. The lower laminar horizon is thick and continuous. Zones dated by radiocarbon indicated. 1 = 21 kyr (table 131); 2 = 32 kyr.

The carbonate morphology and depths in the pipe have chronological implications. The stage I filamentary carbonate in the B21tca horizon should be the youngest; judging from its similarity to carbonate morphology in soils of Fillmore and Organ age, filamentary carbonate in the B21tca horizon has probably been emplaced in late Holocene time and is currently accumulating there.

Stage II horizons (such as the B2tca horizon) do not occur in soils less than 6,000 years old in the study area. Soils of Leasburg and Issacks' Ranch are the youngest soils in which stage II horizons occur. These horizons may have formed mainly during minor pluvials between the start of the Altithermal, 7500 years ago, and the end of the full-glacial period 17,000 years ago. Carbonate in the cellular-appearing horizon below the nodular zone must have been emplaced by water that moved quite deeply, but not as deeply as that involved in development of the still older, underlying laminar horizon. The depth to the laminar horizon and its thickness suggest a time of considerably greater moisture than during the accumulation of carbonate in any of the overlying horizons. This laminar horizon has a C-14 age of 32 kyr (table 131), only slightly greater than for the middle laminar zone of pedon 61-7. This laminar horizon may also have formed during the full-glacial pluvial.

Discussion. The major soils of upper and lower La Mesa are similar in several respects. Soils of both surfaces can have Bt horizons and thick Km horizons that grade through nodular K3 horizons into C horizon material. The Bt horizons contain similar amounts of silicate clay; lower subhorizons commonly contain nodules of carbonate-cemented, former B horizon material. However, the soils do have certain morphological differences that are attributed to an age difference between lower and upper La Mesa. The Km horizon of the Onite phase (dominant on lower La Mesa) lacks a laminar horizon and although some Km horizons of lower La Mesa soils do have laminar horizons, they are commonly single and show no evidence of fracture and recementation. In contrast, Km horizons of upper La Mesa soils commonly have multicyclic laminar zones that consist of a number of laminar horizons, often separated by nonlaminar, carbonate-cemented material. Also, there is evidence of fracture, weathering, and recementation in laminar horizons of some soils on upper La Mesa. Pipes that penetrate the K horizons of upper La Mesa soils are usually thickly (several mm to several cm) lined with laminar carbonate, whereas linings in pipes of lower La Mesa soils have been observed only where the K horizon is shallow, and such linings are very thin. Pipes of upper La Mesa soils have more complex morphologies and contain evidence of a greater number of cycles of carbonate accumulation than do pipes of lower La Mesa soils.

Alluvial parent materials of lower La Mesa soils may have been deposited later than those of upper La Mesa soils. Soil development may therefore have started later in mid-Pleistocene time and this may be the reason for the observed morphological differences in the soils.

153. SOILS OF THE PIEDMONT SLOPES.

A broad area designated the piedmont slope extends from the valley border and the basin floor to the mountains. Individual fans and interfan valleys occur along the mountain fronts. Downslope is a broad, coalescent alluvial-fan piedmont that is dominantly of late-Pleistocene (Jornada II) age, overlain in many places by Holocene (Organ) deposits. Slopes range from 1 percent next to the basin floors to about 40 percent on steeper parts of large fans along the mountain fronts.

The coalescent fan-piedmont. Relative ages of soils along the valley border are determined by their position in the stepped sequence of geomorphic surfaces (fig. 61); on the coalescent fan-piedmont, relative ages of soils of the various surfaces are determined by their position in a vertical section involving buried soils (fig. 117a). The lowest buried soil shown in figure 117a is the oldest, and the soils above are successively younger. All of the buried soils shown in figure 117a occur at the land surface in other areas.

As along the valley border, the stages of carbonate accumulation are valuable chronological and stratigraphic markers of the soils. Table 131a presents the stages of carbonate accumulation for soils of the fan-piedmont. Table 131b shows major soils of the arid part of the piedmont slopes. Most of these occur on the fan-piedmont section of the piedmont slope.

Terraces along the mountain fronts. Terraces of a number of levels and ages are apparent in places along the mountain fronts. The terraces constitute a stepped sequence of surfaces, with relative age relations similar to those along the valley border: age of the terraces and their soils increase with increasing elevation of the steps. While these terraces have been studied in detail in only a few places, at least four ages of terraces are known to occur--Organ, Jornada I and II, and Dona Ana. In other areas the age relations are less apparent. In places downslope many surfaces and soils of different ages gradually merge and are at about the same elevation, resulting in complex soil-landscape relations (section 154). The terraces are most prominent downslope from Ice and Soledad Canyons because these watersheds are the largest and have the highest peaks.

Table 131c gives the stages of carbonate accumulation for soils of the various surfaces in the mountain canyons (rhyolite parent materials). The chronology differs from the arid zone downslope because of greater precipitation. Table 131d shows major soils of the mountain-front areas.

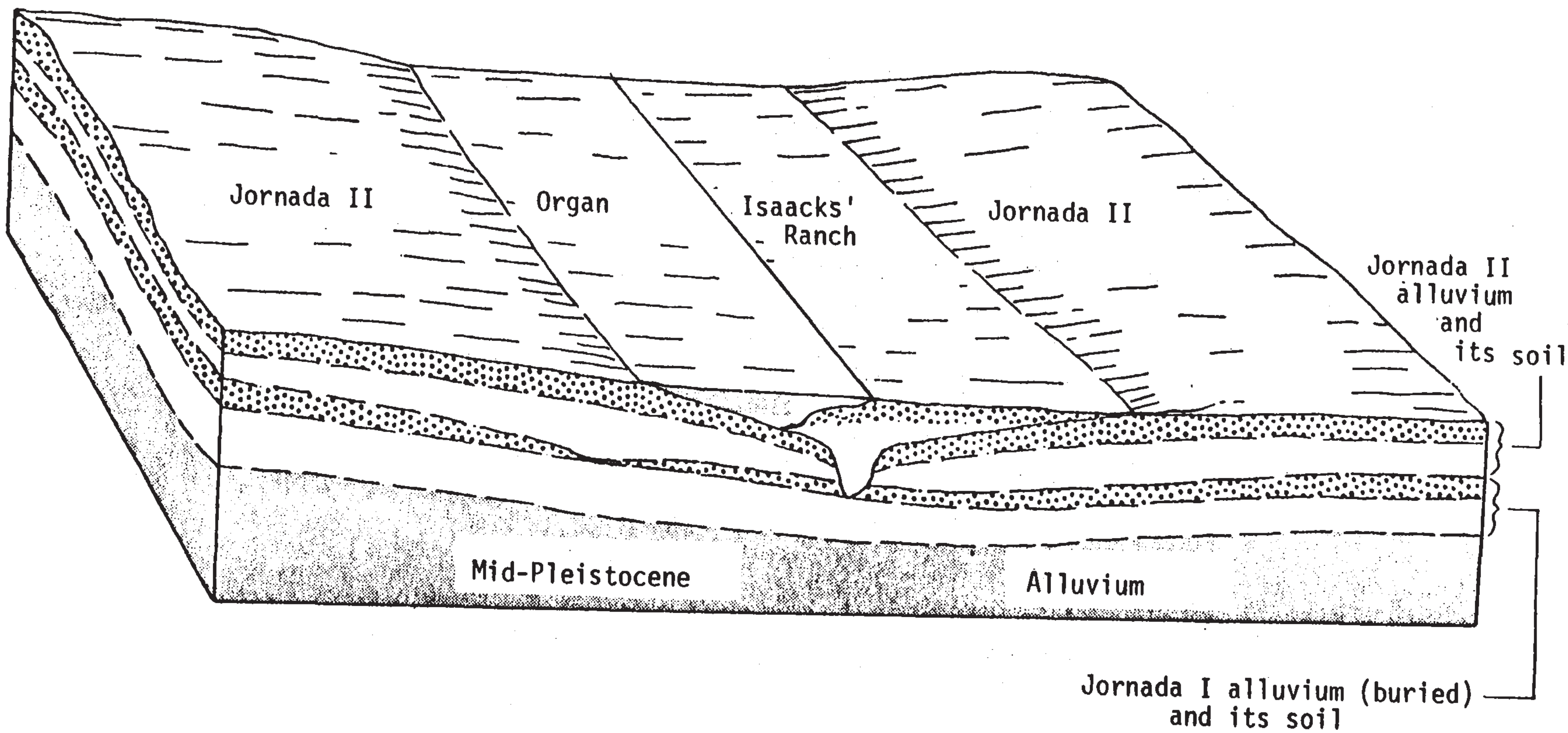


Figure 117a. Generalized diagram in the vicinity of a broad drainageway on the fan-piedmont. The diagram illustrates the relative ages of soils of four geomorphic surfaces. The soils of the Jornada I surface are the oldest; soils of Jornada II, Isaacks' Ranch, and Organ are successively younger. The stipples designate Bt horizons which in the buried soils formed when they were at the land surface. Horizons of carbonate accumulation occur beneath the Bt horizons (see table 131a for stage of carbonate accumulation for soils of each age) The soil morphology and occasional presence of C horizon material in the lower part of Jornada II alluvium demonstrate that the clay and carbonate horizons of Jornada I are those of a buried soil (formed when it was at the land surface) and not the result of deep illuviation or ground-water phenomena.

154. Soils of the Organ surface

The Organ surface is commonly inset below the Jornada surface next to the mountain fronts and deposited on it downslope (see section 164 for an exception). Organ alluvium usually occurs as individual fans or as interfan valley fills next to the mountains; in places it coalesces and constitutes a Holocene fan-piedmont. In the closed basin north of Highway 70, Organ sediments occur on large drainageways miles from the mountains (section 159). Good chronological control for soils of the Organ surface has been established by radiocarbon dating of buried charcoal and soil-geomorphic tracing (section 15).

The range in age of Organ and Fillmore alluviums is about the same. However, most Organ deposits are well preserved and not been affected by downcutting of the Rio Grande. As a whole, therefore, the full expression of pedogenesis is better reflected in soils of the Organ surface than in soils of the Fillmore.

Soils of the Organ surface also illustrate the effect of a change from an arid to a semiarid climate on soils of the same age. Towards the mountains, horizons of carbonate accumulation gradually deepen in the soil because of increased precipitation. Soils of the Organ surface illustrate the transition from the Aridisols to the Mollisols.

Smaller areas of soils of the Isaacks' Ranch surface also occur in this section. These soils are not extensive and no mapping unit consists of soils that occur mainly on this surface (section 166 shows soils of Isaacks' Ranch age in large-scale maps). Soils of this age must once have been more extensive

Table 131a. Stages of carbonate accumulation for soils of the fan-piedmont.

Stage			
Nongravelly soils	Gravelly soils	Youngest geomorphic surface on which stage of horizon occurs, and age	
I	I	Organ	Holocene
II	II	Isaacks' Ranch	Latest Pleistocene
III	III, IV	Jornada II	Late-Pleistocene
III	IV	Jornada I	Late-mid-Pleistocene

Table 131b. Relation of soil development, horizonation and classification to major soils, soil age and geomorphic surfaces of the piedmont slopes in the arid zone.

		Soil Development →								
Geomorphic surface	Soil age, years B.P. or epoch	Entisols (pedologically unmodified materials) C	Torripsamments (partial disruption of strata) C	Entisols ABC or AC	Camborthids ABC	Haplargids ABtC	Haplargids ABtK	Calciorthids ABC, AK, or ABK	Paleargids ABtKm	Paleorthids AKm ABKm
Arroyo channel	Modern	SND #6								
Coppice dunes	0-100		Pintura							
White-bottom[1/]	0-100									
Organ[2/]	100 to 7500			Anthony[4/] Anthony, 1-sk var.[4/] Glendale[4/]	Vado[3/] Pajarito	Onite Pinaleno Onite var.		Reagan[4/]		
Isaacks' Ranch	> 7500 -Latest Pleistocene					Bucklebar Pinaleno (Berino)[3/]		Weiser[4/]		
Jornada II	Late Pleistocene						Berino Dona Ana Hap Nolam Tres Hermanos	Algerita Nickel Jal[4/]	Terino Casito	Monterosa carb. var[4/] Tencee[4/] Conger[4/]
Jornada I	Late mid-Pleistocene								Terino Casito	Monterosa Monterosa, carb. var[4/] Tencee[4/] Conger[4/]

1/ Primarily an erosional surface in the silty, highly calcareous sediments east of the basin floor in the northern part of the study area. Associated sediments, where present, are stratified and only a few cm thick.

2/ Does not include Organ III.

3/ These soils are minor in extent, but are included here to show their presence in the developmental scheme. Only very minor areas of soils of Isaacks' Ranch age have enough carbonate for a calcic horizon and the Berino series (see Berino variant 59-6).

4/ Formed in high-carbonate materials in most areas. All other soils have formed in low-carbonate materials.

Table 131c. Stages of carbonate accumulation for soils of the mountain canyons.

Stage (gravelly sequence)	Youngest geomorphic surface on which stage of horizon occurs, and age	
0 or I	Organ	Holocene
I	Jornada II	Late-Pleistocene
I	Jornada I	Late-mid-Pleistocene
III, IV	Dona Ana	Mid-Pleistocene

Table 131d. Relation of soil development, horizonation and classification to major soils, soil age and geomorphic surfaces of the piedmont slopes in the semiarid zone.

Geomorphic Surface	Soil age, years B.P. or epoch	Soil Development → Entisols (pedologically unmodified materials) C	Haplustolls AC	Haplargids Argiustolls ABtC or ABtK or K & C	Paleustolls, Paleargids ABtKm	Calciustolls ABKm
Arroyo channel	modern	SND #6				
Organ	100 to 7500		Santo Tomas Aladdin Hawkeye Aladdin, calc. var.1/	Sonoita Earp		
Jornada II	Late-Pleistocene			Nolam (K or K & C) Caralampi		
Jornada I	Late mid-Pleistocene			Nolam (K or K & C) Caralampi	Terino Terino, mollic var.2/ Casito	Boracho Boracho, carbonatic var.1/
Dona Ana	Early mid-Pleistocene				Terino Casito Terino, thick-solum var. Terino, mollic var.	Boracho

1/ Formed in high-carbonate parent materials. All other soils have formed in low-carbonate parent materials.

2/ These soils are not extensive, but are included here to show their presence in the developmental scale. A wide variety of other soils also occur on the Dona Ana surface and on sides of the remnants (section 186).

at the surface than they now are because they are buried in many places by soils of Organ age. Soils of the Isaacks' Ranch surface are similar to soils of the Leasburg along the valley border in being about the same age and in being intermediate in morphology between soils of Holocene (Organ) and late-Pleistocene age (Jornada II).

Ten mapping units occur on the Organ surface.

155. PINALENO VERY GRAVELLY SANDY LOAM (13R)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
PINALENO	TYPIC HAPLARGIDS	LOAMY-SKELETAL	70
Onite	Typic Haplargids	Coarse-loamy	10
Onite, gravelly var.	Typic Haplargids	Coarse-loamy	10
Other inclusions (Torriorthents, Camborthids, Haplustolls, Entisols)			10

LOCATION, LANDSCAPE, VEGETATION

These soils occur west of the southern and middle parts of the Organ Mountains. In the southern part of the area, the soils have formed in sediments that are virtually 100 percent rhyolitic. Northward there are small amounts of andesite and monzonite in the alluvium. Elevations range from about 4400 to 5000 feet.

These soils occur on individual fans that extend outward from major canyons along the mountain front. In upslope parts the soils commonly occur on narrow terraces inset against higher, older alluvium. Downslope the sediments have spread out and buried older sediments and soils. The soils have formed in deposits of two general ages (Organ and Isaacks' Ranch, with Organ dominant) and this is manifested in places by several levels of fans that differ slightly in elevation. At other places the soils of Isaacks' Ranch age are buried by those of Organ age. Arroyos and gullies are common. Slope ranges from 8 percent next to the mountains to 3 percent in the western part of the unit.

Vegetation consists of snakeweed, Mormon tea, mesquite, fluffgrass, cholla, prickly pear, and a few creosotebush and bush muhly. Black grama occurs in a few places in the mountainward parts of the mapping unit.

TYPICAL PEDON, PROPERTIES AND RANGES

Pinaleno

A typical pedon of Pinaleno is described in the Appendix (pedon 67-4). Figures 118 and 119 are photographs of the pedon and its landscape. A table of properties and ranges is given below.

Table 132. Typical (underlined) and range in selected properties for major horizons of Pinaleno.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	<u>sl</u> ls	0-75	5YR- <u>7.5YR</u>	<u>5</u>,6	3-5 <u>4</u>	2-4 <u>3</u>,<u>4</u>
B2t	18-30	<u>sl</u> hv.sl	35-75	<u>5YR</u>	4-6 <u>5</u>	3-5 <u>3.5</u>	<u>4</u>-6
C1ca	51-71	<u>sl</u>,ls s	0-75	7.5YR- 10YR <u>9YR</u>	5,<u>6</u>	<u>4</u>,5	3,<u>4</u>
Control section		sl	35-75				

<u>Other</u>. At stable sites (which are dominant in this mapping unit), where there is little or no evidence of soil truncation, the noncalcareous zone ranges from about 25 cm in the western part of the unit to 75 cm at higher elevations in the eastern part of the unit. In a few places the soils are of Isaacks' Ranch age and usually these soils have more carbonate. In some pedons of Isaacks' Ranch age the carbonate horizon would probably qualify as a calcic horizon except for the requirement that the carbonate be soft and powdery (Soil Taxonomy, in press). Usually the carbonate ranges from slightly hard to very hard. These soils are commonly underlain by buried soils with argillic horizons and calcic or petrocalcic horizons. In most places the deposits in which the Pinaleno soils have formed are at least one to several m thick.

SOIL OCCURRENCE

For several reasons this unit is dominated by soils of a single soil series. (1) Most soils are old enough to have developed argillic horizons and are Argids. (2) The soils are not old enough to have developed calcic or petrocalcic horizons, thus complex occurrence of one or both of these horizons in some soils but not in others is not a factor. (3) Textures of the fine earth in the upper 40 cm are coarse-loamy, which at these elevations indicate that organic carbon is too low for the Ustollic subgroups; hence, all soils are Typic Haplargids. (4) The alluvium is generally very gravelly and complex occurrence of skeletal and nonskeletal families is not a factor for most of the area.

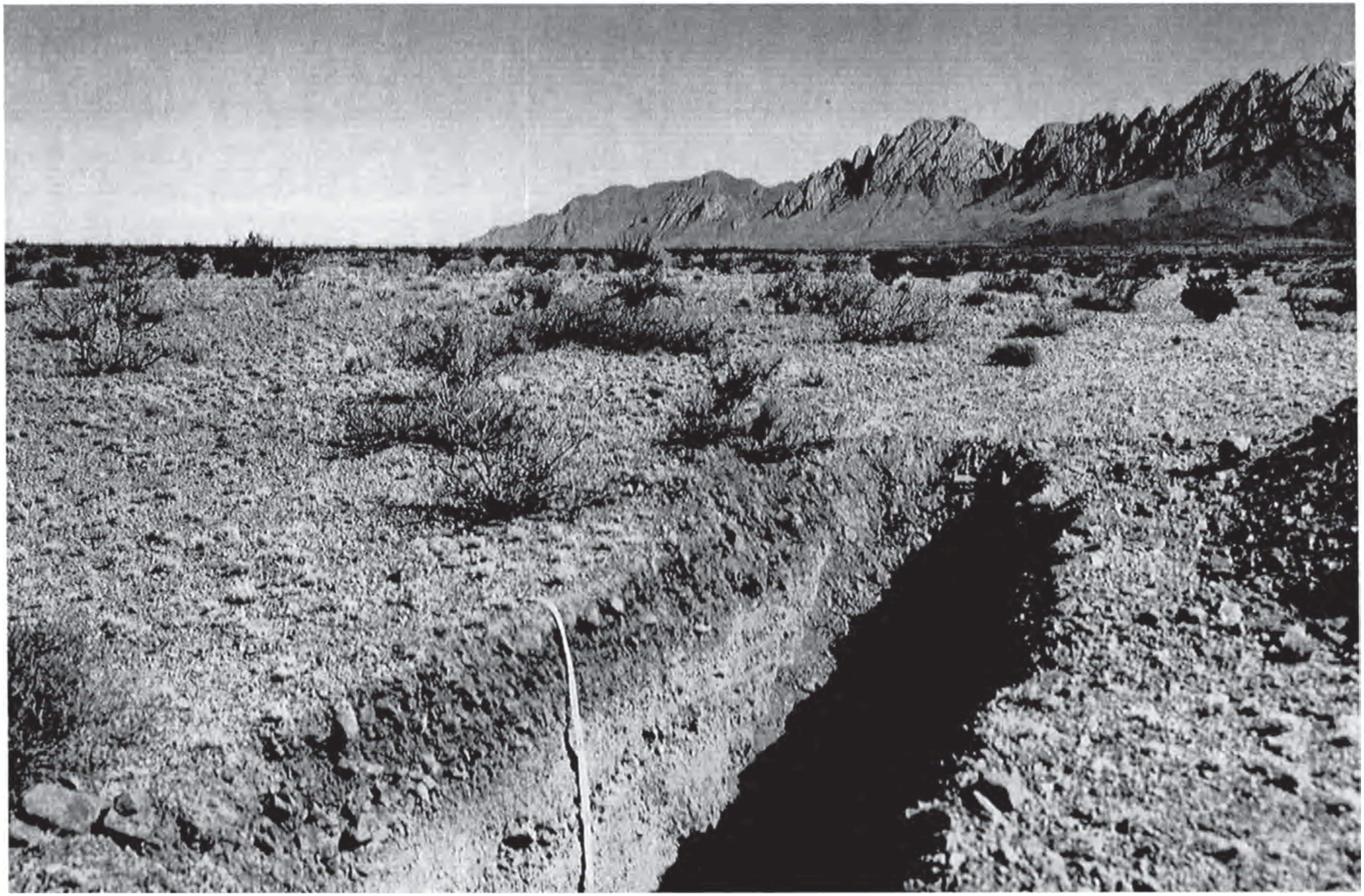


Figure 118. Landscape of a Typic Haplargid, Pinaleno 67-4, on the Organ surface. Vegetation consists of mesquite, Mormon tea, cholla, snakeweed, ratany, scattered clumps of fluffgrass, and a few <u>Condalia lycioides</u>. Slope is 4 percent.

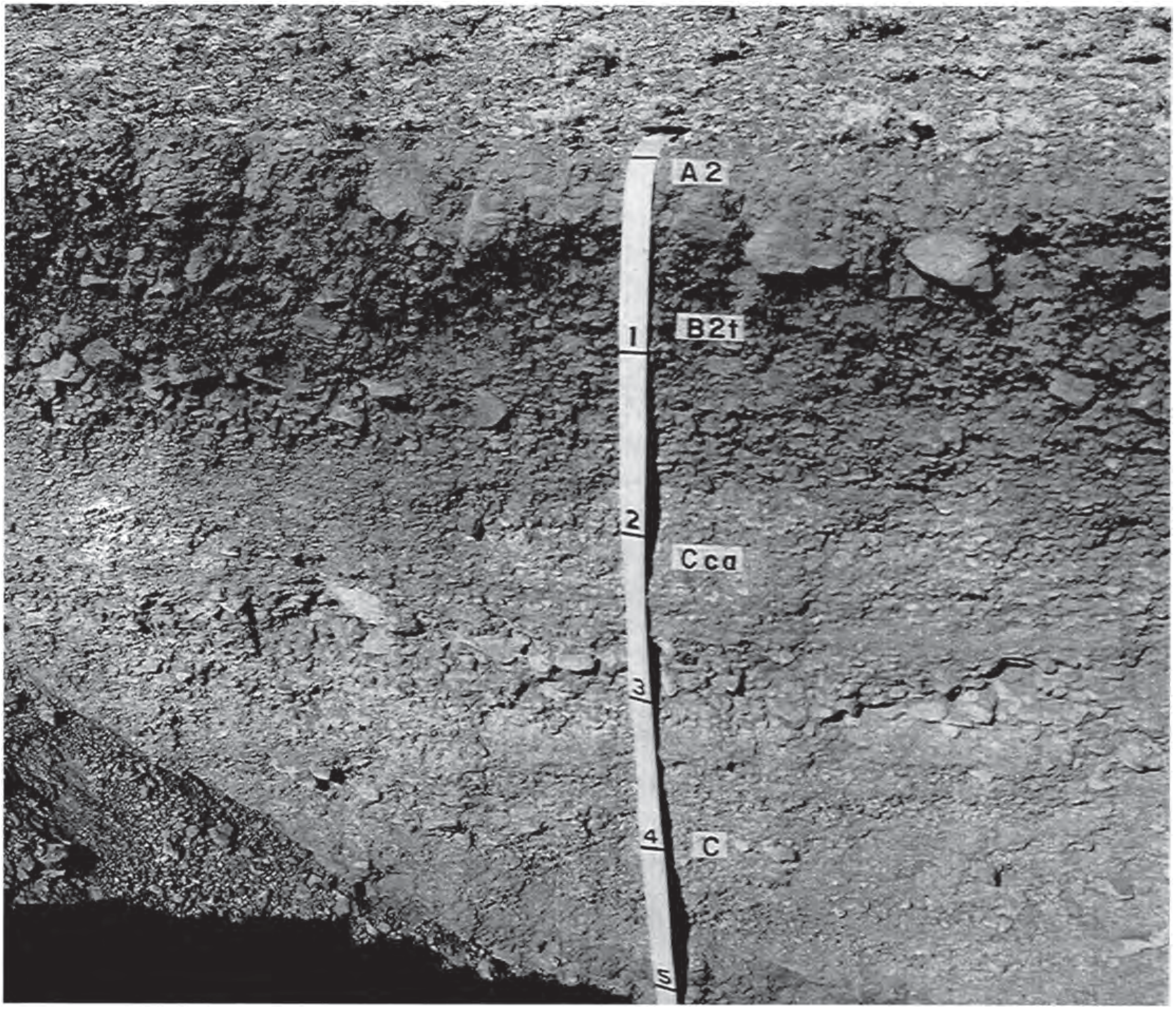


Figure 119. Pinaleno 67-4, a Typic Haplargid. Scale is in feet.

Haplargids. The loamy-skeletal PINALENO soils are by far the dominant soil and occur over major portions of the mapping unit. The coarse-loamy Onite soils and their gravelly variant occur in less gravelly materials. The fine-loamy Bucklebar soils occur in a few small areas where gravel content is low and textures in the control section (the upper 50 cm of the argillic horizon) average between 18 and 35 percent silicate clay.

Camborthids. The loamy-skeletal Vado soils; their sandy-skeletal variant; and the coarse-loamy Pajarito soils occur in youngest parts of the Organ surface. These areas are usually adjacent to large arroyos and commonly are less than 1 m higher than the channel.

Torriorthents. The sandy-skeletal Arizo soils also occur on younger parts of the Organ surface, adjacent to arroyos.

Haplustolls. Santo Tomas, Torriorthentic variant occurs in a few places at highest elevations.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 133 gives information about boundaries to major adjacent units. Figure 120 shows boundaries and stratigraphy of some of the units.

Table 133. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Monterosa complex (10RR)	The boundary has been caused by a younger alluvium and geomorphic surface (usually Organ, in places Isaacks' Ranch) in unit 13R. Where soils of unit 13R border those of unit 10RR they are commonly lower, occurring in small valley fills between ends of ridges in unit 10RR.
Terino very gravelly sandy loam (12R)	The boundary has been caused by a younger alluvium and geomorphic surface (usually Organ, in places Isaacks' Ranch) in unit 13R. At lower elevations the 12R soils, buried in unit 13R, emerge at the surface on the 12R side of the boundary. The topographic boundary between 13R and 12R is fairly distinct in places, but in others is very subtle. Nearest the mountains, soils of unit 13R are commonly inset against and are lower than soils of the adjacent unit 12R. Downslope the 13R soils commonly spread out on fans and bury soils of the Jornada surface. In the latter areas, soils of unit 13R commonly occur on slight ridges. Vegetation tends to be somewhat sparser than on soils of unit 12R.
Arizo complex (13F)	The boundary is due to a younger alluvium and geomorphic surface (younger Fillmore) in unit 13F. Topographically the boundary is distinct since the 13F soils occur in topographic lows occupied by the arroyo and adjacent Fillmore terraces.

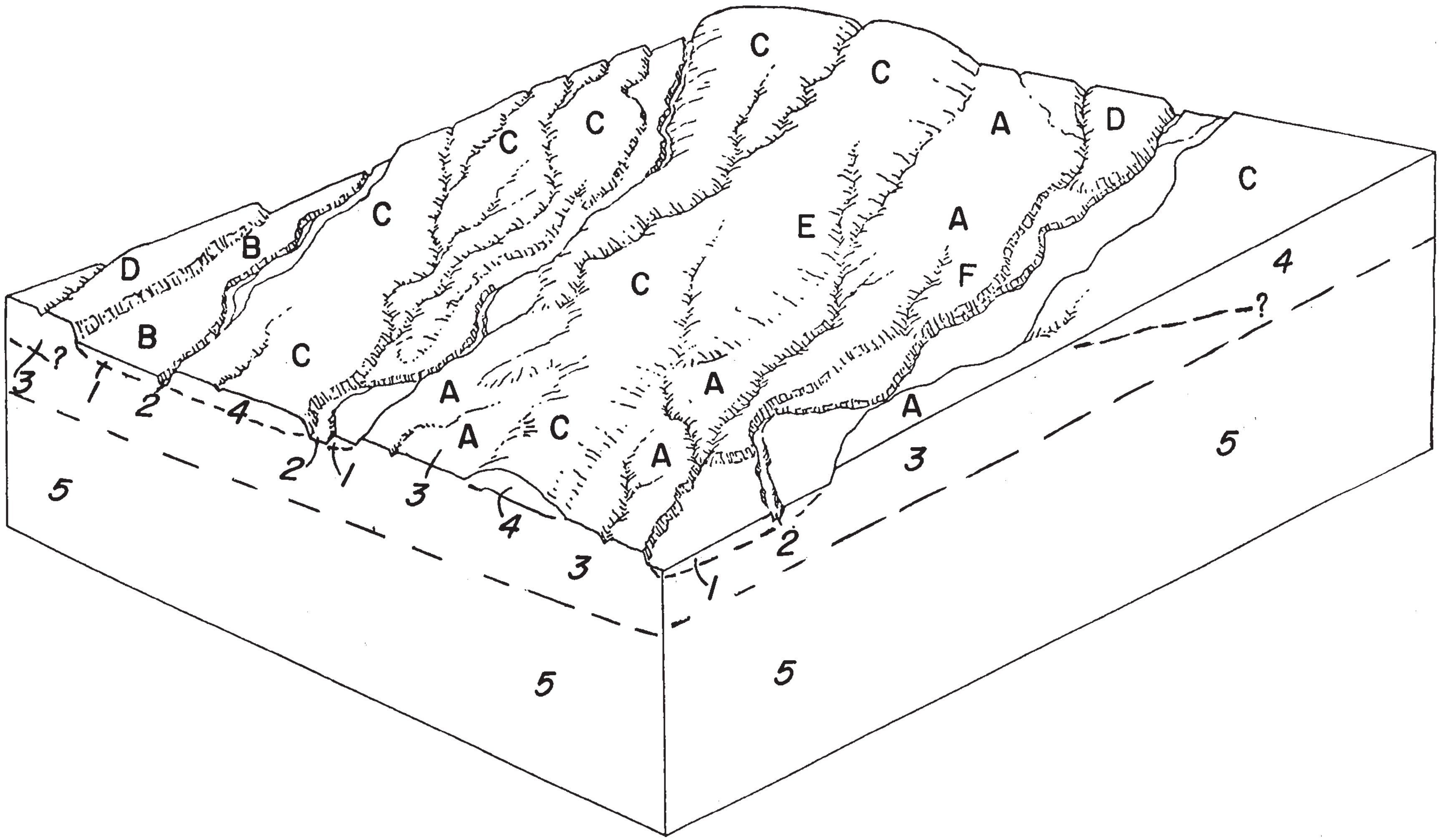


Figure 120. Block diagram of soil-landscape relations and soil stratigraphy in an area of Terino very gravelly sandy loam, Arizo complex, and Pinaleno very gravelly sandy loam. A = Terino-Nolam complex (Jornada, undifferentiated surfaces). B = Arizo complex (Organ and arroyo channel surfaces). C = Pinaleno very gravelly sandy loam (Organ surface). D = Terino, moderately deep variant (Jornada, undifferentiated surfaces). E = Pinaleno 67-4. F = Nolam 59-15.
1 = Organ alluvium and soils. 2 = Arroyo channel alluvium (not outlined). 3 = Jornada alluvium and soils. 4 = Organ alluvium and soils. 5 = Upper Camp Rice Formation (piedmont facies).

OTHER STUDIES: MERGENCE OF TERRACED TERRAIN

Figure 120a locates the area. Stable terraces of the valley border and mountain fronts present a fairly clear picture of soil geomorphic relations; specific kinds of soils occur on specific terraces, and the soils are progressively older with increasing elevation of the steps. Between the two areas. however, is a terrain in which these relations often do not hold. In some of these terrains the soils of adjacent higher surfaces are younger instead of older; and in others, soils of greatly different ages occur at about the same elevation. One of these areas is shown in a soil map (fig. 121, upper) and in diagrams (figs. 120 and 121, lower). The soils have formed in alluvium derived from rhyolite.

There are two levels above the arroyo channel in this sense, the topography is similar to the terraced terrain along the valley border. Here, however, the chronological relationships are reversed and the highest of the two surfaces is the youngest. This topographic high is the Organ surface of Holocene age and its sediments bury soils of the Jornada II surface.

Figures 120 and 121 show the geomorphic surfaces, alluviums and soils. Laboratory data for two of the soils are in table 134. Pinaleno 67-4 (Organ surface) is of Holocene age; Caralampi 59-15 (Jornada II surface) is of late-Pleistocene age. Both soils have 50 percent or more by volume of coarse fragments in all horizons and the 2-0.5 mm, which like the coarse fragments tends to act as a diluent, exceeds 25 percent (weight basis) of the fine earth in the B horizons (Appendix). Reflecting particle size distribution, both soils are highly pervious. This should maximize infiltration of silicate clay and carbonate of atmospheric origin.

Pinaleno 67-4 (table 134, fig. 119) has a thin A2 horizon, a very gravelly argillic horizon and a very gravelly Cca horizon. The soil morphology and Holocene age indicate that all horizons are within reach of wetting at the present time and are forming now. Texture is coarse in the C horizon and silt increases in upper horizons. Some of the silt, probably much of the silicate clay, and essentially all of the carbonate apparently were derived from atmospheric sources. Horizons of silicate clay and carbonate are deeper than in materials of similar texture to the west, probably a reflection of greater precipitation. The accumulations of carbonate and silicate clay are quite discrete and separate from each other; they usually overlap in soils of Pleistocene age. Flaky carbonate coatings on pebbles from the Cca horizon have been dated at 3 kyr (section 89), which does not conflict with the estimated age (from about 2000 to 6000 yr) of the soil.

In Caralampi 59-15, the size of the clay bulge (two-fold higher than in Pinaleno 67-4) is probably responsible for the higher content of organic carbon since landscape positions do not differ greatly. Silicate clay and carbonate maxima extend deeper in this soil--a reflection of greater depths of leaching in the late-Pleistocene pluvial period. Extractable iron does not show an appreciable increase from A2 to the B2t horizon, despite the large increase in clay percentage.

Carbonate contents are also greater in Caralampi than in Pinaleno (table 134). Caralampi 59-15 lacks a calcic horizon; laterally the soils do have 15

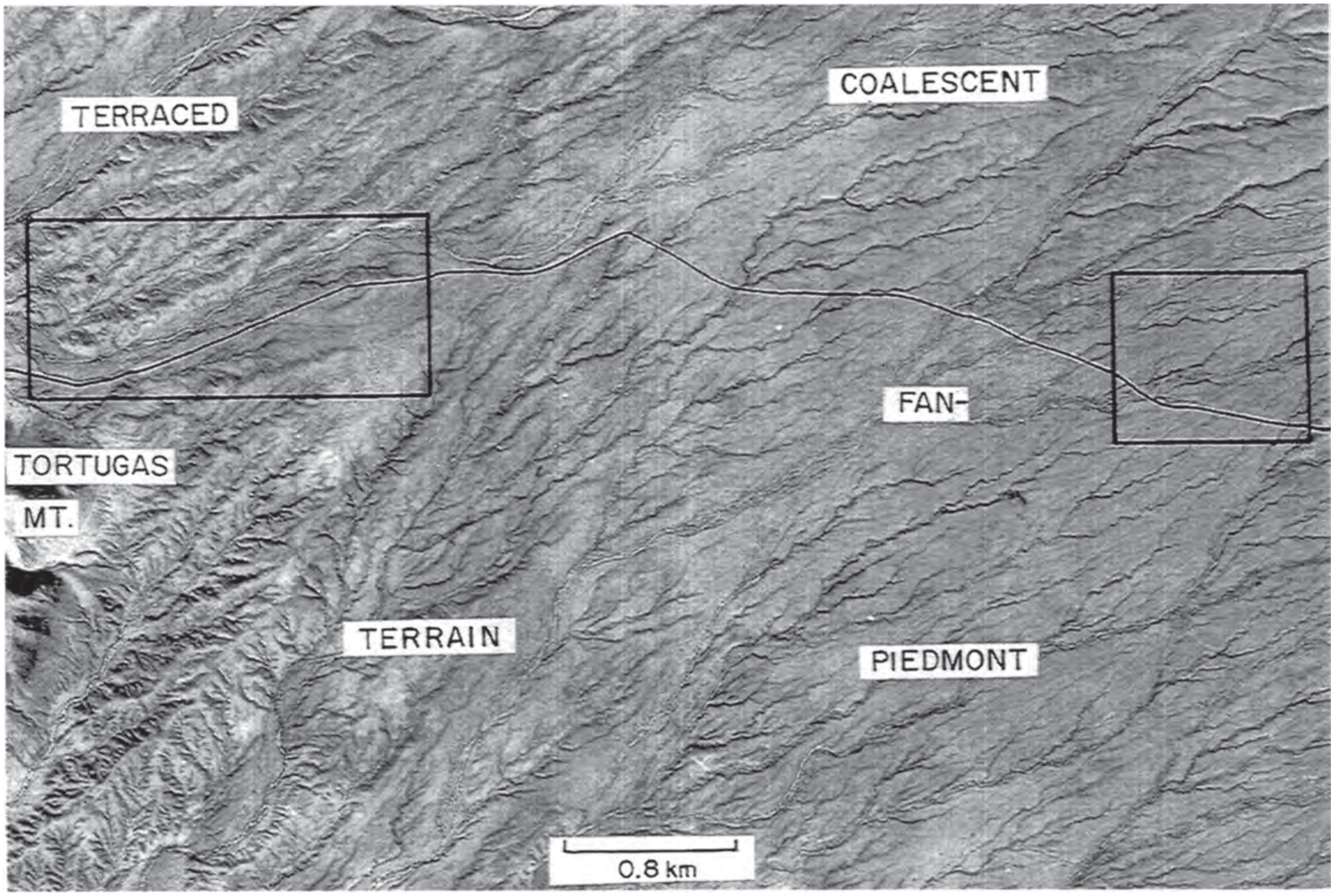


Figure 120a. Location of soil map (rectangle at right), terraced terrain and the coalescent fan-piedmont. Rectangle at left locates the soil map in section 138.

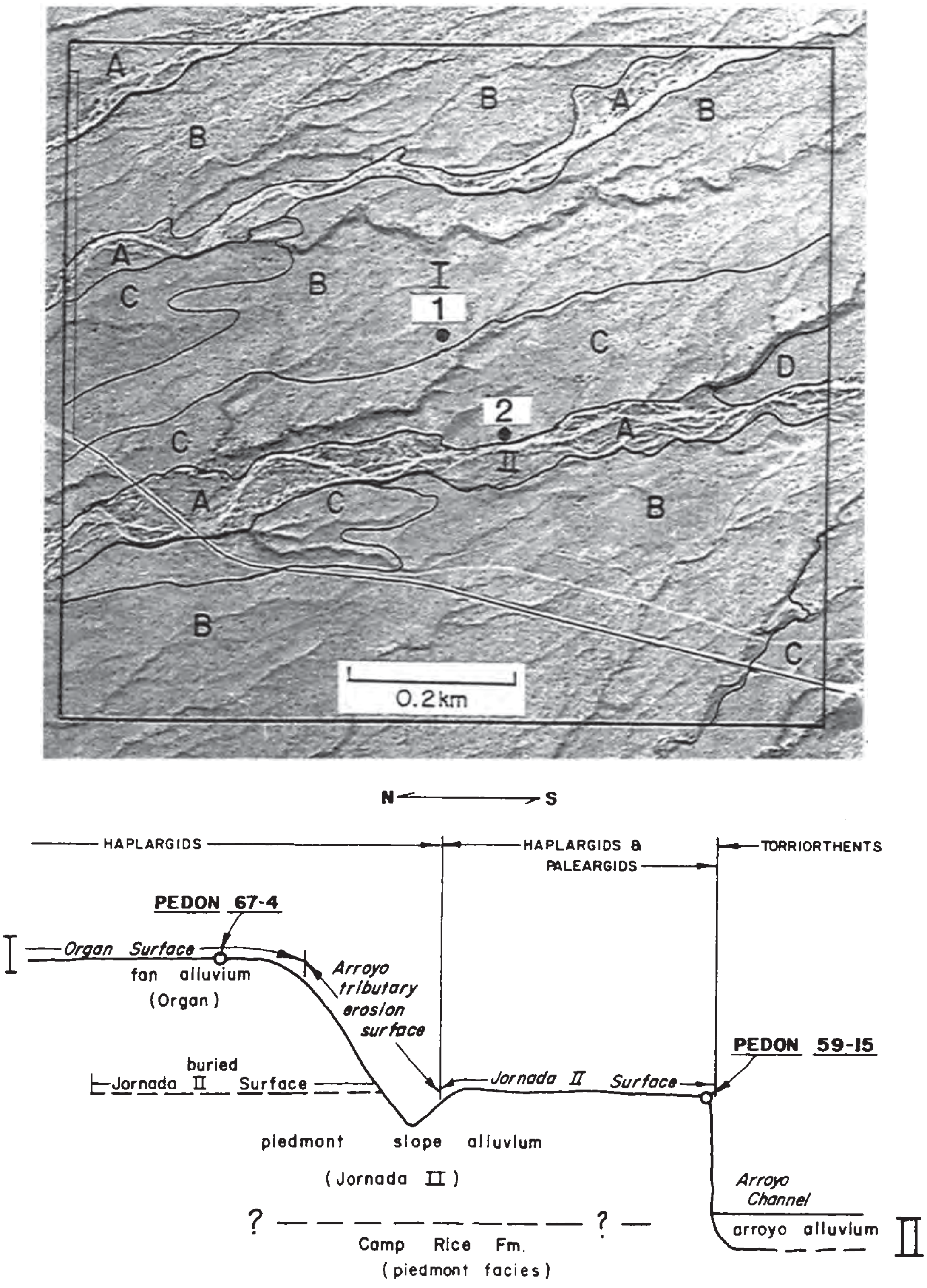


Figure 121. Upper. Map of soils in the vicinity of the Haplargids 67-4 and 59-15. A = Arizo-Torriorthent complex (Organ and arroyo channel surfaces). B = Pinaleno very gravelly sandy loam (Organ surface). C = Terino-Nolam complex (Jornada, undifferentiated, surfaces). D = Terino, moderately deep variant (Jornada, undifferentiated, surfaces). 1 = Pinaleno 67-4; 2 = Caralampi 59-15. I to II locates cross section.

Lower. Cross section from I to II on the soil map.

Table 134. Laboratory data for a Typic Haplargid and an Ustollic Haplargid.

Horizon	Depth	Sand[1/]	Silt[1/]	Clay[1/]	> 2 mm Vol.	Carbonate	Extractable iron	Organic carbon
	cm	pct	pct	pct	pct	pct	pct	pct
Typic Haplargid (Pinaleno 67-4)								
A2	0-5	68	23	8	50	tr(s)	0.9	0.18
B1t	5-18	67	22	11	50	tr(s)	0.9	0.28
B2t	18-30	65	20	15	65	tr(s)	0.9	0.30
B3t	30-51	68	19	13	65	tr(s)	0.8	0.23
C1ca	51-71	72	19	9	65	2	0.7	0.11
C2ca	71-94	75	17	8	65	1	0.7	0.07
C3	94-147	86	11	4		1	0.7	0.03
Btb	147-178	45	21	34		1	1.3	0.11
	0-38[2/]		25	14				0.41
Organic carbon, 0.9 kg/m^2 to 94 cm								
Ustollic Haplargid (Caralampi 59-15)								
A2	0-6	59	29	12	50	-(s)[3/]	0.9	0.41
B21t	6-23	51	23	26	70	-(s)[3/]	1.0	0.61
B22t	23-43	55	17	28	70	tr(s)	1.0	0.57
B3ca	43-71	74	13	14	85	4	0.7	0.27
K&C	71-109	71	16	13	55	10	0.7	0.11
Cca	109-145	79	13	8		6	0.6	
Organic carbon, 1.6 kg/m[2/] to 109 cm								

1/ Carbonate-free basis for Caralampi 59-15 only.
2/ Composite.
3/ Pebble coatings contain tr(s).

* * *

percent or more carbonate, thus have calcic horizons (Nolam soils); and in places they have petrocalcic horizons (Terino soils). The local shifts from stage II to incipient stage IV of carbonate accumulation in the soils of Jornada II appear to be due to local changes in the pattern of moisture penetration. The soils formed partly in the late-Pleistocene pluvial, and are also located in a zone transitional to a more moist environment in the mountains. Thus, episodic deep leaching is likely. Local variations in depth and frequency of deep wetting due to influence of soil truncation and subtle shifts in gravel content should be expected.

Another difference between Caralampi and Pinaleno is that there is substantial overlap between the carbonate and silicate clay accumulations in Caralampi. The Holocene carbonate is emplaced as filaments and coatings in the B3tca horizon, which must have been essentially carbonate-free during the full-glacial interval.

Soil morphology is useful in identifying the age bracket of soils and surfaces where the soil-landscape relations are complex and the relative age relations of the various deposits are not clear. Soil morphology is particularly useful in distinguishing between soils of Holocene and Pleistocene age. Thus the Bt horizons of Holocene soils (e.g., Pinaleno 67-4) have hues no redder than 5YR and chromas no higher than 4; and in Holocene soils the carbonate horizon is stage I. In contrast, Bt horizons of soils of late-Pleistocene age (e.g., Caralampi 59-15) are usually 2.5YR in part and chromas are commonly 6 or 8; and carbonate horizons range from stage II to earliest stage IV.

156. SANTO TOMAS-EARP COMPLEX (13RO)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
EARP	ARIDIC ARGIUSTOLLS	LOAMY-SKELETAL	25
SANTO TOMAS	PACHIC HAPLUSTOLLS	LOAMY-SKELETAL	25
SANTO TOMAS, TORRIORTHENTIC VARIANT	TORRIORTHENTIC HAPLUSTOLLS	LOAMY-SKELETAL	35
Aladdin	Torriorthentic Haplustolls	Coarse-loamy	5
Caralampi	Ustollic Haplargids	Loamy-skeletal	5
SND-6	Entisols		5

LOCATION, LANDSCAPE, VEGETATION

These soils occur in several small areas along the front of the southern portion of the Organ Mountains, in and adjacent to the mountain canyons. The soils have formed in alluvial-fan sediments derived from rhyolite. Elevations range from about 4900 to 5800 feet.

The soils occur on terraces inset against alluvium underlying older surfaces. The soils have been trenched by arroyos in many places. Slopes range from about 5 to 10 percent.

Vegetation consists of snakeweed, fluffgrass, black grama, blue grama (at higher elevations), squawbush, mesquite, cholla, Apache plume, Lippia Wrightii, and prickly pear.

TYPICAL PEDONS, PROPERTIES AND RANGES

These soils have formed in alluvium that is commonly at least several m thick, and that in places is underlain by buried soils.

Earp

A typical pedon of Earp is described below. The location is the NE 1/4 NE 1/4 Sec. 23, T23S, R3E, west bank of arroyo, about 0.2 mile east of Soledad Canyon road. A table of properties and ranges follows the description.

Soil surface. About 95 percent covered with coarse fragments of rhyolite, mostly from 1 to 3 cm diameter, with very few scattered cobbles 20 to 30 cm diameter.

A 0-4 cm. Dark brown (7.5YR 4/3, dry) or very dark brown (7.5YR 2.5/3, moist) very gravelly sandy loam; weak fine and very fine crumb; soft; few roots; noncalcareous; abrupt smooth boundary.

B11t 4-21 cm. Dark brown (7.5YR 4/3, dry) or very dark brown (7.5YR 2.5/3, moist) very gravelly sandy loam, with slight increase in clay; weak fine and very fine crumb; soft and loose; fine roots common; very thin clay coatings on pebbles; noncalcareous; clear wavy boundary.

B12t 21-35 cm. Dark brown (7.5YR 4/3, dry) or very dark brown (7.5YR 2/3, moist) very gravelly sandy loam; mostly weak fine and medium subangular blocky, with a few parts weak fine crumb; soft and slightly hard, friable; fine roots common; thin clay coatings on sand grains and pebbles; noncalcareous; clear wavy boundary.

B2t 35-57 cm. Brown (7.5YR 5/4, dry) or dark brown (7.5YR 3/3, moist) very gravelly heavy sandy loam; weak fine and medium subangular blocky; slightly hard, friable; roots common; thin clay coatings on sand grains and pebbles; noncalcareous; clear wavy boundary.

B3t 57-79 cm. Brown (7.5YR 5/3, dry) or dark brown (7.5YR 3.5/3, moist) very gravelly sandy loam; weak fine and medium subangular blocky; slightly hard, friable; few roots; very thin clay coatings on pebbles; noncalcareous; clear wavy boundary.

C1 79-90 cm. Brown (7.5YR 5/3, dry) or dark brown (7.5YR 3.5/3, moist) very gravelly loamy sand; massive and single grain; soft and loose; few roots; noncalcareous; abrupt wavy boundary.

C2 90-103 cm. Brown (7.5YR 5/3, dry) or dark brown (7.5YR 3.5/3, moist) very gravelly loamy sand; massive; slightly hard and hard; very few roots; noncalcareous.

Table 135. Typical (underlined) and range in selected properties for major horizons of Earp.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-4	sl	25-70	7.5YR-10YR	4,5	2,3 2.5	2-4 3
B2t	35-57	sl scl	35-70	5YR-7.5YR	4,5	2,3	3,4
C	79-90	ls,s sl	10-70	7.5YR-10YR	5-7	3-5 3.5	3,4
Control section		sl	35-75				

Other. These soils are usually noncalcareous to a depth of about a m or more.

Santo Tomas

A typical pedon of Santo Tomas is described in the Appendix (pedon 60-12). Figure 122 is a photograph of the pedon and its landscape. Table 136 gives some of the properties and ranges.

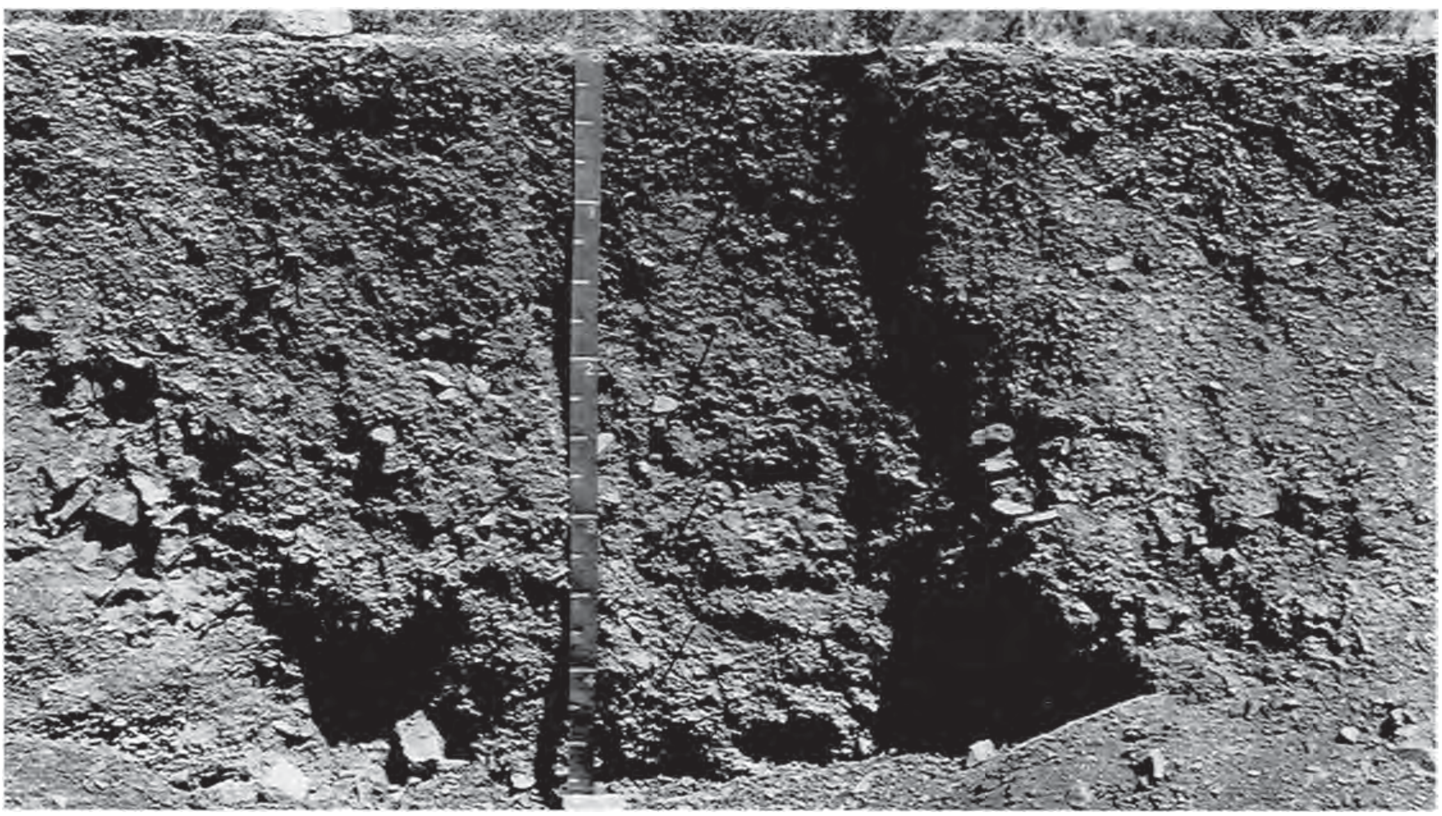


Figure 122. Upper. Landscape of the Pachic Haplustoll, Santo Tomas 60-12. Organ terrace in foreground; Jornada I remnant on the next level, in middle ground; Organ Mountains on skyline. Vegetation consists of snakeweed, Apache plume, cholla, fluffgrass, blue grama, and sideoats grama. Slope is 7 percent.
Lower. Santo Tomas 60-12. Scale is in feet.

Table 136. Typical (underlined) and range in selected properties for major horizons of Santo Tomas.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	3-79	<u>sl</u>,l	35-75	7.5YR- <u>10YR</u>	3,<u>4</u>	<u>2</u>,3	1-3 <u>2</u>
C	79-104	<u>sl</u>,l	35-75	<u>5YR</u> 10YR	<u>5</u>,6	<u>3.5</u>-5	<u>3</u>,4
Control section	25-100	sl,l	35-75				

Other. Thickness of the mollic epipedon ranges from 1/2 to 1 1/2 m. These soils are noncalcareous to depths of at least 18 cm and typically are noncalcareous to depths of 1 m or more. Some pedons have stage I horizons of carbonate accumulation with upper boundaries at depths of about 1/2 to 1 m; these soils usually have textures of sandy clay loam in the zone of carbonate accumulation.

Santo Tomas, Torriorthentic variant

This soil is similar to Santo Tomas but its mollic epipedon is thinner than 50 cm.

SOIL OCCURRENCE

Complexity of the soil pattern is determined by the disposition of arroyo channels and by landscape position and stability. Because of these factors there is substantial variation in the proportion of the component soils in the various delineations.

Haplustolls. The Pachic Haplustolls, SANTO TOMAS soils, occur in places favoring slow sediment accumulation in stabler positions adjacent to some of the major drainage lines, and in areas adjacent to steep slopes. Santo Tomas, Torriorthentic variant, occurs in less stable positions and on younger parts of the Organ surface. The coarse-loamy Aladdin soils occur in less gravelly areas.

Argiustolls. The loamy-skeletal Earp soils occur in older parts of the Organ surface. These soils tend to occur in places (such as topographic highs) that have received little or no sediment since pedogenesis started.

Haplargids. The loamy-skeletal, Ustollic Haplargids, the Caralampi soils, occupy a few slight ridges of the Jornada surface.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 137 presents information on boundaries to major adjacent units. Figure 123 shows boundaries and stratigraphy of some of the units.

Table 137. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Terino very gravelly sandy loam (12R)	The boundary is caused by a younger geomorphic surface and alluvium (Organ) in unit 13RO. The topographic boundary between the 13RO and 12R mapping units is commonly distinct, occurring along the margins of small fans and terraces inset against or overlapping soils of unit 12R.
Rhyolite rock outcrop and Argids (40R)	Cause of the boundary is a change from thick alluvium (unit 13RO) to steep colluvial slopes or bedrock that is near or at the surface (unit 40R). The boundary is prominent and marked by the slopes and bedrock of the Organ Mountains.
Caralampi-Nolam complex (12MO, 123R)	The boundary is caused by a younger geomorphic surface and alluvium (Organ) in unit 13RO. The boundary is similar to that described above for Terino.

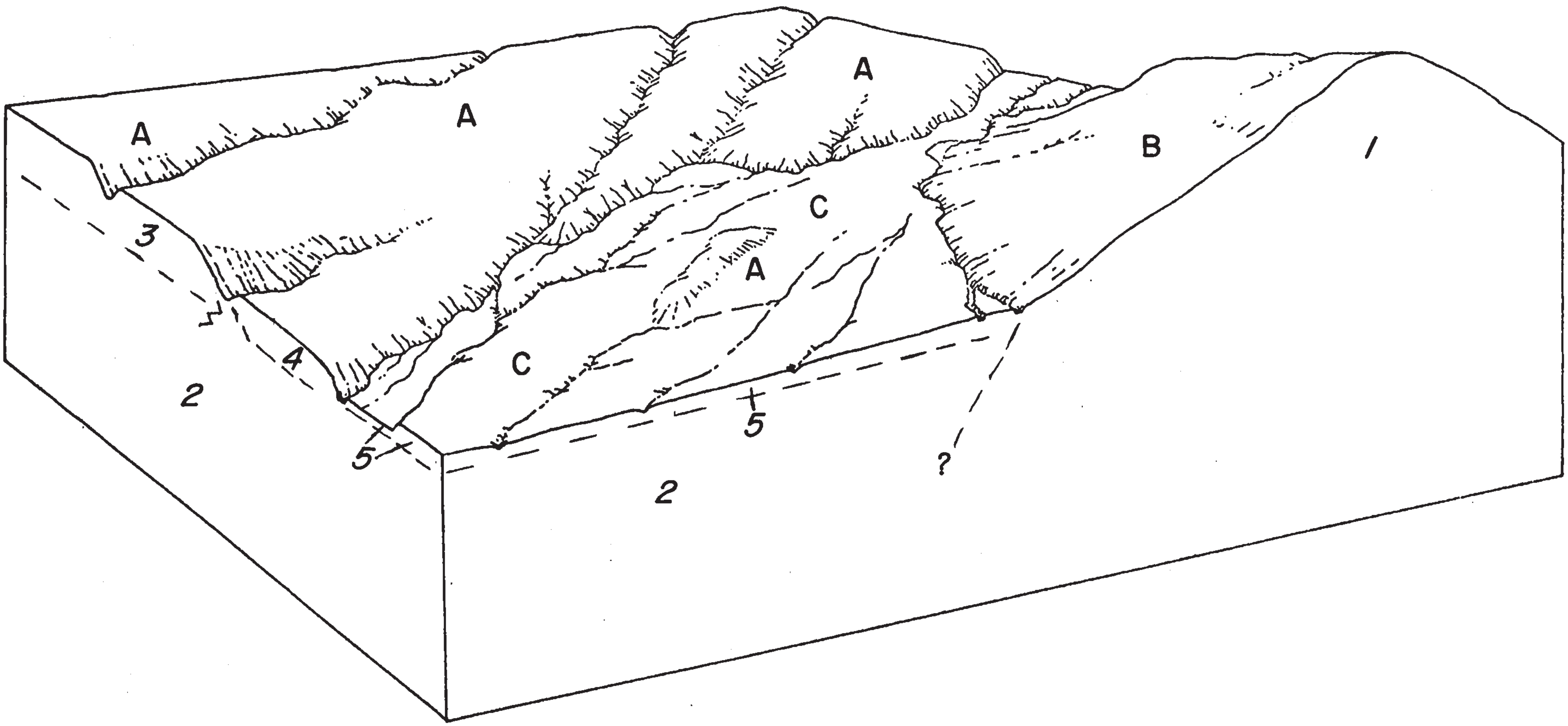


Figure 123. Block diagram of soil-landscape relations and soil stratigraphy in an area of Santo Tomas-Earp complex. This area, west of Soledad Canyon, is where the Organ surface was first discovered. A = Caralampi-Nolam complex. B = Rhyolite rock outcrop and Argids. C = Santo Tomas-Earp complex. 1 = Rhyolite bedrock. 2 = Upper Camp Rice Formation (piedmont facies). 3 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 4 = Jornada II alluvium and soils. 5 = Organ alluvium and soils.

OTHER STUDIES: SOILS OF A STEPPED SEQUENCE IN THE MOUNTAIN CANYONS.

Mountain-front terraces were mentioned in section 153. Soils of three terraces illustrate the general character of the morphological change that occurs with increasing age (table 138). Two of the illustrative soils occur on the Organ and Jornada I surfaces in Soledad Canyon of the Organ Mountains (fig. 122). The other occurs on the Dona Ana surface in Ice Canyon to the north (fig. 123a). Annual precipitation in this area is probably about 35 cm. All soils have formed in alluvium derived from rhyolite.

Santo Tomas 60-12 occurs on an Organ terrace inset against a remnant of Jornada I (figs. 122, 124). Santo Tomas has a thick epipedon that is easily dark enough and has enough organic carbon to qualify as mollic (table 138). The soil is noncalcareous throughout. The considerable thickness of the mollic epipedon is thought to be caused by slow accumulation of sediment during soil development.

Caralampi 59-14 occurs on the edge of the Jornada I remnant (fig. 124). The Bt horizon is thick (table 138). The horizon of carbonate accumulation is stage I and no calcic horizon occurs within a depth of several m. Organic carbon is high and the soil is well within the Ustollic subgroup. Upper horizons have chroma too high for a mollic epipedon. This may be partly due to very slow erosion of upper horizons, as indicated by slight drainageways across the remnant. This erosion would have brought Bt horizons closer to the surface. The present A horizon may have formed in what was once part of the B horizon. High chromas preclude a mollic epipedon. In contrast, the soils of the Organ surface are much younger and have undergone much less erosion; their A horizons have generally been preserved and chroma are relatively low. Similar relationships are common elsewhere along the front of the Organ Mountains.

Carbonate filaments and thin coatings on pebbles are characteristic in middle to lower subhorizons of the Bt horizon, generally occurring at depths ranging from about 1/2 to 1 m. That this carbonate is of Holocene age (and probably is presently accumulating) is indicated by its similarity to carbonate accumulation in Holocene soils, and by its position well above the lower part of the Bt horizon. During pluvial times of the Pleistocene, carbonate would have been moved very deeply; it may have moved completely out of the soil zone and then downslope by laterally moving ground water. This stage I carbonate is in marked contrast to the carbonate accumulations in soils of the same age (Jornada I) along the valley border, where soils formed in very gravelly sediments have thick stage IV horizons with multiple laminar horizons.

Terino variant 60-5 has a petrocalcic horizon and illustrates the completion of the morphogenetic sequences along the mountain fronts. A much longer time is required for completion in this area than along the valley border because of the greater precipitation. This pedon is further discussed in section 185.

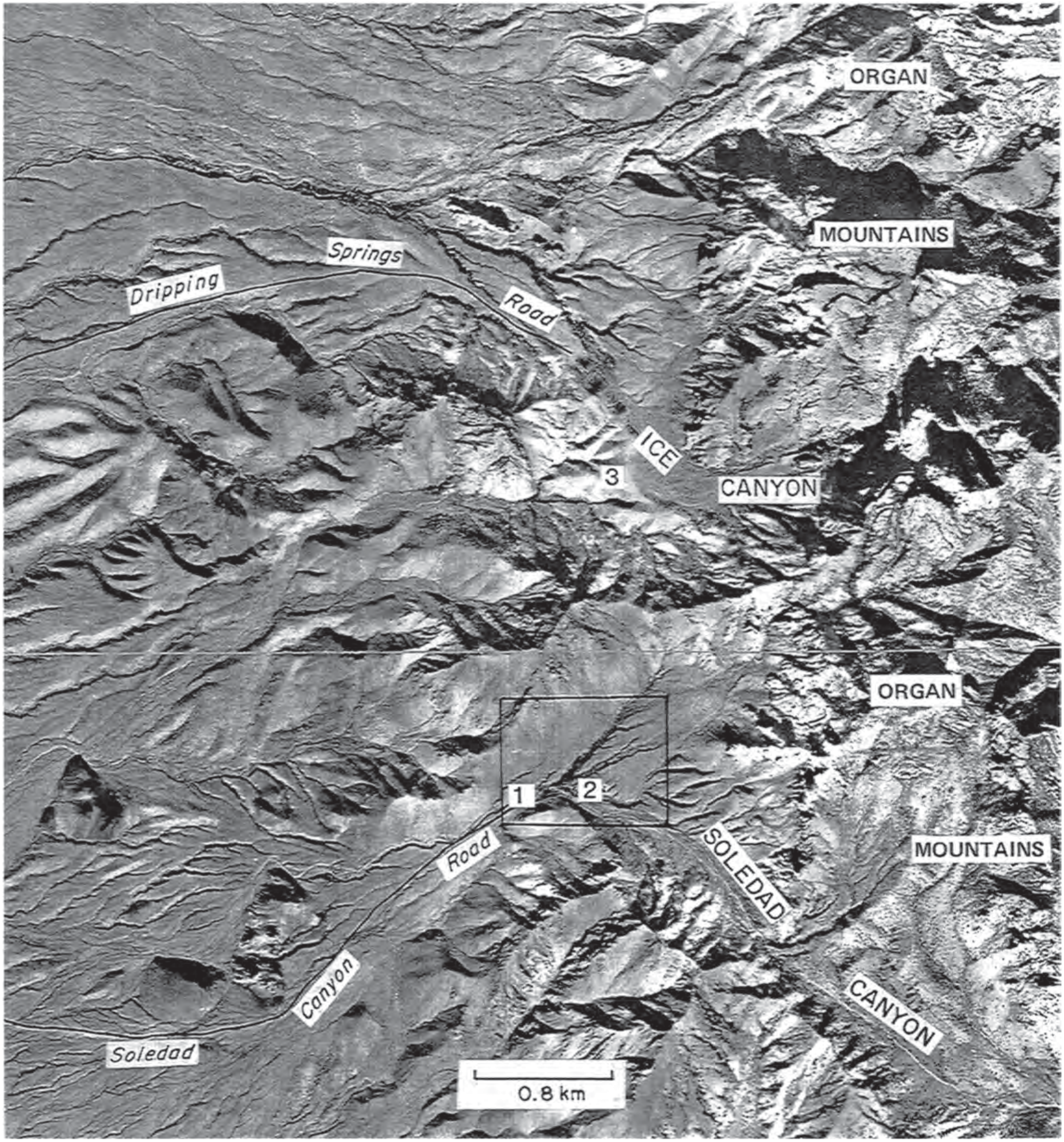
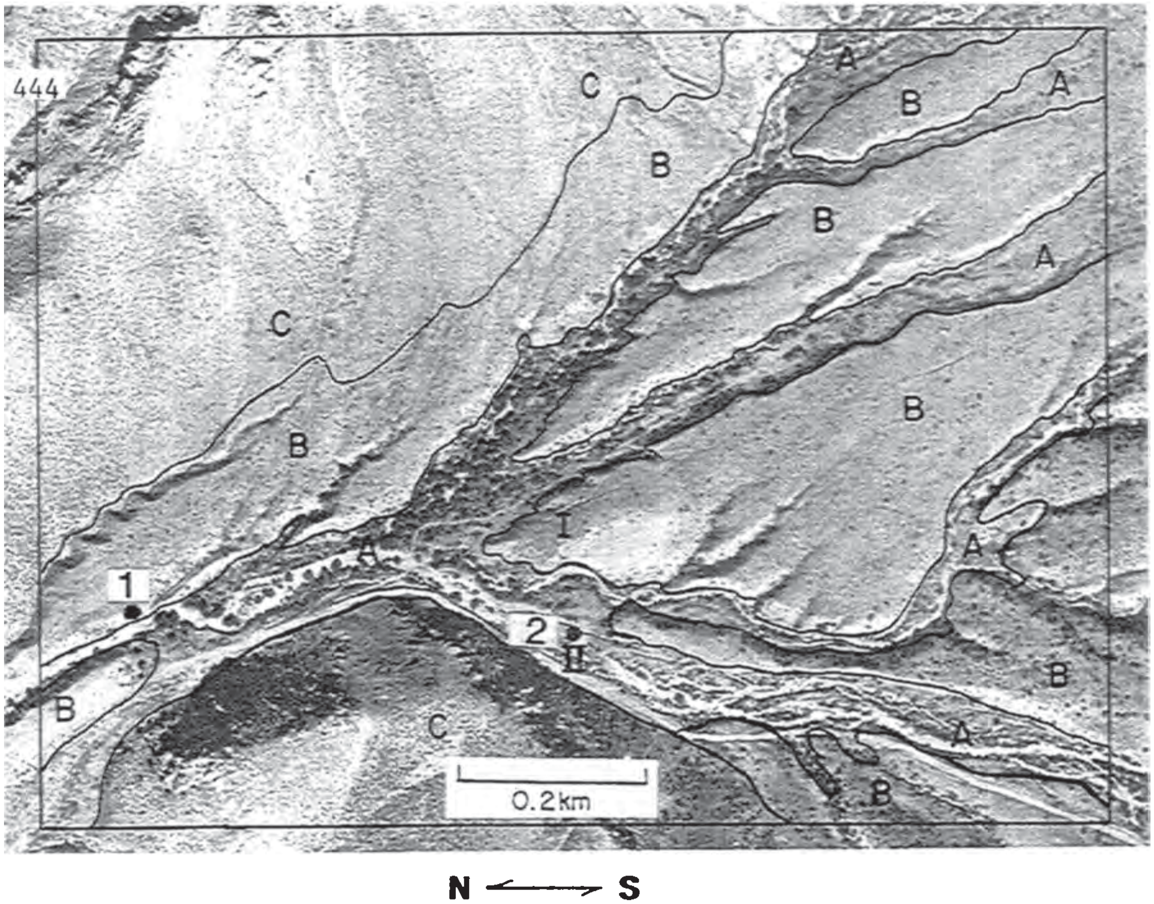


Figure 123a. Location of soil map (fig. 124), sampled pedons, and Ice and Soledad Canyons in the Organ Mountains. 1 = Caralampi 59-14; 2 = Santo Tomas 60-12; 3 = Terino variant 60-5.

Table 138. Selected data for soils of a stepped sequence in the mountain canyons.

Horizon	Depth	Sand 1/	Silt 1/	Clay 1/	Vol. > 2 mm	Ext. 1/ iron as Fe	Carbonate	EC 2/	Organic Carbon
	cm	pct	pct	pct	pct	pct	pct	mmhos/cm	pct
Pachic Haplustoll (Santo Tomas 60-12) on the Organ surface, Soledad Canyon									
C	0-3	66	26	8	40		tr(s)		1.00
A11	3-8	58	30	12	50		tr(s)		1.32
A12	8-28	59	29	12	50		tr(s)		1.18
A13	28-53	60	27	13	45		tr(s)		0.81
A3	53-79	60	28	12	45		tr(s)		0.47
C	79-104	63	25	11	50		tr		0.30
Organic carbon 4.6 kg/m^2 to 104 cm									
Ustollic Haplargid (Caralampi 59-14) on the Jornada I surface, Soledad Canyon									
A	0-5	59	28	13	50		tr(s)		0.76
A1	5-20	51	30	19	60		-(s)		0.83
B1t	20-46	38	29	33	80		tr		0.88
B21t	46-76	47	22	31	60		tr		0.36
B22tca	76-97	46	29	25	60		tr		0.31
B3tca	97-147	52	28	20	70		1		0.11
Cca	147-173	62	23	15	75		1		0.10
Organic carbon 2.6 kg/m^2 to 97 cm									
Petrocalcic Ustollic Paleargid (Terino variant 60-5) on the Dona Ana surface, Ice Canyon									
A1	0-8	61	25	14	45	0.8	-		0.88
B1t	8-20	49	28	23	60	1.2	-		1.16
A2	20-23	51	34	15	50	1.1	-		0.70
B21t	23-38	21	16	63	25	1.7	-	0.8	0.87
B22tcs	38-58	18	8	74	35	2.1	1	1.1	
K1 3/	58-64	28	12	60	20		60	3.8	0.40
K1 4/	58-64	34	9	57	5		87	3.5	0.27
K21m 5/	64-71	40	18	42	5		88	6.9	0.21
K21m 6/	64-71	52	11	37	5		90	5.0	0.20
K22m	71-86	61	12	27	45		62	4.6	0.05
K31	86-114	64	13	23	45		39	2.5	
K32	114-142	46	31	23	55		39	1.6	
K&Cca	142-168	73	15	12	55		17	1.6	

1/ Carbonate-free basis.
2/ Beginning with K1 horizon, determined on whole material ground to pass 2 mm.
3/ Non-indurated part.
4/ Indurated plates.
5/ Laminar subhorizon.
6/ Upper part of plugged horizon.



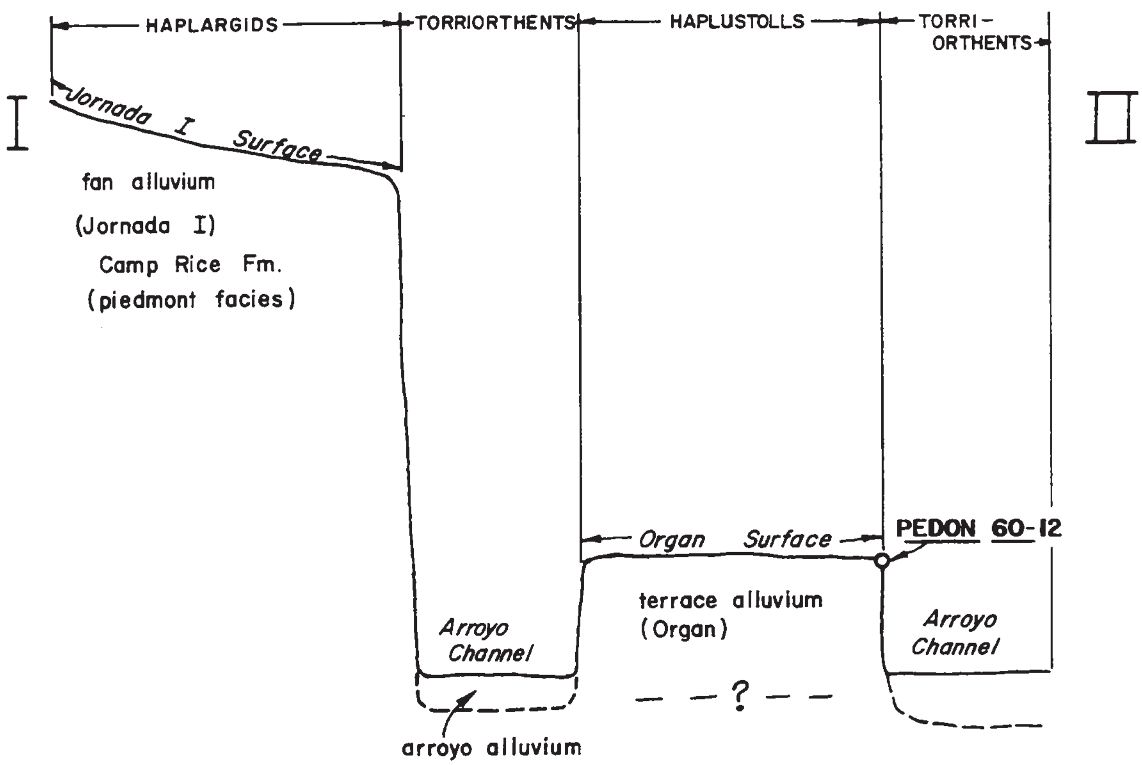


Figure 124. Upper. Map of soils in the vicinity of a partial stepped sequence in Soledad Canyon. A = Santo Tomas-Torriorthent complex (Organ and arroyo channel surfaces). B = Caralampi very gravelly sandy loam (Jornada I surface). C = Rock outcrop, Haplargids, and Argiustolls (Mountain slopes and summits, undifferentiated). 1 = Caralampi 59-14; 2 = Santo Tomas 60-12. I to II locates cross section.

Lower. Cross section from points I to II, soil map.

157. ONITE-PAJARITO COMPLEX (13M)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ONITE	TYPIC HAPLARGIDS	COARSE-LOAMY	40
PAJARITO	TYPIC CAMBORTHIDS	COARSE-LOAMY	40
Bucklebar	Typic Haplargids	Fine-loamy	5
Pintura, thin variant	Typic Torrifluvents	Coarse-loamy	5
Other inclusions (Torrifluvents, Torriorthents, Haplargids)			10

LOCATION, LANDSCAPE, VEGETATION

These soils occur west of the northern part of the Organ Mountains, and in the vicinity of the northern part of the Dona Ana Mountains. The soils have formed in alluvium derived primarily from monzonite, in places with minor amounts of andesite and rhyolite. Elevations range from about 4300 to 4600 feet.

In the main area of occurrence (west of the northern part of the Organ Mountains) the soils occur on slight, east-west ridges. The ridges are subdued and the landscape is gently undulating transversely. Arroyo and gullies have trenched the sediments in places. Arroyo channels rise to the general level of the landscape in some areas and youthful fans have been deposited. A few long, narrow ridges of Organ sediments extend from the main part of the Organ sediments towards the basin floor. Slopes are 2 percent over most of the area and grade to 1 percent near the basin floor. North of the Dona Ana Mountains, the soils occur on a coalescent alluvial-fan piedmont. There are a few gullies but no large arroyos. Slopes range from 2 to 3 percent.

Vegetation usually consists of scattered snakeweed, *Yucca elata*, and Mormon tea. Black grama occurs in a very few areas, such as in the vicinity of Pajarito 67-3. A few creosotebush occur in places.

TYPICAL PEDONS, PROPERTIES AND RANGES

Buried soils with argillic horizons are common beneath soils of this mapping unit. Tops of these buried soils are usually at a depth of at least one m.

Onite

See section 158 for the description of Onite.

Pajarito

A typical pedon of Pajarito is described in the Appendix (pedon 67-3). Figure 125 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

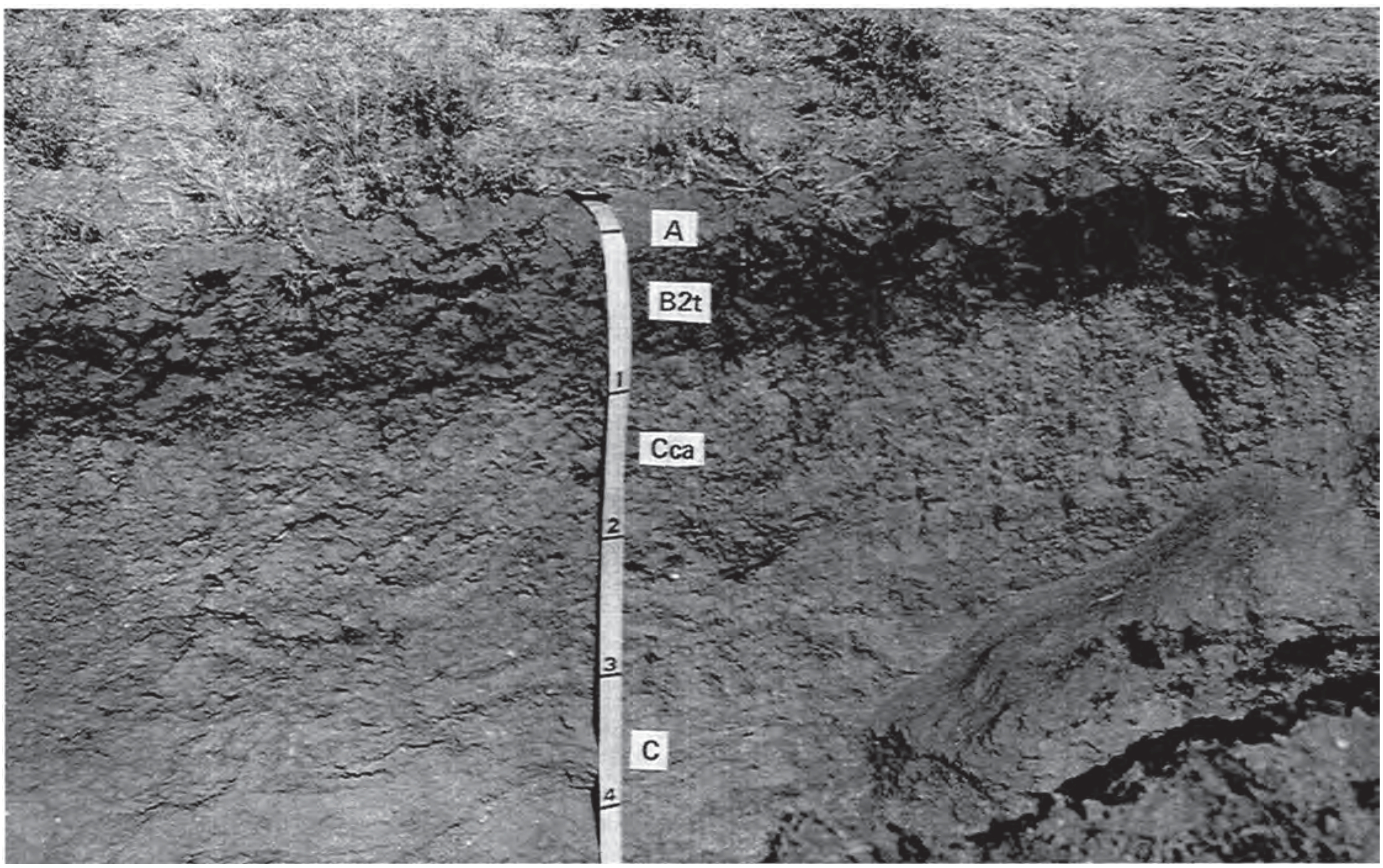


Figure 125. Upper. Landscape of the Typic Camborthid, Pajarito 67-3, on the Organ surface, at the Isaacks' radiocarbon site.
Lower. Pajarito 67-3. Scale is in feet.

Table 139. Typical (underlined) and range in selected properties for major horizons of Pajarito.

Horizon	Depth cm	Particle Size <2mm	Particle Size >2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-10	sl ls	0-20	7.5YR	5,6	4,5	2-4 3,4
B2t	10-28	sl	0-15	5YR 6YR	4-6 5	3-5 3.5	3,4
C	28-58	ls sl s	0-15	7.5YR	5,6 5.5	4,5	3,4
Control section		sl	0-15				

Other. The clay content of the B2t is usually about the same or only slightly more than in the A horizon.

SOIL OCCURRENCE

Soil occurrence is dependent on soil age, texture and landscape stability. This mapping unit illustrates incipient development of the argillic horizon, and there is common gradation back and forth between the Camborthids and the Haplargids.

Haplargids. The coarse-loamy ONITE soils occur in stablest, oldest positions of the Organ surface. These are usually on the highest ridges. They also occur where the parent materials are finer so that more clay is available for illuviation. A few Onite soils are more strongly developed than typical, being in the heavy end of the coarse-loamy family. Most of these are older soils of the Isaacks' Ranch surface. The fine-loamy Bucklebar soils occur in low areas between ridges, where textures are fine enough for the fine-loamy family. The fine-loamy Berino soils differ from Bucklebar soils in having a calcic horizon within one m, and occur in scattered places near the margins of the mapping unit. Onite, thin solum variant and Onite, sandy subsoil variant occur on and near the crests of some of the narrower ridges.

Camborthids. The coarse-loamy PAJARITO soils occur in complex association with the Onite soils, and occur in places where illuviation of silicate clay has been too slight for an argillic horizon. Such places are most common in the younger parts of the Organ surface.

Torrifluvents. The sandy Vinton soils and the coarse-loamy Anthony soils occur in younger alluvium near arroyos, where there is irregular decrease of organic carbon with depth. Pintura, thin variant, occurs where sandy sediments, mostly in dunes, range from 50 to 100 cm thick. These areas are north of the Dona Ana Mountains.

Torriorthents. The sandy Yturbide and Canutio, loamy subsoil variant occur near arroyos and lower sides of ridges.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 140 gives information on boundaries to major adjacent units.

Table 140. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Anthony complex (13ML, 13V, 13LG)	The boundary has been caused by a change in parent materials, from sediments that are almost wholly monzonite (in 13M) to materials containing moderate amounts of sedimentary rock fragments. The topographic boundary is not prominent, being marked in places by an increase in density of small drainageways. The boundary is marked by a distinct change in vegetation. In the (13ML,13V,13LG) mapping unit vegetation consists mainly of creosotebush and tarbush. These are generally absent from the 13M unit, which is dominated by *Yucca elata*, Mormon tea and snakeweed.
Onite sandy loam (13MM)	Two factors may be involved in the boundary--a slightly older alluvium of Organ age, and slightly more precipitation in unit 13MM. The topographic boundary is not distinct since soils of both mapping units occur on slight ridges and slight lows between ridges.
Berino-Bucklebar association (15M)	The boundary has been caused by a younger geomorphic surface (mostly Organ, some Isaacks' Ranch) and associated alluvium in unit 13M. The 15M soils, analogues of which are buried by Organ alluvium in unit 13M, emerge at the surface on the 15M side of the boundary. Topographically the 13M areas appear as slight ridges that are higher than the adjacent 15M soils.

OTHER STUDIES

Studies in and adjacent to this mapping unit are located in figure 125a. One is the Isaacks' radiocarbon site and the other consists of transects in and near drainageways on the piedmont toeslope.

The Isaacks' radiocarbon site

Figure 126 is a soil map and cross section in the vicinity of the radiocarbon site. The first buried charcoal was discovered in the south bank of a gully (#2, fig. 126). Since the soil along the edge of the gully was truncated, a sampling site (#1, fig. 126) was selected on a stable surface nearby. Much more charcoal was found upon excavation. It was dated at 4200 ± 105 yr B.P., compared to a C-14 date of 4035 ± 115 yr B.P. for the first charcoal discovered. The dates show that the soils above the charcoal can be no older than about 4000 yr. They would be about 4000 yr old if sediments above the charcoal were deposited soon after the fire.

Figure 125 shows Pajarito 67-3; table 141 contains laboratory data. The

* * *

Table 141. Laboratory data for Pajarito 67-3, a Typic Camborthid.

Horizon	Depth	Sand1/	Silt1/	Clay1/	> 2 Vol.	Carbonate	Organic carbon
	cm	pct	pct	pct	pct	pct	pct
A	0-3	78	15	7	10	tr(s)	0.18
A	3-10	73	18	9	5	tr(s)	0.30
B21t	10-20	75	16	9	5	tr(s)	0.26
B22t	20-28	73	18	9	10	tr(s)	0.22
C1ca	28-58	74	18	8	15	2	0.19
C2ca	58-91	74	17	9	10	3	0.13
C3	91-127	91	5	4	20	1	0.04
Organic carbon 2.2 kg/m^2 to 91 cm							

1/ Carbonate-free basis.

* * *

pedon lacks the necessary increase of 3 percent from the A to the B horizon for an argillic horizon. Laterally, however, in places the increase in clay is sufficent for the B horizon to qualify as an argillic horizon; these are Haplargids (Onite soils). The horizon of carbonate accumulation is stage I, typical in soils of the Organ surface.

The ridge just south of Pajarito 67-3 (fig. 126) is thought to be of earliest Isaacks' Ranch age. The ridge is the topographic high in this general area, and the Organ deposits south of Pajarito 67-3 are inset against the ridge. In contrast to Pajarito 67-3 the silicate clay maximum is distinct and all soils are Haplargids (Onite series). Carbonate morphology is late stage II, stronger than in most soils of Isaacks' Ranch age.

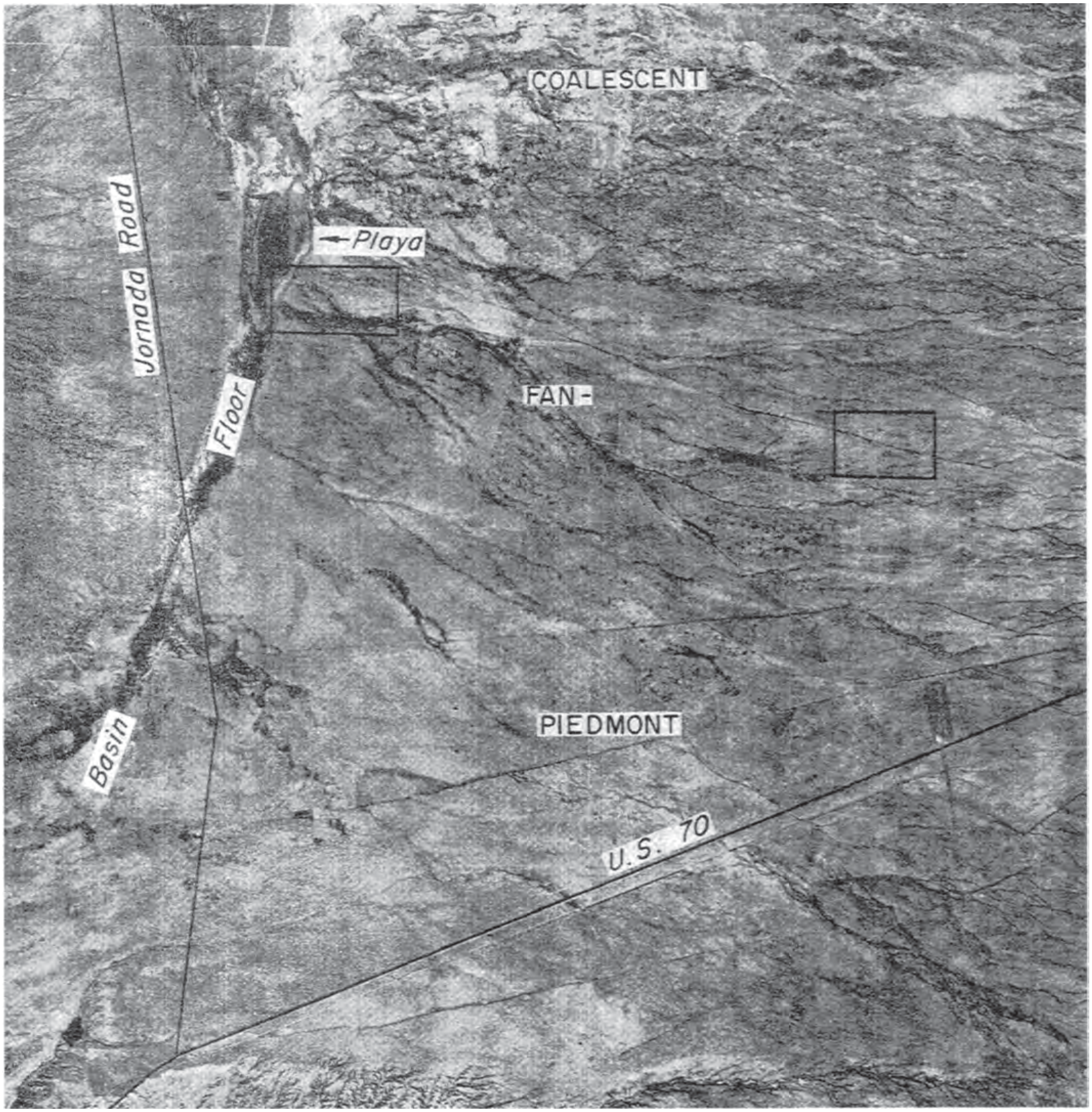


Figure 125a. Location of soil maps (figs. 126 and 127) Isaacks' Lake Playa, the basin floor and the coalescent fan-piedmont.

