AN ABSTRACT OF THE THESIS OF

Diane A. S. Hoppe for the degree of Master of Science in Soil Science presented on December 14, 1988.

Title: Interrelationships of Spodosols, Andepts, and Ultisols on Coastal Terraces in Curry County, Oregon

Abstract approved: Redacted for Privacy

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Distribution and characteristics of soils were determined across a series of six coastal terraces in Curry Co., Oregon. Classification of soils and interrelationships of properties were determined. Soil-landscape relationships were examined and soil profile development related to relative ages of terraces. Ten pedons were sampled from five terraces of Pleistocene age. All profiles were analyzed for particle size distribution; bulk density; water retention, -1.5 MPa; aluminum and iron extracted with oxalate, citrate-dithionite and sodium pyrophosphate; pH; phosphate retention; exchangeable aluminum; organic carbon; and cation exchange capacity.

Andeptic Humitropepts occur on intermediate terraces, in close proximity to the coast. Andeptic Haplohumults occur on the better drained areas of the intermediate terrace, but further inland. Soils in less well drained areas of the intermediate and higher terraces classify as Spodosols, based on morphological features. Ultisols occur on the highest terraces. Profile morphology, particle size and iron extracts are compared between terraces to derive age relationships.

Interrelationships of Spodosols, Andepts, and Ultisols on Coastal Terraces in Curry County, Oregon

by

Diane A.S. Hoppe

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

Completed December 14, 1988

Commencement June 1989

APPROVED:

Redacted for Privacy

Professor of Soil Science in charge of major

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Date thesis is presented December 14, 1988

Typed by Diane Hoppe for Diane A. S. Hoppe

ACKNOWLEDGEMENTS

I would like to thank the Soil Science Department for their support of this study, and the many staff members for assistance and encouragement through all stages of the project.

Many people deserve special appreciation for their efforts in the completion of this thesis: Dr. G.H. Simonson, for support, guidance, and the freedom to independently pursue my goals; Dr. H. Huddleston, George Green, and Frank Reckendorf, for their input and field assistance, especially in the initial stages, and for their interest and support throughout; Dr. J. Baham, for his ideas, guidance, perceptive encouragement, and patience during my return to chemistry; and all of my committee members, for their constructive criticisms of the thesis. For their interest and cooperation, I sincerely acknowledge the landowners of Curry County.

Special thanks to Matthew Fillmore for his continual interest and assistance, and Elaine, Carrie, Bridgett, and Tommy for their warmth and companionship during stays in Curry County. Thanks also to Heidi Hoffman and Mark Humphrey for their many hours of assistance in the lab. To all of my friends in Corvallis, and to the Williams family, thank you for making my stay here an enjoyable one. And to Ray Sanders, a big thank you for picking me up when I was down. To my family and friends back East, thank you for your constant love and support.

Finally, this thesis is dedicated to my daughter, Neenah, who has made many sacrifices during this project. May she some day forgive me for leaving her kitten, HCT, and Allen in Virginia.

Contribution of authors

Diane Hoppe is the primary author of the manuscripts, and is responsible for all aspects of the research. Dr. G.H. Simonson is the major professor on the thesis project, and assisted with selection of the research topic, and with the field work, including site selection, descriptions, and samplings. Dr. J. Baham is the Soil Science Dept. secondary advisor, and supervised all laboratory analyses and sampling for bulk density measurements. Both Drs. G.H. Simonson and J. Baham assisted in interpretation of results and editorial review.

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INTERRELATIONSHIPS OF SPODOSOLS, ANDEPTS, AND ULTISOLS ON COASTAL TERRACES IN CURRY COUNTY, OREGON

INTRODUCTION

A series of coastal terraces, of different ages, provide a setting for the study of soil-geomorphic relationships in Curry County, Oregon. Some of the soil pedons have unique properties similar to soils formed in parent materials of volcanic origin. The U.S. Soil Taxonomy (Soil Survey Staff, 1975) is currently being revised, and will include a new soil order, Andisols, to include these soils (Leamy et al. 1988). Soils with spodic horizons, and cemented iron pans, occur in distinct landscape positions on the terraces. Study of the interrelationships between the soils and between terrace level and landscape position clarifies problems in soil classification and provides a basis for study of soil formation with respect to time.

Soils with thick, dark surface layers, soil mineralogy dominated by amorphous (short order) or non-crystalline clay, high water retention, high phosphate retention, and low bulk density have been identified around the Pacific Rim - that part of the world's land surface that borders the Pacific Ocean. (Tan, 1984). It is a tectonically active area with relatively recent volcanic activity, and the soils generally reflect parent material of volcaniclastic materials. The new order of Andisols would include these soils which are currently classified primarily as Andepts in the U.S. Soil Taxonomy. They have been identified in Oregon in the vicinity of or downwind from major recently active volcanoes. Soils with similar properties have been identified along the coast of Oregon (Badayos, 1983; Baham and Simonson, 1985). The purpose of this part of the study is to determine the nature of the soils along the coast of Curry County in relation to other soils of the area, and for application in the progressive soil survey of the area.

The terraces have been studied in other areas along the coast (Griggs, 1945; Nettleton et al. 1982) and related to soil types, but questions remain in correlation of the soils and geomorphic surfaces in Curry County. This study will contribute to the understanding of soil-geomorphic relationships in the study area and be of assistance to the Curry County Soil Survey.

Objectives

The objectives of this thesis are to:

1. Classify the soils using present criteria, evaluate proposed changes in criteria, expand our understanding of unique properties of the soils and determine relationships of the soils to landscape position.

2. Determine the distribution of soils in relation to geomorphology of the coastal terraces and relate relative age of the terrace surfaces to soil development in the area.

The thesis is in the manuscript format, with two chapters. The first chapter addresses objective 1, and the second chapter, objective 2.

STUDY AREA

An area near Cape Blanco, in Southwestern Oregon, was chosen as the research site because of the extensive coastal marine terraces, and the eroded coastal bluffs that expose the underlying sediments. The area represents approximately 50 km^2, between Floras Lake and Port Orford, centered at Cape Blanco, and includes confluences of the Elk and Sixes Rivers with the Pacific Ocean (Figure 1).

The coastal plain in this area consists of a series of marine terraces ranging from 6 to 240 m above sea level. Five terraces have been outlined for study (Figure 2). Griggs (1945) identified and named three terraces near Cape Arago: the Whiskey Run, the Pioneer, and the Seven Devils. The surfaces in this study were tentatively named with this system, but are not meant to indicate exact correlation. The names are used simply to indicate sampling sites. Reckendorf (1987) outlined surfaces in Curry County on which soils were sampled for this study.

The series of terraces are believed to represent wave-cut terraces of Pleistocene age, (Baldwin, 1981) capped with unconsolidated beach and offshore deposits (Beaulieu, 1976). The terraces were formed by varying sea level high stands, and in this area appear to be also a result of tectonic uplift (Palmer, 1967). Chapter 2 examines the relationship of the ages of the surfaces to soil profile development.

The study area is within the coastal fog belt, a temperate, marine climate influenced by proximity to the Pacific Ocean, and

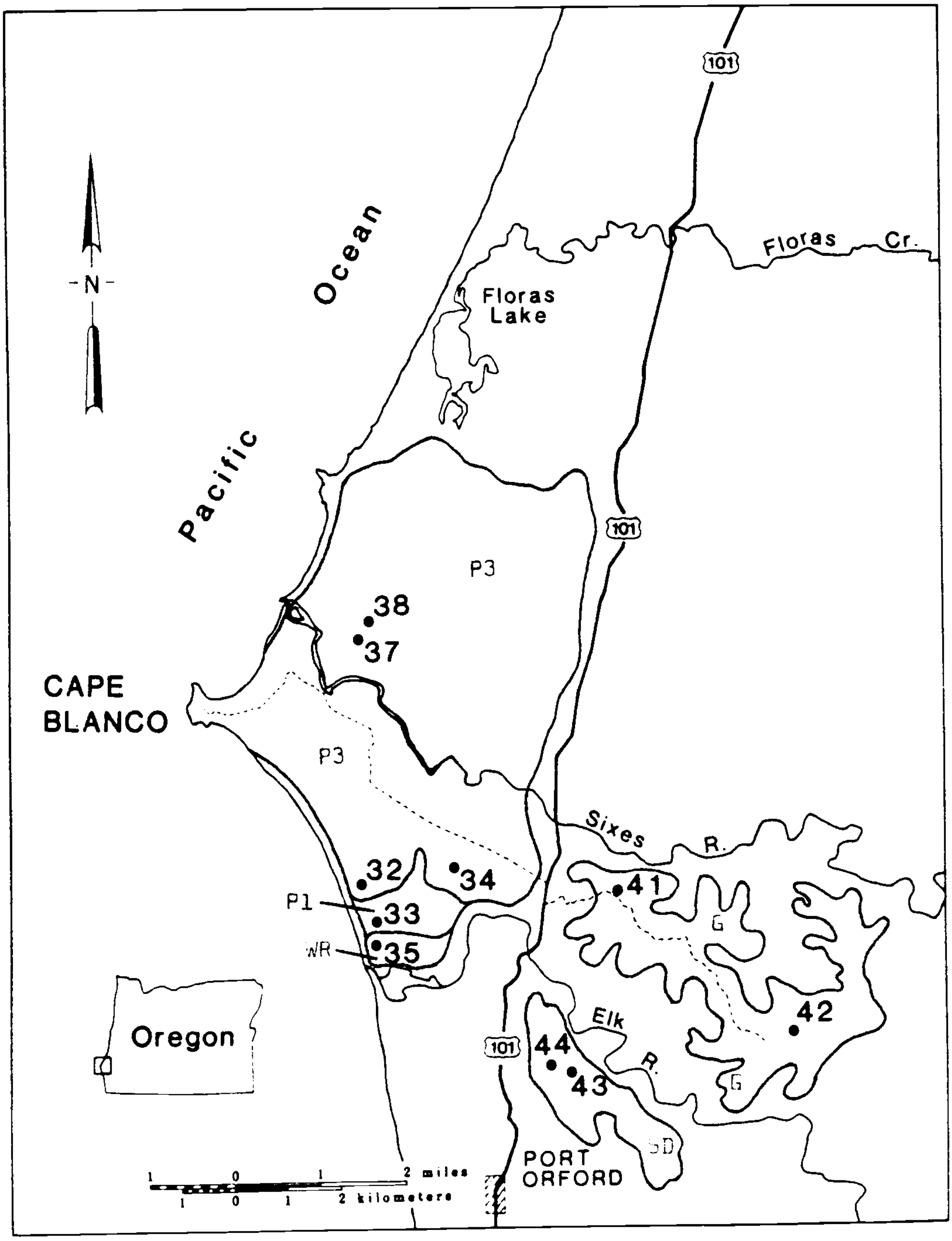
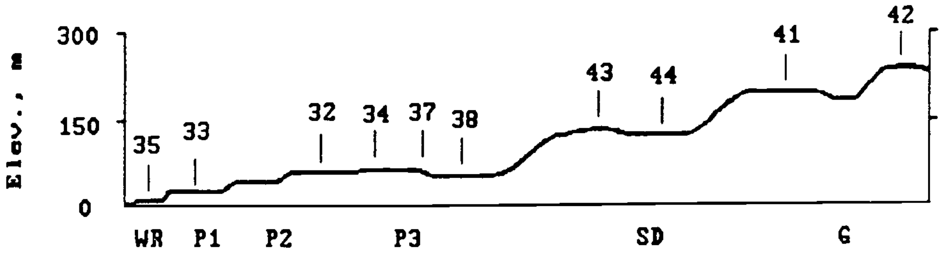


