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A Soil-Geomorphic Study In the Oregon Coast Range

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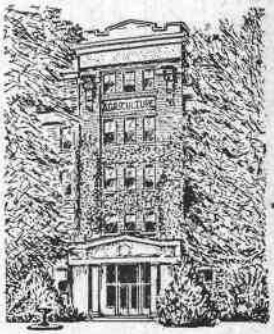

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A Soil-Geomorphic Study in the Oregon Coast Range

C. A. Balster and R. B. Parsons

Detailed mapping of 3,500 acres of the Coast Range near Kings Valley, Oregon, (Figure 1) has shown well-defined relationships between soils and geomorphic surfaces. The area encompasses a variety of landscapes, varying from a deeply dissected highland on the east to a lowland with subdued topography on the west.

The master stream for the local area is the Luckiamute River. Price Creek is a major tributary of the Luckiamute River. Although Woods Creek is a tributary of Price Creek, the two are almost equal in size. Both streams are perennial and flow out of deep canyons in the highlands on the east side of the area.

Dissection of the area is almost complete. Remnants of old high surfaces are scattered and small. Neither Price Creek nor Woods Creek has developed a valley bottom significantly wider than its channel.

CLIMATE AND VEGETATION

Climatic data from the nearest weather stations indicate the following: rainfall in the lowland is about 60 inches per year (*12*), while the mean annual temperature is about 52° F. The amount of rainfall increases with increasing elevation and probably exceeds 70 inches at the higher elevations (about 1,850 feet). Mean annual temperature decreases at the higher elevations to about 48° F.

Native vegetation of the highland was predominantly Douglas-fir (*Pseudotsuga menziesii*) with grand fir (*Abies grandis*), bigleaf maple (*Acer macrophyllum*), and red alder (*Alnus rubra*). Logging operations have virtually denuded the hills of their original cover. Natural reproduction of Douglas-fir has been slow and patchy, allowing many species of shrubs and deciduous trees to predominate in the present vegetative cover. An understory of grass, bracken fern, Oregon grape, and thimbleberry is ubiquitous. Since Douglas-fir in the area is shallow rooted and subjected to occasional severe winds, tree throw has undoubtedly disrupted the upper two feet of soil to some extent.

According to local information[1], the lowland area was originally covered with mixed Douglas-fir, Oregon oak (*Quercus garryanna*), and grassy meadows. Essentially, the entire lowland has been cleared and tilled since settlement in the early 1840's. The greatest part is now under grass cover with groves of Oregon oak occupying most of the hills and sideslopes.

GEOLOGY

Basic lavas and pyroclastic materials of the Siletz River Formation (*9*) are the oldest exposed rocks and underlie the highlands of the area (Figure 1). Pillow basalts are predominant, but flow breccias and tuffs are common. These materials are resistant to erosion and tend to form steeply sloping landforms with high relief.

Tuffaceous shales, mudstones, sandstones, tuffs, and volcanic conglomerates[2] of the Kings Valley Member of the Siletz River Formation underlie the lowlands of the area. Shales and mudstones are grossly predominant. In general, these rocks contain expanding lattice clays and are easily weathered. Removal of calcium carbonate from the shales and mudstones by weathering processes renders the clays subject to expansion and slaking upon contact with rain. Rounded landforms of moderate relief are typical of the lowland.

Rocks of the Tyee Formation (*3*) underlie an extensive area immediately west of the lowlands and furnish most of the source material for the alluvium of the Luckiamute River. Sandstones and shales, both somewhat tuffaceous, are the principal lithologies, and may be distinguished from sedimentary rocks of the Kings Valley Member by an abundance of muscovite and quartz.

Diabasic and basaltic dikes have intruded rocks of the Siletz River Formation, the Kings Valley Member, and the Tyee Formation and are thus the youngest rocks of the area. Dikes are more common in the basic igneous terrane, however, than in the sedimentary rocks.

The area is structurally complex. A set of faults that trends N 20° E and a set of faults that trends N 50° W seem to be important to the interpretation of the landforms. The major Kings Valley fault zone (*13*) belongs to the former set.

The Kings Valley fault zone has displaced sediments of the Kings Valley Member downward in relation to the Siletz River volcanic rocks. In this way, the fault zone is indirectly responsible for the lowland topography. It is directly responsible for the abrupt topographic boundary between the highlands and the lowlands.

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[1] Chambers, C. W. Personal communications, Kings Valley, Oregon, 1962.

[2] Volcanic conglomerate is used here as defined in *Glossary of Geology and Related Sciences,* p. 315, 1957.

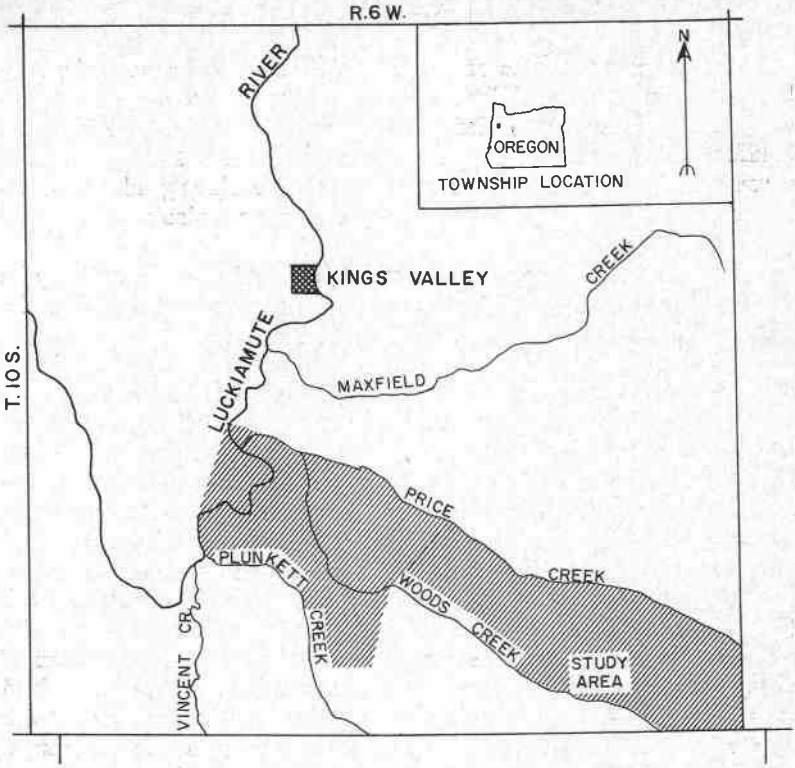

Figure 1. Index map showing the location of the study area in Oregon.

Many valleys in the area reflect structural control by the set of faults that trends N 50° W. Woods Creek and Price Creek both have canyons that are probably controlled by faults that belong to this set. Fault planes with slickensiding and gouge are present in both Woods Creek and Price Creek canyons. Slickensiding, in most instances, indicates that the last movement along the faults was mostly of strike-slip component at a low angle (12 to 20 degrees). Directions of displacement have not been obtainable.