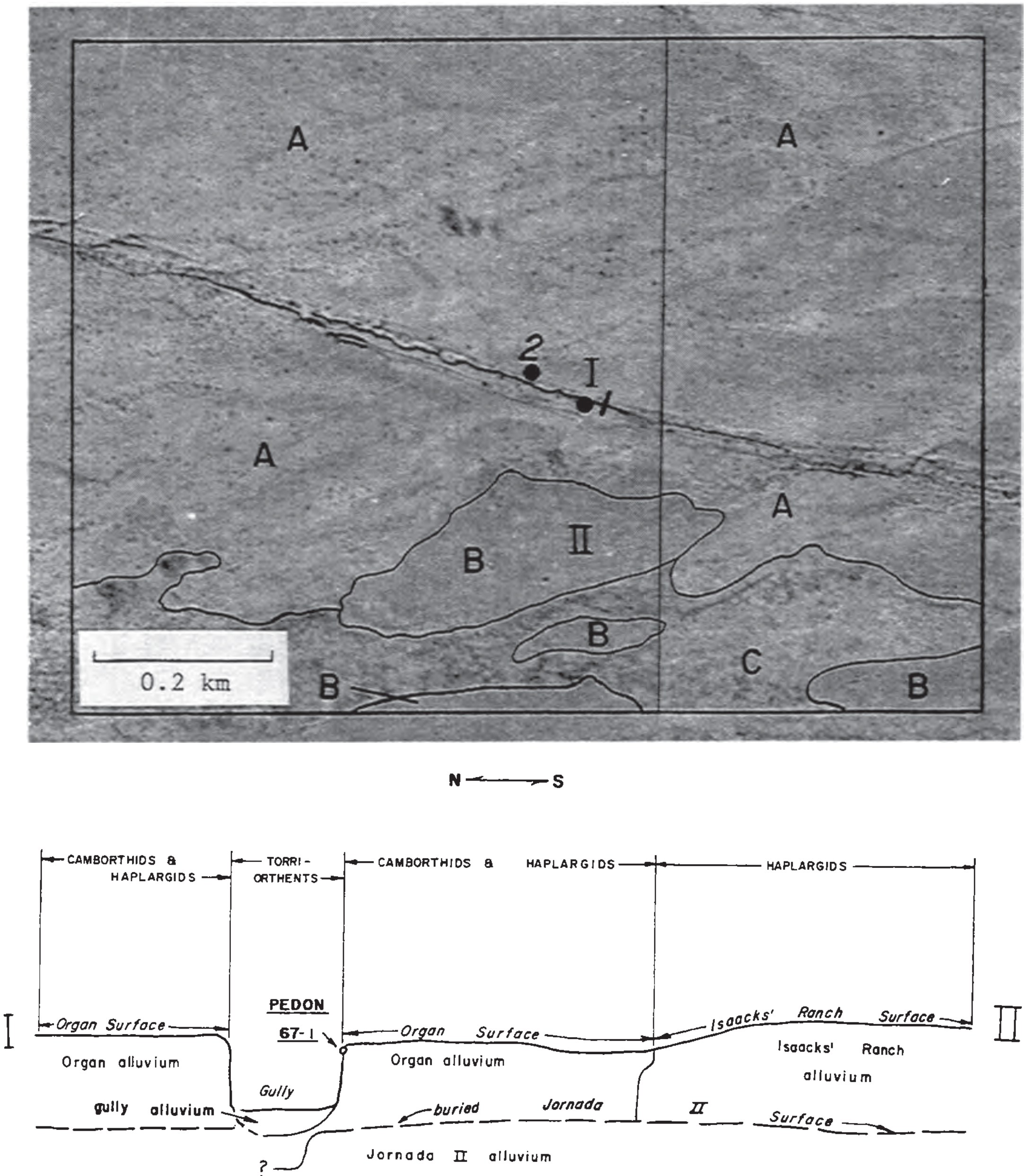


Figure 126. Upper. Map of soils in the vicinity of the Isaacks' radiocarbon site. A = Onite-Pajarito complex (Organ surface). B = Onite sandy loam (Isaacks' Ranch and Organ surfaces. C = Bucklebar, overflow phase (Organ and Isaacks' Ranch surfaces). 1 = location of charcoal dated at 4035 $\pm$ 115 yr B. P.; 2 = location of Pajarito 67-3 and charcoal dated at 4200 $\pm$ 105 yr B. P. North-south line is section line road. A gully, which formed along an old road, occurs between the two sites. I to II locates cross section, below.

Lower. Cross section from points I to II, soil map. The Holocene soils (in Organ alluvium) are inset against soils of Isaacks' Ranch age on the slightly higher ridge at the right. Both Organ and Isaacks' Ranch alluviums overlie buried soils of Jornada II age.

Soils of drainageways on the piedmont toeslope

The westerly study area consists of two north-south transects east of Isaacks' Lake Playa (figs. 125a, 127). Soils of widely variable ages and textures are closely associated in large drainageways just above the termination of the piedmont slope.

Transect 1. This transect is from III to IV in figures 127 and 128. The transect starts in soils of late-Pleistocene age, crosses a Holocene ridge and ends in a drainageway of Holocene age. The transect illustrates soil burial, and changes in soil morphology due to changes in landscape position and texture of parent materials.

Five pedons are analyzed (table 142); they are discussed from north to south (fig. 128).

Berino 68-9 is the northernmost pedon (figs. 127, 128). The soil surface is barren (west side of pit) where the whole pedon was sampled; a few burro grass and tobosa clumps occur just to the east. See section 61 for discussion of barren strips and organic carbon. The silicate clay maximum is distinct (table 142) and the stage III carbonate horizon is typical of soils of Jornada II age. Reddish brown volumes in the K horizon indicate that the Bt horizon once extended deeper and has been largely engulfed by carbonate.

The second soil is Onite variant 68-5 (figs. 127, 128, 129). The upper 30 cm is formed in Organ alluvium. Underlying is a thin soil in a deposit of possible Isaacks' Ranch age; it rests on the buried analogue of Berino 68-9. The thin soil in Organ alluvium barely has enough clay increase for an argillic horizon.

Onite variant 68-3 (figs. 127, 128, 129) is in a ridge-crest position and is developed in coarse Organ alluvium. This pedon also illustrates the initial development of the argillic horizon. A trench was dug south of Onite variant 68-3 down the side of the ridge to the edge of the drainageway, to study the effects of changes in landscape position and texture of parent materials on soils of the same age. Sedimentary strata in Organ alluvium could be traced from the ridge crest down into the drainageway, showing that the soils are the same age.

Downslope from the ridge crest, percentages of coarse sand and fine gravel decrease markedly and clay and finer sand fractions increase over a distance of only a few m. These monzonite-derived parent materials are high in sand and low in silt, with less fine silt than coarse silt. Their water retention against 1/3 bar is only about half that of silty soil materials to the north (section 191). This suggests that a given amount of infiltrated precipitation would wet these soils to greater depths than their silty analogues. The surface may not "seal" as tightly under a beating rain as would silty soils.

Upper horizons of a satellite pedon 5 m south of Onite 68-3 do not show sufficient clay increase for an argillic horizon, although the Bt horizon is similar in morphology. The satellite pedon is a Camborthid in the Pajarito series. The pedons are the same age because sedimentary strata could be traced between. As at the Isaacks' radiocarbon site, this area well illustrates the

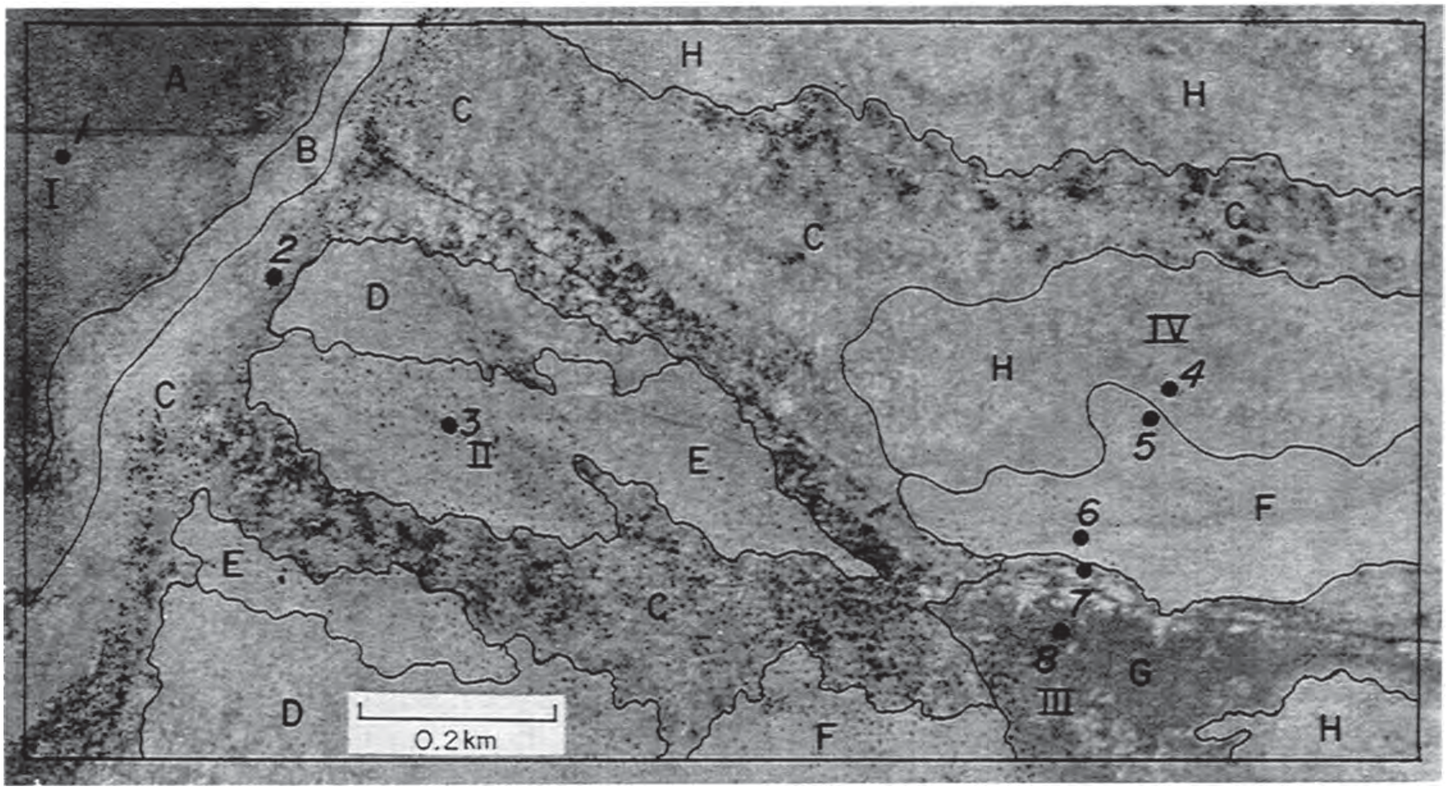


Figure 127. Map of soils east of and partly in Isaacks' Lake playa. A = Dalby, very fine taxadjunct, overflow phase (Lake Tank surface). B = Bucklebar, fine variant, overflow phase (Lake Tank surface). C = Bucklebar, overflow phase (Organ, Isaacks' Ranch and Lake Tank surfaces). D = Bucklebar sandy loam (Organ and Isaacks' Ranch surfaces). E = Onite sandy loam (Organ and Isaacks' Ranch surfaces). F = Onite-Pajarito complex (Organ surface). G = Headquarters, fine variant, overflow phase (Organ surface). H = Berino sandy loam (Jornada II surface). 1 = Pedon 60-16; 2 = 70-6; 3 = 70-5; 4 = 68-9; 5 = 68-5; 6 = 68-3; 7 = 68-4; 8 = 69-8. I to II, III to IV locate cross sections.

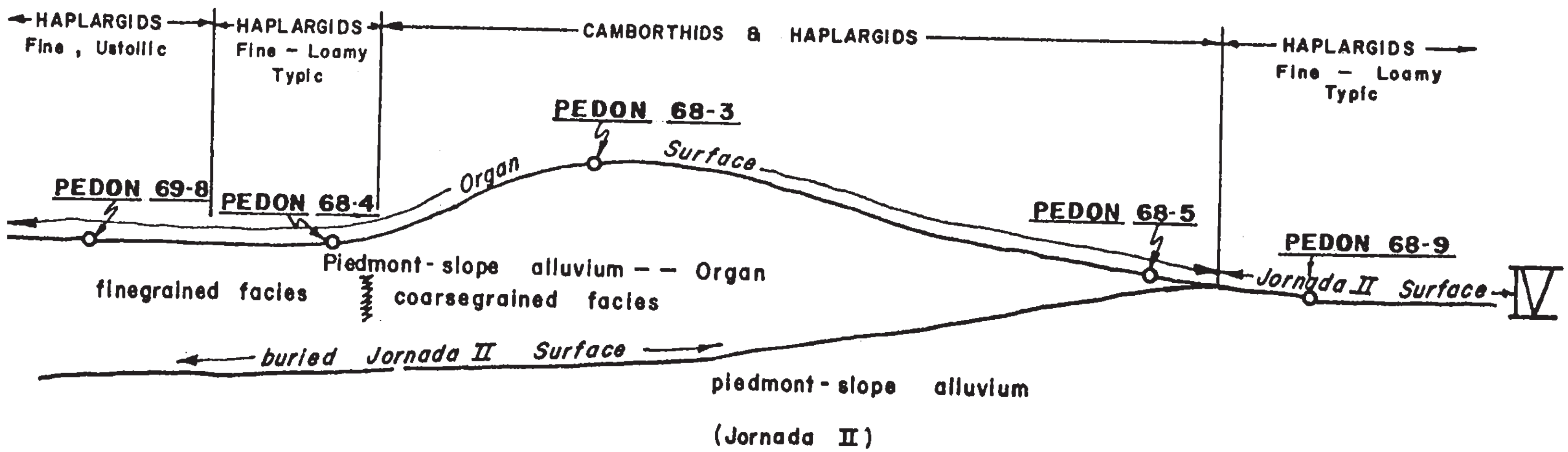


Figure 128. Cross section from III to IV on the soil map (fig. 127).

Table 142. Laboratory data for five Haplargids of transect no. 1, east of Isaacks' Lake playa.

Alluvium	Horizon	Depth	Sand 1/	Silt 1/	Clay 1/	Vol. > 2 mm	Carbon-ate	Organic Carbon	Extractable Sodium
		cm	pct	pct	pct	pct	pct	pct	me/100g
	Berino 68-9								
Jornada II	A2	0-3	62	21	17	-	tr(s)	0.29	0.2
↓	B21t	3-13	51	19	30	-	tr(s)	0.32	0.2
	B22t	13-28	60	15	25	2	tr	0.36	0.2
	B23tca	28-43	65	13	22	4	3	0.28	0.2
	K2	43-61	63	9	28	1	19	0.21	0.3
	Bca	61-84	70	9	21	1	12	0.11	0.4
	K	84-107	72	9	19	2	13		0.4
	K	107-132	80	7	13	3	11		0.4
	C1ca	132-157	84	6	10	5	7		0.3
	C2ca	157-185	84	6	10	4	4		0.1
	C 2/	0-8	84	8	8	tr	tr(s)		
Jornada II	A2 2/	8-14	65	18	17	tr	tr(s)		
	Organic carbon, 2.9 kg/m^2 to 84 cm.								
	Onite variant 68-5								
Organ I	A	0-5	77	14	9	10	1	0.26	0.2
↓	B21t	5-13	76	14	10	10	tr	0.21	0.2
	B22t	13-23	73	15	12	10	1	0.18	0.2
	Cca	23-38	70	17	13	15	4	0.21	0.3
Isaacks'	2B21cab	38-48	60	24	16	3	4	0.28	0.5
Ranch (?)	2B22cab	48-64	45	31	24	tr	5	0.30	1.1
Jornada	2B1tb2	64-86	64	17	19	tr	2	0.15	1.4
II	2B2tb2	86-104	61	12	27	-	4	0.15	2.6
↓	2K21b2	104-137	76	7	17	3	14	0.12	2.3
	2B22tb2	137-160	73	7	20	1	1	0.03	3.0
	Organic carbon, 3.2 kg/m^2 to 104 cm								
	Onite variant 68-3								
Organ I	A	0-5	80	12	8	10	tr(s)	0.21	0.1
↓	A2	5-8	77	14	9	15	tr(s)	0.20	0.1
	B1t	8-13	78	12	10	20	tr(s)	0.25	0.2
	2B2t	13-23	81	7	12	30	tr	0.19	tr
	2C1ca	23-36	84	6	10	30	2	0.13	0.1
	2C2ca	36-51	88	4	8	30	1		0.1
	2C3	51-81	90	2	8	25	1		0.3
	2C4	81-117	92	3	5	25	1		0.3
	A2 3/	0-3	75	14	11				
	B21t 3/	3-10	75	13	12				
	B22t 3/	10-20	79	12	9				
	Organic carbon, 0.7 kg/m^2 to 36 cm								
	Bucklebar 68-4								
Organ I	A	0-5	54	27	19	-	tr	0.71	0.2
↓	A2	5-15	65	21	14	tr	tr	0.43	0.1
	B1t	15-28	61	18	21	1	tr	0.28	0.2
	B2t	28-46	58	21	21	tr	tr	0.29	0.1
	B3tca	46-76	56	27	17	tr	3	0.20	0.2
	C1ca	76-130	55	30	15	tr	3	0.12	0.2
	C2	130-157	80	11	9	tr	1	0.08	0.2
Jornada	B1cab	157-193	74	11	15	tr	1	0.08	0.3
II	B2tcab	193-206	64	7	29	1	4	0.15	0.4
Organ I	A2 3/	0-5	71	18	11	3			
↓	B21t 3/	5-16	69	18	13	5			
	B22t 3/	16-25	69	19	12	6			
	Organic carbon, 3.3 kg/m^2 to 76 cm								
	Headquarters variant 69-8								
Organ I	C	0-6	42	36	22	-	tr(s)	1.95	0.0
↓	A2	6-10	39	33	28	tr	tr(s)	1.26	0.0
	B21t	10-23	26	28	46	-	2	0.86	0.1
	B22t	23-49	19	29	52	-	3	0.54	0.7
	B23t	49-79	16	36	48	-	4	0.54	2.0
	Cca	79-89	6	64	30	-	5	0.49	2.4
	B21cab	89-107	4	48	48	-	7	0.42	4.2
	B22cab	107-125	3	47	50	-	5	0.37	4.6
	2C	125-138	45	38	17	-	2	0.12	1.3
	Organic carbon, 10 kg/m^2 to 107 cm.								

1/ Carbonate - free basis.

2/ Offset sample. C is a youthful surficial deposit probably less than 100 years old.

3/ Satellite pedon.

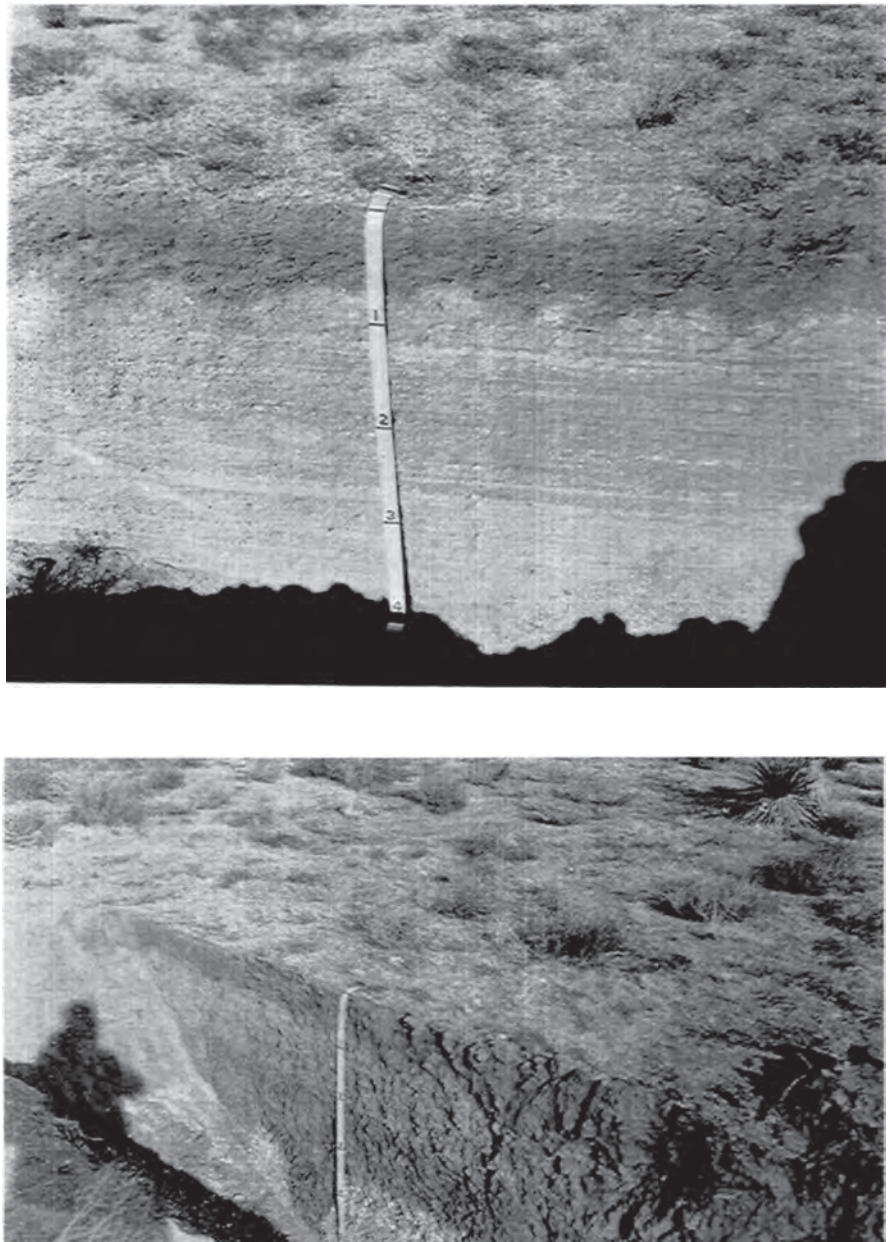


Figure 129. *Upper*. Onite, sandy subsoil variant 68-3, a Typic Haplargid on the Organ surface. Vegetation consists of scattered snakeweed, *Yucca elata*, and Mormon tea. Slope is 1 percent.

Lower. Onite, thin solum variant 68-5, a Typic Haplargid on the Organ surface. Vegetation consists of scattered snakeweed, *Yucca elata*, dropseed, and fluffgrass. Slope is 1 percent.

argillic horizon in its initial stages of development.

Bucklebar 68-4 (figs. 127, 128, 130) occurs on the edge of the drainageway, which has sediments much finer than the ridge sediments to the north. The clay difference between A and B horizons is greater than for Onite 68-3 on the ridge crest. Bucklebar 68-4 receives considerable drainageway water and the sediment initially is more clayey. Both should favor more rapid clay illuviation. Bucklebar 68-4 has more authigenic carbonate than Onite variant 68-3 on the ridge crest. This may be due to its drainageway position and consequent more frequent wetting. However, organic carbon is still too low for the Ustollic subgroup.

Headquarters variant 69-8 (figs. 127, 128, 130) is in the central part of the broad drainageway. Composited samples (0-38 cm) from a barren area 40 m north average 0.78 percent organic carbon as compared to 0.94 percent organic carbon at the sample site. The organic carbon from both the sampled pedon and the composited sample is ample to place these soils within the Ustollic subgroups. The Bt horizon has clay texture. The wide difference in clay content compared to Onite 68-3 and Bucklebar 68-4 shows that silicate clay content of the argillic horizon cannot be used as an indicator of soil age. The horizon of carbonate accumulation is a much better indicator, since the carbonate accumulations in these soils are morphologically similar; all are in stage I of carbonate accumulation. Greater carbonate content for this pedon (table 142) is attributed to its drainageway position. Headquarters 69-8 has markedly higher organic carbon than other pedons of the transect. This is due to greater moisture in the drainageway position and fine texture, both of which favor a dense stand of grass and consequently higher organic carbon. Higher clay contents tend to be associated with a landscape position that is favorable to run-in.

Transect 2. Three pedons were sampled in this transect (fig. 127), which extends southward from Onite 70-5 (No. 3, fig. 127). The southernmost of the three pedons is south of the area shown in figure 127. Figure 130a illustrates the stratigraphic relationships in the vicinity of the sampled pedons. The pedons increase in age to the south, and are of Organ, Isaacks' Ranch, and Jornada II age. Laboratory data are in table 143. Onite 70-5 (fig. 131) occurs on a broad, very gentle ridge just east of the playa (fig. 127). This soil is on the heavy end of the coarse-loamy Haplargids, distinctly heavier than pedon 68-3 on the narrow ridge crest to the east. The greater clay content is thought to be due partly to the initial texture of the sediments, and partly due to the broad ridge itself. The latter should insure maximum infiltration of precipitation for movement of clay. Carbonate accumulation is typical for soils of Organ age. Carbonate nodules in the first buried soil are typical of soils of Isaacks' Ranch age. The upper part of the buried Bt horizon is noncalcareous; carbonates associated with pedogenesis in the thick deposit of Organ age have not reached the buried B horizons of Isaacks' Ranch age. The upper part of the Bt horizon in the second buried soil is noncalcareous in places, indicating that depth of illuviation during Isaacks' Ranch time at this spot was not great. The amount of the carbonate accumulation in this soil is somewhat greater than usually encountered in soils of Jornada II age, and this soil may be of Jornada I age.

Onite 70-6 (fig. 132) occurs on a very slight ridge. The stratigraphy

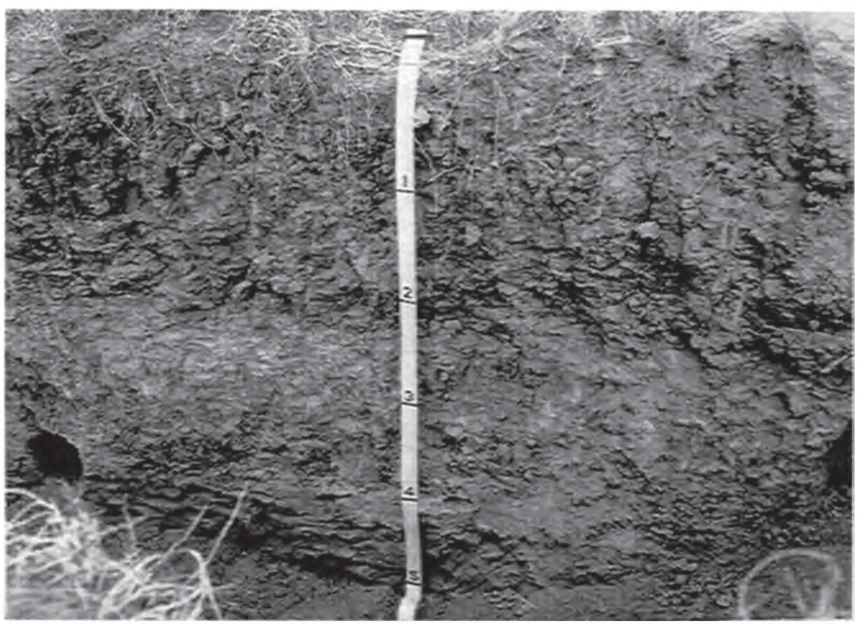


Figure 130. Upper. Bucklebar 68-4, a Typic Haplargid on the Organ surface, and part of study trench, transect 1. Vegetation consists of scattered clumps of burro grass, tobosa, and snakeweed. Slope is 1 percent.

Lower. Headquarters, clayey subsoil variant 69-8. Vegetation is tobosa grass. Slope is 1 percent.

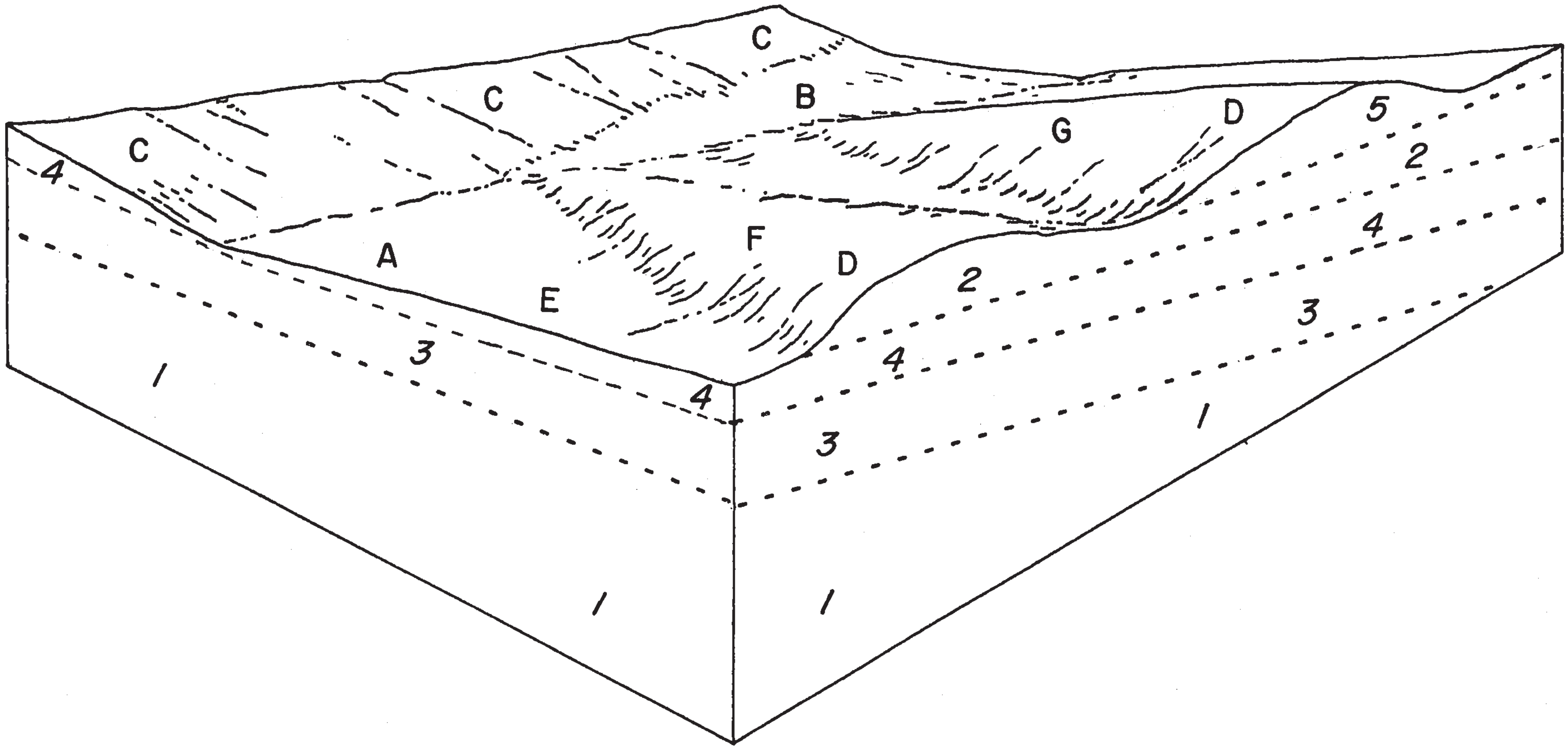


Figure 130a. Block diagram of soil-landscape relations and soil stratigraphy in the vicinity of transect 2, east of Isaacks' Lake playa. A = Berino-Bucklebar association (Jornada II surface), here all Berino. B = Dalby clay (Lake Tank surface). C = Dona Ana sandy clay loam (Jornada II surface). D = Onite sandy loam (Organ and Isaacks' Ranch surface). E = Berino 70-7. F = Onite 70-6. G = Onite 70-5.
1 = Upper Camp Rice Formation, fluvial facies (ancient river alluvium). 2 = Isaacks' Ranch alluvium and soils. 3 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 4 = Jornada II alluvium and soils. 5 = Organ alluvium and soils.

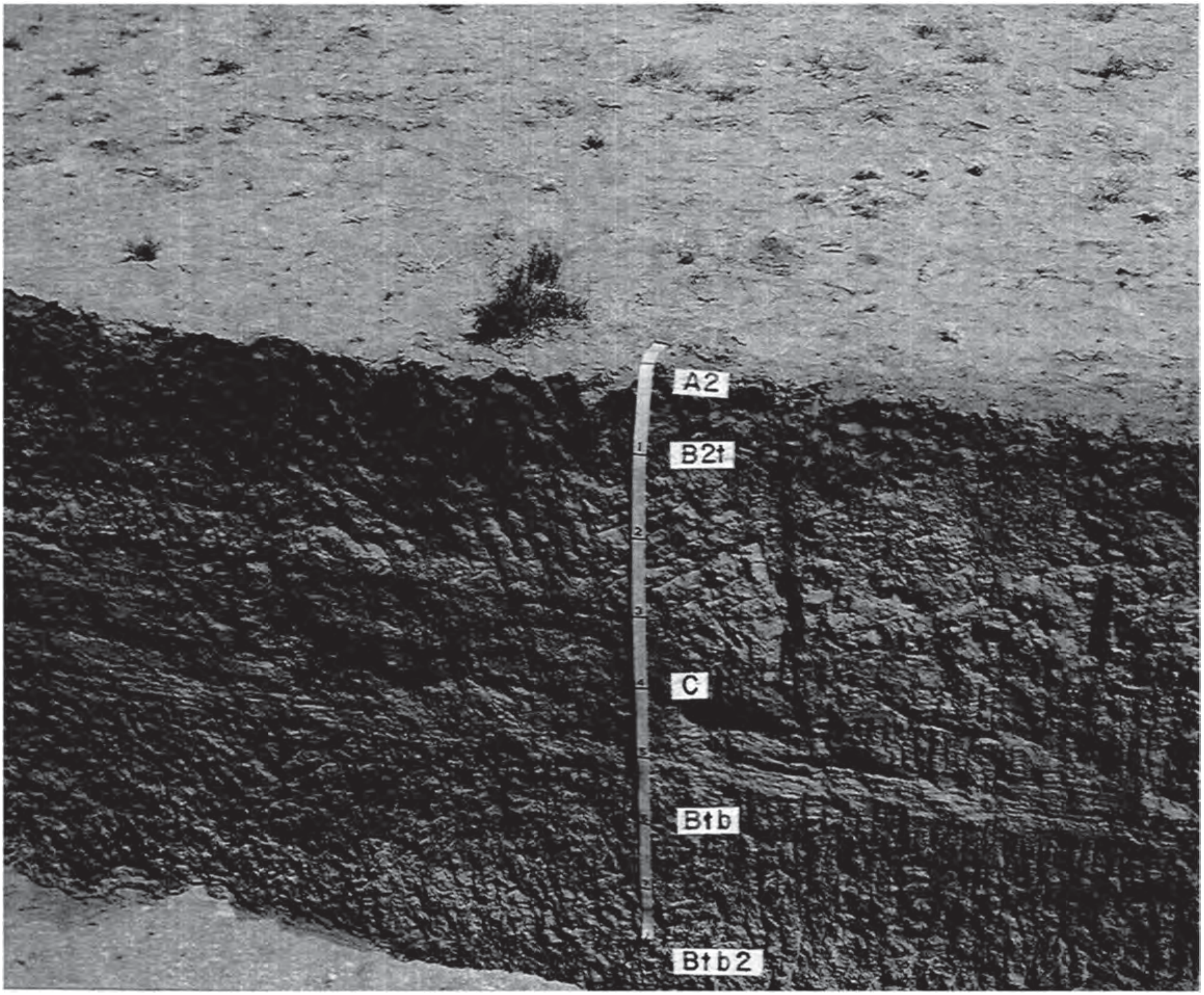


Figure 131. Profile of a Typic Haplargid (Onite 70-5) on the Organ surface. Scale is in feet.

Table 143. Laboratory data for three Typic Haplargids, transect no. 2 east of Isaacks' Lake playa.

Alluvium	Horizon	Depth	Sand 1/	Silt 1/	Clay 1/	Vol. > 2 mm	Carbon- ate	Organic Carbon	Extract- able Sodium
		cm	pct	pct	pct	pct	pct	pct	me/100g
	Onite 70-5								
Organ I	A2	0-6	73	15	12	1	tr(s)	0.22	0.0
	B21t	6-16	68	15	17	tr	tr(s)	0.20	tr
	B22t	16-32	59	21	20	tr	tr(s)	0.23	0.1
	B31tca	32-47	66	20	14	4	1	0.16	tr
	B32ca	47-74	74	16	10	8	1	0.08	tr
	C1ca	74-87	61	28	11	2	3		tr
	2C2	87-157	87	7	6	5	tr		0.1
	3C3	157-169	55	26	19	tr	1		1.1
Isaacks' Ranch	3B21tb	169-189	59	19	22	tr	tr		1.7
	3B22tca	189-215	46	28	26	tr	4		2.4
Jornada II	3B3tcab	215-239	49	29	22	tr	5		2.2
	3B1tcab2	239-255	69	15	16	2	tr		1.4
	3B2tcab2	255-268	48	8	44	tr	4		4.0
	3K2b2	268-278	51	8	41	tr	40		3.4
	Organic carbon, 1.9 kg/m^2 to 87 cm.								
	Onite 70-6								
Isaacks' Ranch	A2	0-6	77	10	13	tr	tr(s)	0.15	0.0
	B1t	6-15	77	9	14	tr	-(s)	0.15	0.0
	B21t	15-34	71	13	16	tr	tr(s)	0.15	tr
	B22tca	34-41	71	14	15	tr	4	0.18	tr
	B3ca	41-74	75	13	12	5	6	0.11	0.1
	2Cca	74-104	87	7	6	30	2	0.04	0.1
Jornada II	3B1cab	104-120	68	21	11	tr	2	0.04	0.4
	3B21tcab	120-136	75	12	13	tr	tr	0.04	0.5
	3B22tcab	136-165	73	8	19	tr	tr	0.07	0.9
	3B31tcab	165-194	79	8	13	1	1	0.01	1.1
	3B32tcab	194-215	82	7	11	5	4	0.04	1.2
	Organic carbon, 1.6 kg/m^2 to 104 cm.								
	Berino 70-7								
Jornada II	A2	0-7	51	27	22	tr	tr(s)	0.81	tr
	B21t	7-18	51	18	31	1	1	0.54	0.1
	B22t	18-34	54	17	29	1	4	0.38	0.1
	B23tca	34-49	48	15	37	1	10	0.30	0.3
	K2	49-71	51	18	31	tr	23	0.27	0.5
	K3	71-100	40	30	30	-	24	0.08	1.4
	Bca	100-129	43	28	29	-	10		2.1
	Bcab-1	129-153	22	37	41	-	7		3.1
	Bcab-2	153-170	23	33	44	-	7		3.7
Jornada I	B1tcab2	170-182	49	20	31	tr	2		3.1
	B2tcab2	182-195	40	16	44	tr	3		3.4
	K1b2	195-215	59	14	27	tr	14		2.5
	K2b2	215-242	67	11	22	tr	25		2.3
	Organic carbon, 4.6 kg/m^2 to 100 cm.								

1/ Carbonate-free basis.

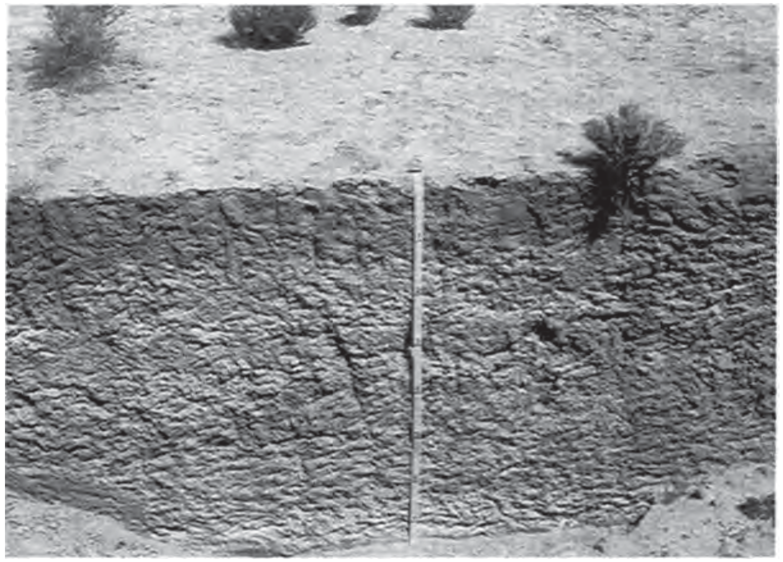


Figure 132. Upper. A Typic Haplargid, Onite 70-6, on the Isaacks' Ranch surface. Vegetation consists of snakeweed, Mormon tea, and *Yucca elata*. Slope is 1 percent. Scale is in feet.

Lower. A Typic Haplargid, Berino 70-7, on the Jornada II surface. Vegetation (where the pedon was sampled on the west end of the pit) is a thick stand of burro grass and tobosa. On the east end of the pit, the vegetation is mostly burro grass. In places there are a few snakeweed and *Yucca elata*. Scale is in feet.

indicates that the parent materials of soils on the ridge to the north (where Onite 70-5 is located) were inset against this ridge of older (Isaacks' Ranch) soils.

The clay content of the argillic horizon of Onite 70-6 is similar to that of Onite 70-5 again indicating that the silicate clay maximum is not necessarily a reliable indicator of soil age. The parent materials of this soil apparently contained more sand than Onite 70-5; this would have lessened the amount of clay for illuviation. Onite 70-6 does have a stronger horizon of carbonate accumulation (stage II) than Onite 70-5, consistent with its greater age.

The buried Haplargid contains less carbonate than common for Jornada II soils. This is attributed to a drainageway position, which could have moved carbonates deeply (section 166). High sand and low silt may also have been a factor in increasing the depths of illuviation.

Berino 70-7 (fig. 132) occurs on the edge of a broad area that is level transversely. No deposits younger than Jornada II occur in this area, which has not been covered by the drainageway deposits to the north. The parent materials of this soil are finer-textured than in the buried soil of Onite 70-6, and may represent a zone away from the main channel that deposited the sediments. The Bt horizon and carbonate horizons are prominent. The waters of overland flow may have augmented the amount of moisture provided by the precipitation. Despite the dense grass (fig. 132), organic carbon is not quite enough for the Ustollic subgroups.

The buried Jornada I Haplargid has a prominent bulge in silicate clay and in carbonate. Black filaments occur both in the Bt and K horizons. In the arid zone the latter features have been observed only in buried soils; they have been seen at the land surface only in soils of Jornada I age along the mountain fronts.

Discussion: exchange chemistry and soluble salts.

The exchange chemistry and soluble salt relationships for soils of these transects and the Vertisol in the playa (section 189) are considered in this section. Comparison of the Vertisol (Dalby 60-16) of the playa, with the fine-textured Haplargid (Headquarters variant 69-8), of the drainageway is instructive since it suggests how differences in water regime and vegetation for soils of comparable texture may affect the exchange chemistry. Dalby 60-16 has low extractable sodium and also low soluble salts (section 189). This is thought to be due to episodic flooding and a net downward water movement to below the depth of sampling and into the pervious alluvium beneath. In contrast, Headquarters 69-8 has appreciable extractable sodium above 1 m and associated considerable soluble salts. The difference is probably due to less net downward water movement in Headquarters 69-8 since it receives less water and is not subject to standing water for long periods.

The Dalby and Headquarters pedons differ markedly in extractable potassium. Headquarters 69-8 has 2 me/100 g of extractable potassium in upper horizons. This compares to only a trace at comparable depths in Dalby 60-16. The difference may be related to less vegetation and related less potassium mobilization for Dalby. In this regard, Headquarters 69-8 contains appreciably more organic carbon.

The two transects east of the playa provide an opportunity to examine the relationship of extractable sodium and soluble salts to landscape position and stratigraphy. Depth to extractable sodium above 1 me/100 g (abbreviated 1 me) equals or exceeds 1/2 m for all pedons. Soils of Organ age at the land surface have values below 1 me except for Headquarters 69-8, the fine-textured pedon in drainageway position. Increases in extractable sodium with depth to values exceeding 1 me are associated with most changes in sediment age. Buried Jornada II sediment mostly has over 1 me of sodium (except for Bucklebar 68-4). Soils in Jornada II sediment at the land surface have less than 1 me of extractable sodium through the upper 1/2 m.

Water soluble ions were determined on samples with over 1 me of extractable sodium. Generally sodium is the dominant water-soluble cation. Magnesium and calcium are present in roughly equal quantities in most samples. Sulfate generally is the dominant anion. Chloride exceeds sulfates in some samples, particularly in upper horizons of the zones analyzed. Nitrate was determined on samples where cations and anions did not balance closely. Onite variant 68-5 has appreciable nitrate in deeper horizons.

The two transects illustrate that generally organic carbon increases as clay content rises. Similar relations are also shown by other soils in the project. This may be in part due to the more favorable conditions for plant growth and organic carbon retention produced by greater amounts of clay. But, as these transects illustrate, clay content is higher in sites subject to increased moisture from run-in. This increase in moisture may be an important factor in producing a positive statistical correlation between amount of organic carbon and clay content (section 63). The significance of vegetation is shown at the Dalby site in the playa, where organic carbon is relatively low (despite high clay) because of the scarcity of vegetation.

158. ONITE SANDY LOAM (13MM)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
ONITE	TYPIC HAPLARGIDS	COARSE-LOAMY	75
Agustin	Typic Camborthids	Coarse-loamy	10
Sonoita	Typic Haplargids	Coarse-loamy	5
Other inclusions (Camborthids, Haplargids, Entisols)			10

LOCATION, LANDSCAPE, VEGETATION

These soils occur mainly in one large area (a broad band that roughly parallels the mountain front) west of the northern part of the Organ Mountains. A smaller area occurs just south of the main body. The soils have formed in alluvium derived primarily from monzonite. In places there are minor amounts of andesite and rhyolite in the alluvium. Elevations range from about 4600 to 5000 feet.

The soils occur mostly on very slight to distinct east-west ridges. Longitudinal slopes along the ridge crests range from about 5 percent closest to the mountains to 2 percent at lower elevations. Transverse slopes of ridge sides range from about 2 to 10 percent. Most ridge crests are quite broad and are essentially level transversely for several tens of m. Others are narrow and are level transversely for only several m; in places, waterways extend laterally from arroyos up the ridge sides. Gullies are common and usually occur in or parallel old roads.

Vegetation consists of scattered Mormon tea, prickly pear, and *Yucca elata*. Creosotebush occurs in a few places, mainly on the slightly dissected, higher ridges of the mapping unit. Tarbush also occurs in some of these areas. There are scattered clumps of black grama in a very few places. The occurrence of extensive areas of Onite soils on stable surfaces, but with black grama occurring only in a few places, suggest the possibility that this grass might once have been more extensive on these soils (see section 62 for discussion of vegetative changes caused by wind erosion and formation of coppice dunes).

TYPICAL PEDON, PROPERTIES AND RANGES

Buried soils are common beneath Onite soils. The buried soils are of earliest Organ, Isaacks' Ranch, or Jornada II age. Most of these buried soils have argillic horizons. Some have calcic horizons but only a few have petrocalcic horizons.

Onite

A typical pedon of Onite is described below. The location is the NW 1/4 Sec. 22, T22S, R3E, north bank of gully slightly less than 0.1 mile east of Pole Line road. Figure 133 is a photograph of the pedon and its landscape. A table of properties and ranges follows the description.

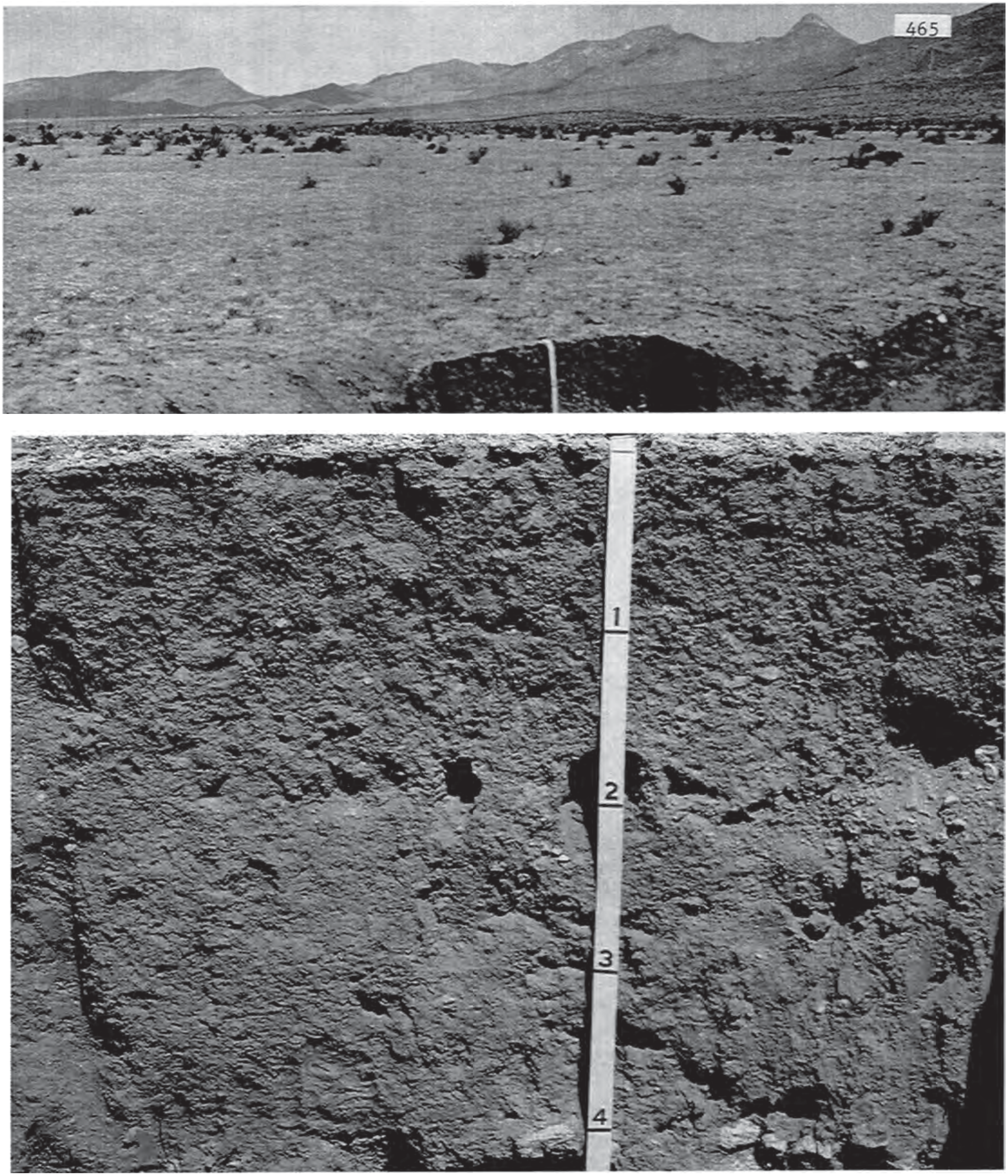


Figure 133. Upper. Landscape of a Typic Haplargid, Onite sandy loam, on the Organ surface. Vegetation consists of a very few Mormon tea, *Yucca elata*, and prickly pear. Slope is 2 percent. The San Andres Mountains are on the skyline at left; the San Agustin Mountains are at the center and right except for the far right where slopes lead upward to the Organ peaks beyond the edge of the photographed area.

Lower. Onite sandy loam. Scale is in feet.

Soil surface. About 30 percent covered with coarse and very coarse sand grains and fine monzonite pebbles, mostly 1/4 to 1 cm in diameter but with a few slightly larger than 1 cm.

A2 0-6 cm. Brown (7.5YR 5/3, dry) or dark brown (7.5YR 3.5/3, moist) light sandy loam; weak medium platy; soft; very few fine roots; noncalcareous; abrupt smooth boundary.

B1t 6-21 cm. Brown (7YR 5/4, dry) or dark brown (7YR 3/4, moist) sandy loam; massive; slightly hard; few fine roots; coatings of silicate clay on sand grains; 5 to 10 percent by volume of fine pebbles; a few insect burrows, about 1 cm diameter, filled with grayish fine earth; noncalcareous; clear wavy boundary.

B2t 21-38 cm. Dominantly yellowish red and reddish brown (5YR 5/5, dry, 5YR 3.5/5, moist) sandy loam, with lesser amount of 7YR hue; weak medium subangular blocky; mostly hard, with some parts slightly hard; few fine roots; harder in place than above; yellowish red and reddish brown silicate clay coatings on many sand grains and pebbles; insect burrows more common than above, in places occupy 10 to 15 percent of the horizon, and are 1 to 2 cm diameter; most empty, some filled with grayish fine earth; noncalcareous; clear wavy boundary.

B3t 38-48 cm. Brown (7.5YR 5/4, dry) or dark brown (7.5YR 3.5/4, moist) sandy loam with slightly less clay than above; massive; mostly slightly hard, a few parts hard; few fine roots; silicate clay coatings on pebbles and sand grains, but less apparent than above; few insect burrows, some empty and some filled with fine earth; noncalcareous; clear and abrupt, smooth boundary.

2C1ca 48-71 cm. Brown (9YR 5/3, dry) or dark brown (9YR 4/3, moist) loamy sand, with more coarse sand and fine gravel than above; this horizon facies into a gravelly pocket on the east side of the cut; massive; slightly hard; three rodent burrows, ranging from 5 to 20 cm across, empty; pebbles and sand grains thinly and discontinuously coated with carbonate; effervesces strongly; abrupt wavy boundary.

3C2ca 71-85 cm. Pale brown (7YR 6/3, dry) or dark brown (9YR 4/3, moist) sandy loam; massive; slightly hard; no roots, very few empty insect tunnels, commonly of elliptical shape, about 1/2 by 1 cm, with some burrows round and 1/2 cm diameter; less gravel and coarse sand than above; commonly the base of the horizon is marked by a layer of coarse sand 1/2 to 2 cm thick; few carbonate filaments, and discontinuous coatings of carbonate on sand grains; effervesces strongly; abrupt smooth boundary.

4B1cab 85-97 cm. Light brown (8YR 6/4, dry) or brown (8YR 5/4, moist), sandy loam; massive; slightly hard; no roots; a few empty insect burrows, same size as above; a few carbonate filaments; thin discontinuous carbonate coatings on sand grains; less coarse and very coarse sand than above; effervesces strongly; clear wavy boundary.

4B2cab 97-119 cm. Brown (7.5YR 5.5/4, dry) or dark brown (7.5YR 4/4, moist) sandy loam; slightly redder than above; massive; slightly hard; no roots; effervesces strongly; a few carbonate filaments; thin discontinuous carbonate coatings on sand grains; very few insect tunnels, one rodent burrow, 5 cm across, empty; effervesces strongly; clear wavy boundary.

5C1cab 119-144 cm. Light brown (8YR 6.5/4, dry) or brown (8YR 5/4, moist) gravelly loamy sand, with 30 to 40 percent gravel; in places, texture is a gravelly sandy loam; massive; soft and loose; a few roots (probably from vegetation in the gully rather than from the soil surface); pebbles and sand grains have thin, discontinuous carbonate coatings; effervesces strongly; abrupt wavy boundary.

6C2cab 144-161 cm. Light brown (8YR 6/4, dry) or brown (8YR 4.5/5, moist) sandy loam, with some strata of sand; much less gravel than above; massive; no roots; in places there are strata of coarse and very coarse sand, 1 to 2 cm thick, that are soft or loose; thin, discontinuous carbonate coatings on pebbles and sand grains, except for the lower several cm; effervesces strongly except in places the lower several cm are noncalcareous; abrupt smooth boundary.

7B1cab2 161-170 cm. Light brown (7.5YR 6/4, dry) or brown (7.5YR 4.5/4, moist) fine sandy loam; massive; slightly hard; no roots; a few carbonate filaments; thin, discontinuous carbonate coatings on pebbles; few very fine tubular pores; clay increases with depth, and this horizon rests on a heavy fine sandy loam; effervesces strongly.

Remarks. Buried soils are common beneath Onite soils. The buried soils may be of earliest Organ age, as at this site, from 85 to 161 cm. Other buried soils are of Isaacks' Ranch age, or, more commonly, of Jornada II age. The horizon from 161 to 170 cm is considered to be a buried B1 horizon of Isaacks' Ranch age. Augering below 170 cm showed first a distinct Bt horizon, typical of soils of Isaacks' Ranch age, then more gravelly, looser material suggestive of C horizon material at a depth of about 230 cm.

Table 144. Typical (underlined) and range in selected properties for major horizons of Onite.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-6	ls sl (underlined)	0-20	7.5YR (underlined)	4-6 5 (underlined)	3-5 3.5 (underlined)	2-4 3 (underlined)
B2t	21-38	sl (underlined),hv. sl	0-15	5YR (underlined)	4-6 5 (underlined)	3-5 3.5 (underlined)	4-6 5 (underlined)
Cca	48-71	s,ls (ls underlined) sl	0-20	7.5YR- 10YR 9YR (underlined)	5 (underlined),6	4 (underlined),5	3 (underlined),4
Control section		sl	0-15				

Other. On stable sites, which are dominant in this mapping unit, the thickness of both the Bt horizon and the noncalcareous zone increases from lower elevations in the western part of the unit to highest elevations in the eastern part. The maximum thickness of the Bt horizon occurs in the latter area where the lower boundary extends to 75 cm. The heavier end of the textural range is common between ridges since the ridges represent former main channel zones (where textures tend to be coarser) of arroyos that deposited the sediments. The heavier sandy loams occur both as a facies change in Organ alluvium and as older Onite soils that have formed in Isaacks' Ranch alluvium. These older Onite soils occur in scattered ridges of Isaacks' Ranch age and are also fairly common cropping out around the edges of the Organ deposits, being buried beneath Organ deposits in many places upslope.

SOIL OCCURRENCE

For several reasons this unit is dominated by a single soil series. (1) Most soils are old enough to have developed argillic horizons, and the parent materials contain little carbonate; thus most soils are Argids. (2) Most soils are too young to have developed a calcic or petrocalcic horizon. Differentiae involving these horizons and resulting in different classes are therefore not a factor. (3) The parent materials are dominated by materials having very little gravel; thus there are no complexes caused by the occurrence of skeletal and nonskeletal families. (4) Texture (sandy loam) of the dominant soils at these elevations precludes the accumulation of enough organic carbon for the Ustollic subgroups; all Haplargids are Typic.

Haplargids. The coarse-loamy ONITE soils are by far the dominant soil in the mapping unit, occurring on ridge crests and on many gently sloping ridge sides. The fine-loamy Berino, Bucklebar and Hap soils occur in a few places along margins of the mapping unit. The Berino and Hap soils, both of which have calcic horizons within 1 m, also occur in sides of some of the steeper ridges where the Organ sediments have been truncated. Hap soils are similar to Berino but have gravelly control sections. The Bucklebar soils, which lack the calcic horizon of Berino soils, occur mainly in facies changes to finer alluvium in lower areas between the ridges. The coarse-loamy Sonoita soils have sola thicker than 75 cm and occur only in the easternmost part of the mapping unit, nearest the mountain where precipitation is highest.

Camborthids. The Agustin soils average 15 to 35 percent gravel in the 25 to 100 cm control section and occur in younger Organ sediments in the eastern part of the mapping unit. Pajarito soils are similar but average less than 15 percent gravel in the control section and occur mostly on gentler slopes in the western part of the unit.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 145 gives information on boundaries to major adjacent units. Figure 134 shows boundaries and stratigraphy of some of the units.

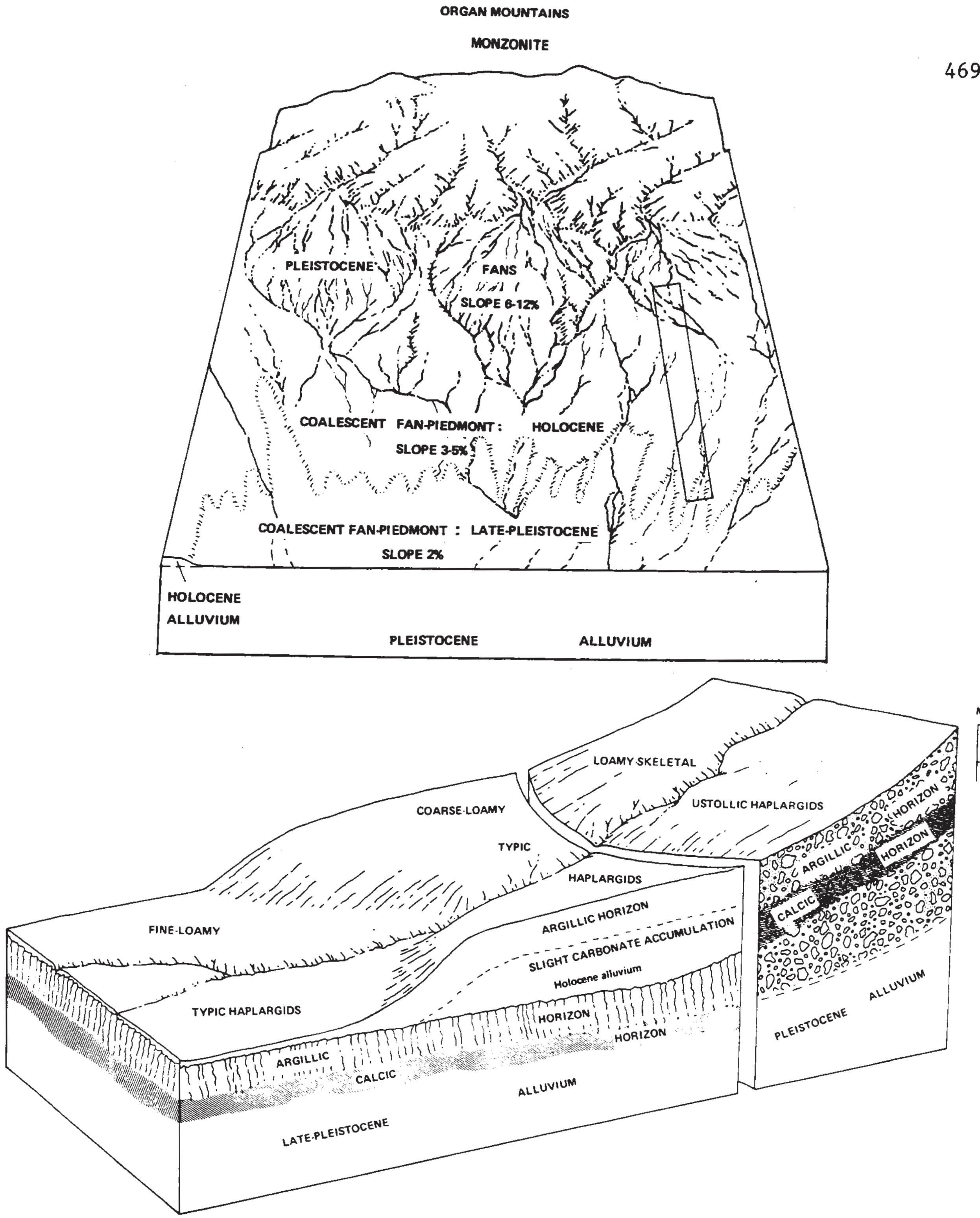


Figure 134. Upper. Organ Mountains and the downslope fans and coalescent fan-piedmont. The parent materials are low-carbonate sediments derived from monzonite. Location of large-scale diagram (below) indicated by rectangle at right.

Lower. Boundaries between soils differing in age and content of coarse fragments but formed in the same low-carbonate parent materials (monzonite alluvium). Fine-loamy Typic Haplargids with calcic horizons dominate the Pleistocene fan-piedmont. Coarse-loamy Typic Haplargids without calcic horizons dominate the Holocene fan-piedmont. The boundary between these soils is marked by the downslope margins (slope exaggerated) of the slight Holocene ridges, where the soils of Pleistocene age emerge from beneath Holocene alluvium. Loamy-skeletal, Ustollic Haplargids dominate the Pleistocene fans. The boundary between these Haplargids and the coarse-loamy Haplargids downslope is apparent because of the steeper slopes and prominent fans on which the former soils occur.

Table 145. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Canutio gravelly sandy loam, loamy subsoil variant (103ML)	The boundary is due to an increase in the limestone content of the parent materials, so that an argillic horizon is no longer apparent. The boundary is not topographically prominent. Vegetatively the boundary between the main body of 13MM and 103ML is marked by the appearance of considerable creosotebush in unit 103ML.
Caralampi-Nolam complex (12MO,123R)	There are several causes for the boundary. One is a younger alluvium and geomorphic surface (Organ and Isaacks' Ranch) in unit 13MM. Another is that there are considerably more coarse fragments in unit (12MO,123R) and most soils are skeletal. Finally, precipitation is greater in soils of unit (12MO,123R) which occur along the mountain front. The topographic boundary between the 13MM and (12MO,123R) unit is distinct. It is marked by a slope increase, from 4 or 5 percent in the eastern part of unit 13MM to 6 or 8 percent in the western part of unit (12MO, 123R). Marked changes in vegetation also occur across the boundary. Vegetation in unit 13MM consists mostly of Mormon tea and _Yucca elata_. Soils of unit (12MO,123R) have a greater density and variety of vegetation, which includes perennial grasses. Dominant vegetation in unit (12MO,123R) near the boundary consists of catclaw, indigo bush, _Lippia Wrightii_, black grama, sideoats grama, snakeweed, and prickly pear.
Onite-Pajarito complex (13M)	The boundary is due to a slightly older alluvium and geomorphic surface and/or slightly greater precipitation in unit 13MM. Topographically the boundary is not distinct because soils of both units occur on slight ridges.
Berino-Bucklebar association (15M)	The boundary is due to a younger alluvium and geomorphic surface (Organ and Isaacks' Ranch) in unit 13MM. The 15M soils, analogues of which are buried by soils of unit 13MM, emerge at the land surface on the 15M side of the boundary. The topographic boundary between these mapping units is not prominent, although it is fairly distinct in most places. It is marked by the digitating downslope margins of slight east-west ridges. The dominant vegetation changes from scattered Mormon tea, prickly pear, and _Yucca elata_ in unit 13MM to scattered patches and clumps of tobosa, with some snakeweed and mesquite, in unit 15M.

159. CANUTIO, GRAVELLY SANDY LOAM, LOAMY SUBSOIL VARIANT (103ML)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
CANUTIO	TYPIC TORRIORTHENTS	LOAMY-SKELETAL (CALCAREOUS)	15
CANUTIO, LOAMY SUBSOIL VARIANT	TYPIC TORRIORTHENTS	COARSE-LOAMY (CALCAREOUS)	45
Anthony	Typic Torriorthents	Coarse-loamy (calcareous)	10
Arizo	Typic Torriorthents	Sandy-skeletal	10
Glendale	Typic Torrifluvents	Fine-loamy (calcareous)	5
Pajarito	Typic Camborthids	Coarse-loamy	5
SND-6	Entisols		5
Other inclusions (Paleorthids, Haplustolls, Haplargids)			5

LOCATION, LANDSCAPE, VEGETATION

These soils occur in one area near the mountain front, west of the central part of the Organ Mountains. The soils have formed in alluvium derived mostly from monzonite but with smaller amounts of rhyolite, limestone and sandstone. Elevations range from about 4800 to 5100 feet.

Ridges (Isaacks' Ranch and Organ surfaces) are the dominant land form. In places, narrow terraces of later Organ age are inset against the ridges. The sediments have been cut by arroyos and large gullies. Slopes along the ridge crests range from 5 percent nearest the mountains to 2 percent at lower elevations. Ridge sides are often steep and in places are verticle or nearly so.

Creosotebush is dominant. Tarbush and mesquite are also present in many places. A few four-wing saltbush, Yucca baccata, and mariola occur in some areas.

TYPICAL PEDONS, PROPERTIES AND RANGES

All soils are calcareous throughout. Some strata are very gravelly. These soils are commonly underlain by buried soils. Petrocalcic horizons and bedrock are generally not present within a depth of a few m.

Canutio

This soil is similar to the variant, below, but has more gravel.

Canutio, loamy subsoil variant

A typical pedon of Canutio, loamy subsoil variant is described below. The location is SE 1/4 NE 1/4 Sec. 34, T22S, R3E, about 75 m west of NS road, north bank of arroyo. The site is the crest of an Organ ridge about 10 feet higher than the arroyo channel. Figure 135 is a photograph of the pedon and its landscape. A table of properties and ranges follows the description.

Figure 135. Upper. Landscape of a Typic Torriorthent, Canutio variant, on the Organ surface. Vegetation is mostly mesquite, with a few tarbush and four-wing saltbush. Slope is 3 percent. The Organ Mountains are on the skyline.
Lower. Canutio, loamy subsoil variant. Scale is in feet.

Soil surface: Desert pavement of monzonite, rhyolite, andesite and limestone pebbles, mostly from 1/2 to 3 cm in diameter, with several up to 10 cm diameter.

Aca 0-5 cm. Light brown (10YR 6/3, dry) or dark brown (10YR 4/3, moist) gravelly sandy loam; upper cm is weak coarse platy, beneath is mainly a loose mass of soft, very fine crumbs, with some weak medium platy; loose and soft; few roots; thin, discontinuous carbonate coatings on pebbles, mainly on undersides; effervesces strongly; abrupt smooth boundary.

B2ca 5-13 cm. Light brown (10YR 6/3, dry) or dark brown (10YR 4/3, moist) gravelly sandy loam; very weak medium subangular blocky; soft; few roots; carbonate coatings on pebbles; a few carbonate filaments; effervesces strongly; clear wavy boundary.

C1ca 13-39 cm. Light brown (10YR 6/3, dry) or dark brown (10YR 4/3, moist) gravelly heavy sandy loam; very weak medium subangular blocky; mostly hard, with some parts slightly hard; roots common; carbonate coatings on pebbles and sand grains, with coatings generally thicker than above; most coarse fragments are of gravel size but in places there are cobbles up to 15 cm diameter; effervesces strongly; clear wavy boundary.

C2ca 39-69 cm. Light brown (10YR 6/3, dry) or dark brown (10YR 4/3, moist) gravelly sandy loam; very weak medium subangular blocky; mostly hard, with some parts slightly hard; few roots; thin carbonate coatings on pebbles, thinner than in the overlying horizon; the lower boundary is commonly marked by a concentration of pebbles, with scattered fragments of cobble size; few carbonate filaments; effervesces strongly; abrupt smooth boundary.

2B1cab 69-82 cm. Light yellowish brown (9YR 6/4, dry) or dark yellowish brown (9YR 4/4, moist) fine sandy loam; very weak medium subangular blocky; slightly hard and hard; very few roots; few carbonate filaments; few fine tubular pores; effervesces strongly; clear wavy boundary.

2B2cab 82-111 cm. Light yellowish brown (9YR 6/4, dry) or dark yellowish brown (9YR 4/4, moist) fine sandy loam, with more clay than above; compound weak medium prismatic and weak coarse subangular blocky; very few roots; common carbonate filaments on ped surfaces and within peds, occurring as linings in the common fine and very fine tubular pores; elliptical and round insect burrows 1/2 to 1 cm diameter, filled with dark fine earth; in places, the lower boundary is marked by a layer, 1 to 2 pebbles thick, of scattered fine pebbles; effervesces strongly; abrupt to clear, smooth boundary.

2B2tcab2 111-136 cm. Light yellowish brown (7.5YR 6/4, dry) or yellowish brown (7.5YR 5/4, moist) heavy fine sandy loam; weak medium and coarse subangular blocky; very hard; firmer in place than above; no roots; common carbonate filaments, occurring as linings in very fine tubular pores, some of which are not lined with macroscopic carbonate; silicate clay coatings on sand grains between the carbonate filaments; most parts effervesce weakly, a few parts noncalcareous; clear wavy boundary.

2B3cab2 136-157 cm. A mixture of colors, pale brown, very pale brown, white, (10YR 6/3, 7/3, and 8/2, dry), respectively, dark brown, brown and light brownish gray, (10YR 4/3, 5/3, and 6/2, moist) with a few parts 7.5YR 6/4, dry, 5/4, moist, sandy clay loam; weak coarse platy and weak medium subangular blocky; very hard; no roots; continuous, thin carbonate coatings on some ped faces; common carbonate filaments that occur as linings in very fine tubular pores; effervesces strongly; clear wavy boundary.

2B2tcab3 157-185 cm. Yellowish red (5YR 5/5, dry) (5YR 5/4, moist) medium sandy clay loam; weak medium subangular blocky; very hard; no roots; common black (Mn? Fe?) coatings and filaments on ped faces; common carbonate filaments within peds, occurring as very fine pore linings; carbonate coatings on some peds; some grains between carbonate accumulations are coated with clay; parts between visible carbonate accumulations effervesce weakly, remainder effervesce strongly; clear wavy boundary.

2K2b3 185-213 cm. Dominantly very pale brown (10YR 9/3, dry, 10YR 7/3, moist) with some very pale brown (10YR 8/4, dry) or light yellowish brown (10YR 6/4, moist) clay loam; weak medium platy and weak medium subangular blocky; generally hard, with a few parts very hard; no roots; carbonate-impregnated throughout, with sand grains separated by carbonate; effervesces strongly; clear wavy boundary.

3K3b3 213-230 cm. Dominantly very pale brown (10YR 8/3, dry) or pale brown (10YR 6/3, moist) very gravelly with a few parts slightly lighter and darker; very gravelly sandy loam; massive; generally hard, with a few parts very hard; no roots; carbonate coatings on pebbles and sand grains; there is K-fabric throughout, but is more easily removed than the K2; effervesces strongly.

Remarks. This soil is similar to Canutio soils as they occur in the study area, but the 25 to 100 cm control section averages less than 35 percent coarse fragments by volume. The buried soils described above are considered to be the following ages: 69-111 cm, earliest Organ; 111-157 cm, Isaacks' Ranch; 157-230 cm, Jornada II. There is no good lithologic discontinuity between the second and third buried soils, but a pebble line can be seen in places along the cut. The separation of the major accumulations of clay and carbonate is pedologic evidence to suggest two soils.

Table 146. Typical (underlined) and range in selected properties for major horizons of Canutio, coarse-loamy variant.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	sl	0-50	7.5YR- 10YR	5-7 6	3-5 4	2-4 3
B2	5-13	sl	0-35	7.5YR- 10YR	5-7 6	3-5 4	3,4
Cca	13-39	sl	0-35	10YR	5,6	4,5	3,4
Control section		sl	0-35				

SOIL OCCURRENCE

This mapping unit is dominated by Entisols because of high-carbonate parent materials. North and south of this unit, high-carbonate materials are absent or sparse and Argids are dominant.

Torriorthents. CANUTIO, LOAMY SUBSOIL VARIANT occurs on most ridges and also on some of the low, narrow terraces. The loamy-skeletal Torriorthents, CANUTIO soils, occur in more gravelly areas. These areas are fairly narrow zones that represent former main channels. The sandy-skeletal Arizo soils also occur in these areas where textures in the control section average sandy.

Torrifluvents. The coarse-loamy Anthony soils occur in places where organic carbon decreases irregularly or remains above 0.2 percent to 1.25 m. The alluvium in these areas is commonly stratified.

Camborthids. Pajarito soils occur only in a few of the highest, stablest ridge crests (usually Isaacks' Ranch age). In these older soils, in places the carbonate maximum is deep enough that the B horizon qualifies as a cambic horizon.

Haplargids. Hap soils occur only in a few spots near the northern and western margins of the unit.

Haplustolls. Aladdin, calcareous variant and Santo Tomas, calcareous variant occur mostly in steeper areas in the eastern part of the unit, with a very few spots in stablest areas westward.

Paleorthids. Monterosa soils occur in a few places on ridges on the western part of the unit.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 147 gives information about boundaries to major adjacent units.

Table 147. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Monterosa complex (10RR)	The boundary has been caused by a younger geomorphic surface and alluvium (usually Organ, in places Isaacks' Ranch) in unit 103ML. The 10RR soils, analogues of which are buried in most areas of unit 103ML, emerge at the surface on the 10RR side of the boundary. The boundary is not topographically prominent.
Nolam complex (12RR)	The boundary has been caused by a younger geomorphic surface and alluvium (Organ) in unit 103ML.
Onite sandy loam (13MM)	The boundary is due to a change to low-carbonate parent materials (in unit 13MM) so that the argillic horizon has formed in soils of unit 13MM.
Pinaleno very gravelly sandy loam (13R)	The boundary is due to a change to low-carbonate parent materials. At the boundary to unit 13R, the limestone content of the parent materials drops so that the argillic horizon has formed in soils of unit 13R. Coarse fragments also increase, and more soils are skeletal in unit 13R.
Caralampi-Nolam complex (12MO,123R)	The boundary has been caused by a younger geomorphic surface and alluvium (Organ and Isaacks' Ranch) in unit 103ML, and increase in carbonate content of the parent materials in unit 103ML.

160. ALADDIN GRAVELLY SANDY LOAM (13MO)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ALADDIN	TORRIORTHENTIC HAPLUSTOLLS	COARSE-LOAMY	65
Hawkeye	Torriorthentic Haplustolls	Sandy	10
Sonoita	Typic Haplargids	Coarse-loamy	10
Other inclusions (Argiustolls, Haplargids, Torriorthents)			15

LOCATION, LANDSCAPE, VEGETATION

These soils occur mainly west of the northern part of the Organ Mountains. Smaller areas are located near the northern part of the Dona Ana Mountains. These soils have formed in alluvium derived from monzonite. Elevations range from about 4600 to 5600 feet.

The soils occur on fans and terraces that are commonly inset against ridges of older alluvium or monzonite bedrock. Arroyos and gullies are common. Slopes range from about 13 percent next to the mountains to 4 percent in the western part of the unit. Near the Dona Ana Mountains, slopes range from 5 to 10 percent.

Vegetation consists primarily of snakeweed, Mormon tea, *Yucca elata*, fluffgrass, cholla and mesquite; there are scattered patches of black grama and at highest elevations, blue grama is also present. Creosotebush occurs in a few places at lower elevations.

TYPICAL PEDON, PROPERTIES AND RANGES

In places, monzonite bedrock is not far from the surface but depth to bedrock is usually several m or more. A few krotovinas are usually present in the A and C horizons.

Aladdin

A typical pedon of Aladdin is described in the Appendix (pedon 59-1). Figure 136 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

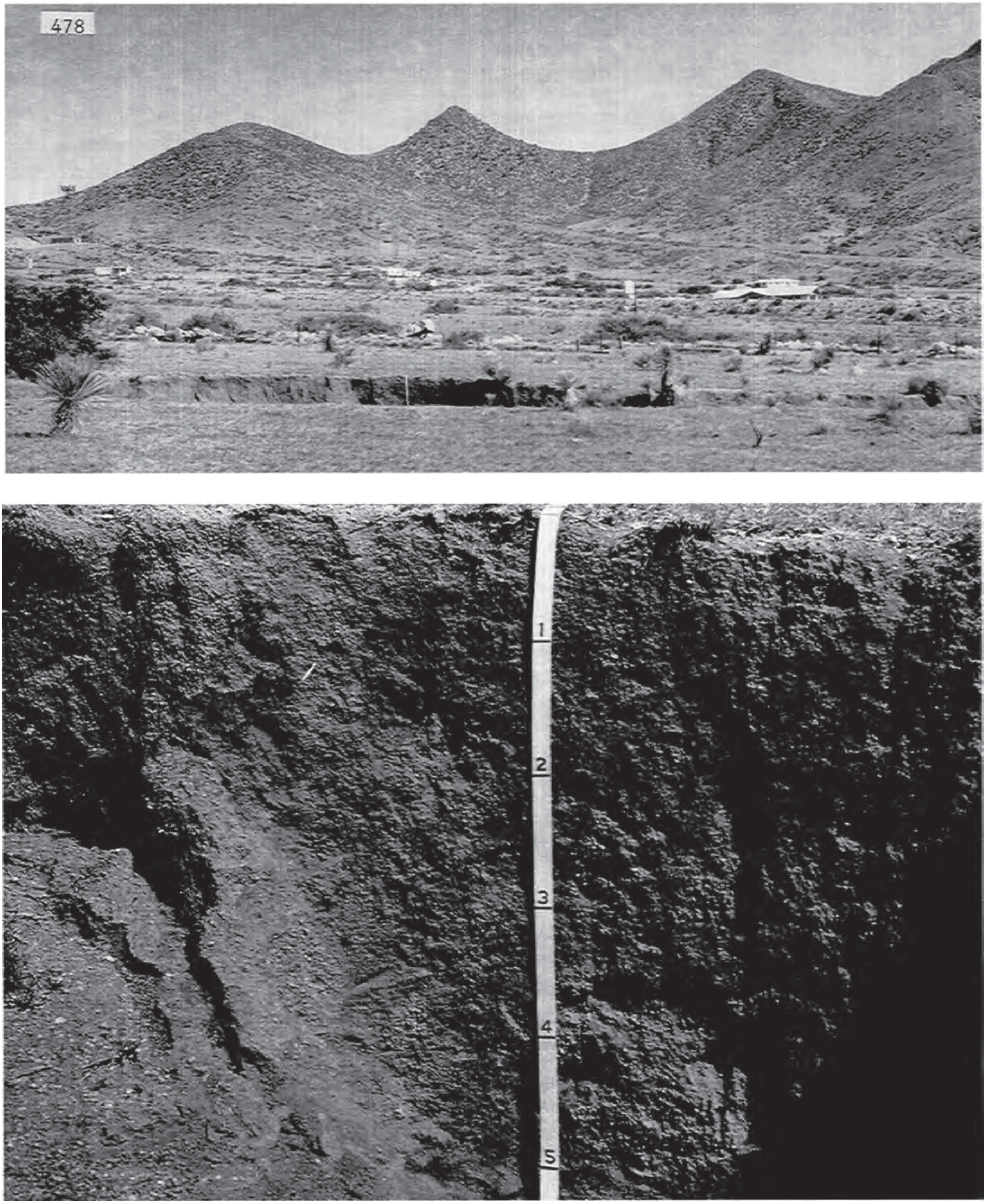


Figure 136. Upper. Landscape of a Torriorthentic Haplustoll, Aladdin 59-1, on the Organ surface. Vegetation consists of snakeweed, *Yucca elata*, prickly pear, fluffgrass, sumac, a few clumps of blue grama, and a few cholla. Slope is 8 percent. Organ Mountains in background.

Lower. Aladdin 59-1. Scale is in feet.

Table 148. Typical (underlined) and range in selected properties for major horizons of Aladdin.

Horizon	Depth cm	Particle Size <2mm	Particle Size >2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-117	sl	15-35	7.5YR-10YR	3-5 4.5	2-3	1-3 2
C	147-173	sl	15-35	7.5YR-10YR	4,5	3,4 3.5	3,4
Control section		sl	15-35				

Other. Thickness of the A horizon ranges from about 1/4 to 1 1/2 m. These soils are noncalcareous to at least 18 cm and typically are noncalcareous to a depth of at least one m.

SOIL OCCURRENCE

The soil pattern is determined by the location of occasional bedrock outcrops, by landscape stability, and partly by texture of the parent materials.

Haplustolls. The coarse-loamy ALADDIN soils occur where textures of the control section average coarse-loamy. Commonly these are on the highest and broadest parts of the Organ surface. The sandy Hawkeye soils tend to occur mainly on areas of youngest Organ--usually low terraces immediately adjacent to major arroyos.

Haplargids. The fine-loamy Hap soils occur on a few remnants of Jornada II age. The coarse-loamy Sonoita soils occur on crests of a few narrow ridges of Organ and possibly Isaacks' Ranch age. Haplargids (Coxwell, shallow variant) formed in bedrock occur in low bedrock ridges.

Argiustolls. Coarse-loamy Argiustolls (SND-9) occur in scattered stable areas of apparent early Organ age.

Torriorthents. Torriorthents (SND-7) (see pedon 59-3, Appendix) occur in a very few places in the western part of the unit. These soils have dark fairly thick A horizons with not quite enough organic carbon for a mollic epipedon. These soils occur on stablest areas of the Organ surface, occur at lowest elevations in the mapping unit and illustrate the transition from the Mollisols to the Aridisols.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 149 gives information about boundaries to major adjacent units.

Table 149. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Caralampi-Nolam complex (12MO,123R)	The boundary has been caused primarily by a younger alluvium and geomorphic surface (Organ) in unit 13MO. Also, soils of unit 13MO contain fewer coarse fragments. The topographic boundary is prominent, occurring at the lower margins of large, high fans of unit (12MO,123R).
Onite sandy loam (13MM)	The boundary has been caused primarily by landscape dissection with precipitation being another factor. Along the boundary the thick A horizons of the Haplustolls (unit 13MO) tend to be preserved only on broadest, stablest interfluves. Precipitation is also a factor in the presence of the mollic epipedon and decreases downslope away from the mountains. The topographic change, while not prominent, is marked by a shift from relatively broad interfluves (unit 13MO) to relatively narrow ones (unit 13MM).
Monzonite rock outcrop and Argids (40M)	The boundary is due to a change from thick alluvium to monzonite bedrock, which is at or very near the surface in unit 40M.

OTHER STUDIES

Other studies in this mapping unit involve the Mollisol-Aridisol transition in Holocene soils; and soils formed in monzonite bedrock. Figure 137 locates the sampled pedons and a soil map (fig. 138), which covers part of an area designated a pediment by Dunham (1935). The landscape lacks deep canyons such as Soledad Canyon (section 156) thus contrasts with that area.

The Mollisol-Aridisol transition

Because of extensive Organ deposits, this area (fig. 138) well illustrates the character of the Mollisol-Aridisol transition, both within the semiarid zone, and downslope toward the arid zone. Nearly all of the Mollisols are of Holocene age because in most places the Organ surface is quite stable and level transversely, and the mollic epipedon is still preserved. Many soils of Pleistocene age have dark surface horizons with fairly high organic carbon, but lack a mollic epipedon because a Bt horizon, with chroma too high for a mollic epipedon, occurs at shallow depths. Similarly, Holocene soils on narrow ridges also lack mollic epipedons.

The A horizon of Aladdin and Hawkeye soils is thick and noncalcareous. The thickness is thought to be the result of episodic sedimentation with intervals of stability during which an A horizon formed. The area is directly downslope from steep slopes of the San Agustin Mountains, and is in the path of main drainage lines from these mountains. It is therefore in a position favoring accumulation of sediments. The soils are highly pervious and have relatively low retention at field capacity (table 150). Therefore, a given increment of precipitation should cause relatively deep wetting, which may increase the thickness of the zone strongly exploited by roots. Mixing by rodents may have added to the thickness of A horizons; krotovinas have been observed in some areas.

The majority of the soil material is in the size range of 5 to 0.5 mm (table 150). Aladdin and Hawkeye pedons contain 15 to 20 percent by volume of coarse fragments, with most in the 5 to 2 mm range, and 40 percent of the fine earth is 2-0.5 mm. This particle size distribution directly reflects the comminution tendency of the monzonite bedrock. Extractable iron content is high relative to clay content (table 150), perhaps related to the abundance of iron-bearing minerals. The sands of Hawkeye 59-2 contains about 4 percent (by volume) of biotite, which comes from monzonite that crops out a short distance to the east.

Pedons 59-1 to 3 (figure 138, table 150) illustrate the Mollisols and the transition to the Aridisols. Hawkeye 59-2 is shown in figures 139 and 140; Aladdin 59-1 is upslope and pedon 59-3 is downslope (fig. 137). Pedon 59-3, a Typic Torriorthent, occurs at lower elevations in the transition between the arid and semiarid parts of the study area. Carbonate occurs at shallower depth and the amount of organic carbon (kg/m^2) is lower for pedon 59-3, a reflection of its lower elevation and drier moisture regime.