Fig. 1 Location of study area and sites with selected marine terraces (WA-Whiskey Run, P1-Pioneer 1, P3-Pioneer 3, G-Griggs, SD-Seven Devils)



WR - Whiskey Run
P1 - Pioneer 1
P2 - Pioneer 2
P3 - Pioneer 3
SD - Seven Devils
G - Griggs

Figure 2. Schematic of terraces and sampling sites

characterized by frequent fogs. The soil moisture regime is udic, with 1948 mm (76.7 inches) average annual rainfall, at Cape Blanco, (NCC, 1983) and a short dry period during the summer. Mean annual air temperature is 10.2° C. at Cape Blanco (NCC, 1983) with less than 5° C. difference between mean annual summer and mean annual winter soil temperatures; an isomesic soil temperature regime.

Natural vegetation adjacent to the coastline is a coniferous forest of Sitka spruce (*Picea sitchensis*), Port Orford cedar (*Chamaecyparis lawsoniana*), or shore pine (*Pinus contorta*), with a thick understory of salal (*Gaultheria shallon*), evergreen huckleberry (*Vaccinium ovatum*), brackenfern (*Pteridium aquilinum*), and rhododendron (*Rhododendron macrophyllum*). On the higher terraces, further inland, western hemlock (*Tsuga heterophylla*) and Douglas fir (*Pseudotsuga Carr.*) are more predominant (Randall, 1985; Wiedmann, 1974). Much of the area that is well-drained has been cleared and is used for pasture, while the Spodosols with a cemented ortstein horizon that perches water are commonly used for cranberry bogs or timber production.

CHAPTER 1

CLASSIFICATION AND PROPERTIES OF ANDEPTS, SPODOSOLS, AND ULTISOLS ON COASTAL TERRACES OF SOUTHWESTERN OREGON.

D. Hoppe
G.H. Simonson
J. Baham

Abstract

Distribution and characteristics of soils were studied across a series of coastal terraces in Curry Co., Oregon. Classification of soils and interrelationships of properties were determined. Ten pedons were sampled from five terraces of Pleistocene age. All profiles were analyzed for: particle size distribution; bulk density; - 1.5 MPa water content; aluminum and iron extracted with oxalate, citrate-dithionite, and sodium-pyrophosphate; pH; phosphate retention; exchangeable aluminum; organic carbon; and extractable bases and hydrogen.

Inceptisols with andic properties occur on low and intermediate terraces, in close proximity to the coast. Spodosols are found in less well drained areas of the intermediate and higher terraces. Ultisols occur in well-drained areas on the intermediate and higher terraces.

CHAPTER 1: CLASSIFICATION AND PROPERTIES OF ANDEPTS, SPODOSOLS, AND ULTISOLS ON COASTAL TERRACES OF SOUTHWESTERN OREGON.

Introduction

Many soils along the coast of Oregon have been identified as Andepts in the U.S. Soil Taxonomy system of classification, (Soil Survey Staff, 1975) and also meet the criteria (Table 1.1) for the proposed new order of Andisols (Badayos, 1983; Baham and Simonson, 1985; Shoji et al. 1987; Kimble and Nettleton, 1987). These soils exhibit the characteristics of andic soils: low bulk density values, high amounts of aluminum and iron extracted with acid oxalate, and high phosphate retention. They do not appear to have significant amounts of allophane, but rather have iron- and aluminum-humus complexes (Baham and Simonson, 1985). Many of these non-allophanic andisols also meet the current chemical criteria (Table 1.2) for Spodosols, but do not resemble Spodosols morphologically.

The objectives of this study are to examine the soils on the coastal terraces in Curry Co., in order to classify them according to Soil Taxonomy (Soil Survey Staff, 1975) and to test the criteria for Andisols (Leamy, 1988). This study also examines relationships of soil types to landscape position. A companion study (Hoppe et al. 198x) relates soil profile development to terrace levels and the relative ages of the terraces.

Table 1.1 Criteria for Classification of Andisols (Leamy, 1988)

To have andic soil properties, the soil material must meet one or more of the following three requirements:

1. a. Al_o + 1/2 Fe_o > 2.0%, and
   b. Bulk density of the < 2mm fraction, at 1/3 bar water retention, is < 0.90 g cm-3, and
   c. Phosphate retention is > 85%, or

2. a. More than 60% by volume of the whole soil is volcaniclastic material coarser than 2 mm, and
   b. Al_o +1/2 Fe_o >0.4% in the < 2 mm fraction, and
   c. Phosphate retention is more than 25%; or

3. The 0.02 - 2.0 mm fraction is at least 30% of the <2 mm fraction and meets one of the following three requirements:

   a. If the < 2mm fraction has phosphate retention > 25% and has (Al_o + 1/2 Fe_o) > 0.40%, there is at least 30% volcanic glass in the 0.02 - 2.0 mm fraction, or
   b. If the < 2mm fraction has (Al_o + 1/2 Fe_o) >2.0%, there is at least 5% volcanic glass in the 0.02 - 2.0 mm fraction, or
   c. If the < 2mm fraction has 0.40% < (Al_o + 1/2 Fe_o) < 2.0%, there is at least a proportional content of volcanic glass in the 0.02 - 2.0 mm fraction between 30 and 5 percent.

Andisols are soils that:

1. Have andic soil properties:

   a. Throughout all subhorizons, whether buried or not, which make up a thickness of 35 cm or more within 60 cm of the mineral soil surface, or

   b. Throughout 60% or more of the total soil thickness if a lithic or paralithic contact occurs within 60 cm of the mineral soil surface, and

2. Do not have an albic horizon, or remnants of an albic horizon, with an associated spodic horizon, unless it occurs below the depth of the total thickness required in 1.

Table 1.2 Criteria for classification of Spodosols (Soil Survey Staff, 1975)

Spodic horizon:

- Hue and chroma remain constant with increasing depth or the subhorizon that has the reddest hue or highest chroma is near the top of the horizon.
- If frigid or warmer, some part of the spodic horizon must meet the following requirements below a depth of 12.5 cm or below any Ap horizon that is present.
- Must meet one or more of the following:

  1) Have a subhorizon >2.5 cm thick that is continuously cemented by some combination of organic matter with iron or aluminum or with both;

  2) Have a particle size class that is sandy or coarse-loamy, and sand grains are covered with cracked coatings or there are distinct dark pellets of coarse-silt size or larger, or both; <u>or</u>

  3) Have one or more suabhorizons in which:

     a) If $> 0.1\%\ Fe_p$, $(Fe_p + Al_p) / \%\ clay > 0.2$
        If $< 0.1\%\ Fe_p$, $(Al_p + C_p) / \%\ clay > 0.2$

     b) $(Fe_p + C_p) / (Fe_d + Al_d) > 0.5$

     c) [CEC at pH 8.2 - 0.5(% clay)] x thickness,cm
        sum of all subhorizons > 65

Spodosols :

do not have a plaggen epipedon but have either:

1) A spodic horizon where the upper boundary is within 2 m of the surface

2) A placic horizon that meets all the requirements of a spodic horizon except thickness and index of accumulation and rests on a fragipan, on a spodic horizon, or on an albic horizon that rests on a fragipan.

Study Area

Cape Blanco, in Southwestern Oregon, is the site of the study area, and represents approximately 50 km^2, between Floras Lake and Port Orford, centered at Cape Blanco, and including the junctions of the Elk and Sixes Rivers with the Pacific Ocean (Figure 1).

The coastal plain in this area consists of a series of marine terraces ranging from 6 to 240 m above sea level. Five terraces have been outlined for study (Figure 2). Griggs (1945) identified and named three terraces near Cape Arago: the Whiskey Run, the Pioneer, and the Seven Devils. The surfaces in this study were tentatively named with this system, but use of the names is not meant to indicate exact correlation. Reckendorf (1987) outlined surfaces in Curry County on which soils were sampled for this study. The series of terraces are believed to represent wave-cut terraces of Pleistocene age (Baldwin, 1981).

The study area is within the coastal fog belt, a temperate, marine climate influenced by proximity to the Pacific Ocean, and characterized by frequent fogs. The soil moisture regime is udic, with 1948 mm (76.7 inches) average annual rainfall, at Cape Blanco, (NCC,1983) and a short dry period during the summer. Mean annual air temperature is 10.2° C. at Cape Blanco (NCC,1983) with less than 5° C. difference between mean annual summer and mean annual winter soil temperatures; an isomesic soil temperature regime.