The major contributions of the set of N 20° E faults, aside from the Kings Valley fault, are in controlling side valley drainage and causing abrupt shoulders on the ridges between major streams such as Price Creek and Woods Creek. Many seeps and landslide areas are associated with faults of this set. Fault planes of this set are observable in the head of Price Creek Canyon.

SOILS AND GEOMORPHOLOGY

Geomorphic surfaces of the area differ widely between the lowlands and the highlands. The landforms of the lowlands are a well developed sequence of modified pediments and terraces. The highland landforms are not so easily placed into a sequential arrangement because they are predominantly slope forms with various gradients. Scattered remnants of two levels of high pediments are also present in the highlands.

For the purposes of this discussion, all of the landforms may be grouped into 15 classes (Figure 2). They are enumerated and briefly discussed below.

The soils may be separated into three groups: those that developed in alluvium, those formed in pedisediment (*1, 7*) over sedimentary rocks, and those formed in basaltic materials. Soil associated with faults in the area (*1, 5*) and the detailed soil relationships in the basalt highlands (*4*) have been previously reported. Standard soil terminology (*10*) was used for descriptions of profiles, in excavations, which were modal for each mapping unit. Abbreviated descriptions of the profiles are given in Table 1. The W or P in each profile designation refers, respectively, to the Woods Creek (lowland) or Price Peak (highland) segment of the study area. Soil mapping was on aerial photographs at a scale of 8 inches per mile (Figure 3). Discussion of soil-geomorphic relationships is restricted to the 14 major, well-drained soils of the area. Catenary associates and soils of minor extent are omitted. Table 2 shows the classifications of the soils into subgroups. Detailed soil profile descriptions are presented in the Appendix.

Lowland Soils and Landforms

Luckiamute River floodplain (FL). The floodplain of the Luckiamute River is narrow and only slightly incised below low terraces. Lateral cutting by meanders has initiated widening of the floodplain. The principal land area of the floodplain is on slip-off slopes of meanders. Alluvium is derived principally from rocks of the Tyee Formation.

Profile WR (Table 1) is representative of soil on the floodplain. WR exhibits a very dark grayish brown (10YR 3/2) loam A horizon 24 inches thick over a brown (10YR 4/3) clay loam AC horizon. Horizon differentiation is limited to organic accumulation and weak subangular blocky structural development in the AC. WR soil is underlain at depths of 30 to 40 inches by sand, sandy loam, or sandy clay loam deposits.

Luckiamute River terraces (TL). Two low terraces, separated by a scarp with about eight feet of relief, border the floodplain of the river and account for the greatest part of the width of the low valley. Pediments with varying degrees of development join these terraces with higher surfaces, but are included, for convenience, with higher pediments which will be discussed later.

Soil of the terraces is represented by profile WS which differs from WR by exhibiting finer textures and moderate structural grades in the B horizons. WS soil has profile depths of about 54 inches without evidences of a lithologic discontinuity (*10*).

High terrace (TH). About 100 feet above the level of the Luckiamute River, a landform with the morphology of a terrace has been formed by coalescence of the floodplains of the streams entering Kings Valley from the east. As they left the highland and entered the valley, the streams appear to have turned and flowed northward for some distance before joining the Luckiamute. Over the course of their northward flow they cut laterally to form the terrace and covered it with a mantle of coarse gravel, now deeply weathered. Woods Creek follows a similar course today.

Soil (WG) on the high terrace has slope gradients of 0 to 12%. The sola consist of a weakly horizonated matrix, diluted by 20 to 30% basalt gravel, which overlies weathered basalt gravel at 14 inches. The shallow sola show some structural differentiation (*10*).

Tributary floodplains (FT). The floodplains of the westward flowing tributaries (Woods Creek, Price Creek, and so forth) traverse the high terrace for some distance and, in general, are incised into it to a varying degree. These floodplains are presently being widened by the channels' sweeping laterally from side to side in the valley. Coarse gravel similar to that of the high terrace mantles the floodplain. The floodplain gravels are easily distinguished from the terrace gravels by being conspicuously less weathered.

Soil (WM) on the tributary floodplains is relatively deep, fine textured, and strongly structured with gravel contents which range from 2 to 30%. Gravelly mapping units (WMg) were separated. This soil is underlain at 30 to 40 inches by gravelly clay.

Pediments (PY). Small pediments have been formed in the lowland wherever dissection of older landforms has occurred. Well developed, small pediments join the high terrace to the low terraces of the Luckiamute River. Similar pediments occur between the high terrace and the bordering highlands.

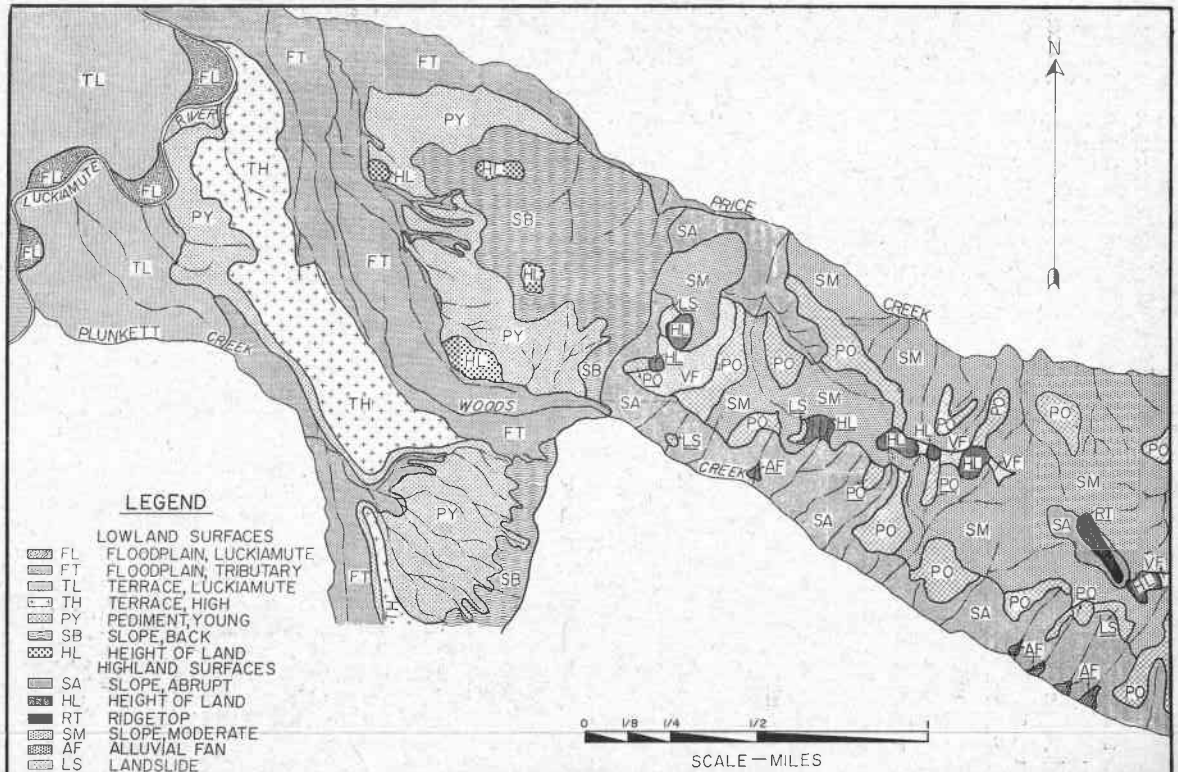

Figure 2. Geomorphic map of the Price Creek-Woods Creek area, western Oregon.