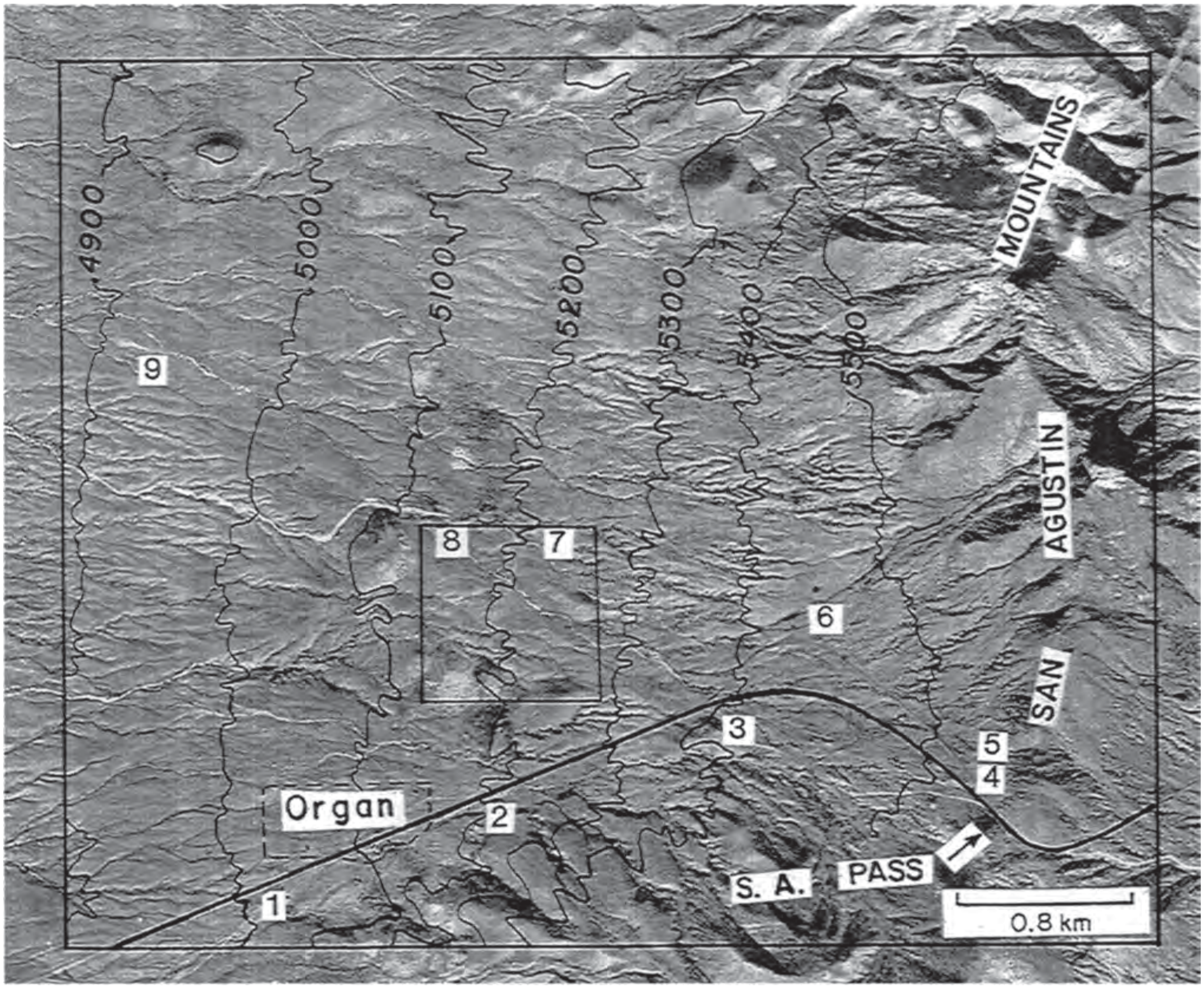


Figure 137. Location of San Agustin Mountains and Pass, town of Organ, U. S. Hwy. 70, soil map and sampled pedons. 1 = pedon 60-8; 2 = 60-9; 3 = 66-15; 4 = 66-9; 5 = 66-10; 6 = 59-1; 7 = 70-1; 8 = 59-2; 9 = 59-3. Contour intervals are in feet.

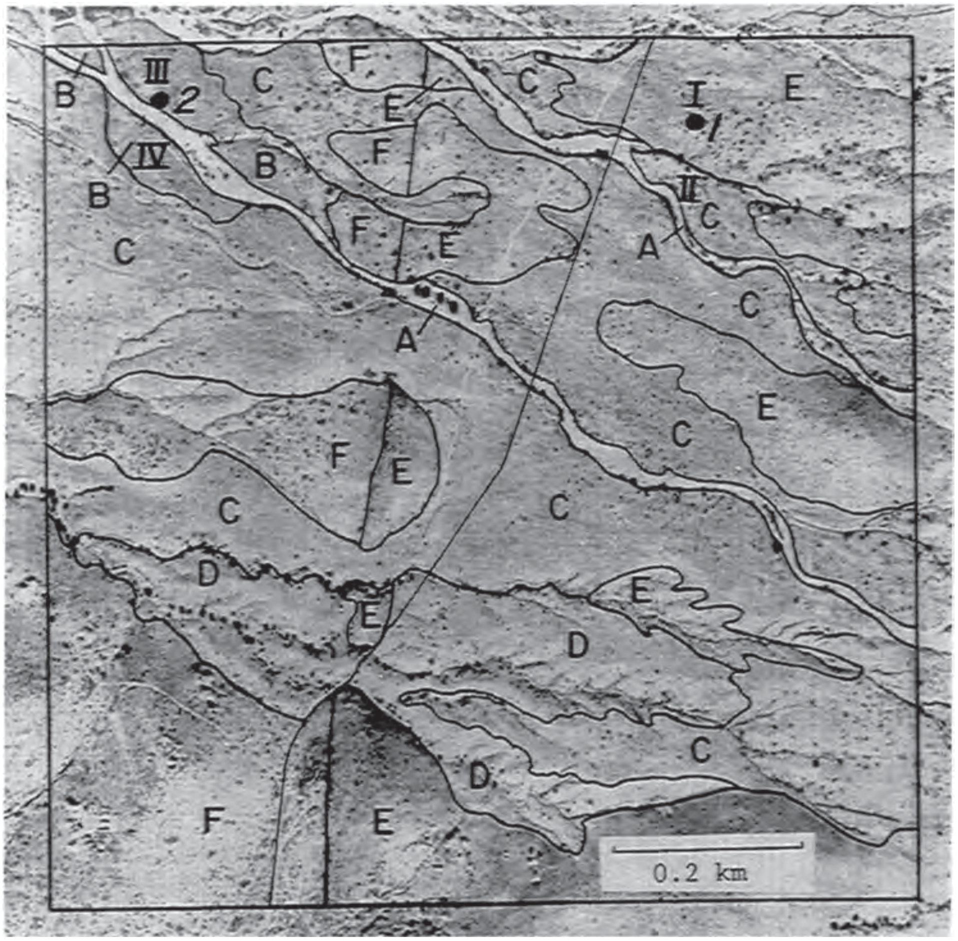


Figure 138. Map of soils in the vicinity of pedons 59-2 and 70-1. A = Torriorthents (arroyo channel surface). B = Hawkeye sandy loam (Organ surface). C = Aladdin sandy loam (Organ surface). D = Sonoita sandy loam (Organ surface). E = Haplargids and rock outcrop (Jornada pediment surfaces and Mountain slopes and summits, undifferentiated). F = Torriorthents and Calciorthids (Jornada pediment surfaces and Mountain slopes and summits, undifferentiated). 1 = Coxwell variant 70-1; 2 = Hawkeye 59-2. I to II and III to IV are cross sections.

Table 150. Laboratory data for two Haplustolls and a Torriorthent.

Horizon	Depth	Sand 2-0.5 mm	Silt	Clay	Vol. > 2 mm	Extractable iron	Carbonate Regular	Carbonate Pebble coatings	Organic carbon
	cm	pct	pct	pct	pct	pct	pct	pct	pct
Torriorthentic Haplustoll (Aladdin 59-1); elevation 5500 ft, 1676 m									
A11	0-5	35	22	7	15	0.6	-(s)		0.83
A12	5-36	32	23	11	15	0.7	-(s)		0.57
A13	36-53	46	19	11	20	0.7	-(s)		0.49
A14	53-89	41	20	11	20	0.7			0.36
A15	89-117	48	17	9	20	0.6			0.32
AC	117-147	33	20	11	20	0.7	tr(s)		0.21
C1	147-173	41	15	9	20	0.7	-(s)		0.14
C2	173-218	42	14	8	15	0.7			0.11
Organic carbon, 5.0 kg/m^2 to 89 cm									
Torriorthentic Haplustoll (Hawkeye 59-2); elevation 5125 ft, 1562 m									
A11	0-3	34	20	8	5	0.8	-(s)	tr(s)	1.03
A12	3-20	47	12	6	20	0.9	-(s)	tr(s)	0.67
A13	20-41	43	13	6	15	1.0	-(s)	tr(s)	0.52
A14	41-71	39	13	7	15	0.9	-(s)	tr(s)	0.29
C1	71-99	42	18	8	15	0.9	-(s)	tr(s)	0.26
C2	99-132	34	19	9	15	0.8	-(s)	0.1	0.20
C3	132-173	35	15	7	20	1.0	tr	0.6	0.17
Organic carbon, 4.9 kg/m^2 to 99 cm									
Typic Torriorthent (SND-7 59-3); elevation 4600 ft, 1401 m									
A11	0-4	26	25	9	5	0.9	-	tr(s)	0.80
A12	4-15	42	15	7	20	0.8	1		0.64
A13	15-30	38	14	7	15	0.8	1	3.8	0.33
C1ca	30-61	45	12	6	20	0.8	1	3.0	0.29
C2ca	61-102	42	14	7	20	1.0	1		0.20
Organic carbon, 4.0 kg/m^2 to 102 cm									
Water retention 0.1 bar, 0-100 cm, 0.083[2/]									

1/ Carbonate-free basis.
2/ Assume 13% for A11 horizon.

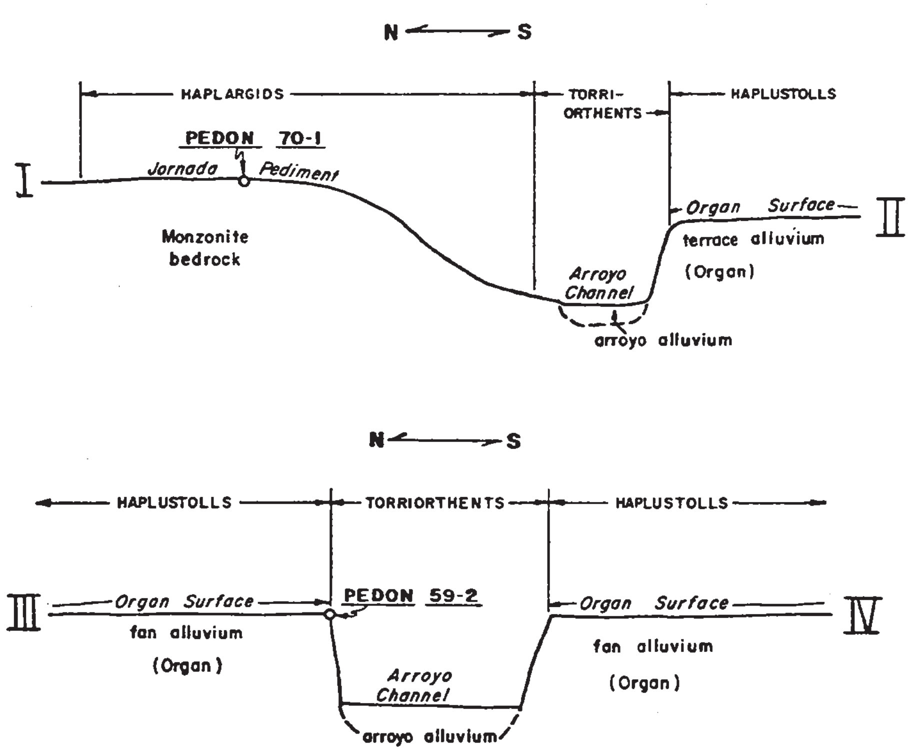


Figure 139. Cross section from I to II and III to IV, soil map.

Typic Haplargids are also on the Organ surface in the semiarid zone. They occur at about the same elevation as Aladdin and Hawkeye soils but they have Bt horizons and do not have thick dark A horizons. In contrast to the Aladdin and Hawkeye soils, the Haplargids occur on slight ridges that could not have been accessible to sedimentation for some time. The evidence suggests that while sediments were still accumulating at the surface of Aladdin and Hawkeye soils, Bt horizons were forming in the Haplargids.

Laboratory data for Sonoita 60-8 are in table 151. The coarse fragments are less than 20 mm and about half of the fine earth is very coarse and coarse sand. Most of the material in the 2.0 to 0.5 mm range is controlled by the pattern of physical weathering of the monzonite source rock. Organic carbon is low; less than half that of Haplustolls developed in similar alluvium at about the same elevation (table 150). A major reason for this is the location of Sonoita 60-8 on a slight ridge. The site is subject to runoff and has undergone some truncation. The Bt horizon is thicker than in soils of the same age at lower elevations; this is attributed to higher elevation and precipitation.

Soils formed in monzonite bedrock

The bedrock areas occur both as pediments that grade smoothly into adjacent alluvial fans, and as low hills that project above the general relief. The soils formed in bedrock show the effects of differences in carbonate content of the bedrock on soil development (fig. 138); the soils (mostly Ustollic Haplargids) in monzonite bedrock have reddish, largely noncalcareous Bt horizons whereas the soils (Torriorthents and Calciorthids) in calcareous rocks lack these horizons and are strongly calcareous throughout. The linear contact between these soils (fig. 138) marks a fault between sedimentary rocks (limestone and shale) and quartz monzonite (Dunham, 1935).

Figure 137 shows the location of four Ustollic Haplargids developed wholly or partly in monzonite bedrock in the vicinity of San Agustin Pass. Laboratory data are in table 152.

Figs. 139, 141 and 142 show the landscape and morphology of Coxwell variant 70-1, which developed in a pediment cut on monzonite bedrock. The pedon occurs in the center of a slight bedrock ridge. Age of the pediment is unknown but it is older than Organ and is probably at least Jornada I in part. Absence of steep slopes or strong dissection, presence of bedrock at quite uniform depths, and lateral continuity of the soil suggest relative stability for a long period of time. The pedon has thin A and Bt horizons over bedrock (R horizon) at 52 cm. A weak horizon of carbonate accumulation begins at about 20 cm. Clay and carbonate, probably derived largely from atmospheric additions, has moved into the bedrock, forming horizons of clay and carbonate accumulation. Preferred orientation of clay in the B2t horizon is weak. Coatings of oriented clay in the B2t horizon on sand grains are thin and indistinct, and the plasma away from the skeletal grains exhibits only weak, short range interference color. Strongly expressed clay films are present in the B3t and in the Rt horizons. Most of the books of mica in the B2t horizon appear fairly altered but the overall optical properties of biotite are retained; the hornblende looks rather fresh (Appendix). Although this soil must have formed partly during at least one pluvial and would have been moistened even more frequently than now, mineral alteration has not been rigorous.

Table 151. Laboratory data for a Typic Haplargid (Sonoita 60-8), elevation 5000 ft, 1524 m.

Horizon	Depth	Sand[1/] 2-0.5mm	Silt[1/]	Clay[1/]	Vol. > 2 mm	Carbonate	Organic carbon
	cm	pct	pct	pct	pct	pct	pct
A	0-8	44	12	6	10	tr	0.15
B21t	8-23	37	13	12	15	-	0.21
B22t	23-48	48	13	12	30	tr	0.23
B3	48-81	53	11	7	20	tr(s)	0.09
2C	81-102	52	13	6	25	1	
Organic carbon, 1.7 kg/m^2 to 102 cm.							

1/ Carbonate-free basis.

Table 152. Laboratory data for Ustollic Haplargids developed in monzonite bedrock or its local colluvium.

Horizon	Depth	Volume > 2 mm	Sand 2-0.5 mm	Clay	Cation Exchange Capacity	Carbonate	pH	Organic Carbon
	cm	pct	pct	pct	me/100g	pct		pct
Coxwell variant 70-1								
A2	0-5	20	20	10	8	-(s)	7.2	0.4
B1t	5-11	20	23	15	12	-(s)	7.6	0.5
B2t	11-21	45	28	24	15	tr(s)	7.7	0.6
B3tca	21-52							0.2
R1tca	52-93							
R2t	93-118							
Organic carbon, 2.0 kg/m^2 to 52 cm.								
Coxwell variant 66-9								
A1	0-5	30	33	12	12	-(s)	7.3	0.66
B21t	5-15	30	37	17	24	-(s)	7.3	0.86
B22t	15-33	35	35	17	25	-(s)	7.1	0.43
B31	33-48	40	37	16	25	-(s)	6.8	0.42
B32	48-84	10	41	16	25	-(s)	6.9	0.13
B33	84-122	10	34	14	25	-(s)	6.7	
B34	122-198	20	37	16	27	tr(s)	6.6	
R	198-234		52	3	9	tr(s)		
Organic carbon, 3.4 kg/m^2 to 84 cm.								
Coxwell variant 66-10								
A1	0-5	45	35	12	12	tr(s)	7.2	0.62
B21t	5-13	35	24	22	19	tr(s)	6.5	1.01
B22t	13-25	40	35	23	20	tr(s)	6.4	0.70
B23t	25-43	45	55	11	12	tr(s)	6.6	0.27
B3	43-84	50	49	9	11	tr(s)	6.6	0.11
R1	84-132		57	3	10	tr(s)	6.7	
R2	132-178		50	6	12	tr(s)	6.8	
Organic carbon, 2.4 kg/m^2 to 84 cm.								
SND-4 66-15								
A1	0-10	40	34	12	12	-(s)	7.0	0.94
B1t	10-28	40	26	18	13	-(s)	7.0	0.90
2B1t&A	28-41	25	25	17	12	-(s)	7.1	0.55
2B2t&A	41-58	25	21	18	12	-(s)	7.1	0.38
3B21t	58-81	50	24	27	18	tr(s)	7.3	0.28
4B22t	81-102	25	22	23	17	tr(s)	7.8	0.16
4B23tca	102-142	25	27	21	17	tr(s)	7.9	0.10
4B3tca	142-185	30	41	14	17	tr(s)	7.9	
R1	185-201		42	13	18	tr(s)	7.9	
R2	201-244		64	3	15	tr(s)	8.1	
Organic carbon, 4.9 kg/m^2 to 102 cm.								

Figure 140. A Torriorthentic Haplustoll, Hawkeye 59-2. Vegetation consists of snakeweed, Yucca elata, mesquite, Mormon tea, fluffgrass, and cholla. Slope is 5 percent. The San Andres Mountains are in the background. Scale is in feet.

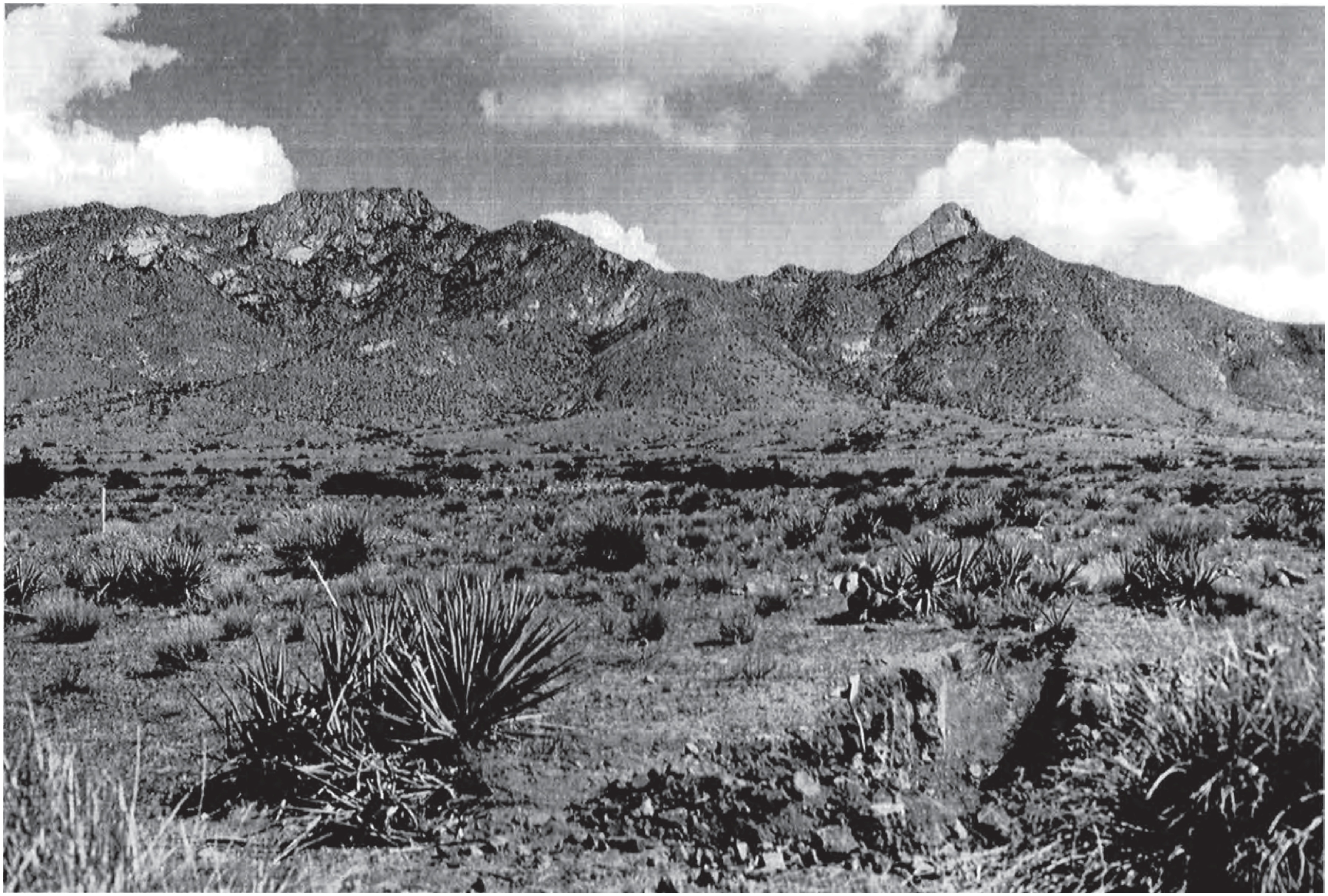


Figure 141. Landscape of an Ustollic Haplargid, Coxwell variant 70-1, on Jornada pediment. Vegetation is snakeweed, Yucca baccata, prickly pear, fluffgrass, blue grama, cholla and beargrass. Slope is 5 percent. San Agustin Mountains in background; San Agustin Peak at the right.

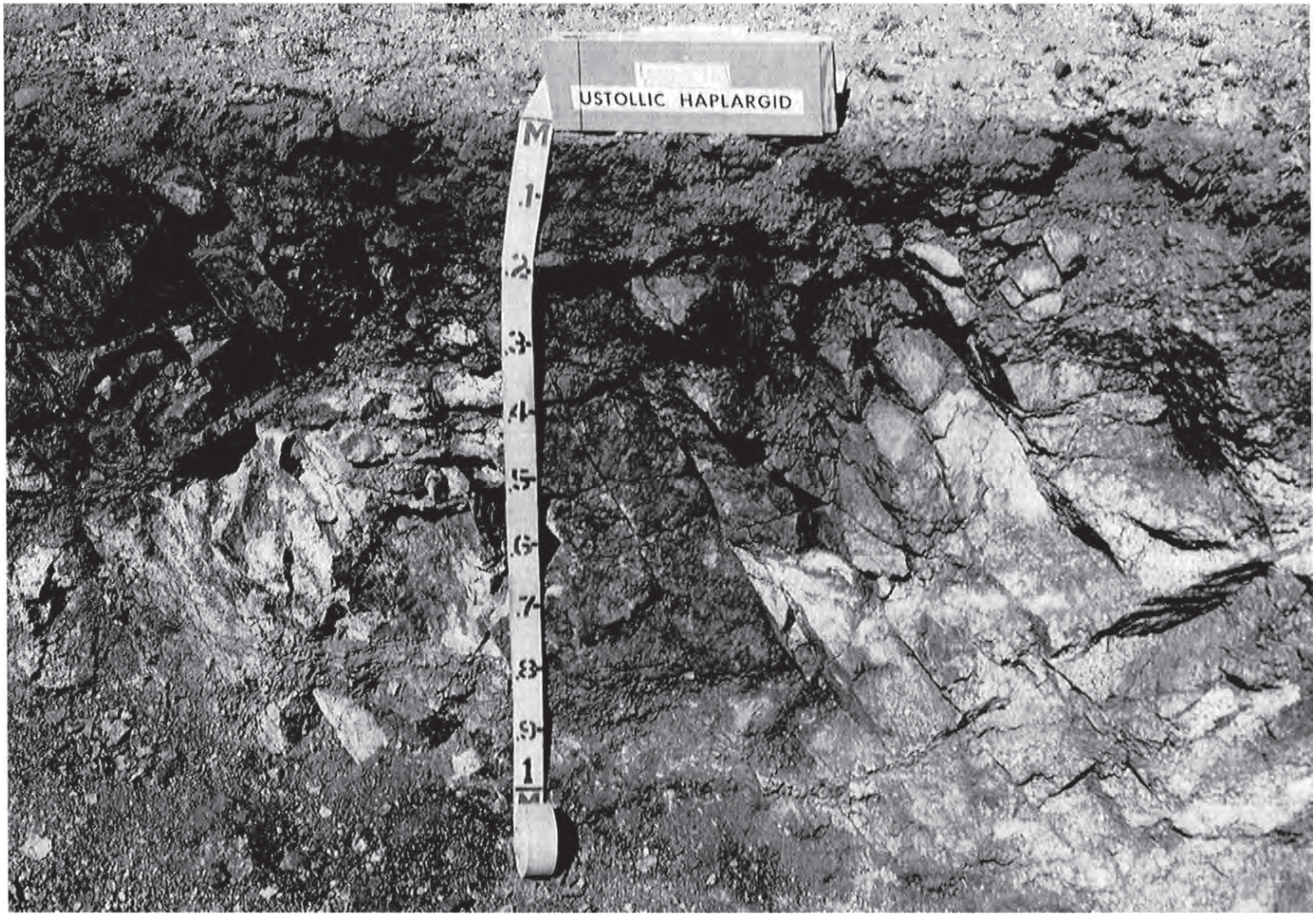


Figure 142. An Ustollic Haplargid, Coxwell variant 70-1. Scale is in meters.

Figure 143 shows Coxwell variant 66-9. The pedon has formed in bedrock except for the upper 15 cm, which is colluvium. Upper horizons are dark enough for a mollic epipedon but not thick enough. The B horizon consists largely of weathered bedrock that is softer and coarser than the R horizon.

Pedon 66-15 has formed partly in colluvium-alluvium and partly in bedrock. The lower B horizon has distinct clay skins which, except for pipes, are not found in the arid part of the project area. Position of this soil on a ridge side, and aspect to the northeast may have increased soil moisture enough that clay skins could form. Filamentary carbonate occurs in the lower B horizon on clay skins and hence postdates them. The carbonate filaments are considered to be of Holocene age.

Features of the laboratory data for these four soils (table 152) are the high proportions of coarse fragments (the pedons are either skeletal or nearly so); the large component of sand, 2-0.5 mm, in the fine earth; the narrow range in clay percentage for A horizons (10 to 12 percent) and for the maximum in the B2t horizon (17 to 27 percent); cation exchange capacities that are high relative to the clay percentage in the lower B horizon; lack of, or extremely low carbonate; pH values that range down to 6.5 in lower B horizons; relatively high organic carbon percentages, with the amounts (kg/m^2 to variable depth) reduced somewhat because of the volume of coarse fragments.

The high exchange capacities relative to the clay appear related to the presence in the sand of macroscopic micaceous minerals with exchange capacity rather than to incomplete disaggregation of the clay. The evidence for this is the lack of correspondence between the ratios of 15 bar water and of exchange capacity to clay.

The mineralogy of these soils is directly related to the composition of the monzonite bedrock. Fresh monzonite bedrock contains feldspar phenocrysts up to 2 cm across commonly interspersed with fine to coarse sand-sized grains of quartz. Hornblende and biotite are common accessory minerals. Some of the feldspar phenocrysts are distinctly zoned with an intermediate calcium plagioclase core and a potassium feldspar rind. Pyrite is present locally. The plutonic mass is intruded by dikes and some alteration of the monzonite has occurred near the dikes. The proportion of mica in the monzonite ranges widely from place to place. Most of this mica is biotite, but with some chlorite (?). It alters early in the weathering process. Thin sections of hard and rather fresh-appearing monzonite show altered biotite grains whereas the feldspars and hornblende appear unaltered. Numerous cracks are lined with clay which seems to be associated with the biotite.

The mineraology of the sand in the soils indicates weak weathering. The very fine sand contains 5 to 15 percent plagioclase feldspar in the oligoclase-andesine range. Albite plus potassium feldspars range from 30 to 45 percent. The potassium feldspars are principally orthoclase with some microcline and sanidine. The sanidine may be related to the intrusive dikes in the monzonite rock. Quartz ranges from 25 to 45 percent in most soils compared to less than 15 percent for the monzonite rock in pedon 66-9. Microcrystalline aggregates constitute 10 to 20 percent of the very fine sand fractions. The aggregates consist of small domains of feldspar and inclusions of mica. Mica is common.

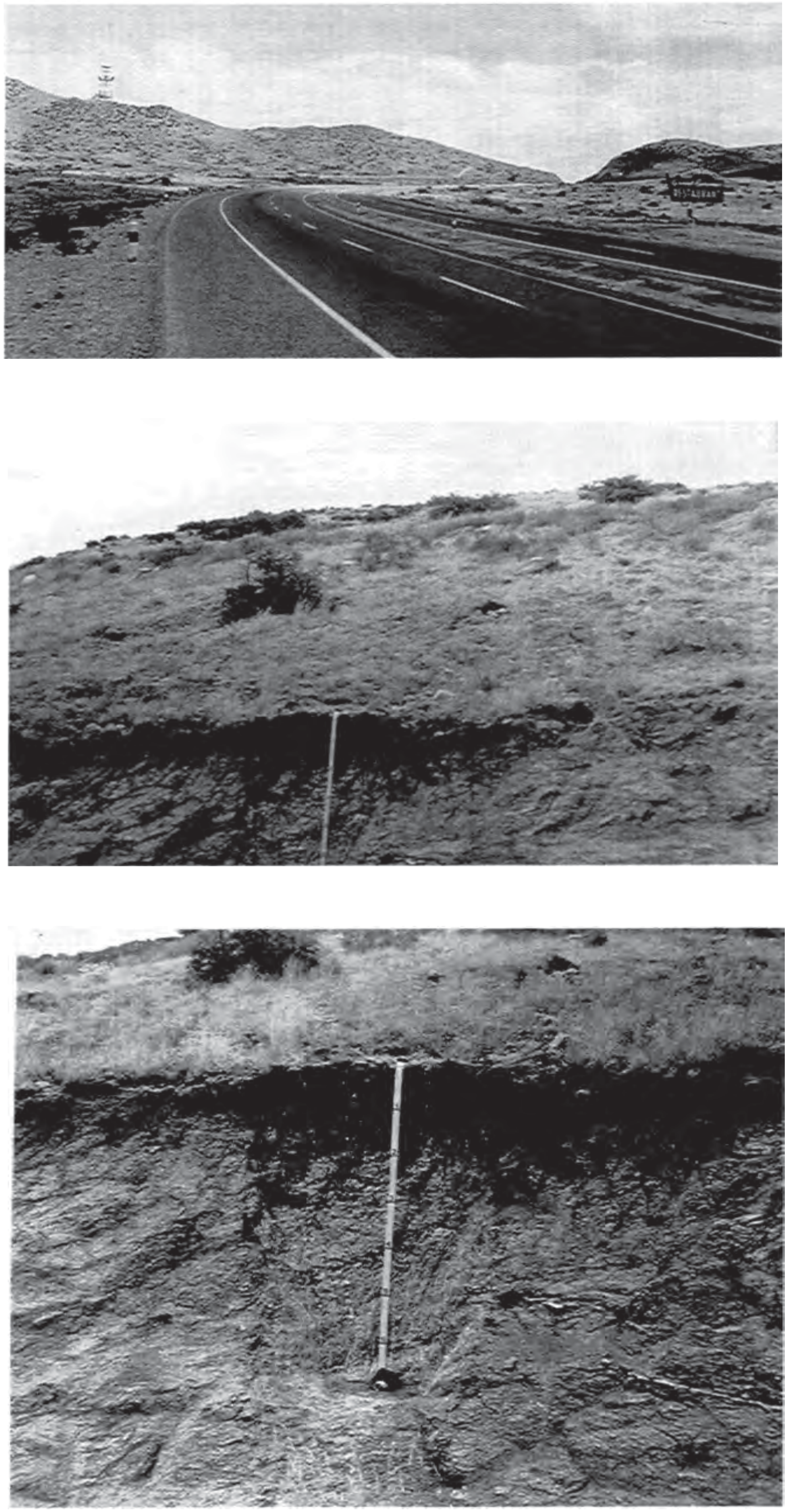


Figure 143. Upper. San Agustin Mountains and San Agustin Pass (left). View is to the east.
Middle. Landscape of an Ustollic Haplargid in monzonite bedrock, Coxwell variant 66-9.
Lower. Coxwell variant 66-9. Scale is in feet.

The total sand in B2t horizons of two pedons contain 7 and 14 percent mica. The very fine sand contains 1 to 5 percent ferromagnesian minerals other than mica.

Soil clays are well crystallized. In pedon 66-9 the mica (mostly biotite) weathers to a montmorillonite through an intermediate, regularly alternating biotite-montmorillonite similar to hydrobiotite. In pedon 70-1, the mica weathers to montmorillonite through a vermiculite that expands on solvation to spacings indicative of regularly alternating 14 and 10 angstrom minerals.

Kaolinites give very sharp, intense diffraction peaks which correspond to a kaolinite content of 10 to 15 percent by differential thermal analysis. Soils throughout the study area also have clays with 10 to 15 percent kaolinite, but the associated X-ray diffraction peaks are much less intense. The R horizon of pedon 66-9 is devoid of kaolinite. The other rock or weathered rocks analyzed have some kaolinite. It is reasonable to assume that fresh monzonite rock initially lacks kaolinite except perhaps in dikes. It is assumed that the well-ordered kaolinite is an early weathering product on rather fresh feldspar surfaces.

161. TRES HERMANOS-ONITE COMPLEX (14V)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ONITE, GRAVELLY VARIANT	TYPIC HAPLARGIDS	COARSE-LOAMY	20
PINALENO	TYPIC HAPLARGIDS	LOAMY-SKELETAL	15
TRES HERMANOS	TYPIC HAPLARGIDS	FINE-LOAMY	30
Anthony	Typic Torrifluvents	Coarse-loamy, (calcareous)	10
Arizo	Typic Torriorthents	Sandy-skeletal	5
Canutio	Typic Torriorthents	Loamy-skeletal, (calcareous)	5
Onite	Typic Haplargids	Coarse-loamy	10
Other inclusions (Torrifluvents)			5

LOCATION, LANDSCAPE, VEGETATION

Soils of this mapping unit occur in one large delineation east of the Dona Ana Mountains. The soils have formed in sediments derived from rhyolite, monzonite, andesite and latite. Elevations range from about 4350 to 4500 feet.

The soils occur on alluvial fans. Small drainageways, a few cm to several cm deep, are common, and there are several small arroyos. Transverse relief is gently undulating due to the presence of the drainageways. Longitudinal slopes range from 2 to 3 percent.

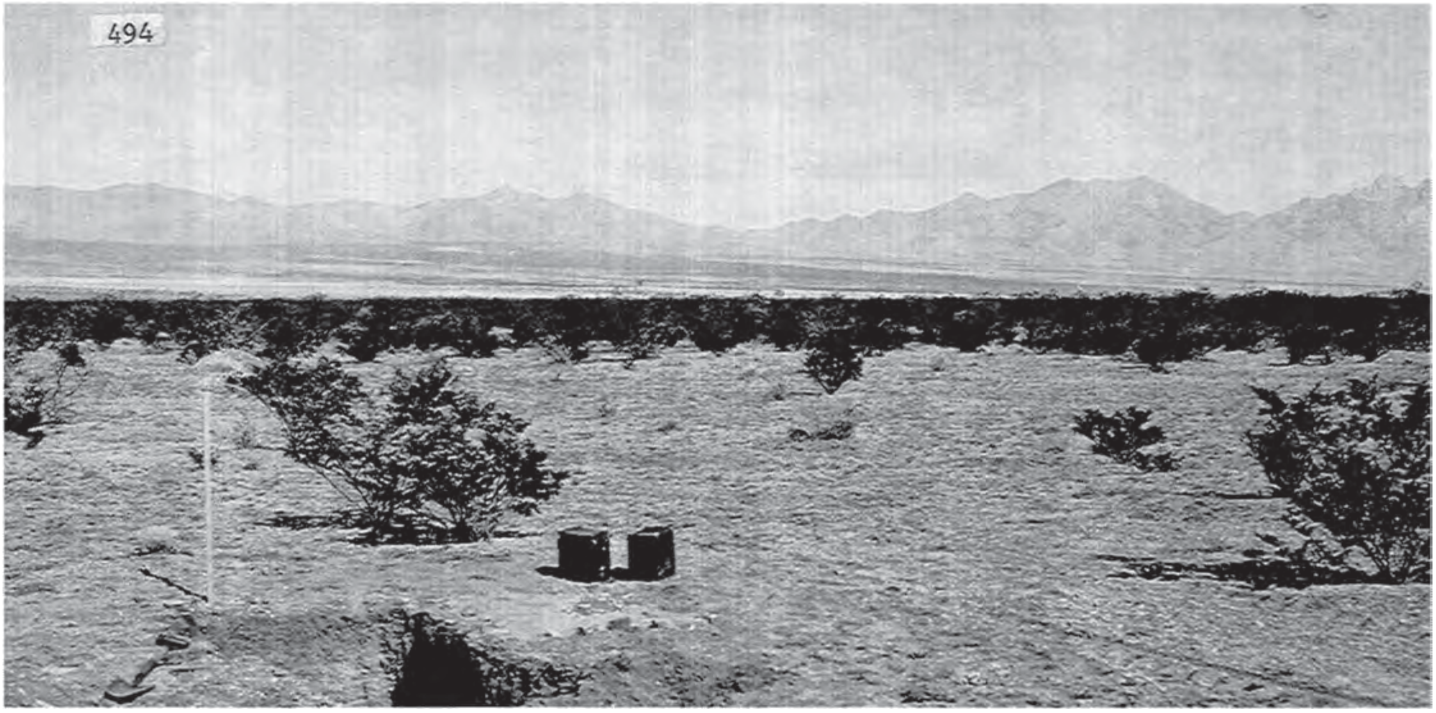
Scattered cresostebush, snakeweed and Mormon tea are dominant on slight ridges; creosotebush, tarbush, desert thorn and mesquite are dominant in drainageways.

TYPICAL PEDONS, PROPERTIES AND RANGES

These soils are usually underlain by buried soils with argillic horizons.

Onite, gravelly variant

A typical pedon of Onite, gravelly variant is described in the Appendix (pedon 61-5). Figure 144 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.



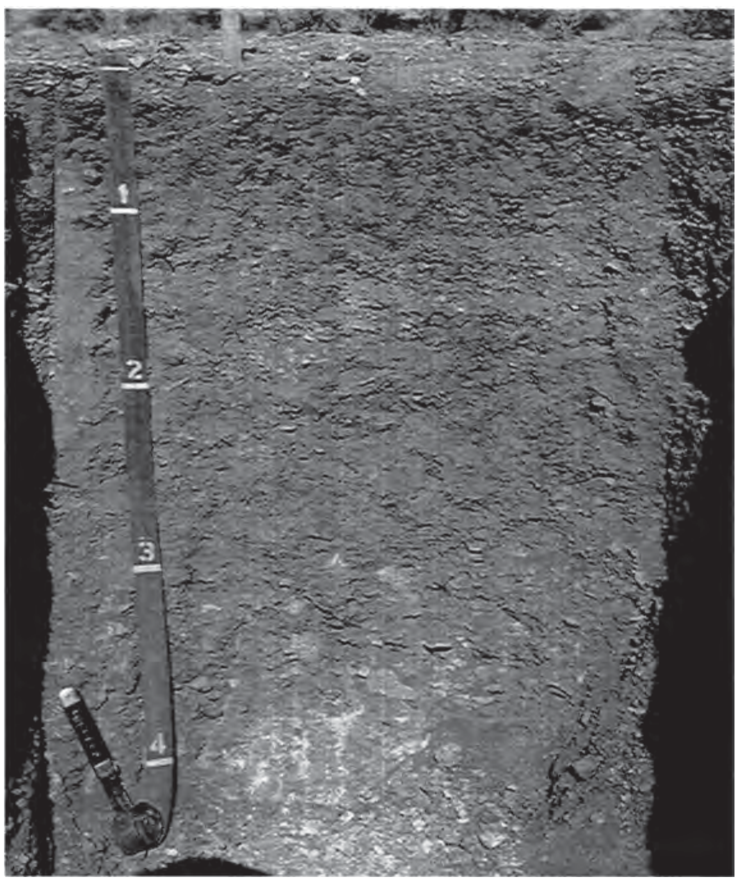


Figure 144. Upper. Landscape of a Typic Haplargid, Onite variant 61-5, on the Organ surface. Vegetation is mostly creosotebush with scattered Mormon tea, tarbush, snakeweed and sumac. Although this area now contains no grass, evidence at the Dona Ana rain gauge site to the south (Herbel and Gile, 1973) suggests that it once may have had a grassy cover. Slope is 3 percent.

Lower. Onite variant 61-5. Scale is in feet.

Table 153. Typical (underlined) and range in selected properties for major horizons of Onite, gravelly variant.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A2	0-8	<u>sl</u>	0-25	<u>7.5YR</u>	<u>5</u>,6	3-5 <u>3.5</u>	2-4 <u>3,4</u>
B2t	8-23	<u>sl</u>	15-35	<u>5YR</u>	<u>5</u>,6	3-5 <u>3.5</u>	<u>4</u>,5
Cca	23-36	<u>sl</u>	15-50	<u>7.5YR</u>	<u>5</u>,6	<u>3</u>,4	3,<u>4</u>
Control section	25-100	sl	15-35				

Other. In places, the A horizon has been truncated and the Bt horizon is at the surface. These soils are generally noncalcareous to depths ranging from 10 to 25 cm (approximately the top of the ca horizon) but range to calcareous in places.

Pinaleno

See section 155 for a description of Pinaleno and a table of properties and ranges.

Tres Hermanos

A typical pedon of Tres Hermanos is described below. The location is a drainageway in the NE 1/4 SW 1/4 Sec. 8, T21S, R2E. A table of properties and ranges follows the description.

Many of these soils have a thin (< 50 cm) mantle of youthful materials at the surface. The mantle is usually gravelly or very gravelly in part. Horizons beneath the mantle are typically a gravelly clay loam Bt horizon and a gravelly clay loam K horizon. These soils are typically calcareous throughout.

A 0-3 cm. Reddish brown (6YR 5/4, dry, 3.5/4, moist) gravelly sandy loam; weak fine and medium platy; soft; effervesces weakly; abrupt smooth boundary.

B2ca 3-13 cm. Reddish brown (5YR 5/4, dry, 5YR 3.5/4, moist) sandy loam; massive; slightly hard; few discontinuous carbonate filaments; few pebbles, with discontinuous carbonate coatings; effervesces strongly; few roots; clear wavy boundary.

2C1ca 13-30 cm. Light reddish brown (6YR 6/4, dry) and reddish brown (6YR 4/4, moist) very gravelly sandy loam; single grain; loose; prominent, continuous carbonate coatings on pebbles (7.5YR 8/3, dry; 7/4, moist); effervesces strongly; few roots; clear boundary.

3C2ca-Bbca 30-38 cm. Reddish brown (5YR 5.5/4, dry; 4/4, moist) gravelly loam; weak and moderate medium subangular blocky; slightly hard and hard; pebbles thinly coated with carbonate; few carbonate filaments; clear boundary.

3B21tcab 38-56 cm. Reddish brown (5YR 5.5/4, dry; 4/4, moist) gravelly heavy clay loam, with few parts slightly redder and of higher chromas; hard; few carbonate filaments and nodules; thin carbonate coatings on pebbles; few roots; effervesces weakly; clear boundary.

3B22tcab 56-69 cm. Light brown (7.5YR 6/4, dry) or brown (7.5YR 5/4, moist) gravelly clay loam; few parts slightly redder; weak and moderate medium subangular blocky; hard; common carbonate nodules (7.5YR 8/2, dry; 7/4, moist) thin carbonate coatings on pebbles; few roots, effervesces strongly; clear boundary.

3Kb 69-94 cm. White (7.5YR 9/2, dry) and light brown (7.5YR 6.5/4, dry) or pink (7.5YR 7/4, moist) and brown (7.5YR 5/4, moist) gravelly clay loam; mainly weak medium subangular blocky; with some massive parts and few cylindroidal forms; hard; few roots; effervesces strongly.

Table 154. Typical (underlined) and range in selected properties for major horizons of Tres Hermanos.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
B2tb	38-69	cl (underlined) scl	15-35	2.5YR- 7.5YR 5YR (underlined)	5,6 (6 underlined)	4,5 (4 underlined)	4-6 (4 underlined)
Kb	69-94	cl (underlined) scl	15-50	7.5YR (underlined)	6-9 (9 underlined)	5-8 7 (underlined)	2-4 (4 underlined)
Control section		cl,scl	15-35				

Other. The range of characteristics are those of the prominent soil and not the mantle of younger material, which is absent in some areas. Thickness of the mantle ranges from 0 to 50 cm. Depth to the calcic horizon (the 2Kb horizon in the description) is usually from 50 to 75 cm, ranging from 30 to 100 cm. These soils are calcareous throughout.

SOIL OCCURRENCE

Soil occurrence is determined by the depth to buried soils, by gravel content of the alluvium, and by occasional small arroyos.

Haplargids. The coarse-loamy Onite soils; ONITE, GRAVELLY VARIANT; and PINALENO soils occur primarily in upper and middle slopes of the mapping unit where gravel content is greater. TRES HERMANOS soils occurs in drainageways and on lower slopes where the buried soil (Tres Hermanos) is within 50 cm of the surface and there are no diagnostic horizons in the overlying alluvium.

Torrifluvents. The sandy Vinton soils and the coarse-loamy Anthony soils occur where diagnostic horizons are absent and organic carbon decreases irregularly with depth. These are mostly adjacent to arroyos and in places of strong erosion, where diagnostic horizons have been eroded.

Torriorthents. The sandy-skeletal Arizo soils and the loamy-skeletal Canutio soils occur adjacent to arroyos.

SOIL BOUNDARIES

Table 155 gives information about boundaries to major adjacent units.

Table 155. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Casito-Terino complex (12V)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 14V. The topographic boundary is not distinct but characteristically these soils occur on younger deposits downslope from areas of unit 12V.
Anthony complex (13ML,13V, 13LG)	The boundary is due to slightly less landscape dissection in unit 14V. The topographic boundary between these units is not distinct.
Dona Ana sandy clay loam (16VG)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 14V. The 16VG soils, analogues of which are buried by Organ alluvium and its soils in unit 14V, emerge at the surface on the 16VG side of the boundary. The topographic boundary is not distinct; vegetatively it is commonly marked by an increase in density of shrubs in unit 16VG.

162. ANTHONY COMPLEX (13ML, 13V, 13LG)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
ANTHONY	TYPIC TORRIFLUVENTS	COARSE-LOAMY (calcareous)	40
Canutio	Typic Torriorthents	Loamy-skeletal (calcareous)	5
Canutio, loamy subsoil variant	Typic Torriorthents	Coarse-loamy (calcareous)	10
Dalian, sandy-skeletal variant	Typic Torriorthents	Sandy-skeletal (carbonatic)	5
Vinton	Typic Torrifluvents	Sandy	10
Vinton, sandy-skeletal variant	Typic Torrifluvents	Sandy-skeletal	10
Other inclusions (Torrifluvents, Torriorthents, Haplargids, Entisols)			20

LOCATION, LANDSCAPE, VEGETATION

These soils occur in two general areas--one in a broad belt east of the Dona Ana Mountains and the other in an east-west strip west of the southern part of the San Andres Mountains. East of the Dona Ana Mountains, the soils have formed in alluvium derived from rhyolite, monzonite and andesite. West of the San Andres Mountains soils have formed in alluvium derived mainly from monzonite, with smaller amounts of limestone and calcareous sandstone. Elevations range from about 4300 to 4800 feet.

The area is located primarily on the coalescent fan-piedmont. In places there are small individual fans and terraces. Small arroyos and gullies are common. Slopes range from 3 percent next to the mountains to 2 percent at lower elevations.

Vegetation consists mostly of creosotebush, in places, with mesquite, fluffgrass, snakeweed, _Yucca baccata_, _Yucca elata_, prickly pear, Mormon tea, tarbush and alkali sacaton.

TYPICAL PEDON, PROPERTIES AND RANGES

These soils are calcareous throughout. Usually they are underlain by buried soils. Very gravelly strata occur in places. In some areas loam textures occur in the lower part of the control section. Some pedons have thin B horizons underlain by weak carbonate accumulations.

Anthony

A typical pedon of Anthony is described in the Appendix (pedon 65-3). Figure 145 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

Table 156. Typical (underlined) and range in selected properties for major horizons of Anthony.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-38	<u>sl</u> ls	0-35	7.5YR- <u>10YR</u>	<u>5</u>,6	3-5 <u>4</u>	<u>3</u>,4
C		<u>sl</u> ls	0-35	7.5YR- <u>10YR</u>	<u>5</u>,6	3-5 <u>4</u>	<u>3</u>,4
Control section	25-100	sl	0-35				

SOIL OCCURRENCE

Very few Argids occur in this mapping unit. East of the Dona Ana Mountains, this is due to soil truncation; small drainageways are common and upper horizons have generally been truncated. Argillic horizons have been preserved only in a very few spots. West of the San Andres Mountains the lack of Argids is due to high carbonate content of the parent materials and youth of the soils. Since diagnostic horizons are generally absent, most soils are Entisols and the kind of Entisol present is dependent on texture and the amount and distribution of organic carbon.

<u>Torrifluvents</u>. These soils occur where organic carbon decreases irregularly with depth. The coarse-loamy ANTHONY soils are most common. These soils average less than 35 percent by volume of coarse fragments in the control section and grade to Anthony, loamy-skeletal variant where coarse fragments average more than this. The shift is due to changes in gravel content of the alluvium. The more gravelly soils tend to be dominant on steeper slopes and in main channel zones of streams that deposited the sediments. Occurrence of the coarse-loamy Gila soils, the sandy Vinton soils and Vinton, sandy skeletal variant is also determined by texture to the alluvium.

<u>Torriorthents</u>. The sandy-skeletal Arizo, loamy-skeletal Canutio and Canutio, loamy subsoil variants occur in places where decrease of organic carbon is regular. The sediments in such areas lack distinct stratification, or textures are too coarse. The carbonatic Torriorthents, Dalian and its sandy-skeletal variant, occur only west of the San Andres Mountains in places where carbonates are high enough for the carbonatic family.

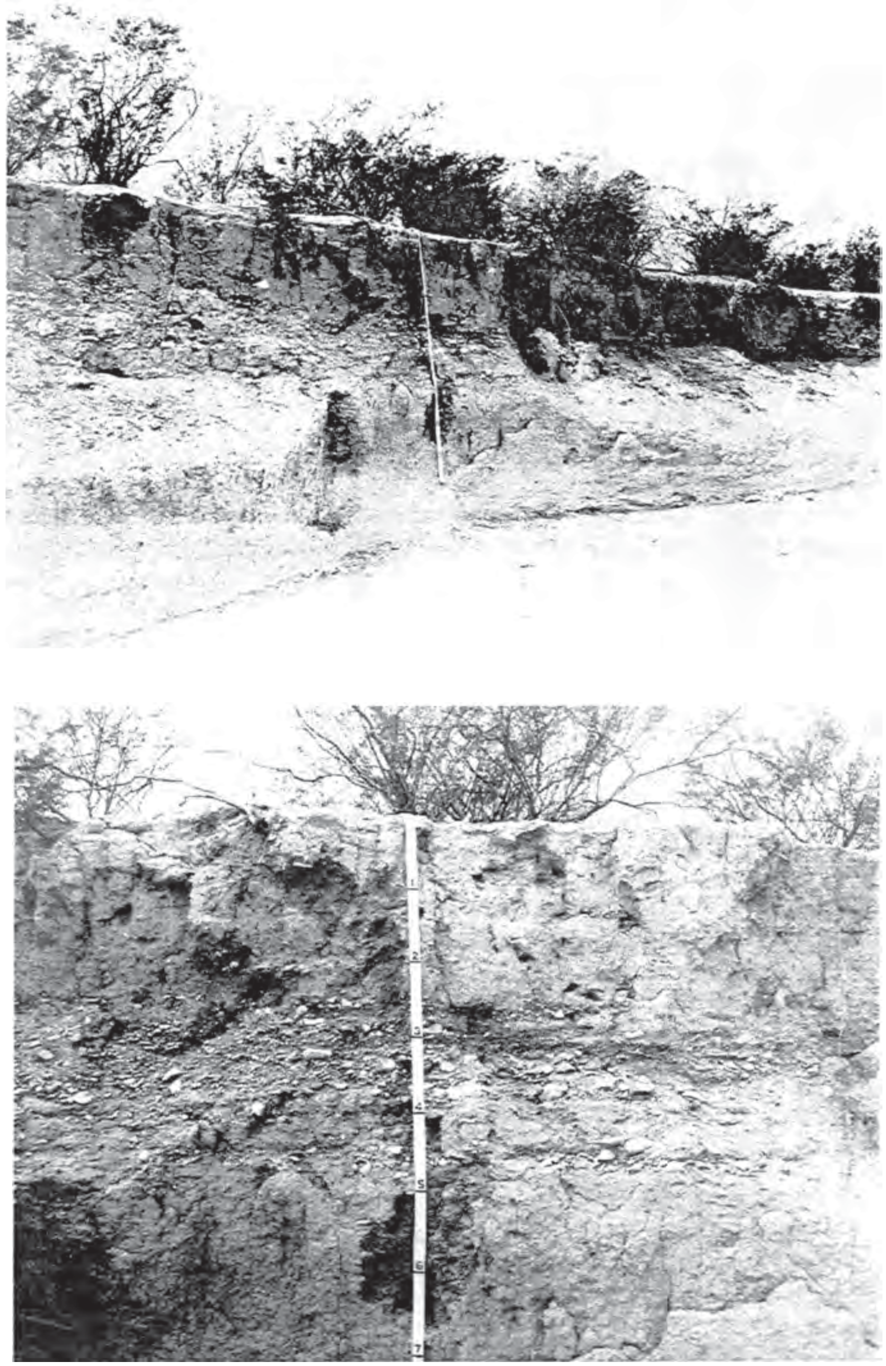


Figure 145. Upper. View of a Typic Torrifluvent, Anthony 65-3, along Gardner Spring Arroyo. Vegetation is creosotebush.
Lower. Anthony 65-3. Scale is in feet.

Entisols. SND-6 occurs in arroyo channels.

Haplargids. The coarse-loamy Onite soils and loamy-skeletal Pinaleno soils occur in the stablest, best-preserved areas in centers of broadest interfluves east of the Dona Ana Mountains. Fine-loamy Haplargids occur in a few areas near margins of the mapping unit.

SOIL BOUNDARIES

Table 157 gives information on boundaries to major adjacent units. Figure 146 shows boundaries and stratigraphy of some of the units.

Table 157. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Onite-Pajarito complex (13M)	The boundary has been caused by a change from nearly all monzonite (unit 13M) to sediments containing substantial limestone. The topographic boundary is not prominent but vegetatively the boundary is distinct. Vegetation changes from scattered Mormon tea and Yucca elata (unit 13M) to creosotebush and mesquite (unit [13ML,13V,13LG]).
Conger complex (10LL)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit (13ML,13V,13LG). The topographic boundary to unit 10LL is fairly distinct, since the 10LL soils are on a higher surface.
Algerita sandy clay loam (16L)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit (13ML,13V,13LG). The topographic boundary is not distinct; it occurs between soils of about the same elevation.
Glendale-Reagan complex (13L)	The boundary is due to a change in texture of the parent materials from dominantly coarse-loamy (unit [13ML,13V,13LG]) to fine-silty (unit 13L). In places the topographic boundary is not distinct but in others the 13L soils border slightly higher ridges of the (13ML,13V,13LG) soils.
Casito-Terino complex (12V)	Cause of the boundary is the presence of a younger alluvium and geomorphic surface (Organ) in unit (13ML,13V,13LG). The topographic boundary to the 12V soils is not prominent, but the (13ML,13V,13LG) soils are generally lower than and inset against the higher 12V soils.
Dona Ana sandy clay loam (16VG)	The boundary is caused by a younger alluvium and geomorphic surface (Organ) in unit (13ML,13V,13LG). The topographic boundary to unit 16VG is not distinct.

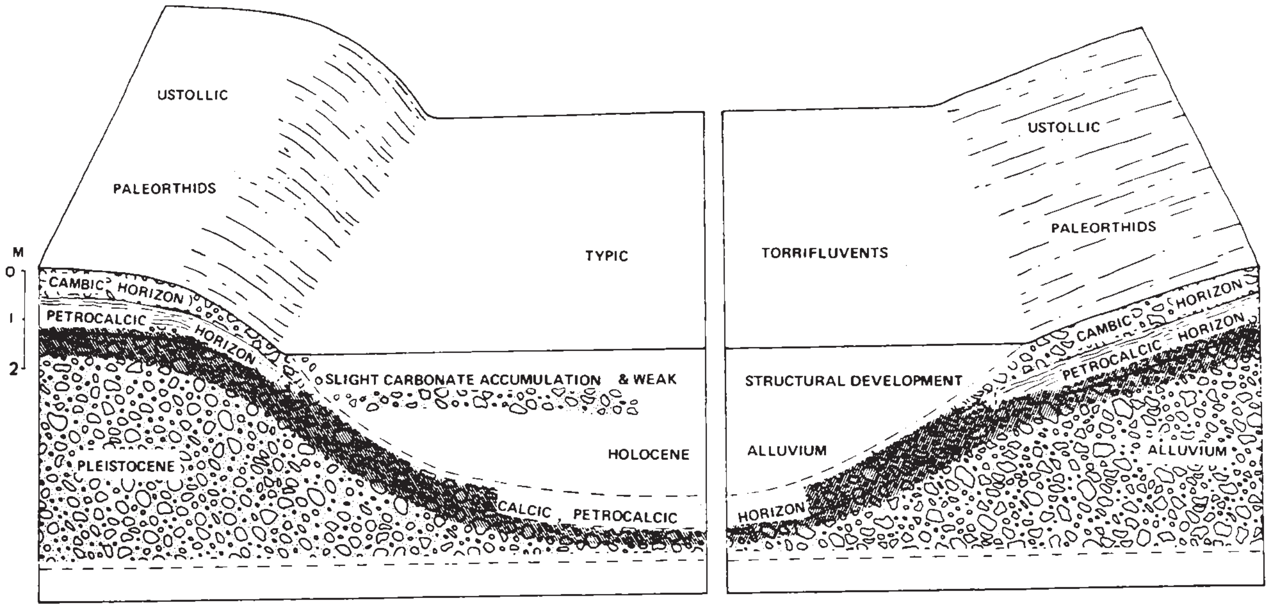


Figure 146. Soil boundaries, diagnostic horizons and stratigraphy in an area of Anthony complex and Monterosa variant, near the Gardner Spring radiocarbon site. Orthids of Pleistocene age have been buried by the Holocene valley fill.

OTHER STUDIES: THE GARDNER SPRING RADIOCARBON SITE

A characteristic landscape occurs along the front of the San Andres Mountains. Large alluvial fans at the mouths of canyons form the topographic highs; valleys between the fans constitute the lows. The commonly light-colored, grassy cover of these valleys, and the darker, dominantly creosotebush vegetation of adjacent areas form a marked color contrast that is visible for long distances away from the mountains. The Gardner Spring radiocarbon site occurs in one of these interfan valleys (fig. 147). Studies at this site illustrate soil distribution and soil-landscape relations in one of these areas (fig. 148). Detailed studies of the soil chronology in this area and at the Isaacks' radiocarbon site (section 157) constitute the basis for the chronology of Holocene soils along the mountain fronts.

The Gardner Spring radiocarbon site contains by far the largest number of dated charcoal horizons (8) of any radiocarbon site in the Desert Project and because of this has been studied in more detail than the others. Locations of the dated charcoal are shown on the soil map; the chronostratigraphic relations are shown diagrammatically in figure 150. All of the charcoal horizons were found in walls of Gardner Spring arroyo and its tributary gullies, which also provided excellent exposures of the soils and sediments. Long trenches dug for construction of the Apollo site in 1963 were also very useful. Elevation in the Gardner Spring area is about 4700 ft (1433 km). Precipitation is estimated to be about 25 to 30 cm annually.

The radiocarbon ages and stratigraphic relationships demonstrate approximate ages of soils formed in Organ I, II, and III alluviums (fig. 150). Soils formed in Organ III alluvium must be less than 1100 years old. Organ II alluvium was cut by the channel now filled by Organ III alluvium and therefore the soils of Organ II must be at least 1100 yr old. Two charcoal horizons at the base of Organ II alluvium demonstrate that soils of Organ II can be no older than 2100 yr. The soils of Organ I alluvium must be more than 2200 yr old but less than about 4600 yr old.

Slight channel shifts during downcutting of the present arroyo have caused several minor terraces along the margins of the channel. Since the present channel cuts Organ III alluvium, these small deposits are all younger than Organ III. Land surveys in 1858 traversed the boundary between sections 2 and 3, and in the T.21S, R.3 E. Although frequent comments were made in field notes (Bureau of Land Management, Santa Fe, New Mexico) about landscape and soil conditions, no mention was made of a large arroyo in the area where it now occurs. In 1932, however, another land survey noted the presence of an arroyo 80 links (23 m) wide. Further, regional evidence indicates that arroyo entrenchment in many areas of the Southwest occurred from 1860 to 1890 (Bryan, 1925). The present arroyo channel and the small terraces along its margin may be less than 100 yr old.

Distribution of soils in the vicinity of the Gardner Spring radiocarbon site is shown in figure 148. All soils are strongly calcareous throughout because of the highly calcareous parent materials. Slopes range from 2 to 4 percent except for soils of Jornada ridge sides (figs. 148, 149) which slope from 5 to 25 percent.

The location of four pedons sampled in the vicinity of the radiocarbon site

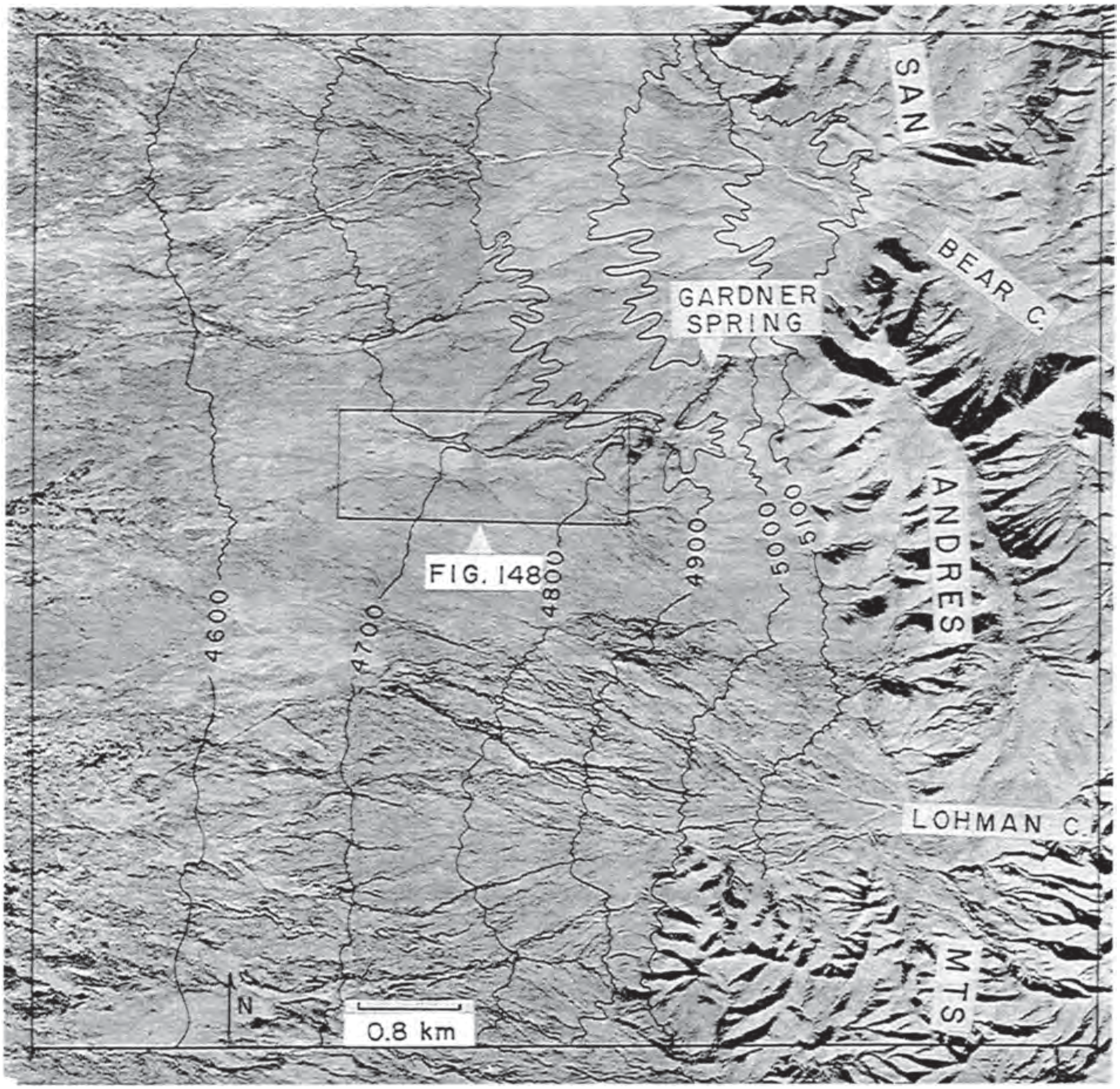


Figure 147. Aerial photograph of part of the mountain-front landscape along the western flank of the San Andres Mountains. Two large fans lie west of Bear and Lohman Canyons. Location of the large-scale soil map (between the two fans) is outlined. Contour intervals are in feet.

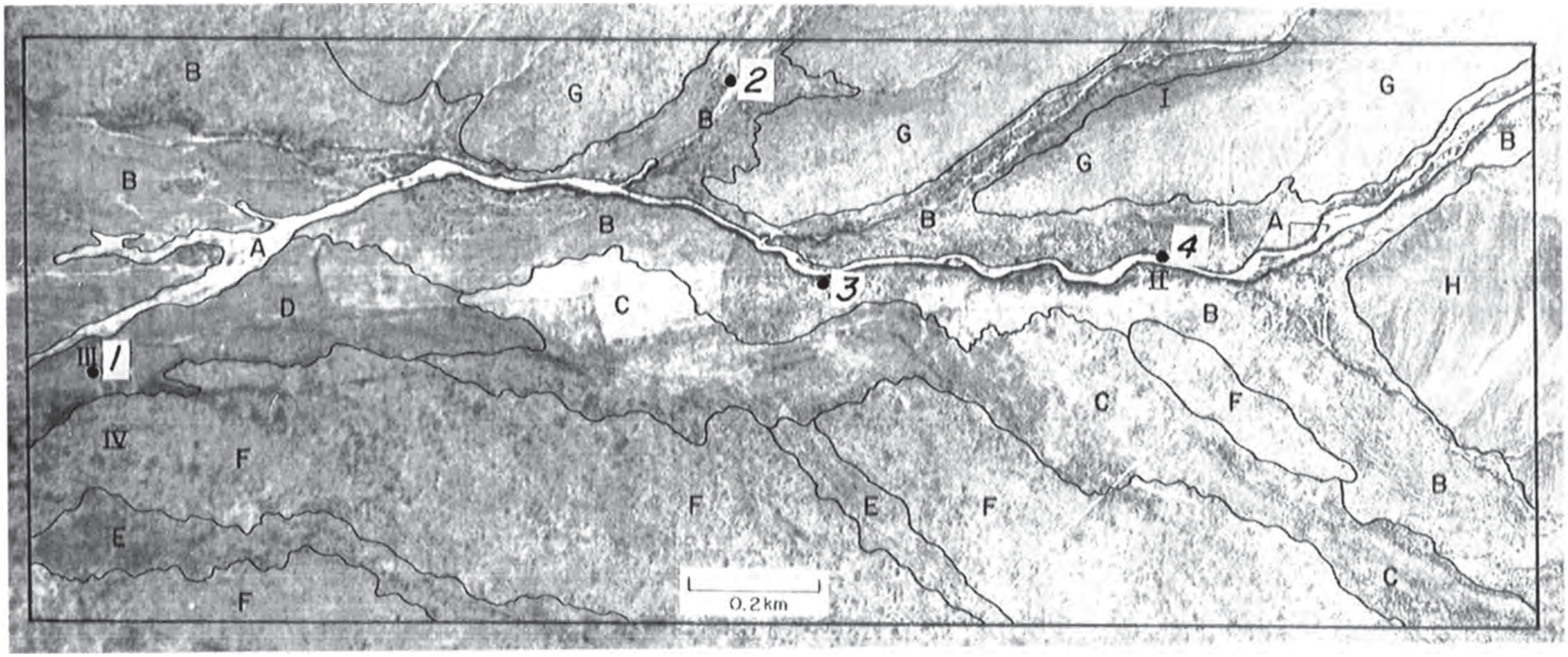


Figure 148. Map of soils in the vicinity of the Gardner Spring radiocarbon site. A = Torriorthents (arroyo channels). B = Anthony-Anthony, loamy-skeletal variant complex (Organ surface). C = Reagan complex (Organ surface). D = Reagan clay loam (Organ surface). E = Conger complex, overflow phase (Jornada surface). F = Conger-Monterosa, carbonatic variant complex (Jornada surface). G = Monterosa, carbonatic variant (Jornada surface). H = Sedimentary rock land (Mountain slopes and summits, undifferentiated). 1 = Reagan 65-1; 2 = Anthony 65-4; 3 = Anthony 65-3; 4 = Anthony variant 65-2. I to II and III to IV locate cross sections. The charcoal dated at 4570 ± 120 B.P. (section 15) is at #2; the other sites are in the vicinity of #4 and east.

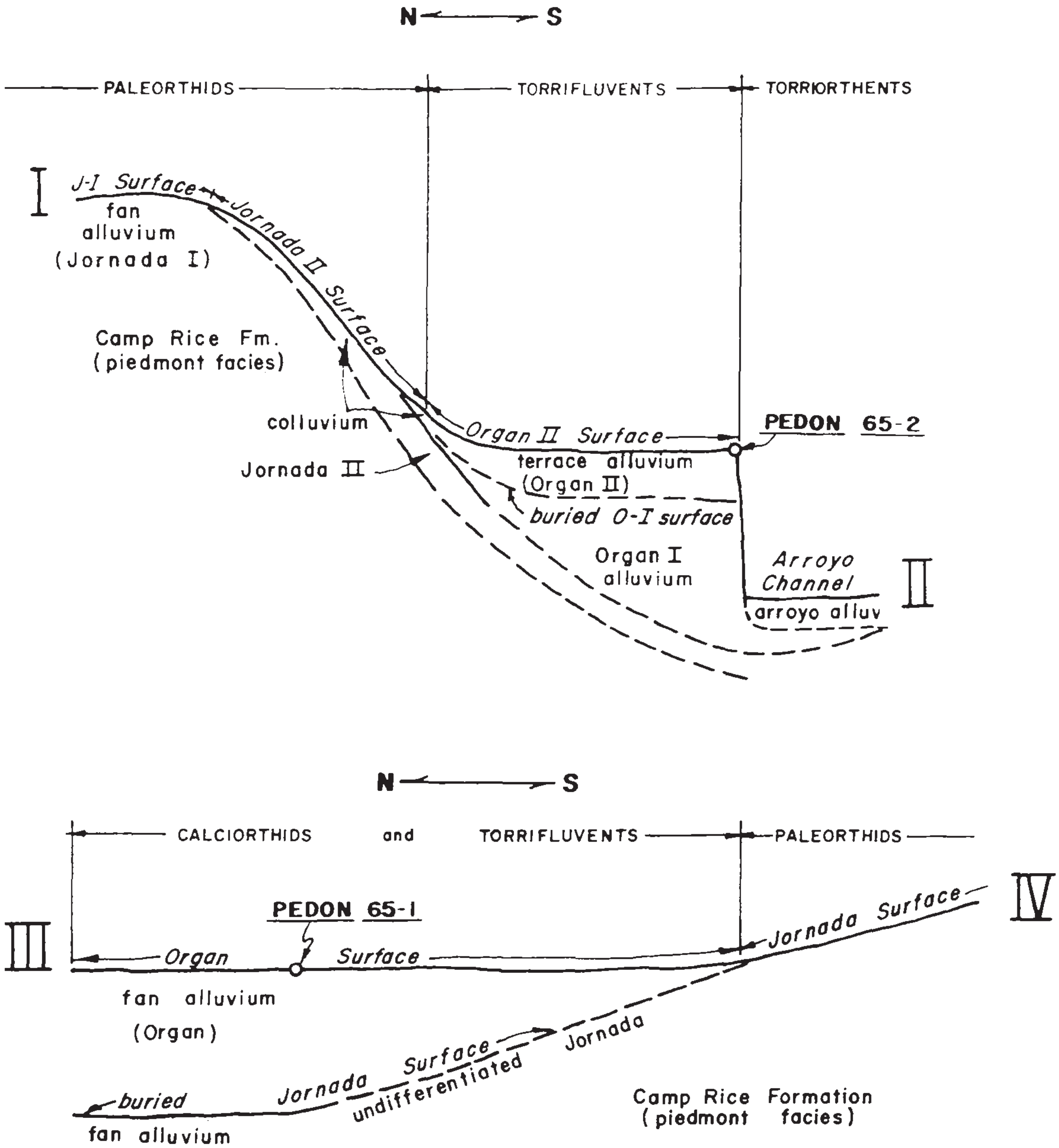


Figure 149. Cross section from I to II and III to IV, soil map.

is shown in figure 148. Data for these pedons are presented in table 158. Relations between soil age and development are discussed in the following sections.

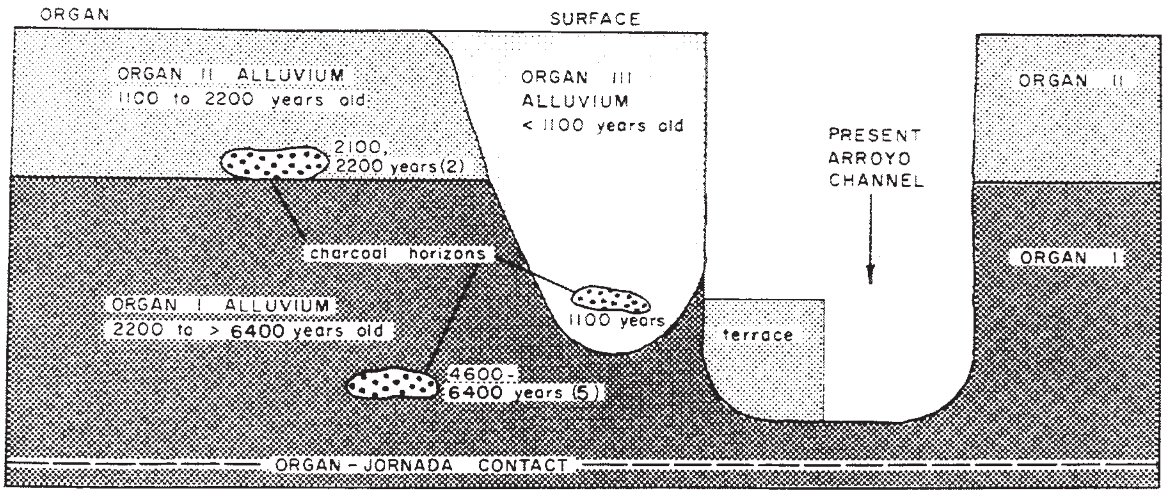
Soils less than 100 (?) yr old. These soils, which may be less than 100 yr old, occur on small terraces along the arroyo channel and in thin deposits in the side valleys. The pedon examined was a sandy-skeletal Torriorthent (Arizo). A thin (0.1-0.5 cm), gray A horizon, commonly vesicular, has formed at the surface. Such horizons can be very young; a brown vesicular horizon in the study area had formed in a deposit partially filling a tire track known to be less than 2 yr old. In some instances the presence of roots suggests a slight accumulation of organic carbon in the upper few cm of the terrace deposits. Both thin and thick strata[6] are common and appear to have been little disturbed except for occasional roots or insect tunnels.

Soils less than 100 (?) to 1100 yr old. These soils have formed in Organ III alluvium and are older than terraces along the arroyo, but are less than 1100 yr old (fig. 150). Textures range from loamy sand to light loam; in places there are scattered pebbles. The soils have a thin (3-5 cm) A horizon, grayish in its upper part, with weak platy and crumb structure. There is evidence of slight carbonate accumulation in the form of a few filaments and patchy coatings on some of the scattered pebbles. Few thin strata are apparent; scattered insect tunnels and roots indicate mixing. Thick strata (2-10 cm thick) do occur, however, with a texture of loamy sand, as compared to adjacent strata with texture of sandy loam. These relationships show that in less than 1100 years, sufficient mixing of the soil material has occurred to destroy most thin strata, but that thick strata have been little altered. Most soils are Torrifluvents because organic carbon decreases irregularly or remains above 0.2 percent to a depth of 125 m or both.

Soils 1100 to 2100 yr old. These soils have formed in Organ II alluvium and must be at least 1100 yr old, but are not older than 2100 yr (fig. 150). Textures are commonly sandy loam, with some of loam, and many horizons are gravelly or very gravelly. Thin strata are absent; thick strata are present in places. Most soils are Torrifluvents.

In gravelly materials a weak, but morphologically distinct horizon of carbonate accumulation has formed in Organ II alluvium. Whereas pebble coatings in soils of Organ III alluvium are only partial, in soils of Organ II the coatings in the carbonate maximum are complete. Pebbles in very gravelly horizons serve as very sensitive indicators of slight carbonate accumulation because of the greatly restricted volume for the accumulation. Anthony variant 65-2 illustrates. These soils and Anthony soils, discussed in the following section, are well exposed along the north bank of Gardner Spring Arroyo (figs. 148, 150). Organ I alluvium is uniformly free, or almost free of gravel; Organ II alluvium, which extensively overlies Organ I, is very gravelly in some places but not in others. Anthony, loamy-skeletal variant occur where content of coarse fragments in the control section averages more than 35 percent by volume; in Anthony soils, coarse fragments average less than this.

6/ As used here, the term thin strata designates strata about 1 to 2 mm thick. The term thick strata designates strata (about 2 to 15 cm thick) that contain more sand than adjacent strata and that consist dominantly or wholly of fine earth.



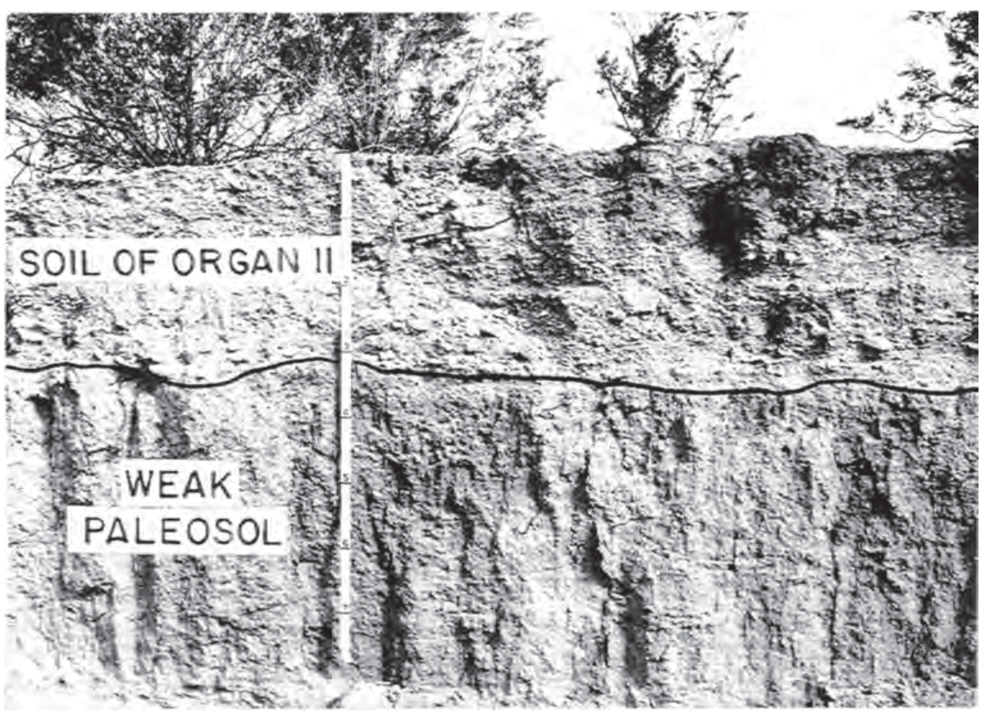


Figure 150. Upper. Generalized diagram of the chrono-stratigraphic relations at the Gardner Spring radiocarbon site.

Lower. A Typic Torrifluvent, Anthony variant 65-2; profile of soil formed in gravelly Organ II alluvium, and of underlying buried soil formed in Organ I alluvium. Scale is in feet.

Table 158. Laboratory data for three Torrifluvents and a Calciorthid at the Gardner Spring radiocarbon site.

Alluvium	Horizon	Depth	Sand1/	Silt1/	Clay1/	> 2mm Vol.2/	Carbonate <2 mm	Carbonate <0.002 mm	Organic Carbon	Bulk Density
		cm	pct	pct	pct	pct	pct	pct	pct	g/cc
	Anthony 65-3. 1100 to 2100 years old.									
Organ II	A	0-5	75	16	9		8	tr	0.7	
	A	5-13	70	21	12		13	tr	0.7	1.43
	2A	13-18	73	16	11		16	tr	0.5	
	3A	18-38	60	25	14		14	2	0.5	1.32
	4C1	38-43	70	19	11		14	1	0.3	
	5C2	43-64	63	25	12	4	14	1	0.4	1.33
	5C3	64-81	78	14	9	10	14	tr	0.2	
	6C4	81-119	82	12	7	70	16	1	0.2	
	7C5	119-152	69	20	11	16	14	1	0.2	
	Anthony variant 65-2. Soil in Organ II alluvium is 1100 to 2100 years old.									
Organ II	Aca	0-3	70	20	10	20	8	tr	0.57	
	Bca	3-8	68	21	11	20	9	1	0.57	
	2C1ca2/	8-28	67	20	13	50	15	4	0.79	
	2C2ca	28-41	75	15	10	50	16	1	0.41	
	2C3	41-64	85	8	7	45	16	1	0.33	
	3C4	64-89	69	18	13	15	17	3	0.25	
	4C5	89-97	80	11	9	30	16	tr	0.16	
	VC6	97-107	59	25	16	4	15	1	0.28	
	(Buried soil, below, has been buried 2200 years and is from 2200 to 4600 years old.)									
Organ I	5Ab	107-117	46	36	18	1	18	2	0.35	1.25
	5B1b	117-130	42	38	20	tr	16	2	0.36	1.27
	5B21cab	130-150	41	38	21	tr	15	3	0.47	1.39
	5B22cab	150-180	43	36	21	1	16	4	0.44	1.46
	5B3b	180-216	45	34	21	2	17	3	0.34	1.32
	5C1b	216-259	43	34	23	1	17	4	0.34	1.26
	5C2b	259-287	49	32	19	tr	17	3	0.28	1.31
	Anthony 65-4. 0-36 cm, <100 years (?) old.									
<Organ	A & C1	0-10	85	9	5	40	11	tr	0.16	
III (?)	C2	10-36	89	6	5	15	13	tr	0.10	
	(Buried soil, below, is from 2200 to 4600 years old.)									
Organ I	2Acab	36-43	66	23	11	10	6	1	0.49	1.44
	2Acab	43-64	67	21	12	10	10	3	0.42	1.36
	2Acab	64-76	69	20	11	10	11	4	0.36	1.41
	2C1cab	76-109	76	15	9	5	9	1	0.16	1.55
	2C2b	109-135	77	15	8	2	10	1	0.15	1.52
	2C3b	135-160	78	14	8	3	10	1	0.12	
	Reagan 65-1 3/ Soil in Organ I alluvium is 2200 to 4600 years old.									
Organ I	A4/	0-5	41	44	15	tr	12	tr	0.83	
	A4/	5-13	31	47	22	tr	13	tr	1.09	1.25
	B1	13-23	38	40	22	tr	13	2	0.67	1.34
	B21ca	23-38	30	43	27	tr	15	2	0.70	1.39
	B22ca	38-66	25	42	33	tr	17	5	0.58	1.40
	B23ca	66-94	28	39	33	tr	16	4	0.45	1.33
	B3ca	94-114	40	32	28	2	12	4	0.29	1.43
	C	114-132	50	25	25	2	8	2		
	(Buried soil, below, has been buried at least 6500 years and is of late—Pleistocene age.)									
Jornada	Btcab	132-150	62	19	19	3	5	2		
II	2K2b	150-173	67	15	18	3	43	13		
	2K31b	173-190	66	17	17	75	41	14		
	2K32b	190-216	69	16	15	60	41	15		
	2K32b	216-241	74	14	12	60	37	11		

1/ Carbonate - free basis.

2/ C-14 sample No. 1 (table 66) is from this horizon.

3/ Reagan 65-1 is an Ustollic Calciorthid; the others are Typic Torrifluvents.

4/ Discontinuous occurrence of fine strata in the A horizon, and a stone line at its base indicate that the A is much younger than the underlying horizons. The increase in silicate clay from the A to the B horizon is probably not pedogenic.

Pedon 65-2 (fig. 150) has a thin Bca horizon, with some pebbles thinly carbonate-coated on the undersides, and a Cca horizon in which many pebbles are continuously coated with carbonate. Laboratory evidence is the higher percentage of carbonate clay in the IIC2ca horizon (table 158). These carbonate coatings must have developed in less than 2100 yr (but in at least 1100 yr, cf. fig. 150). This stage I horizon is very similar to that of Dalian 66-4, at the Shalam Colony radiocarbon site. The upper boundary of a weak paleosol, discussed later, is at 107 cm. Since organic carbon decreases irregularly and also remains above 0.2 percent to a depth of 1.25 m (table 158), the paleosol is considered together with the overlying soil of Organ II for classification purposes and the two are classified together as a Torrifluvent (Soil Survey Staff, in press).

Soils formed in low-gravel materials of Organ II differ only slightly from soils of Organ III. The morphology does not show a distinct carbonate maximum. There are a very few faint, discontinuous filaments and grain coatings. Where a few pebbles occur they do tend to have more complete carbonate coatings than soils of Organ III. There is evidence of soil mixing, as shown by a few filled insect burrows and in places by lack of thick fine-earth strata. Anthony 65-3 (fig. 145) illustrates. It occurs in the south bank of the arroyo, downslope from Anthony variant, and has less gravel than Anthony variant. The morphology does not show a carbonate maximum. There are a very few faint, discontinuous filaments and grain coatings. $CaCO_3$ equivalents show little change with depth below 5 cm. In the field, the 13-18 cm and 38-43 cm layers appear coarser-textured than adjacent layers; analysis shows these two horizons to be higher in sand and lower in organic carbon than adjacent horizons. A few insect tunnels, with higher silt and clay, extend into the coarser-textured horizons and show partial mixing of the layers. The buried soil in Organ I alluvium also occurs in this area and underlies the lowest sampled horizon (fig. 145).

Soils 2200 to 4600 yr old. These soils have formed in Organ I alluvium and must be more than 2200 yr old, but are not older than about 4600 yr (fig. 150). Textures are commonly clay loam, with some of loam and sandy loam. Gravelly materials occur in a few places. Thick strata are absent.

Figure 150 shows a buried soil in Organ I alluvium. The soil has been buried about 2200 yr (fig. 150). There is evidence of weak soil development prior to burial. Bulk density of the Ab horizon is relatively low, and increases in the Bb horizon (table 158). The paleosol has a weak structural B horizon with weak prismatic and subangular blocky structure. There are a very few carbonate filaments on ped faces in the B horizon. The slight bulge in clay-sized carbonate (table 158) agrees with field evidence for weak carbonate accumulation prior to burial by Organ II alluvium. Insect burrows, some partially filled with fine earth, indicate soil mixing.

Organ I alluvium, shown buried by Organ II in figure 150, emerges at the land surface away from Gardner Spring Arroyo. Reagan 65-1 (fig. 151), a Calciorthid, illustrates a land-surface soil that is at least 2200 yr old, but not older than 4600 yr. This pedon is a land-surface analogue of the paleosol shown in figure 150. Comparison of the two indicates the character of pedogenesis in these parent materials within the last 2200 yr. Distinct differences are apparent. Most obvious is the horizon of carbonate accumulation, with common carbonate filaments on ped faces. Since there is very little evidence of carbonate accumulation in the buried analogue of this soil (pedon 65-2), this indicates that a calcic horizon can form in these highly calcareous parent materials in approximately 2500 yr (some time would be required for the development of structure as at pedon 65-2). The carbonate maximum, both by morphology and laboratory analysis, occurs in the B22ca horizon (table 158), which qualifies as a calcic horizon and the soil is therefore a Calciorthid.

These relationships illustrate the importance of high-carbonate parent materials on the classification of soils of Holocene age. Freshly deposited, high-carbonate parent materials already contain more than 15 percent $CaCO_3$ equivalent, one of the requirements of the calcic horizon in these soils. All that is needed is an accumulation of authigenic carbonate in a horizon that is more than 15 cm thick and that has at least 5 percent more $CaCO_3$ equivalent than the C horizon.

This relatively short time required for the development of the calcic horizon - about 2500 yr - contrasts greatly with the time required for low-carbonate parent materials. As suggested by the soils of Isaacks' Ranch and Jornada II, the time required for the development of a calcic horizon may be about 15,000 or 20,000 yr where calcium for the carbonate must be derived entirely from the atmosphere.

The calcic horizon in this vicinity is in its incipient stages, occurring in some places but not in others. The lateral shift from a horizon that qualifies as calcic to one that does not is marked morphologically by a change from common carbonate filaments on ped faces (as in the calcic horizon of Reagan 65-1) to very few or no carbonate filaments on ped faces. The latter soils are Torrifluvents, where textures are relatively fine (silt loam; silty clay loam; clay loam) since analyses indicate that organic carbon values would be more than 0.2 percent to a depth of 125 cm. Such a soil is illustrated by Glendale 60-15 (section 163), which lacks a calcic horizon both by morphology and analyses.

The relations above show the character of development of carbonate horizons and the effect on soil classification in high-carbonate parent materials of the area. Soils illustrating the transition from the Entisols to the Aridisols do not pass through the Camborthids as is the case in low-carbonate parent materials. This is because of soil morphology and the interrelations of the definitions of the cambic and the calcic horizons. If carbonates are present in the parent materials, the cambic horizon must be underlain by a horizon with much larger amounts of carbonate (taxonomy section). Such a carbonate horizon in these high-carbonate parent materials would contain enough carbonate for a calcic horizon and the soils would be Calciorthids.