Natural vegetation adjacent to the coastline is a coniferous forest of Sitka spruce (*Picea sitchensis*), Port Orford cedar

(*Chamaecyparis lawsoniana*), or shore pine (*Pinus contorta*), with a thick understory of salal (*Gaultheria shallon*), evergreen huckleberry (*Vaccinium ovatum*), brackenfern (*Pteridium aquilinum*), and rhododendron (*Rhododendron macrophyllum*). On the higher terraces, further inland, western hemlock (*Tsuga heterophylla*) and Douglas fir (*Pseudotsuga Carr.*) are more predominant (Randall, 1985; Wiedmann, 1974). Much of the area that is well-drained has been cleared and is used for pasture, while Spodosols with a cemented ortstein horizon that perches water are commonly used for cranberry bogs or timber production.

Methods

Sampling

The geomorphic surfaces (terrace levels) were outlined in the field by observing the number of terrace levels from the floodplain of the Elk and Sixes Rivers, elevation changes, and continuity of surface (Reckendorf, 1987). The names are taken from the study by Griggs (1945) near Cape Arago, but do not imply correlation. They are tentatively named as follows:

WR - (6 m elevation) Whiskey Run
P1 - (24 m elevation) Pioneer 1
P2 - (35 m elevation) Pioneer 2 (not sampled)
P3 - (50 m to 65 m elevation) Pioneer 3
SD - (95 m to 125 m elevation) Seven Devils
G - (170 m to 235 m elevation) Griggs

Soils of the study area were examined initially with auger borings, and from roadcuts and eroded cliffs. Pedon descriptions were made at 45 sites. Ten pedons were chosen to represent the soils observed, and to compare soil development across the terraces (Figure 1). Each site was excavated to a depth of at least 150 cm, if possible, and described according to standard soil survey techniques (SCS, 1981). Soil morphological features are shown in abbreviated form in Table 1.3. Suggested correlation with known soil series is indicated.

Table 1.3. Morphological features of the soils, Curry Co., Oregon

Horiz	Depth (cm)	Color Dry	Color Moist	Mottles	Texture (field)	Structure	Consistence M	Consistence W	Bdy.	Other features
LINT or TEMPLETON										
Profile No. 32 -- Andic Humitropept, loamy, isomesic										
A	0 - 23	10YR 5/4	10YR 3/3		sil	2fgr	fr	ss/sp,wksm	gs	few charcoal frag.
AB	23 - 48	10YR 4/3	10YR 3/3		l	1msbk/1fgr	fr	ss/sp,wksm	gs	
BA	48 - 71		10YR 3/4	7.5YR 5/8	l	1msbk	fr	ss/sp	cs	
Bw	71 - 99		10YR 6/6	5YR 4/6,6/8	l-cl	m	fi	ss/sp	as	
BC	99 -130	mottled:	10YR 6/6,6/3, 5YR 4/6		l	m	fi	ss/sp	as	
2C	130-140	variegated			gr & silt stone					
LINT or TEMPLETON										
Profile No. 33 -- Andic Humitropept, loamy, isomesic										
A	0 - 23	10YR 4/3	10YR 3/2		sil	2fgr	fr	ss/sp,wksm	cw	
AB	23 - 36	10YR 5/4	10YR 3/3		sil	2fsbk	fr	ss/sp,wksm	cw	
BA/A	36 - 69	10YR 5/4	10YR 3/4		l	1msbk	vfr	ss/sp	cw	A hor mater/root ch
Bw	69 -119		10YR 5/6		l	1msbk	fr	ss/sp	cw	
BC	119-137		10YR 4/4		l	m	fr	ss/sp	cw	
2C	137-152				gr & s		wk cem			
Profile No. 34 - Andeptic Haplohumult, fine-loamy, isomesic										
A	0 - 23	10YR 3/3cr	10YR 3/2		sil	2m&fgr	fr	ss/sp,wksm	cs	charc frag
AB	23 - 38	10YR 3/3cr	10YR 3/2		sil	2mgr	fr	ss/sp,wksm	cs	charc frag
BA	38 - 56		10YR 4/4		l	1msbk	fr	ss/sp	as	charc frag
Bt1	56 - 71		10YR 4/6		cl	2msbk	fr	ss/p	cs	f2d cl films,pores,faces
Bt2	71 - 94		10YR 4/6		l	1msbk	fr	ss/sp	cw	c2&2d cl fi,pores,faces
BC	94 -132		10YR 5/6		grl	1msbk	fi	ss/sp	ci	f1d cl fi
C	132-152		10YR 5/8	10YR 5/3	grsl	m	vfi,wkcm			

Table 1.3. (Continued)

Horiz	Depth (cm)	Color Dry	Color Moist	Mottles	Texture (field)	Structure	Consistence M	Consistence W	Bdy.	Other features
WOLFER										
Profile No. 35 - Andic Humitropept, loamy, isomesic										
A1	0 - 15	10YR 5/3	10YR 2/2		grl-fsl	2mgr	fr	ns/np	cs	charc frag
A2	15 - 38	10YR 4/3	10YR 2/2		grl	1mgr	fr	ss/sp,wksm	gs	charc frag
AB	38 - 66	10YR 4/3	10YR 2/2		grl	2mfsbk/1mgr	fr	ss/sp,wksm	cs	charc frag
BA1	66 - 79	10YR 4/3	10YR 3/2		grl	1fsbk/1mgr	fr	ss/sp,wksm	cs	charc frag
BA2	79 -109		10YR 2/2		grl	1fsbk/1mgr	fr	ss/sp,wksm	as	charc frag
Bw	109-125		10YR 3/3		grl	1msbk	fr	ss/sp,wksm	cw	
C	125-163		10YR 5/6	7.5YR 5/6	grl	massive	fr	ss/sp,wksm		
BANDON-NELSCOTT?										
Profile No. 37 - Typic Troporthod, coarse-loamy, isomesic, ortstein										
A1	0 - 38	10YR 4/3	10YR 2/1		sil	2mgr	fr	ss/sp,wksm	cs	
A2	38 - 64	10YR 5/4	10YR 2/2		sil	1msbk/1mgr	fr	ss/sp,wksm	cs	
E/A	64 - 81		10YR 4/4, 10YR 3/2		sil	1msbk	fr	ss/sp,wksm	aw	
2E	81 - 91		10YR 6/4	7.5YR 5/6	l	1msbk	fr	ss/sp	aw	
2Bsm1	91 -117		10YR 5/6	7.5YR 5/8	ls-s	m/2mpr	fi		cs	7.5YR 4/6,cem part
2Bsm1	117-142		10YR 5/6	7.5YR 5/8	ls-s	m/2mpr	fi			7.5YR 4/6,cem part
2Bsm2	142-160		10YR 5/6	5YR 5/6	ls-s	massive	fi		cs	
2Bsm3	160-178		5YR 4/6upper, 2.5Y 6/4		s	massive	fr		as	5YR 4/6cem,upper5cm
3C	178-191		10YR 7/1	10YR 5/6	sicl	1csbk	fi	ss/sp		
DEPOE?										
Profile No. 38 - Typic Tropaquod, fine-loamy/sandy, isomesic, ortstein										
A1	0 - 10	10YR 5/1	10YR 2/2		sil	2mgr	fr	ns/sp	as	
A2	10 - 20	10YR 5/1	10YR 2/1		sil	1msbk	fr	ns/sp	cs	
E	20 - 31		10YR 5/1	10YR 5/8	sicl	1msbk	fi	ss/p	as	
E/B	31 - 43		2.5Y 6/2, 10YR 6/8		sicl	2f,msbk	fi	ss/sp	aw	large pocket-tree throw?

Table 1.3. (Continued)

Horiz	Depth (cm)	Color Dry	Color Moist	Mottles	Texture (field)	Structure	Consistence M	Consistence W	Bdy.	Other features
Profile No. 38 - (Continued)										
2Bsm1	43 - 69		7.5YR 5/8	10YR 7/4	sl	2vcpl/1mabk	exfi	ns/np	ai	root penetr-ireg bound
2Bsm2	69 - 94		7.5YR 5/8, 2.5Y 5/4		ls	1cpr	exfi/fi	ns/np	cs	
2BC	94 -122		2.5Y 5/2	10YR 5/4	s	m	fi	ns/np	as	
2C	122-152		5Y 4/2		s	loose		ns/np		
JOENEY?										
Profile No. 41 - Typic Tropaquod, fine-silty, iosmesic, ortstein										
A	0 - 13	7.5YR 5/0	10YR 2/1		sil	2mgr	fr	ns/sp	as	ch fr
E	13 - 25	10YR 7/1	10YR 6/2	7.5YR 5/6	sil	1mpl	fr	ns/sp	cw	ch fr,krotovinas
BE	25 - 37	mottled:	10YR 4/6,5/4, 7.5YR 5/6		sil	massive	fr	ss/sp	aw	5YR 4/4 thin cemented pans
Bh	37 - 38		10YR 2/2		sil	1fpl/1fgr				7.5YR 5/6 concr
2Bsm1	38 - 53		10YR 5/6		sicl	massive	exfi		as	5YR 4/4 indurated pockets
2Bsm2	53 - 61		10YR 5/8	5YR 5/8,4/4, 10YR 7/3	sicl	massive	exfi		aw	
2C1	61 - 99		10YR 5/6		sicl	1fpl/1fsbk	fi	s/p	ds	ch fr
2C2	99 -142		10YR 5/6	10YR 6/2	sic	1csbk	fi	vs/p	aw	ch fr
2C3	142-158		10YR 4/6		sicl	massive		s/p		ch fr
EDSON?										
Profile No. 42 - Typic Haplohumult, fine-loamy, isomesic										
A	0 - 18	10YR 5/4	10YR 4/4		l	3f,mgr	fr	ns/sp	aw	
2BA	18 - 33		7.5YR 4/6		l-sil	3fsbk	fr	ns/sp	cs	ch fr
2Bt1	33 - 53		7.5YR 4/6		l	2fsbk	fr	ss/p	cs	ch fr
2Bt2	53 - 84		5YR 5/6		sicl	2fsbk	fr	s/p	cs	ch fr,f1d cl fi,pores,faces
3Bt3	84 -112		5YR 5/8		scl-cl	1msbk	fi in pl	ss/sp	cs	c1d cl fi,pores,faces;weath ss
3Bt4	112-132		5YR 5/8		cl	1csbk	fi in pl	s/p	gs	c1d cl fi,pores,faces
3BC	132-160		5YR 5/8	10YR 5/6	sl	m	fi in pl	ns/np		