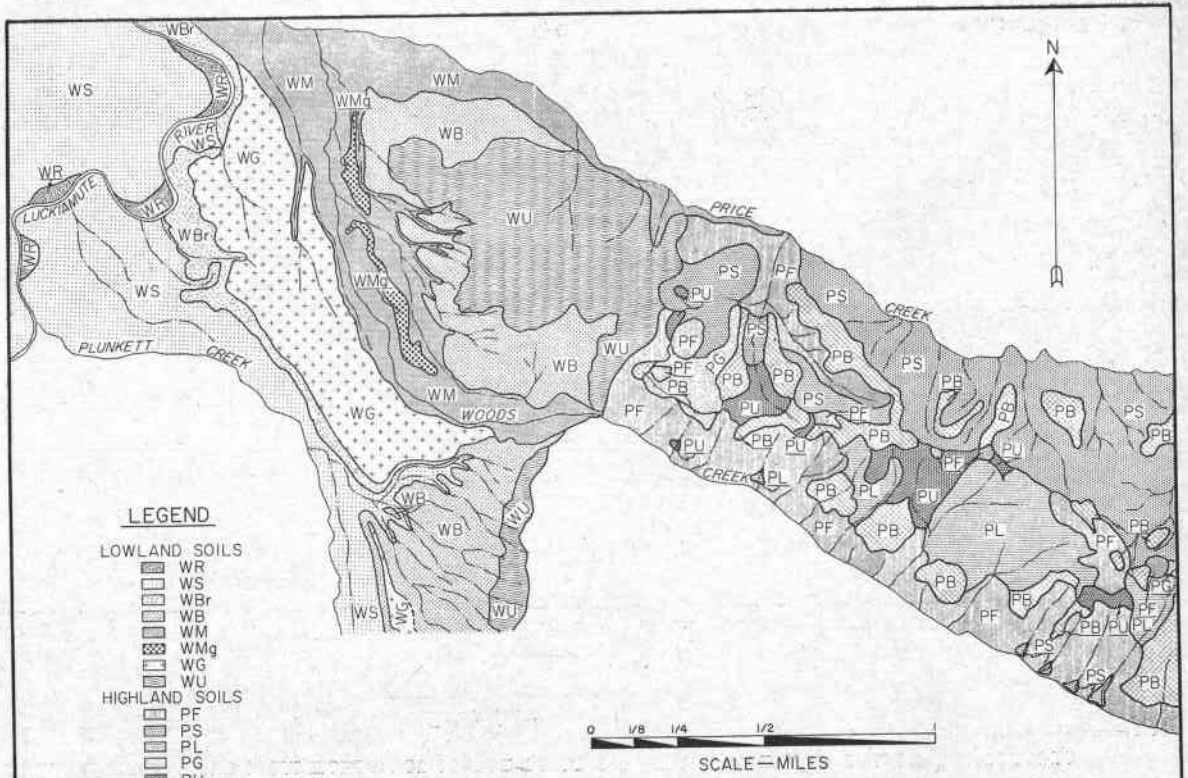

Figure 3. Generalized soil map of the Price Creek-Woods Creek area, western Oregon.

TABLE 1. GENERALIZED MORPHOLOGY OF MAJOR SOILS ON THE SHALE AND BASALT LANDSCAPES

Profile	Landform	Horizon	Depth	Color (moist) Hue	Value / Chroma	Texture*	Structure*	Other components
			inches					
				Woods Creek Lowland Area				
WR	Floodplain Luckiamute River	A	0-24	10YR	3/2	l	2vfgr	
		AC	24-34	10YR	4/3	cl	2fgr & 1vfsbk	
		IIC	34-54+	10YR	4/3	scl	m	
WS	Terrace Luckiamute River	A	0-17	10YR	2/2	sicl	2fgr	Many flakes of muscovite throughout profile
		B	17-38	10YR	4/3	sicl+	2msbk	
		C	38-50+	10YR	5/6	sicl	m	
WG	High terrace	Ap	0-5	10YR	3/3	sicl	2vfgr	10% basalt gravel
		B	5-14	7.5YR	3/2	gsicl	2fsbk	30% basalt gravel
		IIC	14-20+	Weathered basalt gravel 2-4" diameter				
WM	Tributary floodplains	Ap	0-6	10YR	3/3	sicl	3fgr	5% ½ to 1" basalt pebbles
		B	6-31	7.5YR	3/4	sic	3fsbk	5% ½ to 1" basalt pebbles
		IIC	31-39+	10YR	4/3 & 5/6	gc	m	40% basalt pebbles & cobbles
WB	Pediment	Ap	0-6	10YR	3/3	sicl	2vfgr	Occasional basalt pebbles & many shale fragments throughout solum
		B	6-20	10YR	3/3	sicl	3fsbk	
		IIC	20-27+	Kings Valley shale				
WU	Pediment backslope	Ap	0-5	7.5YR	4/4	sicl	2vfgr	A few ½ to 1" basalt pebbles
		B2	5-25	5YR	4/4	sic	2fsbk→3vfgr†	
		IIB3	25-41	5YR	4/4	sic	1fsbk→3vfgr	20% 2-4" basalt pebbles and cobbles
		IIIC	41-51 +	Kings Valley shale				

PF	Abrupt slopes, heights of land	A	0-9	5YR	3/2	gl	2vfgr	35% angular ½-1" basalt pebbles
		IIB	9-20	5YR	3/4	sicl	2fsbk→3vfgr	10% angular 1-2" basalt pebbles
		IIIR	20-30+	Basalt bedrock				
PL	Moderate slopes (S facing)	A	0-7	5YR	3/3	sicl	2vfgr	10% angular 1" basalt pebbles
		IIB	7-33	5YR	3/4	vgsic	2fsbk→2vfgr	55% subangular 3" basalt pebbles
		IIIC	33-45+	7.5YR	5/8	sicl	m→3vfgr	Saprolitic basalt; 12% hard cores
PS	Moderate slopes (N facing)	A	0-5	5YR	3/3	sicl	2vfgr	2% basalt pebbles 1-2"
		IIB	5-34	5YR	3/4	sic	3fsbk→3vfgr	20% basalt pebbles 1-9"
		IIC	34-54+	10YR	6/8	cl	m→3vfgr	Basalt saprolite
PB	Pediments and ridgetops	A	0-14	5YR	3/4	sicl	3vfgr	A few basalt pebbles
		IIBt	14-64	2.5YR	3/6	c	3vfsbk→3vfgr	65% basalt pebbles in upper 5"; many thin clay films
		IIIC	64-69+	5YR	4/6	sicl	m→3vfgr	Basalt saprolite
PU	Landslides	A	0-5	10YR	3/3	sicl	3fgr	15% basalt pebbles ½"
		IIBt	5-27	7.5YR	4/4	sic	2msbk	5% basalt pebbles 2½"
		IIIC	27-33+	10YR	5/6	sicl	m→2vfgr	Basalt saprolite
PG	Valley fill	A	0-10	5YR	3/4	sicl	2fgr	10% 1-3" basalt pebbles
		IIB	10-110	2.5YR	3/6	sicl	2msbk→3vfgr	A few fragments of basalt saprolite
		IIC	110-112+	5YR	4/6	sicl	m→3vfgr	Basalt saprolite

* Symbols used are the same as given in Soil Survey Manual, USDA Agr. Handbook No. 18, pp. 139-140, 1951.
† Arrow indicates a primary structure which breaks to the secondary structure when disturbed.