Stratigraphic tracing and the C14 age of buried charcoal at pedon 65-4 (figs. 148, 150) demonstrate that Organ I alluvium extends up the side valleys. Anthony 65-4 (table 158) was sampled at a stable site about 5 m southwest of the charcoal horizon. The deposit from 0 to 36 cm is thought to be about the same age (less than 100 yr old) as the small terraces along the main channel of Gardner Spring Arroyo. Soils of the two deposits are very similar. Both have very thin, grayish A horizons and many sedimentary strata are undisturbed. The buried soil of Organ I alluvium has an A horizon with an accumulation of

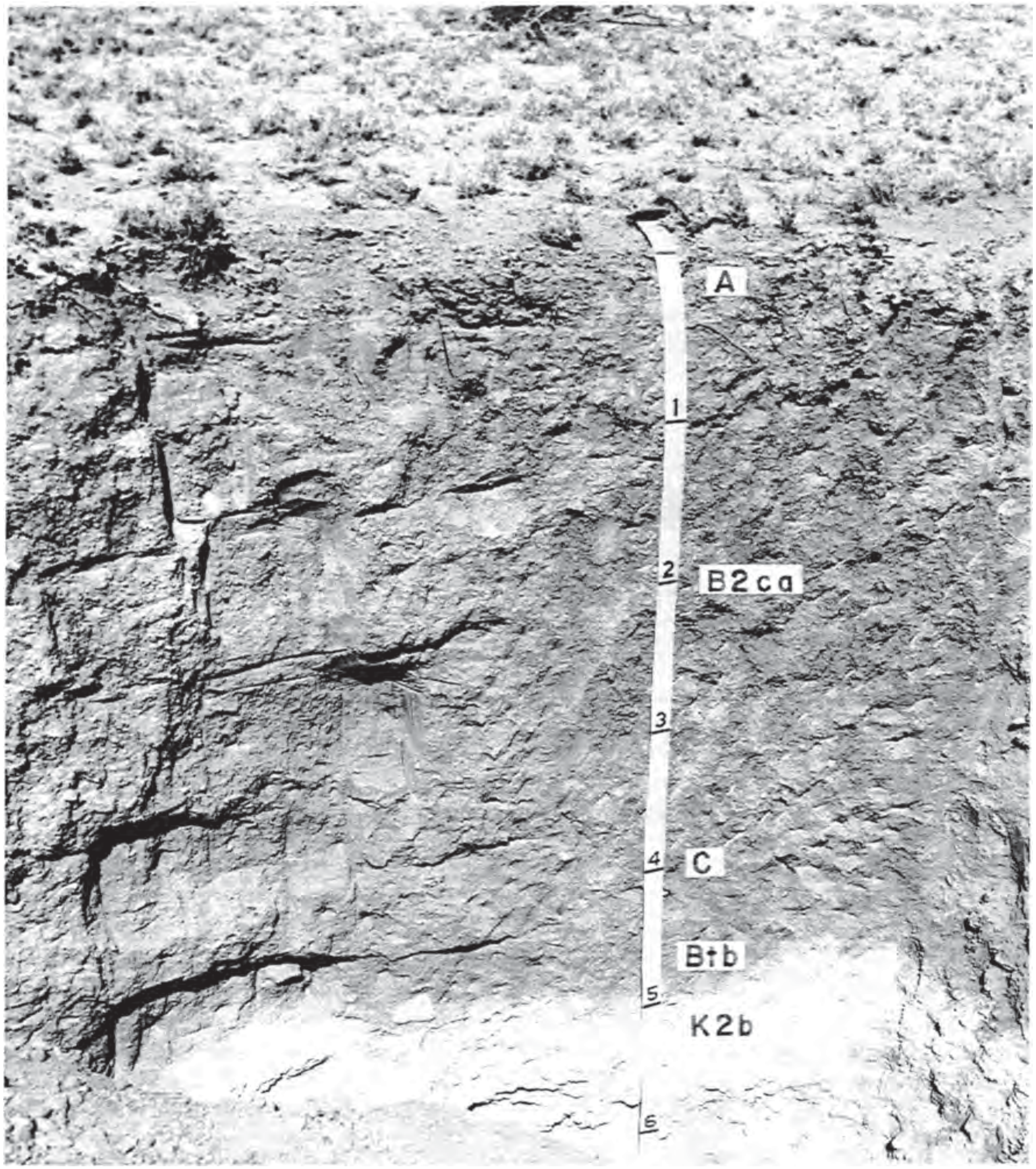


Figure 151. An Ustollic Calciorthid, Reagan 65-1. Profile of soil formed in Organ I alluvium, and a buried Haplargid in Jornada II alluvium. This pedon illustrates initial development of the calcic horizon (the B2ca horizon, above; table 158), in a Holocene soil formed in high-carbonate parent materials. The Btb and K2b symbols designate the buried Haplargid. Scale is in feet.

organic carbon (table 158). Since organic carbon decreases irregularly with depth, Anthony 65-4 is also a Torrifluvent. Although there is slightly less carbonate clay than in Reagan 65-1, the bulge is of about the same magnitude.

The chrono-stratigraphic information at the charcoal dated-sites (section 15) and soil-geomorphic tracing provide information for a chronology of Holocene pedogenesis in the study area (table 159). Contents of carbonate and coarse fragments are important parent material features affecting the morphology (table 159).

Soils of the Jornada surface occur both in land-surface and buried position. The Jornada II surface and its soils are buried by Organ sediments over most of the area of the interfan valley. Buried Paleorthids, Calciorthids, and Haplargids occur beneath the soils formed in Organ alluvium. A buried Haplargid underlies the Holocene soil in Reagan 65-1 (fig. 151). This buried Haplargid must have formed prior to about 6000 yr ago, primarily or wholly during the Pleistocene. In contrast, after 2200 yr of soil formation in Holocene time, abundant carbonate is still present in the upper part of Organ I alluvium (table 88), and no morphological evidence of an argillic horizon can be observed. It is postulated that the wetter climates of Pleistocene pluvials, together with sufficient landscape stability, vegetative cover, and time, were required for development of the argillic horizon in these highly calcareous parent materials. Evidence along the valley border (section 86) indicates that even in stable sites and during Pleistocene pluvial conditions, argillic horizons did not form in parent materials with extremely high proportions of carbonate rock fragments.

The date of 6400 B.P. came from charcoal in the lower part of Organ alluvium, which here rests on Jornada II alluvium of late-Pleistocene age (Gile and Hawley, 1968). Hence the initiation of Organ alluviation may approximately coincide with the start of the Altithermal, which began about 7500 B.P. (Antevs, 1955). The Altithermal ended about 4000 B.P. according to Antevs (1955), but in some areas there is evidence that it ended about 5000 B.P. (Mehringer, 1967; Irwin-Williams and Haynes, 1970). The start of such a warm, dry period could have reduced the vegetative cover enough that erosion started in particularly susceptible areas such as steep slopes adjacent to drainageways. Additional evidence for climatic change as a cause of Organ alluviation is the remarkable ubiquity of the deposits in areas accessible to Holocene sedimentation (e.g., in valley fills between Pleistocene fans); and Organ alluvium occurs downslope from all mountain ranges in the area, even the small ones.

All dated charcoal horizons between 4000 and 5000 B.P. are well below the surface of Organ I. Hence, sedimentation of Organ I could have ended about 4000 years ago. The return of more moist conditions should have stabilized the land surface so that soils could form in Organ I alluvium. Pollen evidence suggests that this may be the case. Freeman (1972) found a decrease in cheno-ams and an increase in grass pollen toward the upper part of Organ I alluvium. This would fit Antevs' model of an end to the Altithermal about 4000 years ago.

Table 159. The chronology of Holocene pedogenesis in the study area[1/]

Soil age, years B.P.	High-carbonate parent materials: Low-gravel materials	High-carbonate parent materials: High-gravel materials	Low-carbonate parent materials: Low-gravel materials	Low-carbonate parent materials: High-gravel materials
0 (fresh alluvium in arroyo channels)	← calcareous →		← mostly calcareous →	
< 100(?)	Thin gray A horizon that is vesicular in places; slight accumulation of organic carbon. Torrifluvents, Torriorthents			
100(?) to 1100	Slight carbonate accumulation in the form of a few filaments and patchy coatings on some of the scattered pebbles. Torrifluvents, Torriorthents	Similar to low-gravel materials except that the carbonate maximum is slightly more apparent, with filaments and discontinuous coatings on pebbles. Torrifluvents, Torriorthents	Chronological control not available for this interval. Observations suggest features similar to high-carbonate materials except for development of noncalcareous upper horizons in places. Torriorthents	
1100 to 2100	A very few faint, discontinuous filaments and grain coatings. Where a few pebbles occur they tend to have complete carbonate coatings. Torrifluvents, Torriorthents	Thin Bca[2/] horizon with little or no macroscopic carbonate, underlain by Cca horizon with thin, continuous carbonate coatings on pebbles. Torrifluvents, Torriorthents	(Fillmore) Noncalcareous, brown or reddish brown B horizon underlain by horizon with few faint, discontinuous carbonate filaments and grain coatings. Cambic horizon[3/] Camborthids	(Fillmore) Noncalcareous, reddish brown B horizon underlain by Cca horizon with thin, continuous carbonate coatings on pebbles. Cambic horizon[3/] Camborthids Argillic horizon[3/] Haplargids
4000? (2200 to 4600)	Texture clay loam, silty clay loam, silt loam; development of compound prismatic and subangular blocky structure; carbonate filaments common in places. Torrifluvents Calcic horizon[3/] Calciorthids	Similar to above except that the pebble coatings are thicker. Torrifluvents Torriorthents Calcic horizon[3/] Calciorthids	Noncalcareous, brown or reddish brown B horizon underlain by Cca horizon with carbonate coatings on sand grains. Camborthids Argillic horizon[3/] Haplargids	Noncalcareous, reddish brown B horizon underlain by Cca horizon with carbonate coatings on pebbles. Haplargids
7000?			Noncalcareous, reddish brown B horizon underlain by Cca horizon with carbonate coatings on sand grains. Haplargids	

1/ Summarized for all major sediments except sandy ones. (Sandy sediments were excluded to simplify the table. Soils of coppice dunes are less than 100 years old and consist of C horizon material. Most other sandy soils occur along the valley border. At stablest sites these soils have noncalcareous brown B horizons and weak Cca horizons. In low-gravel sediments the soils are Torripsamments; in high-gravel sediments they are Torriorthents. At unstable sites, where the soils have been truncated, the B horizons may be calcareous throughout or may have been truncated.) Illustrative soils are on stable sites of the Organ surface except for those designated Fillmore. Cited expression of pedogenesis usually occurs within the upper 0.5 to 0.8 m of the deposit. Only major morphological features listed here.

2/ Horizon between the A horizon and the carbonate maximum. Does not extend deep enough for a cambic horizon.

3/ Marks initial development of named diagnostic horizon under stated conditions.

163. GLENDALE-REAGAN COMPLEX (13L)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
GLENDALE	TYPIC TORRIFLUVENTS	FINE-SILTY (CALCAREOUS)	65
REAGAN	USTOLLIC CALCIORTHIDS	FINE-SILTY	15
Anthony	Typic Torrifluvents	Coarse-loamy (calcareous)	5
Dalian	Typic Torriorthents	Loamy-skeletal, carbonatic	5
Gila	Typic Torrifluvents	Coarse-loamy (calcareous)	5
Other inclusions (Torrifluvents, Paleorthids)			5

LOCATION, LANDSCAPE, VEGETATION

This mapping unit occurs west of the San Andres Mountains. The soils have formed in sediments derived primarily from limestone, calcareous sandstone, siltstone and shale, in places with andesite, rhyolite, granite, and quartzite. Elevations range from about 4300 to 4800 feet.

The soils occur on a coalescent fan-piedmont and are nearly level transversely. Scarplets are common in many areas and range from a few cm to one m or more in height. Small drainageways occur downslope from scarps. There are no large arroyos. Slopes range from 2 percent in the eastern part of the unit to about 1 percent in the western part.

Vegetation is mostly burro grass, tarbush and creosotebush, with scattered clumps of tobosa in some places. Many areas are barren.

TYPICAL PEDONS, PROPERTIES AND RANGES

All soils in this unit are highly calcareous throughout due to the high carbonate content of the parent materials. Buried soils underlie these soils at depths ranging from about one to two m.

Glendale

These soils have structural B horizons. They have no macroscopic accumulation of carbonate, hence the B horizons do not qualify as cambic horizons. Soils on gentlest slopes tend to be in the heavier end of the fine-silty family.

A typical pedon of Glendale is described in the Appendix (pedon 60-15). Figure 152 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

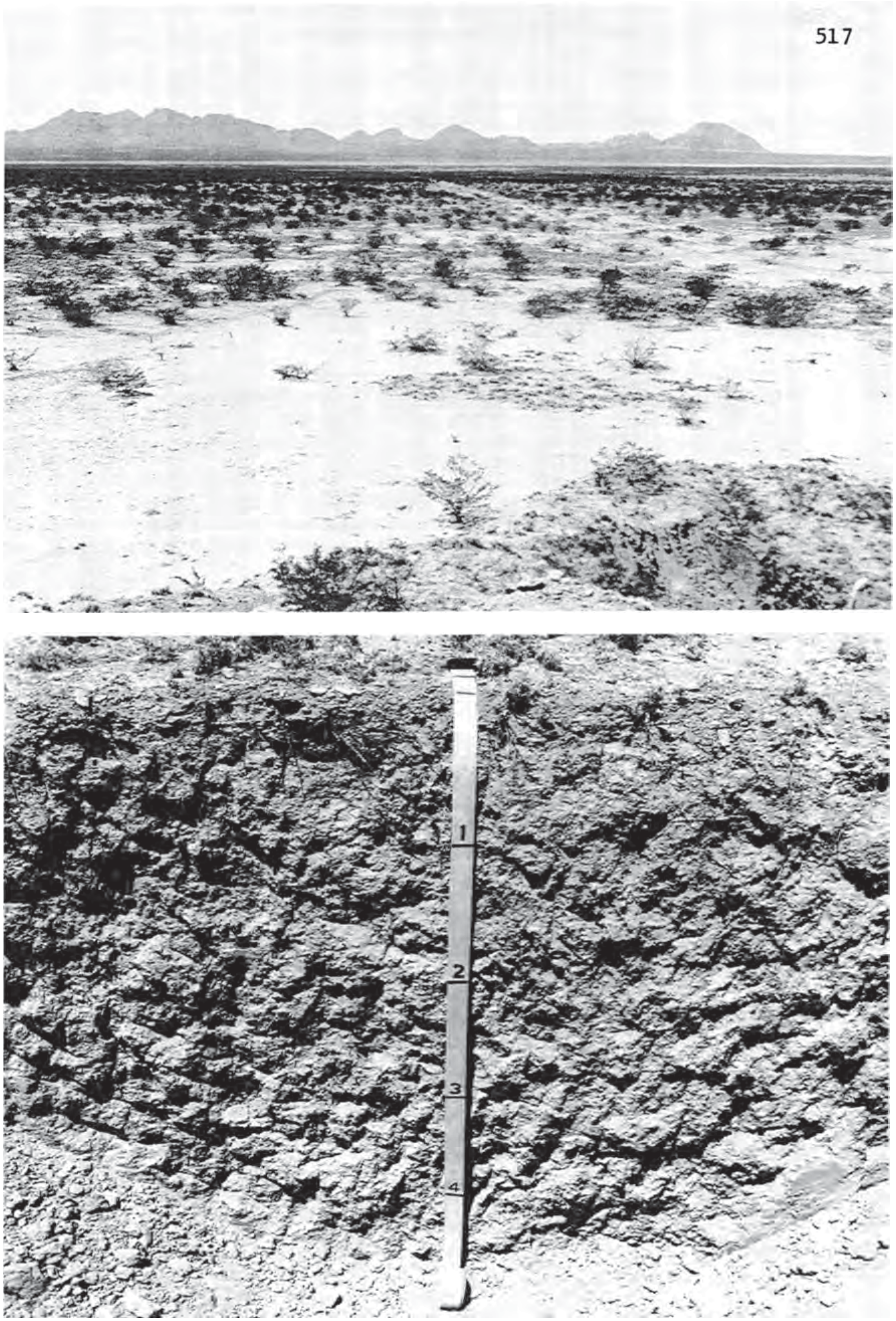


Figure 152. Upper. Landscape of a Typic Torrifluvent, Glendale 60-15, on the Organ surface. Vegetation consists mainly of burro grass, with a few creosotebush. Slope is 2 percent.

Lower. Glendale 60-15. Scale is in feet.

Table 160. Typical (underlined) and range in selected properties for major horizons of Glendale.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-20	sil cl sicl	0-1	7.5YR- 10YR	5-7 5.5	3.5-5 4	2-4 3
B	20-86	sil cl sicl	0-1	7.5YR- 10YR	5-7 5.5	3.5-5 4	3,4
C	86-112	sil cl sicl	0-1	7.5YR- 10YR	5-7 5.5	4,5	3,4
Control section	25-100	sil,cl sicl	0-1				

Reagan

A typical pedon of Reagan is described in the Appendix (pedon 60-14). Figure 153 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

Table 161. Typical (underlined) and range in selected properties for major horizons of Reagan.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-28	sil sicl cl	0-1	7.5YR- 10YR	5-7 6	3.5-5 4	2-4
B	28-99	sil sicl cl	0-1	7.5YR- 10YR	5-7 6	3.5-5 4.5	3,4
C	99-122	sicl sil cl	0-1	7.5YR- 10YR	5,6	4,5 4.5	3,4
Control section	25-100	sicl,sil cl	0-1				

Other. Reagan soils in this mapping unit illustrate minimum expression of the calcic horizon, which in this mapping unit has carbonate filaments but not nodules.

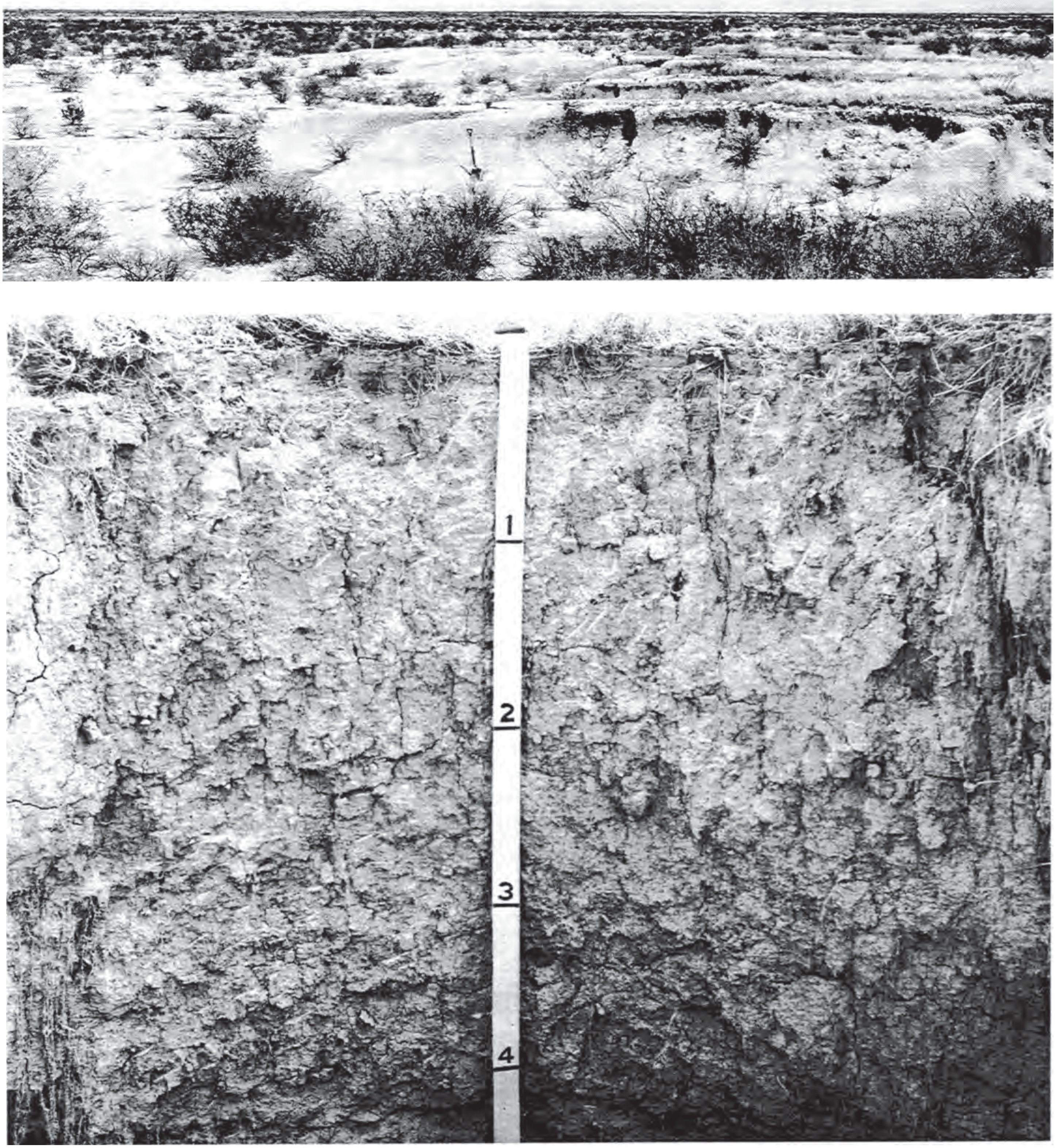


Figure 153. Upper. Landscape of an Ustollic Calciorthid, Reagan 60-14, on the Organ surface. Jornada II surface is left of the scarp; Organ surface to the right. Vegetation consists mainly of burro grass and tobosa, with scattered tarbush, creosotebush and snakeweed. Slope is 1 percent.
Lower. Reagan 60-14. Scale is in feet.

SOIL OCCURRENCE

No Argids occur in this mapping unit because of the highly calcareous parent materials and youth of the soils. Distribution of the various soils is determined mainly by texture. Weak Calciorthids occur in parts of earliest Organ alluvium. Most of the soils have been emplaced long enough for the obliteration of sedimentary strata. Analyses indicate that at least the fine-silty soils, which are dominant, have more than 0.2 percent organic carbon at a depth of 125 cm, hence are Torrifluvents.

Torrifluvents. The fine-silty GLENDALE soils are by far the most common soil. In the eastern part of the unit there are also small areas of the coarse-loamy Anthony and Gila soils, and fine-loamy Torriorthents (SND-8).

Calciorthids. These soils occur mostly in the western part of the unit.

Torriorthents. The loamy-skeletal Dalian soils occur in a few areas in the eastern part of the unit.

Paleorthids. A very few of the loamy, shallow Simona soils occur on remnants of older fans in the eastern part of the unit.

SOIL BOUNDARIES

Table 162 gives information about boundaries to major adjacent units. Figure 154 shows boundaries and stratigraphy of some of the units.

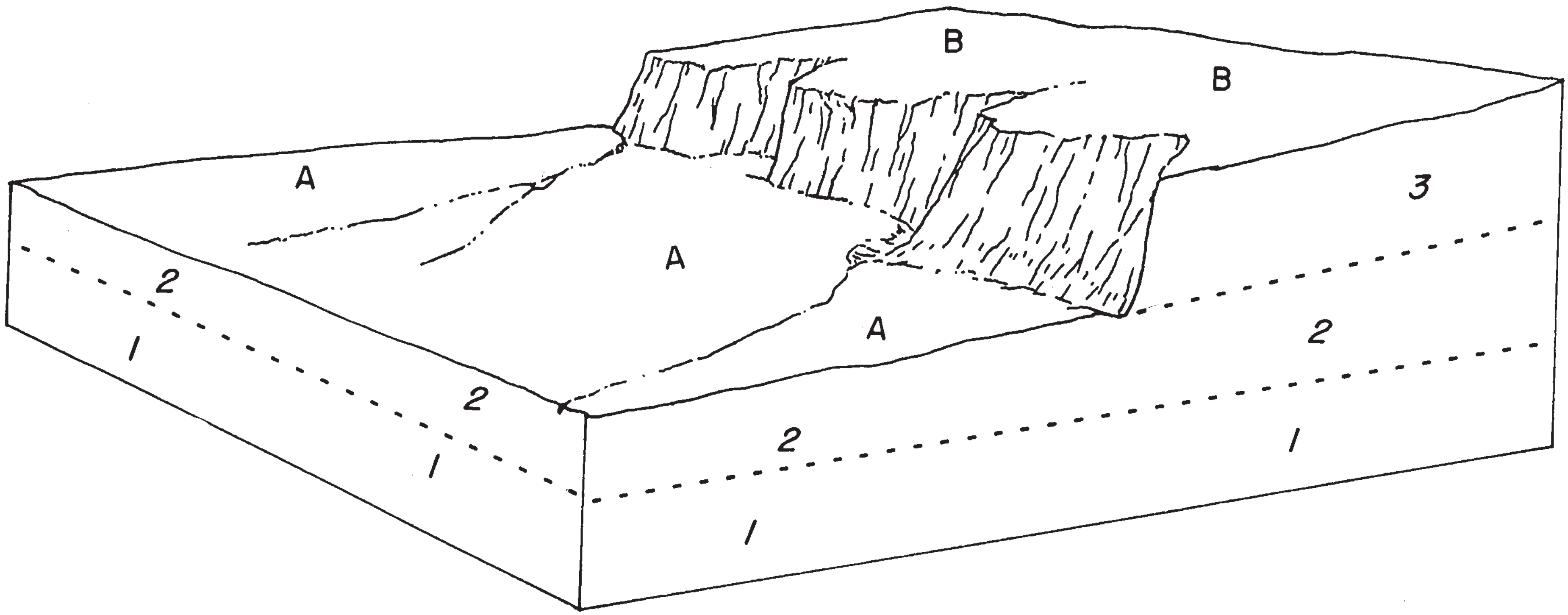


Figure 154. Block diagram of soil-landscape relations and soil stratigraphy in an area of Algerita sandy clay loam and Glendale-Reagan complex. A = Algerita sandy clay loam (Jornada II surface); this soil has been, and is presently being exhumed by erosion along the scarp. B = Glendale-Reagan complex (Organ surface).

1 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 2 = Jornada II alluviaum and soils. 3 = Organ alluvium and soils.

Table 162. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Anthony complex (13ML,13V, 13LG)	The boundary is due to a change in texture of the parent materials, from dominantly fine-silty (unit 13L) to dominantly coarse-loamy (unit 13ML,13V,13LG). The topographic boundary to unit (13ML,13V,13LG) is usually marked by a shift from a landscape that is level transversely (unit 13L) to one that is dominated by slight, east-west ridges. Vegetatively, the boundary is marked by a shift form mostly burro grass, with some creosotebush (unit 13L) to mostly creosotebush (unit 13ML,13V,13LG).
Algerita sandy clay loam (16L)	The boundary has been caused by two factors in various places. One is a younger alluvium and geomorphic surface (Organ) in unit 13L. The 16L soils, analogues of which are buried by Organ alluvium and its soils in unit 13L, emerge at the surface at the 16L side of the boundary. In other places, however, Organ alluvium does occur in unit 16L, but there it is less than about 75 cm thick, whereas it is more than 75 cm thick in unit 13L. In most places the Organ deposits in unit 13L are more than 1 m thick over buried soils. Commonly the topographic boundary to unit 16L is prominent and abrupt; it is marked by a scarp ranging from about 3/4 to 1 1/4 m high, with the 16L soils occurring downslope from the scarp. In these places there is also an abrupt vegetation change. The area below the scarp (unit 16L) is generally barren ot nearly barren of vegetation, whereas the area above the scarp (unit 13L) usually has common burro grass, with some tobosa. In other places the boundary is gradual and less apparent.

OTHER STUDIES: A TORRIFLUVENT AND A CALCIORTHID IN HIGH-CARBONATE PARENT MATERIALS

Two pedons were sampled in this mapping unit--Glendale and Reagan. Laboratory data are in table 163. Both pedons have an increase in silicate clay (both fine and coarse) and in the ratio of the fine to total clay between the A horizon and the B2 horizon. However, they lack the morphological features necessary for recognition of an argillic horizon. The silicate clay is coarser than for most of the soils with argillic horizons formed in alluvium from the other principal parent material sources (see also sections 172 and 191).

Carbonate increases from A to B in both pedons (table 163), and the proportion of carbonate of clay size is larger in the B horizon. Reagan 60-14, the Calciorthid, differs in having a bulge in total carbonate. The bulge is deeper than usual for this parent material and for soils of this age, suggesting the possibility of an overlay of younger material after soil development has started. The Torrifluvent, Glendale, has lower bulk densities; both pedons have relatively low values compared to soils higher in sand and lower in silt, formed in other parent materials from other sources (section 98). The amounts of organic carbon, 8 and 11 kg/m^2, are among the highest for the project area.

Table 163. Laboratory data for soils of Glendale-Reagan complex.

Horizon	Depth	Sand	Silt	Clay	Silicate Clay1/	Fine/ Total Clay2/	Carbonate <2mm	Carbonate <0.002mm3/	Bulk4/ Density	Organic Carbon
	cm	pct	pct	pct	pct		pct	pct	g/cc	pct
Glendale 60-15										
A	0-5	51	36	13	14	0.38	14	2		0.82
A	5-20	24	55	21	24	0.30	17	5	1.30	0.77
B21	20-38	9	60	31	32	0.46	26	10	1.29	0.70
B22	38-64	17	57	26	28	0.46	26	8	1.39	0.58
B3	64-86	15	59	26	27	0.44	25	8	1.37	0.44
C	86-112	15	61	24	27	0.41	26	7		0.36
Organic carbon, 8.1 kg/m^2 to 112 cm.										
Reagan 60-14										
A	0-5	24	54	22	27	0.14	16	4		2.00
A	5-28	24	48	28	29	0.13	15	7	1.47	1.13
B21	28-56	11	54	35	35	0.20	22	10	1.50	0.73
B22	56-76	8	50	42	44	0.20	23	12	1.48	0.70
B23ca	76-99	8	51	41	43	0.32	26	13	1.47	0.51
C	99-122	21	47	32	32	0.47	21	9	1.37	0.30
2Bb	122-140	61	21	18	16	0.53	8	3		0.19
Organic carbon, 11 kg/m^2 to 99 cm.										

1/ Carbonate-free basis.
2/ Determinations on carbonate-free samples.
3/ In <2mm.
4/ Air dry clod bulk density.

164. ALADDIN, GRAVELLY SANDY LOAM, CALCAREOUS VARIANT (13LGO)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ALADDIN, CALCAREOUS VARIANT	PACHIC HAPLUSTOLLS	COARSE-LOAMY	65
SANTO TOMAS, CALCAREOUS VARIANT	PACHIC HAPLUSTOLLS	LOAMY-SKELETAL	35

LOCATION, LANDSCAPE, VEGETATION

These soils occur in one area, just west of Lohman Canyon in the San Andres Mountains. The soils have formed in alluvial-fan sediments derived mainly from limestone, sandstone, siltstone, and shale, with smaller amounts of rhyolite, granite, and quartzite. Elevations range from about 5200 to 5300 feet.

These soils occur on an alluvial fan that has been trenched by the arroyo from Lohman Canyon and cut by gullies in places. Slopes range from 5 to 6 percent.

Vegetation is fluffgrass, creosotebush, mesquite, *Yucca elata*, barrel cactus, prickly pear, snakeweed, mariola, three-awn, dropseed, sumac, ocotillo, and a few clumps of black grama.

TYPICAL PEDONS, PROPERTIES AND RANGES

These soils are calcareous throughout. Bedrock is within a few m of the surface in places.

Aladdin, calcareous variant

A typical pedon of Aladdin, calcareous variant is described in the Appendix (pedon 60-19). Figure 155 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

Table 164. Typical (underlined) and range in selected properties for major horizons of Aladdin, calcareous variant.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-76	<u>sl</u>	15-35	<u>10YR</u>	4,5 <u>4.5</u>	2,<u>3</u>	1-3 <u>2</u>
C1ca	76-102	<u>sl</u>	15-35	7.5YR- <u>10YR</u>	<u>5</u>,6	<u>3</u>,4	2-4 <u>3,4</u>
Control section	25-100	sl	15-35				

Figure 155. Upper. Landscape of Aladdin variant 60-19, on the Organ surface, looking west from Lohman Canyon. The light colored area is occupied by Aladdin and Santo Tomas variants of Holocene age; the darker area beyond is occupied mostly by Paleorthids with creosotebush vegetation.

Lower. Aladdin variant 60-19 is at left, Santo Tomas, calcareous variant (loamy-skeletal) is at right. View along bank shows variation in coarse fragments, and the stage I carbonate typical of Holocene soils. Vegetation is fluffgrass, black grama, dropseed, creosotebush, mesquite, snakeweed, *Yucca elata*, barrel cactus, prickly pear, sumac, and ocotillo. Slope is 5 percent.

Santo Tomas, calcareous variant

Santo Tomas, calcareous variant, is similar to the Aladdin variant except that it is more gravelly.

SOIL OCCURRENCE

Soils of this mapping unit illustrate the thick, dark A horizons typical of Haplustolls along the mountain fronts. This is because of greater precipitation in these areas as compared to lower elevations. The soils are similar to the Haplustolls formed in low-carbonate parent materials to the south, but differ in being strongly calcareous throughout because of the highly calcareous parent materials.

Haplustolls. The change from the coarse-loamy ALADDIN, CALCAREOUS VARIANT to the loamy-skeletal SANTO TOMAS, CALCAREOUS VARIANT, is determined by increase in gravel content of Organ alluvium to more than 35 percent by volume.

SOIL BOUNDARIES

Table 165 gives information about boundaries to major adjacent units. Figure 156 shows boundaries and stratigraphy of some of the units.

Table 165. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Conger complex (10LL)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 13LGO. The 10LL soils, analogues of which are buried by Organ alluvium and its soils in unit 13LGO, emerge at the surface on the 10LL side of the boundary. The topographic boundary is not distinct.
Sedimentary rock outcrop and Entisols (40L)	The boundary is due to a change from thick alluvium of unit 13LGO to bedrock, which is at or near the surface in unit 40L. The boundary is distinct and marked by steeper slopes and bedrock outcrops.

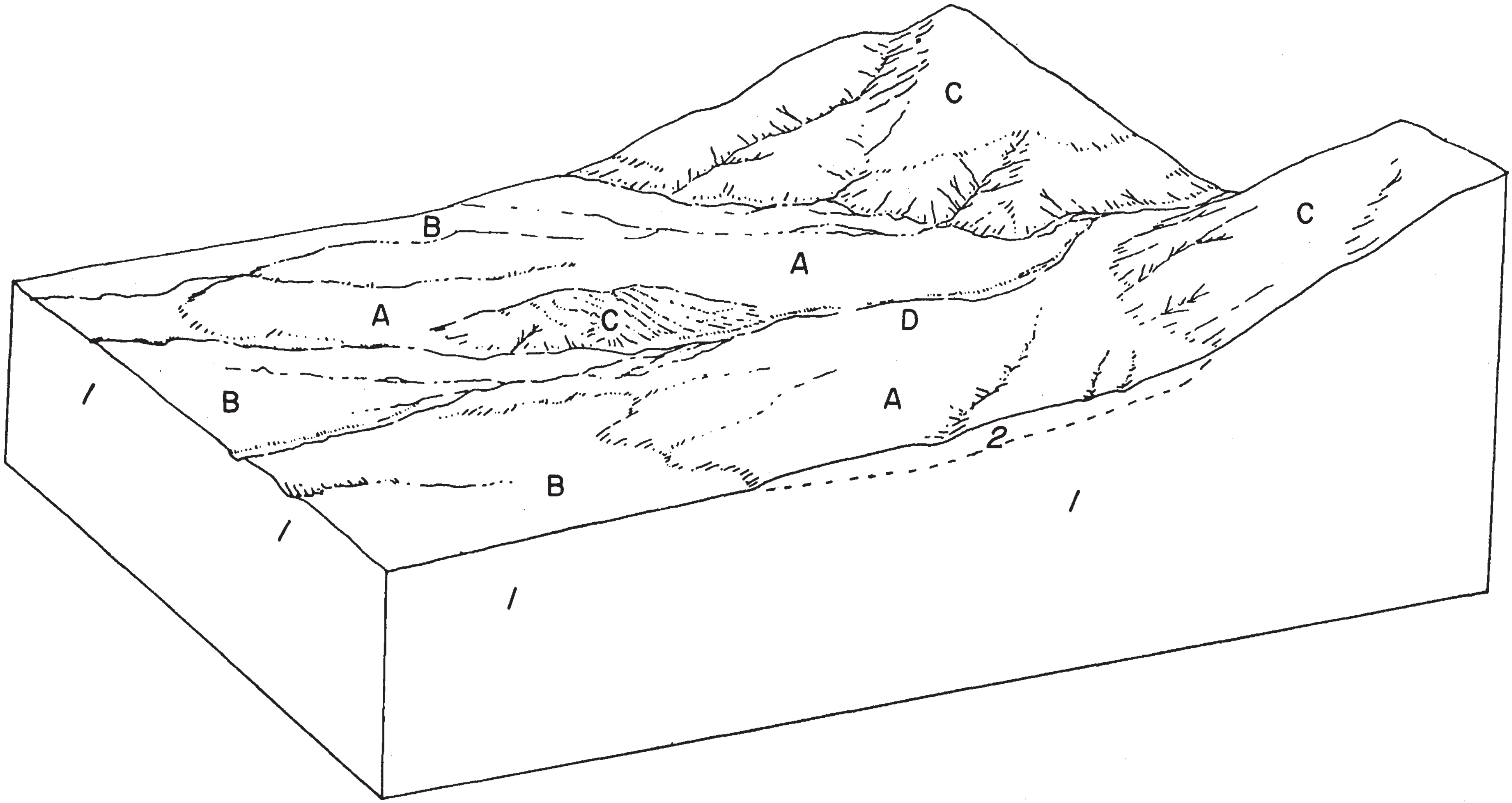


Figure 156. Block diagram of soil-landscape relations and soil stratigraphy in the area of Aladdin gravelly sandy loam, calcareous variant, Conger complex, and sedimentary rock outcrop and Entisols, west of Lohman Canyon. A = Aladdin gravelly sandy loam, calcareous variant (Organ surface). B = Conger complex (Jornada surface). C = Sedimentary rock outcrop and Entisols (mountain slopes and summits). D = Approximate location of Aladdin variant 60-19.
1 = Jornada alluvium and soils. 2 = Organ alluvium and soils.

OTHER STUDIES: A PACHIC HAPLUSTOLL IN HIGH-CARBONATE MATERIALS.

Figure 155 shows Aladdin variant 60-19. Approximate location is shown in figure 156. Laboratory data are in table 166. Abundant carbonate occurs throughout because of the highly calcareous parent materials. There are admixtures of igneous rocks, however, and for this reason the carbonate contents are not particularly high (table 166). This soil has a weak accumulation of carbonate that occurs as thin coatings on sand grains and pebbles.

This pedon still contains abundant carbonate in upper horizons even though it occurs in an area of higher precipitation (probably about 25 to 30 cm annually) near the mountains. This shows that Holocene precipitation has been insufficient to remove the carbonates. However, in a few, small stable areas, soils of the Jornada surface downslope (fig. 156) have reddish brown Bt horizons that in places are noncalcareous in part. This indicates that the greater moisture of a Pleistocene pluvial was sufficient to leach carbonates from upper horizons and to develop a Bt horizon.

* * *

Table 166. Laboratory data for Aladdin variant 60-19, a Pachic Haplustoll.

Horizon	Depth	Sand	Silt	Clay	Carbonate > 2	Carbonate < 2	Organic carbon
	cm	pct	pct	pct	pct	pct	pct
A11ca	0-20	73	19	8	50	7	0.84
A12ca	20-48	69	21	10	22	9	0.65
A13ca	48-76	70	20	10	28	10	0.67
C1ca	76-102	68	22	10	20	11	0.40
C2ca	102-124	74	17	9	20	12	0.30

165. Soils of the Jornada II surface.

These soils occur extensively on both alluvial fans along the mountain fronts and the coalescent fan-piedmont downslope. Soils of Jornada II are similar to and are considered to be about the same age as soils of the Picacho surface along the valley border. In the arid zone their horizons of clay and carbonate accumulation are very similar, and soils of both surfaces must have formed largely in late-Pleistocene time.

Eight mapping units occur on the Jornada II surface.

166. BERINO-BUCKLEBAR ASSOCIATION (15M)

MAPPING UNIT CONSTRUCTION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
BERINO	TYPIC HAPLARGIDS	FINE-LOAMY	45
BUCKLEBAR	TYPIC HAPLARGIDS	FINE-LOAMY	25
Onite	Typic Haplargids	Coarse-loamy	5
Pintura	Typic Torripsamments		10
Pintura, thin variant	Typic Torrifluvents	Coarse-loamy	10
Other inclusions (Haplargids)			5

LOCATION, LANDSCAPE, VEGETATION

These soils occur in one large area west of the northern part of the Organ Mountains. The soils have formed in sediments derived primarily from monzonite. In places there are small amounts of sediments derived from rhyolite, andesite, and limestone. Some soils occur in the sediments of coppice dunes. Elevations range from about 4300 to 4700 feet.

The soils occur on the coalescent fan-piedmont, and the landscape is gently undulating transversely. There are occasional broad drainageways, commonly scores of m wide, and a few very slight, discontinuous ridges. Gullies occur in many places and some of them follow old roads from San Augustin Pass towards the Rio Grande Valley. There are no well-defined arroyos. Drainage from arroyos entrenched in soils to the east continues across these soils in the broad drainageways or in the gullies. Slopes range from 3 percent nearest the mountains to 1 percent on lower slopes of the fan-piedmont. Coppice dunes are common in the southwestern part of the unit.

In stablest areas there are stands or clumps of tobosa; elsewhere there are common snakeweed, mesquite, Mormon tea, Yucca elata, fluffgrass, three-awn, and a few creosotebush. Mesquite is dominant on dunes; a few four-wing saltbush also occur.

TYPICAL PEDONS, PROPERTIES AND RANGES

Berino

A typical pedon of Berino is described in the Appendix (pedon 60-7). Figure 157 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

Table 167. Typical (underlined) and range in selected properties for major horizons of Berino.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	5-13	sl	0-15	5YR- 7.5YR	5,6 5.5	3-5 3.5	2-4
B2t	13-43	scl hv.sl	0-15	2.5YR- 5YR	4,5	3,4	4-6
K2	91-140	scl cl	0-30	5YR- 10YR 7.5YR	6-9 6.5	5-8 5.5	1-4
Cca	140-157	sl scl ls	0-75	5YR- 7.5YR	5-8 5.5	4-7 4.5	3,4
Control section		scl,hv.sl	0-15				

Other. The A horizon has been eroded in many places (particularly between dunes where they are present) and the Bt horizon is at the surface. These soils are typically noncalcareous to depths ranging from 25 to 50 cm but range to calcareous throughout as long as at least the upper subhorizon of the Bt horizon is free of macroscopic carbonate. Depth to the calcic horizon (the K2 horizon in the description) is usually 50 to 100 cm, ranging from 30 to 100 cm. Pipes of reddish brown Bt material extend from the Bt horizon into and commonly through the K horizon. Most pipes range from a few cm to about 1/2 m in diameter. The K horizons tend to be thickest (1 to 2 m) on gentler slopes, towards

Figure 157. Landscape of a Typic Haplargid, Berino 60-7, on the Jornada II surface. Vegetation on dunes is mostly mesquite, with a few four-wing saltbush. A few snakeweed occur between dunes. Slope is 1 percent. (See section 81 for closeup.)

the basin floor. This is because Jornada II alluvium is underlain by buried soils and thins in many areas downslope, where the K horizon of Jornada II age has formed partly in the argillic horizon of the buried soil and merges with the buried K horizon.

Bucklebar

A typical pedon of Bucklebar is described in the Appendix (pedon 59-7). A table of properties and ranges is given below.

Table 168. Typical (underlined) and range in selected properties for major horizons of Bucklebar.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	sl ls	0-15	7.5YR- 10YR	5-7	3-5	2-4 3
B2t	15-58	scl cl,l hv.sl	0-15	5YR 7.5YR	4-6 5	3-5 3.5	3-6 3
Cca	58-97	l,sl scl cl	0-15	5YR- 10YR	4-6 5	3-5 4	3,4
Control section		scl,cl, l,hv.sl	0-15				

Other. These soils are usually noncalcareous to depths ranging from about 25 to 50 cm, but range to calcareous throughout. Scattered carbonate nodules, separated by low-carbonate material, form the carbonate maximum. These soils have formed in a thin deposit that in most places ranges from about 1/2 to 1-1/2 m thick, and that rests on buried soils.

SOIL OCCURRENCE

The Berino soils of late-Pleistocene age are dominant. Most other soils are younger, and generally occur in or near drainageways.

Typic Haplargids. The fine-loamy BERINO soils, which have calcic horizons, occupy major segments of the Jornada II landscape not covered by Holocene sediments. These areas are usually slightly higher positions between drainageways. BUCKLEBAR soils, also fine-loamy but without calcic horizons, occur in or near drainageways. In some areas these soils have developed in gully fills with slopes that blend smoothly with those of adjacent soils. In these cases, marked changes in soils occur with little or no topographic suggestion of such changes. The coarse-loamy Onite soils occur on very slight ridges. Dona Ana soils occur in a few areas where the argillic horizons contain some macroscopic carbonate in all subhorizons; these are mainly on slight ridges in the Jornada II surface. Hap soils differ from Berino soils in having gravelly B horizons; these soils occur mostly on the slopes of 2 or 3 percent. Berino, overburden variant occurs locally in drainageways where a fine-loamy soil of Organ age is underlain by a soil of Jornada II age (analogue of Berino) at depths of from 20 to 50 cm.

Ustollic Haplargids. The fine Stellar soils, with calcic horizons, occur in a few areas on lower slopes near Isaacks' Lake. Headquarters, clayey subsoil variant occurs in drainageway deposits of Organ age near Isaacks' Lake. Berino, Ustollic variant, is preserved beneath low dunes in a few spots in drainageways.

Torripsamments and Torrifluvents. Pintura soils, Torripsamments, occur in dunes where thickness of sand or loamy sand is one m or more. Pintura, thin variant, is a Torrifluvent because of irregular decrease in organic carbon; these soils occur where thickness of the dune materials is from 50 to 100 cm.

SOIL BOUNDARIES

Table 169 gives information about boundaries to major adjacent units. Figure 158 shows boundaries and stratigraphy of some of the units.

Table 169. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Onite-Pajarito complex (13M)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 13M. The 15M soils, analogues of which are buried by Organ alluvium in unit 13M, emerge at the surface on the 15M side of the boundary. The topographic boundary is generally distinct. The 13M soils generally occur on slight, but long east-west ridges.
Onite sandy loam (13MM)	The boundary has been caused by a younger alluvium and geomorphic surface (mostly Organ, and some Isaacks' Ranch) in unit 13MM. The 15M soils, analogues of which are buried in unit 13MM emerge at the surface on the 15M side of the boundary. The topographic boundary is digitated and fairly distinct in most places, occurring at the downslope margins of slight east-west ridges.
Algerita sandy clay loam (16L)	The boundary is due to a change in parent materials, from dominantly monzonite (unit 15M) to highly calcareous materials derived from mostly sedimentary rocks, including limestone (unit 16L). The approximate boundary is marked topographically by an increase in small drainageways and in places there are small scarps in unit 16L. Vegetation changes from scattered mesquite, tobosa, and snakeweed (unit 15M) to mostly tarbush and creosotebush, with burro grass in some areas (unit 16L).
Dona Ana-Algerita complex (16M)	The boundary has been caused by closeness to strongly dissected terrain. The 16M soils are generally calcareous throughout because of soil truncation related to the dissection. The boundary is not prominent but approximately parallels the strongly dissected landscape.
Stellar clay loam, overflow (55)	The boundary is partly caused by a younger alluvium and geomorphic surface (Jornada II) in unit 15M. Analogues of the 55 soils are buried by Jornada II alluvium and its soils in unit 15M. These analogues emerge at the surface or are very near the surface on the 55 side of the boundary. Increase in clay, vegetation and organic carbon, causes a change from Typic to Ustollic Haplargids. The topographic boundary to unit 55 is also important; this is distinct, occurring at the margin between level basin floor and toeslopes of the fan-piedmont. Vegetatively the boundary is prominent, changing from scattered mesquite, tobosa, and snakeweed (unit 15M) to a nearly continuous stand of tobosa (unit 55).

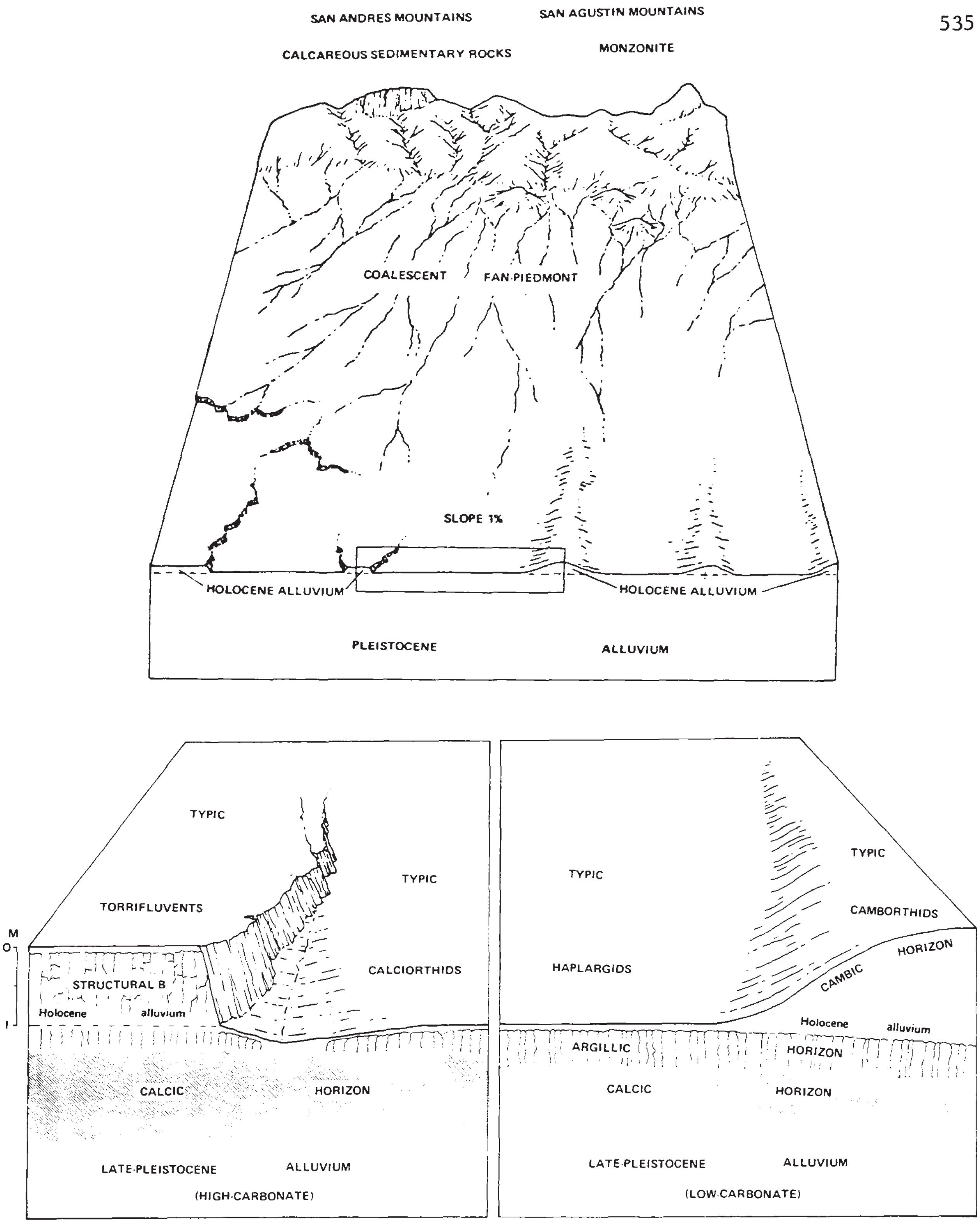


Figure 158. Character of soil boundaries between the Berino-Bucklebar association, the Onite-Pajarito complex, Algerita sandy clay loam and the Glendale-Reagan complex. The transition from the prominent Argids in monzonite alluvium to the Calciorthids in high-carbonate alluvium is a gradual one, and is marked by these changes, commonly in the following order: the argillic horizon becomes calcareous throughout; macroscopic carbonate appears in all subhorizons of the argillic horizon; and colors become less red in the B horizon, finally reaching the 7.5YR or 10YR hues characteristic of B horizons in Calciorthids of the area.

OTHER STUDIES

Long gullies in soils of this mapping unit were very useful in studying the soils and soil-landscape relations. By offsetting at various places, the gullies provide an almost continuous cross section of the piedmont slopes along and near Highway 70. The gullies expose both the land-surface and buried soils for long distances; cross drainageways of various sizes; illustrate the effect of drainageway position on the soils and alluviums; and show the effect of thinning of major alluviums on soil morphology.

The studies will be considered in four parts: Evidence of clay illuviation in a Typic Haplargid; Haplargids in a broad drainageway; Haplargids in and near a narrow drainageway; and the transition from the piedmont slopes to the basin floor. Location of the areas involved is indicated in figure 159.

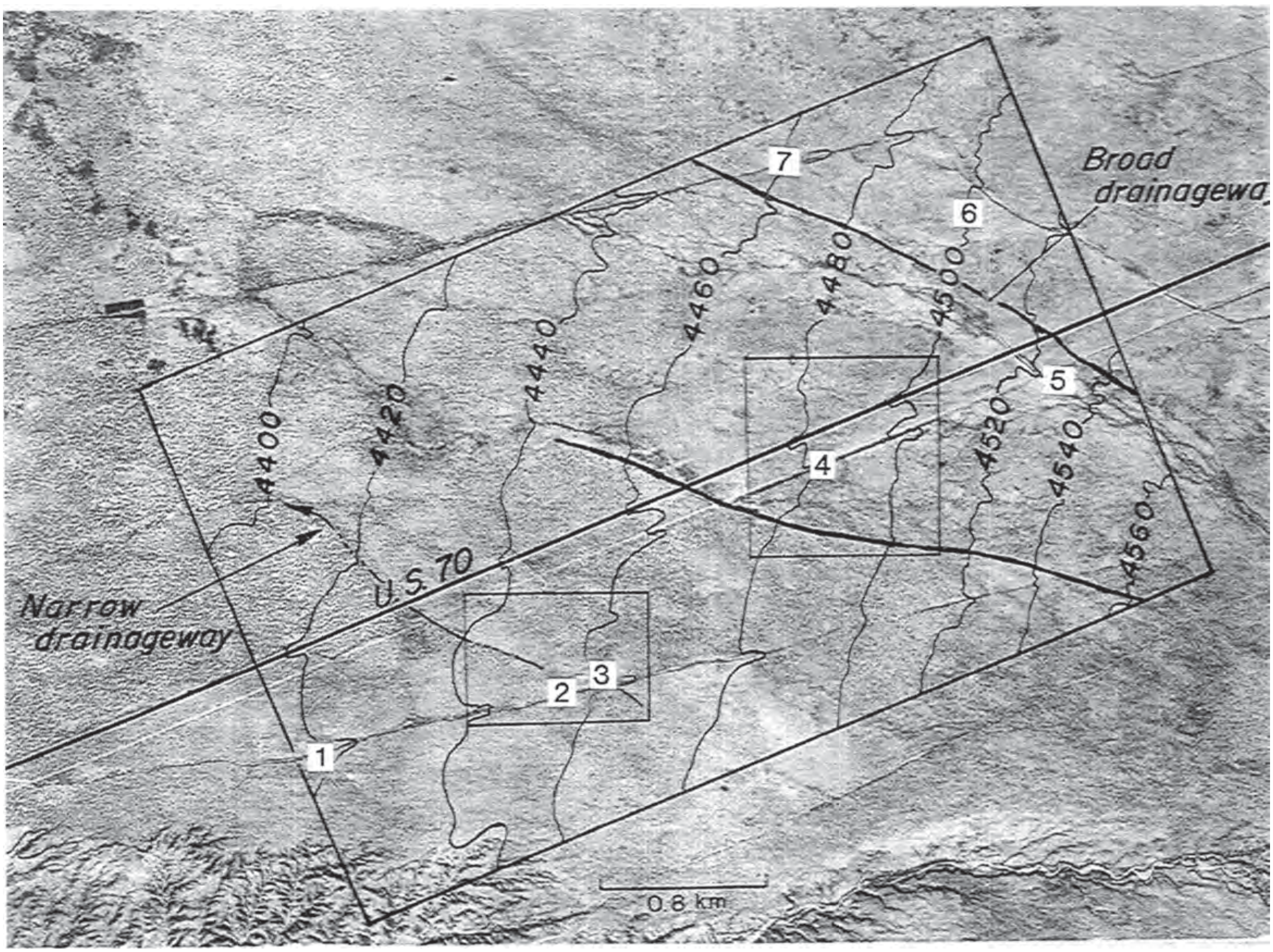


Figure 159. Location of two soil maps (figs. 161 and 164) and the broad and narrow drainageway. 1 = Dona Ana 60-6; 2 = Berino 60-7; 3 = Bucklebar 68-8; 4 = Berino variant 59-6; 5 = Bucklebar 59-7; 6 = Onite 62-3; and 7 = Bucklebar variant 59-8.

Evidence of clay illuviation in a Typic Haplargid

Berino 60-13 (also discussed in section 81) occurs on the fan-piedmont east of the broad drainageway (fig. 159). Slope is 2 percent. Vegetation consists of snakeweed, Mormon tea, a few Yucca elata, fluffgrass, and scattered clumps of three-awn.

Total analyses (see Appendix) are consistent with illuviation being the primary cause of the bulge in clay in the B2t rather than weathering and clay synthesis. Uniformity in the degree of weathering of the sand of the C horizon and of horizons above supports illuviation as the primary cause for the clay bulge. The clay mineralogy was studied by Vanden Heuvel (1966). His observations follow (unpublished information, Soil Conservation Service); subsequent work has shown that the trends with depth are applicable generally.

> X-ray diffraction analysis of the less than 0.0002 clay samples shows that they all contain montmorillonite, mica, and kaolinite. The montmorillonite maxima become progressively more intense with sample depth being barely detectable at the surface and quite large at the base of the profile. Conversely, the moderately intense mica diffraction maximum decreases somewhat in intensity with depth, which correlates with the decreasing K_2O content of the fine clay. The decrease in the mica peak size is not as great as the increase in the montmorillonite peak size with depth, however. The kaolinite peak is small and its size does not change significantly with depth. DTA shows that the kaolinite percentages are about 10 percent.
>
> X-ray diffraction analysis of the 0.002-0.0002 clay shows the same trends in mineralogical changes with depth except that they are less marked. The intensities of the diffraction maxima indicate that, compared to the less than 0.0002 clay, montmorillonite is less abundant, and mica about the same. The coarse clay from sample 13202 gives a significantly larger montmorillonite peak than any of the other coarse clays, which might be expected because of the difficulty in dispersing this sample. Apparently, the coarse clay contains undispersed fine clay, which raises its montmorillonite content.

Haplargids in a broad drainageway

A broad drainageway crosses U.S. Highway 70 downslope from Berino 60-13 (fig. 159). Gullies south of and parallel to the highway show a cross section of the land-surface and buried soils to depths ranging up to nearly 4 m. The various gullies illustrate soils of four ages--Organ, Isaacks' Ranch, Jornada II, and Jornada I. All may be viewed in buried position; the soils of Organ age (the youngest) are buried, in places, by coppice dunes. General relations of the buried and land-surface soils are shown in figure 160; figure 161 is a soil map.

Onite 62-3 (table 170) occurs in Organ alluvium on the crest of a very slight ridge near the margin of the drainageway. Photographs and other details of Onite 62-3 are given in section 81. Bucklebar variant 59-8 is located on

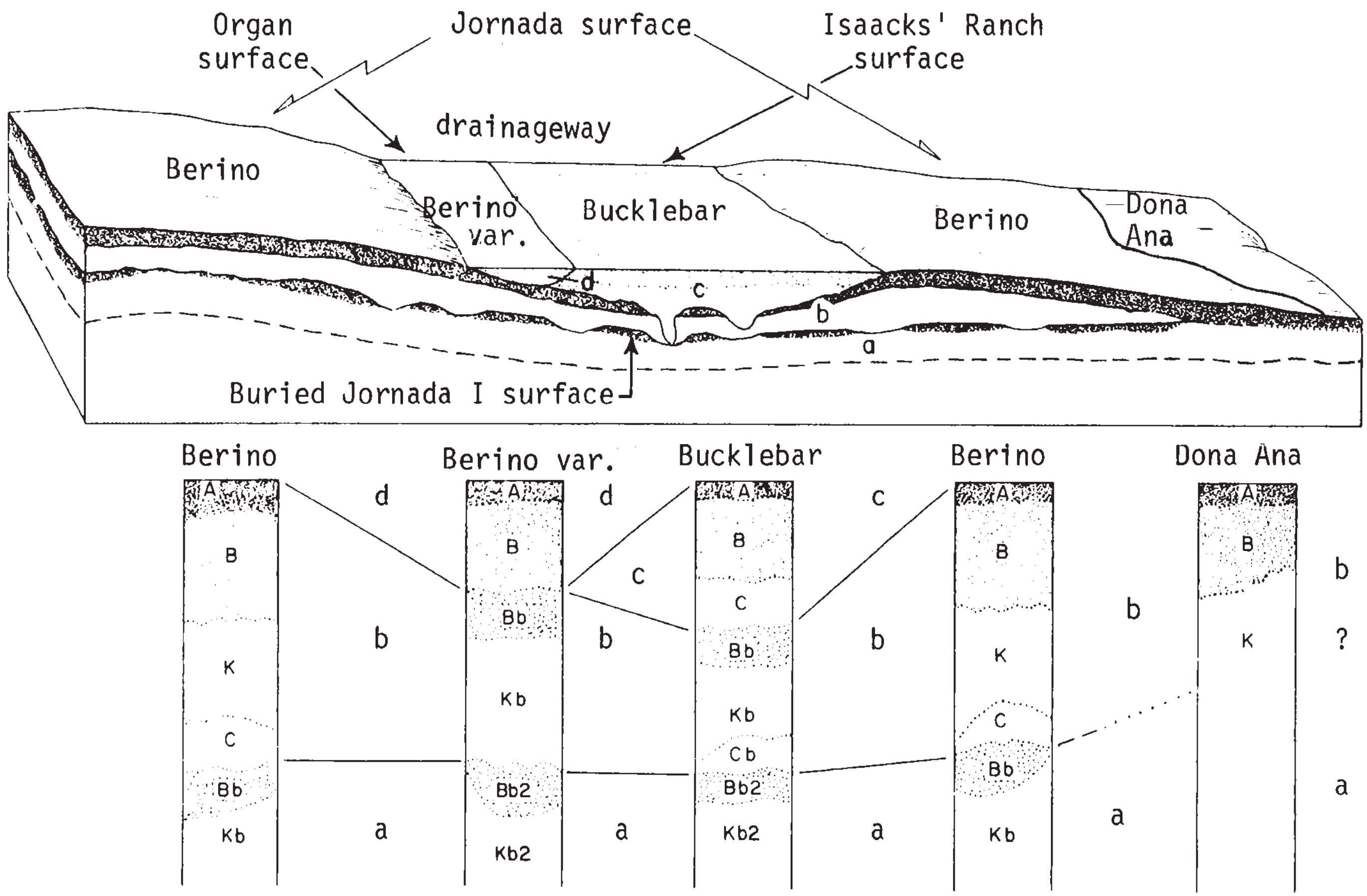


Figure 160. Generalized diagram showing relationship of sediments, common land-surface soils, and buried soils in and adjacent to the broad drainageway crossed by the Highway 70 gully. Scale exaggerated to show stratigraphic relationships. a = Jornada I alluvium (Upper Camp Rice formation); b = Jornada II alluvium; c = Isaacks' Ranch alluvium; d = Organ alluvium.

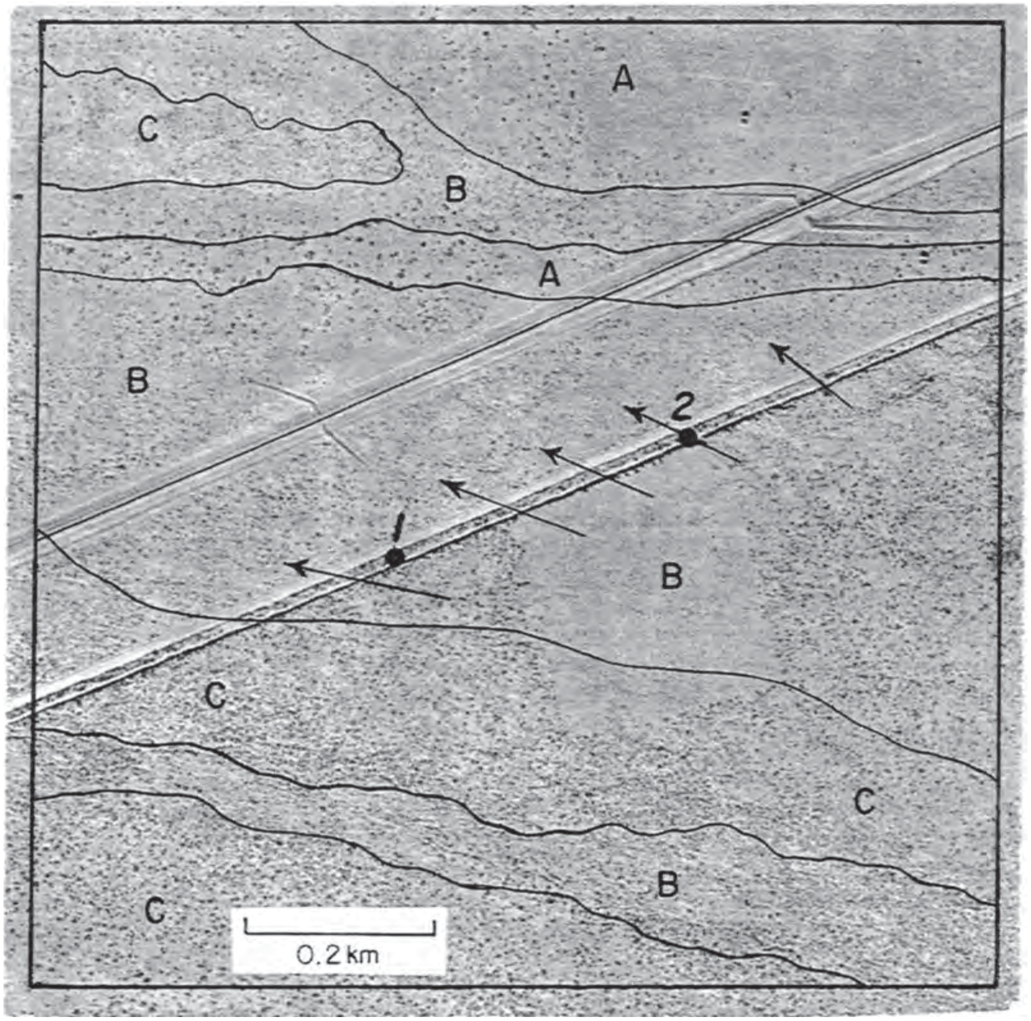


Figure 161. Map of soils in part of the broad drainageway. A = Onite sandy loam (Isaacks' Ranch surface). B = Bucklebar, overflow phase (Isaacks' Ranch surface). C = Berino sandy loam (Jornada II surface). Arrows show location and direction of Isaacks' Ranch channel fills. 1 = Berino variant 59-6; 2 = Isaacks' Ranch channel fill (see figure 163).

Table 170. Laboratory data for Berino 60-13 and pedons in the broad drainageway.[1/]

Alluvium	Horizon	Depth	Sand[2/]	Clay[2/]	Fine/[2/] Total Clay	Extractable Fe[2/] Clay	Carbonate <2mm	Carbonate <0.002mm	Total Phosphorus	Organic Carbon
		cm	pct	pct	pct	pct	pct	pct	pct	pct
	Berino 60-13									
Jornada II	A1	0-8	79	13	0.57	.06	tr		0.05	0.26
↓	B21t	8-28	72[3/]	18	0.72	.05	tr		0.04	0.30
	B22t	28-43	61[3/]	25	0.74	.04	tr		0.03	0.29
	B23tca	43-56	63[3/]	23	0.77	.04	4	1	0.04	0.28
	K1	56-71	66[3/]	17	0.51	.05	13	4	0.06	0.20
	K2	71-86	57[3/]	18		.04	20	5	0.08	0.12
	Cca	86-114	82[3/]	7	0.66	.08	5		0.07	
	Organic carbon, 3.0 kg/m² to 86 cm.									
	Berino variant 59-6									
Isaacks' Ranch	A1	0-13	62	17		.05	tr	tr	0.03	
↓	B21tca	13-30	55	28	0.38	.03	8	6	0.04	0.73
	B22tca	30-51	53	26	0.31	.03	15	11	0.04	0.55
Jornada II	B1b	51-71	64	18	0.48	.04	5	3	0.03	0.39
↓	B2tb	71-91	51	38	0.52	.02	5	1	0.03	0.13
	K1b	91-117	65	21	0.44	.03	12	8	0.03	0.22
	K2b	117-168	71	15	0.58	.04	18	10	0.04	0.05
Jornada I	B2tb2	168-201	36[3/]	25	0.41	.04	15	12	0.03	
↓	K21b2	201-231	70	21	0.48	.03	32	21	0.02	
	K22b2	231-262	67	19		.04	34	19	0.05	
	Organic carbon, 4.8 kg/m² to 91 cm.									
	Bucklebar 59-7									
Isaacks' Ranch	A	0-15	63	14	0.38	.06	1			0.43
↓	B21t	15-38	62[3/]	22	0.48	.04	tr			0.40
	B22tca	38-58	49[3/]	23	0.47	.03	3			0.25
	C1ca	58-97	71[3/]	19	0.38	.04	8			0.19
	C2ca	97-127	35	27	0.34	.04	6			0.12
Jornada II	Bbca	127-147	57[3/]	23	0.27	.05	8			
	Organic carbon, 3.9 kg/m² to 97 cm.									
	Bucklebar variant 59-8									
Organ	C	0-5	78	10		.07	0.2			0.14
↓	A2	5-13	70	12		.07	0.1			0.21
	B21t	13-28	62	26		.04	1			0.31
	B22t	28-46	50	34		.03	1			0.28
Jornada II	B2b	46-71	56	27		.04	1			0.16
↓	2K21b	71-112	70[3/]	20		.04	19	11		0.10
	3K22b	112-155	73	17		.04	22	14		
	3K3b	155-178	77	13			13			
	Organic carbon, 3.1 kg/m² to 112 cm.									
	Onite 62-3									
Organ	A2	0-5	77[3/]	7	0.41	.12	tr(s)		0.03	0.25
↓	B1t	5-8	71[3/]	12	0.48	.07	tr(s)		0.04	0.24
	B21t	8-20	72[3/]	14	0.64	.07	tr(s)		0.03	0.27
	B22t	20-30	68[3/]	14	0.59	.06	1		0.03	0.24
	2C1ca	30-43	72[3/]	13	0.33	.05	5		0.05	0.23
	3C2ca	43-61	73[3/]	11	0.47		3			0.12
	4C3ca	61-76	84[3/]	8	0.32	.14	3		0.03	0.10
Jornada II	5B1b	76-84	55	19	0.32	.05	2		0.04	0.12
↓	5B21b	84-102	47	30	0.36	.04	1		0.03	0.16
	5B22b	102-112	49	31	0.43	.04				0.13
	Organic carbon, 2.4 kg/m² to 102 cm.									

1/ All are Typic Haplargids except Berino variant 59-6, an Ustollic Haplargid.
2/ Carbonate-free material.
3/ > 5 percent by weight > 2 mm.

the edge of the drainageway in a thin deposit of finer-textured organ alluvium over Jornada II alluvium. The A2 horizon has been well preserved by a thin deposit of younger C horizon material (see section 59 for further discussion of the A2 horizon). The buried soil, formed in Jornada II alluvium, is the analogue of paleosol 1 at Berino variant 59-6 and other localities discussed later.

Bucklebar 59-7 occurs on the eastern edge of the drainageway, in Isaacks' Ranch alluvium over Jornada II alluvium. The carbonate horizon is stage II instead of the stage I in Organ alluvium.

Berino variant 59-6 (fig. 162) is an Ustollic variant of the Berino series. It occurs near the margin of the Isaacks' Ranch alluvium of the drainageway, where it is thinner than at Bucklebar 59-7 (50 compared to 130 cm). The sampled horizons are covered by 20 cm of dune sediments in which mesquite and four-wing saltbush grows and their roots extend into the upper horizons of the soil beneath. Presence of these roots, and preservation of the A horizon by the dune materials are considered to be the major reasons that organic carbon is enough for an Ustollic subgroup; most soils in the area are Typic Haplargids. Berino variant 59-6 has a calcic horizon and for this reason is in a different series than Bucklebar 59-7. The higher carbonate content may be a reflection of low infiltration rate of the B2tb horizon which contains nearly 40 percent silicate clay. As a result the downward moving water may have precipitated its carbonate over a more restricted depth range.

Several radiocarbon ages of inorganic carbon were obtained from pedons 59-6 and 59-7 (table 171). Radiocarbon ages from carbonate nodules in the

* * *

Table 171. Radiocarbon ages of inorganic carbon in pedons 59-6 and 59-7.

Alluvium	Horizon	Depth	Carbonate dated	C-14 age kyrs
		cm		
	Bucklebar 59-7			
Isaacks' Ranch	Cca	66-91	Fine-earth carbonate in nodules	8
			Sand-size carbonate in nodules	8
	Berino variant 59-6			
Jornada II	K1b	81-96	Fine-earth carbonate	12
	K2b	142-168	Fine-earth carbonate	26
			Sand-size carbonate	30
Jornada I	K22b2	231-269	Fine-earth carbonate	27

* * *

soil of Isaacks' Ranch alluvium (Bucklebar 59-7) are only slightly older than the oldest C-14 age from buried charcoal in Organ alluvium. Relative ages are

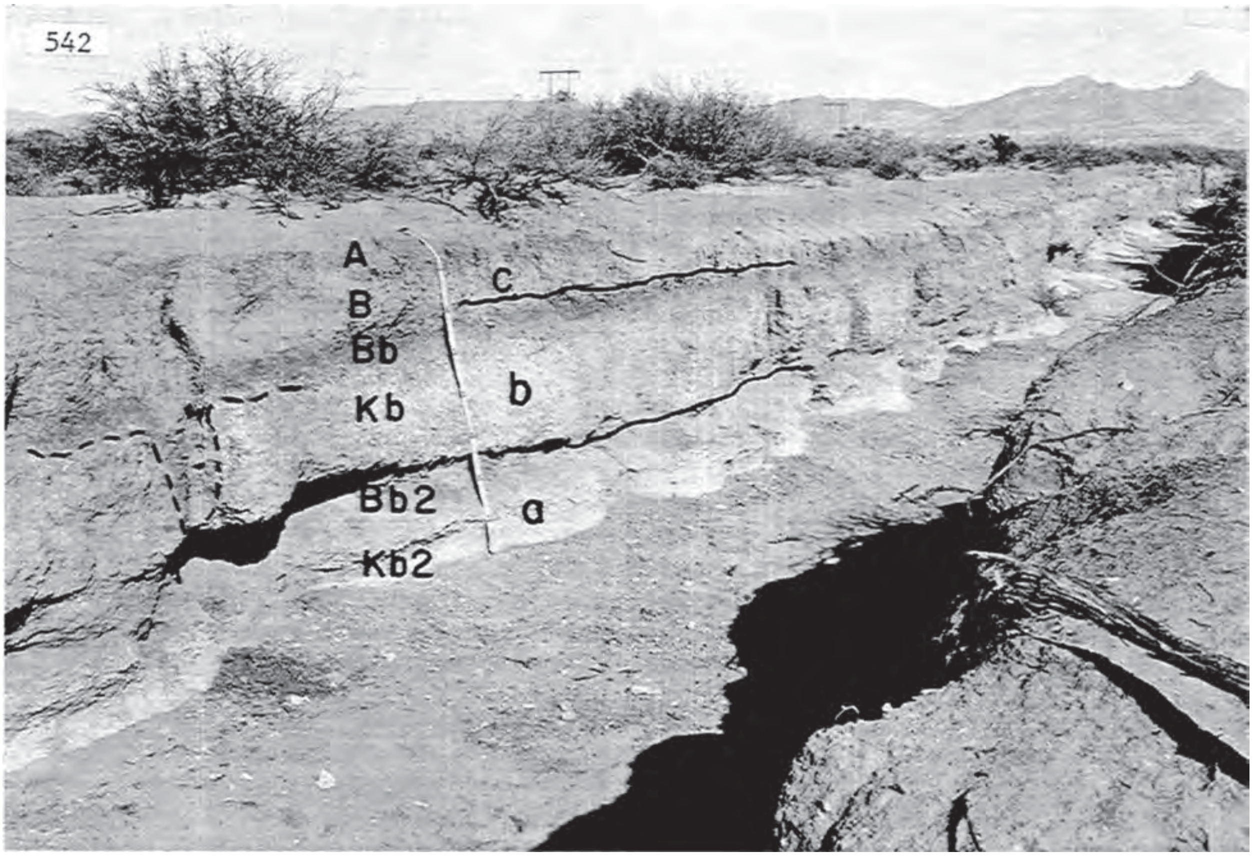


Figure 162. Berino variant 59-6 and buried soils. a = Jornada I alluvium; b = Jornada II alluvium; c = Isaacks' Ranch alluvium. Pipe outlined at left.

reasonable since in other parts of the project area Isaacks' Ranch alluvium is locally buried by Organ alluvium and overlies Jornada II alluvium. The C-14 age from fine-earth carbonate of the K22b2 horizon of Berino variant 59-6 is only slightly older than the one obtained from the overlying K2b horizon. This relatively young age is probably related to deep percolation of moisture and consequent youthening of carbonate during pluvial periods.

In Berino variant 59-6 the Bt horizon and nodular carbonate horizon of Isaacks' Ranch age rest directly on the Jornada II paleosol. This paleosol has a prismatic, reddish Bt horizon and a nodular, light-colored K horizon. The effects of soil formation subsequent to deposition of the overlying Isaacks' Ranch alluvium are shown by scattered filaments and nodules extending into its upper part. Eastward the Jornada II paleosol occurs beneath a C horizon in Isaacks' Ranch alluvium. This demonstrates that the paleosol formed at the land surface and was subsequently buried (fig. 162). These relations also show that Berino soils must have formed almost wholly in the Pleistocene. The Jornada II paleosol emerges at the land surface on each side of the drainageway and it is the most extensive soil on the Jornada II surface in this area.

The Jornada I paleosol is exposed fairly continuously in the gully and has a Bt horizon (where not truncated) and a prominent K horizon that is well shown along the gully bottom. Commonly, the gully bottom coincides with about the middle or upper part of the K horizon, so that the Jornada I paleosol is not wholly exposed. Reddish, low-carbonate pipes occasionally penetrate the K horizon. Formation of the Jornada I paleosol at the land surface is strongly suggested by the morphology of its Bt and K horizons, including pipes of Bt material that descend into the K horizons. All these features are similar to those of soils at the present land surface. East of Berino variant 59-6, conclusive evidence of burial is provided by the occasional presence of overlying C horizon material with essentially no illuvial clay or carbonate.

In places the Bt horizon of the Jornada I paleosol was truncated before Jornada II alluvium was deposited. The K horizon remains and is a useful marker horizon for tracing. Also, the Jornada I paleosol has been affected by events during deposition of the Jornada II alluvium and subsequent soil development. The upper few cm of the Jornada I paleosol in places contains weak accumulations of reddish, high-chroma silicate clay. These may be traced upward into overlying sandy sediments or into pipes of the overlying Jornada II paleosol. The deeply illuviated clay occurs as discontinuous coatings on peds of the Bt horizon, or, where the Bt has been completely truncated, as discontinuous coatings on carbonate aggregates in the K horizon. Another effect is the occasional extension of carbonate nodules and filaments from the lower part of the K horizon of the Jornada II paleosol into the Bt horizon of the Jornada I paleosol. This happens in some of the areas lacking C horizon material above the Jornada I paleosol.

Waters of large, former channels, now filled with younger sediment, have also affected buried soils. As shown in figure 163, the lower K horizon of the Jornada I paleosol grades laterally into reddish zones beneath the Isaacks' Ranch channel fill. These B-like zones are common beneath former channels of the study area and are thought to have formed prior to their filling with younger alluvium. Some of the water in the channels apparently leached the channel sediments free or nearly free of carbonate and formed the reddish zones. Such concentrations of water can thus cause major differences in soils of the same age.

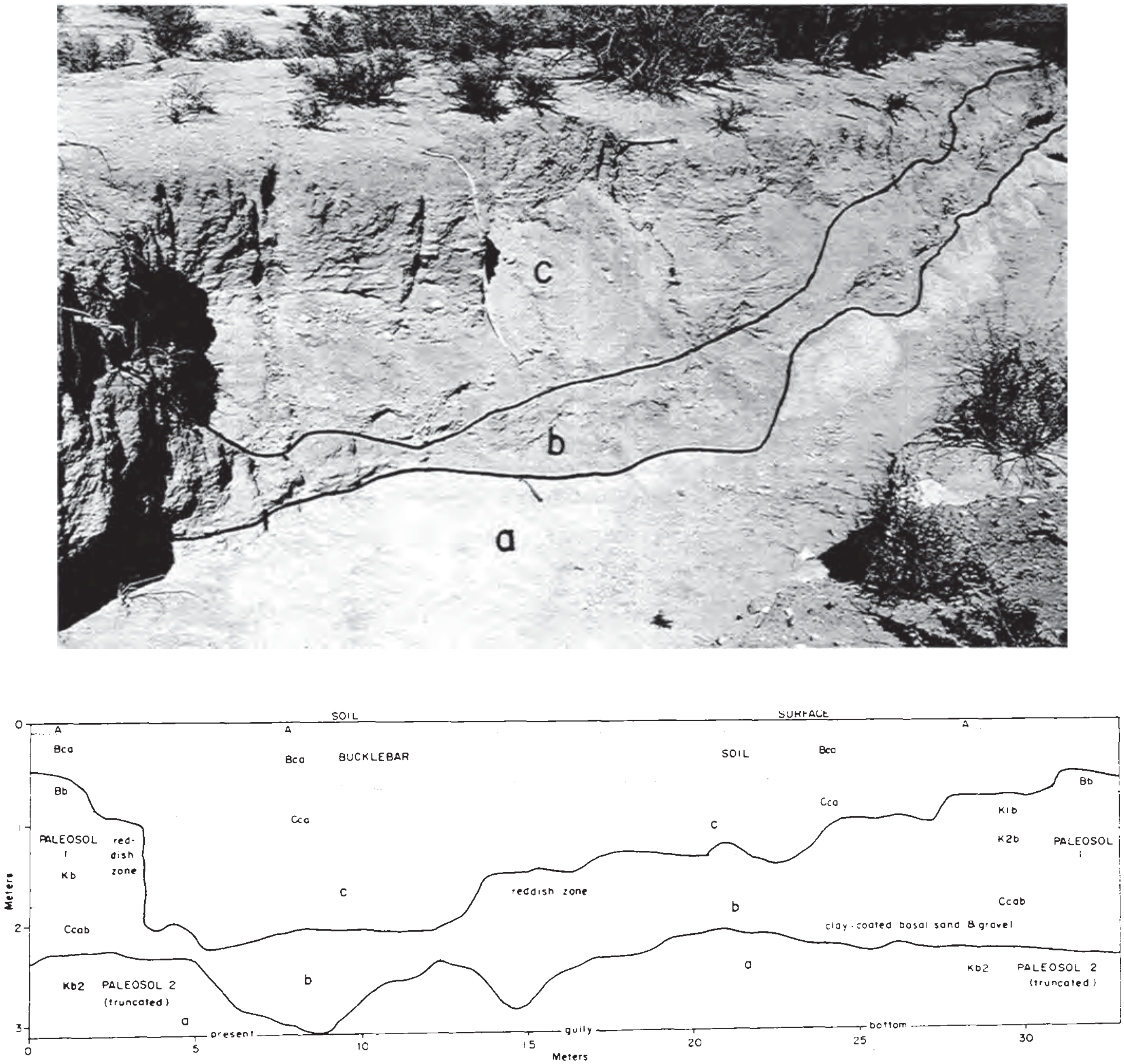


Figure 163. Upper. Photograph of Isaacks' Ranch gully fill located in figure 161. A = Jornada I alluvium and soils; b = Jornada II alluvium and soils; c = Isaacks' Ranch alluvium and soils.

Lower. Diagram on gully fill shown above.

Water concentrations can cause deep emplacement of silicate clay, suggesting the presence of buried horizons. In places, accumulations of reddish, high-chroma silicate clay are prominent in sandy sediments of basal Jornada II alluvium (as in figure 163, left). The clay tends to "hang" in these coarser textured sediments; water movement into the underlying, compact, Jornada I paleosol would be much slower, especially where the sandy sediments rest on the K horizon of the truncated paleosol. The water is thought to have moved downward from former zones that were either particularly pervious (pipes) or sites of local water concentration (channels). The reddish silicate clay coatings in the K beneath are less continuous than where the deep clay accumulations are considered of pedogenic origin.

Haplargids in and near a narrow drainageway

Figure 164 shows the location, cross sections, and soils in the vicinity of Berino 60-7 and Bucklebar 66-8. Morphology and landscape of Bucklebar 68-8 are shown in figure 165. Laboratory data are in table 172.

Bucklebar 66-8 is developed in Organ alluvium (about 50 cm thick) over Jornada II alluvium. The narrow drainageways concentrate runoff from upslope, more than the broad drainageway. This water concentration is thought to have caused the greater thickness of the noncalcareous zone in Bucklebar 66-8. Excluding the uppermost C horizon, the pedon is noncalcareous for slightly over 1 m in depth, well into the Jornada II paleosol.

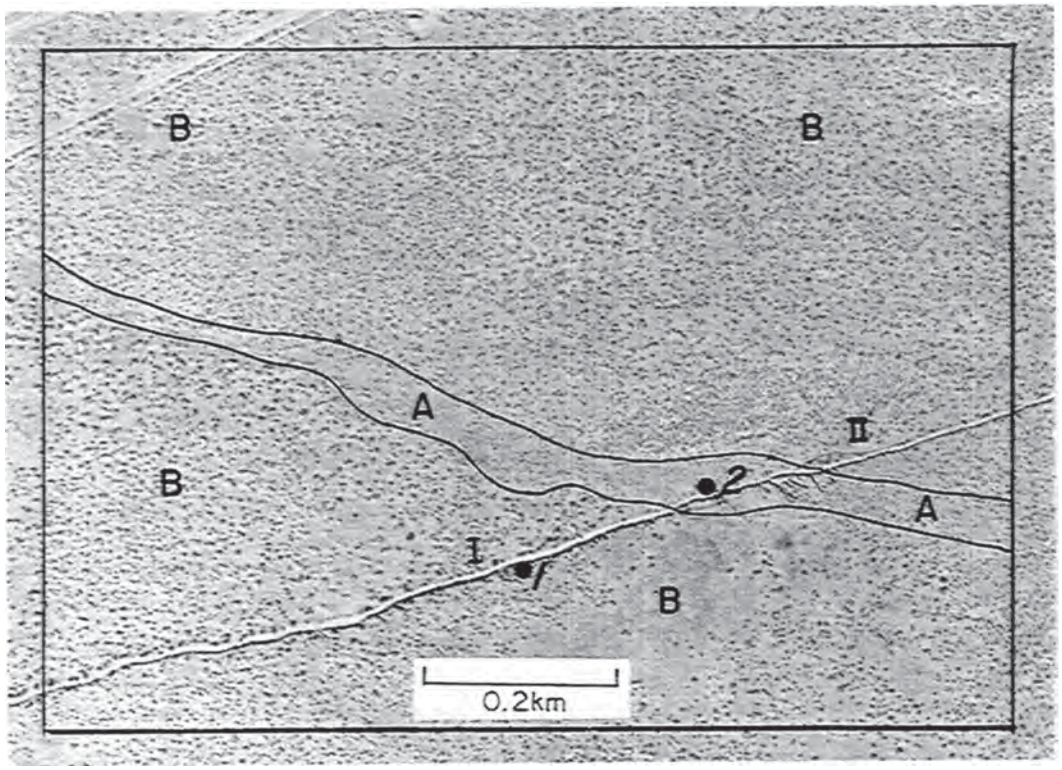
Berino 60-7, which occurs adjacent to the drainageway, is developed in Jornada II alluvium over Jornada I alluvium. Berino 60-7 (further discussed in section 81) received no drainageway water, and consequently a K horiozn has formed in Jornada II alluvium. The K horizon of the buried soil, developed in Jornada I alluvium, contains distinct black filaments and coatings on structural surfaces. These features appear to consist largely of iron, manganese, or both. They may have been deposited from the water that emplaced the Jornada II alluvium.

Soils of the lower piedmont slope

Jornada II alluvium thins towards the basin floor and in places the K horizon of Jornada II age has formed in the soil of underlying Jornada I. This is illustrated by Dona Ana 60-6, west of Berino 60-7 (fig. 159). Jornada II alluvium has thinned at this location, so that the carbonate accumulation in the soil of Jornada II coincides with and has largely masked the argillic horizon of the soil in Jornada I alluvium. The K horizon is very thick as a result of coalescence of the zones of carbonate accumulation in the Jornada I and II alluviums. The K horizon in the Jornada I alluvium has the black filaments and coatings present in Berino 60-7, discussed previously.

Thin sections were made of the K21 horizon of Dona Ana 60-6 (fig. 166). They show substantial differences in grain separation. This is due to variability in carbonate impregnation and is common in stage III horizons. Parts widely separated by carbonate tend to be harder and some are indurated.

Several general statements may be made concerning the laboratory data in tables 170 and 172. The ratio of fine to total clay follows the general pattern



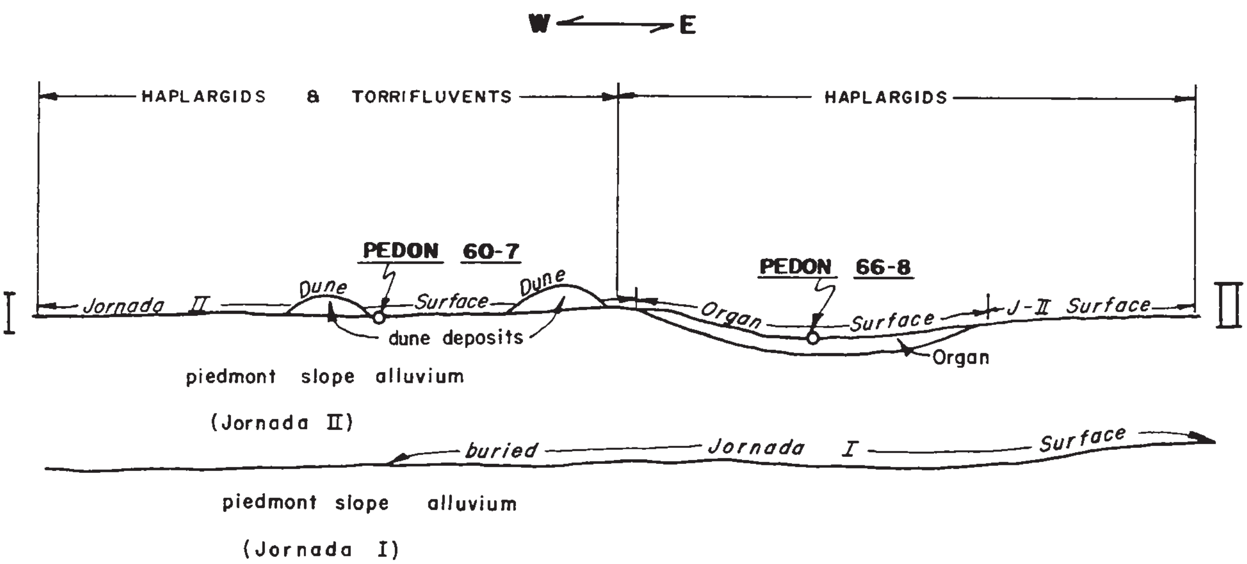


Figure 164. Upper. Soil map in the vicinity of the narrow drainageway. A = Bucklebar, overflow phase (Organ surface). B = Berino-Bucklebar-Pintura thin variant complex (Jornada II surface and dunes). Location of cross section I to II indicated. 1 = Berino 60-7; 2 = Bucklebar 66-8.