Table 1.3. (Continued)

Horiz	Depth (cm)	Color		Mottles	Texture (field)	Structure	Consistence		Bdy.	Other features
		Dry	Moist				M	W		
ORFORD										
Profile No. 43 - Typic Haplohumult, clayey, isomesic										
EA	0 - 8	10YR 6/3	10YR 4/3		sil	1fpl	fr	ss/sp	cw	
BE	8 - 20		7.5YR 5/6	5YR 5/8	sicl	1msbk	fr	s/p	cs	ch fr
Bt1	20 - 43		7.5YR 5/6		sicl	3fsbk	fr	s/p	gs	f1f cl fi,faces
Bt2	43 - 66		10YR 5/8		sic	2fsbk	fr	vs/vp	gs	c1&2d 7.5YR 4/4 cl fi,faces
BC	66 - 91		10YR 5/8	7.5YR 5/6, 10YR 7/4	sic	1msbk	fi in pl	vs/p	cs	c1d cont cl fi
2C1	91 -132		10YR 6/8	10YR 5/8	l	m	fi in pl	ns/sp	cs	
2C2	132-160		10YR 5/6		sl	m	fi in pl	ns/sp		
JOENEY?										
Profile No. 44 - Typic Tropaquod, fine-silty, isomesic, ortstein										
A	0 - 15	10YR 6/1	10YR 5/1		sil	m/1fpl	fr	ns/p	aw	
E	15 - 43	10YR 7/1	10YR 6/1	7.5YR 4/6	sil	1fpl	fr	ns/sp	aw	cf concr
Bhsm	43 - 58		10YR 5/8	10YR 2/1,6/3		1cpl	vfi		as	mult layers of Bh
Bsm	58 - 74		10YR 5/6	2.5YR 4/6, 10YR 6/2	sil	1cpl	fi	ss/sp	cs	org stains,& red,faces plates
BC	74 - 91		10YR 5/6	2.5YR 4/8, 10YR 6/2	sicl	1cabk	slfi	s/p	cs	red mott cem
C1	91 -127		10YR 5/6	10YR 6/2, 7.5YR 5/6	sicl	m	fr	s/p	gs	white concr
C2	127-152		10YR 6/2	10YR 5/6,8/2	sicl	m	fr	s/p		

Analysis

Soil samples were air-dried, hand-crushed, and passed through a 2 mm sieve. The coarse fragments were removed and their mass recorded. Bulk density and cation exchange capacity (CEC) analyses were determined on selected horizons.

Particle size analysis was performed by first sieving and weighing the coarse fragments. Forty grams of the < 2 mm fraction was treated with hydrogen peroxide (H_2O_2) to remove organic matter. Ten grams of the oven dried sample was then dispersed with sodium hexametaphosphate and shaken for 16 hours on a horizontal reciprocating shaker. Sand, silt, and clay were determined using the pipette method (method 3A1, SCS, 1984).

Water retention measurements were made at -1.5 MPa (15 bar) using the Pressure-Membrane Extraction (method 4B2a,b, SCS, 1984). This was done on field moist and air dry samples for the surface horizons of those pedons considered to be Andepts, and on air dry samples only, for all other horizons. Pressure was applied to moistened samples immediately, rather than allowing them to equilibrate overnight as in method 4B2. Coarse fragments were not sieved from the field moist samples, so adjustments in moisture contents were estimated from horizon coarse fragment percentages.

Bulk density measurements were made on samples taken with a drop-hammer core sampler at field moisture (Blake & Hartge, 1986). Samples were taken horizontally into the face of the soil pit, in the surface layers of the soils considered to be andic. During the following summer, in June 1988, an attempt was made to take bulk density measurements for all the pedons, using aluminum rings pushed into the face of the soil pit. The soils were not as dry as they were during the original sampling. However, all horizons could not be sampled due to compaction or cementation.

Chemical analyses were done on the <2 mm fraction, on an oven-dry weight basis. Aluminum (Al_o), iron (Fe_o), and silica (Si_o) were extracted with acid oxalate (Blakemore et al, 1977) and with sodium pyrophosphate (Al_p, Fe_p, Si_p) at pH 10 (methods 6C8 & 6C8a, SCS, 1984) and analyzed by atomic absorption. Aluminum (Al_d) and iron (Fe_d) were extracted with sodium dithionite-citrate (method 6C2, in, SCS, 1984) and analyzed by atomic absorption. Al was extracted with 1 N KCl and analyzed by AAS. (Barnishel and Bertsch, 1982) Soil pH was determined with a combination glass electrode.
Phosphate retention was determined according to the method of Blakemore (Blakemore et al, 1977). Organic matter content (later converted to Organic Carbon content) was determined using the Walkley-Black wet oxidation method (Nelson and Sommers, 1975). CEC is by sum of the cations at pH 8.2 with exchangeable bases added to extractable acidity (methods 5A3a & 6H4, SCS, 1984). Tables of the complete physical and chemical data are in Appendix B.

Sand fractions of the surface layers of the andic soils were examined under a petrographic microscope to determine percent of volcanic glass present.

Results

Andisol Classification

Five of the pedons sampled (32, 33, 34, 35, 37) have morphological features similar to soils meeting the Andisol criteria. They have a thick dark surface layer with strong granular structure, low bulk density, high organic matter content, and a smeary moist consistence. Soils with these features have been identified along other parts of the Oregon coast (Badayos, 1983; Baham and Simonson, 1985), and meet the criteria for the proposed order of Andisols (Leamy, 1988) shown in Table 1.1.

Based on morphology, five pedons were considered to be possible Andisols. Only pedon 32 meets the criteria for Andisols (Table 1.4). Pedon 33 narrowly misses the requirement for $Al_o + 1/2\ Fe_o$, and should probably be considered an Andisol. The bulk density measurements show considerable variation between the two methods of sampling. Nearly all of the bulk density measurements on samples taken with the aluminum rings are approximately 0.2 Mg m-3 higher than those taken with the drop-hammer. The only exception is pedon 35, which is also the only site that could not be found exactly for the resampling, due to reseeding of the pasture. A new excavation was made at a point as close to the original site as possible. This suggests that some compaction occurred on the sides of the original soil pits from being excavated, refilled, and reexcavated. Therefore, it is reasonable to assume that pedons 32, 33 and 35 have bulk densities less than 0.9 Mg m-3.

Table 1.4. Andic soil properties, Curry Co., Oregon

Horiz. Desig.	Depth (cm)	Bulk Density (Mg m-3)		P-ret (%)	Alo +1/2 Feo (%)	Andic Prop.
LINT or TEMPLETON						
Profile No. 32 -- Andic Humitropept, loamy, isomesic----------						
A	0 - 23	0.92	0.72	93.7	2.0	x
AB	23 - 48	0.97	0.67	95.7	2.1	x
BA	48 - 71	0.95	0.62	94.6	2.1	x
Bw	71 - 99	1.09		93.2	2.1	
BC	99 -130			86.4	1.7	
2C	130-140					
LINT or TEMPLETON						
Profile No. 33 -- Andic Humitropept, loamy, isomesic----------						
A	0 - 23	0.93	0.80	84.2	1.6	
AB	23 - 36	0.88	0.80	93.2	2.0	x
BA/A	36 - 69	0.81		91.7	2.1	x
Bw	69 -119	1.01		81.7	1.4	
BC	119-137	1.12		73.0	1.1	
2C	137-152					
Profile No. 34 -- Andeptic Haplohumult, fine-loamy, isomesic--						
A	0 - 23	0.91	0.69	90.4	1.6	
AB	23 - 38	0.90	0.83	93.7	1.8	
BA	38 - 56	0.95	0.69	93.6	1.8	
Bt1	56 - 71	0.89	0.69	94.6	2.4	x
Bt2	71 - 94	0.49		96.7	2.8	x
BC	94 -132			93.2	2.3	x#
C	132-152			84.0	1.5	
WOLFER						
Profile No. 35 -- Andic Humitropept, loamy, isomesic----------						
A1	0 - 15	0.75	0.68	68.8	1.0	
A2	15 - 38	0.66	0.90	92.1	1.8	
AB	38 - 66	0.64	0.81	91.2	1.8	
BA1	66 - 79	0.75	0.81	90.2	2.1	x
BA2	79 -109	1.33		93.5	1.9	
Bw	109-125			89.7	1.8	
C	125-163			87.0	1.7	
BANDON-NELSCOTT?						
Profile No. 37 -- Typic Troporthod, coarse-loamy, isomesic, or						
A1	0 - 38	0.96	0.77	85.8	1.4	
A2	38 - 64	0.91	0.77	91.2	1.7	
E/A	64 - 81			88.3	1.5	
2E	81 - 91			80.9	1.4	
2Bsm1	91 -117			91.2	2.6	x#
2Bsm1	117-142			87.5	2.0	x
2Bsm2	142-160			ERR	1.2	
2Bsm3	160-178			41.2	0.7	
DEPOE?						
Profile No. 38 -- Typic Tropaquod, fine-loamy/sandy, isomesic-						
A1	0 - 10	1.01		19.0	0.2	
A2	10 - 20	1.09		32.6	0.3	

Table 1.4. (Continued)