TABLE 2. SUBGROUP CLASSIFICATION

Profile	7th Approximation	Classification (*11*)*
WR	Cumulic	Haploxeroll†
WS	Cumulic	Haploxeroll
WG	Entic	Haploxeroll
WM	Cumulic	Haploxeroll
WB	Typic	Haploxeroll
WU	Typic	Dystrochrept
PB	Typic	Normihumult
PU	Typic	Argixeroll
PG	Cumulic	Haplumbrept
PS	Cumulic	Haplumbrept
PL	Cumulic	Haplumbrept
PF	Lithic	Haplumbrept

* Number in parenthesis indicates literature citation.
† Classified with the assistance of A. O. Ness, Senior Soil Correlator, SCS, Portland, Oregon, 1965.

WB soil on pediments has brown (10YR 3/3), strongly structured, medium textured sola which overlie shale or sandstone bedrock at depths less than 20 inches. Slope gradients range from 2 to 15%. The soil, when in proximity to faults, is influenced by base-rich water which seeps from the faults (*5*). WBr, a variant of WB, has 7.5YR 4/4 sola and apparently lacks the influence of fault seep water.

Backslopes (SB). The pediments above the high terrace rise gradually to merge into backslopes with gradients exceeding 12%. These backslopes in turn rise into the highlands, or onto heights of land.

Soil (WU) on backslopes is distinguished from those of pediments primarily by redder hues, weaker grades of structure, and deeper sola. Textural discontinuities are marked by stone lines (*6*) composed of basalt pebbles which vary in quantity from 2 to 20%. WU soil occurs on slopes of 12 to 30%. The sola are separated from shale bedrock, at depths of 35 to 45 inches, by abrupt wavy horizon boundaries.

Highland Soils and Landforms

Abrupt slopes (SA). The lower sideslopes of many valleys of the highland have gradients exceeding 45%. Movement of material down these slopes is visible after heavy rains. Accumulations of debris on the upslope side of recently fallen trees are abundant and show the amount of downslope movement of material.

PF soil occurs on abrupt slopes having gradients which exceed 45%. Development is limited in the shallow profiles to organic accumu-

lation and moderate grades of structure. Basalt bedrock occurs at depths of about 20 inches. Gravel contents in the sola range from 25 to 35%. Bedrock outcrops are rare.

Moderate slopes (SM). Many long slopes with gradients up to about 45% appear to be relatively stable under their present vegetative cover. It seems reasonable that material must move down these slopes, but the rate or magnitude of such movement is inconspicuous.

PL soil occurs on moderate slopes, up to 45%, which have a southerly exposure. Gravel contents often decrease with profile depth (*4*). PL soil has rock contents which average 55% in the B horizon. PS soil also occurs on moderately steep slopes, but differs from PL soil by having relatively stonefree profiles and by occurring on slopes having a northerly exposure. A few areas of PB soil were mapped on moderate slopes.

Pediments (PO). Remnants of two levels of high pediments are scattered throughout the highland area. Most of the remnants are small, but an occasional sizable area of the two pediments suggests that both levels may have been extensive. Saprolitic material developed from basalt typically underlies the soil of the pediments.

PB soil primarily occurs on pediments and highland remnants having slopes of 2 to 20% and is characterized by dark red (2.5YR 3/6), strongly structured, clay B horizons. Clay films are common on B horizon peds. Stone lines of fresh basalt separate the A and B horizons. The sola gradually merge into a C horizon composed of basalt saprolite. This soil has long been considered as being residual from basalt (*2, 8, 10*). However, the stone lines in the upper sola indicate that the soil is not truly residual (*4*), but has developed in part from alluvium or alluvium-colluvium.

Ridgetops (RT). Relatively narrow ridgetops occur as divides between many of the major valleys. Mantling material is usually very thin along these ridges, indicating extensive stripping of weathered material.

Heights of land (HL). The highest points in the local landscape characteristically are somewhat rounded and bordered by relatively steep slopes. Basalt bedrock is typically very near the surface.

Very gravelly and cobbly PF soil is also common on ridgetops and heights of land as well as on steep, abrupt slopes.

Landslides (LS). Landslides are very common features throughout the highland. Size varies from large massive landslides covering many acres to small local movements.

PU soil is largely limited to old landslide areas or saddles and is characterized by 10YR hues in the A horizons, fine textured B horizons, and high base saturation. Base-rich groundwater percolating through basalt saprolite has probably provided a means of base enrichment (*4*). Stone lines of unweathered basalt pebbles separate the A and B horizons, while basalt saprolite comprises the C horizons.

Valley fill (VF). Filled valleys trending somewhat transverse to the modern drainage pattern are present in the highland. The deposits in these old valleys are composed of sediments which vary from fine material to coarse, highly weathered gravels of mixed lithology. Their occurrence as elongated bodies with steeply inclined sides, their composition, and their position are indicative of an origin as filled valleys.

Many of the smaller deposits appear to be almost entirely derived from transported peds and disaggregated soil material. Dark, rounded aggregates of fine material (probably abraded peds) with fragments of clay films are common in these deposits.

PG soil occurs in valley fill, below PF soil, on slopes of 2 to 12%. The profiles are deep, dark red (2.5YR 3/6), silty clay loams with moderate structural development in the B horizons. Thicknesses of the sola range from 70 to 110 inches. PG soil is relatively stonefree except in the upper 10 to 20 inches. Bodies of PG soil rapidly thin upslope toward the shallow PF soil. This relationship provides evidence that this soil was developed in slopewash or valley fill. Low values for base saturation and contents of exchangeable bases further suggest that the PG soil was derived from weathered materials transported from a position further upslope (*4*).

Alluvial fans (AF). Valleys of south-facing slopes commonly have small alluvial fans at their mouths. Alluvial fans are almost unknown on north-facing slopes. Fan sediments are composed of crudely sorted material varying from silt-size to boulders.

PS soil occurs in the alluvial fans as well as on moderate slopes. Gravel content is less than 50%.

CONCLUSIONS

Areas mapped as Luckiamute River floodplain and terrace coincide with soil areas WR and WS, respectively. WS soil on terraces has a B horizon, while the floodplain WR soil does not. This developmental difference may be attributed to differences in the age of two surfaces of alluvial origin.