Lower. Cross section from I to II on the soil map.

Figure 165. Upper. Landscape of the Typic Haplargid, Bucklebar 66-8, in a narrow drainageway on the Organ surface. Vegetation consists of a few tarbush and mesquite. Slope is 1 percent. Dona Ana Mountains are on the skyline (center and right).

Lower. Bucklebar 66-8. Scale is in meters.

Table 172. Laboratory data for Typic Haplargids in and west of a narrow drainageway.

Alluvium	Horizon	Depth	Sand[1]	Clay[1]	Fine Clay	Fine/[1] Total Clay	Extractable Fe[1]	Carbonate <2mm	Carbonate <0.002mm	Organic Carbon
		cm	pct	pct	pct	pct	pct	pct	pct	pct
	Bucklebar 66-8									
	C	0-8	81[2]	12				2	tr	0.15
Organ	A2	8-15	67	17				tr(s)	-	0.27
↓	B21t	15-30	56	28				tr(s)		0.35
	B22t	30-51	69[2]	23				tr(s)		0.23
Jornada II	B21tb	51-81	56	29				tr(s)		0.20
↓	B22tb	81-124	53	24				tr(s)	-	0.20
	B31b	124-150	59	17				2	tr	0.16
	B32b	150-198	57	19				6	tr	0.12
	Organic carbon, 2.9 kg/m² to 81 cm.									
	Berino 60-7									
Jornada II	A	5-13	76	14	4	0.25	0.6	tr		0.20
↓	B21t	13-33	60	28	12	0.44	0.8	tr		0.28
	B22tca	33-43	52	33	18	0.55	0.9	2		0.29
	K11	43-66	67	24	14	0.57	0.6	9	7	0.11
	K12	66-91	71	20	11	0.58	0.6	10	6	
	K2	91-140	70[2]	18	12	0.67	0.6	15	8	
	C1ca	140-157	77[2]	13				8		
	2C2ca	157-165	82[2]	12				7		
Jornada I	3B2tcab	165-183	80	13				8		
↓	3K1b	183-193	76	17				34		
	3K2b	193-229	74	18				44		
	3K31b	229-246	66	20				44		
	3K32b	246-267	68	17				30		
	3K33b	267-279	67	17				17		
	3Bcab2 ?	279-300	69	16				15		
	Dona Ana 60-6									
Jornada II	A	13-18	74	17	5	0.30		1		0.32
↓	A	18-28	69	20	7	0.35		2		0.45
	B21tca	28-41	64	24	10	0.43		5		0.40
	B22tca	41-51	51	32	19	0.59		8	5	0.43
	K1	51-64	59	29	18	0.62		23	17	0.33
	K21	64-86	72	16	13	0.80		22	14	0.10
	K21	86-112	74	17	13	0.76		28	16	
	K22	112-142	74	20	15	0.73		27	12	
Jornada I	K31Bb	142-175	79	14	9	0.63		25		
↓	K21b	175-208	78	15	10	0.71		15		
	K22b	208-244	78	13	7	0.52		19		
	C1cab	244-274	80	10	5	0.44		14		
	C2cab	274-310	81	10	4	0.36		7		
	Organic carbon, 3.2 kg/m² 13-112 cm.									

1/ Carbonate-free material
2/ > 5 percent by weight > 2 mm.

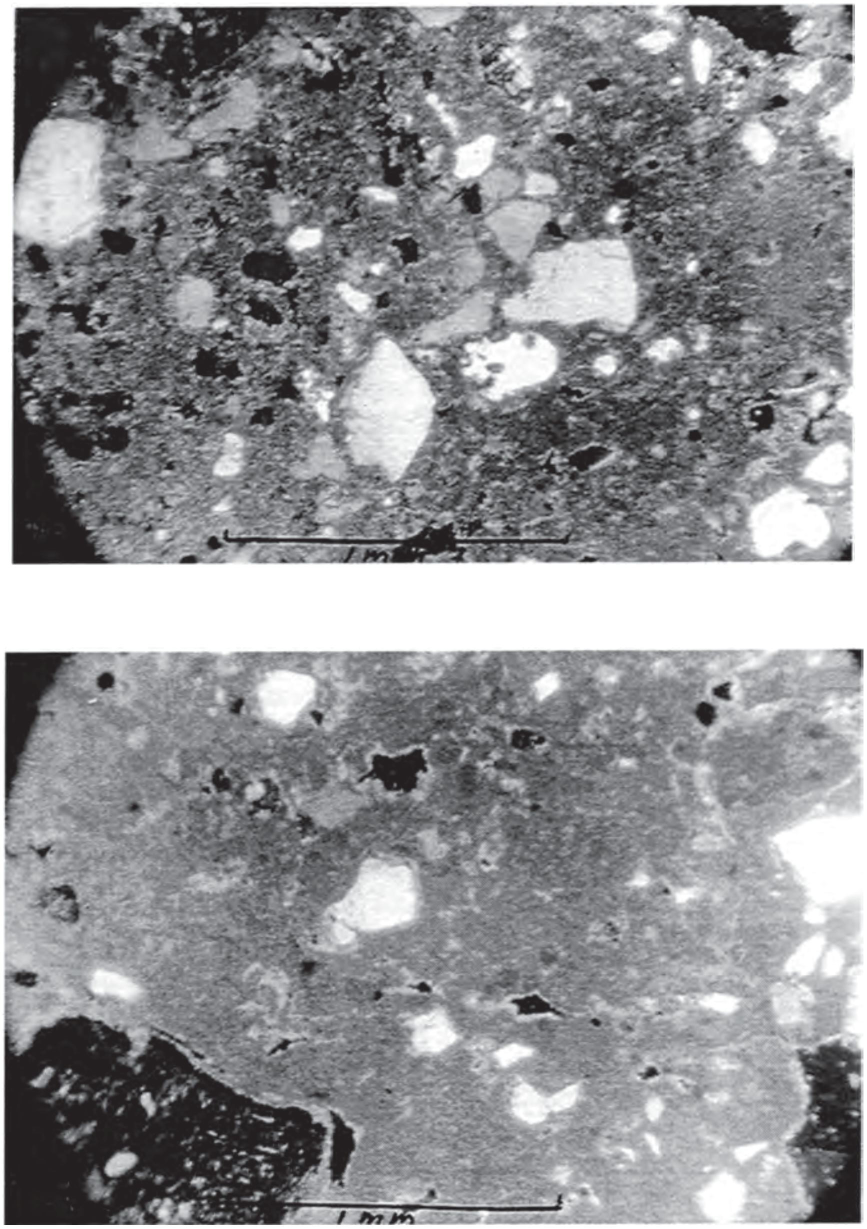


Figure 166. Upper. Thin section of K21 horizon, Dona Ana 60-6. Many allogenic grains are in or almost in contact (compare below). There are scattered pores. Most of the carbonatic fabric has a dense appearance. Crossed polarizers.

Lower. From same thin section as above, most allogenic grains are well separated by carbonate. There are few pores. The carbonate fabric has a very dense appearance. Crossed polarizers.

for Argids: the clay in the A horizon is coarser than in the B2t horizon beneath (section 93). The ratio of extractable iron to clay tends to decrease from the A horizon to the underlying B2t horizon. This may be due to the lower clay contents of the A horizons, which lead to greater influence of extractable iron associated with the sand and silt on the ratio of extractable iron to clay (section 94). In most instances over half of the carbonate in horizons with over 5 percent carbonate is of clay size (section 92). Total phosphorus ranges narrowly from 0.03 to 0.05 for the A and the B2t horizon beneath, of the three pedons analyzed. The range in the amount of organic carbon of from 3.0 to 4.7 kg/m^2 for the 7 fine-loamy pedons is not large. It shows a strong central tendency among soils of similar particle size distribution over a diversity of landscape positions.

167. HAP GRAVELLY SANDY LOAM (15MG)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
HAP	TYPIC HAPLARGIDS	FINE-LOAMY	60
Berino	Typic Haplargids	Fine-loamy	10
Bucklebar, gravelly variant	Typic Haplargids	Fine-loamy	10
Canutio, loamy subsoil variant	Typic Torriorthents	Coarse-loamy (calcareous)	10
Other inclusions (Camborthids, Calciorthids, Torriorthents, Entisols)			10

LOCATION, LANDSCAPE, VEGETATION

These soils occur west of the northern part of the Organ Mountains and the town of Organ. The soils have formed in sediments derived from monzonite. Elevation is about 4900 feet.

Low ridges are characteristic. The ridges are usually separated by arroyos or small drainageways. Slopes along ridge crests range from 3 percent in the western part of the unit to 5 percent in the eastern part.

Vegetation consists of creosotebush, tarbush, Yucca elata, Yucca baccata, snakeweed, fluffgrass, and a very few clumps of tobosa in scattered areas. Bush muhly occurs at the base of shrubs in a few spots.

TYPICAL PEDON, PROPERTIES AND RANGES

Hap

A typical pedon is described below. The location is the SE 1/4 NW 1/4 Sec. 35, T21S, R3E, about 0.2 mile east of the NASA road, north bank of arroyo. Figure 167 is a photograph of the pedon and its landscape. A table of properties and ranges follows the description.

Soil surface. About 60 percent covered with coarse fragments of monzonite, mostly from 2 mm to 3 cm in diameter but a few ranging up to 15 cm diameter.

A 0-3 cm. Brown (7.5YR 5/4, dry) or dark brown (7.5YR 3/4, moist) gravelly sandy loam; massive and weak medium platy; slightly hard; very few roots; noncalcareous; abrupt smooth boundary.

B21t 3-19 cm. Yellowish red (5YR 5/5, dry, 5YR 4/5, moist) gravelly light sandy clay loam; very weak medium and coarse subangular blocky; slightly hard; noncalcareous; few roots; sand grains coated with silicate clay; noncalcareous; clear wavy boundary.

B22tca 19-41 cm. Yellowish red (4YR 5/6, dry, 4YR 3/6, moist) gravelly light sandy clay loam; weak medium subangular blocky; hard; firmer in place than above; few roots; common carbonate filaments; some sand grains and pebbles discontinuously coated with carbonate; sand grains in low-carbonate zones stained with clay; some have patchy black (Mn? Fe?) coatings; effervesces strongly; clear wavy boundary.

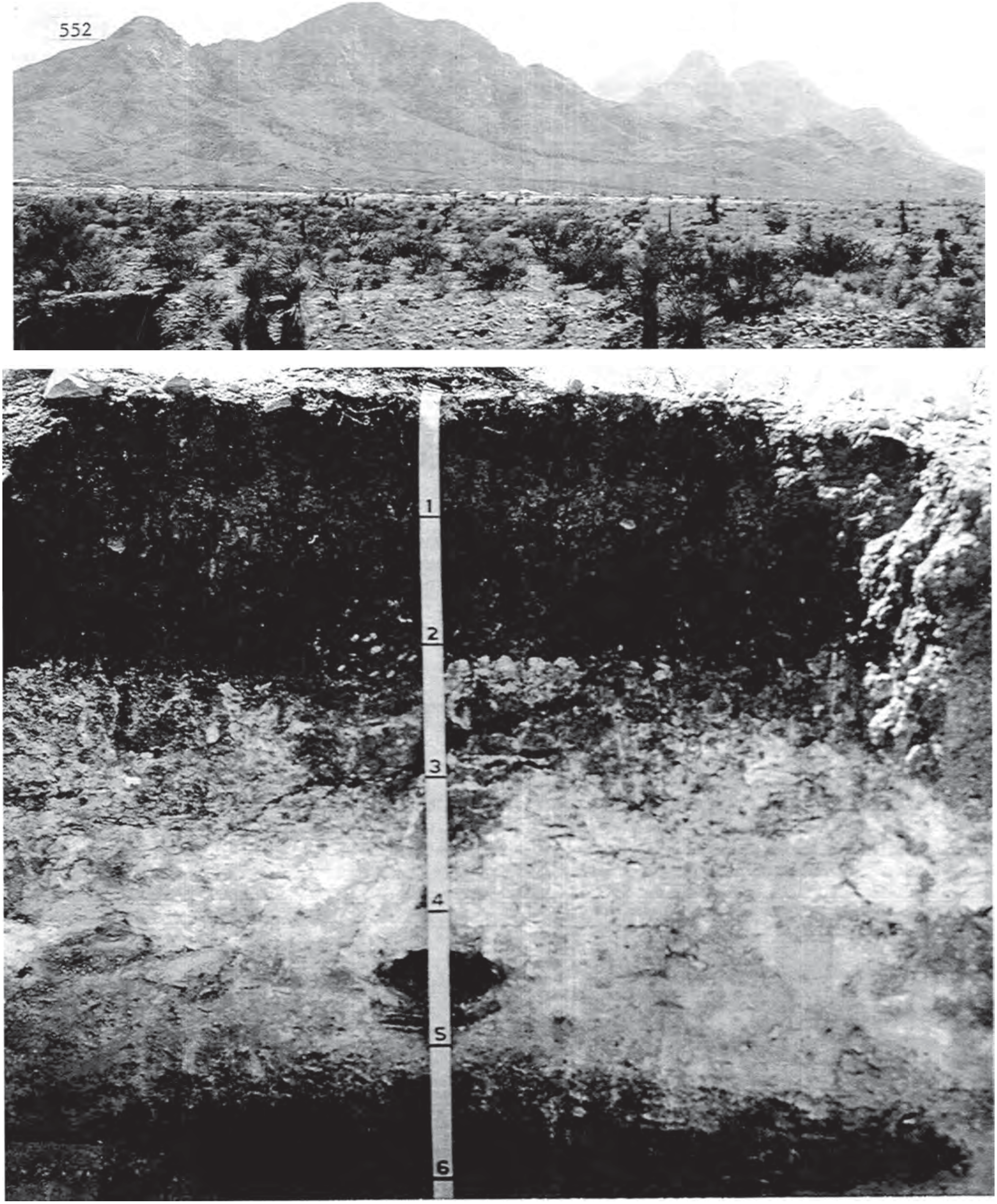


Figure 167. Upper. Landscape of a Typic Haplargid, Hap gravelly sandy loam, on the Jornada II surface. Vegetation consists of tarbush, Mormon tea, fluffgrass, *Yucca elata*, a few creosotebush, and bush muhly. Slope is 3 percent. Lower. Hap gravelly sandy loam. Scale is in feet.

B31tca 41-61 cm. Yellowish red (5YR 5/6, dry, 5YR 4/6, moist) heavy sandy loam; very weak coarse subangular blocky; very hard; very few roots; sand grains coated with silicate clay; some grains have patchy black (Mn? Fe?) coatings; a few carbonate filaments and grain coatings; most of horizon effervesces weakly, parts are noncalcareous; generally a clear wavy boundary, in places, boundary is abrupt.

B32tca 61-88 cm. Dominantly reddish brown (5YR 5/4, dry, 5YR 4/4, moist) medium sandy loam with smaller amount pink (7.5YR 8/4, dry), or light brown (7.5YR 6/4, moist), very weak medium subangular blocky; hard; very few roots; common carbonate filaments; sand grains in low-carbonate parts stained with clay; a few parts light brown (7.5YR 6/4, dry) or brown (7.5YR 5/4, moist); generally effervesces strongly, some of reddish brown parts noncalcareous; clear wavy boundary.

K2 88-126 cm. White (10YR 9/3, dry) or very pale brown (10YR 7/3, moist) medium sandy loam; massive; hard; no roots; sand grains coated with carbonate; scattered tongues and pockets, one to several inches diameter, of material, very pale brown (7.5YR 7/4, dry) or yellowish brown (7.5YR 5.5/4, moist), in which the carbonate coatings are thinner; this is the carbonate maximum and easily qualifies as a calcic horizon; effervesces strongly; clear wavy boundary.

K3 126-151 cm. Very pale brown (7.5YR 8/4, dry) or light yellowish brown (7.5YR 6/4, moist) sandy loam; massive; slightly hard; no roots, carbonate coatings on sand grains and pebbles thinner than above; effervesces strongly; clear wavy boundary.

C1ca 151-168 cm. Dominantly pink (7.5YR 6.5/4, dry) or brown (7.5YR 5/4, moist) gravelly sandy loam, with smaller amounts of carbonate-impregnated material colored white (10YR 9/4, dry) or very pale brown (10YR 7/4, moist); massive; hard; no roots; pebbles and sand grains coated with carbonate; stratification weakly apparent in places; most effervesces strongly, some brown parts effervesce weakly and a few are noncalcareous; clear wavy boundary.

C2 168-188 cm. Light brown (7.5YR 6/4, dry) or brown (7.5YR 5/4, moist) sand; massive; soft; no roots; strata of coarse sand, 1/2 to 2 cm thick, alternate with strata of finer sand; occasional black strata 1 to 5 mm thick, high in black mineral grains, some of which are magnetite; dominantly noncalcareous with a few spots and thin, light-colored lenses of carbonate along some of the coarser sand strata.

Remarks. In many areas these soils were once covered by Organ alluvium that has now been largely or wholly eroded. Buried analogues of Hap soils occur extensively beneath Organ alluvium and its soils adjacent to this mapping unit. The distribution of these soils and their erosion in many places show that they must have contributed to the parent materials of soils of Organ age downslope. Additional evidence of this is the presence of the occasional bits of allogenic, carbonate-cemented materials in the latter soils.

Table 173. Typical (underlined) and range in selected properties for major horizons of Hap.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-3	sl	0-50	5YR- 7.5YR	5,6	3,4	2-4
B2t	3-41	scl	15-35	2.5YR- 5YR	4-6 5	3-5 4	4-6
K2	88-126	sl scl	0-50	7.5YR- 10YR	6-9	5-8 7	3,4
C1ca	151-168	s ls sl	0-50	7.5YR- 10YR	5-7 6	4-6 5	3,4
Control section		scl, hv.sl	15-35				

Other. Depth to the calcic horizon (the K2 horizon of the description) ranges from 25 to 100 cm. This fairly wide depth range occurs within small areas because of soil truncation, which is common on the narrow ridges found in this mapping unit. These soils are usually noncalcareous in upper horizons. Thickness of the noncalcareous zone ranges widely (from about 0 to 50 cm) in short distances because of soil truncation. Also because of soil truncation, many A horizons have probably formed in part in a former B1 horizon.

SOIL OCCURRENCE

Haplargids. The gravelly HAP soils occupy most of the ridge crests and have commonly been variably truncated. The Bt and calcic horizons are usually present over most or all of the ridge crest. In many places, however, the Bt horizon has been truncated, exposing the calcic horizon on the lower parts of ridge sides; these are the Calciorthids noted below. Berino soils occur in scattered areas where gravel content in the control section drops below 15 percent. Bucklebar, gravelly variant lacks a calcic horizon within 1 m.

Calciorthids. Rilloso soils are located on some ridge sides and on entire portions of some narrow, strongly eroded ridges.

Camborthids. Agustin soils occur in small areas of Organ deposits adjacent to arroyos.

Entisols. SND-6 occurs in arroyo channels.

Torriorthents. Canutio, coarse-loamy variant, occurs in youngest Organ deposits along margins of arroyos.

SOIL BOUNDARIES

Table 174 gives information about boundaries to major adjacent units. Figure 168 shows boundaries and stratigraphy of some of the units.

Table 174 . Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Onite sandy loam (13MM)	The boundary has been caused by a younger alluvium and geomorphic surface (mostly Organ, with some Isaacks' Ranch) in unit 13MM. The 15MG soils, analogues of which are buried in unit 13MM (fig.168) emerge at the surface on the 15MG side of the boundary. The boundary to unit 13MM is not well marked on the landscape. Generally unit 15MG contains more shrubs (creosotebush, tarbush, *Yucca baccata*) than unit 13MM (which typically has Mormon tea, *Yucca elata* and prickly pear) but in places--particularly on narrow ridges in unit 13MM--the shrubs are similar in both.
Aladdin gravelly sandy loam (13MO)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 13MO. Also, the landscape in 13MO is less dissected; this factor and the age difference determines the location of the boundary. The 15MG soils, analogues of which are buried in unit 13MO, emerge at the surface on the 15MG side of the boundary. The boundary to unit 13MO is not distinct topographically, but commonly is marked by a lesser degree of landscape dissection; narrow ridges are less prominant in unit 13MO. Vegetatively the boundary is marked by a shift from mostly creosotebush, tarbush, *Yucca baccata*, fluffgrass, and snakeweed (unit 15MG) to Mormon tea, snakeweed, *Yucca elata* and fluffgrass (unit 13MO).

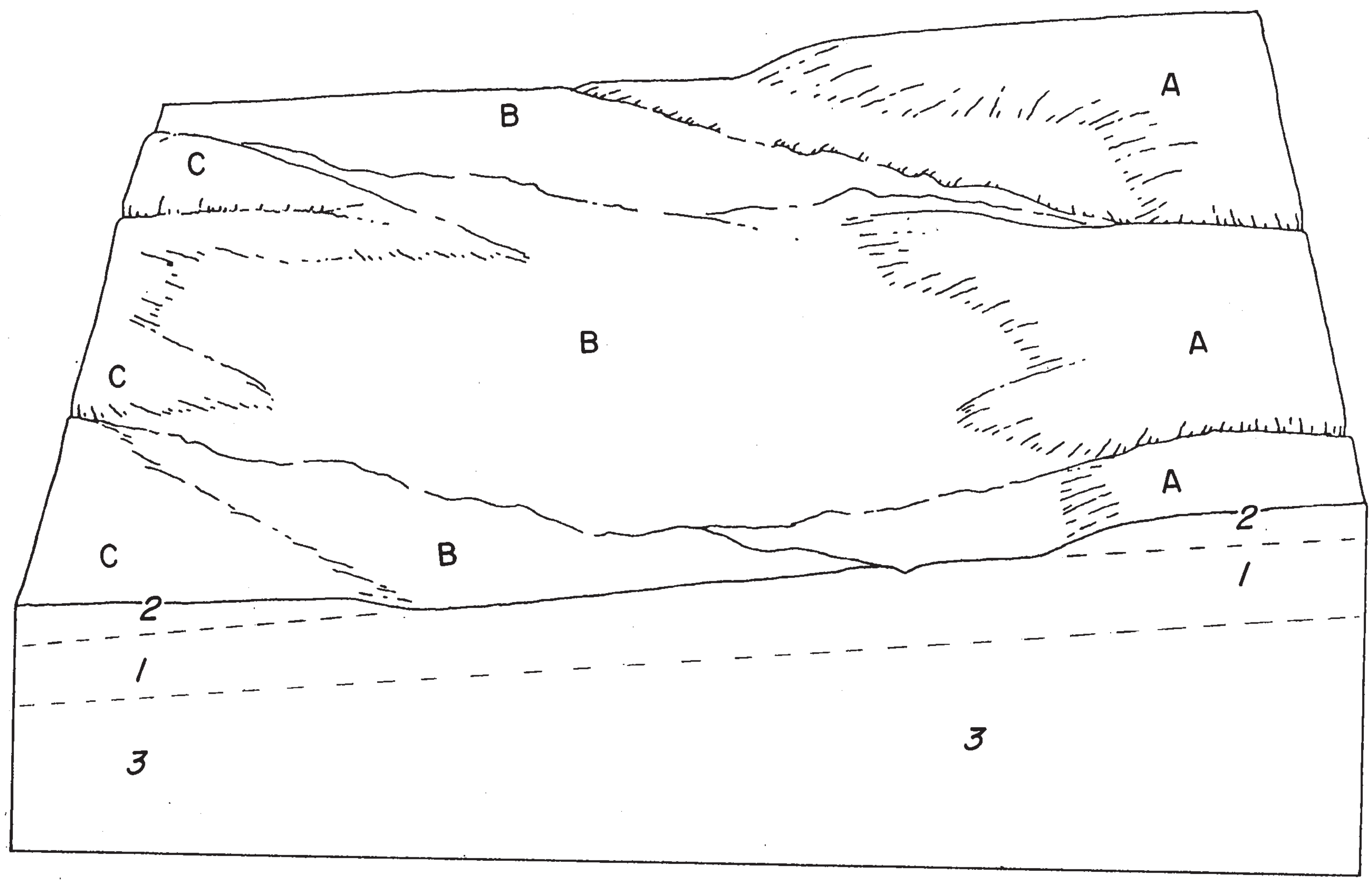


Figure 168. Block diagram of soil-landscape relations and soil stratigraphy in an area of Onite sandy loam, Hap gravelly sandy loam, and Aladdin gravelly sandy loam. A = Aladdin gravelly sandy loam (Organ surface). B = Hap gravelly sandy loam (Jornada II surface). C = Onite sandy loam (Organ surface). 1 = Jornada II alluvium and soils. 2 = Organ alluvium and soils. 3 = Upper Camp Rice Formation (piedmont facies).

168. BERINO SANDY LOAM (15MA)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
BERINO	TYPIC HAPLARGIDS	FINE-LOAMY	75
Bucklebar	Typic Haplargids	Fine-loamy	10
Onite	Typic Haplargids	Coarse-loamy	10
Stellar	Ustollic Haplargids	Fine	5

LOCATION, LANDSCAPE, VEGETATION

These soils occur north of the Dona Ana Mountains. The soils have formed in alluvium derived from monzonite. Elevations range from about 4300 to 4600 feet.

The soils occur on alluvial fans and the fan-piedmont. The soils are undissected by arroyos; there are a few gullies and waterways. Slopes range from 2 percent nearest the mountains to 1 percent on the lowest part of the fan-piedmont.

Vegetation consists mainly of fluffgrass, Mormon tea, mesquite, and in a few areas, there are scattered clumps of tobosa.

TYPICAL PEDON, PROPERTIES AND RANGES

Berino

A typical pedon of Berino is described in the Appendix (pedon 60-7). A table of properties and ranges is given in section 166.

SOIL OCCURRENCE

Soils of this mapping unit are similar to the soils in the same series described in the Berino-Bucklebar association and are not discussed in detail here. The mapping unit differs from the Berino-Bucklebar association in the number and proportion of soils.

Haplargids. The fine-loamy BERINO soils occur over most of the fan-piedmont. Bucklebar soils, also fine-loamy but lacking a calcic horizon within 1 m occur only in a few places. The coarse-loamy Onite soils occur in scattered areas of Organ deposits. Stellar soils occur in a few places on gentlest slopes of the lower fan-piedmont.

169. DONA ANA-ALGERITA COMPLEX (16M)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ALGERITA	TYPIC CALCIORTHIDS	COARSE-LOAMY	25
DONA ANA	TYPIC HAPLARGIDS	FINE-LOAMY	35
PINTURA, THIN VARIANT	TYPIC TORRIFLUVENTS	COARSE-LOAMY	15
Berino	Typic Haplargids	Fine-loamy	10
Jal	Typic Calciorthids	Coarse-loamy, carbonatic	5
Pintura	Typic Torripsamments		10

LOCATION, LANDSCAPE, VEGETATION

These soils occur in scattered places east of the valley and north of the Dona Ana Mountains. Most of the soils have formed in sediments derived mainly from monzonite, with smaller amounts of andesite and rhyolite. Elevations range from about 4300 to 4700 feet.

The soils occur on a broad, coalescent alluvial-fan piedmont. There are a few gullies and small drainageways but no arroyos. Slope is 1 percent over most of the area but is almost level near the basin floor.

Most of the vegetation is on dunes and consists mainly of mesquite in places with four-wing saltbush and a few creosotebush. Interdune areas are barren or contain a few snakeweed, creosotebush or tarbush.

TYPICAL PEDONS, PROPERTIES AND RANGES

The A horizon has been partly or wholly truncated in many places, and the B horizon is at or very near the surface. Buried soils commonly underlie these soils and in many places buried argillic horizons have been partly carbonate-engulfed by pedogenesis associated with Jornada II time.

Algerita

A typical pedon of Algerita is described below. The location is the NE 1/4 Sec. 23, T22S, R2E. Figure 169 is a photograph of the pedon and its landscape. Following the description a table of properties and ranges is given.

Soil surface. A few fine pebbles and sand grains are scattered over the surface.

A 0-5 cm. Reddish brown (6YR 5/4, dry, 6YR 4/4, moist) fine sandy loam; weak medium platy and single grain; soft and loose; effervesces strongly; abrupt smooth boundary.

B21ca 5-25 cm. Brown (7.5YR 5/4, dry) or brown to dark brown (7.5YR 4/4, moist) heavy fine sandy loam; massive; soft to slightly hard; roots common; carbonate filaments and flakes on sand grains common; few fine carbonate nodules;

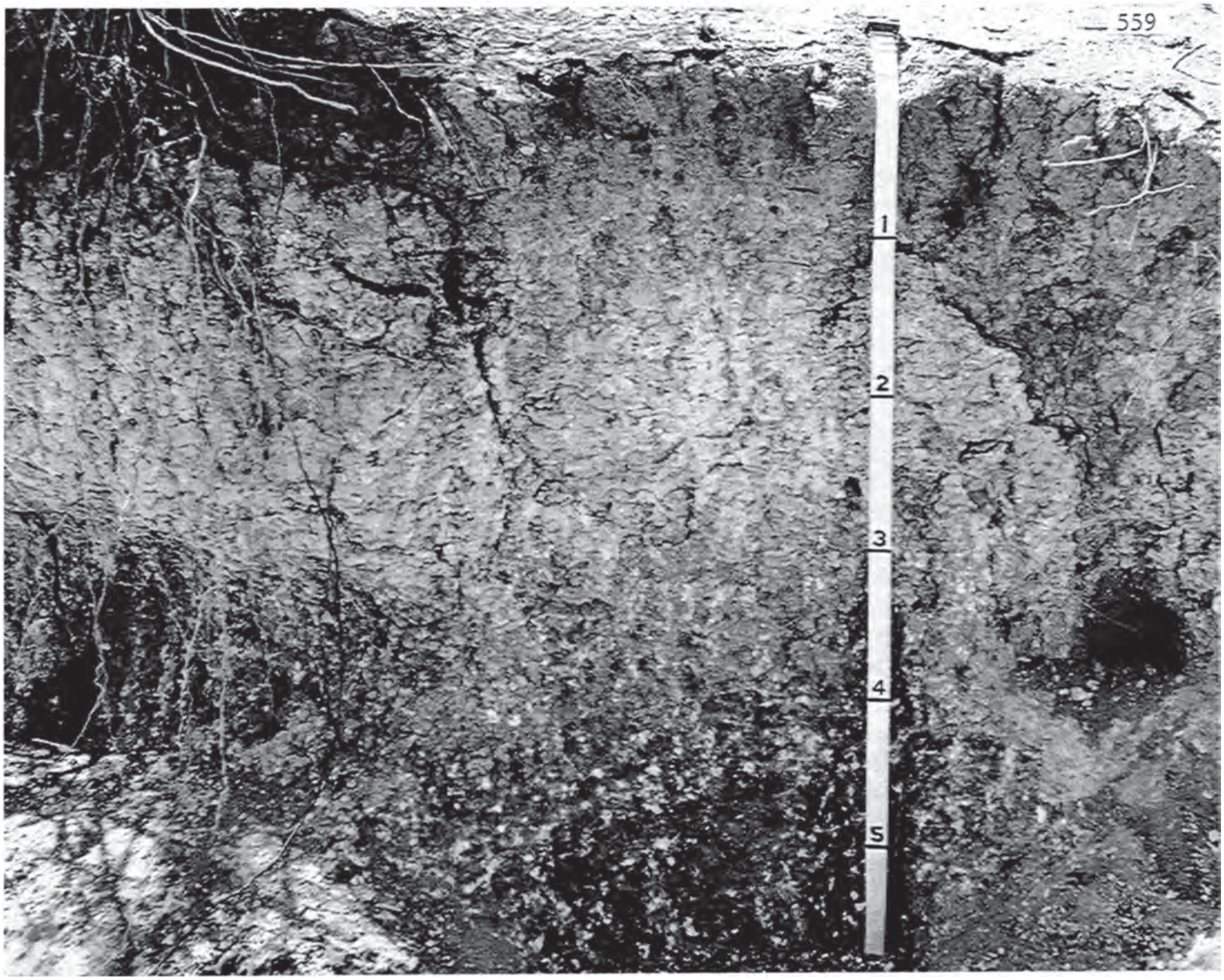


Figure 169. Algerita sandy loam, a Typic Calciorthid. Scale is in feet.

effervesces strongly; clear wavy boundary.

B22ca 25-41 cm. Matrix light brown (7.5YR 6/4, dry) or brown (7.5YR 4.5/4, moist) fine sandy loam; massive; soft; roots common; medium pinkish white (7.5YR 8/2, dry) and light brown (7.5YR 6/4, dry) carbonate nodules common; carbonate in matrix occurs as flakes on sand grains and as common filaments, and effervesces strongly; clear wavy boundary.

K2 (C1ca) 41-89 cm. White (7.5YR 9/2, dry) or pinkish white (7.5YR 8/4, moist) to pink (7.5YR 7.5/4, dry) or light brown (7.5YR 5.5/4, moist) clay loam; moderate medium and coarse subangular blocky; very hard; few roots; material difficultly removed from horizon; many carbonate nodules, a few of which are strongly indurated; carbonate coatings on sand grains, and along cleavage planes; effervesces strongly; clear wavy boundary.

K31 (C2ca) 89-112 cm. White (7.5YR 9/2, dry) and pink (7.5YR 8/4, moist) to reddish brown (5YR 5.5/4, dry) and reddish brown (5YR 4/4, moist) sandy clay loam; moderate medium subangular blocky; very hard; very few roots; relatively loose in place; many very hard nodules and cylindroids; effervesces strongly; clear wavy boundary.

K32 (C3ca) 112-140 cm. Light reddish brown (5YR 5.5/4, dry) and reddish brown (5YR 4.5/4, moist) and light brown (7.5YR 6.5/4, dry) or brown (7.5YR 5/4, moist) sandy clay loam; weak medium angular to subangular blocky; hard and very hard; very few roots; common white (7.5YR 8/1, dry) nodules and cylindroids; few carbonate flakes on sand grains in matrix; effervesces weakly and strongly.

Table 175. Typical (underlined) and range in selected properties for major horizons of Algerita.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	sl	0-20	5YR-7.5YR 6YR	5,6	4,5	2-4
B2	5-41	sl scl	0-15	7.5YR	5,6	4,5	3,4
K2	41-89	scl cl	0-15	7.5YR-10YR	6-9	5-8	2-4
Control section		scl,cl	0-15				

Other. Silicate clay averages less than 18 percent in the control section, but texture averages sandy clay loam or clay loam, partly because of large amounts of carbonate clay and silt. Depth to the calcic horizon (the K horizon in the description) is usually from 20 to 50 cm, ranging to 100 cm. These soils are calcareous throughout. The K horizons are 1 to 2 m thick in some areas where Jornada II alluvium is thin. In these places the K horizon of Jornada II age has formed partly in the argillic horizon of the buried soil and has merged with the buried K horizon.

Dona Ana

A typical pedon of Dona Ana is described in the Appendix (pedon 60-6). A table of properties and ranges is given below.

Table 176. Typical (underlined) and range in selected properties for major horizons of Dona Ana.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	13-28	<u>sl</u> hv.sl	0-5	<u>5YR</u>- 7.5YR	<u>5</u>,6	<u>4</u>,5	2-<u>4</u>
B2t	28-51	<u>scl</u> cl hv.sl	0-5	2.5YR- <u>5YR</u>	<u>5</u>,6	<u>4</u>,5	<u>4</u>-6
K2	64-142	<u>scl</u> cl sl	0-50	<u>5YR</u>- 10YR	6-9 <u>8</u>	5-8 <u>6</u>	2-<u>4</u>
Control section			0-5				

Other. Depth to the calcic horizon (the K horizon in the description) ranges from 25 to 100 cm. These soils are usually calcareous throughout but range to noncalcareous in the upper several cm. All subhorizons of the Bt horizon contain some macroscopic carbonate. The K horizon is only about 1/2 to 1 m thick in some areas, but is 1-1/2 to 2 m thick in other places. This is because Jornada II alluvium thins in many areas downslope, particularly on lower slopes near the basin floor--and the K horizon of Jornada II age has formed partly in the argillic horizon of the buried soils (Jornada I).

Pintura, thin variant

Pintura, thin variant is similar to pedon 68-1 (Appendix) except that the sandy materials are between 50 and 100 cm thick.

SOIL OCCURRENCE

The occurrence of the Aridisols is determined by the presence of the argillic horizon, which in places has been obliterated by soil fauna, or has been truncated. The Torripsamments occur in coppice dunes, and Torrifluvents in the low dunes and horizons just beneath.

Haplargids. The fine-loamy DONA ANA soils, which have some visible carbonate in all subhorizons, and the fine-loamy Berino soils, which do not, occur in stablest areas away from drainageways and scarps.

Calciorthids. The coarse-loamy Algerita soils occur in steeper parts of the mapping unit. Jal soils occur in some of the nearly level areas west of the junction of the Highway 70 and Jornada Road. The control section of the Jal soils averages more than 40 percent carbonate.

Torripsamments. Pintura soils occur in dunes that have sand textures to a depth of at least 1 m.

Torrifluvents. Pintura, thin variant occurs where dune sand is from 50 cm to 100 cm thick; irregular decrease of organic carbon is caused by the buried soil, the top of which is at a depth of from 50 to 100 cm.

SOIL BOUNDARIES

Table 177 gives information about boundaries to adjacent major units.

Table 177. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Berino-Bucklebar association (15M)	The boundary is due to a slight increase in soil truncation in unit 16M. The topographic boundary is not distinct but does tend to approximately parallel the arroyos.
Algerita complex (16MA)	The boundary has been caused by a marked increase in landscape dissection and soil truncation. Bt horizons once present have been eroded, and only thin A and/or B horizons remain above a calcic horizon. The topographic boundary is distinct. The landscape changes from one that is nearly level transversely to one dominated by ridges.

170. DONA ANA FINE SANDY LOAM (16LS)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
DONA ANA	TYPIC HAPLARGIDS	FINE-LOAMY	70
Algerita	Typic Calciorthids	Coarse-loamy	10
Headquarters	Ustollic Haplargids	Fine-loamy	10
Jal	Typic Calciorthids	Coarse-loamy, carbonatic	10

LOCATION, LANDSCAPE, VEGETATION

These soils occur in one area west of the San Andres Mountains and just east of the basin floor. The soils have formed in sediments derived mainly from limestone, calcareous sandstone and shale, with smaller amounts of granite, quartzite, andesite and rhyolite. Elevations range from about 4300 to 4350 feet.

The soils occur on the lower part of the coalescent alluvial-fan piedmont. Slopes are level or nearly level transversely. These are scattered minor drainageways but no large gullies or arroyos. Slope is 1 percent to the west.

Snakeweed, *Yucca elata*, fluffgrass, tarbush, and occasional clumps of burrograss, tobosa, and alkali sacaton are the dominant vegetation. Barren areas are common.

TYPICAL PEDON, PROPERTIES AND RANGES

These soils are calcareous throughout and have formed in thick deposits with no bedrock or petrocalcic horizon within a depth of many m. Buried soils occur in places.

Dona Ana

A typical pedon of Dona Ana is described in the Appendix (pedon 65-5). Figure 170 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

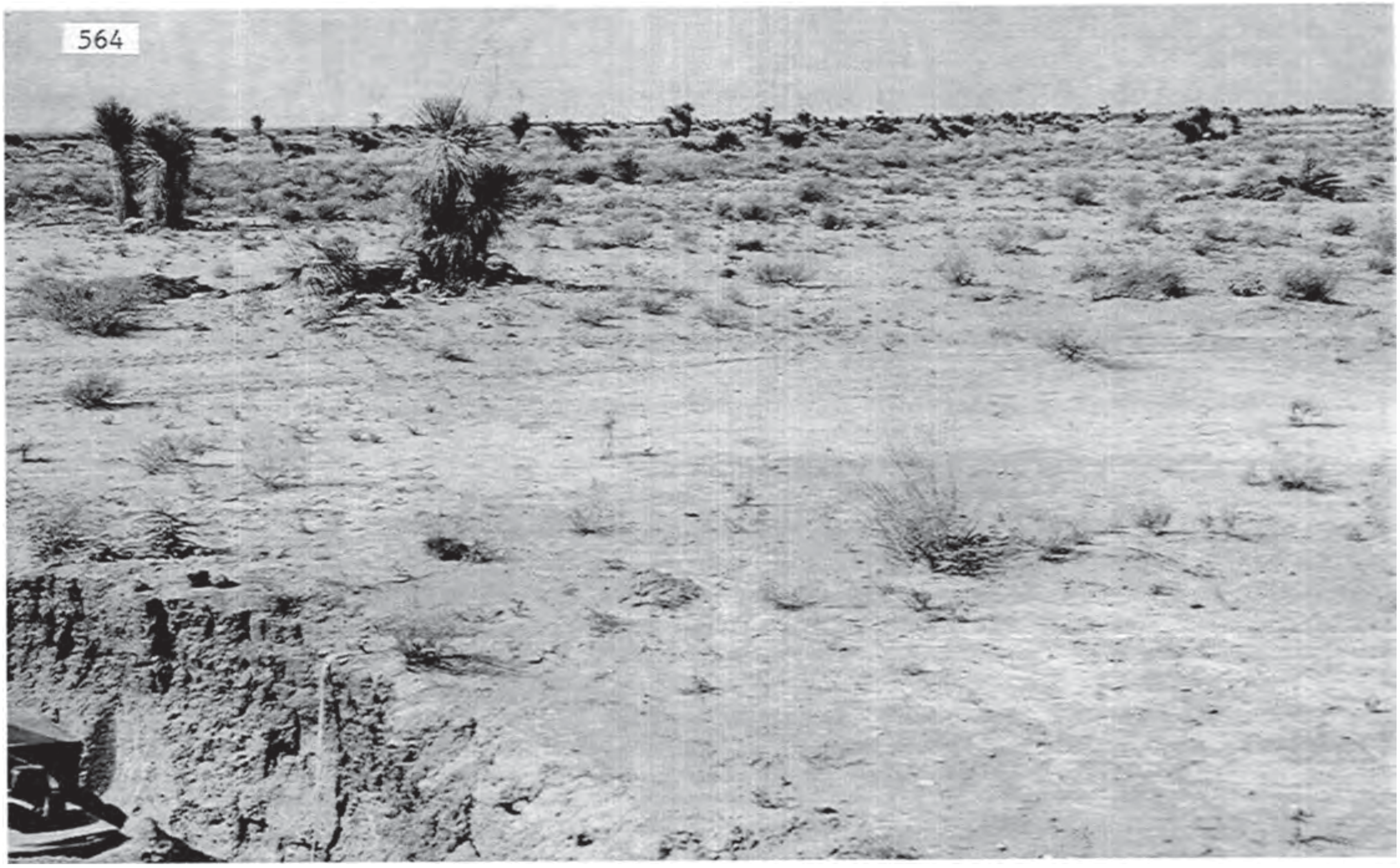


Figure 170. Upper. Landscape of a Typic Haplargid, Dona Ana 65-5, on the Jornada II surface. Vegetation is fluffgrass, tarbush, and a few Yucca elata. Slope is 1 percent.

Lower. Dona Ana 65-5. Scale is in feet.

Table 178. Typical (underlined) and range in selected properties for major horizons of Dona Ana.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-4	sl	0-15	5YR- 7.5YR	6	5	2-4
B2t	13-41	hv.sl scl	0-15	2.5YR- 5YR	5,6 5.5	3.5-4	4-6
K2	56-114	cl scl	0-35	7.5YR- 10YR	6-9	5-8	2-4
Control section		hv.sl,scl	< 15				

Other. Depth to the calcic horizon (the K horizon in the description) ranges from 25 to 75 cm. In places the A horizon has been eroded and the B horizon is at the surface.

SOIL OCCURRENCE

Haplargids. The fine-loamy Dona Ana soils occur over most of the area. Headquarters soils, Ustollic Haplargids, occur in a few places where textures of the A and upper B horizons are finer (sandy clay loam or clay loam) and organic carbon is higher.

Calciorthids. The coarse-loamy Algerita soils are found in places where upper horizons have been truncated; places in which the argillic horizon has been mixed by biota or engulfed by carbonate; and in spots in which the parent materials may have contained somewhat more carbonate, thus retarding development of the argillic horizon. Jal soils are similar but average more than 40 percent carbonates in the 25 to 100 cm control section.

SOIL BOUNDARIES

Table 179 gives information about boundaries to major adjacent units. Figure 171 shows some of the boundaries.

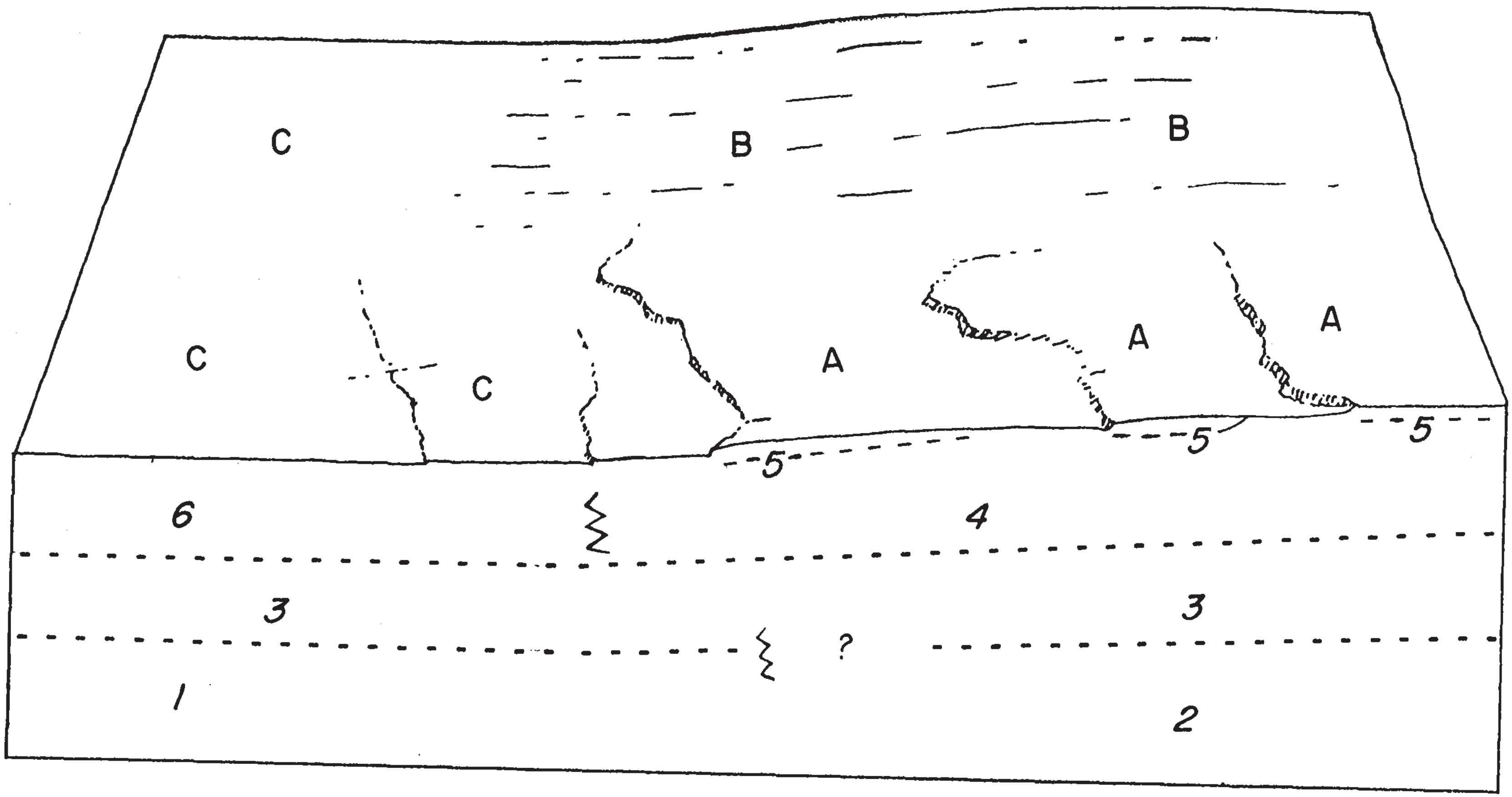


Figure 171. Block diagram of soil-landscape relations and soil stratigraphy in an area of Reagan clay loam, Dona Ana fine sandy loam, and Algerita sandy clay loam. A = Algerita sandy clay loam (Jornada II and Organ surfaces). B = Dona Ana fine sandy loam (Jornada II surface). C = Reagan clay loam (Petts Tank surface). 1 = Upper Camp Rice Formation, fluvial facies (ancient river alluvium). 2 = Upper Camp Rice Formation (piedmont facies). 3 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 4 = Jornada II alluvium and soils. 5 = Organ alluvium and soils. 6 = Petts Tank sediments and soils.

Table 179. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Algerita sandy clay loam (16L)	The boundary has been caused by an increase in clay and a decrease in sand in soils of unit 16L. Topographically the boundary is not prominent, but the soils of unit 16LS do occur on a very slight topographic high between areas of unit 16L. Vegetatively the boundary is marked by a shift from mostly *Yucca elata*, snakeweed and tarbush, with a few scattered spots of burro grass and tobosa, and extensive barren areas (unit 16LS) to extensive stands of tobosa, burro grass and tarbush (unit 16L).
Reagan clay loam (51)	The boundary has been caused by a substantial increase in silt and clay in soils of unit 51, due to gentler slopes in the latter area and resultant deposition of finer parent materials. The boundary is topographically distinct, occurring between the eastern side of the basin floor (which slopes from 0 to 1/2 percent) and the western margin of the fan piedmont, which slopes about 1 percent. Vegetatively the boundary changes from the 16LS assemblage noted above, to mostly burro grass in unit 51.

171. DONA ANA SANDY CLAY LOAM (16VG)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
DONA ANA	TYPIC HAPLARGIDS	FINE-LOAMY	65
Berino	Typic Haplargids	Fine-loamy	5
Casito	Petrocalcic Ustollic Paleargids	Loamy-skeletal, shallow	5
Hap	Typic Haplargids	Fine-loamy	10
Headquarters	Ustollic Haplargids	Fine-loamy	5
Tres Hermanos	Typic Haplargids	Fine-loamy	10

LOCATION, LANDSCAPE, VEGETATION

These soils are located in large areas east of the Dona Ana Mountains. The soils have formed in alluvium derived from rhyolite, monzonite, andesite and latite; in a few places there are minor amounts of limestone. Elevations range from about 4300 to 4400 feet.

The soils occur on a broad, coalescent alluvial-fan piedmont. There are scattered small drainageways up to 1 to 2 dm deep between shrubs and a few gullies up to about a 4 dm deep. Thin deposits, ranging from a few cm to about 1/2 m in thickness are common in places, particularly along mountainward parts of the mapping unit. Slopes range from about 1 to 2 percent.

Vegetation consists mainly of tarbush, creosotebush and desert thorn; scattered clumps of tobosa occur in a few places.

TYPICAL PEDON, PROPERTIES AND RANGES

A typical pedon of Dona Ana is described in the Appendix (pedon 61-4). Figure 172 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

Table 180. Typical (underlined) and range in selected properties for major horizons of Dona Ana.

Horizon	Depth cm	Particle Size 2mm	Particle Size 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	sl	0-15	5YR-7.5YR	6	4	2-4
B2t	5-33	scl	0-15	2.5YR-5YR	5,6	3,4	4-6
K2	51-97	scl	0-50	5YR-7.5YR	6-9 8	5-8 6	1-5 4
Control section		scl	< 15				

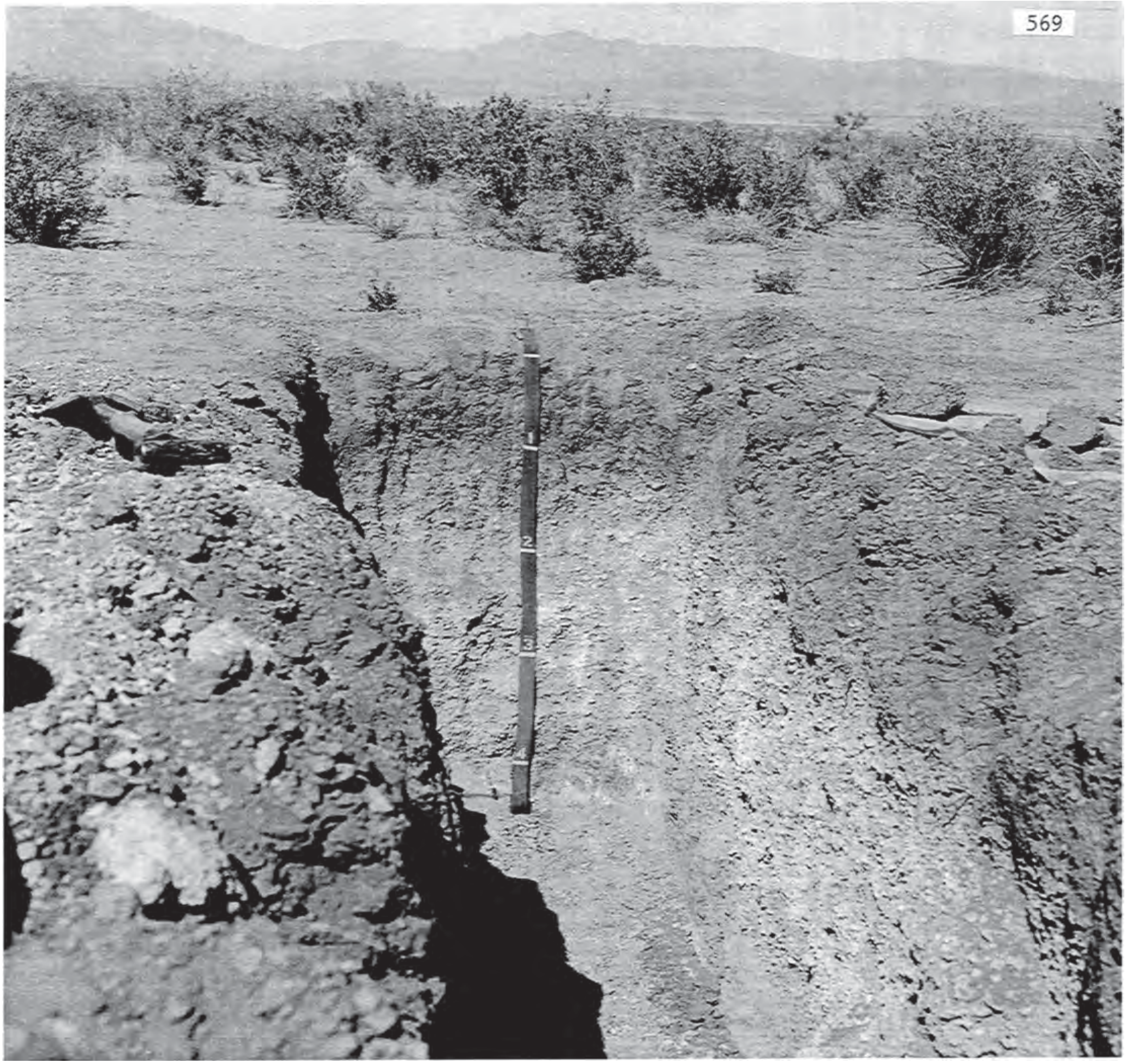


Figure 172. A Typic Haplargid, Dona Ana 61-4. Vegetation is tarbush, desert thorn, a few Mormon tea, and scattered clumps of tobosa grass. While the surface is barren between many of the shrubs, there is evidence that this area once had a grassy cover. This evidence consists of a few scattered clumps of tobosa and a few eroded bases of clumps still present in places. These areas grade to the much more continuous grassy cover on the Stellar soils at lower elevations. Drainageways are common and indicate soil truncation. Slope is 1 percent.

Other. Depth to the calcic horizon (the K horizon in the description) ranges from 20 to 75 cm.

SOIL OCCURRENCE

Haplargids. The fine-loamy DONA ANA soils occupy most of the area. The fine-loamy Berino soils occur in a few places and have argillic horizons that are free of macroscopic carbonate in their upper parts. The fine-loamy Headquarters soils, Ustollic Haplargids, occur in a few of the stablest, finer-textured areas and have more organic carbon than in Dona Ana soils. The fine-loamy Tres Hermanos soils have argillic horizons that are gravelly throughout and occur mainly in the steeper parts of the slope range. The Hap soils are similar but lack visible carbonate in all subhorizons of the Bt horizon.

Paleargids. The loamy-skeletal Casito soils occur in places on the steeper parts of the slope range and have petrocalcic horizons at shallow depths.

SOIL BOUNDARIES

The boundaries are generally not topographically prominent. This is because of the relatively small size and low elevations of the Dona Ana Mountains as a source of sediments; the land forms are not as prominent as they are downslope from the Organ and San Andres Mountains. Table 181 presents information about boundaries to major units. Figure 173 shows the boundaries and stratigraphy of some of the units.

Table 181. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Casito-Terino complex (12V)	The boundary has been caused by an increase in the percentage of coarse fragments in unit 12V. The topographic boundary is not distinct but slopes do tend to be greater in unit 12V, increasing to about 3 percent.
Anthony complex (13ML,13V, 13L) and Tres Hermanos-Onite complex (14V)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in the (13ML,13V,13L) and 14V units. The 16VG soils, analogues of which are buried in the (13ML,13V,13L) and 14V units, emerge at the surface on the 16VG side of the boundary. The topographic boundaries are not distinct, but are marked by a general slope increase to about 3 percent in the (13ML,13V,13L) and 14V units, and in places by a slight ridged appearance.
Stellar clay loam (16V)	The boundary has been caused by gentler slopes and more clay in soils of unit 16V. The boundary is marked topographically by a decrease in slope from 2 percent in unit 16VG to about 1 percent in unit 16V. Vegetatively the boundary is marked by a change from substantial amounts of tobosa in unit 16V to little or none in unit 16VG.
Stellar clay loam, overflow (55)	The boundary is due to a change in landscape position (fan-piedmont to basin floor) which causes a change in parent materials (to clay) and increases effective moisture in unit 55. Eastward, in and near the lowest part of the basin floor, there is emergence or near-emergence at the surface of older (Jornada I) soils. These soils have similar textures to soils nearer the boundary but have much thicker horizons of carbonate accumulation. Topographically the boundary is fairly distinct, occurring near the border between the basin floor and the fan-piedmont at a point where slopes steepen to more than about 1/2 percent (usually slopes change rather abruptly to about 2 percent in unit 16VG). Vegetatively the boundary is marked by a change from mostly creosotebush and tarbush (unit 16VG) to dominantly tobosa (unit 55).

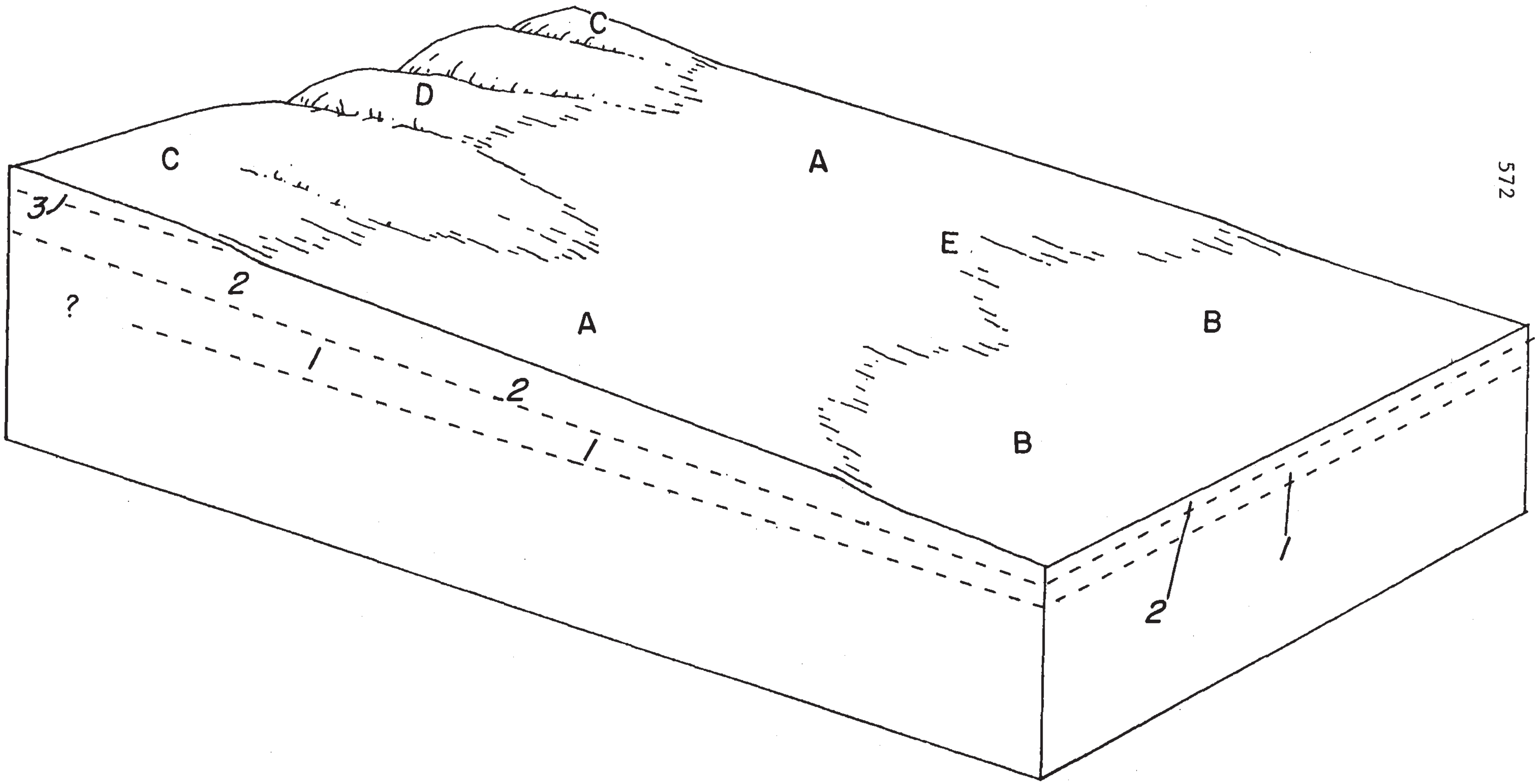


Figure 173. Block diagram of soil-landscape relations and soil stratigraphy in an area of Tres Hermanos-Onite complex, Dona Ana sandy clay loam, and Stellar clay loam. The stratigraphic and general landscape position of Onite variant 61-5 and Dona Ana 61-4 are indicated. A = Dona Ana sandy clay loam (Jornada II surface). B = Stellar clay loam (mostly Jornada II; Jornada I very near the surface at extreme right). C = Tres Hermanos-Onite complex (Organ surface). Tres Hermanos occurs where Organ alluvium is very thin. D = Onite variant 61-5. E = Dona Ana 61-4.
1 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 2 = Jornada II alluvium and soils. 3 = Organ alluvium and soils.

OTHER STUDIES: SOILS OF THIN DEPOSITS EAST OF THE DONA ANA MOUNTAINS

The Dona Ana Mountains are low compared to the San Andres and Organ Mountains; the highest peak (Dona Ana) is only 5829 ft (1776 m) high. Because of the small size of these mountains, lesser precipitation and resultant low energy and sediment source, the land forms are not prominent. Nevertheless, deposits and soils of the various ages downslope from other mountains are also present here. Alluviums associated with the various surfaces tend to be thin for the reasons noted above, and buried soils are quite close to the surface in many areas. Three pedons were sampled in and adjacent to this mapping unit. Laboratory data are in table 182.

Arizo 61-6 is the youngest and easternmost of the three pedons, and may be only a few decades old. It occurs in late phase Organ alluvium near the south edge of a small arroyo, in the eastern part of the mapping unit. The distinct strata and their smooth boundaries indicate that little soil mixing has taken place. The pedon has an irregular distribution of organic carbon and would be a Torrifluvent if textures were finer. Relatively high carbonate contents throughout (table 182) indicates more carbonate than is common in materials derived from the igneous rocks upslope. The parent materials were probably derived in part from dissected soils of the Nickel-Delnorte complex only a short distance upslope. The latter soils are strongly calcareous throughout and their calcic and petrocalcic horizons have been eroded in many places.

Onite variant 61-5 is the central of the three pedons and is located on a slight ridge of earlier Organ age. The silicate clay and carbonate accumulations (table 182) are typical for soils of this age. The buried soil at 86 cm is in Jornada II alluvium and has prominent argillic and calcic horizons. The buried soil contains appreciable soluble salts (table 182) as evidenced by electrical conductivities of 5 and above (refer to section 157 for additional discussion of soluble salts). A distinct increase occurs at the boundary. Only a few m away, in a drainageway where Organ alluvium has been truncated it is so thin that classification is based on the buried soil. The buried soil emerges at the land surface downslope as discussed later.

Dona Ana 61-4 is the land-surface analogue of the buried soil in Onite variant 61-5. In land-surface position the soil has low soluble salts. Apparently, salts in pedon 61-5 moved through the horizons of Organ alluvium and accumulated in the underlying soil. Dona Ana 61-4 also has a buried soil (in Jornada I alluvium) which emerges at the land surface still farther down the slope (section 193).

Dona Ana 61-4 is calcareous throughout, and the argillic horizon contains some macroscopic carbonate in all subhorizons. This is attributed partly to texture (which is finer than Onite 61-5, and should decrease infiltration rates), occurrence in a runoff landscape position, and calcareous runoff waters from the dissected Calciorthids and Paleorthids upslope. Laboratory analyses and morphology (table 182) indicate that the argillic horizon once extended deeper but has since been engulfed by carbonate. Organic carbon values are not quite enough for the Ustollic subgroups. Prior to deterioration of the grassy cover and subsequent erosion, some of these soils might have had enough organic carbon for the Ustollic Haplargids.

Table 182. Laboratory data for one Typic Torriorthent and two Typic Haplargids east of the Dona Ana Mountains.

Alluvium	Horizon	Depth	Sand[1/]	Clay[1/]	Volume > 2 mm	Carbonate	Electrical conductivity	Organic carbon
		cm	pct	pct	pct	pct	mmho/cm	pct
	Typic Torriorthent (Arizo 61-6)							
Organ	A	0-8	69	5	15	0.7		0.18
	C1ca	8-33	76	8	25	3		0.21
	2C2ca	33-56	73	10	15	2		0.28
	3C3ca	56-74	78	8	45	3		
	4C4ca	74-112	92	4	40	2		0.08
	Organic carbon, 2.3 kg/m^2 to 112 cm							
	Typic Haplargid (Onite variant 61-5)							
Organ	A	0-8	64	12	5	0.3	0.5	0.27
	B21t	8-15	64	16	15	-	0.5	0.24
	B22t	15-23	68	14	15	0.6	0.5	0.20
	C1ca	23-36	69	12	20	3	0.9	0.19
	C2ca	36-61	70	13	25	3	2	0.16
	C3ca	61-86	80	10	45	3	3	0.10
Jornada	2B2tcab	86-112	65	20	40	tr	6	0.09
II	3B2tcab	112-124	51	24	10	2	5	
	3Ccab	124-145	54	25	20	25		
	Organic carbon, 1.8 kg/m^2 to 112 cm							
	Typic Haplargid (Dona Ana 61-4)							
Jornada	A	0-5	70	17	5	0.7	0.5	0.31
II	B21tca	5-15	65	22	5	3.4	0.3	0.45
	B22tca	15-33	44	34	10	13	0.5	0.58
	2K1	33-51	50	35	35	37	0.9	0.51
	2K21	51-81	74	15	35	37	1.5	0.16
	2K22	81-97	72	9	40	29	0.8	0.08
Jornada	3B1tcab	97-107	64	18	5	11	0.7	0.22
I	3B2tcab	107-119	52	30	3	21	0.7	
	3K2b	119-142	52	30	3	44	0.9	
	Organic carbon, 3.4 kg/m^2 to 97 cm							

1/ Carbonate-free basis.

172. ALGERITA SANDY CLAY LOAM (16L)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ALGERITA	TYPIC CALCIORTHIDS	COARSE-LOAMY	25
HEADQUARTERS	USTOLLIC HAPLARGIDS	FINE-LOAMY	20
REAGAN, LIGHT SUBSOIL VARIANT	USTOLLIC CALCIORTHIDS	FINE-LOAMY	20
Dona Ana	Typic Haplargids	Fine-loamy	5
Glendale	Typic Torrifluvents	Fine-silty	10
Jal	Typic Calciorthids	Coarse-loamy, carbonatic	10
Other inclusions (Paleargids, Paleorthids, Calciorthids)			10

LOCATION, LANDSCAPE, VEGETATION

These soils occur in several large areas east of the basin floor, on the lower piedmont slopes west of the San Andres Mountains. The soils have formed in sediments derived mainly from limestone, sandstone, siltstone and shale, with smaller amounts of granite, andesite, quartzite, and rhyolite. Elevations range from about 4300 to 4500 feet.

The soils occur on a broad, coalescent alluvial-fan piedmont. Broad, gently sloping drainageways occur in places, range up to 1/2 mi in width, and are level or nearly level transversely. The drainageways extend westward towards the basin floor. Between drainageways are slightly higher (several m) very gentle ridges. In many areas there are common scarps ranging from a few cm to nearly one m in height. The scarps are commonly cut in the Organ (Holocene) mantle, and in places penetrate the underlying soil of late-Pleistocene (Jornada II) age. The scarps occur at intervals of from several tens to several hundreds of m. Low dunes occur above some scarps. Between the scarps, the microrelief is either of constant slope or there are slight drainageways several dm in depth. Small drainageways are also common in front of scarps. Slopes range from 2 percent in the eastern part of the unit to 1 percent in the western part.

Areas above scarps or intermediate between scarps commonly contain burro grass and tarbush with scattered clumps of tobosa. Areas of truncated soils below scarps are generally barren or contain tarbush or few creosotebush in drainageways. There is some alkali sacaton in sandier areas, and scattered *Yucca elata*. In stablest drainageways there are occasional thick stands of tobosa and burro grass.

TYPICAL PEDONS, PROPERTIES AND RANGES

These soils are strongly calcareous throughout. They have formed in thick deposits with no bedrock (and usually no petrocalcic horizon) within a depth of many m. Buried soils are usually present, at a depth ranging from about 1/2 to 2 m.

Algerita

A pedon of Algerita is described in section 169. A table of properties and ranges is given below.

Table 183. Typical (underlined) and range in selected properties for major horizons of Algerita.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-2	scl cl sl	0-5	7.5YR- 10YR	5-7 6	3-5 4	2-4 3
B2	2-20	scl cl	0-10	7.5YR	5,6	4,5	4,5
K2	20-65	cl scl	0-30	7.5YR- 10YR	6-9	5-8 7	1-4 2
Control section	25-100	scl	< 15				

Other. Depth to the K horizon is highly variable because of soil truncation. Next to scarps and in drainageways it is within a few cm of the surface. Downslope and away from drainageways, depth to the K horizon ranges up to 75 cm. The contact between Organ and Jornada II and Pleistocene materials is commonly marked by a "stone line" of scattered pebbles, with gravel-free material above and below.

Headquarters

A typical pedon of Headquarters is described below. The location is the NW 1/4 NW 1/4 Sec. 13, T21S, R2E, 50 feet east of section line at a point about 850 feet south of section corner. Figure 174 is a photograph of the pedon and its landscape. A table of properties and ranges follows the description.

Loose, curled plates, about 1 in diameter and 1/8 in thick, are scattered over the surface.

A1 0-8 cm. Light gray (10YR 7/2, dry) or brown (10YR 5/3, moist); sandy clay loam; moderate fine and medium platy structure; slightly hard, friable; few roots; discontinuous layers, less than 1 mm thick, of reddish brown fine sand between plates; calcareous; abrupt smooth boundary.

B1ca 8-15 cm. Light brown (7.5YR 6/4, dry) or brown (7.5YR 5/4, moist); sandy clay loam; weak medium and coarse prismatic structure, parting to very weak medium subangular blocky structure; hard, friable; roots common; calcareous; abrupt smooth boundary.

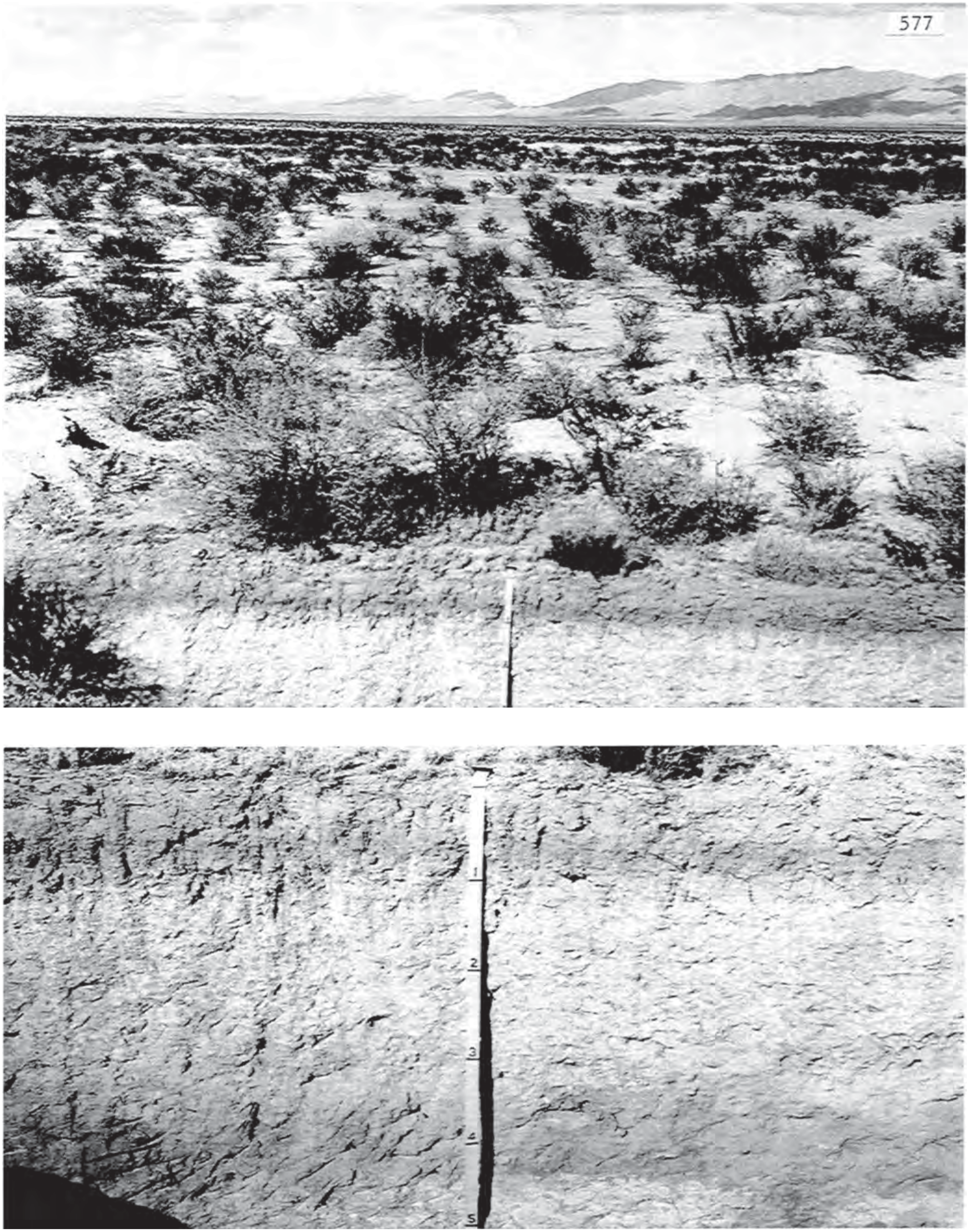


Figure 174. Upper. Landscape of an Ustollic Haplargid, Headquarters sandy clay loam, on the Jornada II surface. Vegetation is burro grass, tarbush creosotebush and crucifixion thorn. Slope is 1 percent.
Lower. Headquarters sandy clay loam. Scale is in feet.

B2tca 15-30 cm. Reddish brown (5YR 5/4, dry) or reddish brown (5YR 4/4, moist) heavy sandy clay loam; weak medium and coarse prismatic structure, parting to weak medium subangular blocky structure; slightly hard, friable; roots common; some parts light brown (7,5YR 6/4); some sand grains in reddish-brown parts are coated with silicate clay; few carbonate nodules in the lower part; few carbonate filaments; calcareous; clear wavy boundary.

K1 30-51 cm. Pink (7.5YR 8/1, dry) or pink (7.5YR 7/4, moist); clay loam; with lesser amount light brown (7.5YR 6/4, dry), brown (7.5YR 5/4, moist); weak medium subangular blocky structure, with tendency to platiness; hard, friable; few roots; calcareous; clear wavy boundary.

K2 51-74 cm. White (7.5YR 8/1, dry) or pinkish gray (7.5YR 7/2, moist); sandy clay loam; with some light brown (7.5YR 6/4, dry) brown (7.5YR 5/4, moist) massive; hard, friable; very few roots; many sand grains separated by carbonate; calcareous; abrupt wavy boundary.

IIK3 74-99 cm. Pink (7.5YR 7/4, dry) or brown (7.5YR 5/4, moist); gravelly heavy sandy loam; massive; hard, friable; few roots; many sand grains separated by carbonate; thin, continuous carbonate coatings on pebbles; calcareous; clear wavy boundary.

IICca 99-129 cm. Light yellowish brown (10YR 6/4, dry) or yellowish brown (10YR 5/4, moist); gravelly sandy loam; massive; soft; very few roots; most pebbles have thin discontinuous carbonate coatings, some pebbles carbonate-free; calcareous.

Table 184. Typical (underlined) and range in selected properties for major horizons of Headquarters.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-8	scl (underlined) cl hv.sl	0-5	7.5YR- 10YR (underlined)	5-7 (7 underlined)	3-5 (5 underlined)	2-4
B2t	15-31	hv.scl (underlined) cl	0-10	5YR (underlined)	5,6	4,5	4,5 (4 underlined)
K2	51-74	cl scl	0-30	7.5YR- 10YR (underlined)	6-9 8 (underlined)	5-8 7 (underlined)	1-4 (4 underlined)
Cca	99-130	sl (underlined) ls	0-50	7.5YR- 10YR (underlined)	5,6 (6 underlined)	4,5 (5 underlined)	3,4 (4 underlined)
Control section		hv.scl, cl	< 15				

Other. Depth to the calcic horizon (the K1, K2, and 2K3 horizons in the description) is usually about 25 to 50 cm, ranging from 15 to 75 cm. In this area the Headquarters soils are restricted to soils with A and B horizons having fairly high percentages of silicate clay, or silicate clay plus carbonate clay. When this value drops much below about 30 percent, ordinarily there would be too little organic carbon for the Ustollic subgroup (such soils are Dona Ana, the Typic analogues of the Ustollic Headquarters soils). In places, the Bt horizon has been partially or completely truncated. The K horizon is penetrated in a few places by roughly vertical pipes, into which the Bt horizon descends. The pipes range from less than one to several m in diameter. The C horizon is variable and may be either very gravelly or low in gravel. Abrupt facies changes covering this range are not uncommon.

Reagan, light subsoil variant.

A description of Reagan, light subsoil variant is in the Appendix (pedon 66-7). Figure 175 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

Table 185. Typical (underlined) and range in selected properties for major horizons of Reagan, light subsoil variant.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-18	<u>cl</u> sil sicl	0-1	7.5YR- <u>10YR</u>	5-7 <u>6</u>	<u>4</u>-6	2-4 <u>3</u>
B	18-41	cl sil <u>sicl</u>	0-1	7.5YR- <u>10YR</u>	5-7 <u>6</u>	<u>4</u>-6	<u>3</u>,4
Bb	51-61	<u>cl</u> scl	0-5	5YR- 7.5YR <u>6YR</u>	5,6 <u>5.5</u>	<u>4</u>,5	<u>4</u>
K2b	61-89	<u>cl</u> scl	0-35	<u>7.5YR</u>- 10YR	6-9 <u>8</u>	5-8 <u>7</u>	2-<u>4</u>
Control section	25-100		< 15				

Other. A weak calcic horizon has formed in Organ alluvium. The buried soil, of Jornada II age, has a much more prominent calcic horizon.

SOIL OCCURRENCE

Soils of this mapping unit illustrate incipient development of the argillic horizon in soils that have formed in parent materials containing substantial amounts of carbonate. The argillic horizon has nowhere developed in soils of the Holocene (Organ) mantle, but has formed in some soils of late-Pleistocene (Jornada II) age where carbonate content of the parent materials was

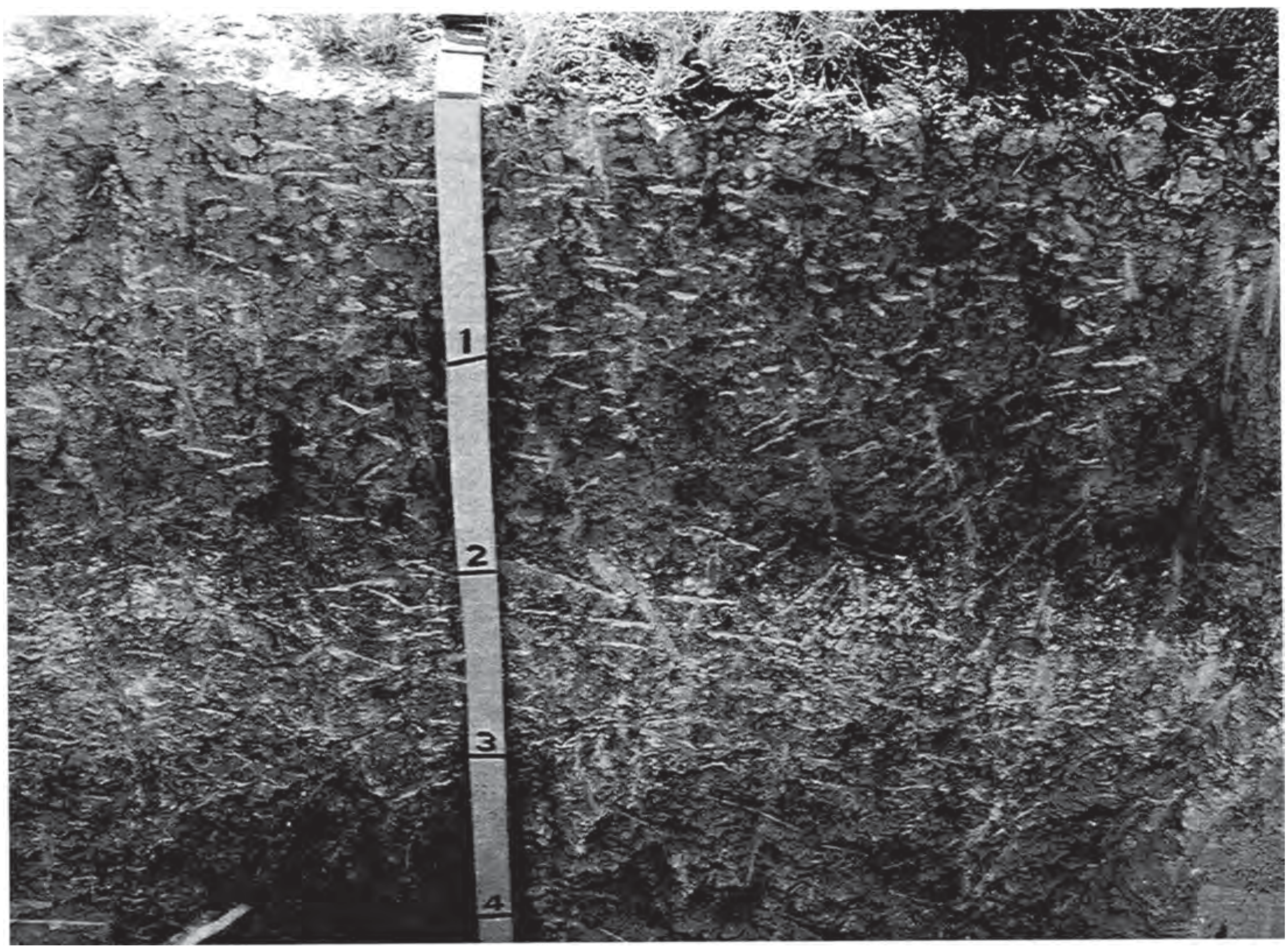


Figure 175. Upper. Landscape of an Ustollic Calciorthid, Reagan variant 66-7, on the Organ surface. Vegetation is burro grass, creosotebush and tarbush. Slope is 1 percent.

Lower. Reagan variant 66-7. Scale is in feet.

sufficiently low. Soil patterns are also intricate because of soil truncation, and variable thicknesses of the Organ mantle. Soil boundaries are abrupt in places because truncated Calciorthids can occur below scarps cut in Entisols. Truncation can also cause barren areas and an abrupt transition from Ustollic to Typic subgroups. In other places there is a transition from a Haplargid to a Calciorthid by truncation of the argillic horizon. There are also variable thicknesses of younger (Organ) deposits on the soils of Jornada II. Where the younger deposits (which generally lack diagnostic horizons because of their youth and high carbonate status) are less than 50 cm thick, classification is based on the buried soil. Where this younger alluvium is more than 50 cm thick, classification is based on the soil at the land surface.

Calciorthids. These soils occur in areas where a Bt horizon has been truncated, and in places where carbonate content of the parent materials was high enough that an argillic horizon never formed. ALGERITA soils are coarse-loamy. REAGAN, LIGHT SUBSOIL VARIANT is fine-loamy and has enough organic carbon for the Ustollic subgroup. Another Calciorthid, unnamed, is similar but is coarse-loamy. The Jal soils have more than 40 percent carbonates in the 25 to 100 control section.

Haplargids. The Ustollic Haplargids, HEADQUARTERS soils, occur in stabler areas that are commonly grass-covered and where textures of upper horizons are clay loam or sandy clay loam. The Typic Haplargids, Dona Ana soils occur in less stable areas; the soil type is commonly a sandy loam.

Torrifluvents. Glendale soils occur in deposits of Organ age. These usually occur in broad drainageways where the deposits are thick enough (greater than 50 cm) for classification to be based on the younger mantle.

Paleargids and Paleorthids. The loamy-skeletal Casito soils and the loamy Upton soils occur in a few places in the eastern, steeper part of the unit.

SOIL BOUNDARIES

Table 186 gives information about boundaries to major adjacent units. Figure 176 shows boundaries and stratigraphy of some of the units.

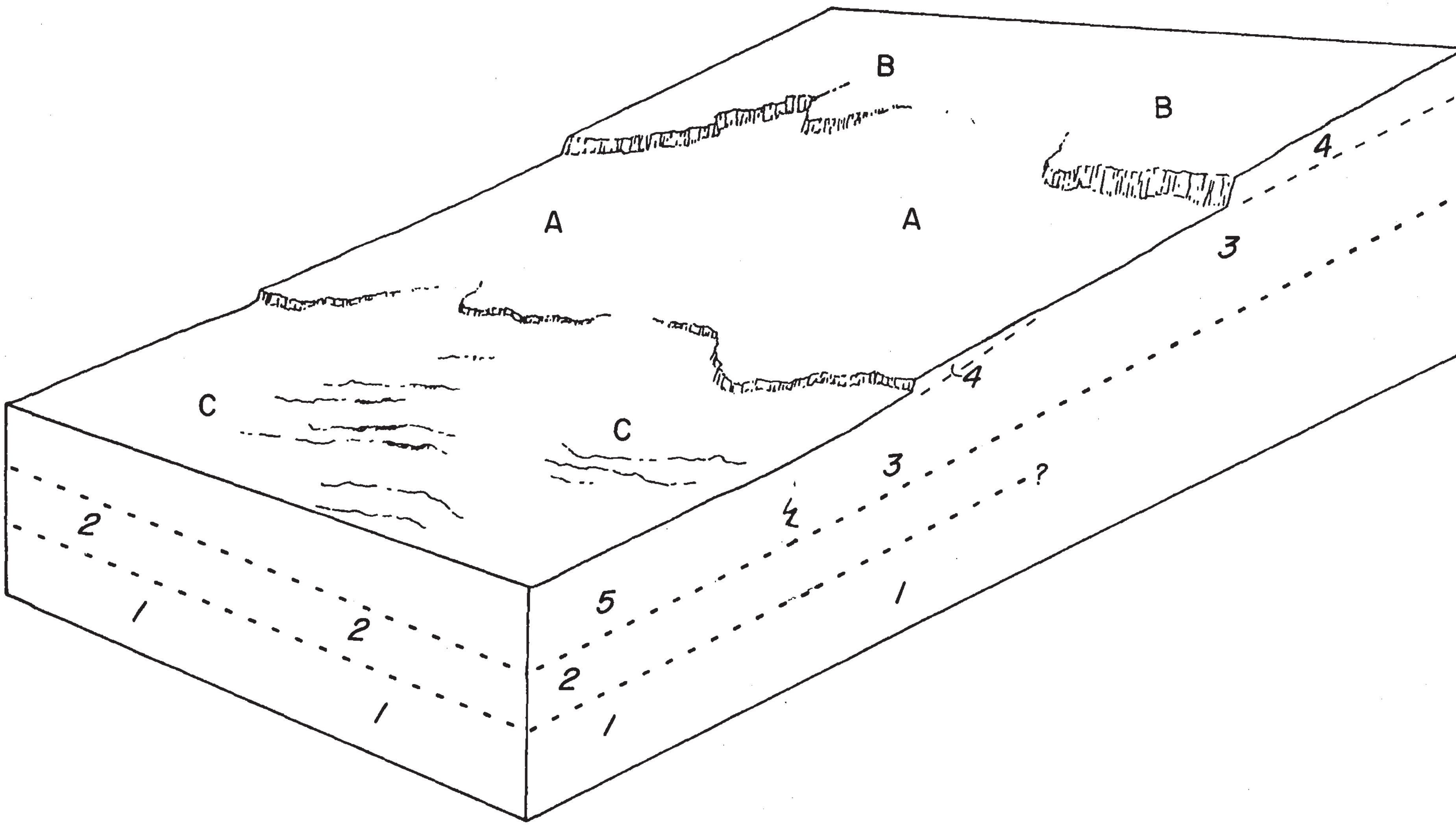


Figure 176. Block diagram of soil-landscape relations and soil stratigraphy in an area of Reagan clay loam, Algerita sandy clay loam, and Glendale-Reagan complex. Petts Tank sediments are the basin-floor equivalent of Jornada II. A = Algerita sandy clay loam (Organ and Jornada II surfaces). B = Glendale-Reagan complex (Organ surface). C = Reagan clay loam (Petts Tank surface).
1 = Upper Camp Rice Formation, fluvial facies (ancient river alluvium). 2 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 3 = Jornada II alluvium and soils. 4 = Organ alluvium and soils. 5 = Petts Tank sediments and soils.