Horiz. Desig.	Depth (cm)	Bulk Density (Mg m-3)	P-ret (%)	Alo + 1/2 Fe (%)	Andic Prop.
Profile No. 38 (Continued)					
E	20 - 31	1.23	39.4	0.3	
E/B	31 - 43	1.15	76.0	0.7	
2Bsm1	43 - 69		39.0	0.2	
2Bsm2	69 - 94		42.9	0.5	
2BC	94 -122		24.5	0.4	
2C	122-152		17.5	0.3	
JOENEY?					
Profile No. 41 -- Typic Tropaquod, fine-silty, isomesic, ortst					
A	0 - 13	0.90	31.6	0.3	
E	13 - 25		15.9	0.2	
BE	25 - 37	1.09	69.7	0.8	
Bh	37 - 38		98.2	2.7	x#
2Bsm1	38 - 53		94.6	1.5	
2Bsm2	53 - 61		95.6	2.3	x#
2C1	61 - 99	1.03	89.1	1.5	
2C2	99 -142	1.01	79.2	1.0	
2C3	142-158		91.2	2.1	x#
EDSON?					
Profile No. 42 -- Typic Haplohumult, fine-loamy, isomesic-----					
A	0 - 18	0.79	63.2	0.8	
2BA	18 - 33	1.10	92.7	1.5	
2Bt1	33 - 53	1.28	80.9	1.0	
2Bt2	53 - 84	1.49	50.4	0.4	
3Bt3	84 -112		39.4	0.3	
3Bt4	112-132	1.24	46.0	0.3	
3BC	132-160		37.6	0.2	
3Cr	160.0+		37.6	0.2	
ORFORD					
Profile No. 43 -- Typic Haplohumult, clayey, isomesic---------					
EA	0 - 8		29.3	0.3	
BE	8 - 20	1.18	47.5	0.6	
Bt1	20 - 43	1.25	74.2	0.7	
Bt2	43 - 66	1.25	70.5	0.5	
BC	66 - 91	1.21	15.9	0.5	
2C1	91 -132		42.9	0.3	
2C2	132-160		39.4	0.3	
JOENEY?					
Profile No. 44 -- Typic Tropaquod, fine-silty, isomesic, ortst					
A	0 - 15	1.47	5.2	0.1	
E	15 - 43		9.1	0.1	
Bhsm	43 - 58		98.0	3.8	x#
Bsm	58 - 74		98.7	4.9	x#
BC	74 - 91		91.7	1.7	
C1	91 -127		74.2	0.9	
C2	127-152		91	2.0	

\# - bulk density not determined

The surface layers of pedons 32, 33, 34, 35, and 37 are very similar and all exhibit andic features, morphologically. Pedon 35 appears to be most strongly andic from field morphology, but does not meet the proposed criteria for andic soil properties in order to be classified as an Andisol. It has Al_o + 1/2 Fe_o of 1.0 to 1.8% (less than the required 2%), but has a layer deeper than 60 cm that meets all of the criteria. Since it is on the youngest geomorphic surface, it may not have had time to accumulate high levels of amorphous Al and Fe constituents.

Pedons 34 and 37, and pedons 41 and 44, sampled as Spodosols, generally meet the criteria for andic soil properties, but only at depths greater than 60 cm in the profile, indicating a translocation of amorphous material, or organically bound iron and aluminum (Figure 1.1). Therefore, they do not classify as Andisols.

Andept Classification

Based on current Soil Taxonomy, three pedons (32, 33, 35) were tentatively identified in the field as Dystrandepts. Pedon 34 is classified as a Haplohumult and pedon 37 as a Troporthod because they have, respectively, an argillic horizon and a spodic horizon. All three of the pedons sampled as Dystrandepts narrowly miss the criteria for Amorphous Material Dominant in the Exchange Complex (Table 1.5 and Table 1.5a). Pedon 32 has CEC less than 150 cmol/kg; pedon 33 meets all of the criteria, but only to a depth of 23 cm; pedon 35 has water retention to clay ratio of 1.0 in the subsurface. They classify as Andic Humitropepts, and have very similar morphological featur that pedon 35 has a higher gravel content.

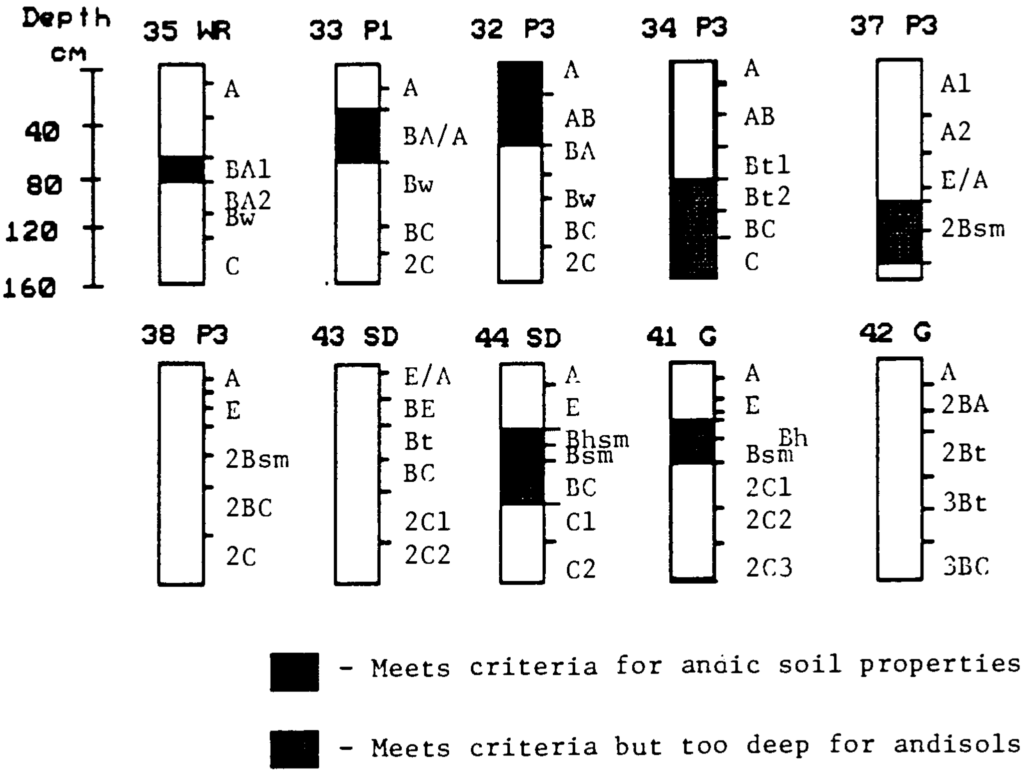


Figure 1.1. Translocation of amorphous material

Table 1.5. Soil properties, Curry Co., Oregon, tested for criteria for Exchange Complex Dominated by Amorphous Material (ECDAM)

Horizon Desig.	Depth (cm)	Water Ret. (-1.5 MPa)	WR-clay ratio	Org C (%)	Bulk Density (Mg m-3)		CEC, 8.2 (cmol/kg clay)	ECDAM?
LINT or TEMPLETON								
Profile No. 32 -- Andic Humitropept, loamy, isomesic-------------------								
A	0 - 23	25.5	1.1	7.40	0.92	0.72	146.6	
AB	23 - 48	23.7	1.1	4.37	0.97	0.67	129.2	
BA	48 - 71	20.7	0.9	2.87	0.95	0.62		
Bw	71 - 99	19.0	0.7	0.89	1.09			
BC	99 -130	14.3	0.6	0.61				
LINT or TEMPLETON								
Profile No. 33 -- Andic Humitropept, loamy, isomesic-------------------								
A	0 - 23	22.2	1.0	8.75	0.93	0.80	153.6	
AB	23 - 36	14.9	0.7	3.70	0.88	0.80	132.5	
BA/A	36 - 69	14.4	0.7	2.55	0.81			
Bw	69 -119	12.4	0.6	0.86	1.01			
BC	119-137	12.2	0.6	0.86	1.12			
Profile No. 34 - Andeptic Haplohumult, fine-loamy, isomesic------------								
A	0 - 23	24.6	1.2	7.66	0.91	0.69	163.6	X
AB	23 - 38	21.9	1.1	5.20	0.90	0.83	143.5	
BA	38 - 56	23.0	0.8	2.81	0.95	0.69		
Bt1	56 - 71	25.4	0.7	1.49	0.89	0.69		
Bt2	71 - 94	23.9	0.9	1.47	0.49			
BC	94 -132	14.0	0.7	0.99				
C	132-152	8.8	0.7	0.7			105.8	
WOLFER								
Profile No. 35 - Andic Humitropept, loamy, isomesic--------------------								
A1	0 - 15	25.7	1.5	11.77	0.75	0.68	251.4	X
A2	15 - 38	20.9	1.0	5.55	0.66	0.90	170.0	
AB	38 - 66	17.8	0.9	4.59	0.64	0.81		
BA1	66 - 79	15.2	0.8	4.63	0.75	0.81		
BA2	79 -109	17.6	1.0	4.27	1.33			
Bw	109-125	12.0	0.6	2.14				
C	125-163	11.5	0.7	1.34				
BANDON-NELSCOTT?								
Profile No. 37 - Typic Troporthod, coarse-loamy, isomesic, ortstein-----								
A1	0 - 38	16.6	1.6	5.17	0.96	0.77	377.2	X
A2	38 - 64	12.3	1.0	4.02	0.91	0.77		
E/A	64 - 81	10.5	0.8	2.68				
2E	81 - 91	9.3	0.8	0.93				
2Bsm1	91 -117	8.9	3.2	0.89				
2Bsm1	117-142	6.3	2.2	0.74				
2Bsm2	142-160	3.1	3.4	0.29				
2Bsm3	160-178	2.9	7.2	0.06				

Table 1.5. (Continued)