Areas of WG soil are limited to the high terrace which constitutes the most prominent geomorphic surface in the lowland. Soil of the tributary floodplains of Woods and Price creeks is represented by soil WM and other catenary associates. A sample of wood from beneath a WM profile on the Woods Creek floodplain indicates that soil development occurred in no more than 555 ± 100 years.[3]

Distribution of WB soil appears to be related to the dendritic drainage pattern on the pediments. The thin sola developed in pedisediment (*1*) apparently have been eroded concurrently with drainage development. In some small areas, the pedisediment has been entirely removed and shale bedrock outcrops along drainageways. In contrast, WU soil on the backslopes has not been severely incised by streams and, hence, exhibits relatively thick sola.

Canyons with abrupt slopes and PF soil have incised pediments with PB soil. A charcoal sample from an alluvial fan at the mouth of one of the canyons has been dated at 9,570 years B.P. (before present).[4] Therefore, PB soil on the pediment remnants has developed over a period of at least 9,570 years. PB soil has strongly developed structure and is the only soil studied which has prominent clay films in the B horizons. PB is, therefore, the most strongly horizonated soil on the landscape.

PS soil is limited to moderate slopes having a northerly exposure and to alluvial fans. PL soil on slopes having a southerly aspect is the stony equivalent of PS. Development is moderate with no evidences of clay illuviation. Incision of moderate slopes and PL soil along Woods and Price creeks has probably resulted in the shallow, very stony, weakly developed PF soil on abrupt slopes and ridgetops.

Dark-colored, fine textured, base-rich PU soil primarily occurs in landslides and saddles where calcium- and magnesium-rich groundwater may temporarily accumulate. The deep, red, weakly horizonated PG soil is limited to areas of valley fill derived from adjacent steep slopes.

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[3] The date on the charcoal was determined by Isotopes, Inc., Westwood, New Jersey.

[4] *Ibid.*

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APPENDIX

Detailed Profile Descriptions

Profile WR

Location: NE SE Sec. 20, T10S R6W

Slope gradient: 0-1%

Landform: Floodplain, Luckiamute River

Classification:

Subgroup: Cumulic Haploxeroll

Probable series: Cloquato

Horizon	Depth	Morphology
	inches	
Ap	0-5	Very dark grayish brown (10YR 3/2) loam; moderate fine granular and weak very fine subangular blocky structure; friable; abundant very fine and fine roots; clear wavy boundary.
A12	5-13	Very dark grayish brown (10YR 3/2) clay loam; weak very fine granular structure to massive; firm; clods seem somewhat brittle; common very fine and fine roots; several dark yellowish brown (10YR 4/4) fine sandy loam krotovinas 2 by 4 to 12 inches; clear wavy boundary.
A13	13-24	Very dark brown (10YR 2/2) clay loam; weak fine granular structure; friable; common very fine roots; several 3 inch diameter krotovinas exhibiting strong very fine granular structure and loose consistence; gradual wavy boundary.
AC	24-34	Brown (10YR 4/3) very dark grayish brown (10YR 3/2) dark grayish brown (10YR 4/2) clay loam; moderate fine granular and weak very fine subangular blocky structure; friable; a few very fine roots; clear wavy boundary.
C	34-54+	Brown and dark yellowish brown (10YR 4/3 and 4/4) sandy clay loam; massive; friable; common very dark grayish brown (10YR 3/2) coatings along pores and fractures.

Profile WS

Location: SE SE Sec. 20, T10S, R6W

Slope gradient: 2%

Landform: Terrace, Luckiamute River

Classification:

Subgroup: Cumulic Haploxeroll

Probable series: Chehalis

Horizon	Depth	Morphology
	inches	
Ap	0-9	Very dark brown (10YR 2/2) silty clay loam; moderate fine granular structure; very friable; abundant very fine roots; abrupt wavy boundary.
A12	9-17	Very dark brown (10YR 2/2) silty clay loam; weak fine granular structure to massive; friable, tends to be somewhat brittle; common very fine roots; a 3 inch krotovina with strong very fine granular structure; clear wavy boundary.
B21	17-25	Dark brown (10YR 3/3 and 4/3) fine silty clay loam; moderate fine subangular blocky structure; firm; common discontinuous very dark grayish brown (10YR 3/2) coatings on peds; numerous very fine roots; gradual wavy boundary.
B22	25-30	Dark brown (10YR 4/3) and dark yellowish brown (10YR 4/4) fine silty clay loam; moderate medium subangular blocky structure; firm; common discontinuous dark grayish brown (10YR 4/2) coatings on peds; few very fine roots; clear wavy boundary.
B23	30-38	Dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; occasional thick discontinuous brown (7.5YR 4/4) clay films on vertical ped surfaces and in pores; common pale brown (10YR 6/3) bleached zones along root channels; clear wavy boundary.
C	38-50+	Yellowish brown (10YR 5/6) silty clay loam; massive; friable; occasional thick discontinuous brown (7.5YR 4/4) clay films along fractures and pores; a few pale brown (10YR 6/3) bleached zones along root channels; common flakes of mica throughout.

Profile WG

Location: SE SW Sec. 28, T10S, R6W

Slope gradient: 2%

Landform: High terrace

Classification:

Subgroup: Entic Haploxeroll

Probable series: none

Horizon	Depth	Morphology
	inches	
Ap	0-5	Dark brown (10YR 3/3) silty clay loam; moderate very fine granular structure; friable, slightly sticky; 10% basalt gravel; abundant fine roots; clear smooth boundary.
B21	5-9½	Dark brown (10YR 3/3) gravelly silty clay loam; moderate fine subangular blocky structure; friable, slightly sticky; a few very thin discontinuous dark reddish brown (5YR 3/3) waxy coatings on peds; dark organic coatings along root channels; about 30% by volume basalt gravel; abrupt wavy boundary.
B22	9½-14	Dark brown (7.5YR 3/2) very gravelly silty clay loam; strong fine subangular blocky structure; friable, slightly sticky; a few discontinuous waxy coatings on peds; about 60% by volume basalt gravel; gradual irregular boundary.
IIC	14-20+	Weathered gravel and cobbles 2-4 inches in diameter; basic igneous gravel has 1-6 mm weathering rinds; fragments of sedimentary rocks are soft and weathered.