Table 186. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Jal sandy loam (11L)	The boundary is due to a change in landscape position from broad drainageways (unit 16L) to slight ridges (unit 11L). Topographically the boundary is commonly fairly distinct between the ridge and drainageway areas. Also, in places there are thin deposits of a younger alluvium and geomorphic surface (Organ) in unit 16L.
Glendale-Reagan complex (13L)	The boundary has been caused by two factors in various places. One is a younger alluvium and geomorphic surface (Organ) in unit 13L. In these areas the topographic boundary is prominent and abrupt; it is marked by a scarp margin from about 3/4 to 1-1/4 m high with the 13L soils (Organ surface) occurring upslope from the scarp and the 16L soils (Jornada II surface) occurring downslope from the scarp. The 16L soils, the analogues of which are buried by Organ alluvium and its soils in unit 13L, emerge at the surface on the 16L side of the boundary. In other places the Organ sediments occur on both sides of the boundary but are thinner (less than about 75 cm) on the 16L side of the boundary.
Dona Ana fine sandy loam (16LS)	The boundary has been caused by a slight decrease in clay and increase in sand in soils of unit 16LS. The boundary is not distinct but the 16LS soils are slightly higher than the 16L soils.
Reagan clay loam (51)	The boundary is due to a slight decrease in clay in parent materials of soils of unit 51. The boundary is topographically apparent, occurring between the eastern side of the basin floor (which slopes from 0 to 1/2 percent) and the western margin of the fan piedmont, where slopes are about 1 percent.

OTHER STUDIES: ARGILLIC HORIZONS FORMED IN PARENT MATERIALS OF INTERMEDIATE CARBONATE CONTENT

No evidence of an argillic horizon has been found in parent materials with abundant fragments of carbonate rocks, even in soils of late-Pleistocene age. However, argillic horizons do occur in materials of this age that must have contained moderate amounts of carbonate. Such soils have C horizons with common limestone fragments, and occur downslope from the San Andres Mountains, a source of these rocks. Dona Ana 65-5 and Headquarters 60-18 illustrate. Both soils have reddish brown Bt horizons that contain enough oriented clay for argillic horizons (Appendix). Laboratory data are in table 187.

Dona Ana 65-5 (fig. 170) illustrates change in the ratio of fine to total clay with depth (table 187). This is typical of Argids (section 93), with the silicate clay in the K horizon commonly finer than in the overlying B horizons. The Bt horizon contains 8 to 11 percent carbonate, essentially all of which is pedogenic as indicated by its morphology and the absence (in thin section) of limestone fragments. It is thought that the Bt horizon was free or nearly free of carbonate in the Pleistocene. This is indicated by noncalcareous Bt horizons observed in places beneath Holocene deposits. Carbonate presently in the Bt accumulated in the Holocene because of reduced effective moisture and ample carbonate in the materials upslope

The proportion of the carbonate of clay size is typical for non-cemented authigenic carbonate (section 92). The Ustollic Haplargid, Headquarters 60-18, has more clay and organic carbon (table 187).

Table 187. Laboratory data for two Haplargids formed in materials with intermediate carbonate content.

Horizon	Depth	Sand[1/]	Clay[1/]	Volume >2mm	Fine/ total clay	Carbonate < 2mm	Carbonate < 0.002mm	Carbonate > 2mm	Organic carbon
	cm	pct	pct	pct		pct	pct	pct	pct
Typic Haplargid (Dona Ana 65-5)									
A	0-4	77	14		0.22	4	2		
B1	4-13	77	15		0.31	7			0.20
B21tca	13-25	74	17		0.36	8	2		0.21
B22tca	25-41	67	22		0.47	11	4		0.24
K1	41-56	67	22		0.54	28	15		0.28
K21	56-89	68	19		0.54	33	15		0.15
K22	89-114	68	17		0.54	32	11		0.08
K3	114-127	75[2/]	13		0.58	24	6		
2C1ca	127-147	83[2/]	9		0.55	17	4		
3C2ca	147-168	86[2/]	8		0.49	11			
Organic carbon, 2.1 kg/m^2 to 89 cm.									
Ustollic Haplargid (Headquarters 60-18)									
A	0-8	46	26	1		9			1.17
AB	8-23	50	37	1		9			0.48
B2tca	23-33	49	36	1		22			0.52
K21	33-51	59	29	1		37			0.41
K22	51-74	64	24	15		32		35	0.13
2K3	74-97	78	13	50		25		56	
2Cca	97-122	84	9	40		13		42	
Organic carbon, 4.7 kg/m^2 to 74 cm.									

1/ Carbonate-free basis.
2/ Over 5 percent by weight > 2 mm.

173. JAL SANDY LOAM (11L)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
JAL	TYPIC CALCIORTHIDS	COARSE-LOAMY, CARBONATIC	75
Dona Ana	Typic Haplargids	Fine-loamy	5
Monterosa, carbonatic variant	Ustollic Paleorthids	Loamy-skeletal, carbonatic, shallow	5
Upton	Typic Paleorthids	Loamy, carbonatic, shallow	10
Other inclusions (Torrifluvents, Torriorthents)			5

LOCATION, LANDSCAPE, VEGETATION

These soils occur mainly west of the San Andres Mountains, with small areas near the Dona Ana Mountains and Tortugas Mountains, and have formed in alluvium derived mainly from limestone, sandstone, siltstone and shale. In places there are smaller amounts of granite, quartzite, andesite and rhyolite in the alluvium. Elevations range from about 4400 to 4550 feet.

There are a few gently sloping drainageways ranging from about a m to a few m wide. There are several very slight ridges. In some areas, small drainageways, one to several dm in height, occur between shrubs. A few cm of sandy sediments have accumulated around some of the shrubs. There are no large arroyos, but there are a few gullies 1 dm or more in depth. Slope ranges from 1 to 2 percent.

Vegetation is dominantly creosotebush, with a few mesquite and tarbush; in places there are a few clumps of tobosa and burrograss.

TYPICAL PEDON, PROPERTIES AND RANGES

These soils are strongly calcareous throughout. No bedrock occurs within many m except on the slopes of Tortugas Mountain. Buried soils are present beneath these soils in many places.

Jal

A typical pedon of Jal is described in the Appendix (pedon 65-6). Figure 177 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

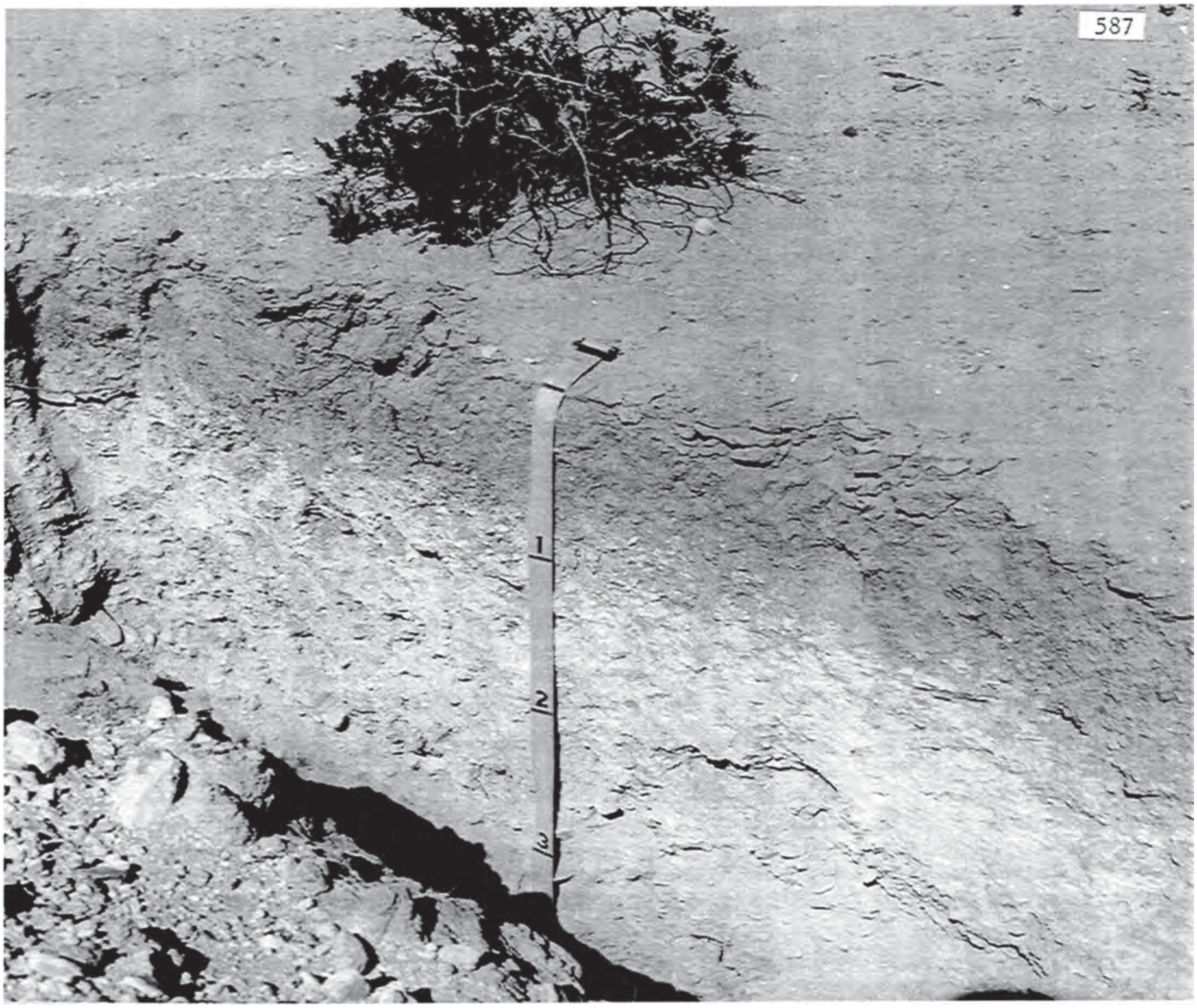


Figure 177. A Typic Calciorthid, Jal 65-6. Scale is in feet.

Table 188. Typical (underlined) and range in selected properties for major horizons of Jal.

Horizon	Depth cm	Particle Size < 2mm	Particle Size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-4	sl	0-50	7.5YR- 10YR	5,6	4,5	2-4 2,3
B2	10-23	hv.sl scl	0-35	7.5YR	5,6	4,5	3,4
K2	33-84	scl cl	0-35	7.5YR- 10YR	6-9	5-8 7	2-4
Cca	109-140	sl scl	0-60	5YR- 7.5YR	5,6	4,5	3,4
Control section	25-100	scl,sl cl	0-35				

Other. Silicate clay in the control section averages less than 18 percent; sandy clay loam and clay loam textures are partly due to high content of carbonate silt and clay. Depth to the calcic horizon (the B2ca and K horizons in the description) is usually 10 to 20 cm, ranging from 5 to 75 cm. Limestone fragments are common on the surface and in places occur in the soil. Usually the surface fragments are of gravel size but cobbles and stones occur on the surface where these soils occur near the base of Tortugas Mountain. West of the San Andres Mountains, pipes have been observed in these soils. Pipes range form a few cm to a m or more across. Some pipes have reddish brown Bt material. There are occasional very gravelly strata. Some cementation occurs in places but not enough for a petrocalcic horizon. Buried soils occur beneath these soils in some areas.

SOIL OCCURRENCE

The soil pattern is determined by gravel content of Jornada alluvium; by the presence of occasional younger deposits and soils; by the presence of occasional low areas; and by variations in carbonate content of the 25 to 100 cm control section.

Calciorthids. Jal soils occur over most of the area.

Paleorthids. The loamy-skeletal Monterosa soils occur where there is enough gravel in the zone of carbonate accumulation to develop a petrocalcic horizon, and more than 35 percent by volume above it. The loamy Upton soils average less than 35 percent by volume of coarse fragments above the petrocalcic horizon.

Haplargids. Small areas of the fine-loamy Dona Ana soils occur in a few of the stablest areas in the eastern part of the area.

Torriorthents, Torrifluvents. The loamy-skeletal Dalian soils, Torriorthents, and the coarse-loamy Anthony soils, Torrifluvents, occur in and adjacent to a few slight ridges. The coarse-loamy Anthony soils are commonly stratified; organic carbon decreases irregularly, or remains above 0.2 percent. to a depth of 1.25 m.

SOIL BOUNDARIES

Table 189 gives information about boundaries to major adjacent units.

Table 189. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Glendale-Reagan complex (13L)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 13L. Topographically the boundary is distinct in some places, with the 13L soils lower than and inset against the 11L soils. In other places the boundary is less apparent and soils of the two units are at about the same elevation.
Algerita sandy clay loam (16L)	The boundary is due partly to differences in landscape stability and partly to differences in geomorphic surface. In places the surface of unit 16L is quite stable and argillic horizons (present in some soils of unit 16L) have been preserved. In other places there is a younger geomorphic surface (Organ) in unit 16L, with deposits thick enough to be considered in soil classification. The topographic boundary between the 16L and 13L units is fairly distinct with soils of unit 11L occurring on slight ridges and unit 16L on lower areas between the ridges. Vegetatively the boundary is commonly marked by a change from mostly creosotebush vegetation (unit 11L) to burro grass, tarbush and creosotebush (unit 16L).

174. Soils of Jornada I; soils of Jornada I and II; and Jornada Undifferentiated.

Many of the older soils along the mountain fronts and upper piedmont slopes fall into this group. Commonly Jornada I and II occur in complex patterns and have not been specifically identified. Some soils of Jornada I have been delineated (section 144); soils of Jornada I and II have been recognized and specifically related to landscape position in section 182.

Nine mapping units occur on these surfaces:

175. TERINO VERY GRAVELLY SANDY LOAM (12R)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
TERINO	PETROCALCIC USTOLLIC PALEARGIDS	LOAMY-SKELETAL, SHALLOW	60
Casito	Petrocalcic Ustollic Paleargids	Loamy-skeletal, shallow	5
Cruces, loamy-skeletal variant	Petrocalcic Paleargids	Loamy-skeletal, shallow	10
Nolam	Ustollic Haplargids	Loamy-skeletal	10
Terino, mod. deep variant	Petrocalcic Ustollic Paleargids	Loamy-skeletal	5
Other inclusions (Entisols, Torriorthents, Haplargids, Paleorthids)			10

LOCATION, LANDSCAPE, VEGETATION

The soils occur extensively west of the southern portion of the Organ Mountains. Smaller areas also flank Quartzite, Goat and Picacho Mountains. In the southern part of the area west of the Organs, these soils have formed in alluvium that is derived from virtually 100 percent rhyolite. Northward rhyolite is still dominant but there are smaller amounts of andesite and monzonite in the alluvium. There are small amounts of quartzite and sedimentary rocks in some of the alluvium near Quartzite Mountain. Elevations range from about 4400 to 5400 feet.

In their major area of occurrence, west of the Organ Mountains, these soils commonly occur on a broad alluvial-fan piedmont. In places the soils occur on two general levels that are closely associated and that differ only a few m or less in elevation. The highest of these are ridges of the Jornada I surface. The lower is the Picacho surface, which commonly occurs as a terrace inset against alluvium beneath Jornada I. In places, a level intermediate between the two is suggestive of Tortugas age. These soils also occur on stablest parts of the Dona Ana surface along the front of the Morgan Mountains. These are fans that are considerably higher and older than Jornada I and Picacho. Although the soils have been cut by arroyos and gullies, many transverse slopes between drainageways are unrounded or have been only slightly rounded by erosion. Slopes range from about 8 percent next to the mountains to 2 percent at lower elevations. Downslope from Quartzite, Goat and Picacho Mountains, the soils occur on small alluvial fans. Slopes in these areas range from about 3 to 15 percent.

Vegetation consists mostly of ratany, fluffgrass, whitethorn, prickly pear, Mormon tea, desert thorn, tarbush and *Yucca baccata*. A few creosotebush occurs in places, particularly at lower elevations. Scattered clumps of black grama and blue grama occur at higher elevations.

TYPICAL PEDONS, PROPERTIES AND RANGES

Terino

A typical pedon of Terino is described below. The location is the NE 1/4 Sec. 21, T23S, R3E, about 15 m east of the Soledad Canyon Road. A table of properties and ranges follows the description.

Soil surface. A closely packed desert pavement of angular rhyolite pebbles.

A2 0-5 cm. Brown (7.5YR 5/4, dry) or dark brown (7.5YR 4/4, moist) very gravelly sandy loam; weak medium platy and weak fine crumb; soft and loose; very few roots; pebbles partially stained yellowish red (5YR 4/6-5/6); noncalcareous; abrupt smooth boundary.

B21t 5-23 cm. Reddish brown (5YR 5/4, dry) or reddish brown (5YR 4/4, moist) very gravelly heavy sandy loam; weak fine and very fine crumb; soft and loose; few roots; pebbles discontinuously stained yellowish red (5YR 4/6); pebbles and sand grains are coated with silicate clay; noncalcareous; clear smooth boundary.

B22tca 23-38 cm. Yellowish red (5YR 5/6, dry) or yellowish red (5YR 4/6, moist) very gravelly sandy clay loam; weak fine and medium subangular blocky; slightly hard; roots common; pebbles discontinuously stained yellowish red (5YR 4/6); pebbles and sand grains coated with silicate clay; few carbonate filaments on pebbles and ped faces; common fine tubular pores, some with roots and weak carbonate accumulations; few volumes in lower part are red (2.5YR 3/6); generally noncalcareous, with scattered calcareous parts; abrupt smooth boundary.

K21m 38-53 cm. Pink (7.5YR 8/4, dry) very gravelly, carbonate-cemented material, with a pebble-studded, discontinuously laminar upper surface; very and extremely hard; no roots except in scattered pockets, 1 to 3" diameter, of loose, uncemented, carbonate-rich material; few volumes of material with 5YR hue in upper part; effervesces strongly; clear wavy boundary.

K3 53-81 cm. Pink (7.5YR 7/4, dry) or light brown (7.5YR 6/4, moist) very gravelly, discontinuously carbonate-cemented material; hard; generally massive, with some single grain parts between pebbles; few fine roots; pebbles thickly coated with carbonate and some are cemented together in clusters; effervesces strongly; clear wavy boundary.

Cca 81-119 cm. Light brown (7.5YR 6/4, dry) or brown (7.5YR 5/4, moist) very gravelly heavy sandy loam; massive and single grain; soft and loose; few fine roots; pebbles thinly coated with carbonate; a few clusters of carbonate-cemented pebbles; effervesces strongly.

Table 190. Typical (underlined) and range in selected properties for major horizons of Terino.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	<u>sl</u> l	0-75	5YR- <u>7.5YR</u>	4-6 <u>5</u>	3-5 <u>4</u>	2-<u>4</u>
B2t	5-38	scl cl	35-75	2.5YR- <u>5YR</u>	4-6 <u>5</u>	3-5 <u>4</u>	<u>4</u>-6
K2m	38-53	--	--	<u>7.5YR-</u> 10YR	6-9 <u>8</u>	5-8 <u>6</u>	2-<u>4</u>
Cca	81-119	<u>sl</u> ls s	10-75	<u>7.5YR-</u> 10YR	5-7 <u>6</u>	4-6 <u>5</u>	3,<u>4</u>
Control section		scl,cl	> 35				

Other. Depth to the petrocalcic horizon (the K2m horizon of the description) is usually 30 to 40 cm, ranging from 18 to 50 cm.

Nolam

A typical pedon of Nolam is described below. The location is the NE 1/4 Sec. 21, T23S, R3E, about 60 m west of the Soledad Canyon road.

A2 0-5 cm. Light brown (7.5YR 6/4, dry) or brown (7.5YR 5/4, moist) very gravelly fine sandy loam; weak fine crumb; soft; few roots; noncalcareous; abrupt smooth boundary.

B21t 5-25 cm. Red (2.5YR 4/6, dry) or dark red (2.5YR 3/6, moist) very gravelly sandy clay loam; breaks out as weak medium and coarse subangular blocks of pebbles (mainly fine) and interpebble fine earth; slightly hard, friable; roots common; pebbles and sand grains thickly coated with clay; some volumes of 5YR hue; noncalcareous; clear wavy boundary.

B22tca 25-43 cm. Dominantly reddish brown (5YR 5/4 dry, 5YR 4/4, moist) very gravelly sandy clay loam; with some parts of 7.5YR hue, particularly in lower part; massive; soft; roots common, silicate clay coatings on some sand grains and pebbles, primarily on upper sides of pebbles in upper half of horizon, fewer in lower half; effervesces strongly; abrupt wavy boundary.

K2 43-61 cm. Dominantly pink (7.5YR 8/4, dry) or pink (7.5YR 7/4, moist) very gravelly sandy loam; massive; generally slightly hard and friable, with a few hard parts; few roots; most pebbles are separated from each other by carbonate; a few reddish brown parts; effervesce strongly; clear wavy boundary.

K31 61-102 cm. Pink (7.5YR 8/4, dry) or light brown (7.5YR 6/4, moist) very gravelly sandy loam, and light brown (7.5YR 6/4, dry) or brown (7.5YR 5/4, moist); massive; generally slightly hard, very friable, a few parts hard; very few roots; carbonate thickly coats pebbles in light-colored parts, thinly coats them in darker parts; light and dark parts occur in nearly vertical tongues and in irregular volumes, 2 to 10 cm across; effervesces strongly; clear wavy boundary.

K32 102-132 cm. Alternating tongues and lenses of very pale brown (10YR 7/4, dry) or yellowish brown (10YR 5/4, moist), and yellowish brown (7.5YR 5/4, dry) or dark yellowish brown (7.5YR 4/4, moist) very gravelly loamy sand; massive; soft and slightly hard, very friable; very few roots; light-colored parts commonly held together by weak carbonate cementation, darker parts have only thin carbonate coatings; effervesces strongly; clear wavy boundary.

C1ca 132-180 cm. Dominantly brown (7.5YR 5/4, dry) or dark brown (7.5YR 4/4, moist) very gravelly sand; massive; soft and slightly hard; very friable; very few roots; a few tongues and lenses of pink (7.5YR 8/4, dry) or light brown (7.5YR 6/4, moist) material weakly held together by carbonate; calcareous; clear wavy boundary.

C2 180-201 cm. Brown (7.5YR 5/4, dry) or dark brown (7.5YR 4/4, moist) gravelly sand, gravel is mainly fine; massive and single grain; soft and loose; no roots; some pebbles have very thin discontinuous carbonate coatings; noncalcareous or effervesces weakly.

SOIL OCCURRENCE

For several reasons a relatively large proportion of this mapping unit consists of one soil series. (1) The control section (in these soils, the Bt horizon) is very gravelly in virtually all of the Argids. Thus the great majority of the soils are in one textural family (loamy-skeletal), avoiding complications caused by families of different texture. (2) The soils are old enough to have argillic horizons, and, in these very gravelly materials, petrocalcic horizons as well. The great majority of the soils in this mapping unit are Petrocalcic Ustollic Paleargids. (3) The landscapes are relatively stable between gullies and the soils have not been greatly eroded in most places. Argillic horizons have generally been preserved, avoiding large areas of Orthids caused by soil truncation. Orthids do occur extensively to the west because of such stripping but this is in another mapping unit--the Monterosa complex. (4) Analyses indicate that most soils have sufficient organic carbon for the Ustollic subgroups.

Some Petrocalcic Paleargids (Cruces, loamy-skeletal variant) would be expected at lower elevations.

Ustollic Haplargids. The loamy-skeletal Haplargids, NOLAM, soils, occur in places where a calcic, but not a petrocalcic horizon has formed, and occurs within a depth of 1 m. These soils are most common on the Picacho terraces and its mountainward analogue, the Jornada II surface. The loamy-skeletal Caralampi soils occur where a calcic horizon is not present within one m. These soils are most common near the mountains.

Petrocalcic Ustollic Paleargids. The loamy-skeletal TERINO soils occur on broad interfluves, particularly at middle and higher elevations in the unit. The Casito soils are similar but have some macroscopic carbonate in all subhorizons of the Bt horizon. Terino, moderately deep variant has a petrocalcic horizon 50 to 100 cm from the surface. These soils occur mostly along the mountain fronts.

Petrocalcic Paleargids. Cruces, loamy-skeletal variant, occurs where organic carbon is insufficient for the Ustollic subgroup. Most of these soils are at lower elevations in the mapping unit.

Typic Haplargids. The fine-loamy, gravelly Hap soils and the fine-loamy, gravelly Tres Hermanos soils are most common at lower elevations and slopes where gravel content is lower. The latter soils are calcareous throughout.

Torriorthents. The sandy-skeletal Arizo soils and the loamy-skeletal Canutio soils occur adjacent to gullies and arroyos, and on the sides of some ridges.

Paleorthids. The loamy-skeletal Monterosa soils occur where the argillic horizon has been truncated, carbonate-engulfed, or both. These soils occur mostly on the shoulders of interfluves and on a few narrow ridges.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 191 presents information about boundaries to adjacent major units. Figure 178 shows some of the boundaries and the stratigraphy.

Table 191. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Boracho complex (10RO)	The boundary has been caused by greater dissection and soil truncation in unit 10RO. Argillic horizons once present in unit 10RO have in most places been truncated or carbonate-engulfed. The topographic boundary is marked by a narrowing of ridges at the border of unit 10RO.
Monterosa complex (10RR)	Landscape dissection has caused the boundary resulting in truncation or carbonate engulfment of argillic horizons formerly present in the 10RR soils. Towards the Rio Grande Valley, the degree of dissection increases, ridges develop and then become narrower. With increasing dissection and narrowing of ridges, the argillic horizon gradually disappears. The location of this disappearance marks the boundary to unit 10RR. The boundary between these units is long and sinuous. It is not topographically prominent but does occur where the ridges have considerably narrowed.
Caralampi-Nolam complex (12MO,123R)	In places the boundary is due to greater precipitation toward the Organ Mountains. In stablest areas this increased moisture causes thickening of the B horizons and deepening of the horizons of carbonate accumulation. In other places the 12R soils extend mountainward where they commonly occur on higher surfaces than soils of unit (12MO,123R).
Arizo complex (13F)	The boundary has been caused by a younger alluvium and geomorphic surface (Fillmore) in unit 13F. The topographic boundary is usually distinct since soils of unit 13F occur on terraces inset against higher soils of unit 12R.
Pinaleno very gravelly sandy loam (13R)	The boundary has been caused by a younger alluvium and geomorphic surface (usually Organ, in places Isaacks' Ranch) in unit 13R. At lower elevations the 12R soils, buried in unit 13R, emerge at the surface on the 12R side of the boundary. The topographic boundary between the 13R and 12R soils is usually fairly distinct but is indistinct in places. Nearest the mountains, soils of unit 13R are commonly inset against and are lower than soils of the adjacent 12R unit. Downslope, the 13R soils commonly spread out on fans and bury soils of the Jornada surface. Vegetation tends to be somewhat more common on soils of unit 12R than on soils of unit 13R.
Rhyolite rock outcrop Argids (40R)	The boundary has been caused by a change from thick alluvium (unit 12R) to steep colluvial slopes or to bedrock at or near the surface (unit 40R). The boundary is topographically prominent being marked by steeper slopes and bedrock of the Organ Mountains.

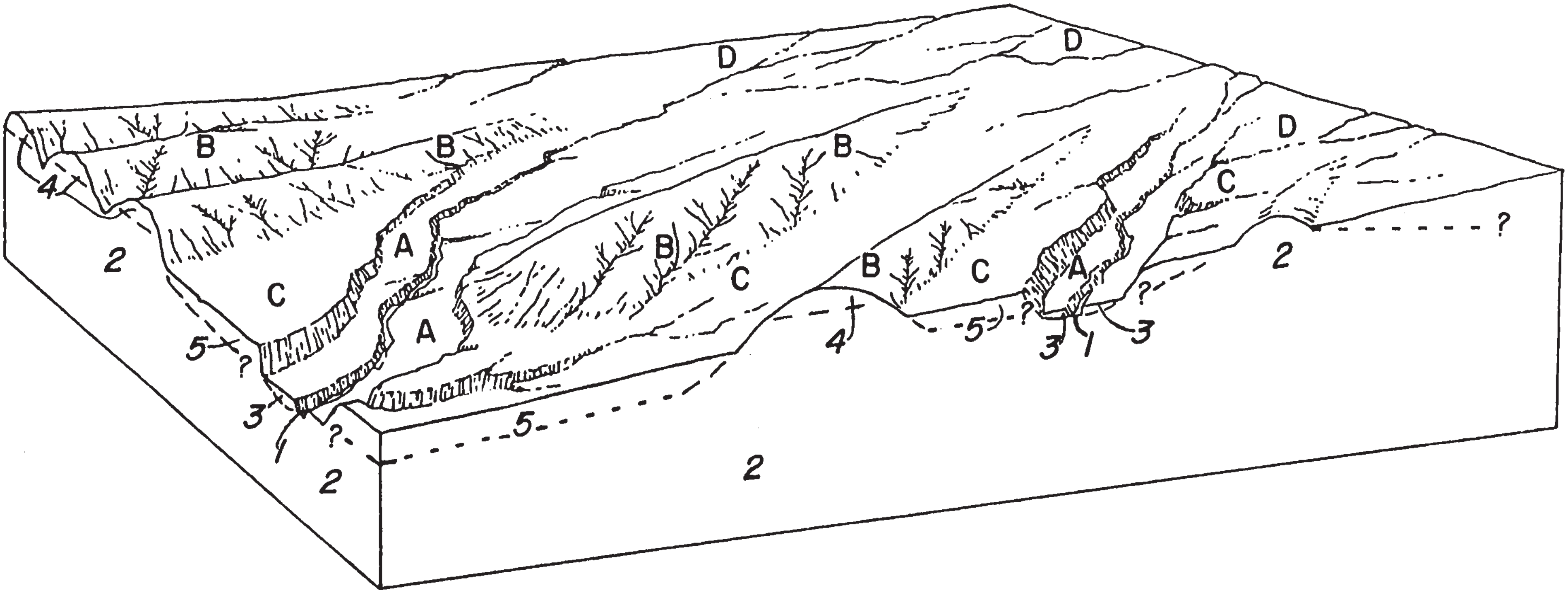


Figure 178. Block diagram of soil-landscape relations and soil stratigraphy along the western boundary of Terino very gravelly sandy loam. Picacho terraces are particularly distinct in this area (south of Tortugas Mountain). The terraced terrain grades out to the east and transverse elevations are about the same for long distances. A = Arizo complex. B = Monterosa complex. C = Nolam complex. D = Terino very gravelly sandy loam.
A = Arroyo channel alluvium (not outlined). 2 = Upper Camp Rice Formation (piedmont facies) and buried soils. 3 = Fillmore alluvium and soils. 4 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 5 = Picacho alluvium and soils.

176. CARALAMPI VERY GRAVELLY SANDY LOAM (14RO)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
CARALAMPI	USTOLLIC HAPLARGIDS	LOAMY-SKELETAL	80
Earp	Aridic Argiustolls	Loamy-skeletal	5
Santo Tomas	Pachic Haplustolls	Loamy-skeletal	10
SND-6	Entisols		5

LOCATION, LANDSCAPE, VEGETATION

These soils occur in several small areas in and west of Soledad Canyon in the Organ Mountains. The soils have formed in alluvium derived from rhyolite. Elevations range from about 5500 to 6000 feet.

The landscape consists of high remnants of alluvial fans. The remnants are separated from each other by arroyos that have deeply trenched the sediments. Crests of the remnants are commonly quite stable and level or nearly level transversely but a few areas have been strongly dissected and rounded by arroyos. Longitudinal slope along the ridge remnants is about 8 percent over most of the area, ranging to about 15 percent at higher elevations.

Vegetation consists of snakeweed, whitethorn, prickly pear, black grama, blue grama, *Yucca baccata*, catclaw, bush muhly, cholla, mesquite and Mormon tea.

TYPICAL PEDON, PROPERTIES AND RANGES

These soils have formed in thick alluvium in which no calcic horizons, petrocalcic horizons, buried soils, or bedrock have been observed to depths of at least several m.

Caralampi

A typical pedon of Caralampi is described in the Appendix (pedon 59-14). A table of properties and ranges is given below.

Table 192. Typical (underlined) and range in selected properties for major horizons of Caralampi.

Horizon	Depth cm	Particle Size < 2 mm	Particle Size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-20	sl,l	20-75	7.5YR 5YR	3-6	3-5	3,4
B2t	46-97	scl cl	35-75	2.5YR- 5YR	4,5	3,4	4-6
C	147-173	ls sl	20-75	5YR- 7.5YR	5,6	4,5	3,4
Control section		scl,cl	> 35				

Other. These soils are usually noncalcareous to depth of from 50 to 100 cm, ranging from 25 to 125 cm. The noncalcareous zone tends to be thickest in areas of higher precipitation in the easternmost and highest part of the mapping unit.

SOIL OCCURRENCE

This mapping unit illustrates a unit that is dominated very largely by soils of one series (Caralampi). The reasons for this are: (1) virtually all the soils are old enough to have developed an argillic horizon and are Argids. (2) soils with these parent materials and of this age and position along the mountain fronts do not have calcic or petrocalcic horizons, so that no separations are needed because of this. (3) The alluvium is very gravelly in the control section so that all soils are in the same textural family (loamy-skeletal).

Ustollic Haplargids. Nearly all of the soils on the crests of the remnants are loamy-skeletal CARALAMPI.

Aridic Argiustolls. In a few places at highest elevations on the ridges, a mollic epipedon is preserved; these are the loamy-skeletal Earp soils.

Pachic Haplustolls. The loamy-skeletal Santo Tomas soils occur on narrow terraces bordering small arroyos, and at the base of some of the steep slopes.

Entisols (SND-6) are in arroyo channels.

SOIL BOUNDARIES

Table 193 presents information on boundaries to adjacent major units.

Table 193. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Caralampi-Nolam complex (12MO,123R)	The boundary is caused by increased precipitation along the mountain front. This greater moisture thickens the Bt horizons and deepens horizons of carbonate accumulation, resulting in different classes of soils. The topographic boundary is not distinct since the soils are on the same surface and there is no apparent change in landscape stability.
Santo Tomas-Earp complex (13RO)	The boundary is caused by a younger alluvium and geomorphic surface (Organ) in unit 13RO. The boundary is topographically prominent since soils of unit 13RO occur on terraces lower than and inset against the higher soils of unit 14RO.
Rhyolite rock outcrop and Argids (40R)	The boundary is caused by a change from thick alluvium of unit 14RO to bedrock and steep colluvial slopes. The boundary is distinct because of the steeper slopes of the Organ Mountains; bedrock is at, or very near the surface in places.

177. NICKEL-DELNORTE COMPLEX (10V)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
DELNORTE	TYPIC PALEORTHIDS	LOAMY-SKELETAL, SHALLOW	30
NICKEL	TYPIC CALCIORTHIDS	LOAMY-SKELETAL	40
Canutio	Typic Torriorthents	Loamy-skeletal (calcareous)	10
Casito	Petrocalcic Ustollic Paleargids	Loamy-skeletal, shallow	5
Simona	Typic Paleorthids	Loamy, shallow	10
SND-6	Entisols		5

LOCATION, LANDSCAPE, VEGETATION

These soils border parts of the Dona Ana Mountains. The soils have formed in sediments derived primarily from andesite, monzonite and rhyolite. Elevations range from about 4300 to 4800 feet.

Most areas have been strongly dissected by arroyos; narrow ridges are the dominant landscape feature. Longitudinal slopes along ridge crests range from about 3 to 7 percent; slopes of ridge sides range from 10 to 35 percent.

Vegetation is mostly creosotebush with scattered mesquite, *Yucca baccata*, and prickly pear.

TYPICAL PEDONS, PROPERTIES AND RANGES

In places these soils are underlain by buried soils. Bedrock does not occur within a depth of many m except near bedrock outcrops.

Delnorte

A description of Delnorte is given below. The location is the NW 1/4 Sec. 29, T21S, R2E, north bank of arroyo. Vegetation is creosotebush, mesquite, and prickly pear. Slope is 4 percent. Table 194 gives properties and ranges.

Soil surface. Desert pavement of angular and subangular pebbles, with a few cobbles of andesite, latite and rhyolite. A discontinuous layer of reddish sand occurs between and below pebbles.

Aca 0-5 cm. Pinkish gray (7.5YR 6/2, dry) and dark brown (7.5YR 4/2, moist) gravelly fine sandy loam; upper 1/2 in moderate medium platy, slightly hard and strong vesicular; lower part moderate fine and very fine crumb and loose; few roots; pebbles thinly and continuously coated with carbonate; effervesces strongly; abrupt wavy boundary.

Bca 5-18 cm. Light brown (7.5YR 6/4, dry) and dark brown 7.5YR 4/4, moist) very gravelly sandy loam; massive with a few medium crumb parts; loose and soft; few roots; some pebbles have noncalcareous tops which are stained yellow or brown, and have bottoms which are continuously coated with carbonate; some pebbles wholly coated with carbonate; effervesces violently; clear smooth boundary.

K1 (C1ca) 18-28 cm. Horizon consists of (1) 75 percent carbonate-cemented fragments, pinkish white (7.5YR 8/2, dry), pinkish gray (7.5YR 7/2, moist), and white (10YR 8/1, dry), light gray (10YR 7/2, moist), which can be readily removed by knife; some fragments have laminae which total less than 1 mm thickness, with "pustulose" bottoms; (2) matrix is light brown (7.5YR 6/4, dry) and dark brown (7.5YR 4/4, moist); gravelly sandy loam; single grain; loose; effervesces strongly; abrupt smooth boundary.

K2m (C2cam) 28-74 cm. Pinkish white (7.5YR 8/2, dry), pinkish gray (7.5YR 7/2, moist), and white (10YR 8/1, dry), light gray (10YR 7/2, moist), very gravelly carbonate-cemented material; weakly platy in upper part, massive in lower; very hard; very few roots; pebbles widely separated by carbonate; a laminar subhorizon occurs discontinuously at the top and in general ranges from about 1 to 5 mm in thickness; effervesces strongly; clear wavy boundary.

K3 74-99 cm. Light yellowish brown (10YR 6/4, dry) and dark yellowish brown (10YR 4/4, moist) very gravelly sandy loam; single grain and massive; soft and loose, few indurated lenses, continuous carbonate coatings on pebbles; effervesces strongly; few roots; clear boundary.

Cca 99-124 cm. Light brown (7.5YR 6/3, dry) and dark brown (7.5YR 4/3, moist) very gravelly sandy loam; single grain; massive; loose and soft; thin, discontinuous carbonate coatings on pebbles; effervesces strongly.

Table 194. Typical (underlined) and range in selected properties for major horizons of Delnorte.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	sl	20-75	7.5YR	5-7 6	4-6	2-4
B2	5-18	sl scl	35-75	5YR- 7.5YR	5,6	4,5	3,4
K2m	28-74	sl	--	7.5YR- 10YR	6-9 8	5-8 7	2-4
C	99-124	sl ls	10-75	7.5YR- 10YR	5,6	4,5	3,4
Control section		sl,scl	35-75				

Other. These soils are usually calcareous throughout but range to noncalcareous in the upper several cm. On stablest sites (the centers of ridges that are level or nearly level transversely for several m or more), the tops of some pebbles (in the upper part of the B horizon) are noncalcareous and reddish brown, though the matrix is strongly calcareous. Where ridge crests are rounded, with little or no part level transversely, the noncalcareous pebble tops are sparse or absent altogether.

Nickel

See section 139 for a description of Nickel.

SOIL OCCURRENCE

Calciorthids. The loamy-skeletal Nickel soils tend to be dominant on ridge crests where the original surface and its soils have been substantially truncated. They also occur in areas with gravel content in the 25 to 100 cm control section low enough to retard development of the petrocalcic horizon, but high enough for the skeletal family.

Paleorthids, Paleargids. The loamy-skeletal Delnorte soils and the loamy Simona soils tend to be dominant on stablest parts of the ridge remnants and in areas of sufficient gravel content in the horizon of carbonate accumulation to expedite development of the petrocalcic horizon. The Paleorthids are most common on ridge crests but also occur on parts of sides of the oldest ridges. The loamy-skeletal Paleargids, Casito soils, occur only in the centers of stablest ridge crests.

Torriorthents. The loamy-skeletal Canutio soils occur on some of the lower parts of ridge sides and also border arroyos.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 195 presents information on boundaries to adjacent major units.

Table 195. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Casito-Terino complex (12V)	The boundary is due to landscape dissection in unit 10V. This has resulted in carbonate engulfment of the argillic horizon formerly present in the 10V soils. The topographic boundary is not prominent, but is marked by increasing dissection and the development of ridges in unit 10V.
Anthony complex (13ML,13V, 13LG)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in units (13ML,13V,13LG). The topographic boundary is not distinct but soils of unit 10V commonly are on slight ridges that are slightly higher than soils of the adjacent (13ML, 13V,13LG) unit.
Andesite rock outcrop and Argids (40V)	The boundary has been caused by a change from thick alluvium of unit 10V to bedrock, which is commonly at or near the surface in unit 40V. The boundary is usually distinct and marked by steeper slopes and bedrock of the Dona Ana Mountains.

178. CONGER COMPLEX (10LL)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
CONGER	USTOLLIC PALEORTHIDS	LOAMY, SHALLOW	30
MONTEROSA, CARBONATIC VARIANT	USTOLLIC PALEORTHIDS	LOAMY-SKELETAL, CARBONATIC, SHALLOW	25
Anthony	Typic Torrifluvents	Coarse-loamy (calcareous)	5
Dalian, sandy-skeletal variant	Typic Torriorthents	Sandy-skeletal, carbonatic	5
Jal	Typic Calciorthids	Coarse-loamy, carbonatic	10
Simona	Typic Paleorthids	Loamy, mixed, shallow	5
SND-6	Entisols		5
Tencee	Typic Paleorthids	Loamy-skeletal, carbonatic	10
Weiser	Typic Calciorthids	Loamy-skeletal, carbonatic	5
Other inclusions	(Torrifluvents, Paleargids)		< 1/2

LOCATION, LANDSCAPE, VEGETATION

The soils occur west of the San Andres Mountains. The soils have formed in alluvium derived mainly from sedimentary rocks such as limestone, sandstone, siltstone, and shale, in places with smaller amounts of rhyolite, granite, quartzite and andesite. Elevations range from about 4500 to 5000 feet.

The soils occur on individual fans next to the mountain fronts and on the coalescent fan-piedmont downslope. Arroyos and gullies are common. Narrow Holocene terraces border the arroyos in some areas. Slopes range from about 5 percent on fans nearest the mountains to 2 percent on the fan-piedmont downslope.

Vegetation consists mainly of creosotebush, with a few tarbush, mesquite and *Yucca baccata*.

TYPICAL PEDONS, PROPERTIES AND RANGES

These soils are calcareous throughout and in most places are in thick alluvium with no bedrock to a depth of many m.

Conger

A typical pedon of Conger is described in the Appendix (pedon 60-20). A table of properties and ranges is given below.

Table 196. Typical (underlined) and range in selected properties for major horizons of Conger.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	sl l	0-50	7.5YR- 10YR	5,6	3.5-5 4.5	2-4
B2	5-13	sl l	0-35	7.5YR- 10YR	5,6	3.5-5 4	3,4
K2m	23-46	--	--	7.5YR- 10YR	6-9 8	5-8 7	1-4 2
C1ca	140-185	sl ls s	10-75	7.5YR- 2.5Y 10YR	5.7 6.5	4-6 5	3,4
Control section		sl,l	< 35				

Other. In places, there are occasional pipes, or channel fills which penetrate the petrocalcic horizon; these range from about 1/2 to 10 m in width. These pipes and channel fills generally contain material with little soil development. Larger pipes and channel fills extend through the Km horizon. In a few places there are tubes a few cm to several dm across, which extend laterally through the Km horizon. These tubes usually contain materials of similar color and texture to that of the B horizon; fine roots are common. Thickness of the Km horizon ranges from a few cm to about 1 m. The K horizon is thicker on the Jornada I surface (which usually occurs on highest ridges) than on Jornada II. The laminar horizon at the surface of the Km is generally present except where pipes and tubes occur. Multiple laminar horizons are not uncommon and these occur mainly in the soils of Jornada I.

Monterosa, carbonatic variant

See section 182 for description of Monterosa, carbonatic variant.

SOIL OCCURRENCE

Soil distribution is dependent primarily upon landscape position and gravel content. The Paleorthids and Calciorthids occur on the topographic highs (the Pleistocene fans and fan-piedmont). The Torriorthents and Torrifluvents occur on the narrow, lower, Holocene terraces.

Ustollic Paleorthids. The loamy CONGER soils occur in intricate patterns with the loamy-skeletal MONTEROSA, CARBONATIC VARIANTS. Change from one to the other is caused by changes in gravel content above the petrocalcic horizon. Both soils have petrocalcic horizons and occur on the same surface, the shift from Paleorthid to the loamy-skeletal Paleorthid being caused by increase in content of coarse fragments above the petrocalcic horizon.

Typic Paleorthids. These soils occur mostly at lower elevations, and also at higher elevations where depth to the petrocalcic horizon is less than 18 cm. The shift from the loamy Simona to the loamy-skeletal Tencee is also caused by increases in gravel content above the petrocalcic horizon.

Typic Calciorthids. Jal soils occur mostly at lower elevations and slopes. The alluvium in these areas has less gravel; the petrocalcic horizon has developed in the very gravelly, but not in the low-gravel sediments. This causes complex association of Calciorthids (Jal soils) with Paleorthids (mostly Simona and Tencee soils). Weiser soils occur in areas where a petrocalcic horizon has not quite formed and where one once existed but has been broken up by landscape dissection and soil truncation.

Torrifluvents. Anthony and Anthony, loamy-skeletal variant occur on the Holocene terraces, with the variants having more gravel than the Anthony soils.

Torriorthents. Dalian, sandy-skeletal variant also occur on the Holocene terraces. These soils lack irregular decrease in organic carbon, or it does not remain above 0.2 percent to a depth of 1.25 m.

Entisols. SND-6 occurs in arroyo channels.

Paleargids. The loamy-skeletal Casito soils occur in a very few places (where the alluvium is relatively low in calcareous rocks) where an argillic horizon has formed and has been preserved.

SOIL BOUNDARIES

Table 197 gives information about boundaries to major units. Figure shows boundaries and stratigraphy of some of the units.

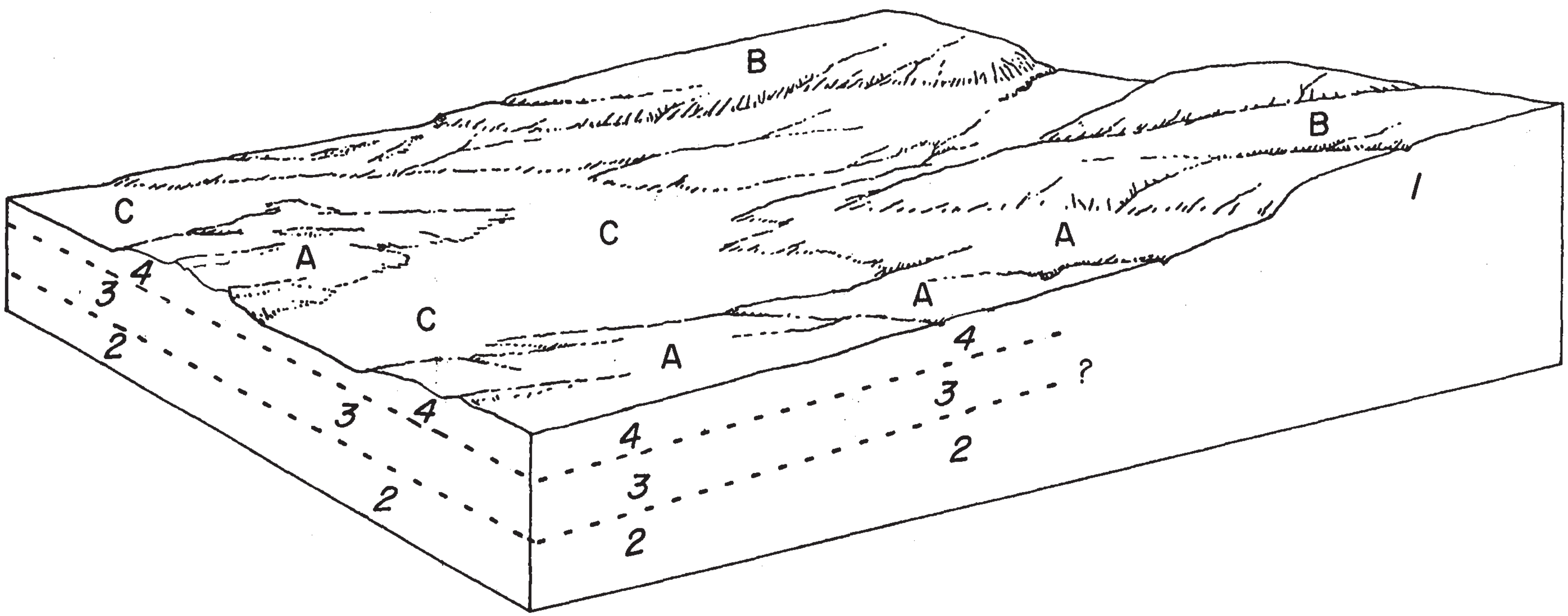


Figure 179. Block diagram of soil-landscape relations and soil stratigraphy in an area of Conger complex, Anthony complex, and Glendale-Reagan complex. A = Anthony complex (Organ surface), on slight ridges. B = Conger complex (Jornada surface). C = Glendale-Reagan complex (Organ surface).
1 = Jornada alluvium and soils. 2 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 3 = Jornada II alluvium and soils. 4 = Organ alluvium and soils.

Table 197. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Monterosa very gravelly sandy loam, carbonatic variant (100L)	The boundary is due to a large, high fan remnant in unit 100L, which presents a distinctive pattern of dissection and soils in the area of its occurrence. The topographic boundary is marked by an increase in elevation in unit 100L. There is also a difference in terrain, with unit 10LL generally having little relief transversely and unit 100L consisting of distinct ridges.
Anthony complex (13ML, 13V, 13L)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit (13ML, 13V, 13L). Topographically the boundary is distinct since the (13ML, 13V, 13L) soils occur on terraces inset against the higher soils of unit 10LL.
Sedimentary rock outcrop and Entisols (40L)	The boundary is due to a change from thick alluvium to bedrock that is at or very near the surface. The boundary to unit 40L is prominently marked by the steeper slopes and bedrock of the San Andres Mountains.

179. CASITO-TERINO COMPLEX (12V)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
CASITO	PETROCALCIC USTOLLIC PALEARGIDS	LOAMY-SKELETAL, SHALLOW	25
PINALENO	TYPIC HAPLARGIDS	LOAMY-SKELETAL	20
TERINO	PETROCALCIC USTOLLIC PALEARGIDS	LOAMY-SKELETAL, SHALLOW	25
Canutio	Typic Torriorthents	Loamy-skeletal (calcareous)	5
Delnorte	Typic Paleorthids	Loamy-skeletal, shallow	5
Nolam	Ustollic Haplargids	Loamy-skeletal	10
SND-6	Entisols		10

LOCATION, LANDSCAPE, VEGETATION

The soils occur on piedmont slopes east of the Dona Ana Mountains and have formed in alluvium derived mainly from monzonite and mixed volcanic rocks--andesite, rhyolite, and latite. Elevations range from about 4400 to 4800 feet.

The soils occur on the coalescent fan-piedmont. Arroyos are common and have dissected the sediments in many places. Smaller drainageways extend laterally from the arroyos, causing variable degrees of soil truncation. Longitudinal slopes range from about 3 to 5 percent.

Vegetation consists mainly of creosotebush with a few tarbush, mesquite and *Yucca baccata*.

TYPICAL PEDONS, PROPERTIES AND RANGES

These soils are calcareous throughout in many places, but may be noncalcareous in the upper several cm. Buried soils have been observed beneath these soils in some areas.

Casito

A typical pedon of Casito is described below. The location is the NE 1/4 Sec. 29, T21S, R2E, about 7 m south of road. A table of properties and ranges follows the description.

Soil surface: Desert pavement of closely packed andesite, rhyolite, and monzonite pebbles. A thin (less than 1 mm) discontinuous layer of loose sand occurs between and on pebbles.

A 0-3 cm. Brown (7.5YR 5/3, dry) or dark brown (7.5YR 3.5/3, moist) very gravelly sandy loam; weak medium platy and weak fine crumb; soft and loose; no roots; noncalcareous; abrupt wavy boundary.

B21tca 3-13 cm. Reddish brown (5YR 4.5/4, dry) or dark reddish brown (5YR 3.5/4, moist) very gravelly light sandy clay loam; weak fine crumb between pebbles; soft and loose; many pebble tops noncalcareous and reddish-stained; pebble bottoms have continuous carbonate coatings; fine earth effervesces strongly; clear smooth boundary.

B22tca 13-28 cm. Light brown (7.5YR 6/4, dry) or brown (7.5YR 4.5/4, moist) very gravelly light sandy clay loam; weak fine crumb between pebbles; soft; friable; few fine roots; most pebbles have continuous clay coatings, with only a few having reddish stains; few zones of redder fine earth have weak subangular blocky structure and appear like partially carbonate-engulfed Bt fabric; effervesces strongly; abrupt smooth boundary.

K2m (C1cam) 28-43 cm. White (10YR 9/2, dry) and very pale brown (10YR 7/3, moist) very gravelly, massively carbonate-cemented material, very hard; few roots; pebbles and sand grains widely separated by carbonate; few discontinuous zones filled with loamy material; effervesces strongly; clear wavy boundary.

K3 (C2ca) 43-61 cm. Dominantly white (10YR 9/2, dry) or very pale brown (10YR 7/3, moist) weakly carbonate-cemented, massive material, with lesser amounts of light brown (7.5YR 6/4, dry) or dark brown (7.5YR 4.5/4, moist) low-carbonate sandy loam; hard and soft; few roots; clear wavy boundary.

Cca (C3ca) 61-86 cm. Brown (10YR 5/3, dry) or dark brown (10YR 4/3, moist) very gravelly loamy sand; massive and single grain; soft and loose; thin, discontinuous carbonate coatings on pebbles.

Table 198. Typical (underlined) and range in selected properties for major horizons of Casito.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-3	sl	0-75	7.5YR-10YR	5,6	3.5-5	2-4 3
B2t	3-28	scl hv.sl	35-75	2.5YR-7.5YR	4-6	3.5-5 4.5	4-6
K2m	28-43	--	--	7.5YR-10YR	6-9	5-8 7	1-4 2,3
C	61-86	ls	0-75	7.5YR-10YR	5,6	4,5	3,4
Control section		scl,hv.sl	35-75				

Pinaleno

See section 155 for description of Pinaleno.

Terino

See section 175 for description of Terino.

SOIL OCCURRENCE

The occurrence of specific soils depends on the degree of soil truncation, location of arroyos and occasional presence of younger (Organ) deposits.

Paleargids. The loamy-skeletal TERINO soils, with upper subhorizons of the Bt horizon free of macroscopic carbonate, are located in stablest, least-truncated sites. CASITO soils have some visible carbonate in all subhorizons of the Bt horizons and occur in areas of slight soil truncation.

Haplargids. The Typic Haplargids, PINALENO soils, occur on scattered areas of the Organ surface. The heavier-textured, Ustollic Haplargids, Nolam soils, occur on the Jornada surface and have more organic carbon.

Paleorthids. Delnorte soils are found in areas of still greater soil truncation, where the argillic horizon has been truncated and/or carbonate-engulfed.

Torriorthents. Canutio soils are located on deposits of Organ age that are very young, or have been truncated, carbonate-engulfed, or both, so that a Bt horizon is not present.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

The boundaries are not topographically prominent. This is because of the relatively small size and low elevations of the Dona Ana Mountains as a source of sediments. The land forms are not as prominent as they are downslope from the San Andres and Organ Mountains. Table 199 presents information on boundaries to adjacent major units.

Table 199. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Nickel-Delnorte complex (10V)	The boundary is due to landscape dissection in unit 10V. Truncation has resulted in carbonate engulfment of the argillic horizon formerly present in the soils of unit 10V. The topographic boundary is not prominent but is marked by increasing dissection and development of ridges in unit 10V.
Anthony complex (13ML, 13V, 13L)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit (13ML, 13V, 13L). The topographic boundary is not distinct. The (13ML, 13V, 13L) soils commonly occur downslope from 12V soils, or on small fans adjacent to the 12V soils.
Tres Hermanos-Onite complex (14V)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 14V. The topographic boundary is not distinct but characteristically these soils occur on younger deposits downslope from areas of unit 12V.
Rhyolite rock outcrop and Argids (40R)	The boundary is due to a change from thick alluvium of unit 12V to bedrock which is at or near the surface in unit 40R. The boundary is distinct and marked by the steeper slopes and bedrock of the Dona Ana Mountains.

180. CARALAMPI-NOLAM COMPLEX (12MO,123R)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
CARALAMPI	USTOLLIC HAPLARGIDS	LOAMY-SKELETAL	25
NOLAM	USTOLLIC HAPLARGIDS	LOAMY-SKELETAL	20
Earp	Aridic Argiustolls	Loamy-skeletal	10
Pinaleno	Typic Haplargids	Loamy-skeletal	10
Terino	Petrocalcic Ustollic Paleargids	Loamy-skeletal	5
Terino, mod. deep variant	Paleargids	Loamy-skeletal	10
Terino, mollic variant	Petrocalcic Paleustolls	Loamy-skeletal	5
SND-6	Entisols		10
Other inclusions (Paleorthids, Haplustolls)			5

LOCATION, LANDSCAPE, VEGETATION

Soils of this mapping unit occur along the front of the central part of the Organ Mountains, and have formed in sediments derived mainly from monzonite and/or rhyolite; in places there are small amounts of andesite and limestone. Elevations range from about 4800 to 6000 feet.

The soils occur on high fans extending westward from the mountain canyons, and on terraces between the fans. There are commonly several levels within each large fan. Piles of cobbles and boulders are common on steeper slopes. The sediments have been cut by arroyos and in places have been trenched to depths of several m or more. Most slopes range from about 10 to 20 percent, with extremes from about 5 to 40 percent.

There is a wide variety of vegetation, including catclaw, prickly pear, beargrass, indigo bush, sideoats grama, black grama, blue grama, sprangletop, cotton top, cholla, bristle grass, *Yucca baccata*, sotol, sumac, mariola, winter fat, and barrel cactus.

TYPICAL PEDONS, PROPERTIES AND RANGES

Caralampi

See the Appendix for a description of Caralampi (pedon 59-14). These soils are similar except in places they have more stones.

Nolam

See section 175 for a description of Nolam. These soils are similar except that in places they have more stones.

SOIL OCCURRENCE

Soil patterns are commonly intricate because of erosion and deposition at various places on the fans. Soil occurrence is dependent largely upon landscape position. Soils of this unit illustrate the transition from the Ustollic subgroups to the Mollisols, which occur only on the broadest, stablest surfaces of the fans.

Ustollic Haplargids. The loamy-skeletal Caralampi soils occur mostly at higher elevations. They lack calcic horizons within a depth of 1 m, and thus differ from the loamy-skeletal Nolam soils which occur mostly at lower elevations in this unit.

Typic Haplargids. The Pinaleno soils occur at lowest elevations; in younger soils with less clay; and in truncated areas (see "other studies").

Aridic Argiustolls. The loamy-skeletal Earp soils occur in stablest areas (of Organ age) where mollic epipedons are preserved. These soils are generally inset below the older soils.

Petrocalcic Paleustolls. The loamy-skeletal Terino soils, mollic variants, occur in stablest areas of older landscapes. These soils have petrocalcic horizons.

Petrocalcic Ustollic Paleargids. Terino and Terino, moderately deep variants, tend to occur on older landscapes that are somewhat less stable--on the ridges of remnants where there has been enough truncation to remove the mollic epipedon.

Haplustolls. The coarse-loamy Aladdin soils and the loamy-skeletal Santo Tomas soils occur in younger deposits of Organ age, inset below, or in places burying older soils.

Paleorthids. The loamy-skeletal Monterosa soils, Ustollic Paleorthids, occur on some of the highest, oldest fan remnants--commonly narrow ridges where the soils have been truncated. The argillic horizons that must once have been present have been truncated, carbonate-engulfed, or both. The loamy-skeletal Delnorte soils, Typic Paleorthids, occur in areas where depth to the petrocalcic horizon is less than 18 cm.

Petrocalcic Calciustolls. The loamy-skeletal Boracho soils occur in a few high ridges where a mollic epipedon is present but not an argillic horizon.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 200 presents information on boundaries to adjacent major units.

Table 200. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Canutio gravelly sandy loam, loamy subsoil variant (103ML)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 103ML. Parent materials also change, from mostly monzonite and rhyolite with little or no limestone in unit (12MO, 123R) to lesser amounts of monzonite and rhyolite and more limestone in unit 103ML. The topographic boundary to unit 103ML is marked by a difference in elevation with soils of unit 103ML being lower than and in places inset against soils of unit (12MO, 123R). Vegetation in unit 103ML consists mostly of creosotebush, with a few _Yucca baccata_, tarbush, and mariola; the perennial grasses, and the density and variety of vegetation in unit (12MO, 123R) are generally lacking.
Onite sandy loam (13MM)	The boundary is due to a younger alluvium and geomorphic surface (Organ and Isaacks' Ranch) in unit 13MM; and to more coarse fragments and greater precipitation in unit (12MO, 123R). The topographic boundary is marked by an increase in slope from 4 to 5 percent in the eastern part of unit 13MM, to 6 to 8 percent in the western part of unit (12MO, 123R). Vegetation shifts from mostly _Yucca elata_ and Mormon tea in unit 13MM to catclaw, indigo bush, _Lippia Wrightii_, black grama, sideoats grama, snakeweed, and prickly pear in unit (12MO, 123R).
Monzonite rock outcrop and Argids (40M)	The boundary is due to a shift from thick alluvium in unit (12MO, 123R) to bedrock which is at or near the surface in unit 40M. The topographic boundary is prominent, being marked by the steeper slopes and bedrock of the Organ Mountains. The boundary is irregular because of the extensions of unit (12MO, 123R) up into canyons flanked by bedrock.

181. MONTEROSA VERY GRAVELLY SANDY LOAM (10OR, 10MLO)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
MONTEROSA	USTOLLIC PALEORTHIDS	LOAMY-SKELETAL, SHALLOW	60
Conger	Ustollic Paleorthids	Loamy, shallow	10
Delnorte	Typic Paleorthids	Loamy-skeletal, shallow	10
Other inclusions (Calciorthids, Paleorthids, Torriorthents)			20

LOCATION, LANDSCAPE, VEGETATION

These soils occur in a few small areas west of the central portion of the Organ Mountains, and west of the San Andres Mountains. The soils have formed in alluvium derived largely to wholly from rhyolite, but in places with sediments derived from andesite, monzonite, and limestone. Elevations range from about 4800 to 5400 feet.

These soils occur on isolated ridge remnants of alluvial fans. Most of the ridges are isolated by younger terraces inset against them. Slopes along the ridges range from about 3 to 15 percent. Slopes of ridge sides range from 10 to 25 percent.

Vegetation consists primarily of ratany, creosotebush, fluffgrass, and *Yucca baccata*.

TYPICAL PEDONS, PROPERTIES AND RANGES

Delnorte

See section 139 for a description of Delnorte.

Monterosa

A typical pedon of Monterosa is described in the Appendix (pedon 66-2).

SOIL OCCURRENCE

Soil distribution depends upon gravel content and depth to the petrocalcic horizons; essentially all Paleorthids contain enough organic carbon for the Ustollic subgroups.

Ustollic Paleorthids. The loamy-skeletal MONTEROSA soils dominate most of the delineations. Conger soils, loamy, have fewer coarse fragments. A few Paleorthids have a petrocalcic horizon at depths of 50 to 100 cm.

Typic Paleorthids. The loamy-skeletal DELNORTE soils occur where depth to the petrocalcic horizon is less than 18 cm. Such areas are most common adjacent to drainageways where erosion has stripped away part of the overlying horizons.

Typic Torriorthents. The loamy-skeletal Canutio soils occur on the lower sides of some of the ridges.

Typic Calciorthids. The loamy-skeletal Nickel soils occur in a few places where a calcic, instead of a petrocalcic horizon is present.

SOIL BOUNDARIES

Table 201 presents information on boundaries to adjacent major units.

Table 201. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and Character
Canutio gravelly sandy loam, loamy sub-soil variant (103ML) Onite sandy loam (13MM) Pinaleno very gravelly sandy loam (13R)	The boundaries are caused by a younger alluvium and geomorphic surface (Organ) in the 103ML, 13MM, and 13R mapping units. The topographic boundary usually is distinct, because most areas of unit (10MLO,100R) occur as isolated ridge remnants that are higher than adjacent terraces. Vegetatively the boundary is apparent in many places. Creosotebush is the dominant vegetation on unit (10MLO,100R). Adjacent mapping units (except for unit 103ML, where the soils are highly calcareous) generally lack creosotebush or it occurs in much smaller amounts.
Caralampi-Nolam complex (12MO,123R)	The boundary to unit (12MO,123R) is generally caused by a change in parent materials, with enough limestone occurring in unit (10MLO,100R) to prevent development of the argillic horizon.

182. MONTEROSA VERY GRAVELLY SANDY LOAM, CARBONATIC VARIANT (100L)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
MONTEROSA, CARBONATIC VARIANT	USTOLLIC PALEORTHIDS	LOAMY-SKELETAL, CARBONATIC, SHALLOW	50
TENCEE	TYPIC PALEORTHIDS	LOAMY-SKELETAL, CARBONATIC, SHALLOW	20
Anthony	Typic Torrifluvents	Coarse-loamy (calcareous)	5
Canutio	Typic Torriorthents	Loamy-skeletal (calcareous)	5
Canutio, loamy subsoil variant	Typic Torriorthents	Coarse-loamy (calcareous)	5
Conger	Ustollic Paleorthids	Loamy, shallow	10
SND-6	Entisols		5

LOCATION, LANDSCAPE, VEGETATION

These soils occur in one area (west of Bear Canyon) along the western front of the San Andres Mountains. The soils have formed in sediments derived mostly from the sedimentary rocks, limestone, sandstone, and shale, commonly with variable amounts of rhyolite, granite and quartzite. Elevations range from about 4700 to 4900 feet.

Ridge remnants of a large alluvial fan are the major landscape features. Ridge crests are Jornada I and ridge sides are Jornada II (see section 162). Small valley fills, commonly cut by gullies, occur at the base of ridge sides. Longitudinal slopes along ridge crests range from 3 to 5 percent. Slopes of ridge sides range from 5 to 20 percent.

Vegetation consists of creosotebush, fluffgrass, mesquite, zinnia, bush muhly and mariola.

TYPICAL PEDONS, PROPERTIES AND RANGES

All soils are strongly calcareous throughout. They have formed in thick deposits and no bedrock is present to depths of many m.

Monterosa, carbonatic variant

A typical pedon of Monterosa, carbonatic variant is described below. The location is a ridge crest in the SW 1/4 Sec. 35, T20S, R3E, along pipeline just SE of NASA road. A table of properties and ranges follows the description.

Soil surface. The surface is about 90 percent covered with limestone, sandstone, rhyolite and granite pebbles. There are also a few pebbles composed of carbonate-cemented material derived from the soil horizons beneath. A discontinuous layer of loose reddish sand occurs between and beneath pebbles.

A   0-5 cm. Grayish brown (10YR 5.5/1.5, dry) or dark grayish brown (10YR 3.5/2, moist) very gravelly sandy loam; weak medium platy; soft; very few roots; the upper cm is vesicular; effervesces strongly; abrupt smooth boundary.

B21ca   5-10 cm. Brown (10YR 5/3, dry) or dark brown (10YR 3.5/3, moist) very gravelly light loam; weak coarse platy; slightly hard; very few roots; some pebble tops are brownish and carbonate-free in upper cm, but in lower part the pebbles are continuously coated; effervesces strongly; clear wavy boundary.

B22ca   10-23 cm. Pale brown (10YR 6/3, dry) or dark brown (10YR 4/3, moist) very gravelly fine sandy loam; weak medium subangular blocky; slightly hard; roots common; carbonate coatings on pebbles and sand grains; effervesces strongly; clear wavy boundary.

B23ca   23-36 cm. Pale brown (10YR 6/3, dry) or dark brown (10YR 4/3, moist) very gravelly fine sandy loam; weak fine and medium subangular blocky; slightly hard; roots common; carbonate coatings on pebbles and sand grains; part of gravel fraction consists of carbonate-cemented fragments that are extremely hard; effervesces strongly; clear wavy boundary.

K21m   36-69 cm. Dominantly white and very pale brown (10YR 8/1 and 10YR 8/3, dry) or very pale brown (10YR 7/3 and 10YR 7/4, moist) with some very pale brown (10YR 7/3, dry) or pale brown (10YR 6/3, moist), carbonate-cemented material; massive; extremely hard; no roots; laminar horizon, 1-5 mm thick, in upper part; effervesces strongly; clear wavy boundary.

K22m   69-107 cm. Pinkish white (7.5YR 8/2, dry) or light brown (7.5YR 6/4, moist), carbonate-cemented material; massive; extremely hard; no roots; effervesces strongly; clear wavy boundary.

K & C 107-114 cm. Light brown (7.5YR 6/4, dry) or brown (7.5YR 5/4, moist), very gravelly loamy sand, with discontinuous lenses of lighter-colored carbonate-cemented material; slightly and extremely hard; massive and single grain; pebbles are discontinuously coated with carbonate between the cemented lenses; effervesces strongly.

Table 202. Typical (underlined) and range in selected properties for major horizons of Monterosa, carbonatic variant.

Horizon	Depth cm	Particle size < 2mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	sl l	10-75	7.5YR- 10YR	4-6 5.5	3.5-5	1-3 2
B2	5-36	sl l	35-75	7.5YR- 10YR	5,6	4,5	3,4
K2m	36-107	--	--	7.5YR- 10YR	6-9 8	5-8 7	1-4 3
C	107-114	ls s	10-75	7.5YR- 10YR	5,6	4,5	3,4
Control section		sl,l	35-75				

Other. Depth to the petrocalcic horizon (the K2m horizon in the description) is usually 25 to 40 cm on ridge crests (about 18-30 on ridge sides), ranging from 18 to 50 cm. The petrocalcic horizon is not as thick on ridge sides (where it is commonly a few cm to several dm thick) as it is on ridge crests.

Tencee

A description of Tencee is in the Appendix (pedon 62-1).

SOIL OCCURRENCE

Soil occurrence varies with landscape position, depth to the petrocalcic horizon in the soils concerned, and gravel content. All Paleorthids occur on the ridges. Most Torriorthents and all Torrifluvents occur between the ridges.

Ustollic Paleorthids. The loamy-skeletal MONTEROSA, CARBONATIC VARIANTS, and the loamy Conger soils occur where depth to the petrocalcic horizon is 18 cm or more. The loamy Conger soils average less than 35 percent by volume of coarse fragments above the petrocalcic horizon. These soils also have mixed mineralogy because of the corresponding lower contribution of the coarse fragments of calcareous coarse fragments to the mineralogy. The Ustollic Paleorthids occupy almost all of the area of the ridge crests and most of the ridge sides.

Typic Paleorthids. The loamy-skeletal TENCEE soils occur where depth to the petrocalcic horizon is less than 18 cm. These places occur near drainageways on the sides of the ridges.

Torriorthents occur mainly in the valley fills between the ridges. Canutio, loamy subsoil variant, occurs where coarse fragments in the 25 to 100 cm control section average less than 35 percent by volume. Canutio soils occur where coarse fragments in the control section average more than 35 percent; these areas are mostly in the valley fills, with smaller areas occurring in pipes in soils of the ridges.

Torrifluvents occur in the valley fills, in places where organic carbon decreases irregularly with depth or remains above 0.2 percent to a depth of 1.25 m.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 203 presents information on boundaries to adjacent major units.

Table 203. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Conger complex (10LL)	The boundary is due to a large, high fan remnant in unit 100L. The remnant and its pattern of dissection, in which high ridges alternate with narrow valley fills, present an assemblage of soils that is distinctive along the front of the San Andres Mountains in the study area. The topographic boundary is marked by a general increase in elevation in unit 100L. Also, landscapes in unit 10LL usually have relatively little transverse relief whereas terrain in unit 100L is marked by high ridges.
Boracho very gravelly fine sandy loam, carbonatic variant (10LO)	The boundary is due to greater landscape dissection in unit 100L. The ridge remnants in unit 100L are markedly narrower and the epipedon is too light-colored to qualify as mollic. The topographic boundary to unit 10LO is marked by broader ridge crests in that mapping unit.
Anthony complex (13ML, 13V, (13LG)	The boundary is due to a younger alluvium and geomorphic surface (Organ) in unit (13ML,13V,13LG). The topographic boundary is distinct, with soils of unit (13ML,13V,13LG) occurring on narrow fills between ridges of unit 100L and also on low terraces along the margin of the large fan remnant on which soils of unit 100L occur.

183. BORACHO VERY GRAVELLY FINE SANDY LOAM, CARBONATIC VARIANT (10L0)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
BORACHO, CARBONATIC VARIANT	PETROCALCIC CALCIUSTOLLS	LOAMY-SKELETAL, CARBONATIC, SHALLOW	50
KIMBROUGH	PETROCALCIC CALCIUSTOLLS	LOAMY, SHALLOW	35
Santo Tomas, calcareous variant	Pachic Haplustolls	Loamy-skeletal	10
SND-6	Entisols		5

LOCATION, LANDSCAPE, VEGETATION

These soils occur at higher elevations in two small areas along the fronts of the San Andres Mountains - one west of Bear Canyon and the other west of Hawkeye Canyon. The soils have formed in alluvium derived from limestone, sandstone, siltstone and shale, in places with smaller amounts of rhyolite, granite, quartzite or andesite. Elevations range from about 4900 to 5100 feet.

The soils occur on ridge remnants of alluvial fans. Small arroyos occur between the larger ridges. Longitudinal slopes along ridge crests range from about 3 to 8 percent; ridge sides slope from about 10 to 25 percent.

Vegetation consists of creosotebush, mariola, *Yucca baccata*, mesquite, snakeweed and fluffgrass.

TYPICAL PEDONS, PROPERTIES AND RANGES

These soils are calcareous throughout and are underlain by alluvium many m thick.

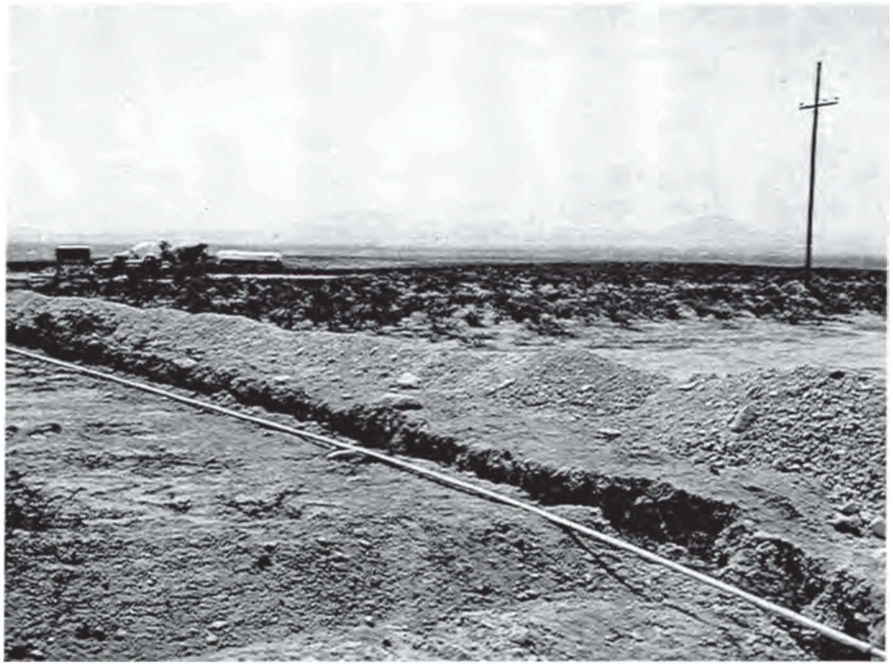
Boracho, carbonatic variant

A typical pedon of Boracho, carbonatic variant is described below. The location is the NW 1/4 Sec. 36, T21S, R3E, about 90 m north of the Bear Canyon Road. Figure 180 is a photograph of the pedon and its landscape. A table of properties and ranges follows the description.

Soil surface. Desert pavement consisting of about 90 percent pebbles; discontinuous layer of reddish sand between and under pebbles; limestone pebbles and calcrete fragments are etched and pitted; some pebbles have discontinuous carbonate coatings, and some are coated with black desert varnish.

A11 0-4 cm. Gray (10YR 5/1, dry) or very dark grayish brown (10YR 3/2 moist) very gravelly fine sandy loam; weak medium platy and weak fine crumb; soft and loose; effervesces strongly; few roots; abrupt smooth boundary.

A12ca 4-20 cm. Dark grayish brown (10YR 4/2, dry) or very dark grayish brown (10YR 3/2.5, moist) very gravelly loam; mainly weak medium subangular



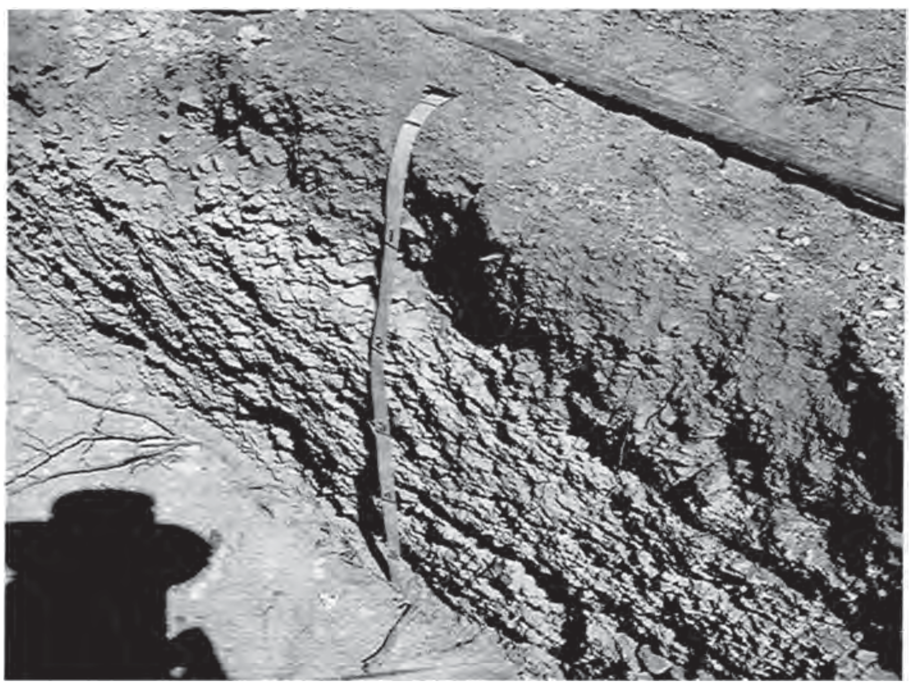


Figure 180. Upper. Landscape of a Petrocalcic Calciustoll, Boracho variant, on the Jornada I surface. Vegetation is creosotebush, prickly pear, and snakeweed.

Lower. Boracho, carbonatic variant. Scale is in feet.

blocky and hard, with some weak fine crumb and loose; many roots; pebbles thinly and continuously coated with carbonate; upper 2 to 5 cm is weak coarse platy, and has some pebble tops free of carbonate; effervesces strongly; clear smooth boundary.

A13ca 20-30 cm. Dark grayish brown (10YR 4/2, dry) or very dark grayish brown (10YR 3/2.5, moist) very gravelly light loam; massive, with some weak fine crumb; soft and slightly hard; many roots; effervesces strongly; abrupt smooth boundary.

K21m 30-41 cm. White (10YR 9/2, dry) or very pale brown (10YR 8/3, moist); platy K-fabric; massive; plates range from 2 to 10 cm thick and their upper part consists of laminar horizons, 1 to 10 mm thick; extremely hard; surface of laminar horizon stained 10YR 7/2, dry, 6/3, moist; laterally there are discontinuous pockets, a few cm deep into which the A horizon descends; laminar horizon has dominant color of 10YR 8/2 and 7/2, dry, with a few laminae slightly lighter or darker; surface of laminar horizon has a smooth but slightly pitted appearance; fine roots concentrated on laminar horizon; a few interconnecting open channels, several mm diameter, are partly filled with loamy material; very few pale yellow (2.5 YR 7/4, dry) staining along fracture surfaces; effervesces strongly; clear smooth boundary.

K22m 41-66 cm. White (7.5YR 9/2, dry) or pink (7.5YR 7.5/4, moist); very gravelly, carbonate-cemented material, massive; thick, coalescent carbonate coatings on pebbles; no roots; very few yellowish stainings on fracture surfaces, extremely hard; effervesces strongly; clear wavy boundary.

K23m 66-91 cm. Dominantly pinkish white (7.5YR 8/2, dry) and light brown (7.5YR 6.5/4, moist) with a few parts white, very gravelly, carbonate-cemented material; very few yellow parts; massive; very hard; no roots; effervesces strongly; clear wavy boundary.

K24m 91-114 cm. Similar to K23m but contains less gravel (about 50 to 60 percent).

K3 114-150 cm. Pinkish gray (7.5YR 7/3, dry) or brown (7.5YR 5/4, moist) very gravelly loamy sand, with few cemented parts; massive; slightly hard, no roots; pebbles thinly, discontinuously coated with carbonate; effervesces strongly; clear wavy boundary.

Cca 150-160 cm. Brown (7.5YR 5/4, dry) or dark brown (7.5YR 4/4, moist) very gravelly loamy sand; massive and single grain; soft and loose; no roots; few partial carbonate coatings on pebble bottoms; some pebbles without macroscopic carbonate; effervesces strongly.

Table 204. Typical (underlined) and range in selected properties for major horizons of Boracho, carbonatic variant.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-30	sl l	35-75	7.5YR- 10YR	4,5	2,3	1-3 2
K2m	30-114	--	--	7.5YR- 2.5Y	6-9	5-8	1-4
C	150-160	ls,s sl	10-75	7.5YR- 10YR	5,6	4,5	3,4
Control section		sl,l	35-75				

Other. The K horizon generally ranges from about 1/2 to 1 m thick on the ridge crests but is thinner on ridge sides. There are occasional pipes which cut through the K horizon; these range from about 1/2 to a few m in width. In places there are tubes, a few cm across, which extend laterally through the K horizon. Tubes and pipes are generally filled with material which is similar to the overlying A horizon. Laminar horizons are usually present at the surface of the Km horizon except where it is cut by pipes or tubes. The soils are generally very gravelly throughout, though in places there are a few low-gravel lenses a few cm thick.

Kimbrough

These soils are similar to Boracho variant but have less gravel.

SOIL OCCURRENCE

Soil occurrence is determined by landscape position, gravel content, mineralogy and pipes.

Calciustolls. The loamy-skeletal BORACHO, CARBONATIC VARIANT occurs where gravel content above the petrocalcic horizon averages more than 35 percent by volume. The loamy KIMBROUGH soils average less than 35 percent gravel, and also have mixed mineralogy. When gravel content thus drops, analyses of soils with similar mineralogy indicate that these soils (which have some noncalcareous rock fragments in the parent sediments) would drop below 40 percent carbonate in the less than 20 mm fraction.

Haplustolls. Santo Tomas, calcareous variants occur in pipes that penetrate the petrocalcic horizon and in Holocene deposits along small arroyos.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 205 gives information about boundaries to adjacent major units. Figure 181 shows boundaries and stratigraphy of some of the units.

Table 205. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Monterosa very gravelly sandy loam, carbonatic variant (100L)	The boundary is due to landscape dissection in unit 100L. The ridge remnants in unit 100L are markedly narrower and the epipedon is too light-colored to qualify as mollic. The topographic boundary to unit 10LO is marked by broader ridge crests in that unit (fig. 181).
Terino very gravelly sandy loam (12R)	The boundary is due to a change in parent materials, from sediments containing a high proportion of sedimentary rocks to sediments that are mostly or wholly rhyolitic. Part of the boundary is marked by an arroyo, upslope from which virtually all the parent materials are rhyolitic.
Anthony complex (13LG)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 13LG. The topographic boundary is prominent; it is marked by the contact of low terraces (unit 13LG) against the higher fan remnants of unit 10LO.
Sedimentary rock outcrop and Entisols (40L)	The boundary is due to a change from deep alluvium (unit 10LO) to bedrock which is at or very near the surface. Topographically the boundary is prominent, being marked by the steeper slopes and bedrock of the San Andres Mountains.

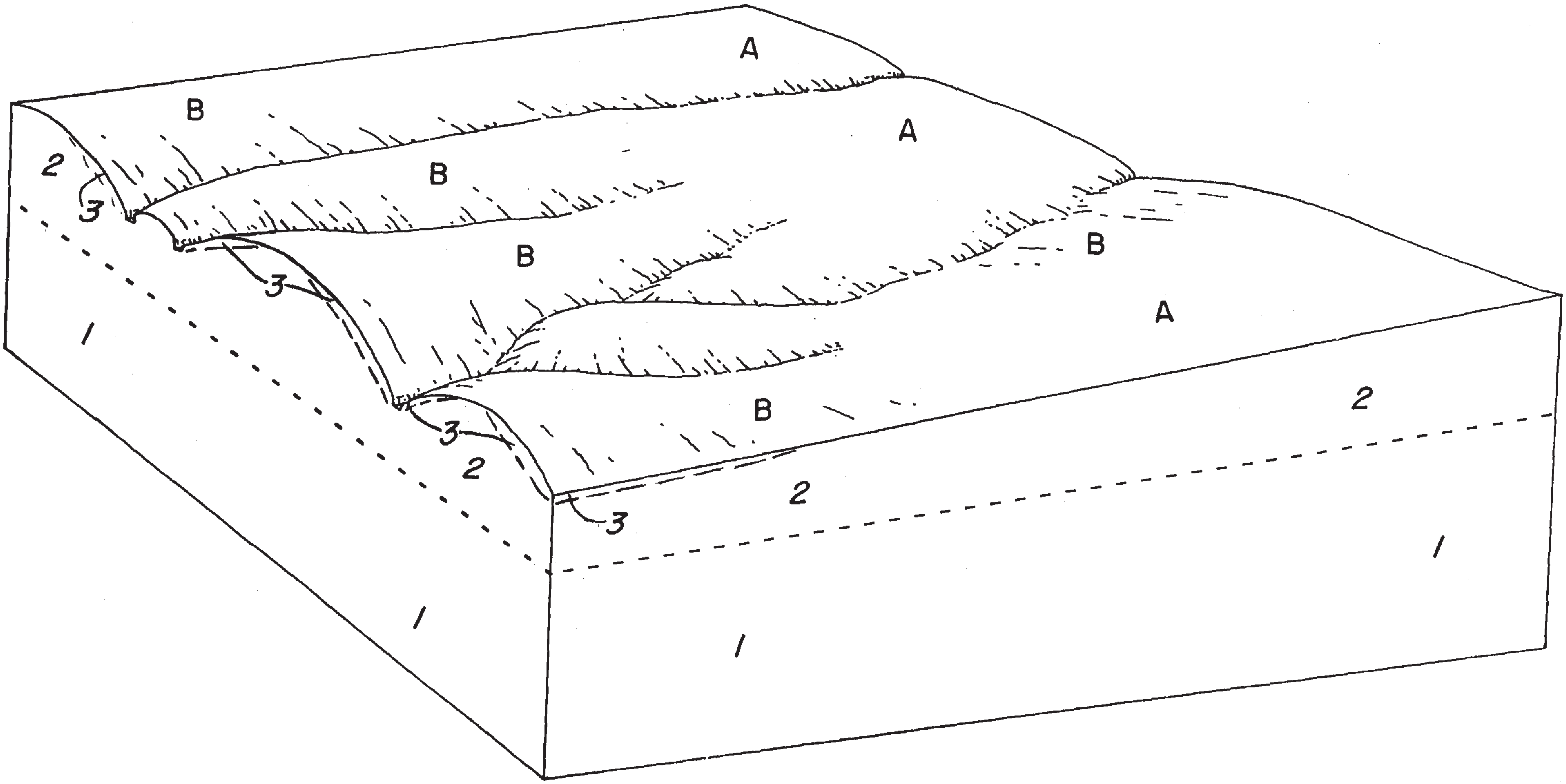


Figure 181. Block diagram of soil-landscape relations in an area of Monterosa very gravelly sandy loam, carbonatic variant, and Boracho very gravelly fine sandy loam, carbonatic variant. This is a boundary between the Aridisols and Mollisols. A = Boracho very gravelly fine sandy loam, carbonatic variant (Jornada I surface). B = Monterosa very gravelly sandy loam, carbonatic variant (Jornada I surface).
1 = Upper Camp Rice Formation (piedmont facies). 2 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 3 = Jornada II alluvium.

184. Soils of the Dona Ana and younger surfaces.

These soils occur on the highest fan remnants along the front of the Organ Mountains. Surfaces younger than Dona Ana--probably of Jornada age--occur on sides of the remnants.

Soils of the Dona Ana surface illustrate development of the laminar horizon and stage IV completion of carbonate accumulation in soils of the mountain canyons. Stage IV has not formed in soils of Jornada I age in Soledad Canyon, but has formed in soils of Dona Ana age in Ice Canyon. Soils of these remnants illustrate the transition from soils with argillic horizons (Argids) on stable sites to soils without them (Calciustolls) in dissected areas.

Soils of two mapping units occur on remnants of this ancient surface. In one the soils occur on a relatively stable bedrock-defended remnant in Ice Canyon. Soils of the other unit are on dissected remnants west of Ice Canyon; scattered remnants also occur along the mountain front to the south.

Mapping units on the Dona Ana and younger surfaces are: Terino very gravelly loam, thick solum variant (12RO), and Boracho complex (10RO).

185. TERINO VERY GRAVELLY LOAM, THICK SOLUM VARIANT (12RO)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping unit
TERINO, MOLLIC, MOD. DEEP VARIANT	PETROCALCIC PALEUSTOLLS	LOAMY-SKELETAL	45
TERINO, THICK SOLUM VARIANT	PETROCALCIC USTOLLIC PALEARGIDS	CLAYEY-SKELTAL	30
Casito	Petrocalcic Ustollic Paleargids	Loamy-skeletal, shallow	5
Limpia	Pachic Argiustolls	Clayey-skeletal	10
Terino	Petrocalcic Ustollic Paleargids	Loamy-skeletal, shallow	10

LOCATION, LANDSCAPE, VEGETATION

These soils occur in one area, in Ice Canyon, along the front of the Organ Mountains. The soils have formed in sediments derived from rhyolite. Elevation ranges from about 5700 to 5900 feet.