Horizon Desig.	Depth (cm)	Water Ret. (-1.5 MPa)	WR-clay ratio	Org C (%)	Bulk Density (Mg m-3)	CEC, 8.2 (cmol/kg ECDAM? clay)
DEPOE?						
Profile No. 38 - Typic Tropaquod, fine-loamy/sandy, isomesic, ortstein--						
A1	0 - 10	18.1	0.9	10.82	1.01	196.4
A2	10 - 20	10.6	0.5	7.15	1.09	162.8
E	20 - 31	11.2	0.4	1.82	1.23	
E/B	31 - 43	19.6	0.6	1.28	1.15	
2Bsm1	43 - 69	14.3	1.6	0.19		119.7
2Bsm2	69 - 94	2.5	2.3	0.03		
2BC	94 -122	1.5	5.0	0.06		
JOENEY?						
Profile No. 41 - Typic Tropaquod, fine-silty, iosmesic, ortstein--------						
A	0 - 13	19.7	1.6	9.90	0.90	284.7
E	13 - 25	4.7	0.3	0.57		80.6
BE	25 - 37	11.2	0.5	1.85	1.09	
Bh	37 - 38	21.8	1.2	8.49		
2Bsm1	38 - 53	28.8	0.7	2.04		
2Bsm2	53 - 61	23.7	0.7	1.06		71.7
2C1	61 - 99	22.4	0.8	0.48	1.03	0.0
2C2	99 -142	22.6	0.7	0.29	1.01	
EDSON?						
Profile No. 42 - Typic Haplohumult, fine-loamy, isomesic----------------						
A	0 - 18	13.4	0.5	5.04	0.79	112.1
2BA	18 - 33	11.9	0.6	3.45	1.10	137.6
2Bt1	33 - 53	14.1	0.6	2.19	1.28	
2Bt2	53 - 84	15.3	0.4	0.81	1.49	
3Bt3	84 -112	12.4	0.4	0.38		
3Bt4	112-132	13.6	0.4	0.28	1.24	
3BC	132-160	10.0	0.3	0.16		25.7
ORFORD						
Profile No. 43 - Typic Haplohumult, clayey, isomesic--------------------						
EA	0 - 8	11.5	0.7	3.77		142.0
BE	8 - 20	11.7	0.4	1.85	1.18	74.7
Bt1	20 - 43	19.7	0.4	1.69	1.25	
Bt2	43 - 66	22.1	0.4	1.13	1.25	
BC	66 - 91	17.0	0.4	0.16	1.21	
2C1	91 -132	9.3	0.4	0.09		
2C2	132-160	9.5	0.4	0.13		40.5
JOENEY?						
Profile No. 44 - Typic Tropaquod, fine-silty, isomesic, ortstein--------						
A	0 - 15	4.5	0.4	2.99	1.47	194.5
E	15 - 43	3.7	0.4	0.47		99.8
Bhsm	43 - 58	19.1	***	7.86		
Bsm	58 - 74	20.8	***	3.1		
BC	74 - 91	22.4	0.9	0.91		
C1	91 -127	21.9	0.7	0.34		
C2	127-152	16.6	0.6	0.56		

Table 1.5a. Criteria for classification of Andepts (Soil Survey Staff, 1975)

Amorphous material dominant in the exchange complex (ECDAM):

1) CEC > 150 cmol (+) kg-1 clay
2) NaF pH value > 9.4, after 2 minutes
3) -1.5 MPa water content / %clay > 1.0
4) Organic C > 0.6 %
5) DTA shows low temperature endotherm
6) BD < 0.85 Mg m-3

Andepts:

are Inceptisols that have, to a depth of 35 cm or more, one or more of the following:

1) BD < 0.85 Mg m-3 and ECDAM; or

2) >60 %, by weight of soil is vitric volcanic ash, cinders, or other pyroclastic materials

Humitropepts, and have very similar morphological features, except that pedon 35 has a higher gravel content.

Spodosol Classification

Pedons 37, 38, 41, and 44 were classified as Spodosols, based on morphological features alone: they have eluvial horizons and cemented ortstein layers. The presence of an ortstein layer indicates a strongly developed spodic horizon (Nettleton et al. 1982).

Pedon 37 is a Typic Troporthod. It has a thick, dark surface layer that resembles the andic soils morphologically, but does not meet the criteria for andic soil properties within the 60 cm depth required to classify as an Andisol. It classifies as a Spodosol in current Soil Taxonomy because it has a spodic horizon within a depth of 2 m. This pedon represents a soil transitional between the Andisols or Humitropepts and the Aquods.

Pedons 38, 41, and 44 are Typic Tropaquods. All have a surface layer high in silt content, and an increase in sand content in their spodic horizons. The Spodosols on the higher level SD and G surfaces (41 and 44) have textures much finer than commonly found in Spodosols. While the A and E horizons of pedons 37 and 38 (on the P3 surface) average between 40 to 60 % silt and 10 to 30 % clay, their spodic horizons drop to 2 to 15 % silt and 0 to 10 % clay, and the C horizons have negligible amounts of either. This may be the result of cementation or poor dispersion of the spodic horizons. The A and E horizons of pedons 41 (G) and 44 (SD) average between 70 to 85% silt, and 8 to 15% clay; the spodic horizon of pedon 41 has

45 to 55% silt and 30 to 40 % clay. Particle size analysis was not determined on the spodic horizon of pedon 44, because it was so strongly cemented. The C horizons of pedons 41 and 44 average 45 to 65 % silt and 25 to 30 % clay. The finer particle sizes may be a result of in situ weathering of initially sandy deposits.

Some coastal soils in Oregon that meet requirements for Andisols have also been found to meet the chemical criteria for Spodosols (Badayos, 1983; Kimble and Nettleton, 1987). Analyses were done on all ten pedons of this study to determine if they meet chemical criteria for classification as Spodosols (Table 1.6). Only pedons 37 and 38 meet the chemical criteria, in the lower part of their spodic horizons. Pedons 41 and 44 (Typic Tropaquods) do not meet the $(Fe + Al)_p$/clay ratio or the $(Fe + Al)_p/(Fe + Al)_d$ ratio requirements. This may be due to their unusually high clay contents. Strongly developed spodic horizons do not necessarily meet the requirements of $(Fe + Al)_p/(Fe + Al)_d$ because they may have "a significant amount of free iron that moved as an organic-metal complex but is no longer in that form, perhaps because the organic ligands have been broken by biological activity. The solubility of such iron in pyrophosphate is relatively low compared to the solubility in dithionite-citrate. As a consequence, spodic horizons that have an appreciable accumulation of iron do not necessarily meet all the chemical tests. These tests are intended for the spodic horizons so weakly developed that positive identification in the field is impossible" (Soil Survey Staff, 1975). The andic soils, pedons 32, 33, and 35, do not meet the spodic chemical criteria, primarily on the $(Fe + Al)_p$/clay ratio.

Table 1.6. Spodic properties of the soils, Curry Co., Oregon

Horizon	Depth (cm)	%(Fe+Al)p / %clay	%(Fe+Al)p / %(Fe+Al)d	Index Accum.	Org C (%)	%Fed / %Org C	clay (%)
Profile 32 - Andic Humitropept							
A	0 - 23	0.09	0.62	502	7.40	0.28	22.7
AB	23 - 48	0.15	0.89	451	4.37	0.52	22.4
BA	48 - 71	0.09	0.57		2.87	0.77	23
Bw	71 - 99	0.06	0.47		0.89	2.29	27.5
BC	99 -130	0.03	0.22		0.61	3.90	22.8
2C	130-140						
Profile 33 - Andic Humitropept							
A	0 - 23	0.06	0.43	515	8.75	0.22	21.7
AB	23 - 36	0.06	0.33	232	3.70	0.62	22.1
BA/A	36 - 69	0.07	0.32		2.55	1.01	20.2
Bw	69 -119	0.04	0.29		0.86	1.99	22.2
BC	119-137	0.03	0.29		0.86	1.93	20.9
2C	137-152						
Profile 34 - Andeptic Haplohumult							
A	0 - 23	0.14	0.69	518	7.66	0.36	19.9
AB	23 - 38	0.12	0.54	287	5.20	0.62	20.2
BA	38 - 56	0.06	0.31		2.81	1.25	27.1
Bt1	56 - 71	0.03	0.16		1.49	3.29	36
Bt2	71 - 94	0.03	0.11		1.47	3.10	26.6
BC	94 -132	0.02	0.09		0.99	3.63	21.4
C	132-152	0.04	0.14	142	0.70	3.56	12.6
Profile 35 - Andic Humitropept							
A1	0 - 15	0.09	0.62	536	11.77	0.14	17.5
A2	15 - 38	0.10	0.55	550	5.55	0.39	20
AB	38 - 66	0.07	0.39		4.59	0.55	20.5
BA1	66 - 79	0.11	0.54		4.63	0.53	18.4
BA2	79 -109	0.08	0.40		4.27	0.54	18.1
Bw	109-125	0.06	0.37		2.14	0.96	19.3
C	125-163	0.05	0.28		1.34	1.49	16.4
Profile 37 - Typic Troporthod							
A1	0 - 38	0.16	0.64	1271	5.17	0.29	10.2
A2	38 - 64	0.12	0.47		4.02	0.41	12.1
E/A	64 - 81	0.09	0.42		2.68	0.57	12.6
2E	81 - 91	0.07	0.44		0.93	1.03	11.6
2Bsm1	91 -117	0.21	0.26		0.89	1.19	2.8
2Bsm1	117-142	0.19	0.37		0.74	0.86	2.9
2Bsm2	142-160	0.33	0.32		0.29	1.69	0.9
2Bsm3	160-178	0.85	0.58		0.06	4.39	0.4

Table 1.6. (Continued)