Profile WM

Location: NW NW Sec. 28, T10S, R6W *Classification:*

Slope gradient: 3% *Subgroup:* Cumulic Haploxeroll

Landform: Floodplain, tributaries *Probable series:* Abiqua

Horizon	Depth	Morphology
	inches	
Ap	0-6	Dark brown (10YR 3/3) silty clay loam; strong fine granular and weak very fine subangular blocky structure; friable, slightly sticky and slightly plastic; a few ½ to 1 inch subrounded basalt pebbles; abrupt wavy boundary.
B1	6-10	Dark brown (7.5YR 3/3 crushed) silty clay; moderate fine subangular blocky structure; firm, slightly sticky and slightly plastic; a few ½ to 1 inch subrounded basalt pebbles; common thin very dark brown (10YR 2/2) coatings on peds; clear wavy boundary.
B21	10-18	Dark brown (7.5YR 3/4 crushed) silty clay; strong fine subangular blocky structure; firm, sticky and plastic; common thin dark reddish brown (5YR 3/3) clay films on subrounded ½ to 1 inch basalt pebbles; gradual wavy boundary.
B22	18-24	Dark brown (7.5YR 3/4) silty clay; strong fine subangular blocky structure; firm, sticky and plastic; common thin dark reddish brown (5YR 3/3) clay films on subrounded ½ to 1 inch basalt pebbles; abrupt wavy boundary.
IIB3	24-31	Dark brown (7.5YR 3/4) gravelly silty clay; moderate fine subangular blocky structure; firm, sticky and plastic; abundant dark reddish brown (5YR 3/4) clay films on basalt pebbles; clear wavy boundary.
IIC1	31-39	Dark grayish brown, brown, and yellowish brown (10YR 4/2, 4/3, and 5/6) gravelly clay; massive; very firm, sticky and very plastic; common, fine, distinct, strong brown (7.5YR 5/8) mottles; 40% ½ to 2 inch, with occasional 4 inch, rounded and subrounded basalt cobbles; abundant dark reddish brown (5YR 3/4) clay films on pebbles.
IIIC2	39-45+	Massive gleyed clay; very sticky and very plastic.

Profile WB

Location: SE SE Sec. 28, T10S, R6W

Slope gradient: 18%

Landform: Pediment

Classification:

Subgroup: Typic Haploxeroll

Probable series: Chehulpum

Horizon	Depth	Morphology
	inches	
Ap1	0-2	Dark brown (10YR 3/3) silt loam; moderate very fine granular structure; friable, slightly sticky; many fine roots; abrupt wavy boundary.
Ap2	2-6	Dark brown (10YR 3/3) silty clay loam; moderate very fine subangular blocky structure; friable, slightly sticky; numerous fine roots; abrupt wavy boundary.
B21	6-10	Dark brown (10YR 3/3) silty clay loam; strong fine subangular blocky structure; friable, slightly sticky; some very thin very dark grayish brown (10YR 3/2) coatings on ped surfaces; gradual wavy boundary.
B22	10-15	Dark brown (10YR 3/3) silty clay loam; strong fine subangular blocky structure; friable, slightly sticky; numerous thin dark reddish brown (5YR 3/2) waxy coatings on ped surfaces; gradual wavy boundary.
B23	15-21	Very dark grayish brown (10YR 3/2) fine silty clay loam; strong fine subangular blocky structure; firm, slightly sticky; common discontinuous dark reddish brown (5YR 3/2) waxy coatings especially along root channels; some sand-size shale fragments; abrupt wavy boundary.
IIC	21-27+	Kings Valley shale heavily coated with "MnO_2." Many dark reddish brown (5YR 3/2) clay films along fracture planes.

Profile WU

Location: SE SE Sec. 28, T10S, R6W
Slope gradient: 30%
Landform: Pediment backslope

Classification:
Subgroup: Typic Dystrochrept
Probable series: Similar to Hullt

Horizon	Depth	Morphology
	inches	
Ap	0-5	Brown (7.5YR 4/4) silty clay loam; moderate very fine granular structure; friable, slightly sticky, slightly plastic; common fine roots; several ½ to 1 inch subangular basalt pebbles; abrupt wavy boundary.
B21	5-10	Reddish brown (5YR 4/4) coarse silty clay; moderate very fine subangular blocky breaking to strong very fine granular structure; friable, slightly sticky, slightly plastic; numerous fine roots; several ½ to 1 inch subangular basalt pebbles without a weathering rind; a few thin continuous clay films along root channels; clear wavy boundary.
B22	10-16	Reddish brown (5YR 4/4) silty clay; moderate fine subangular blocky breaking to strong very fine granular structure; friable, sticky, plastic; numerous fine roots; a few thin continuous clay films along root channels; clear wavy boundary.
B23	16-25	Reddish brown (5YR 4/4) silty clay; weak very fine subangular blocky breaking to strong very fine granular structure; friable, sticky, plastic; a few thin continuous clay films along root channels; a few thin discontinuous clay films on peds; several ¼ to ½ inch subangular basalt pebbles; abrupt wavy boundary.
IIB31	25-32	Reddish brown (5YR 4/4) gravelly silty clay; weak very fine subangular blocky breaking to strong very fine granular structure; firm, sticky, plastic; with a few dark reddish brown (5YR 3/4) coatings and few fine faint yellowish red (5YR 4/6) mottles along pores; a few 1 mm shale fragments; 20% 2 to 4 inch subangular basalt pebbles and cobbles with discontinuous yellowish red (5YR 4/6) clay films and a trace of weathering rind; gradual wavy boundary.
IIB32	32-41	Reddish brown (5YR 4/4) fine silty clay loam; weak very fine subangular blocky breaking to strong very fine granular structure; friable, slightly sticky, slightly plastic; with common fine faint yellowish red (5YR 4/6) mottles along pores; abundant 1 mm shale fragments; 10% ¼ to 1 inch Kings Valley shale fragments; very few basalt pebbles; abrupt wavy boundary.
IIIC	41-51+	Kings Valley shale with abundant black and red segregations and coatings.

Profile PF

Location: SW NE Sec. 35, T10S, R6W

Slope gradient: 50%

Landform: Abrupt slopes and heights of land

Classification:

Subgroup: Lithic Haplumbrept

Probable series: Witzel

Horizon	Depth	Morphology
	inches	
A1	0-3	Dark reddish brown (5YR 2/2) loam; moderate very fine granular structure; friable; numerous ½ to 2 mm weathered basalt fragments and 35% ½ to 1 inch angular and subangular basalt gravel; common flakes of charcoal; abundant fine roots; clear wavy boundary.
A3	3-9	Dark reddish brown (5YR 3/3) clay loam; weak very fine granular and moderate very fine subangular blocky structure; friable; abundant ½ to 2 mm weathered basalt fragments; a few ½ to 1 inch angular basalt pebbles; common flakes of charcoal; clear wavy boundary.
IIB1	9-15	Dark reddish brown (5YR 3/3) silty clay loam; moderate very fine and fine subangular blocky breaking to moderate very fine granular structure; friable; common 1 to 3 inch angular basalt fragments; some flakes of charcoal in ped interiors; gradual wavy boundary.
IIB2	15-20	Dark reddish brown and dark red (2.5YR 3/4 and 3/6) fine silty clay loam; moderate fine subangular blocky breaking to strong very fine granular structure; friable; common 1-3 inch angular basalt fragments; a few thin discontinuous dark reddish brown (5YR 3/4) ped coats; abrupt irregular boundary.
IIIR	20-30+	Relatively unweathered basalt bedrock.