The soils occur on a ridge remnant that has been protected from erosion by adjacent bedrock outcrops. The ridge crest is nearly level transversely for a few m , and has a longitudinal slope of 8 to 9 percent to the west. Most parts of the ridge sides slope steeply (30 to 45 percent) and in places are incised by waterways leading to the crest.

Vegetation on the ridge crest is mainly snakeweed, mesquite, prickly pear, whitethorn and mariola; there are scattered clumps of black grama and sideoats grama. On south-facing ridge sides the dominant vegetation is tarbush, whitethorn, mariola, catclaw, snakeweed, mesquite, black grama, and *Yucca baccata*. Scattered juniper and pinon occur on north and east sides of the ridges. On north-facing sides of ridges, there is more grass, mostly blue grama. There are also fewer shrubs, which consist mostly of small oak, 1/2 to 1 m high, snakeweed, and scattered juniper trees.

TYPICAL PEDONS, PROPERTIES AND RANGES

Terino, mollic, moderately deep variant

A typical pedon of Terino, mollic, moderately deep variant is described below. The location is the NE 1/4 SW 1/4 Sec. 12, T23S, R3E, east side of road cut. A table of properties and ranges follows the description.

Soil surface. Covered with rhyolite fragments of gravel and cobble size. There are a few small rills.

A1 0-13 cm. Dark reddish gray (5YR 4/2, dry) or dark reddish brown (5YR 3/2, moist) very gravelly loam; weak fine crumb; soft; roots common; noncalcareous; clear wavy boundary.

B1 13-33 cm. Dark reddish gray (5YR 4/2, dry) or dark reddish brown (5YR 3/2, moist) very gravelly heavy loam; compound weak medium subangular blocky and weak fine and medium crumb; soft; roots common; noncalcareous; clear smooth boundary.

B21t 33-56 cm. Reddish brown (5YR 3.5/3, dry and moist) very gravelly heavy sandy clay loam; structure is pebble-controlled but a few fine and medium angular blocks occur between pebbles, and some weak fine crumb; slightly hard; roots common; pebbles coated with clay; the few ped surfaces are commonly smooth and reflective; noncalcareous; clear wavy boundary.

B22t 56-76 cm. Reddish brown (4YR 4/4, dry) and dark reddish brown (4YR 3.5/4, moist) very gravelly sandy clay; weak fine angular blocky and weak fine crumb between pebbles; slightly hard and hard; roots common; pebbles coated with clay; few black stains (Fe, Mn?) on pebbles; ped surfaces smooth and reflective; noncalcareous; clear wavy boundary.

B23t 76-94 cm. Reddish brown (4YR 4/5, dry) and dark reddish brown (4YR 3.5/5, moist) very gravelly sandy clay loam; weak fine and medium subangular blocky and weak fine granular between pebbles; slightly hard and hard; roots common; pebbles coated with clay and some have black stains; noncalcareous; abrupt smooth boundary.

K1 94-102 cm. Light brown (7.5YR 6.5/4, dry) or brown (7.5YR 5/4, moist) very gravelly heavy fine sandy loam, with scattered yellowish stains on pebbles, and few parts of 5YR hue; massive; slightly hard; very few roots; black stains on some pebbles; carbonate coatings on pebbles; effervesces strongly; abrupt smooth boundary.

K2m (C2cam) 102-117 cm. Dominantly pink (7.5YR 8/4, dry, 7.5YR 7/4, moist) very gravelly, carbonate-cemented material; some pebble coatings whiter than above, and a few zones are light brown (7.5YR 6.5/4, dry) or brown (7.5YR 5/4, moist); massive; very hard; no roots; pebbles thickly coated with carbonate; effervesces strongly.

Table 206. Typical (underlined) and range in selected properties for major horizons of Terino, mollic, mod. deep variant.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-13	s,<u>l</u>	25-75	<u>5YR-</u> 7.5YR	<u>4</u>,5	2,<u>3</u>	<u>2</u>,3
B2t	33-94	<u>scl</u> cl sc c	35-75	2.5YR- <u>5YR</u>	3,<u>4</u>	2-4 <u>3.5</u>	3-6 <u>4</u>
K2m	102-117	<u>sl</u>	--	<u>7.5YR-</u> 10YR	6-9 <u>8</u>	5-8 <u>7</u>	1-<u>4</u>
Control section		scl,cl	> 35				

<u>Other.</u> Depth to the petrocalcic horizon ranges from 1/2 to 1-1/2 m. These soils are noncalcareous to depths ranging from about 25 to 125 cm, with the noncalcareous zones generally being thickest in the middle and lower sides of ridges. The Km horizon is nearest the surface on the upper parts of the ridge sides and gradually deepens downslope.

Terino, thick solum variant.

See pedon 60-5, Appendix, for the description of Terino, thick solum variant. Figures 182 and 183 are photographs of the pedon and its landscape. A table of properties and ranges is given below.

Table 207. Typical (underlined) and range in selected properties for major horizons of Terino, thick-solum variant.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-8	sl l (underlined)	50-75	5YR (underlined)	4 (underlined),5	3 (underlined),4	2-4 3,4 (underlined)
B2t	20-58	c (underlined)	35-75	10R- 5YR 2.5YR (underlined)	4 (underlined),5	3 (underlined),4	4-6 (6 underlined)
K2m	64-86	--	--	7.5YR- 10YR (underlined)	6-9 (9 underlined)	5-8 (8 underlined)	1-4 2 (underlined)
Control section		c	> 35				

Other. These soils are noncalcareous in the A horizon and in upper subhorizons of the Bt horizon. In places, macroscopic gypsum is not present in the Bt horizon. A discontinuous A2 horizon was observed in one spot at a depth of about 20 cm. The prominent, red Bt horizon thins toward the ridge sides. The extremely high clay content of this Bt horizon is unusual in Desert Project soils; this is the only known location of a Bt horizon of this character. This is attributed to the great age of this soil, which may date from early in mid-Pleistocene time.

SOIL OCCURRENCE

Soil occurrence is determined by position on the ridge.

Paleargids. TERINO, THICK SOLUM VARIANT, occurs only on the crest of the ridge. Casito soils have some macroscopic carbonate in all subhorizons of the Bt horizon; they occur only on shoulders of the ridge. Terino soils also occur on shoulders of the ridge; they do not have macroscopic carbonate in all subhorizons of the Bt.

Paleustolls. Terino, mollic, moderately deep variant occurs only on the sides of the ridge.

Argiustolls. The clayey-skeletal Limpia soils occur in places on the lower sides of the ridge.

Figure 182. Landscape of a Petrocalcic Ustollic Paleargid, Terino variant 60-5. The pedon occurs on a high, bedrock-defended ridge remnant of the Dona Ana surface. Ice Canyon is beyond the jeep. Vegetation is snakeweed, mesquite, cholla, black grama, sideoats grama, and prickly pear. Slope is 9 percent.

Figure 183. A Petrocalcic Ustollic Paleargid, Terino variant 60-5. Scale is in feet.

SOIL BOUNDARIES

Table 208 presents information on boundaries to adjacent major units.

Table 208. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Santo Tomas - Earp complex (13RO)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 13RO. Topographically the boundary is prominent; soils of unit 13RO on low terraces inset against the much higher fan remnant on which the 12RO soils are located.
Rhyolite rock outcrop and Argids (40R)	The boundary is due to a change from thick alluvium in unit 12RO to bedrock, which is commonly at or near the surface in unit 40R. Topographically the boundary to unit 40R is not prominent but bedrock is visible in places adjacent to the boundary.

OTHER STUDIES: AN ANCIENT PALEARGID IN THE MOUNTAINS

Location and summary data for the ancient Paleargid, Terino variant 60-5, are given in section 156. Composition and morphology of this Paleargid are distinctive for the project area. The B2t has 10R hue in part and portions have more than 70 percent clay. Thin sections show that the clay is strongly oriented, mostly as striae with a subordinate portion as coatings on sand grains and pebbles. Gypsum is present in the lower B2t and more soluble salts are present in the K2m beneath.

The A2 horizon has not been observed elsewhere on the ridge and is thought to have been a relict of an earlier period of soil formation, when an A2 horizon could have been present over much or all of the ridge crests. The A2 horizon probably developed largely in the Pleistocene pluvials, and was subsequently engulfed by illuvial clay of atmospheric origin. The petrocalcic horizon shows that the gravelly sequence of carbonate accumulation may be completed in the semiarid zone, but that a much longer time is required than for the arid part (section 126).

The mineralogy was studied by McKim (McKim, H. L. 1969. The mineralogy of a Petrocalcic Paleargid from southern New Mexico. M. S. Thesis, Univ. of Nebr., Lincoln, Nebraska) and is summarized in the Appendix (pedon 60-5). Information is given on the mineralogical composition of Soledad rhyolite. The term groundmass as used by McKim is roughly equivalent to microcrystalline grain used elsewhere in this report. The mineralogical composition for the whole rock by sodium pyrosulfate fusion agrees reasonably well with the values calculated from chemical analyses on the groundmass plus optical determinations of the mineralogy of the greater than 0.05 mm in the pebbles. Quartz is considerably higher and feldspar lower than the mineralogical analyses based on total chemical determinations reported by Dunham (1935; table 208a).

Thin section examination of the rock showed that quartz greater than 0.05 mm occurs in segregations of discrete grains. The phenocrysts consist of feldspar, mostly microcline, and orthoclase with some oligoclase. Grains of biotite greater than 0.05 mm occur in trace amounts throughout the groundmass. An isotropic mineral is present which has an index of refraction substantially below 1.550.

Examination of the rock under the scanning electron microscope showed that the groundmass is flaky at 10,000X magnification. Flakes of clay size should spall off under mechanical impact. These flakes may weather readily to clay minerals.

The decrease in groundmass in upper horizons for the 0.25-0.1 and 0.1-0.05 mm suggests that it weathers preferentially. Biotite increases markedly in the lower K horizon. The increase may be the result of more intense weathering in upper horizons or a shift in the original mineralogical composition of the alluvium. Feldspar remains fairly constant with depth in the 0.1-0.05 and 0.05-0.02 mm, whereas quartz increases towards the soil surface. The increase in quartz may be the consequence of concentration through the weathering of groundmass and biotite. Consistency of the feldspar with depth could result if it weathered less rapidly than groundmass and biotite. The 0.1-0.05 mm for Terino 70-8 contains similar percentages of microcrystalline aggregates for the same relative position in the pedon as the percentage of groundmass in the pedon of this study.

The ratios of quartz to feldspar for Terino 70-8 are similar to those for upper horizons of Terino variant 60-5.

X-ray analyses of the total clay indicate that horizons above the K1 contain small to moderate amounts of kaolinite and mica plus traces of inter-layer montmorillonite, chlorite, and quartz. Clays in the K1 horizon and beneath contain a moderate amount of a mica-montmorillonite complex, small amounts of mica and kaolinite, and traces of chlorite and quartz. The proportion of montmorillonite in the K horizon increases somewhat with depth. This increase fits a general pattern for soils of the project. In the fine clay (less than 0.0002 mm), mica predominates above the K1 horizon and a mica-montmorillonite complex predominates below.

Table 208a. Mineralogy of Soledad rhyolite obtained from confirmed optical and chemical analyses on Terino variant 60-5.

Analysis	Material	Groundmass1/	Quartz	Feldspar Total	Feldspar Na	Feldspar K	Feldspar Ca	Mica	Isotropic & opaque
		pct							
Thin section2/	75-20 mm	72	173/	7				2	2
Sodium pyrosulfate fusion4/	Groundmass5/		39.9	51.3	25.2	25.1	0.8	6.9	
Same	75-20 mm		43.0	49.7	25.2	24.4	0.1	10.4	
Calculation6/	75-20 mm		46	44				7	
Total chemical7/			27.3	67.0	31.1	35.6	0.3		

1/ > 0.05 mm excluded.
2/ Method 4E1c.
3/ Includes feldspar with index of refraction near 1.550.
4/ Kiely and Jackson (1965).
5/ Individual grains of 2-0.5 mm that did not contain phenocrysts.
6/ Based on mineralogy of > 0.05 mm in 75-20 mm and chemical analysis of groundmass.
7/ Dunham (1935).

186. BORACHO COMPLEX (1ORO)

MAPPING UNIT COMPOSITION

Series	Subgroup or Order	Family Criteria	Percentage of Mapping Unit
BORACHO	PETROCALCIC CALCIUSTOLLS	LOAMY-SKELETAL, SHALLOW	30
Hathaway	Aridic Calciustolls	Loamy-skeletal	5
Monterosa	Ustollic Paleorthids	Loamy-skeletal, shallow	10
Nolam, mollic variant	Aridic Argiustolls	Loamy-skeletal	10
Polar	Ustollic Calciorthids	Loamy-skeletal	5
Santo Tomas, ov. variant	Pachic Haplustolls	Loamy-skeletal	5
SND-6	Entisols		5
Terino	Petrocalcic Ustollic Paleargids	Loamy-skeletal, shallow	10
Terino, mollic variant	Petrocalcic Paleustolls	Loamy-skeletal, shallow	5
Other inclusions (Torriorthents, Haplargids, Paleargids, Paleorthids, Calciustolls)			15

LOCATION, LANDSCAPE, VEGETATION

These soils occur on scattered high alluvial-fan remnants west of the central part of the Organ Mountains. The soils have formed in sediments derived from rhyolite. Elevations range from about 4800 to 5300 feet.

Much of the area has been deeply dissected by arroyos. High, narrow ridges are typical. Longitudinal slopes along ridge crests range from about 10 percent next to the mountains to 4 percent in the western part of the unit. Slopes of ridge sides range from about 15 to 40 percent, with slopes ranging from 25 to 30 percent being most common.

The prominent east-west ridges with their north- and south-facing slopes have an effect on vegetation. Perennial grasses are more common on the north-facing slopes and the type of shrub is also affected. In the several prominent east-west ridges in the northernmost delineation of this mapping unit, for example, north-facing slopes (of 25 to 30 percent) typically have common black grama, fluffgrass, ratany, mariola, cholla, prickly pear, Mormon tea, *Yucca baccata*, large sumacs, and only a few creosotebush. South-facing slopes, in contrast, are more sparsely vegetated and most of the vegetation consists of shrubs. Vegetation at various places consists mainly of ratany, prickly pear, fluffgrass, creosotebush, *Yucca baccata*, ocotillo and whitethorn.

TYPICAL PEDON, PROPERTIES AND RANGES

Boracho

A typical pedon of Boracho is described below. The location is the SE 1/4 NW 1/4 Sec. 10, T23S, R3E, south-facing side of ridge. Figures 184 and 185 are photographs of the pedon and its landscape. A table of properties and ranges follows the description.

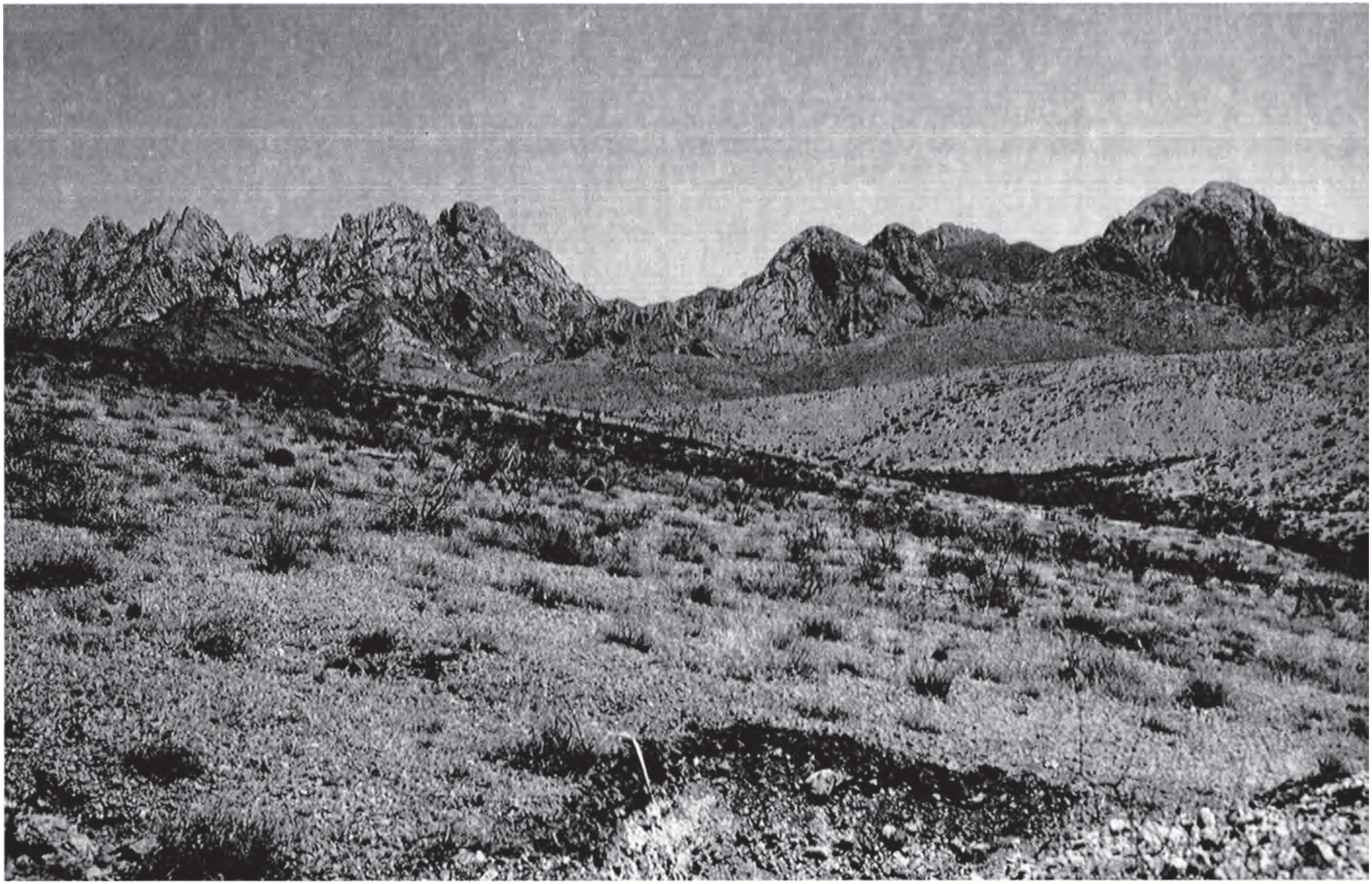


Figure 184. Landscape of a Petrocalcic Calciustoll, Boracho very gravelly sandy loam, on Jornada ridge side of Dona Ana remnant. Vegetation is fluffgrass, ratany, a few Mormon tea and whitethorn. Slope is 20 percent.

Figure 185. A Petrocalcic Calciustoll, Boracho very gravelly sandy loam. Scale is in feet.

Soil surface: 95 percent covered with angular rhyolite fragments, mostly between 1/2 and 5 cm diameter, with only a few being smaller and larger than this. There are very few cobbles up to 20 cm diameter.

A1 0-4 cm. Brown (7.5YR 4.5/3, dry) or dark brown (7.5YR 3/3, moist) very gravelly fine sandy loam; loose mass of soft very fine crumbs; few roots; effervesces weakly; abrupt smooth boundary.

B21ca 4-22 cm. Brown (7.5YR 4.5/3, dry) or dark brown (7.5YR 3/3, moist) very gravelly heavy sandy loam; breaks out as weak medium subangular blocky, with included pebbles, and as weak, very fine and fine crumb; soft; roots common; pebbles and sand grains thinly coated with carbonate, some coatings are discontinuous in the upper part of the horizon; effervesces strongly; clear wavy boundary.

B22ca 22-35 cm. Brown (7.5YR 5/3, dry) or dark brown (7.5YR 4/3, moist) very gravelly light sandy clay loam; weak very fine and fine crumb; roots common; this horizon contains more roots than above, with fine grass roots common; continuous carbonate coatings on sand grains and pebbles; effervesces strongly; abrupt smooth boundary.

K2m 35-53 cm. Dominantly pink (7.5YR 8/4, dry, 7.5YR 7/4, moist) with smaller amount white (10YR 9/2, dry, 10YR 8/2, moist) very gravelly, carbonate-cemented material; massive; extremely hard; no roots except for a few in occasional loose, uncemented pockets of very gravelly fine earth, where a few fine roots occur; pebbles widely separated by carbonate; a discontinuous laminar horizon, 1 to 10 mm thick is at the top of the horizon; effervesces strongly; clear wavy boundary.

K31 53-94 cm. Very pale brown (10YR 8/3, dry, 10YR 7/3, moist) very gravelly sandy loam, with occasional cemented zones, 1 to 5 cm diameter; very few fine roots; easily removed from horizon; pebble coatings much thinner than above, and more pebbles are in, or almost in contact; effervesces strongly; clear wavy boundary.

K32 94-116 cm. Dominantly very pale brown (10YR 8/3, dry, 10YR 7/3, moist) very gravelly light sandy clay loam, with smaller amount light yellowish brown (7.5YR 6/4, dry) or yellowish brown (7.5YR 5/4, moist) massive; slightly hard; no roots; pebbles and sand grains in very pale brown materials are continuously coated with carbonate; generally effervesces strongly, a few of the brownish parts effervesce weakly.

Table 209. Typical (underlined) and range in selected properties for major horizons of Boracho.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-4	sl l	20-75	7.5YR- 10YR	4,5 4.5	2,3	2,3
B2	4-35	sl scl l	35-75	7.5YR- 10YR	4,5 4.5	2-4 3	2,3
K2m	35-53	--	--	7.5YR- 10YR	6-9 8	5-8 7	1-4
Control section		sl,scl,cl	> 35				

Other. These soils are usually calcareous throughout but in places are non-calcareous in the upper several cm. The described pedon occurs on the sides (of probable Jornada age) of Dona Ana ridge remnants, and represents the most typical occurrence of the Boracho soils. Boracho soils of Dona Ana age are much older and occur only on the few remaining broad ridge crests. The Km horizons of these ancient soils, where observed, range from about 1/2 to 1 m in thickness. These older Km horizons also have thicker, harder laminar horizons at their tops.

SOIL OCCURRENCE

This mapping unit has one of the most complex patterns of soil occurrence encountered in the study area. The occurrence of the various soils is determined by location on the ridges, in drainageways between the ridges, and by aspect. The mapping unit also illustrates the transition from Ustollic subgroups to the Mollisols.

Petrocalcic Calciustolls. The loamy-skeletal, shallow, BORACHO soils tend to be dominant on ridge crests and on upper and middle parts of south-facing ridge sides. It also is found on some north-facing ridge sides. The latter occurrence seems to be on the somewhat less stable, less grassy north-facing ridge sides. Moderately deep Calciustolls occur in scattered areas where depth to the petrocalcic horizon ranges from 50 to 100 cm. The loamy, shallow Kimbrough soils occur in a few spots where gravel content above the petrocalcic horizon averages less than 35 percent by volume.

Aridic Calciustolls. The loamy-skeletal Hathaway soils occur in places where the soils have calcic instead of petrocalcic horizons. Some of these places appear to represent spots where the petrocalcic horizon is breaking up as a result of landscape dissection and soil truncation.

Ustollic Paleorthids. The loamy-skeletal Monterosa soils and a moderately deep analogue occur only on some of the south-facing ridge sides; color values are almost, but not quite dark enough for a mollic epipedon.

Typic Paleorthids. The Delnorte soils occur in spots on south-facing slopes where depth to the petrocalcic horizon is less than 18 cm and color values are not quite dark enough for a mollic epipedon.

Aridic Argiustolls. The loamy-skeletal Nolam, mollic variants occur only on stablest, north-facing slopes.

Pachic Haplustolls. Santo Tomas, overburden variant, has formed in colluvium on lower slopes of north-facing ridges.

Typic Haplargids. The loamy-skeletal Pinaleno soils have been observed only on south-facing slopes and on narrow terraces bordering arroyos between the ridges.

Petrocalcic Ustollic Paleargids. The loamy-skeletal Terino soils have been observed on a few ridge crests and on south-facing ridge sides. The Casito soils are similar but have some visible carbonate in all subhorizons of the Bt.

Petrocalcic Paleustolls. The loamy-skeletal Terino, mollic variant, has been observed on stabler parts of north-facing ridge sides.

Ustollic Calciorthids. The Polar soils are similar to Hathaway but lack mollic epipedons. They occur mostly in slightly truncated areas, such as in and adjacent to some of the rills (one to several dm deep, 1/2 to 1 m across) that extend down the sides of the ridges.

Typic Torriorthents. The loamy-skeletal Canutio soils occur on narrow colluvial wedges and terraces of youngest Organ.

Entisols. SND-6 occurs in arroyo channels.

SOIL BOUNDARIES

Table 210 gives information on boundaries to adjacent major units. Figure 186 shows boundaries and stratigraphy for some of the units.

Table 210. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Terino very gravelly sandy loam (12R)	The boundary has been caused by greater landscape dissection in unit 10RO (fig. 186). Soils of unit 12R commonly occur on stabler terraces inset against higher ridge remnants on which soils of unit 10RO are located. In other places soils of unit 12R occur on stablest remnants of the same surface (Dona Ana).
Santo Tomas-Earp complex (13RO)	The boundary has been caused by a younger alluvium and geomorphic surface (Organ) in unit 13RO. The topographic boundary is prominent because the low terraces of unit 13RO are inset against the much higher ridges of unit 10RO.
Rhyolite rock outcrop and Argids (40R)	The boundary is due to a change from deep alluvium of unit 10RO to bedrock that is at or near the surface in unit 40R. The boundary is marked by steeper slopes and bedrock outcrops of the Organ Mountains.

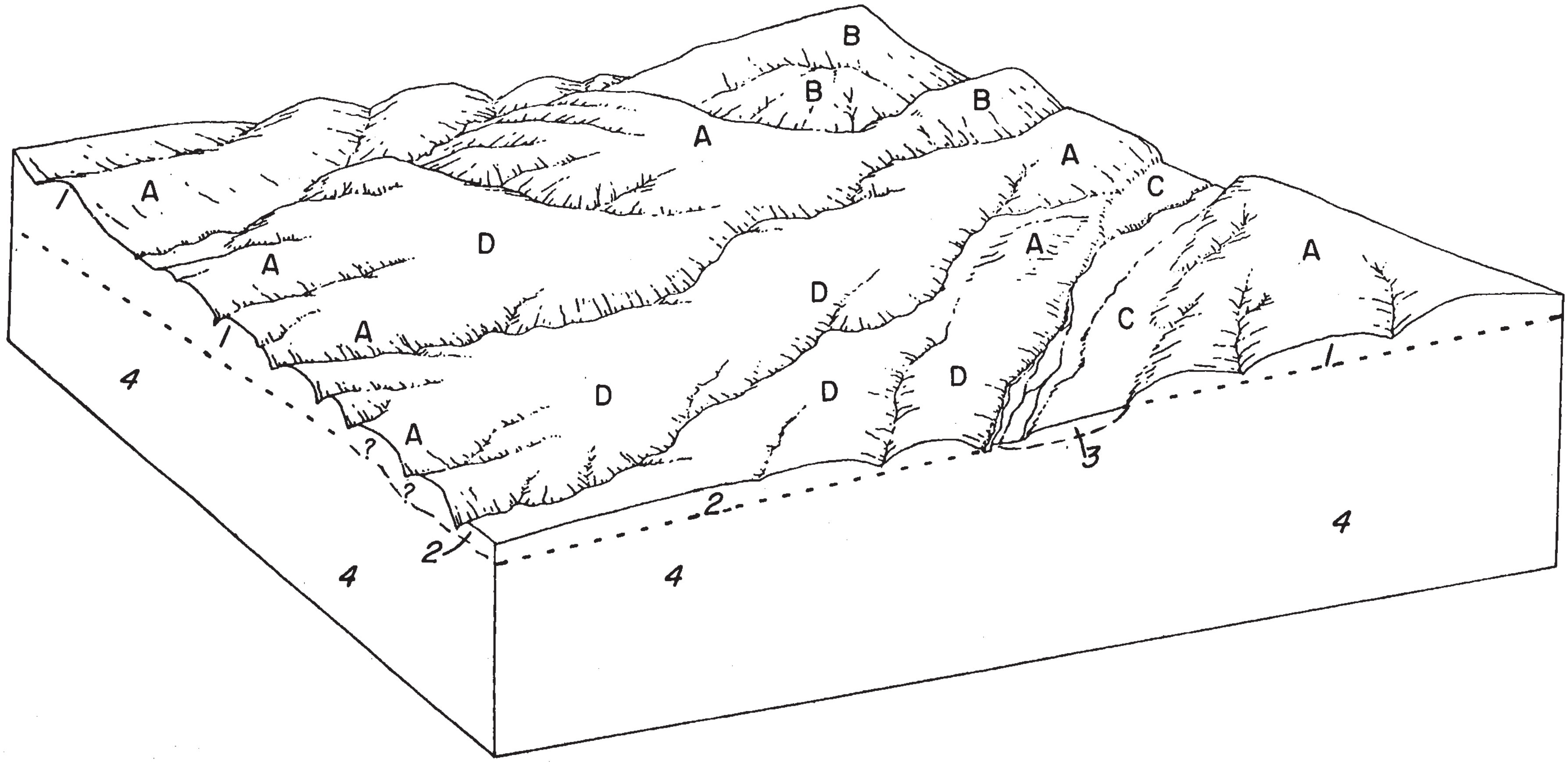


Figure 186. Block diagram of soil-landscape relations and soil stratigraphy in an area of Boracho complex, Terino very gravelly sandy loam, Santo Tomas-Earp complex, and Rhyolite rock outcrop and Argids, west of Ice Canyon. A = Boracho complex (Dona Ana on ridge crests; post-Dona Ana on ridge sides). B = Rhyolite rock outcrop and Argids (mountain slopes and summits). C = Santo Tomas-Earp complex. D = Terino very gravelly sandy loam (Dona Ana and Jornada I surfaces).
1 = Dona Ana alluvium and soils. 2 = Jornada I alluvium (youngest unit of the Upper Camp Rice piedmont facies) and soils. 3 = Organ alluvium and soils. 4 = Upper Camp Rice Formation (piedmont facies).

187. SOILS OF THE BASIN FLOOR NORTH OF HIGHWAY 70.

The gentle slopes and smooth terrain of the basin floor north of Highway 70 contrast markedly with the dissected terrain along the valley border. Complex soil patterns due to strong dissection are absent and the soils are well preserved in many places. Aggradation has occurred at various times since mid-Pleistocene; surfaces and associated deposits of several ages are present. Table 210a shows major soils of the basin floor and their relation to geomorphic surfaces, and soil age, development and classification. Soils of adjacent toeslopes that slope about 1/2 percent or less are included. Figure 187 shows a cross section of soils and surfaces in and adjacent to the south end of Isaacks' Lake Playa.

188. Soils of the Lake Tank surface.

This surface is the lowest part of the Jornada del Muerto basin and in most years receives some sediment (largely silt and clay) at the present time. Lake Tank surface occurs in two areas--Isaacks' Lake playa (by far the largest of the two) and a small playa east of the New Mexico State University Ranch Headquarters. Soil age ranges widely; on the outer edges of the playa the soils are of Holocene age. Soils in the central part of the playa undergo considerable mixing because of shrinking and swelling, discussed later, and range in age from late-Pleistocene or earlier to the last deposit in the playa.

189. DALBY CLAY (53).

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
DALBY CLAY	TYPIC TORRERTS	VERY FINE	65
Bucklebar	Typic Haplargids	Fine-loamy	10
Headquarters, clayey subsoil variant	Ustollic Haplargids	Fine	10
Stellar	Ustollic Haplargids	Fine	5
Other inclusions			10

LOCATION, LANDSCAPE, VEGETATION

The soils in the central and lowest part of Isaacks' Lake Playa have formed in a mixture of sediments derived from monzonite, rhyolite, andesite, latite, limestone, calcareous sandstone, siltstone, and shale. Around the outer parts of the playa the sediments reflect their upslope source. Soils in the southeastern part of the outer rim of playa sediments, for example, were derived largely from monzonite. In the small playa east of the New Mexico State University Ranch Headquarters, sediments were derived mainly from monzonite, rhyolite and andesite, with some from the Camp Rice Formation (fluvial facies) in the adjacent basin floor. Elevation is about 4300 feet.

These areas are level or nearly level. The microrelief of the southern

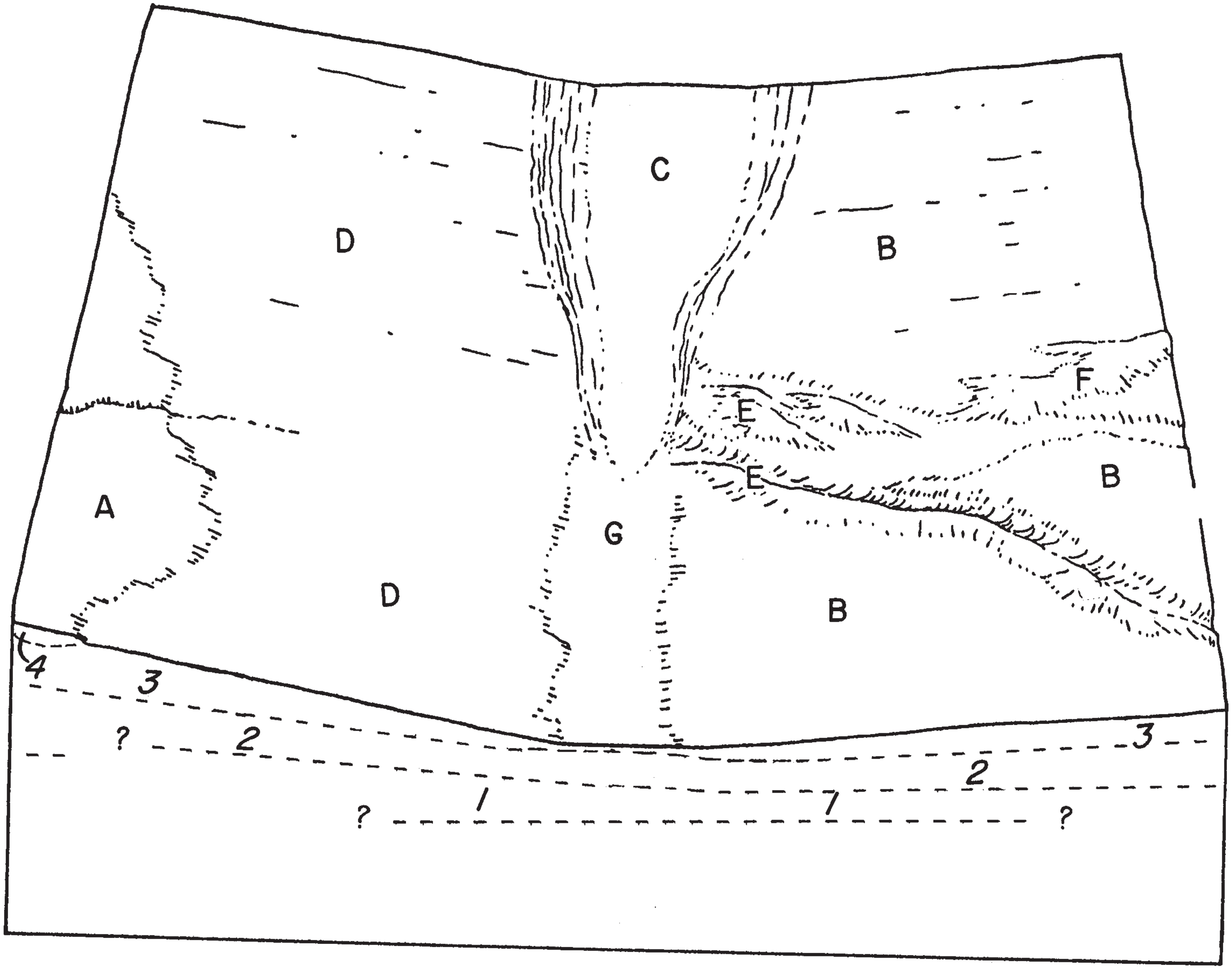


Figure 187. Block diagram of soil-landscape relations and soil stratigraphy in the vicinity of Isaacks' Lake playa (south end). A = Anthony complex (Organ surface). B = Berino-Bucklebar association (Jornada II, Organ and Isaacks' Ranch surfaces). C = Dalby clay (Lake Tank surface). D = Dona Ana sandy clay loam (Jornada II surface). E = Onite sandy loam. F = Onite-Pajarito complex. G = Stellar clay loam, overflow (Jornada I surface).

1 = Upper Camp Rice Formation, fluvial facies (ancient river alluvium). 2 = Jornada I alluvium and soils. 3 = Jornada II alluvium and soils. 4 = Organ alluvium and soils.

Table 210a. Relation of soil development, horizonation and classification to major soils, soil age and geomorphic surfaces of the basin floor north of Highway 70.

Geomorphic surface	Soil age, years B.P. or epoch	Soil → Development →				
		Torrerts AC1/	Haplargids ABtC	Haplargids ABtK	Calciorthids ABC or ABK	Paleorthids AKm ABKm
Organ	100 to 7500		Onite2/		Reagan2/,3/	
Lake Tank	4000 to 7500 (outer part of playa)	Dalby	Bucklebar2/ Bucklebar, fine var.			
	Late-Pleistocene	Dalby, inner part of playa				
	Late mid-Pleistocene					
Petts Tank	Late-Pleistocene				Reagan3/	
Jornada I	Late mid-Pleistocene			Stellar		
Jornada I and La Mesa undifferentiated	Late or early mid-Pleistocene			Dona Ana	Algerita Reagan, light subsoil var.	
La Mesa	Early mid-Pleistocene					Simona2/

1/ An increase in age is not apparent in this zone because of long-continued soil mixing in the playa (Lake Tank surface).

2/ These soils are minor in extent, but are included here to show their place in the classification scheme. Reagan has formed in high-carbonate parent materials whereas Onite has formed in low-carbonate materials. Simona soils occur on some of the highest, best- preserved ridges. Area of Cruces soils in vicinity of Goat Mountain not included in table.

3/ Formed in high-carbonate parent materials.

end of Isaacks' Lake Playa is fairly smooth except for cracks, which during the dry season range up to 5 cm or more in width and a meter or more in depth. The north end of the playa is hummocky in many places. The hummocks range from about 10 to 30 cm high.

Vegetation over most of the playa consists mainly of weeds; blueweed is dominant. Viney mesquite is the dominant vegetation around the edges of the playa. Scattered clumps of alkali sacaton occur on hummocks in the northern part of the Isaacks' Lake Playa.

TYPICAL PEDON, PROPERTIES AND RANGES

These soils are all strongly calcareous throughout in Isaacks' Lake Playa, but in places are noncalcareous in the upper few cm in the playa east of the NMSU Ranch Headquarters. Thickness of the clay is greatest (several m) in the center of the playas but is thinner around the edges. Observations indicate that most or all of the clay is underlain by sandy sediments that in places contain rounded gravel of mixed lithology.

Dalby

A typical pedon of Dalby is described in the Appendix (pedon 60-16). Figures 188 and 189 are photographs of the pedon and its landscape. A table of properties and ranges is given below.

Table 211. Typical (underlined) and range in selected properties for major horizons of Dalby.

Horizon	Depth cm	Particle Size < 2 mm	Particle Size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-23	c	0	7.5YR- 10YR	5,6	3.5-5 4	2-4
C	23-114	c	0	5YR- 7.5YR	4,5	3.5-5 4	3,4 2
Control section		c	0				

SOIL OCCURRENCE

Torrerts. DALBY soils occur in the central part of the playas, where clay content is highest.

Haplargids. Headquarters, clayey subsoil variant, Bucklebar and Stellar soils occur in places on the outer edges of the playa.

Figure 188. Landscape of a Typic Torrert, Dalby 60-16, on the Lake Tank surface (Isaacks' Lake Playa). Vegetation is blueweed. Viney mesquite occurs around the edges.

Figure 189. A Typic Torrert, Dalby 60-16. Scale is in meters.

SOIL BOUNDARIES

Table 212. Cause and character of boundaries to adjacent major units.

The boundary is drawn approximately at the edge of the playa, and in most places is the approximate high water mark at times of episodic flooding. The boundary is generally marked by an increase in slope, from about 1/2 percent at the edge of the playa to 1 percent on the fan-piedmont. The dominant vegetation changes from viney mesquite and blueweed (unit 53) to tobosa in the 55 and 16V mapping units; to creosotebush and tarbush in unit 16VG to burro grass in unit 51; and to snakeweed and *Yucca elata* (with tobosa in drainageways) in unit 15M.

OTHER STUDIES

Two studies were carried out in this mapping unit. One concerns the character of a Vertisol in the playa, and the other deals with the morphological transition from Haplargids of the piedmont toeslopes to Vertisols in the center of the playa. The transition between the playa sediments and the toe of the piedmont slope is shown in figure 191. Onite 70-5 is in transect 2 of the west study area in section 157.

Characteristics of a Vertisol

Dalby 60-16 (table 213) occurs in the lowest part of Isaacks' Lake playa. The pedon has a thin A horizon that grades into a C horizon with common slickensides, plates, and wedges. These distinctive structural features are related to high clay content and to landscape position. Between 1957 and 1972, a lake (fig. 190) formed in the playa five times--1957, 1959, 1963, 1967, and 1972. The lake formed in the late summer and fall, for periods of several months. The clayey materials are subject to shrinking and swelling during cycles of flooding and desiccation. During the long dry seasons, a system of desiccation cracks that are several cm wide and dm deep, form in the soil. During the summer rains, water from adjacent areas commonly moves into the playa and into the cracks. The water contains considerable clay, silt and some of the finer sand fractions. Thus, even though the playa does not flood each year, fine sediments move down many of the cracks. Loose surface material adjacent to the cracks also falls intc them. Repetition of the wet-dry process causes churning and prevents development of horizons of silicate clay and carbonate accumulation. The sediment is assumed to have originated primarily from surficial horizons of soils in the watershed. A mixed rather than montmorillonite clay mineralogy (Appendix) and relative coarseness of the clay are probably a consequence of this origin.

* * *

Table 213. Laboratory data for Dalby 60-16.

Horizon	Depth	Silt[1/]	Clay[1/]	Clay Ratio Fine/Total	COLE	Carbonate	Extractable bases Na	Extractable bases K	Organic carbon
	cm	pct	pct			pct	me/100g	me/100g	pct
A	0-5	31	64	0.14		4	tr	tr	0.58
Ac	5-23	28	66	0.31	0.068	4	tr	tr	0.45
C1	23-48	32	63	0.30	0.081	3	tr	tr	0.26
C2	48-81	29	66	0.43		3	0.1	0.1	0.24
C3	81-114	28	66	0.38	0.071	3	0.1	0.1	0.29

Organic carbon, 4.8 kg/m^2 to 112 cm.

1/ Silt and clay on a carbonate-free basis.

* * *

Silicate clay is nearly constant with depth in Dalby (table 213). The clay is relatively coarse compared to the B2t horizon of Argids. The coarser clay in the surface horizon is common to all kinds of soils in the project (section 93). COLE is high but not excessively so; many soils that are not Vertisols have similar COLE values illustrating that other factors such as the water regime and thickness of the highly extensible zone are important in determining whether the soil is a Vertisol. Carbonate content is low and constant

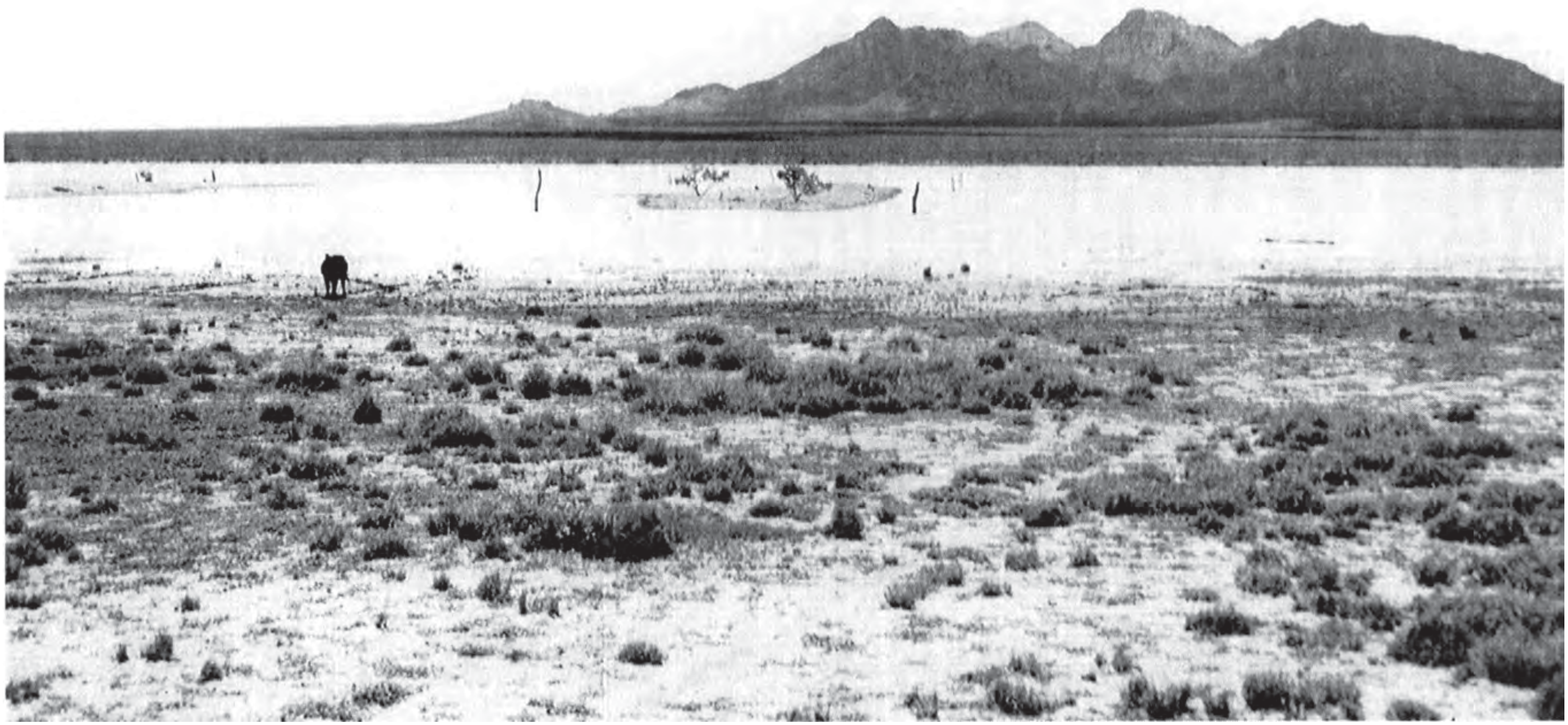


Figure 190. Isaacks' Lake Playa with standing water, photographed August, 1967. The playa flooded August 4, and with subsequent rains the lake did not dry up until late December, 1967.

throughout. Extractable sodium and potassium are both low. The low sodium (and low soluble salts) is undoubtedly related to the deep water table. This allows downward water movement (after episodic flooding) to depths below the sampled horizons. The very low potassium is of interest (section 157). In comparison, Headquarters variant 69-8 (table 142) which has comparable clay content, contains 2 me/100g of extractable potassium in upper horizons. Upper horizons contain somewhat more organic carbon, but the level is low relative to the clay content; the amount in kg/m^2 is about half that in pedon 69-8. The differences from pedon 69-8 both in respect to extractable potassium and organic carbon may be a reflection of less vegetation on Dalby 60-16.

A transect from Haplargids to Vertisols

The margin of the playa is marked by a prominent change in vegetation. The change is about on the contour and apparently the result of standing water when the playa is occupied by a lake. Outward from the margin the vegetation is snakeweed, tobosa, mesquite and yucca. Inward near the margin the vegetation consists of only scattered snakeweed and a few fluffgrass, with other changes towards the center as indicated below.

The cross section extends from Onite 70-5 east of the playa westward to Dalby 60-16 in the playa (figure 189). The transect illustrates a marked change in soil texture, from sandy loam in the Bt horizon of Onite 70-5 to clay of Dalby 60-16. The character of the transition within the playa itself is shown by the morphology of soils in 6 pits in a line from inside the edge of the playa towards its center. No data or detailed descriptions are available to illustrate the transition, but the following notes illustrate its general character. Distances given are paced.

Pit 1. 40 ft, 12 m west of playa margin. Typic Haplargid, fine-loamy; Bucklebar series. Vegetation consists of scattered snakeweed and a few clumps of fluffgrass. The structure is clearly not Vertisolic; there are no wedges or plates. Carbonate expression (filaments) is typical of Organ age. In about the upper dm there is a distinct scattering of coarse monzonite sand grains; these are generally absent below this, suggesting the possibility of a later Organ deposit. The soil is noncalcareous to 23 cm depth.

A2 0-5 cm. Fine sandy loam.

B21t 5-23 cm. Medium sandy clay loam.

B22tca 23-43 cm. Medium clay loam; decrease in sand from above.

B23tca 53-84 cm. Lighter colored than B22tca; loam with more silt than above; carbonate filaments few to common.

C 84-97 cm. A good discontinuity, distinctly sandier. Noncalcareous; illustrates good carbonate bulge in overlying horizons. Largely a loamy sand with some finer strata. This is clearly a sedimentary layer and is present on all sides of the pit. Base of this horizon appears to be the base of the Organ deposit.

Btb (?) 97-109 cm. Finer and redder than overlying C horizon. Noncalcareous.

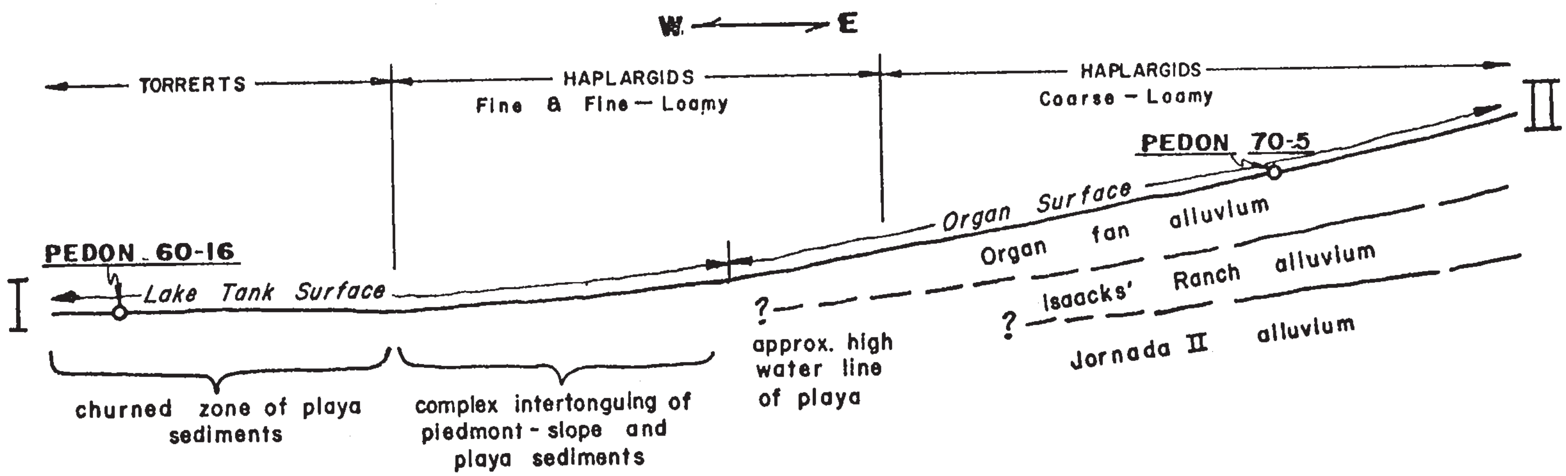


Figure 191. Cross section from I to II on the soil map, figure 127.

Pit 2. 100 ft, 30 m west of playa margin. Typic Haplargid; fine-loamy; Bucklebar series. Vegetation consists of a very few snakeweed, tumbleweed, and viney mesquite; barren areas are common. No wedges are apparent; prisms are the dominant structural element. The Bt is weak medium prismatic, breaking to weak subangular blocky. On the south side of the trench there is a prominent discontinuity at about 43 cm depth where a coarse sandy loam rests abruptly on a much finer clay loam. The weak carbonate accumulation crosses the sedimentary boundary. The Bt has scattered insect tunnels. Structure, etc. very typical of Organ in sediments of this texture. The soil is noncalcareous to a depth of 15 cm.

A2 0-5 cm. Loam; noncalcareous.

B21t 5-15 cm. Sandy clay loam; noncalcareous.

B22tca 15-38 cm. A light sandy clay loam with distinctly less clay than above; carbonate filaments few to common; effervesces strongly.

B23tca 38-69 cm. Clay loam, heavier than above but less than 35 percent clay; carbonate filaments few to common.

B24tca 69-107 cm. A heavy clay loam; carbonate filaments few to common; effervesces strongly.

C 107-119 cm. Light fine sandy loam, parts noncalcareous and parts effervesce weakly.

Btb (?) 119-125 cm. Heavy clay loam; noncalcareous and effervesces weakly.

Pit 3. 168 ft, 50 m west of playa margin. Typic Haplargid; fine-loamy; Bucklebar series. Snakeweed almost entirely absent; scattered viney mesquite and barren areas. The soils are gradually getting heavier in texture towards the center of the playa but are still in the same textural family and series. All three soils have a distinct maximum in silicate clay in the B21t - clearly all are Argids.

A2 0-8 cm. Loam; effervesces weakly.

B21t 8-20 cm. Medium clay loam.

B22tca 20-38 cm. Medium sandy clay loam, carbonate filaments few to common. In the upper several in (just below a contact of fine gravel) there is texture of fine sandy loam.

B23tca 38-61 cm. Medium clay loam; carbonate filaments as above.

B24tca 61-91 cm. Medium-heavy clay loam.

C 91-117 cm. Loamy sand, uniform size, mainly fine; noncalcareous and effervesces weakly; massive and soft.

Btb (?) 117-127 cm. Heavy clay loam; effervesces weakly.

Pit 4. 279 ft, 84 m west of playa margin. Typic Haplargid, fine. There is one snakeweed, about 50 ft north of pit; the rest of the area is viney mesquite and barren. The viney mesquite is more continuous here than to the east. The surface is more prominently cracked. These Organ sediments are certainly distinct and continuous. The upper layer (in the B22t) with coarse sand, thickens and the lower layer (with more fine sand in the C horizon) seems to thin.

A 0-8 cm. Heavy loam; effervesces weakly.

B21t 8-28 cm. Light clay - definitely heavier than at pits 1-2; noncalcareous. Prisms finer and more distinct.

B22tca 28-56 cm. Light clay; effervesces strongly; texture coarsens to a coarse sandy loam in the lower 5 cm; one pebble noted; 2 cm diameter. This is a weaker carbonate accumulation than at pits 1-3; distinct filaments absent but pebbles are coated along lower part of horizon.

B23ca 56-69 cm. A uniform material; fine sandy loam; very few carbonate filaments; slightly hard; this is designated B because of the structural elements - prisms - have started to develop in it, even though it is distinctly coarser than most of the overlying horizon. Also, pedogenic carbonate passes through it and is clearly related to pedogenesis in overlying horizons; effervesces strongly.

B24ca 69-94 cm. Silty clay loam; few carbonate filaments.

C 94-99 cm. Mostly noncalcareous; fine sandy loam; soft.

Bb (?) 99-109 cm. Heavy clay loam; effervesces weakly.

Pit 5. 381 ft, 114 m west of playa margin. Typic Haplargid; fine. Vegetation is all viney mesquite. Although heavily grazed, the plants are quite continuous. This soil differs from those in pits 1-4 in being calcareous throughout, in being more uniformly clayey in the upper part, and in lacking any prominent evidence of a discontinuity; in most of the exposure there are no coarse sand grains. Another difference is that the plates and wedges occur here - a distinct morphological feature of the clayey horizon. This soil is different from those of pits 1-4 in having cracks extending through the clayey horizon. The cracks are 2 to 3 mm wide and about 30 cm apart. Presence of carbonate filaments on some peds argues stability for a time in the soil and not as much mixing. The soil is moist in about the upper 15 cm.

A 0-8 cm. Light-medium clay loam; effervesces strongly.

B21tca 8-18 cm. Heavy clay loam.

B22t 18-64 cm. Clay, with prominent wedges; probably some clay in the upper part is illuvial but most of this clay must be of primary origin. There is no evidence of secondary carbonate (filaments)--although the horizon effervesces strongly.

B23ca 64-107 cm. Clay loam; effervesces strongly; in contrast to the overlying B22, this horizon has distinct carbonate filaments. Probably they are missing in the B22t because of soil mixing. A slightly lighter colored layer, a loam, occurs in places in the upper part of this horizon. Often it has been mixed but in places is apparent.

C 107-112 cm. Fine sandy loam; presently all the way across the pit; apparently the same layer as the C in other pits. Effervesces weakly.

Bb (?) 112-133 cm. Silty clay loam; effervesces weakly.

Pit 6. 552 ft, 166 m west of playa margin. Typic Torrert; fine. There is no viney mesquite. Vegetation - weeds such as stickleaf, blueweed and tumbleweed. In contrast to soils of the other five pits which have consistent slope, this area sets down slightly on the edge of the main floor of the playa -- above the lowest part of the playa but definitely on an increased slope from pits 1-5. This soil has a much thicker clayey layer in the upper part than at pit 5 but the coarser-textured layer marking the discontinuity is still present. The B24ca, as in other positions, has definite structure, carbonate accumulation and here has fine roots. In contrast to pits 1 and 4, this soil has distinct cracks extending all the way through the clayey horizon (to 81 cm). The cracks range from about 1/8 to 1/2 cm wide and are 20 to 40 cm apart. They are more prominent than at pit 5. All horizons are calcareous throughout, except for the C horizon. The boundary between the Argids and the Vertisols is between pits 5 and 6.

A 0-8 cm. Heavy clay loam - clay.

B21 8-18 cm. Clay; not an argillic horizon. In contrast to the pits to the east, there is no distinct clay bulge and morphology of the A and B to support an argillic horizon. Probably the surface cracks will be wide enough as drying progresses in the spring, to qualify as a Vertisol.

B22 18-81 cm. The main clayey horizon; there are prominent wedges and slickensides; similar to B21 but wedges are more distinct; very hard.

B23ca 81-94 cm. Prisms and carbonate extend through this horizon and it is therefore designated B. A fine sandy loam, the same horizon seen to the east. It is not the base of the Organ-age sediments; soft.

B24ca 94-130 cm. This horizon has the striking different colors seen near the bottom of 69-8, apparently caused by mixing of strata of different texture.

C 130-137 cm. Stratified material, strata still largely preserved. Average texture is sandy clay loam; parts are noncalcareous but most effervesces weakly or strongly; some thin strata high in sand are visible.

Bb (?) 137-142 cm. Heavy sandy loam, noncalcareous in part, some sand grains larger than in horizon above.

At pedon 60-16. This is very likely the oldest part of the playa and Organ deposits, if present, are probably completely mixed with the older sediments. The surface in this area is definitely different than at pit 6. Deep cracks have not yet opened up, but their outlines are clearly seen and some are already a few cm deep. This area definitely qualifies as Vertisol since cracks (which must be at least 1 cm wide at a depth of 50 cm) are present now at the surface and probably are present at depth at least 1 cm wide. However, the cracks at pit 6 are not 1 cm wide now.

Comments on transect. The pit in Onite 70-5, samples with the hydraulic probe downslope, and pits 1-6 indicate that Organ sediments extend continuously from Onite 70-5 on the piedmont slopes through pit 6 in the playa. The deposit ranges from 97 cm thick at pit 1 to 137 cm thick at pit 6. Pedogenesis in the deposit is typical of Organ age for these parent materials. Stratified sediments mark the lower part of the Organ deposit and constitute a prominent discontinuity. There is evidence (stratification, some pebbles) of a less prominent discontinuity in the upper part of the deposit. The Organ deposit rests on a buried soil, age not determined.

190. Soils of Petts Tank surface.

These soils occur on the eastern side of the basin floor. They are of late-Pleistocene age (the same as the adjacent soils of the Jornada II surface on the piedmont slopes). In places the Petts Tank soils are buried by thin deposits of Organ age.

191. REAGAN CLAY LOAM (51)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
REAGAN	USTOLLIC CALCIORTHIDS	FINE-SILTY	70
Algerita	Typic Calciorthids	Coarse-loamy	10
Reagan, light subsoil variant	Ustollic Calciorthids	Fine-loamy	10
Other inclusions (Torrifluvents)			10

LOCATION, LANDSCAPE, VEGETATION

These soils occur northeast of Isaacks' Lake Playa. The soils have formed in nongravelly sediments with substantial amounts of silt and clay. The sediments were derived mainly from limestone, calcareous sandstone, siltstone, and shale, with smaller amounts of rhyolite, andesite and granite. Elevation is about 4300 feet.

The soils occur in a level or nearly level basin floor. These soils are level in the westernmost and lowest part of the basin floor but slope about 1/2 percent to the west in the eastern part of the mapping unit. The surface is usually very smooth. In places, broad drainageways from the east extend westward across the mapping unit. Distinct barren strips are common; they are one m or more wide and a few to scores of m long. The strips occur along the contour and often have small scarps, ranging from several cm to 10 cm or more in height. The barren strips are subdued or absent in the level western part of the unit.

Vegetation consists mainly of burro grass, with scattered clumps of tobosa in a few areas, and a few tarbush, sumac and crucifixion thorn.

TYPICAL PEDON, PROPERTIES AND RANGES

All soils are calcareous throughout. In places there are minor deposits of thin sandy overwash adjacent to the 56 mapping unit. Buried soils occur extensively beneath Reagan soils (see pedon description).

Reagan

A typical pedon of Reagan is described in the Appendix (pedon 68-7). Figure 192 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

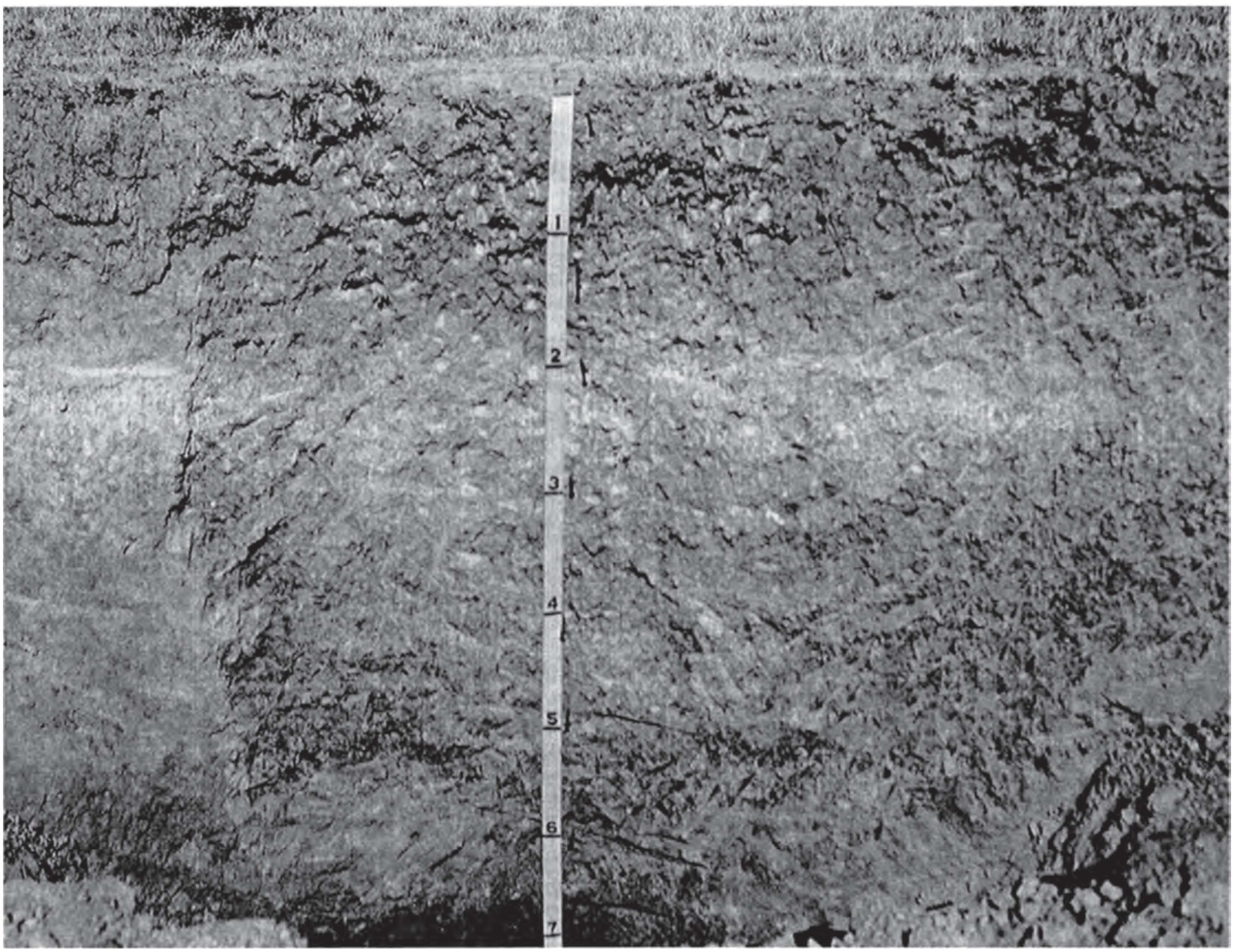


Figure 192. Upper. Landscape of an Ustollic Calciorthid, Reagan 68-7, on the Petts Tank surface. Vegetation is burro grass. The area is level.
Lower. Reagan 68-7. Scale is in feet.

Table 214. Typical (underlined) and range in selected properties for major horizons of Reagan.

Horizon	Depth cm	Particle size < 2mm	Particle size > 2mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-5	sil cl sicl	0	7.5YR- 10YR	5-7 6	4-6 4.5	2-4
B2	5-58	sil cl sicl	0	7.5YR- 10YR	5-7 6	4-6 4.5	3,4
K2	58-86	sil cl sicl	0	7.5YR- 10YR	6-9 7	5-8 6	2-4
C	145-180	sil cl sicl scl	0	5YR- 10YR 7.5YR	5-7 6.5	4-6 5.5	3,4
Control section		sil, cl, sicl, scl	0				

Other. Depth to the calcic horizon (the B23ca, K2, and Bcal horizons in the description) ranges from about 25 to 75 cm. The K2 horizon consists of nodular carbonate, is only slightly hard and hard, and usually ranges from about 25 to 40 cm in thickness. The relative softness of the K2 horizon, as compared to other K2 horizons of the same age, is apparently due to the high amounts of silt and clay in these soils.

SOIL OCCURRENCE

This unit contains a high proportion of soils belonging to one series. There are several reasons for this. (1) The soils have formed in highly calcareous alluvium, which tends to prevent the development of an argillic horizon. The alluvium is also relatively fine-textured, which should cause rather slow infiltration rates. (2) Most soils are old enough to have developed a calcic horizon and are therefore Calciorthids since an argillic horizon is absent. (3) The dominant soil is quite high in silt and clay and also occurs in basin-floor position, receiving some runoff from higher slopes. These factors indicate enough organic carbon so that all pedons are Ustollic. (4) The soils are mostly fine-silty. Large-scale occurrence of other textural families is therefore not a factor.

Calciorthids. The fine-silty REAGAN soils occupy most of the area. Algerita soils and Reagan, light subsoil variant occur mostly in the eastern part of the area.

Torrifluvents. The fine-silty Glendale soils occur in small areas of Organ alluvium, primarily in the eastern part of the unit.

SOIL BOUNDARIES

Table 215 presents information on boundaries to adjacent major units.

Table 215. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Algerita sandy clay loam (16L)	The boundary is due to a decrease in particle size of the materials, which changes from dominantly fine-loamy and coarse-loamy (unit 16L) to fine-silty (unit 51). The decrease in particle size in turn is caused by a change in slope, from 1 percent in unit 16L to level or nearly level in unit 51. The topographic boundary to unit 16L occurs near the border between the basin floor and the fan-piedmont, at a point where slopes steepen to about 1 percent. Vegetatively the boundary is marked by a shift from mostly burro grass to a mixture of burro grass, creosotebush and tarbush.
Stellar clay loam, overflow (55)	The boundary has been caused by a younger alluvium and geomorphic surface (Petts Tank) and by a change to high-carbonate parent materials. Analogues of the 55 soils are buried by Petts Tank alluvium and its soils in unit 51. These analogues emerge at the surface or are very near the surface in unit 55. The boundary is topographically indistinct since slopes are approximately level along the contact. Vegetatively there is a change from mainly tobosa in unit 55 to mainly burro grass in unit 51.

OTHER STUDIES

Studies in this unit consist of a transect study presented in two parts: a transect from the piedmont slopes to the basin floor in high-carbonate materials, and a transect from high-carbonate to low-carbonate materials in the basin floor. Figure 193 locates the transect; figure 194 is a soil map of the area.

A transect from the piedmont slopes to the basin floor in high-carbonate materials

The transition from the piedmont slopes to the basin floor represents an important change in both soils and landscape. The transition is a very gradual one; slopes are gentle, the landscape is subdued and landforms useful in predicting the occurrence of various soils are less apparent than at higher elevations on the piedmont slopes. Furthermore, coarse fragments that in many instances form prominent lithological discontinuities between buried soils of various ages are generally absent. A transect from the toeslopes just east of mapping unit 51, westward across the basin floor, illustrates the general character of the change (fig. 195).

Location of the sampled pedons is shown on the soil map (fig. 194). All soils have relatively high organic carbon and are in Ustollic subgroups of the Aridisols. Laboratory data and ages of the various soils are given in table 216. All soils are highly calcareous throughout and none have argillic horizons. This contrasts with the piedmont slope - basin floor transition in low-carbonate materials (see sections 166, 157, 196).

Reagan variant 66-7 (fig. 175) on the lower part of the piedmont slope, is the easternmost of the four pedons. Both Organ and Jornada II alluviums and their soils are present (table 216). The boundary between Organ and Jornada II alluvium is well marked by a distinct increase in sand at the base of the Organ deposits. A line of pebbles (with little or no gravel above or below) occurred at about this depth all along the sample trench. Soil morphology also indicates that the upper deposit (Organ) is younger. The soil in Organ alluvium has a few carbonate filaments and is in stage I of carbonate accumulation as is typical of soils of Organ age. This carbonate accumulation is distinctly separate from the stage III carbonate horizon in Jornada II alluvium. Wide separation of the two zones of carbonate accumulation indicates that the upper, filamentary horizon developed in a younger deposit and is not the upper part of a bisequum. The carbonate horizon in Organ alluvium is a weak calcic horizon.

Reagan 66-6 (fig. 196) occurs at the margin of the basin floor, on the western border of the piedmont toeslope. The Organ surface and its alluvium extend continuously from Reagan variant 66-7 to this area. This site illustrates some of the problems in recognizing younger deposits and soils on very gentle slopes where gravel or coarse sand are not present to form stone lines. The contact between Organ and Jornada II illustrates. The basal sand and pebbles of Organ alluvium at Reagan variant 66-7 are absent. There is a change in texture along the contact (much less sand and more silt in Organ alluvium) but not as distinct as in many areas upslope. Soil morphology adds supporting evidence for a younger deposit, as at Reagan variant 66-7; the carbonate horizons in the two deposits are distinctly separated.

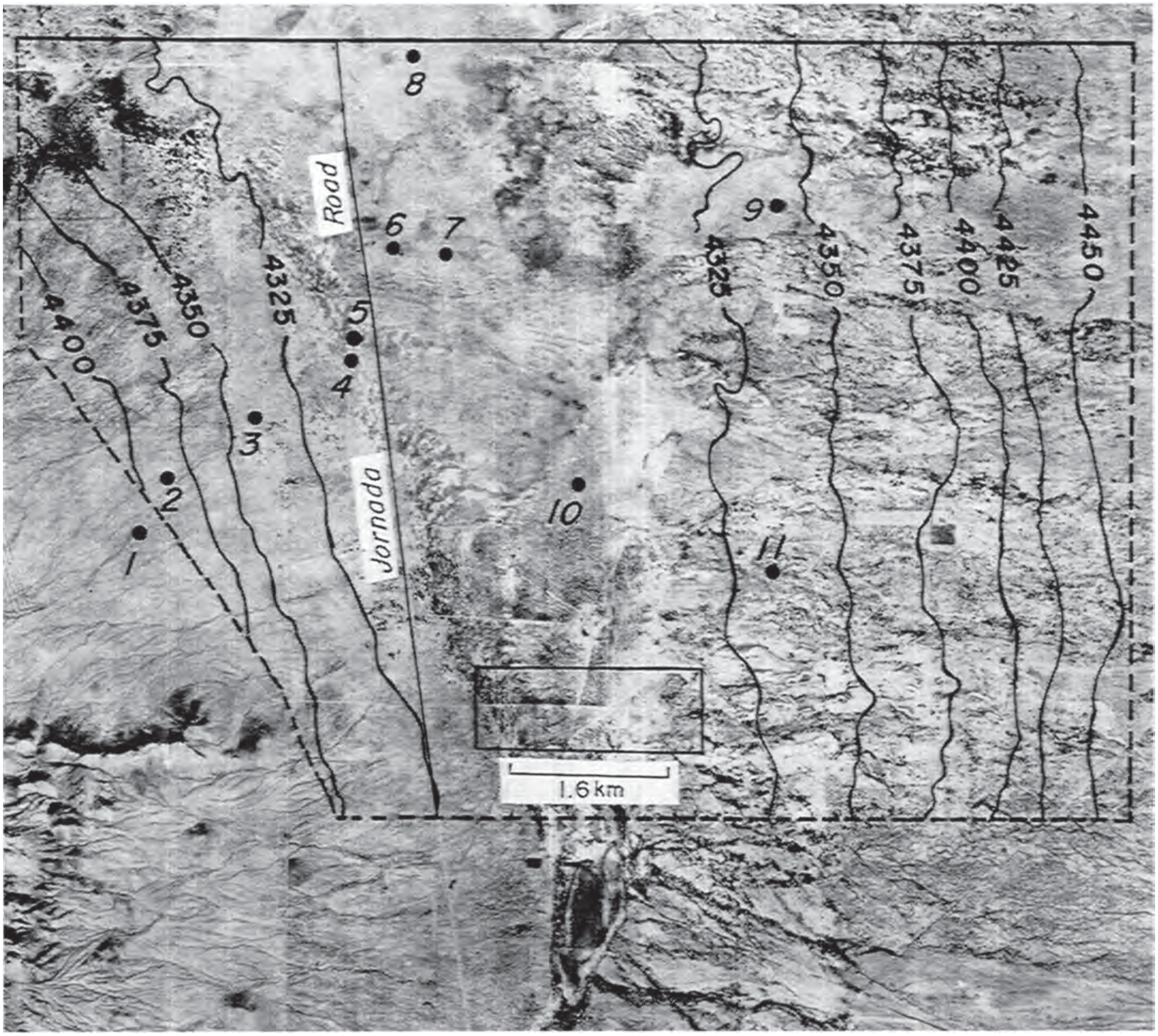


Figure 193. Rectangle locates soil map (fig. 194). 1 = 61-6; 2 = 61-5; 3 = 61-4; 4 = 67-6; 5 = 61-3; 6 = 68-6; 7 = 61-1; 8 = 61-2; 9 = 65-5; 10 = 68-7; 11 = 60-18. See these sections for discussion of these pedons: section 171, pedons 61-6, 61-5 and 61-4; section 196, pedons 61-3, 68-6, 61-1 and 61-2; section 172, pedons 60-18 and 65-5.

Figure 194. Map of soils across the basin floor and up the piedmont toeslope. A = Reagan, light subsoil variant (Organ surface). B = Algerita clay loam (Jornada II surface). C = Reagan clay loam (Petts Tank surface). D = Stellar clay loam (Jornada I surface). E = Dona Ana sandy clay loam (Jornada II surface). 1 = Soil moisture site C (section 51), Jornada Experimental Range; 2 = Stellar 60-21; 3 = Reagan 60-17; 4 = Reagan 66-6; 5 = Reagan variant 66-7. I to II and III to IV locate cross sections.

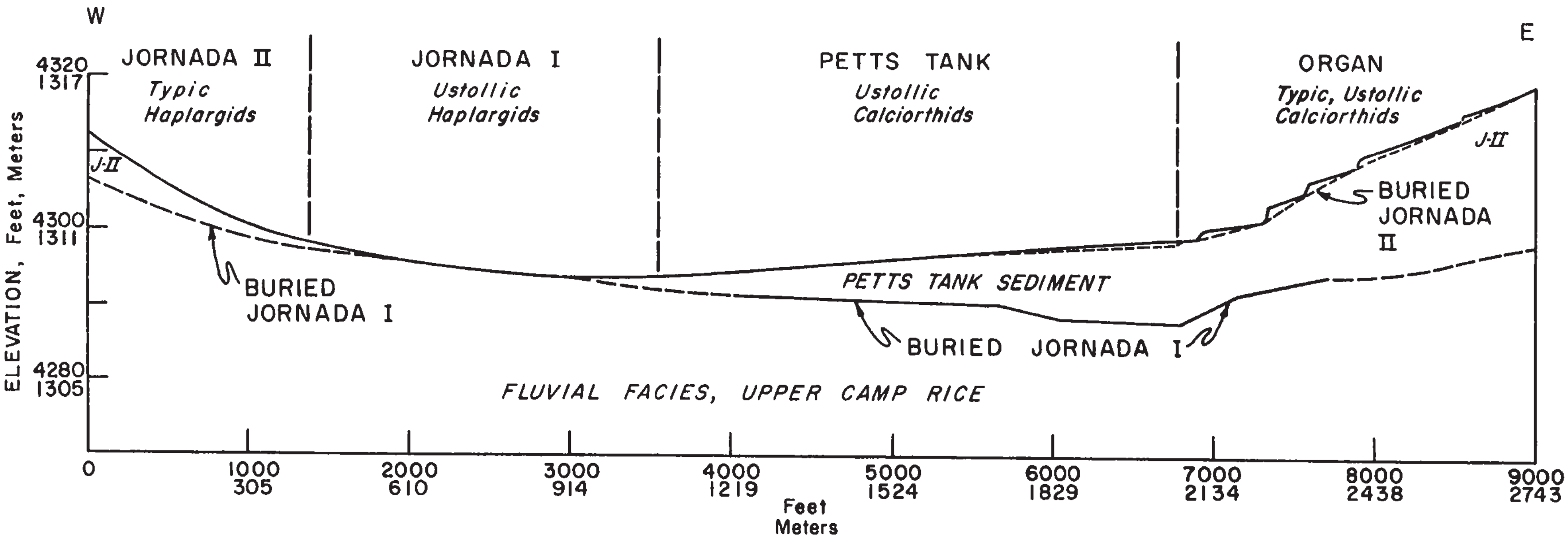
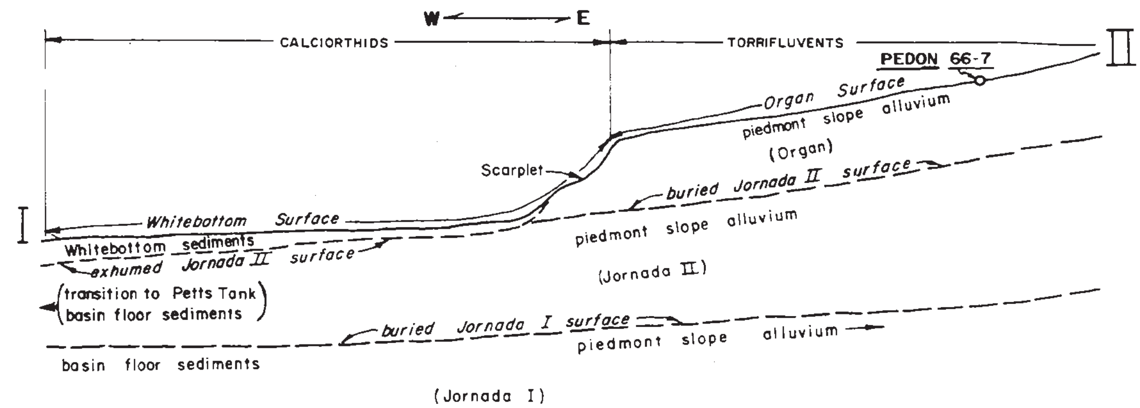


Figure 195. Cross section across the basin floor north of Isaacks' Lake Playa. The Whitebottom surface (primarily an erosion surface) shown by scarplet modification of Organ unit. A thin deposit of Jornada II may extend eastward to meet Petts Tank. Slopes exaggerated. J-II denotes Jornada II alluvium. On the piedmont toeslope there is a zone of intertonguing of fan and fluvial facies of the upper Camp Rice Formation.

Table 216. Laboratory data for four pedons illustrating the transition from the piedmont slopes to the basin floor.

Alluvium	Horizon	Depth	Sand 1/	Clay 1/	Fine 2/ Total Clay	Carbonate <2mm	Carbonate <0.002mm 3/	Extractable Sodium	Extractable 4/ Potassium	Bulk Density	Water Retention Difference	Organic Carbon
		cm	pct	pct	pct	pct	pct	me/100g	pct	g/cc		pct
	Ustollic Calciorthid (Reagan variant 66-7)											
Organ	A	0-8	43	26	0.24	12	2			1.37	0.19	1.17
	A	8-18	41	27	0.22	13	5			1.37	0.19	0.66
	B21ca	18-30	21	41	0.21	19	8			1.25	0.21	0.66
	B22ca	30-41	41	32	0.29	15	7					0.52
	2C	41-51	75	17	0.35	6	3					0.26
Jornada II	3B2cab	51-61	45	38	0.40	25	14			1.41	0.11	0.44
	3K2b	61-89	62	24	0.45	35	16			1.49	0.15	0.30
	3C1cab	89-112				25				1.80	0.15	0.12
	3C2cab	112-140				16				1.75	0.12	
	4C3cab	140-175				15						
	Organic carbon, 6.2 kg/m² to 89 cm.											
	Ustollic Calciorthid (Reagan 66-6)											
Organ	A	0-8	44	19	0.16	9	2			1.43	0.16	0.90
	B1	8-15	22	30	0.11	16	5			1.32	0.19	0.74
	B21	15-33	15	40	0.11	18	7			1.27	0.17	0.70
	B22ca	33-48	14	45	0.14	16	8			1.35	0.15	0.66
	B23ca	48-64	19	46	0.19	15	8			1.41	0.12	0.69
Jornada II	B21cab	64-81	48	32	0.26	13	6			1.59	0.10	0.37
	B22cab	81-114	43	36	0.43	21	11			1.40	0.14	0.34
	K2b	114-135	45	28	0.50	35	18			1.52	0.16	0.23
	C1cab	135-168	45	25	0.40	31	11			1.72	0.13	0.10
	C2cab	168-185	58	23	0.32	19	6					
	C3b	185-208	60	19	0.41	20	5					
	2C4b	208-259	27	30	0.33	28	8			1.39	0.22	
	2C4b	259-300	25	34	0.24	28	8			1.29	0.21	
	2C5b	300-325	21	38	0.23	28	8					
	3C6b	325-348	49	28	0.28	17	6			1.52	0.17	
Jornada I	3B2cab2	348-363	62	25	0.32	13	6					
	3K21b2	363-373	54	30	0.61	44	23					
	3K22b2	373-396	55	30	0.66	50	28			1.45	0.22	
	3K23b2 5/	396-437				28						
	3C1cacsb2 5/	437-457				6						
	3C2csb2 5/	457-518				3						
	Organic carbon, 8.8 kg/m² to 114 cm.											
	Ustollic Calciorthid (Reagan 60-17)											
Petts' Tank	A	0-8	26	34	0.13	10	5	tr	11			1.01
	B21	8-20	27	42	0.18	12	6	0.1	14			0.84
	B22	20-43	35	34	0.30	12	7	0.1	13			0.65
	B23ca	43-76	5	55	0.24	12	6	0.2	12			0.62
	K2	76-112	19	52	0.33	29	19	0.3	9			0.24
	C1ca	112-142	12	51	0.22	32	16	0.5	8			0.12
	C2ca	142-190	19	48	0.23	29	11					
Jornada I	Btbca	190-206	50	36	0.41	7	1					
	Organic carbon, 8.8 kg/m² to 112 cm.											
	Ustollic Haplargid (Stellar 60-21)											
Jornada I	A2	0-8	32	37	0.07	2		tr	12			1.22
	A3	8-13	32	45	0.23	tr		tr	11			0.65
	B1t	13-25	32	47	0.30	tr		tr	11			0.57
	B21t	25-51	31	44	0.29	3		tr	12			0.40
	B22t	51-79	31	49	0.47	6	2	0.1	11			0.27
	K1	79-99	36	48	0.51	24	14	0.1	10			0.17
	K21	99-130	59	29		51		tr	7			
	K22	130-155	64	25		46		0.1	7			
	K23	155-178	66	23		49		0.1	7			
	K24	178-216	68	21		36		0.1	8			
	K3	216-254	70	20		12		0.1	6			
	C1ca	254-284	78	15		9		0.1	6			
	2C2	184-305	87	9		1		0.2	6			
	Organic carbon, 6.0 kg/m² to 99 cm.											

1/ Carbonate-free as percentage of carbonate-free material.
2/ Carbonate removed.
3/ Percentage in < 2 mm.
4/ Percentage of cation exchange capacity.
5/ Gypsum, respectively, zero, 80, and 70 percent, in lower three horizons.



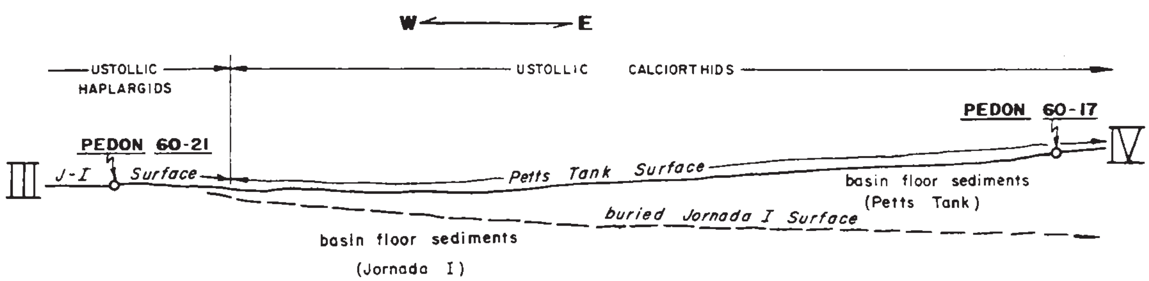


Figure 195a. Cross sections from I to II and III to IV, soil map.

Figure 196. <u>Upper</u>. The trench at the right is the site of the deep trench dug for sampling the Ustollic Calciorthid, Reagan 66-6. A small scarp in Organ alluvium is at left.

<u>Lower</u>. Upper horizons of Reagan 66-6. Scale is in feet.

A distinctive sediment informally termed the "silt zone" extends from 208 to 325 cm (table 216). It is remarkably like the zone from 129 to 170 cm in Berino 70-7 (section 157), despite the considerable difference in lithology of sediments in the two areas.

A second buried soil occurs below the silt zone. Westward the first buried soil rises to the surface (Reagan 60-17, fig. 197, 198); still further westward the second buried soil rises to the surface (Stellar 60-21). Reagan 60-17 occurs on the eastern side of the basin floor. This soil is the same age as the buried soil in Jornada II alluvium upslope. A silicate clay maximum is apparent in the B horizon (carbonate-free basis) but the required amount of oriented clay for an argillic horizon cannot be seen in thin section due to abundant carbonate. This pedon also illustrates the effect of high carbonate content on development of the argillic horizon in soils that started their development in late Pleistocene. These soils are of late-Pleistocene age and must have formed partly during a major pluvial. Even with greater effective moisture of the pluvial, abundant carbonate still remains in upper horizons. However, argillic horizons <u>have</u> formed in late-Pleistocene parent materials that may have less carbonate (section 170).

The horizon of carbonate accumulation in Reagan 60-17 is similar to stage III horizons in nongravelly materials on the piedmont slopes. The carbonate, however, is softer and somewhat more diffuse than on the piedmont slopes. This is thought to be due to the higher proportion of silt and clay in soils of the basin floor. The top of a buried soil of Jornada I age is in the lower part of the pedon. The argillic horizon of this buried soil is still noncalcareous in places, despite abundant carbonate in the overlying horizons.

Emergence of low-carbonate materials in the basin floor

Westward the buried soil at Reagan 60-17 rises to the surface (fig. 195a). Stellar 60-21 (figs. 194, 195a, table 216) on the western edge of the basin floor, has markedly different parent materials from those of the three pedons discussed in the transect to the east. This soil has formed in fine-grained sediments derived mainly from andesite, rhyolite, and monzonite, that grade downward into clean sand and rounded gravel of mixed composition. Thin deposits younger than Jornada I may be present at the surface.

Stellar 60-21 has an A2 horizon, a fine-textured argillic horizon and a thick K horizon. The A2 horizon is quite prominent, probably because of the increased moisture in this basin-floor position; the area receives runoff from piedmont slopes to the west (section 52). This greater moisture also has resulted in one of the best grass stands to be seen in the arid part of the study area; tobosa grass forms an almost continuous cover. The run-in adds calcium and also helps to dissolve carbonate on the soil surface. The A2 horizons of these soils in the basin floor are commonly partly or wholly calcareous, while horizons immediately beneath are noncalcareous. Apparently so much calcium is being supplied to the soil surface that not all of it can be moved into the soil with the moisture available under the present climate.