Horizon	Depth (cm)	%(Fe+Al)p / %clay	%(Fe+Al)p / %(Fe+Al)d	Index Accum.	Org C (%)	%Fed / %Org C	clay (%)
Profile 38 - Typic Tropaquod							
A1	0 - 10	0.01	2.04	288	10.82	-0.00	19.3
A2	10 - 20	0.02	2.72	221	7.15	-0.01	19.4
E	20 - 31	0.01	1.20		1.82	0.04	26.8
E/B	31 - 43	0.02	0.25		1.28	1.16	34.6
2Bsm1	43 - 69	0.04	0.11	154	0.19	14.26	8.7
2Bsm2	69 - 94	0.17	0.49		0.03	4.31	1.1
2BC	94 -122	0.41	1.38		0.06	0.47	0.3
2C	122-152	***	-1.14		0.06	-1.57	0
Profile 41 - Typic Tropaquod							
A	0 - 13	0.03	1.44	382	9.90	0.01	12.82
E	13 - 25	0.01	0.84	52	0.57	0.35	13.5
BE	25 - 37	0.04	0.57		1.85	0.62	23.8
Bh	37 - 38	0.12	0.66		8.49	0.11	18.3
2Bsm1	38 - 53	0.04	0.19		2.04	3.33	42.8
2Bsm2	53 - 61	0.05	0.18	54	1.06	6.06	32.3
2C1	61 - 99	0.02	0.24		0.48	3.94	29.1
2C2	99 -142	0.02	0.19		0.29	9.34	32.56
2C3	142-158	0.04	0.15		0.66	8.85	25.79
Profile 42 - Typic Haplohumult							
A	0 - 18	0.04	0.28	271	5.04	0.51	24.51
2BA	18 - 33	0.08	0.30	246	3.45	0.95	18.51
2Bt1	33 - 53	0.04	0.19		2.19	1.76	25.04
2Bt2	53 - 84	0.02	0.13		0.81	6.65	35.13
3Bt3	84 -112	0.02	0.06		0.38	18.30	33.61
3Bt4	112-132	0.01	0.03		0.28	21.11	38.79
3BC	132-160	0.01	0.02	-194	0.16	41.50	28.60
3Cr	160.0+	0.00	0.03		0.28	10.56	49.25
Profile 43 - Typic Haplohumult							
EA	0 - 8	0.03	0.47	122	3.77	0.27	17.46
BE	8 - 20	0.04	0.37	82	1.85	1.33	26.13
Bt1	20 - 43	0.03	0.23		1.69	2.66	47.17
Bt2	43 - 66	0.02	0.17		1.13	4.16	50.36
BC	66 - 91	0.01	0.04		0.16	32.56	41.04
2C1	91 -132	0.01	0.03		0.09	40.00	24.42
2C2	132-160	0.01	0.04	-59	0.13	26.54	22.30
Profile 44 - Typic Tropaquod							
A	0 - 15	0.01	1.00	241	2.99	0.02	10.97
E	15 - 43	0.01	0.51	120	0.47	0.45	8.63
Bhsm	43 - 58	***	0.79		7.86	0.06	***
Bsm	58 - 74	***	0.15	472	3.10	1.26	***
BC	74 - 91	0.03	0.12		0.91	4.62	25.48
C1	91 -127	0.02	0.17		0.34	8.50	29.47
C2	127-152	0.02	0.10		0.56	6.50	27.96

Discussion

Soils with andic properties (Andepts or Andisols) are found in the study area only on the lower terrace levels, and in close proximity to the coast line. A loess cap covers all of the terraces, extending inland, and exhibits andic properties strongly expressed only in the soils close to the coast. Loess materials further inland have probably been deposited earlier, and possibly from different source materials than that close to the coast. Possibly a difference in mineralogy or weathering intensity is responsible for the occurrence of the andic soils.

Spodosols occur on the intermediate and higher terraces, generally further inland than the andic soils, and generally in depressional or flat landscape positions with limited drainage. Shore pine predominates in these areas rather than the Sitka spruce found on andic soils. Gardner and Bradshaw (1954) found similar landscape-soil relationships in Mendocino County, California . They suggested the possibility that, with the gradual erosion of the coast line and its movement eastward, both the Prairie-like soils [probably andic soils] and the podzolic soils, in that order, have shifted inland. They described a soil very similar to pedon 37 in this study; a Prairie-like soil with characteristics in part of the subsoil, including weak cementation, similar to the Noyo soil, a podzol.

The intermediate, Pioneer 3 terrace, has soils that classify as Inceptisols, Spodosols, and Ultisols. Since it appears that the delineation represents one geomorphic surface, all of these soils apparently have formed during the same time period, and, if so, other factors must have influenced their formation. They are spatially separated: the Andic Humitropepts are adjacent to the present coastline, between the Elk River and Sullivan Gulch; the Andeptic Haplohumults, with andic surfaces, are to the East, along Cape Blanco Rd.; and the Spodosols are between Sullivan Gulch and the Cape itself, and north of the Sixes River -- the Orthods with andic surfaces being adjacent to the coast, and the Aquods being further inland. Although not apparent, these three areas could actually be different surfaces, representing different time spans. Or, the differences in soil expression may be a result of different parent material. All of the sites are underlain by unconsolidated marine sediments. Differences in initial particle size, source, and/or mineralogy of the sediments in the various locations may account for some of the differences. Variations of particle size and possibly mineralogy on individual terraces may be a result of sorting by wave action during deposition. Particle size of the C horizons is coarser on the lowest terraces, and becomes progressively finer on the higher terraces, presumably a result of in situ weathering.

Ultisols and Spodosols with very similar morphology, but finer textures, occur on the higher Seven Devils and Griggs surfaces. The Ultisols occur in more rolling landscapes that are well-drained, while the Spodosols occur on flat or depressional landscape positions. This relationship also occurs on the P3 surface, with Spodosols in depressional landscape positions, and Ultisols, or Humitropepts, in better-drained areas.

Some soils in the study area are similar in morphological features to soils classified as Andepts or Andisols in more northern areas of Oregon, although these features (thickness and darkness of surface layer, low bulk density, smeary consistence) are not as strongly expressed in the soils of this study. Chemical features are also borderline for meeting the criteria for andic properties.

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CHAPTER 2

SOILS IN RELATION TO GEOMORPHIC SURFACES ON COASTAL TERRACES OF SOUTHWESTERN OREGON.

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Abstract

The marine terraces along the coast of southwestern Oregon represent different stages of sea-level highstand, and provide a record of the rate of tectonic uplift. Soils on the terraces have been developing for different lengths of time, and show variations of morphological and chemical characteristics. Analysis of the soil characteristics by terrace level was performed to determine time-dependent changes in soil features, and evaluate relative ages of the surfaces. Ten pedons from five terraces of Holocene to early Pleistocene age were sampled. Dithionite-citrate and acid oxalate extracts of iron and aluminum, particle size, organic carbon, and pH were determined for each profile and compared between terraces. The lower two surfaces show minimal soil profile development and little variation between surfaces. The upper three surfaces show more profile development, and more differentiation between surfaces of dithionite-citrate and oxalate extracts of iron, and clay content. A layer of silt-rich loess covers all of the terraces to a thickness of approximately 40 cm. Soil types can be related to the different surfaces, and interrelationships will aid in soil mapping of the area.

CHAPTER 2: SOILS IN RELATION TO GEOMORPHIC SURFACES ON COASTAL TERRACES OF SOUTHWESTERN OREGON

Introduction

Marine terraces are geologically significant because they are directly related to sea level, and provide a record of the vertical relationship of land to sea (Palmer, 1967). Each terrace level represents a different level of sea level high stand, and thus a different age for each geomorphic surface.

Marine and fluvial terraces have been used for soil chronosequence studies to show variations of soil features over time, contributing to knowledge of soil forming processes. It is assumed that soils begin to form after the waters of the river or ocean recede and expose the surface to the elements generally considered responsible for soil formation (non-aquatic). The major soil forming factors are: parent material, topography, time, climate, and vegetation (Jenny, 1941). Subcategories of these factors include the actual features responsible for the development of different soil types. Parent material includes the mineralogy as well as particle size and discontinuities of the source material. Topography includes slope, aspect, and landscape position of the surface on which the soils form. Time refers to the number of years a surface is exposed to weathering in an undisturbed setting. Climate includes primarily moisture and temperature factors of the specific soil site as well as the region, and must include not only current climate, but the climate over the history of the formation of the soil. Vegetation actually includes all of the biological influences and interactions with the soil; the plants, animals, and microorganisms living within the soil, past and present. All of these factors interact and affect the physical, chemical and biological features of the resulting soil.

In a chronosequence, all factors are constant except for time. A study of 14 marine terraces on San Clemente Island, California, ranging in age from 60,000 to more than one million years, showed that solum thickness, profile clay, salts, smectite/mica ratios in clay, and quartz/plagioclase ratios in silt, increase linearly with age of surface (Muhs, 1982). A chronosequence of two flights of marine terraces in northern California ranging in age from 1700 to over 320,000 years showed significant changes in soil properties with time (Merritts, 1987). Soil profile development has been used as a relative dating tool in geomorphology studies (Burke et al. 1986).

A flight of marine terraces at Cape Blanco was chosen for this study of soil-geomorphic relationships. The objectives of the study are to:

1) Relate soils to geomorphic surfaces to enhance soil mapping in Curry County and surrounding areas.

2) Use soil chemical and morphological data to determine the degree that higher terraces show soil characteristics indicative of progressively greater age than lower terraces. This information should help to resolve controversy of dates and correlation of terraces regionally, and may contribute to ongoing geological investigations being conducted in the area.

Soils have been related to geomorphic surfaces in many parts of the United States in order to facilitate soil mapping and soil genesis studies. In the Willamette Valley of Oregon, seven surfaces ranging in age from recent to middle Pleistocene or older, have been mapped and related to soils developed on them (Parsons et al. 1970). Nettleton et al.(1982) delineated four geomorphic surfaces along the southwest Oregon coast and related the occurrence of Spodosols to the individual surfaces as follows:

Tenmile - (7 - 15 m elevation) Aquic Haplorthods
Whiskey Run - (30 m elevation) Entic and Typic Haplorthods
Pioneer - (60 m elevation) Orthods and Aquods with ortstein
Seven Devils - (120 m elevation) Orthods and Aquods with ortstein

Gardner and Bradshaw (1954), Jenny et al.(1969), and Nettleton et al.(1982) have reported that ortstein occurs only in Spodosols on the Pleistocene Pioneer and Seven Devils terraces.

Problems arise with regional correlation of the terraces, particularly in areas of tectonic activity and differential uplift rates. Correlation using elevation primarily is not valid in areas where faulting, folding, and warping of surfaces has taken place. Palmer mapped coastal terraces from northern Washington through southern California, and found that terraces could be traced fairly continuously from Washington through central Oregon (Palmer, 1967). However, from southern Oregon through northern California, tectonic activity has deformed coastal terraces. Much confusion and controversy surrounds the dating, naming, and correlation of terraces in the Cape Blanco area. Table 2.1 outlines some of the references in the literature that are in conflict.