Profile PL

Location: NW SE Sec. 36, T10S, R6W
Slope gradient: 20%
Landform: Moderate slopes, south facing

Classification:
Subgroup: Cumulic Haplumbrept
Probable series: Klickitat

Horizon	Depth	Morphology
	inches	
A11	0-3	Dark reddish brown (5YR 3/3) silty clay loam; moderate very fine granular structure; friable; 5% angular 1 inch basalt gravel; abundant 2-5 mm weathered basalt gravel with a trace of weathering rind; abundant fine roots; clear wavy boundary.
A12	3-7	Dark reddish brown (5YR 3/3) silty clay loam; moderate very fine granular and weak fine subangular blocky structure; friable; 10% angular 2-3 inch basalt gravel; common fine roots; abrupt wavy boundary.
IIB1	7-13	Dark reddish brown (5YR 3/3) gravelly fine silty clay loam; moderate fine subangular blocky breaking to moderate very fine granular structure; compact *in situ,* friable when disturbed; 45% subangular 3 inch basalt cobbles with 1 mm weathering rinds; clear wavy boundary.
IIB2	13-24	Dark reddish brown (5YR 3/4) very gravelly silty clay; moderate fine and medium subangular blocky breaking to moderate very fine granular structure; with coatings (5YR 3/3); compact *in situ,* firm when disturbed; 55% subangular 4 inch basalt cobbles with a 1-2 mm weathering rind; a few reddish brown (5YR 4/4) variegations; clear wavy boundary.
IIIB3	24-33	Variegated dark reddish brown (5YR 3/4) and yellowish red (5YR 4/8) gravelly silty clay; weak fine subangular blocky breaking to strong very fine granular structure; firm; 25% subangular and subrounded 1-2 inch basalt gravel with a 2-3 mm weathering rind; common saprolite with black segregations on fractures; common thin discontinuous red and dark red (2.5YR 4/8 and 3/6) clay films on fractures in saprolite and on basalt gravels; common 1 mm basalt sand; clear wavy boundary.
IIIC	33-45+	Variegated reddish brown (5YR 4/4), yellowish red (5YR 5/8), strong brown (7.5YR 5/8), and dark red (2.5YR 3/6) fine silty clay loam; massive breaking to strong very fine granular structure; friable; 12% saprolitic pillows with hard cores 1 to 5 inches in diameter with an average of 2 inches; seemingly a saprolitic pillow basalt.

(Note: IIIC may be better designated IVC as the percentage of rock fragments decreases with increasing depth.)

Profile PS

Location: NW SW Sec 27, T10S, R6W
Slope gradient: 8%
Landform: Moderate slopes, north facing

Classification:
Subgroup: Cumulic Haplumbrept
Probable series: Similar to Hullt

Horizon	Depth	Morphology
	inches	
A1	0-5	Dark reddish brown (5YR 3/3) silty clay loam; moderate fine and very fine granular structure; friable, slightly sticky, plastic; many scattered, subangular andesite pebbles up to 1¾ inches in diameter with no weathering rind; clear wavy boundary.
B1	5-10	Dark reddish brown (5YR 3/4) silty clay loam; moderate fine subangular blocky breaking to strong very fine granular structure; friable, sticky, plastic; few scattered subangular andesite pebbles up to 1 inch in diameter with no weathering rind; clear wavy boundary.
B21	10-14	Dark reddish brown (5YR 3/4) silty clay; moderate fine subangular blocky breaking to strong very fine granular structure; friable, sticky and plastic; few scattered subangular andesite pebbles up to 2½ inches in diameter with no weathering rind; several krotovinas up to 2½ inches in diameter with strong very fine granular structure and loose consistence; clear wavy boundary.
IIB22	14-25	Dark reddish brown (5YR 3/4) silty clay; strong very fine subangular blocky structure; firm, sticky, plastic; stone line at top of horizon composed of andesite cobbles and pebbles up to 9 inches in diameter with very thin weathering rinds; lower part of horizon has pockets of saprolitic basalt up to 4 inches in diameter; saprolitic basalt variegated yellow (10YR 7/8), brownish yellow (10YR 6/6), and dark red (2.5YR 3/6), with black (N2/0) coatings; clear wavy boundary.
IIB3	25-34	Dark red (2.5YR 3/6) silty clay; moderate very fine subangular blocky breaking to strong very fine granular structure; firm, sticky, plastic; pockets of saprolite up to 8 inches in diameter; black (N2/0) coatings on saprolitic basalt; variegations of yellow (10YR 7/6), very pale brown (10YR 7/4), brownish yellow (10YR 6/8), and dark red (2.5YR 3/6); clear irregular boundary.
IIC	34-54+	Variegated yellow (10YR 6/8) and very pale brown (10YR 6/4) clay loam; massive basalt saprolite; very firm, slightly sticky, slightly plastic; also variegated strong brown (7.5YR 5/8), yellowish red (5YR 4/8), dark red (2.5YR 3/6) and dark reddish brown (2.5YR 3/4), with black (N2/0) coating and thick discontinuous dark red (2.5YR 3/6) clay films on fractures.

Profile PB

Location: NE SW Sec. 35, T10S, R6W

Slope gradient: 2%

Landform: Pediments and ridgetops

Classification:

Subgroup: Typic Normihumult

Probable series: Similar to Jory

Horizon	Depth	Morphology
	inches	
A11	0-5	Dark reddish brown (5YR 3/4) silty clay loam; strong very fine granular structure; friable; numerous basalt pebbles; average ½ inch and maximum 1 inch in diameter; common 1 mm concretions; clear wavy boundary.
A12	5-8	Dark reddish brown (5YR 3/4) silty clay loam; moderate very fine subangular blocky breaking to strong very fine granular structure; friable; scattered pebbles ½ to 1 inch in diameter; common 1 mm concretions; scattered charcoal fragments; clear wavy boundary.
A3	8-14	Dark reddish brown (2.5YR 3/4) silty clay loam; weak very fine subangular blocky breaking to strong very fine granular structure; friable; rare ½ to 1 inch basalt pebbles; common thin discontinuous clay films; a few 1 mm concretions; rare fragments of charcoal; clear wavy boundary.
B1	14-19	Dark red (2.5YR 3/6) and dark reddish brown (2.5YR 3/4) fine silty clay loam; weak very fine subangular blocky breaking to strong very fine granular structure; friable; a few 1 inch diameter pebbles; a few 1 mm concretions; a few discontinuous clay films; red (2.5YR 4/6) clay films on pebbles; abrupt wavy boundary.
IIB21t	19-24	Red to dark red (2.5YR 3.5/6) clay; moderate fine subangular blocky breaking to strong very fine granular structure; compact *in situ,* friable when disturbed; 65% subangular basalt gravel and cobbles (½ to 6 inches); thin continuous clay films; numerous ½ mm concretions; this horizon is composed, in part, of a stone line marking a discontinuity; abrupt wavy boundary.
IIIB22t	24-32	Red to dark red (2.5YR 3.5/6) clay; strong very fine subangular blocky breaking to strong very fine granular structure; compact *in situ,* friable when disturbed; 5% gravel to 3 inches in diameter with thick continuous clay films; common thin continuous clay films on peds; common ½ mm concretions; clear wavy boundary.