Part of the clay of the Bt horizon is probably inherited from the parent materials, which in this basin-floor position must have been quite high in clay. There is evidence of illuvial clay in the Bt horizon (pedon 60-21, Appendix). The Bt horizon is thicker than in adjacent soils on the fan-piedmont. This is

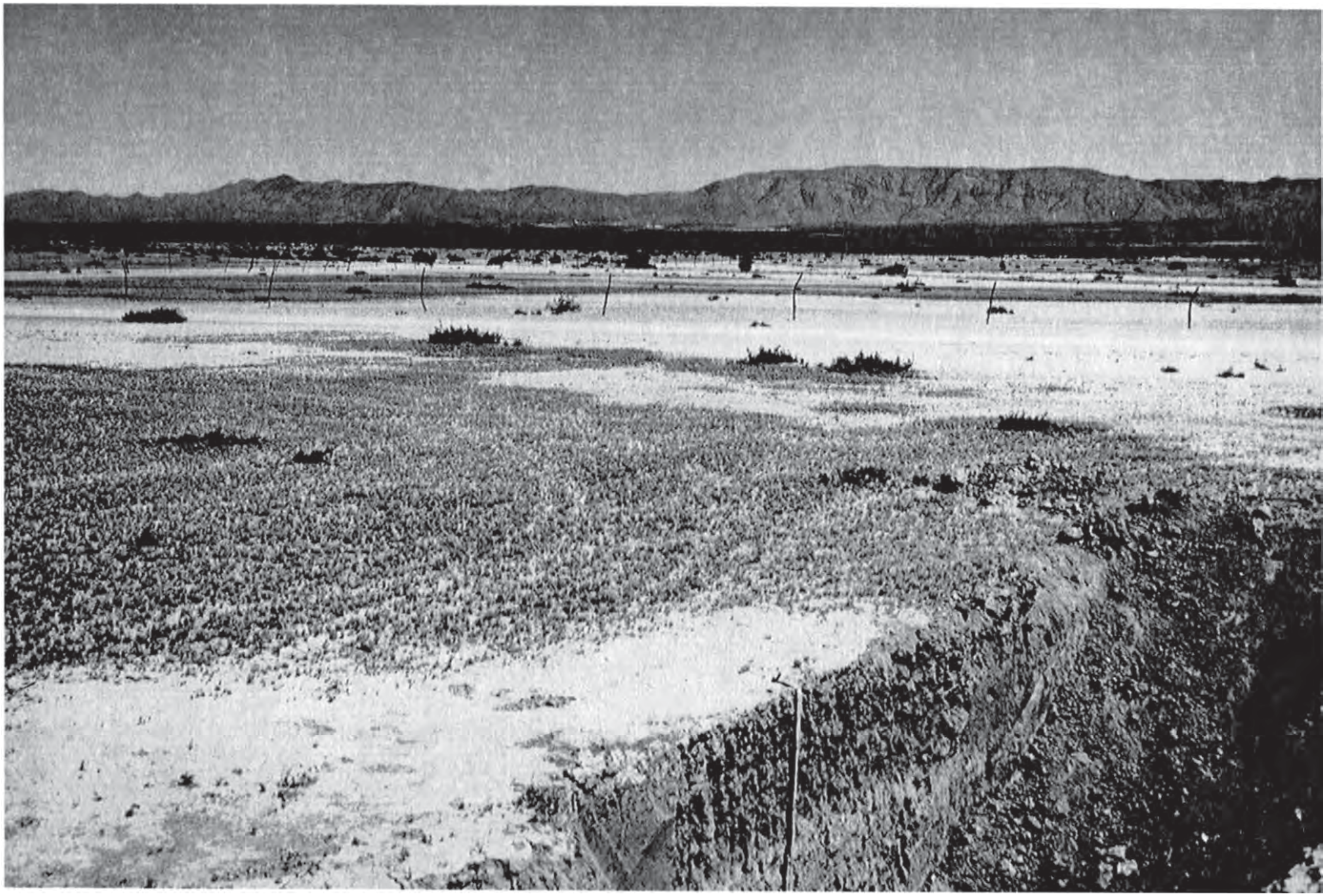


Figure 197. Landscape of an Ustollic Calciorthid, Reagan 60-17, on the Petts Tank surface. Vegetation consists mainly of burro grass, with a few crucifixion thorn and sumac. The slope is nearly level, being less than 1/2 percent to the west.

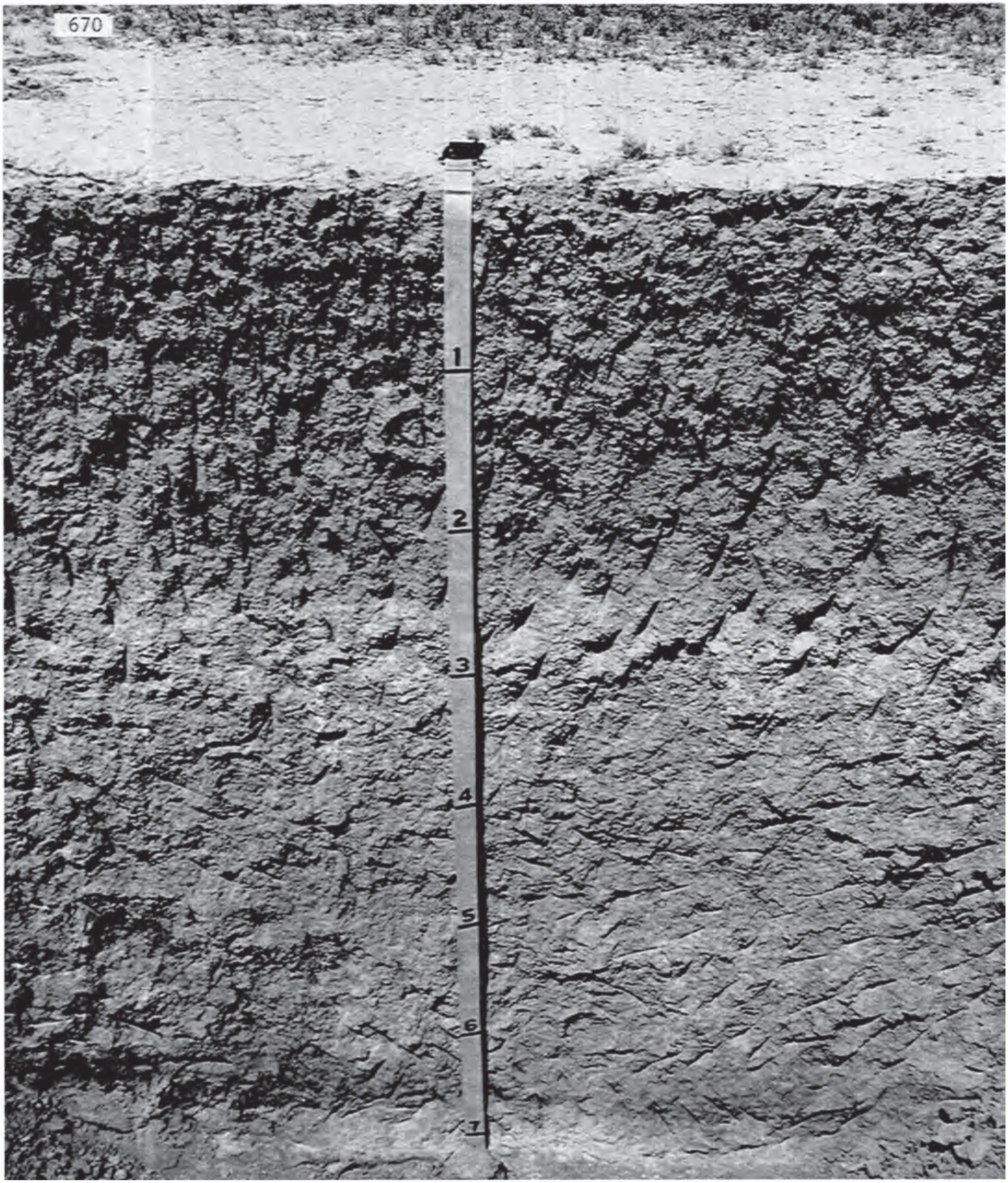


Figure 198. An Ustollic Calciorthid, Reagan 60-17. Scale is in feet.

apparently due mainly to the run-in, which should move clay and carbonate to depths greater than in soils without run-in. The horizon of carbonate accumulation is very thick and although it started developing in mid-Pleistocene time, a petrocalcic horizon has not formed. This is due to the nongravelly materials and is in marked contrast to Paleorthids of the same age (section 145), which have petrocalcic horizons with multiple laminar horizons.

Several statements may be made concerning laboratory data for the transect as a whole (table 216). The silicate clay is finer in the B horizon and K horizon of the buried soils than in the overlying Petts Tank or Organ alluvium, which have relatively coarse silicate clay compared to the soils generally in the project. Carbonate of clay size is an appreciable proportion of the total carbonate in all horizons analyzed. Extractable potassium as a percent of the exchange capacity is particularly high (relative to other soils of the project) in the upper horizons of Reagan 60-17 and Stellar 60-21. Weakly developed horizons formed in the calcareous alluvium may have bulk densities as low as about 1.3; such material is subject to settling on being wetted. The water retention difference of 0.15 to 0.20 in upper horizons of the Organ alluvium are relatively high compared to other soils studied. This may be one of the factors responsible for the relatively large quantities of organic carbon.

The clay mineralogy was determined for selected horizons in each pedon.[7/] All horizons examined contain montmorillonite, mica, and kaolinite. Reagan 66-6 has small quantities of chlorite. Only the montmorillonite ranges much in amount and degree of ordering. It is most abundant (i.e., moderate to abundant amounts) in the B22 horizon of Reagan 60-17 (in Petts Tank sediments) and in the IVC3cab horizon of 66-7 (in Jornada II alluvium). Other horizons of Jornada II age in pedons 66-6 and 66-7 have small amounts of poorly-ordered montmorillonite. Horizons in Organ alluvium also contain small amounts of poorly-ordered montmorillonite. Horizons in basin floor sediments of Stellar 60-21 have trace to small amounts of poorly-ordered montmorillonite. The IIIK22b2 horizon in the basin floor sediments in Reagan 66-6 has somewhat more and better ordered montmorillonite than the same sediments at depth in Stellar 60-21. Clay mineralogy of the Organ alluvium is consistent with findings in other soils in the study area. There is no clear indication of well-ordered montmorillonites being preserved in and below K horizons as has been found in the other soils. Neither is there any clear association of amount or crystallinity of montmorillonite with age of sediments. Mineralogy is roughly similar among the samples over the very wide time span considered. Variations found may reflect differing lithologies or differences in soil genesis. The data are insufficient to test either possibility.

7/ Written by W. C. Lynn

192. Soils of the Jornada I surface.

These soils of Jornada I occur on the western part of the basin floor north of Isaacks' Lake and occupy nearly all of the basin floor south of it. These soils are older than the soils of Petts Tank and Jornada II since they pass beneath them to the east and west respectively. These soils are younger than the soils of mid-Pleistocene La Mesa. The soils occur in the basin floor and on the piedmont toe-slopes. In and near the basin floor, 1/2 to 1 m or more of sediments have accumulated since deposition of the rounded gravel and sand of the mid-Pleistocene river alluvium. This younger sediment is finer-textured than the underlying sediments and was derived upslope. The A, Bt, and part or all of the K2 horizons of Stellar soils have formed in these finer-textured materials. All of these materials are nongravelly and all soils have thick Bt and K horizons. The contact between Jornada I and II is apparent in the piedmont slopes (see Appendix, soil at soil moisture site B) but not in the basin floor. Proximity of this part of the basin floor to the piedmont toe-slopes of the Dona Ana Mountains suggests that some of the upper materials may be Jornada II age.

193. STELLAR CLAY LOAM (16V)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percent of Mapping Unit
STELLAR	USTOLLIC HAPLARGIDS	FINE	65
Berino	Typic Haplargids	Fine-loamy	10
Dona Ana	Typic Haplargids	Fine-loamy	5
Headquarters	Ustollic Haplargids	Fine-loamy	10
SND-3	Typic Haplargid	Fine	10

LOCATION, LANDSCAPE, VEGETATION

These soils occur north of Isaacks' Lake Playa and in a broad band that parallels fan toeslopes east of the Dona Ana Mountains. The soils have formed in alluvium derived from monzonite, rhyolite, and andesite. Elevation is about 4300 feet.

Most slopes range from about 1/2 percent (there are small areas of 1 percent) on mountainward parts of the toeslopes to nearly level next to the basin floor. There are no gullies or arroyos, and no marked undulations in the landscape. In many places there are prominent barren strips that are along the contour and that alternate with vegetated strips. The barren strips commonly occur below small scarps that generally range from 1 cm to about 10 cm in height.

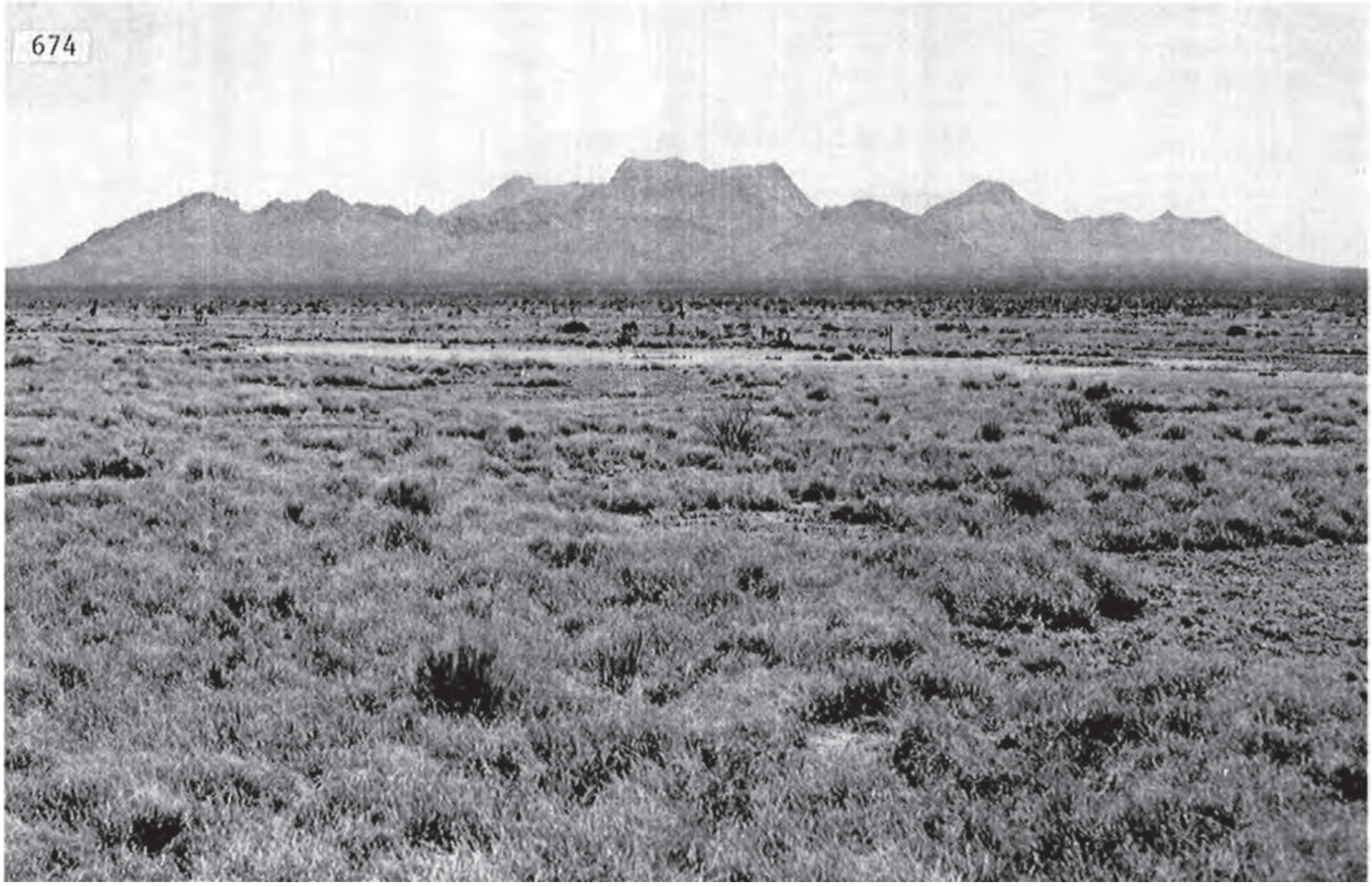
Vegetation consists primarily of tobosa and burro grass, with scattered snakeweed, *Yucca elata* and mesquite.

TYPICAL PEDON, PROPERTIES AND RANGES

In places the A horizon has been partly or wholly truncated and the Bt horizon is at or very near the surface. These areas are in the common barren strips that occur between vegetated strips. On gentlest slopes, near the basin floor, these soils have prominent K horizons underlain by thick sandy deposits, commonly with some gravel. On steeper slopes the K horizon is not as thick and buried soils occur beneath it.

Stellar

A typical pedon of Stellar is described in the Appendix (pedon 61-3). Figure 198 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.



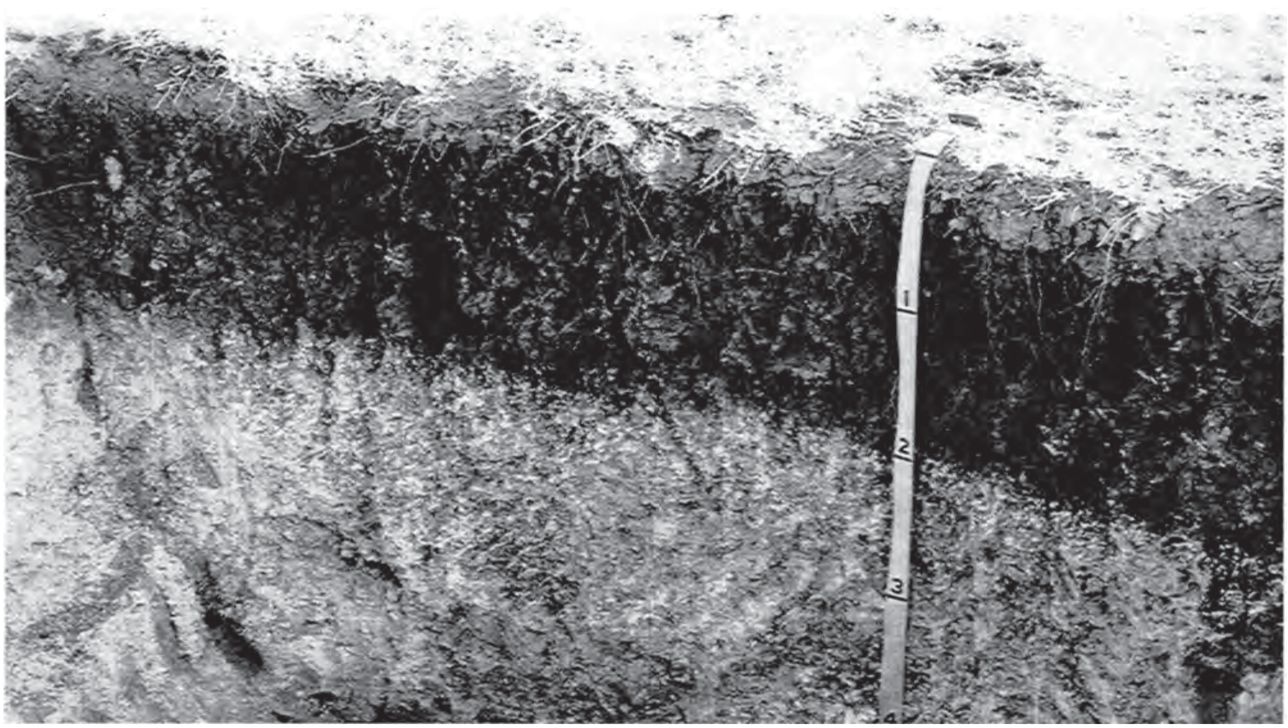


Figure 199. Upper. Landscape of an Ustollic Haplargid, Stellar 61-3, on toe-slopes of the fan-piedmont. Vegetation consists of tobosa grass, scattered snakeweed, and *Yucca elata*. In many places there are prominent barren strips, about on the contour, that occur below small scarps one to a few cm in height (section 61).

Lower. Stellar 61-3. Scale is in feet.

Table 217. Typical (underlined) and range in selected properties for major horizons of Stellar.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-8	cl l	0	7.5YR	6	4	2-4 3
B2t	8-58	c hv.cl	0-15	2.5YR- 5YR	4,5	3.5-5 4	4-6
K2	71-150	cl scl	0-15	7.5YR- 10YR	6-9 8	5-8 6	3,4
Control section		c, hv. cl	< 15				

Other. Depth to the calcic horizon (the K horizon in the description) ranges from 50 to 75 cm. The typical soil of this mapping unit (Stellar 61-3) is further discussed in the "other studies" part of section 196.

SOIL OCCURRENCE

Haplargids. The STELLAR soils occur over nearly all the area. Small areas of the fine-loamy Headquarters and Dona Ana soils occur near the border of the mapping unit. The Typic Haplargid SND-3 occurs in some of the strongly eroded, barren strips where the A horizons have been largely or completely truncated. Organic carbon has been sufficiently lowered that the soil is a Typic, rather than an Ustollic Haplargid. Berino soils occur mostly on upper slopes, where textures are slightly coarser.

SOIL BOUNDARIES

Table 218 presents information on boundaries to adjacent major units.

Table 218. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Dona Ana sandy clay loam (16VG)	The boundary is caused by a change in texture of the materials (to clay) in unit 16V and by increasing effective moisture in the fan toeslope position. The topographic boundary is fairly distinct, occurring along the fan toeslope positions where slope is about 1 percent or less. Vegetatively there is a change from substantial amounts of tobosa in unit 16V to almost none in unit 16VG.
Algerita sandy loam (57)	The boundary is caused by a change in texture of the materials (to clay) in unit 16V and by greater effective moisture in unit 16V. Topographically the boundary occurs at the margin between the level basin floor (unit 57) and the fan toeslopes (unit 16V). The boundary is marked by a shift in dominant vegetation, from tobosa (unit 16V) to burro grass and tarbush (unit 57).

194. STELLAR CLAY LOAM, OVERFLOW (55)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
STELLAR, CLAY LOAM, OVERFLOW PHASE	USTOLLIC HAPLARGIDS	FINE	85
Headquarters	Ustollic Haplargids	Fine-loamy	5
Reagan	Ustollic Calciorthids	Fine-silty	5
Stellar, wedgy subsoil variant	Ustollic Haplargids	Fine	5

LOCATION, LANDSCAPE, VEGETATION

These soils are located just north and south of Isaacks' Lake Playa, south of the Stellar clay loam mapping unit discussed in the preceding section. These soils have formed in sediments derived from monzonite, andesite and rhyolite. Elevation is about 4300 ft.

The soils occur along the axis of the basin, just eastward of the steeper piedmont slopes (of about 2 percent) descending from the Dona Ana Mountains. The surface is fairly smooth except for grass clumps and occasional small depressions. Most of the area is very nearly level; there is slow movement of surface water towards Isaacks' Lake Playa. Slopes of 1/2 percent or less on the piedmont toeslopes along the western edge are included.

Vegetation consists primarily of a heavy stand of tobosa, with only scattered barren areas. There are a few patches of burro grass, and a few *Yucca elata*, snakeweed, and mesquite.

TYPICAL PEDON, PROPERTIES AND RANGES

These soils are underlain by thick sandy deposits; in places there are a few fine, rounded pebbles.

Stellar clay loam, overflow phase.

A description of Stellar clay loam, overflow phase is in the Appendix (pedon 60-21). Figure 199 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

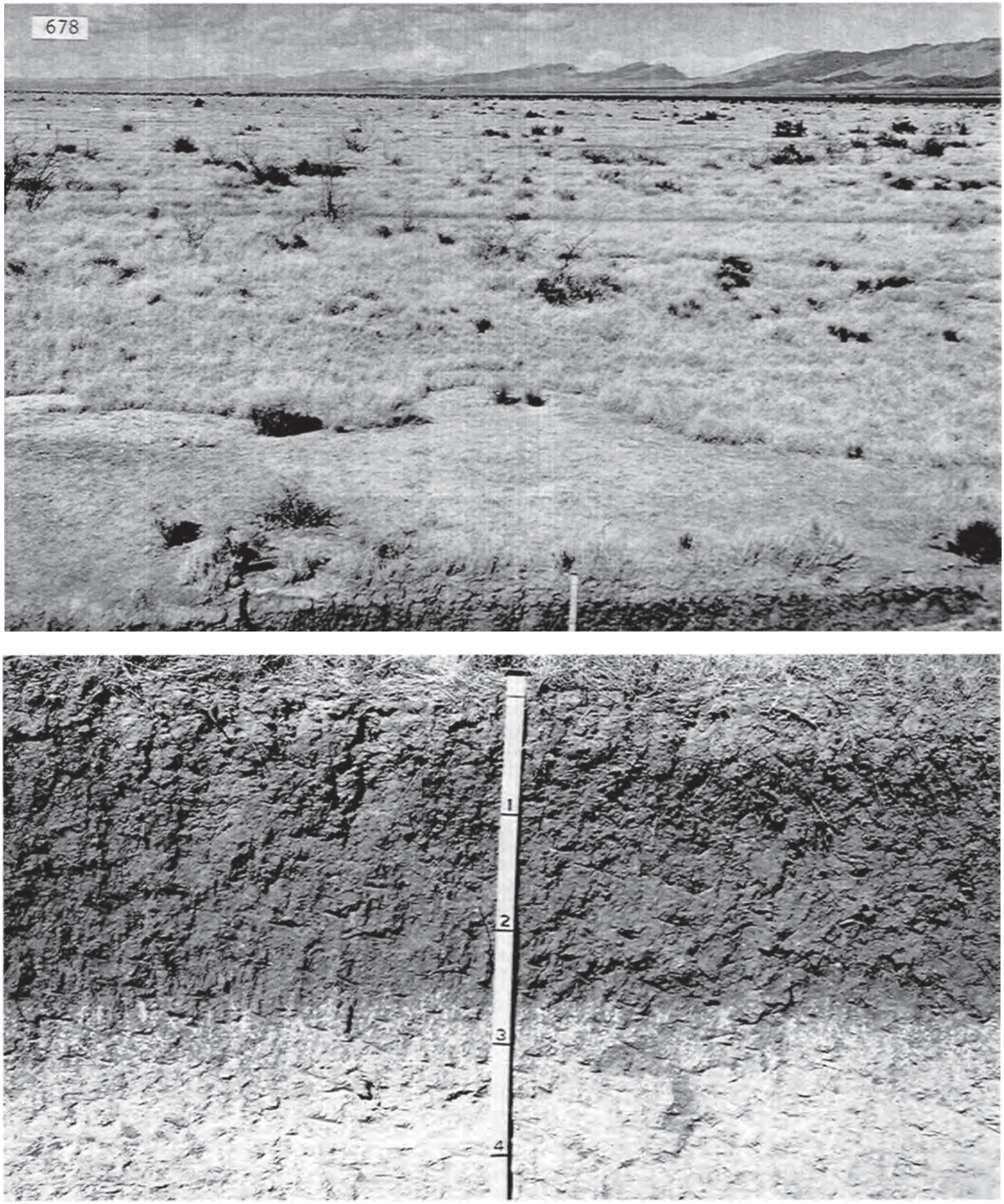


Figure 200. <u>Upper</u>. Landscape of an Ustollic Haplargid, Stellar 60-21, on the Jornada I surface. Vegetation is mainly tobosa, with a very few snakeweed and mesquite.

<u>Lower</u>. Stellar 60-21. Scale is in feet.

Table 219. Typical (underlined) and range in selected properties for major horizons of Stellar clay loam, overflow phase.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	0-13	cl l	0-1	7.5YR	6	4	2-4 3
B2t	13-79	c hv.cl	0-5	5YR- 2.5YR	4,5	3.5-5	4-6
K2	99-216	cl scl	0-10	5YR- 10YR 7.5YR	6-9 7	5-8 6	1-8 4
Clca	254-284	sl ls s	0-15	5YR- 10YR 6YR	5,6	4,5 4,5	3,4
Control section		cl, hv.cl	< 5				

Other. Depth to the calcic horizon (the K1 and K2 horizons of the description) ranges from 75 to 100 cm. In a few places the A horizon has been partly or wholly truncated and the Bt horizon is at, or very near the surface. These areas occur mainly on slightly sloping (1/2 percent) areas in the western part of the unit. The upper part or all of the A horizon is usually calcareous and the upper part of the Bt horizon is usually noncalcareous. Some pedons are calcareous throughout. These are included in the Stellar series as long as they have no visible carbonate in the upper subhorizon of the Bt horizon. Some of these calcareous soils occur north of Isaacks' Lake Playa in the eastern part of the unit, and are gradational to the Reagan soils. Others are associated with small holes and depressions, and are gradational to Stellar, wedgy variant (see Appendix). These soils are quite similar to the Stellar soils in the Stellar clay loam mapping unit, but have thicker argillic horizons that range in thickness from about 75 to 125 cm. Depth to the K2 horizon is correspondingly greater. High chroma in the K2 horizon occurs in thin stainings on high-carbonate peds.

SOIL OCCURRENCE

This mapping unit is an example of one that consists very largely of soils belonging to one series. The reasons for this are: (1) All soils in the unit are quite old and also have formed in low-carbonate parent materials. Slopes are very gentle, the landscape is stable and textures are fine enough to prevent obliteration of the argillic horizon by soil fauna. As a result, all soils (except a few next to the Calciorthids of the Reagan mapping unit) are Argids. (2) There is essentially no gravel, which if present in large amounts in soils of this age would cause the development of a petrocalcic horizon. Hence, Paleargids do not occur and all Argids are Haplargids. Absence of gravel also means that no skeletal families are present. (3) The run-in from adjacent slopes, because of basin-floor position, have caused a heavy stand of tobosa in most areas. This together with fine textures have resulted in enough organic carbon that all Haplargids are Ustollic. (4) Because of the landscape position and very gentle slopes (1/2 percent or less) and resultant fine texture of the parent materials, all soils are in the fine family.

Haplargids. The STELLAR soils occupy nearly all of this mapping unit. The fine-loamy Headquarters soils occur in places along margins of the mapping unit. Stellar, wedgy subsoil variant , occur where small (several dm across and deep) depressions and holes are common.

Calciorthids. The fine-silty Reagan soils occur in a few places on the eastern edge of the mapping unit, next to the Reagan clay loam mapping unit.

SOIL BOUNDARIES

Table 220 presents information on boundaries to major adjacent units.

Table 220. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Berino-Bucklebar association (15M)	The boundary has been caused by several factors: a younger alluvium and geomorphic surface (Jornada II) in unit 15M; a change to clay textures in unit 55; and increased effective moisture in the basin-floor positions (unit 55). Buried soils, analogues of which are buried in unit 15M, emerge at the surface or are very near the surface on the 55 side of the boundary. Topographically the boundary is marked by a change from fan piedmont, sloping 1 percent to the west, to a level basin floor. Vegetatively the boundary is marked by a thick stand of tobosa in unit 55 and only scattered mesquite, tobosa, and snakeweed in unit 15M.
Dona Ana sandy clay loam (16VG)	The boundary is due to a change in texture of the materials (to clay) in unit 55 and by increased effective moisture in the basin floor positions adjacent to the fan-piedmont. The topographic boundary is fairly distinct, occurring near the border between the basin-floor and fan-piedmont, at a point where slopes steepen to more than about 1/2 percent. Vegetatively the boundary is marked by a shift from dominantly tobosa grass to dominantly creosotebush and tarbush.
Reagan clay loam (51)	The boundary is due to a change from low-carbonate parent materials (unit 55) to high-carbonate materials (unit 51). The topographic boundary to unit 51 is not distinct. The boundary occurs about in the center of the basin floor, at the border between high-carbonate sediments derived from the San Andres Mountains and low-carbonate sediments derived from the Dona Ana Mountains. Vegetation shifts along the boundary from mainly tobosa (unit 55) to mainly burro grass (unit 51).

195. Soils of the Jornada and La Mesa surfaces undifferentiated.

These soils occur on slight ridges and depressions in the basin floor. The soils have formed in sediments of the Upper Camp Rice Formation (fluvial facies), but are not as prominently developed as in soils of the La Mesa surface along the Rio Grande Valley border. Petrocalcic horizons are seldom present, although there is evidence in some soils that a petrocalcic horizon might once have been present and since been fractured. The details of soil age are not known with certainty in this area but most soils are thought to fall in the general age range of Jornada I and La Mesa. Minor deposits observed in parts of some of the depressions may be younger than Jornada I. Parts of La Mesa in the closed basin could have been occupied by a shallow lake at some time in the Pleistocene. At that time the soils of La Mesa along the valley border may have already started to develop. Soils of this area could, therefore, be younger than soils of the valley border.

Soils of two mapping units occur on the Jornada and La Mesa surfaces undifferentiated:

196. ALGERITA SANDY LOAM (57)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ALGERITA	TYPIC CALCIORTHID	COARSE-LOAMY	60
REAGAN LIGHT SUBSOIL VARIANT	USTOLLIC CALCIORTHID	FINE-LOAMY	20
Dona Ana	Typic Haplargid	Fine-loamy	10
Reagan	Ustollic Calciorthid	Fine-silty	5
Other inclusions (Haplargids)			5

LOCATION, LANDSCAPE, VEGETATION

These soils occur in the northern part of the basin floor. The soils have formed mainly in noncalcareous sand of the Upper Camp Rice Formation; there are also a few rounded pebbles of mixed lithology. Elevation is about 4300 feet.

The soils do occur in the level or nearly level basin floor. These areas are adjacent to the toeslopes of the fan-piedmont, and also occur in very slight depressions that are about one to several m lower than adjacent slight ridges.

Vegetation consists mainly of burro grass; in places there are scattered tarbush and a few tobosa clumps. There are occasional barren strips.

TYPICAL PEDONS, PROPERTIES AND RANGES

These soils are calcareous throughout except for a few spots in the western part of the unit. Reddish brown pipes occur in places, and have Bt horizon fabric. These soils are underlain by many m of sand, with some gravel, except where underlain by buried soils.

Algerita

A typical pedon of Algerita is described below. This soil occurs in the NE 1/4 Sec. 33, T20S, R2E, about 0.5 mile east of the Jornada Road. Figure is a photograph of the pedon and its landscape. A table of properties and ranges follows the description.

Soil surface: Smooth between grass clumps.

C 0-5 cm. Dominantly pinkish gray (7.5YR 7/2, dry) or brown (7.5YR 5/4, moist), with lesser amount of light brown (7.5YR 6/4, dry) or dark brown (7.5YR 4/4, moist); loamy sand; weak fine and medium platy; soft; very few roots; stratified; effervesces strongly; abrupt smooth boundary.

A 5-13 cm. Pinkish gray (7.5YR 7/2, dry) or brown (7.5YR 5/4, moist) heavy sandy loam; massive; slightly hard, friable; few roots; few fine and very fine tubular pores; effervesces strongly; abrupt smooth boundary.

B1 13-20 cm. Pink (7.5YR 7/4, dry) or brown (7.5YR 5/4, moist) light sandy clay loam; massive; hard, friable; common fine and medium tubular pores; effervesces strongly; clear wavy boundary.

B2ca 20-43 cm. Light brown (7.5YR 6/4, dry) or brown (7.5YR 5/4, moist) clay loam; compound weak coarse prismatic and weak medium and coarse subangular blocky; hard, friable; very few roots; few carbonate filaments; few insect burrows, 1/2 to 1 cm diameter, some empty and some filled with fine earth; few fine tubular pores; effervesces strongly; clear wavy boundary.

K11 43-79 cm. Pink (7.5YR 7/4, dry) or light brown (7.5YR 6/4, moist) clay loam; moderate medium and coarse subangular blocky; very hard, friable; very few roots; carbonate occurs as scattered filaments, nodules and masses of irregular shape; a few insect burrows, 1/2 to 1 cm diameter, filled with dark material; few fine and medium tubular pores; effervesces strongly; clear wavy boundary.

K12 79-94 cm. Dominantly pink (7.5YR 8/4, dry) or light brown (7.5YR 6/4, moist) heavy sandy clay loam, with smaller amount whiter than pink (7.5YR 9/4, dry) or pink (7.5YR 7/4, moist) and pink (7.5YR 7/4 dry) or brown (7.5YR 5/4, moist); very hard, friable; moderate medium and coarse subangular blocky; no roots; common carbonate nodules and masses of irregular shape; effervesces strongly; clear wavy boundary.

K21 94-122 cm. Dominantly white (7.5YR 9/2, dry) or pink (7.5YR 7/4, moist) with lesser amount pink (7.5YR 8/4, dry) or light brown (7.5YR 6/4, moist); clay loam; weak and moderate medium and coarse subangular blocky; very hard, friable; harder in place than horizons above; no roots; carbonate occurs as nodules and masses of irregular shape; breaks out as discrete nodules and segments of nodules, 1 to 2 cm diameter; effervesces strongly.

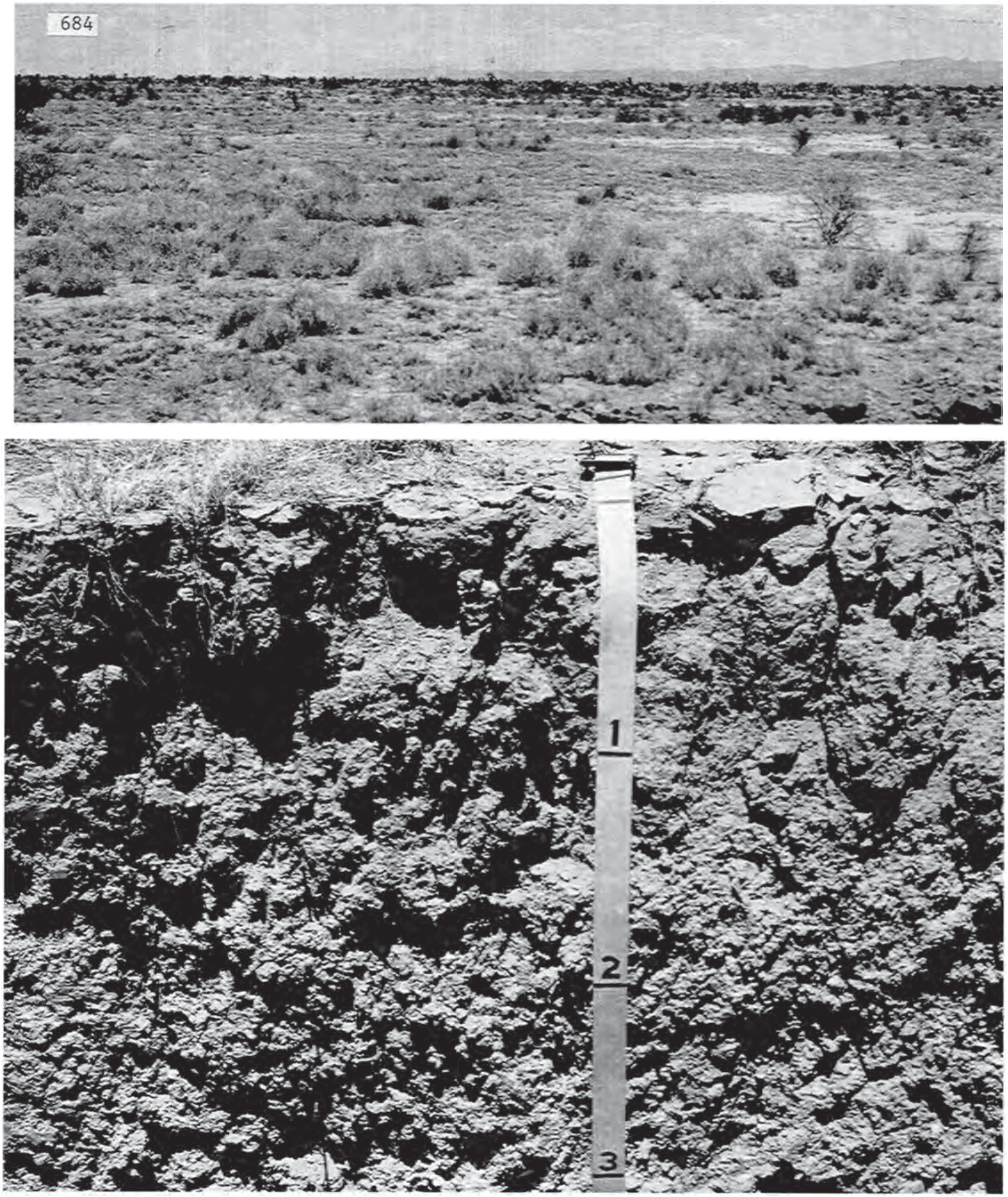


Figure 201. Upper. Landscape of a Typic Calciorthid, Algerita sandy loam, on the Jornada and La Mesa surfaces, undifferentiated. Vegetation consists of discontinuous patches of burro grass and scattered clumps of tobosa. The area is level.

Lower. Algerita sandy loam. Scale is in feet.

K22 122-145 cm. About equal parts of lighter than pink (7.5YR 9/4, dry), or pink (7.5YR 7/4, moist), pink (7.5YR 8/4, dry, 7.5YR 7/4, moist) and pink (7.5YR 7/4, dry) or light brown (7.5YR 6/4, moist); sandy clay loam; weak and moderate medium subangular blocky; very hard; no roots, breaks out as discrete nodules and segments of nodules, 1 to 2 cm diameter; few fine pebbles; few indurated fragments 1 to 3 cm diameter; few fine tubular pores; effervesces strongly; clear wavy boundary.

K3 145-168 cm. Pink (7.5YR 7/4, dry) or brown (7.5YR 5/4, moist), sandy loam; massive; slightly hard, friable; no roots; a few fine igneous pebbles; few carbonate nodules and filaments; sand grains discontinuously coated with carbonate; effervesces strongly.

C 168-196 cm. Pink (7.5YR 7/4, dry) or brown (7.5YR 5/4, moist) sandy loam, with a discontinuous layer, 1 to 2 inches thick, of fine, rounded igneous pebbles at the base of the horizon; massive; slightly hard, very friable; no roots; discontinuous carbonate coatings on sand grains; a few small pockets of loamy sand amongst the pebbles; effervesces strongly; abrupt smooth boundary.

Bcab (?) 196-203 cm. A carbonate-impregnated sandy clay loam, with some pinkish zones; possibly a buried B horizon.

Table 221. Typical (underlined) and range in selected properties for major horizons of Algerita.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	5-13	hv.sl lt.scl	0-1	7.5YR	6,7	4,5	2-4
B2	20-43	scl cl	0-1	7.5YR	6,7	4,5	3,4
K2	94-145	scl cl	0-1	7.5YR- 10YR	7-9	6-8	2-4
C	168-196	sl ls s	0-15	7.5YR- 10YR	6,7	4,5	2-4
Control section		scl,cl	< 15				

Other. Silicate clay content of the control section averages less than 18 percent. The control section averages sandy clay loam or clay loam by field texture because of high content of carbonate clay and silt. Depth to the calcic horizon (the K1 and K2 horizons in the description) ranges from 25 to 75 cm. These soils are calcareous throughout. In places the A horizon has been eroded by wind and sediment has been deposited in adjacent areas. Soils with a thin deposit of surficial C horizon material alternate with soils having B horizons at or very near the surface, and with soils having little evidence of erosion. Nodular carbonate horizons above the K2 horizon usually qualify as calcic horizons, and in most of these soils form the upper part of thick calcic horizons. Depth to the prominent, thick K2 horizon usually ranges from about 50 to 100 cm, but in places the soil with the thick K2 horizon appears to be buried. In these cases a thin, nodular calcic horizon occurs from about 60 to 90 cm and is underlain by a horizon with less carbonate, with the thick K2 horizon occurring at a depth of about 1-1/2 m, beneath a B horizon that in places is reddish brown.

Reagan, light subsoil variant

A pedon of Reagan, light subsoil variant, is described in the Appendix (pedon 66-7).

SOIL OCCURRENCE

This mapping unit illustrates the transition from the Haplargids to the Calciorthids, in parent materials of the same carbonate status (noncalcareous sand).

Calciorthids. The coarse-loamy ALGERITA soils occur over most of the area. Reagan soils, Ustollic Calciorthids, occur in scattered places adjacent to the Reagan clay loam mapping unit. Reagan, light subsoil variant, occurs in places where the 25 to 100 cm control section averages 18 to 35 percent silicate clay. These soils occur mostly in areas near the boundary to the Reagan clay loam mapping unit. In these places, these soils illustrate the transition in texture from the coarse-loamy Algerita soils to the fine-silty Reagan soils.

Haplargids. The fine-loamy Dona Ana soils occur in scattered spots where an argillic horizon has been preserved. The Bt horizons of these soils have some visible carbonate in all subhorizons. Stellar soils, Ustollic Haplargids, occur in a few small areas marginal to the two mapping units dominated by Stellar soils (Stellar clay loam, and Stellar clay loam, overflow). A few pedons of the Berino soils occur in very slight lows near toe-slopes of the fan-piedmont. Such places may be only a few cm lower than adjacent soils, but the slight run-in from these areas is important in keeping the upper part of the Bt horizon of Berino soils free, or nearly free of carbonates.

SOIL BOUNDARIES

Table 222 presents information on boundaries to adjacent major units.

Table 222. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Stellar clay loam (16V)	The boundary has been caused by a change in texture (to clay or heavy clay loam) in soils of unit 16V and by greater effective moisture in unit 16V. Topographically the boundary occurs at the margin between the level basin floor (unit 57) and the fan toeslopes (unit 16V). Vegetatively the boundary is marked by a change from dominantly tobosa (unit 16V) to burro grass and tarbush (unit 57).
Algerita sandy loam, eroded (56)	The boundary is due to slight differences in physiographic position and texture. Soils of unit 57 occur in "flats" and very slight depressions whereas soils of unit 56 occur on very slight ridges. Upper horizons of soils in unit 56 are coarser-textured than soils of unit 57. The topographic boundary is fairly distinct, occurring along the margins between the slight depressions of unit 57 and the slight ridges of unit 56.

OTHER STUDIES: SOILS OF PIEDMONT TOESLOPES AND ADJACENT BASIN FLOOR

Four pedons in and adjacent to this mapping unit (figs. 201, 202) illustrate the transition from the lower piedmont slopes east of the Dona Ana Mountains to the basin floor. Slopes change from about 1/2 percent on the toeslopes to essentially level in the basin floor. Landscape position is important because soils along the margin of the basin floor receive run-in moisture from upslope, whereas soils of the main part of the basin floors receive little or no run-in. Laboratory data are in table 222a.

Stellar 61-3 (fig. 198) occurs on the toeslopes and has a thin A2 horizon, a reddish brown Bt horizon, and a thick K2 horizon that is in late stage III of carbonate accumulation. The pedon occurs in a grassy strip in an area where alternating barren and grassy strips are distinct (section 61). Many of the peds in the Bt horizon have smooth, reflective surfaces. Thin sections show no clay skins on the surfaces of the peds but there is abundant oriented clay within peds, occurring both as coatings on sand grains and as linear bodies. The distinct A2 horizon and clay differences between A and B are other evidences of illuviation in this soil. Observations of water movement in the vicinity of Stellar 61-3 indicate that runoff water from upslope is an important source of added moisture for soils of the toeslopes.

The physiographic transition from the toeslopes to the basin floor is important to both soil moisture and soil morphology. The broad basin floor receives no run-in except along its margin. This general area is also significant from a classification standpoint because the transition between the Argids and the Orthids occurs here. The Stellar soils (Argids) occur in close association with the Dona Ana soils (Argids) and the Algerita soils (Orthids) along the boundary to the basin floor. Dona Ana 68-6 (fig. 203) occurs in a broad, very slight depression in the basin floor, near the boundary between the basin floor and the piedmont toeslopes.

Dona Ana 68-6 has a thick K horizon and a calcareous argillic horizon with about 10 percent by volume of reddish brown Bt material; this represents the minimum for recognition of the argillic horizon (section 20). Whereas the argillic horizon of Stellar is noncalcareous, that of Dona Ana is strongly calcareous throughout and has some visible carbonate in all subhorizons. The morphological difference must be due to differences in landscape position and run-in, since soils in both areas have formed in low-carbonate parent materials. The Stellar soils occur on toeslopes and receive runoff from higher areas, whereas Dona Ana soils occur beyond the toeslopes and receive little or no runoff. Additional evidence supports the importance of landscape position on carbonate status of the B horizon. Small (a few m wide, a few cm deep) drainageways extend from the toeslopes into the basin floor in a few places. Upper subhorizons of the Bt horizon are often noncalcareous in these drainageways whereas soils adjacent to the drainageways are strongly calcareous throughout.

The argillic horizon of Dona Ana 68-6 probably contained little or no carbonate in the full pluvial of the late-Pleistocene. Drier times since then have apparently resulted in carbonate impregnation of most of the argillic horizon.

Most soils of the basin floor lack argillic horizons even though they have formed in low-carbonate parent materials. Many soils, however, have evidence of a former argillic horizon that has now been obliterated (section 85).

A description of Algerita in the basin floor is given in section 197. Data for a typical soil on the ridge crests (Algerita 61-2, figs. 204, 205) is given in table 222a, along with data for the other three pedons analyzed in the area. The two Algerita pedons and Dona Ana 68-6 contain appreciable gypsum below 1-1/2 m. This gypsum may be of geologic origin; to the north there are extensive deposits at the surface. The gypsum may have been deposited when the floor of the basin was occupied by a shallow pluvial lake. Its presence may be related to a gypsum source to the northeast, in the San Andres Mountains. The Algerita soils and Dona Ana 68-6 have 1 me or more extractable sodium within 1 m of the surface. The Stellar pedon has much lower extractable sodium and electrical conductivity. The reason probably is that it is subject to more frequent deep wetting. Extractable potassium as a percent of the exchange capacity is markedly higher for Stellar 61-3. The difference probably is related to greater density of vegetation. The difference, however, extends to depths where amount of organic carbon are similar. Stellar 61-3 contains twice as much organic carbon as the other three pedons, a reflection of its high clay content and greater run-in.

Table 222a. Laboratory data for four pedons illustrating the transition from the piedmont slopes (noncalcareous piedmont-slope alluvium) to the basin floor (noncalcareous ancient river alluvium).

Horizon	Depth	Sand1/	Clay1/	Carbonate	Gypsum	Extractable Sodium	Electrical Conductivity	Extractable Potassium2/	Organic Carbon
	cm	pct	pct	pct	pct	me/100g	mmho/cm	pct	pct
Ustollic Haplargid (Stellar 61-3)									
A2	0-8	29	32	0.9					1.78
B21t	8-18	34	41	0.1		tr		12	0.68
B22t	18-36	27	44	0.1		tr		12	0.54
B23t	36-48	25	46	3					0.46
B24tca	48-58	24	47	7		0.2	0.4	13	0.21
K1	58-71	29	53	37					0.26
K21	71-94	45	36	42		0.2	0.6	14	0.10
K22	94-124	47	33	38			0.6		
K23	124-150	47	35	68			0.6		
K3	150-198	48	36	49					
Bbca	198-221	33	39	21					
Organic carbon, 6.4 kg/m² to 94 cm.									
Typic Haplargid (Dona Ana 68-6)									
A	0-8	68	12	2		0.1		9	0.31
B1	8-18	65	17	5		0.1		7	0.39
B21ca	18-38	65	18	7		0.2		5	0.32
B22tca	38-58	63	20	9		0.6		5	0.32
K1	58-71	69	20	49		1.1		5	0.21
K21	71-94	72	17	32		1.0		6	0.08
K22	94-127	65	24	52		1.0		4	
K23cs	127-160	65	24	34	-	0.7		5	
C1cacs	160-203	74	13	6	20	0.2		5	
2C2cacs	203-231	80	12	6	11	0.1		5	
2C3	231-249	93	5	1	5	0.1		7	
Organic carbon, 3.4 kg/m² to 94 cm.									
Typic Calciorthid (Algerita 61-2)									
A	8-13	74	16	8					0.57
B1ca	13-28	77	13	9					0.36
B2ca	28-38	70	16	10		0.1	0.5	4	0.35
K1	38-56	74	16	25		0.1	0.5	3	0.26
K21	56-76	82	10	34		0.4	0.7	3	0.12
K22	76-112	80	7	37		1.3	2	3	
K23cs	112-124	75	14	31	18	1.8	5	1	
K3cs	124-142	77	12	11	34	1.4	5	3	
C1cs	142-165	80	10	8	21	1.5	6	3	
C2ca	165-185	82	10	6	28	1.8	7	3	
Organic carbon, 2.7 kg/m² to 76 cm.									
Typic Calciorthid (Algerita variant3/ 61-1)									
A	8-13	80	10	6		tr	0.5	10	0.27
B1	13-20	79	12	7		tr	0.5	5	0.34
B21	20-33	82	9	7		0.2	0.4	4	0.36
B22ca	33-46	76	11	13	tr	0.4	0.4	3	0.27
K1	46-69	61	16	41	tr	0.2	0.7	3	0.30
K21	69-81	66	20	56	tr	0.2	2	4	0.22
K22	81-112	62	24	69	tr	1.1	5	3	0.14
K31	112-132	58	19	43	1	2.6	7	3	
K32	132-145	60	21	45	tr	2.6	7	3	
K33	145-173	55	29	32	6				
K34	173-196	28	29	29	30		8		
Organic carbon, 3.7 kg/m² to 112 cm.									

1/ Carbonate-free basis.
2/ As percent of cation exchange capacity by ammonium acetate method.
3/ Partially indurated K horizon.

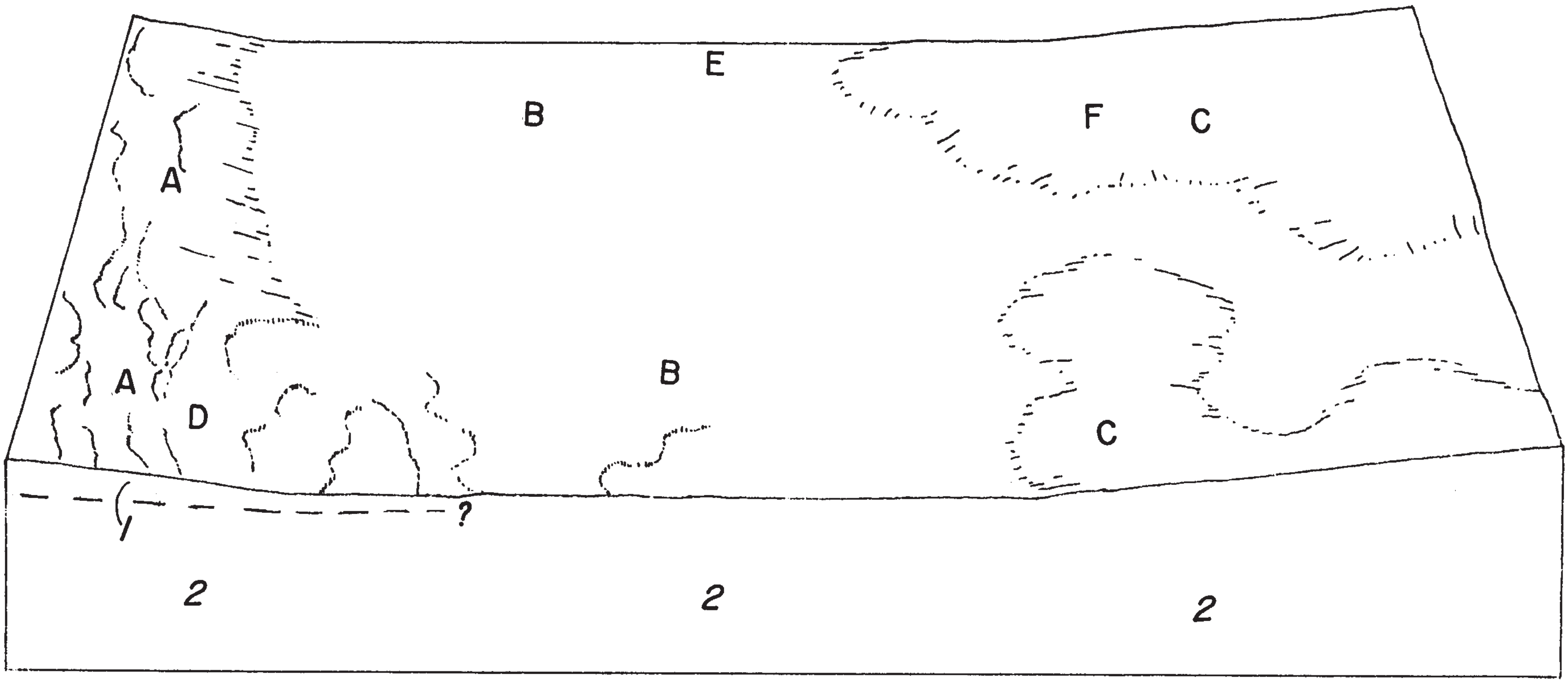


Figure 202. Diagram of the transition from the piedmont slopes to the basin floor. A = Stellar clay loam. B = Algerita sandy loam. C = Algerita sandy loam, eroded. D = Stellar 61-3. E = Dona Ana 68-6. F = Algerita variant 61-1. Algerita 61-2 is north of the area shown. Linear pattern across the slope at left marks the upper margin of barren strips.
1 = Jornada I alluvium and soils. 2 = Upper Camp Rice Formation (fluvial facies) and soils.

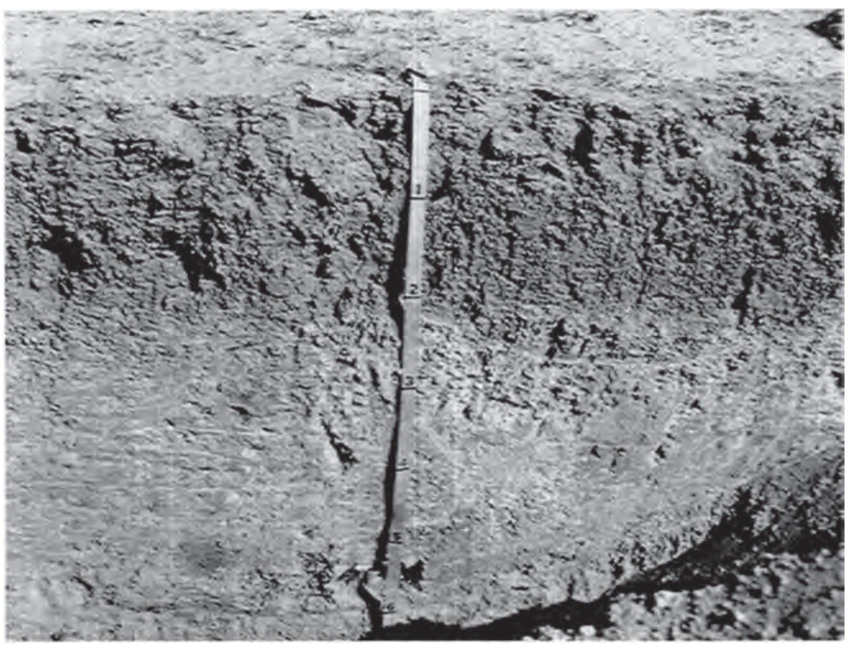


Figure 203. Upper. Landscape of a Typic Haplargid, Dona Ana 68-6, on Jornada I and La Mesa, undifferentiated.

Lower. Dona Ana 68-6. The B horizon has barely enough Bt material for an argillic horizon. Scale is in feet.

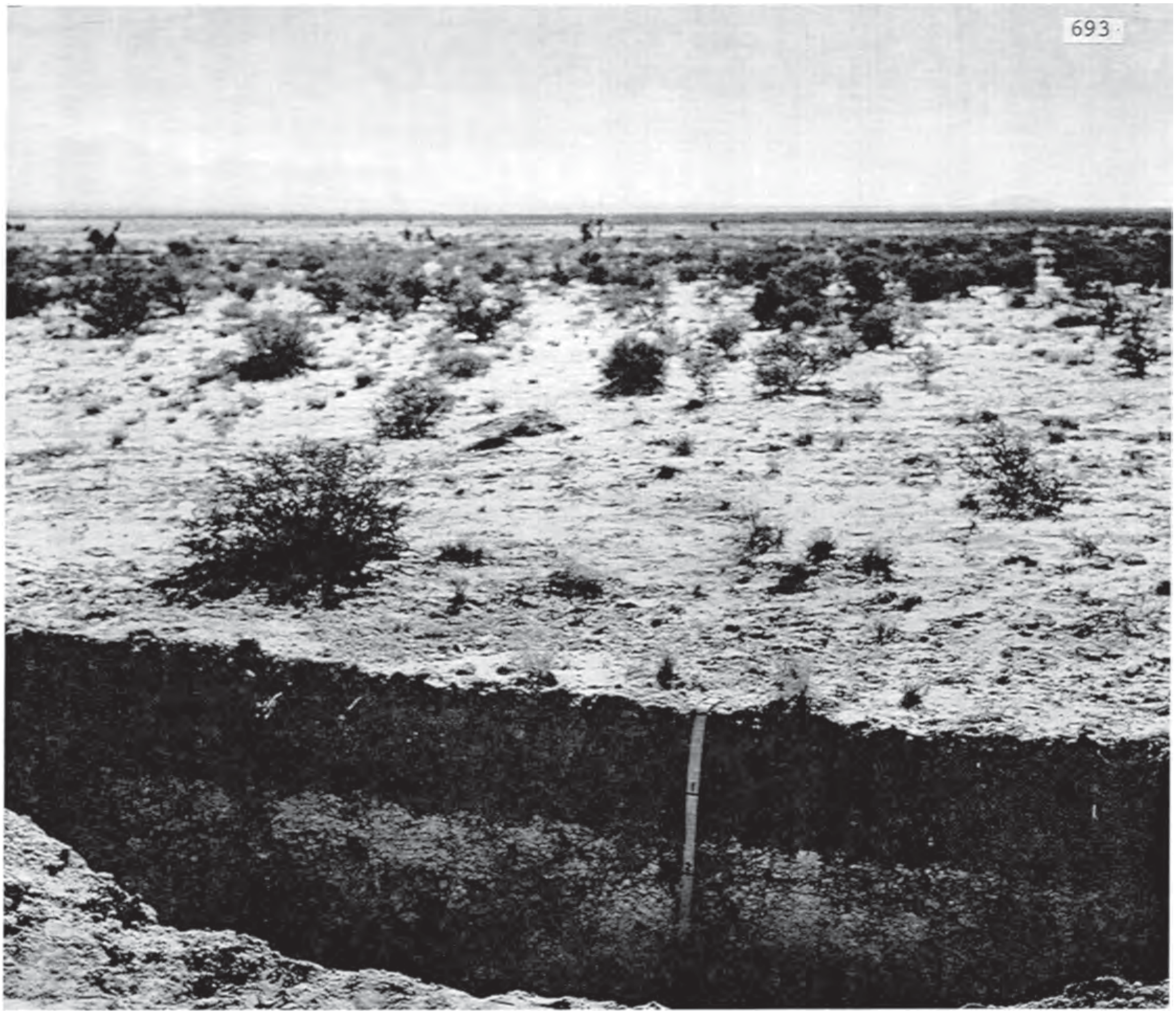


Figure 204. Landscape of a Typic Calciorthid, Algerita variant 61-1, on the Jornada I and La Mesa surfaces, undifferentiated.

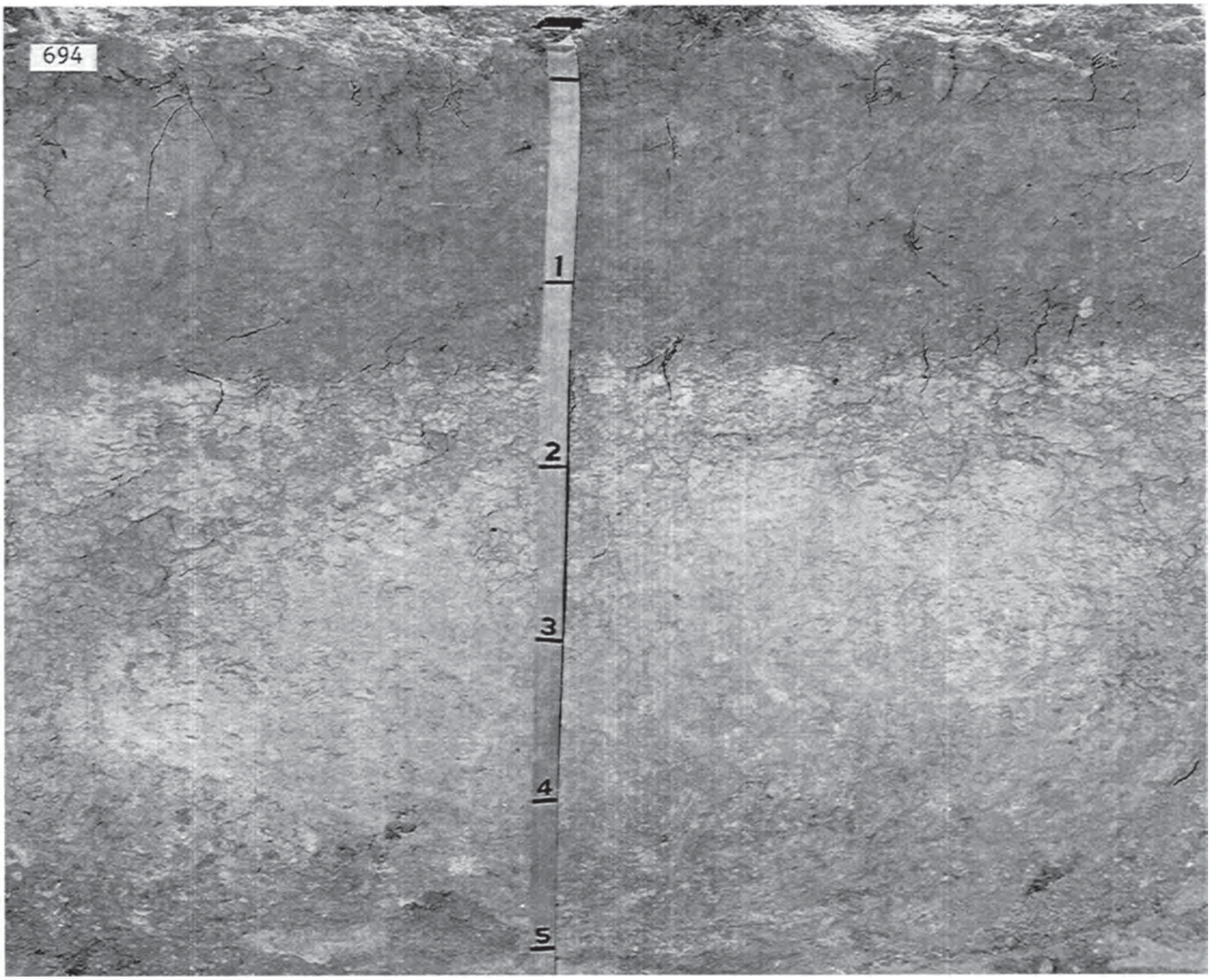


Figure 205. A Typic Calciorthid, Algerita variant 61-1. Scale is in feet.

197. ALGERITA SANDY LOAM, ERODED (56)

MAPPING UNIT COMPOSITION

Series	Subgroup	Family Criteria	Percentage of Mapping Unit
ALGERITA	TYPIC CALCIORTHIDS	COARSE-LOAMY	65
Algerita, partially indurated variant	Typic Calciorthids	Coarse-loamy	10
Dona Ana	Typic Haplargids	Fine-loamy	10
Jal	Typic Calciorthids	Coarse-loamy, carbonatic	10
Other inclusions (Haplargids, Paleorthids)			5

LOCATION, LANDSCAPE, VEGETATION

These soils occur in the basin floor north of Highway 70, mainly in the northern part. There are also a few small areas east and northeast of Goat Mountain. The soils have formed in the sand and mixed rounded gravel of the Upper Camp Rice Formation. Elevation is about 4300 ft.

Broad ridges with little amplitude are characteristic of this mapping unit. Within the broad ridges are somewhat stabler, discontinuous grassy flats. These ridges are only several m higher than the adjacent slight depressions in which mapping unit 57 occurs (see section 196). In places the boundary between the two mapping units is quite sharp and readily observed (fig. 206); but in other places the boundary is less obvious.

Vegetation consists mostly of scattered Yucca elata, fluffgrass, snakeweed, burro grass, tarbush and mesquite. In places there are scattered clumps of tobosa. Barren strips are common.

TYPICAL PEDON, PROPERTIES AND RANGES

Algerita

A typical pedon of Algerita is described in the Appendix (pedon 61-2). Figure 206 is a photograph of the pedon and its landscape. A table of properties and ranges is given below.

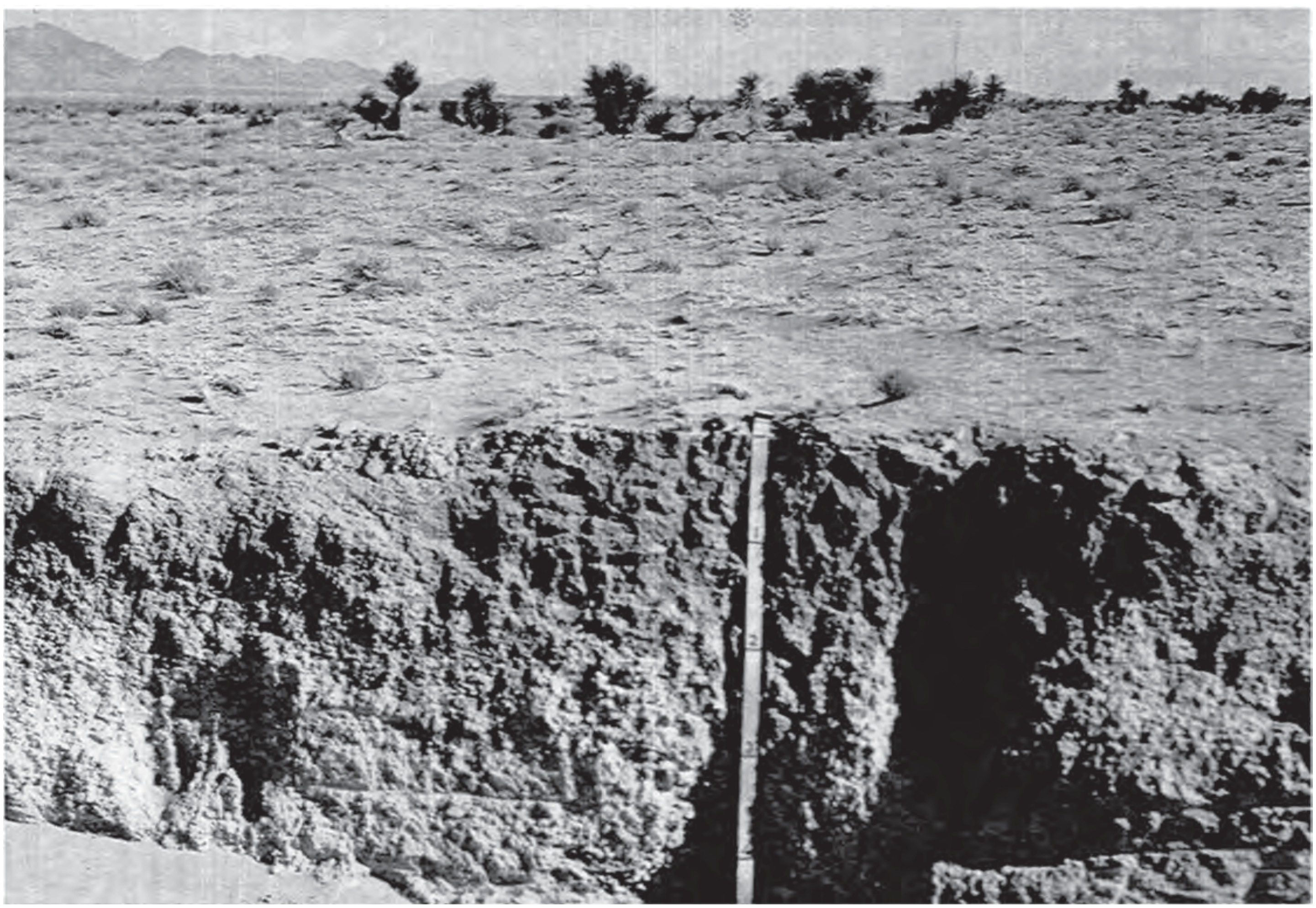


Figure 206. Upper. General view of landscape, Algerita sandy loam (foreground) and Algerita sandy loam, eroded (on the yucca-covered ridge, background). Organ Mountains on the skyline.

Lower. A Typic Calciorthid, Algerita 61-2, and landscape. Scale is in feet.

Table 223. Typical (underlined) and range in selected properties for major horizons of Algerita.

Horizon	Depth cm	Particle size < 2 mm	Particle size > 2 mm, % Vol.	Hue	Value Dry	Value Moist	Chroma
A	8-13	s,ls sl	0-5	7.5YR	6,7	4,5 4.5	2-4
B2	28-38	scl hv.sl	0-5	6YR- 7.5YR	5,6	4,5 4.5	3,4
K2	56-124	scl cl	0-5	7.5YR- 10YR	6-9 8	5-8 7	2-4
C	142-185	sl ls,s lt.scl	0-15	7.5YR- 10YR	6,7 6.5	5,6	3,4
Control section		scl,cl	< 15				

Other. Coarse fragments consist largely of indurated carbonate nodules and occasional plates. Silicate clay in the control section averages less than 18 percent. The control section averages sandy clay loam or clay loam by field texture, however, partly because of high content of carbonate clay and silt. Depth to the thick prominent calcic horizon (the K1 and K2 horizons in the description) is usually about 25 to 40 cm, ranging from 15 to 50 cm.

SOIL OCCURRENCE

This mapping unit is dominated by Calciorthids but Haplargids do occur in a few spots. There is evidence (p.188) that most or all soils in this unit once had argillic horizons that have been obliterated by carbonate engulfment, mixing by soil fauna, or both.

Calciorthids. The coarse-loamy ALGERITA soils are dominant. The coarse-loamy Calciorthids, Algerita, partially indurated variants, occur in a few spots, mainly on narrowest, highest part of ridges. Jal soils, carbonatic, occur where enough carbonates are in the 25 to 100 cm control section.

Haplargids. The fine-loamy Dona Ana soils occur in scattered areas where the argillic horizon is preserved. The coarse-loamy Onite soils occur in small areas east of Goat Mountain.

Paleorthids. The loamy, shallow Simona soils occur in small areas on some of the highest ridges.

SOIL BOUNDARIES

Table 224 gives information about boundaries to major adjacent units. Figure 206 (upper) shows some of the boundaries.

Table 224. Cause and character of boundaries to adjacent major units.

To mapping unit:	Cause and character
Reagan clay loam (51)	The boundary is due to several factors. There is a younger alluvium and geomorphic surface (Petts Tank) in unit 51. Other factors are high carbonate content and finer textures in soils of unit 51. The topographic boundary is commonly distinct, with sediments of unit 51 being inset against the higher ridges of unit 56. In other places the boundary is less apparent and the transition is very gradual. Vegetatively the boundary is marked by a change from mostly burro grass (unit 51) to scattered *Yucca elata*, snakeweed, and tobosa in unit 56.
Algerita sandy loam (57)	The boundary is due to slight differences in physiographic position and texture. The topographic boundary is usually fairly distinct, occurring along the margins between slight depressions of unit 57 and slight ridges in unit 56. Vegetation changes from mostly burro grass in unit 57 to *Yucca elata*, snakeweed, and scattered bunches of burro grass in unit 56.

OTHER STUDIES: SOIL PREDICTION

Information presented in this book may be used to predict the general kinds of soils to be expected in similar areas elsewhere in the Southwest. Great groups that can be predicted include the Haplargids, Paleargids, Calciorthids, Paleorthids, Camborthids, Torrifluvents, Torripsamments and Torriorthents. Mollisols would be expected in the adjacent mountain ranges. When details of soil occurrence have been studied, major soils at the series level can be predicted in some instances. For example, soils of the Tencee and Upton series, Typic Paleorthids, occur extensively along the arid valley border downslope from high-carbonate rocks. These soils can be predicted on late-Pleistocene Picacho fan remnants, with the soils of the Dalian series being extensive on low Fillmore (Holocene) terraces between the remnants and on sides of the remnants. For examples of specific soils occurring downslope from various rock types, consult the soil maps (Appendix); see also Gile and Hawley (1972).

Following is a brief discussion of major factors affecting soil distribution in places similar to the study area, and of materials useful in prediction.

<u>Topography</u>. Much of the Southwest consists of basin and range topography, in which mountain ranges alternate with intervening basins. Piedmont slopes extend from the mountains to the basin floors and are many km across in the larger basins. As in the study area, valleys have been formed by river entrenchment in some areas of the Southwest. Valleys indicate lowering of adjacent water tables, especially in highly pervious materials. Thus salts that would accumulate at shallow depths or at the surface with a high water table can be moved deeper during times of flooding if the water table has been lowered by valley entrenchment. Hydrologic maps also locate water tables. Aerial photographs and topographic maps are useful in considering landscape patterns, relief, and elevations to be expected.

<u>Parent materials</u>. Bedrock of mountain ranges and materials of other topographic highs are major sources of parent materials. This is significant because the mineralogy of vast areas of alluvium has been largely determined by the bedrock upslope. Carbonate content is particularly significant because it can determine the direction of soil development at a high level (suborder) of classification--into Argids and soils other than Argids. Thus Argids that are noncalcareous throughout or in surficial horizons are common downslope from noncalcareous rocks. But because of additions of calcium from the atmosphere (section 40), argillic horizons may be underlain by weak to prominent carbonate horizons depending on soil age (section 68). Thus if the argillic horizon has been truncated the soils may be Orthids (section 68), with calcic or petrocalcic horizons at shallow depth. Ridges are usually distinct landscape features in places where the argillic horizon has been truncated and these can be seen in aerial photographs (soil maps, Appendix).

In contrast, argillic horizons have not developed in parent materials containing abundant fragments of calcareous rocks, even in soils that started their development in late-Pleistocene (section 86). Argids would therefore not be expected downslope from such rocks and all soils would be strongly calcareous throughout.

If a river is present and has trenched the basin floor, then its ancestral deposits can be important (sections 129, 130, 143). The deposits of larger streams have mixed composition and some may be free of carbonate.

For the above reasons, geologic maps showing bedrock distribution (particularly in the mountains) are very useful in soil prediction. Since this bedrock is the ultimate source of much of the alluvium downslope, the general mineralogic composition of the alluvium can be inferred. Bedrock maps are available for many parts of the Southwest. Some geologic reports also show the distribution, composition, and stratigraphy of the basin fills.

Climate. Although desert soils of the Southwest receive relatively little moisture during the present interval (Holocene), the amount they do receive can be important to pedogenesis. Illuvial horizons are presently forming in many soils. However, illuvial horizons formed in the Pleistocene are thicker than those formed in the Holocene. Also, soils of Pleistocene age have much more prominent horizons of clay and carbonate accumulation because of pluvials and much greater age.

Time. The great range in soil age is a major reason for the wide morphological variety of soils in the study area (sections 16, 64, 78). Aerial photographs and topographic maps can indicate the presence of geomorphic surfaces and soils of different ages and degree of erosion. Parts of ancient landscapes favorably situated for protection against erosion, such as relict basin floors, have the oldest soils. In other areas, erosion and sedimentation, stabilization of geomorphic surfaces and the initiation of soil development occurred at various times. There may be some overlap in the times of erosion and sedimentation from one place to another. However, these phenomena do appear to be generally episodic in character, and are roughly synchronous over large areas of the Southwest. This is useful in prediction because soil development in deposits of about the same age would tend to start at about the same general period of time over fairly wide areas. Thus there would be a degree of similarity of soils, soil age and landforms over wide areas.

Biota. Climatic differences since mid-Pleistocene were probably accompanied by differences in soil biota, particularly during the full-glacial interval of the late-Pleistocene. Also, within the last 100 yr there has been a widespread change in vegetation, from grass to shrubs, over extensive areas of the Southwest (section 62). In many places, therefore, the present vegetation has had little effect on soil morphology. Soil fauna can significantly affect desert soils, especially by mixing soil horizons. For example, soil fauna have obliterated the argillic horizons of some soils, changing their classification from Haplargids to Calciorthids (section 85).

198. OTHER MAPPING UNITS

Six mapping units, formerly designated miscellaneous land types, have been renamed. Most of the area concerned occurs in the mountains and is in four units with rock outcrop (40L, 40M, 40R, 40V). Boundaries between the various kinds of rocks must be regarded as generalized and very approximate. The other two units (11Y and 40B) are in primarily unconsolidated materials that occur along the valley border.

199. Haplargids, dissected (11Y)

A broad belt of dissected and partially exhumed paleosols occurs along the eastern side of the valley border (soil association map). Stratigraphically these paleosols occur between Jornada I alluvium and river deposits of the Camp Rice Formation (or the analogue piedmont-slope deposits that these river deposits grade into). The exact number of buried soils is not known, but there are at least four. The land-surface and buried soils range so widely in characteristics that for convenience the unit is considered at the great group level of classification.

The area has been dissected by arroyos and gullies. Narrow ridges are the dominant land form. On many of the narrow ridge crests a thin (usually less than about 1/2 m) layer of gravelly sediments and its soils rest on the uppermost of several buried soils. Ridge sides are a young surface that bevels the ridge crest soil on the upper sides of the ridges, and the underlying paleosols downslope.

Surfaces of a few ridge crests appear to be somewhat like the original depositional surface. Such ridge crests are broader than typical, and parts are level transversely.

The ridge-crest soil commonly has a K horizon that itself is partly or completely truncated on narrow ridges. The beveled paleosols on ridge sides are commonly mantled by a thin (usually less than about 1/4 m) layer of gravelly colluvium. A weak carbonate horizon, with thin carbonate coatings on pebbles, has formed in the colluvium. Since the ridge sides bevel the paleosols and properties of the paleosols vary widely, nature of the paleosolic horizon beneath the colluvium varies widely with slope position. Most paleosols are Typic Haplargids with reddish or reddish brown B horizons; some have K horizons. Texture of the B horizons ranges from sandy loam to clay. Usually the paleosols contain little or no gravel.

200. Entisols, eroded (40B)

The 40B mapping unit consists of strongly dissected materials, of variable texture and cementation, which show little or no evidence of soil development prior to their burial. The mapping unit occurs in small areas along the Rio Grande valley border. The strata are exposed in steeper areas, range in texture from sand to clay, and are usually not cemented. In places, however, such as the Box Canyon area, there are occasional strata of hard rock. Properties of the exposed strata generally are dominant over any weak soils that may have formed during dissection, either in the strata themselves or in lag sediments that discontinuously mantle the slopes. The slope usually ranges from about 10 to 60 percent with some vertical scarps. Some areas are barren. In others --primarily in drainageways and other places of water concentration--such vegetation as creosotebush, tarbush, or mesquite occurs.

201. Sedimentary rock outcrop and Entisols (40L)

The 40L mapping unit consists of bedrock outcrop and thin soils on bedrock. The unit occurs in the San Andres, Organ, Dona Ana, Robledo and Tortugas Mountains. Areas of this mapping unit have been strongly dissected by arroyos, and steep ridges are common. Slopes generally range from about 10 to 50 percent, with a few areas somewhat gentler and steeper. Vegetation includes creosotebush, ratany, prickly pear, ocotillo, catclaw, sotol, mariola, whitethorn, burrograss, needle grass, tarbush, and fluffgrass.

Hard bedrock is at the surface or within several inches of the surface in many areas. In places, soils with thin A horizons occur on stablest slopes. One of these soils is described below.

Soil surface: Many outcrops of limestone or calcareous sandstone bedrock usually occurring as more resistant strata a few cm or so above the general microrelief. Rock fragments are scattered over the surface. A discontinuous layer of loose reddish sand occurs between fragments.

A1 0-13 cm. Dark grayish brown (10YR 4/1.5, dry) and very dark brown (10YR 2/2, moist) gravelly loam; weak subangular blocky, upper 1/2 cm being moderate medium platy; friable; roots common; pebbles coated with carbonate; effervesces strongly; abrupt wavy boundary.

R 13 cm. - Limestone bedrock. Carbonate-impregnated material a few cm thick has penetrated cracks in the bedrock and occupies low areas in bedrock microrelief.

OTHER STUDIES: MINERALOGICAL STUDY OF LIMESTONE

The Lohman Canyon drainage basin in the northeast corner of the study area is one of the larger catchment areas draining the carbonate-rock terrain of the Southern San Andres-Northern San Agustin Mountains. These uplands have been a major source of high-carbonate (calcareous) basin-fill sediments in the southern Jornada del Muerto. Precambrian granite crops out in the eastern part of the watershed, and there are small exposures of lower Paleozoic dolomite, limestone, shale and sandstone. However, the dominant rock types are limestone, and calcareous sandstones, siltstones, and shales of Upper Paleozoic (Pennsylvanian-early Permian) age (Kottlowski, 1960). Three limestone units of probable Pennsylvanian age were sampled from outcrops near the mouth of the canyon, south of Quartzite Mountain, in the north-central part of Section 18, T21S, R4E.

Three samples of limestone were analyzed mineralogically. (1) A hard, black, fine-grained limestone with large chert bodies. (2) A sandy limestone that breaks into pieces up to 20 to 30 cm across. (3) A shaly or sandy limestone that parts every 2 to 5 cm. The laboratory numbers are 70L247, 70L248 and 70L249 respectively. In the vicinity of the sample site, the black, cherty limestone is a major component, the sandy limestone intermediate and the shaly limestone a minor component.

In the laboratory, samples of the limestone were crushed to pass a 2 mm sieve. Subsamples were treated with pH 5 sodium acetate to remove carbonates and concentrate the silicate components. Sand, silt, and clay fractions were separated and analyzed by binocular and petrographic microscopes, and by X-ray diffraction. Analytical results and observations are for residues from the limestones after carbonates were removed.

Hard, black, fine-grain limestone (70L247)

Microscopy--estimated about 90 percent quartz or chert. Many of the grains appear to be aggregates rather than true chert. Most grains have black coatings. A few mica and opaque grains were noted.

X-ray diffraction--The coarse silt is dominantly quartz with a trace of mica. The fine silt is dominantly quartz with a small amount of mica and a trace of kaolinite. The clay contains a moderate amount of mica, a small amount of quartz and a trace of kaolinite. The clay suspensions look black. Subsamples of clay suspension were treated with chlorate and with hydrogen peroxide. The chlorate bleached the suspension and the hydrogen peroxide partially bleached the suspension, indicating the black color arises from carbon.

Sandy limestone (70L248)

Microscopy--estimated 70-80 percent quartz, including some chert, about 10 percent mica, less than 5 percent feldspar, and accessory amphibole.

X-ray diffraction--The coarse silt is dominantly quartz with a small amount of feldspar and traces of mica and chlorite. The fine silt contains abundant quartz, a moderate amount of mica, a small to moderate amount of chlorite, a small amount of kaolinite, and a trace of feldspar. The clay contains a small to moderate amount of mica, small amounts of kaolinite and chlorite, a trace of quartz and possibly a small vermiculite component.

Shaly limestone (70L249)

Microscopy--estimated 80-90 percent quartz or chert, about 10 percent mica, 2-3 percent feldspar, 2-3 percent plant phytoliths or volcanic ash. Much of the quartz-chert material is in a fine mosaic pattern that includes mica. The material looks different than chert. Many of the grains appear to be coated with the mosaic material.

X-ray diffraction--The coarse silt contains abundant quartz, small amounts of mica and chlorite, and a trace of feldspar. The fine silt contains abundant quartz and mica, a small amount of chlorite and a trace of kaolinite. The clay contains a moderate amount of mica and traces of kaolinite, chlorite and quartz.

202. Monzonite rock outcrop and Argids (40M)

The 40M mapping unit consists of soils and outcrops of monzonite bedrock. The unit occurs in the Organ, Dona Ana and San Agustin Mountains. This mapping unit contains some very steep areas of monzonite bedrock especially along the west front of the north-central Organ Mountains. There are many vertical cliffs and steep, bouldery slopes. In some areas of the Dona Ana Mountains monzonite bedrock occupies most of the central and highest portions of steep ridges. Slopes are gentler in other areas such as the northern part of the Organ Mountains. Vegetation is mainly beargrass, sideoats grama, blue grama, snakeweed, Quercus spp. and Yucca baccata.

Soils with distinct A and B horizons have formed in the vicinity of San Agustin Pass. Descriptions of three of these soils are in the Appendix (pedons 66-9, 66-10, and 70-1; see section 160 for discussion).

203. Rhyolite rock outcrop and Argids (40R)

The 40R mapping unit consists of soils and outcrops of rhyolite bedrock. The unit occurs in the Organ, Dona Ana, San Andres, and Robledo Mountains. The mapping unit contains large, very steep masses of rhyolite bedrock, with many vertical cliffs, as well as rock-strewn gentler slopes with a dominant slope range of from 15 to 60 percent. Grasses are prominent in places, chiefly sideoats grama, black grama, and bush muhly. Other common vegetation is sotol, prickly pear, catclaw, yucca, and mesquite. Snakeweed is dominant in a few places. Creosotebush, ocotillo, mariola, tarbush, yucca, fluffgrass, and a few prickly pear are dominant on calcareous soils.

Distinct soil horizons have formed in discontinuous areas of colluvium, steep fans, and in some stable areas of gentler slope. One of these soils is described below.

Soil surface: Rhyolite fragments are scattered over the surface. A discontinuous layer of loose reddish sand occurs between fragments. There are frequent bedrock outcrops.

A1 0-10 cm. Brown (7.5YR 4.5/2, dry) or dark brown (7.5YR 3/2, moist) very gravelly loam; weak medium granular, upper 1/2 cm weak medium platy and weakly vesicular; friable; roots common; noncalcareous; clear wavy boundary.

B2t 10-15 cm. Red (2.5YR 4.5/6, dry) or dark red (2.5YR 3/6, moist), very gravelly sandy clay loam; weak medium subangular blocky between pebbles; very hard; roots common; thin, discontinuous clay coatings on peds; pebbles stained red; noncalcareous; abrupt wavy boundary.

R 15 cm. - Rhyolite bedrock, extremely hard. Joint surfaces of bedrock are stained red; a few surfaces are stained black and a few brown. Staining of joint surfaces extends to a depth of at least one m.

204. Andesite rock outcrop and Argids (40V)

The 40V mapping unit is a complex of soils and outcrops of andesite, latite and rhyolite bedrock. The unit occurs primarily in the Dona Ana Mountains, with smaller areas in the San Andres and Organ Mountains. The areas have been deeply incised by arroyos; steep bedrock ridges are a common landscape feature. Slopes generally range from about 5 to 50%, with a few areas steeper than this. Vegetation is mainly creosotebush on lower slopes of many ridges. Sotol, mesquite, prickly pear, mariola, black grama, blue grama, and sideoats grama occur on higher slopes.

Some stable, little-eroded slopes have thin soils with A and B horizons. Thin, but distinct argillic horizons occur in some soils. Hard bedrock is at the surface in numerous areas. One of the soils is described below. The location is the NW 1/4 Sec. 28 T21S, R2E. Vegetation is mostly creosotebush, with scattered mariola and prickly pear. Slope is 15 percent.

Soil surface: 90-95% covered by angular and subangular fragments of andesite averaging 5 to 10 cm diameter, with some cobbles. A few fragments of calcrete also occur, and in places bedrock emerges at the surface, projecting only slightly above the general relief. Many fragments have a brownish-grayish desert varnish with some black spots; fresh-appearing faces of fragments (due to fracture) are common. A layer of loose reddish fine and very fine sand occurs discontinuously beneath and between pebbles. The reddish sand is noncalcareous whereas the underlying, grayer vesicular horizon effervesces weakly.

Aca 0-3 cm. Brown (7.5YR-10YR 5.5/2, dry) or dark brown (7.5YR-10YR 3.5/2, moist), very gravelly fine sandy loam; moderate fine platy, strongly vesicular; vesicles are mainly 1 mm diameter; slightly hard; few roots; few small portions of reddish fine sand ocurring as discontinuous lenses; pebbles very thinly and discontinuously coated with carbonate; effervesces weakly; abrupt boundary.

Bca 6-15 cm. Brown (7.5YR 5.5/4, dry) or dark brown (7.5YR 3.5/4, moist) very gravelly fine sandy loam; weak medium subangular blocky; slightly hard; roots common; pebbles and cobbles thinly and continuously coated with carbonate; effervesces strongly; abrupt smooth boundary.

K2m 15-18 cm. White (10YR 8/1, dry) or light gray (10YR 7/2, moist) laminar, carbonate-cemented material; very hard; effervesces strongly; abrupt smooth boundary.

R 18 cm. - Andesite bedrock.