IIIB23t	32-40	Dark red (2.5YR 3/6) clay; moderate, very fine subangular blocky breaking to strong very fine granular structure; compact *in situ,* friable when disturbed; common very thin continuous clay films on peds; thick clay films on pebbles; common 1 mm concretions; several isolated areas of saprolite ½ inch in diameter; gradual wavy boundary.
IIIB24t	40-46	Dark red (2.5YR 3/6) fine silty clay loam; moderate fine subangular blocky breaking to strong very fine granular structure; compact *in situ,* friable when disturbed; a few thin discontinuous clay films on blocky peds; moderately thick continuous clay films on gravel; numerous ½ mm concretions; a few isolated areas of saprolite ½ inch in diameter; gradual wavy boundary.
IIIB31	46-52	Dark red (2.5YR 3/6) silty clay loam; moderate fine subangular blocky breaking to strong very fine granular structure; very compact *in situ,* friable when disturbed; a few 1 inch pebbles coated with thin continuous clay films; numerous ½ mm concretions; gradual wavy boundary.
IIIB32	52-60	Variegated red (2.5YR 4/6), dark red (2.5YR 3/6), dark reddish brown (5YR 3/4), and strong brown (7.5YR 5/6) silty clay loam; weak fine subangular blocky breaking to strong very fine granular structure; compact *in situ,* friable when disturbed; occasional 1 inch basalt pebbles; thin discontinuous red (2.5YR 4/6) clay films on saprolite; numerous ½ mm concretions; clear wavy boundary.
IIIB33	60-64	Variegated yellowish red (5YR 4/6), dark reddish brown (5YR 3/4), red (2.5YR 4/8), and dark brown (7.5YR 3/2) silty clay loam; weak medium subangular blocky breaking to strong very fine granular structure; compact *in situ,* friable when disturbed; numerous pebbles of saprolite; a few basalt pebbles; common ½ mm concretions; gradual irregular boundary.
IIIC	64-69+	Variegated yellowish red (5YR 4/6) and dark brown (7.5YR 3/2) silty clay loam saprolite; massive breaking to strong very fine granular structure; friable; yellowish red (5YR 4/6) clay films on pebbles; common ½ mm concretions; abrupt irregular boundary.

Profile PU

Location: SW NW Sec. 36, T10S, R6W

Slope gradient: 6%

Landform: Landslides

Classification:

Subgroup: Typic Argixeroll

Probable series: Similar to Dixonville

Horizon	Depth	Morphology
	inches	
A11	0-2	Dark brown (10YR 3/3) silty clay loam; strong fine and very fine granular structure; friable, slightly sticky and slightly plastic; abundant fine roots; 15% ½ inch rounded unweathered basalt pebbles; clear wavy boundary.
A12	2-5	Dark brown (10YR 3/3) fine silty clay loam; strong very fine granular and weak fine subangular blocky structure; friable; slightly sticky and slightly plastic; common fine roots; 15% ½ inch rounded basalt pebbles; clear wavy boundary.
B1	5-10	Dark brown (7.5YR 3/2) silty clay; moderate fine subangular blocky structure; firm, sticky and slightly plastic; 5% ½ inch rounded basalt pebbles; abrupt wavy boundary.
IIB2	10-17	Brown (7.5YR 4/4) silty clay; moderate medium subangular blocky structure; firm, sticky and plastic; many dark brown (7.5YR 3/2) coatings on peds; 5% subrounded, slightly weathered 2½ inch diabase pebbles; clear wavy boundary.
IIIB3	17-27	Brown (7.5YR 4/4) silty clay; weak medium subangular blocky breaking to moderate very fine granular structure; firm, sticky and slightly plastic; a few yellowish brown (10YR 5/4 and 5/6) pebbles of saprolitic diabasic basalt; a few thin clay films around pebbles; clear wavy boundary.
IIIC	27-33+	Variegated dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/6), brownish yellow (10YR 6/6), and brown (7.5YR 4/4) fine silty clay loam; massive breaking to moderate very fine granular structure; friable, sticky and slightly plastic; diabasic basalt saprolite.

Profile PG

Location: SW NE Sec. 35, T10S, R6W

Slope gradient: 5%

Landform: Valley fill

Classification:

Subgroup: Cumulic Haplumbrept

Probable series: Marty

Horizon	Depth	Morphology
	inches	
A1	0-5	Dark reddish brown (5YR 3/3) silty clay loam; moderate fine granular structure; friable; 10% 1-3 inch basalt pebbles; numerous flakes of charcoal; abundant fine roots; clear wavy boundary.
A3	5-10	Dark reddish brown (2.5YR 3/4) silty clay loam; weak fine subangular blocky breaking to strong very fine granular structure; friable; 5% ½ inch basalt pebbles; a dark red (2.5YR 3/6) burned area with numerous fine charcoal flakes; abundant fine roots; clear wavy boundary.
B1	10-16	Dark reddish brown (5YR 3/4) silty clay loam; weak fine subangular blocky breaking to strong very fine granular structure; friable; common fine roots; clear wavy boundary.
B21	16-27	Dark reddish brown to dark red (2.5YR 3/5) silty clay loam; moderate fine subangular blocky breaking to strong very fine granular structure; friable; a few thin discontinuous clay films on peds; prominent thick continuous brown (7.5YR 4/2) coatings along root channels; several flakes of charcoal; clear wavy boundary.
B22	27-37	Dark red (2.5YR 3/6) fine silty clay loam; moderate medium subangular blocky breaking to strong very fine granular structure; compact *in situ,* friable when disturbed; a few thin discontinuous clay films; common thick continuous brown (7.5YR 4/2) coatings on root channels; numerous 5-10 mm weathered basalt pebbles; abrupt wavy boundary.
IIB23	37-50	Yellowish red (5YR 4/6) coarse clay; moderate medium subangular blocky breaking to strong very fine granular structure; very compact *in situ,* friable when disturbed; common 1 to 3 inch fresh basalt gravel in the upper 2 inches of this horizon; a few 1 inch areas of saprolite; numerous 1 to 2 mm rounded basalt pebbles; a few thin discontinuous clay films; clear wavy boundary.

IIB24	50-62	Yellowish red (5YR 4/6) silty clay loam; moderate medium subangular blocky breaking to strong very fine granular structure; compact *in situ,* friable when disturbed; common 1 mm rounded basalt fragments; a few ½ inch areas of saprolite; common discontinuous reddish brown (5YR 4/4) clay films on peds; clear wavy boundary.
IIB31	62-75	Yellowish red (5YR 4/6) silty clay loam; weak medium subangular blocky breaking to strong very fine granular structure; compact *in situ,* friable when disturbed; common discontinuous clay films on peds and fractures; abundant saprolite; gradual wavy boundary.
IIB32	75-86	Yellowish red (5YR 4/8) silty clay loam; weak medium subangular blocky structure; compact *in situ,* friable when disturbed; a few very thin discontinuous clay films; gradual wavy boundary.
IIB33	86-110	Yellowish red (5YR 4/8) silty clay loam; weak medium subangular blocky structure; compact *in situ,* friable when disturbed; abrupt irregular boundary.
IIC	110-112+	Yellowish red (5YR 4/6) with black segregations; diabase saprolite.