Table 2.1 Comparison of named terraces and dates

Location	Terrace	Elev., m	Date, ka	Method	Source
Bandon	Whiskey Run		72 +/- 5.3	Th/U, solitary corals	(Kennedy, et al, 1982)
Bandon	Whiskey run	15 - 20	83	est. from sea level high stand	(Adams, 1984; from Petersen, 1987)
	Pioneer	40 - 50	103		
	Seven Devils	> 75	124		
Cape Blanco	First marine	60	35	radiocarbon & U/Th	(Janda, 1969)
	2nd marine				
	3rd marine				
	4th marine				
7.5 mi. S. of Cape Blanco	First marine		>45	radiocarbon, wood & cones	(Janda, 1969)
Cape Blanco	Whiskey Run	121	82	est. from radiometric & amino acid dates, with map interpretation	(West & McCrumb, 1988)
Port Orford-Cape Blanco	Pioneer				(Janda, 1970)
	Silver Butte				
	Indian Creek				
	Poverty Ridge				
Curry Co.	Low Marine (Whiskey Run)	9			(Reckendorf, 1987)
	Mid Marine (Pioneer One)	25			
	Mid Marine (Pioneer Two)	40			
	Mid Marine (Pioneer 3)	60			
	High Marine (Seven Devils)	200			
	V.High Marine (Griggs)	250			
Cape Arago	Whiskey Run	15 - 30			(Griggs, 1945)
	Pioneer	38 - 76			
	Seven Devils	84 - 114			
Whiskey Run	Whiskey Run (=Cape Blanco at 60 m)	0 - 225	33.7 +/- 31	C14	(Baldwin, 1981)

Study Area

An area near Cape Blanco, in Southwestern Oregon, was chosen as the research site because of the extensive coastal marine terraces, and the eroded coastal bluffs that expose the underlying sediments. The area represents approximately 50 km^2, between Floras Lake and Port Orford, centered at Cape Blanco, and includes confluences of the Elk and Sixes Rivers with the Pacific Ocean (Figure 1).

The coastal plain in this area consists of a series of marine terraces ranging from 6 to 240 m above sea level. Five terraces have been outlined for study (Figure 2). Griggs (1945) identified and named three terraces near Cape Arago: the Whiskey Run, the Pioneer, and the Seven Devils. The surfaces in this study were tentatively named with this system, but are not meant to indicate exact correlation. Reckendorf (1987) outlined surfaces in Curry County on which soils were sampled for this study.

The series of terraces represent wave-cut platforms of Pleistocene age, (Baldwin, 1981) capped with unconsolidated beach and offshore deposits (Beaulieu, 1976). The wave-cut platform truncates folded Tertiary and pre-Tertiary sediments and igneous rock (Baldwin, 1945). The terraces were formed by varying sea level high stands, and in this area appear to be also a result of tectonic uplift (Palmer, 1967).

Absolute dating of the terraces is not available for all terraces, and some dates that are available are not consistent (Table 2.1). Estimated dates from terrace altitudinal spacing and correlation with glacio-eustatic sea-level highstands (methodology of Bull, 1985, and Bull and Cooper, 1986) were made for terraces near Bandon, Oregon. Adams (Adams, 1984) assigned the Whiskey Run an age of 83,000 years, the Pioneer, 103,000, and the Seven Devils, 124,000 years. These terraces should correlate reasonably well to the terraces in this study of the same names, with the exception of the Whiskey Run. The Whiskey Run terrace outlined in this area appears to be much younger, and is probably fluvial.

The study area is within the coastal fog belt, with a temperate, marine climate influenced by proximity to the Pacific Ocean, and characterized by frequent fogs. The soil moisture regime is udic, with 1948 mm (76.7 inches) average annual rainfall, at Cape Blanco, (NCC, 1983) and a short dry period during the summer. Mean annual air temperature is 10.2° C. at Cape Blanco (NCC, 1983) with less than 5° C. difference between mean annual summer and mean annual winter soil temperatures; an isomesic soil temperature regime.

Natural vegetation adjacent to the coastline is a coniferous forest of Sitka spruce (*Picea sitchensis*), Port Orford cedar (*Chamaecyparis lawsoniana*), or shore pine (*Pinus contorta*), with a thick understory of salal (*Gaultheria shallon*), evergreen huckleberry (*Vaccinium ovatum*), brackenfern (*Pteridium aquilinum*), and rhododendron (*Rhododendron macrophyllum*). On the higher terraces, further inland, western hemlock (*Tsuga heterophylla*) and Douglas fir

(*Pseudotsuga* *Carr.*) are more predominant (Randall, 1985; Wiedmann, 1974). Much of the area that is well-drained has been cleared and is used for pasture, while the Spodosols with a cemented ortstein horizon that perches water are commonly used for cranberry bogs or timber production.

Methods

Sampling

The geomorphic surfaces (terrace levels) were outlined in the field by observing the number of terrace levels from the floodplain of the Elk and Sixes Rivers, elevation changes, and continuity of surface (Reckendorf, 1987). They are tentatively named as follows:

WR - (6 m elevation) Whiskey Run
P1 - (24 m elevation) Pioneer 1
P2 - (35 m elevation) Pioneer 2 (not sampled)
P3 - (50 to 65 m elevation) Pioneer 3
SD - (95 to 125 m elevation) Seven Devils
G - (170 to 235 m elevation) Griggs

Soils of the study area were examined initially with auger borings, and from roadcuts and eroded cliffs. Pedon descriptions were made at 45 sites. Ten pedons were chosen from these, based on characteristics observed in the field, to represent the soils observed, and to compare soil development across the terraces (Figure 2). Each site was excavated to a depth of at least 150 cm, if possible, and described according to standard soil survey techniques (Soil Conservation Service, 1981). Each horizon was then sampled for laboratory analysis. Soil morphological features are shown in abbreviated form in Table 1.3. Suggested correlation with known soil series is indicated.

Analysis

Soil samples were air-dried, hand-crushed, and passed through a 2mm sieve. The coarse fragments were removed and their mass recorded. Bulk density and cation exchange capacity were determined only on selected horizons.

Particle size analysis was performed by first sieving and weighing the coarse fragments. Forty grams of the < 2mm fraction was treated with H_2O_2 to remove organic matter. Ten grams of the oven-dried sample was then dispersed with sodium hexametaphosphate and shaken for 16 hours on a horizontal reciprocating shaker. Sand, silt, and clay were determined using using the pipette method (methods 3A1, SCS, 1984).

Bulk density measurements were made on samples taken with a drop-hammer core sampler at field moisture (Blake & Hartge, 1986). Samples were taken horizontally into the face of the soil pit, in the surface layers of the soils. During the following summer, in June 1988, an attempt was made to take bulk density measurements for all the pedons, using aluminum rings pushed into the face of the soil pit. The soils were not as dry as they were during the original sampling. However, all horizons could not be sampled due to compaction or cementation of the horizon.

Chemical analyses were done on the < 2mm fraction, on an ovendry weight basis. Aluminum (Al_o), iron (Fe_o), and silica (Si_o) were extracted with acid oxalate (Blakemore et al., 1977) and with sodium pyrophosphate (Al_p, Fe_p, and Si_p) at pH 10 (Methods 6C8 & 6C8a, in

SCS, 1984) and analyzed by atomic absorption. Aluminum and iron (Al_d, Fe_d) were extracted with sodium dithionite-citrate (Method 6C2, in SCS, 1984) and analyzed by atomic absorption. Aluminum was extracted with 1 N KCl and analyzed by AAS (Barnishel and Bertsch, 1982). Soil pH was determined with a combination glass electrode. Organic matter content (later converted to Organic Carbon content) was determined using the Walkley-Black wet oxidation method (Nelson and Sommers, 1975). Cation exchange capacity is by sum of the cations at pH 8.2 with exchangeable bases added to extractable acidity (methods 5A3a & 6H4, in SCS, 1984). Tables of the complete physical and chemical data are in Appendix B.

Results and Discussion

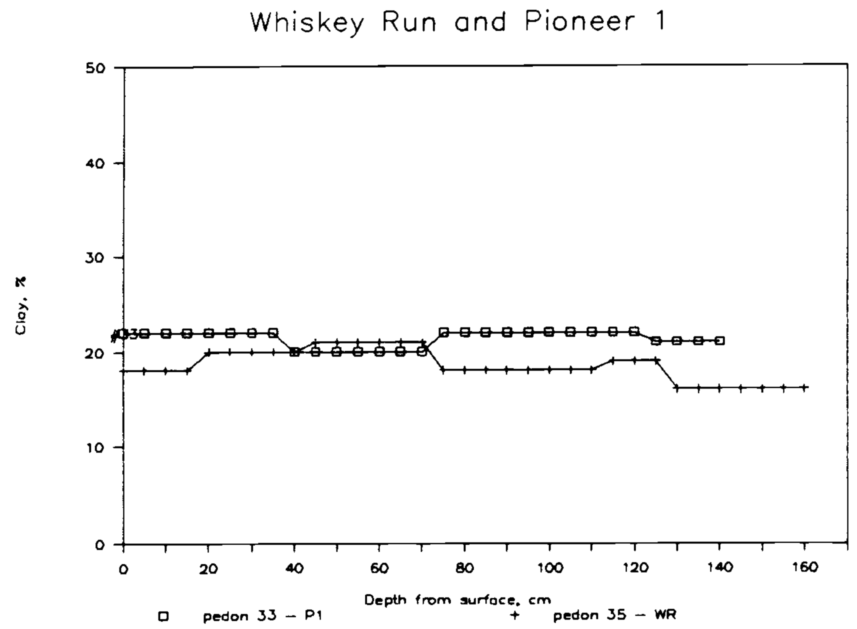
Variations with depth

Clay translocation from the A horizon to the B horizon is a pedological process that requires a considerable amount of time to be measurable. Young soils generally show little variation in clay content with depth, unless stratified, while older soils in a humid environment show a distinct vertical differentiation of clay ("clay bulge"). The clay fractions for soils on the P1 and WR surfaces show almost no variation with depth (Figure 2.1). Soils on the P3 surface show clay accumulation in the B horizon, but pedon 32 shows little variation, similar to soils of the lower terraces. Soils of the Seven Devils and Griggs surfaces show higher clay contents overall, and increasing degrees of clay accumulation with depth. This indicates a progression in accumulation of translocated clay. The soils of the higher terraces may have originated from parent material of finer particle size, and experienced some in situ clay weathering, but the degree of clay movement within the profiles is considerably greater on the higher terraces.

Plots were made of the silt and fine sand fractions on a clay-free basis vs. depth, (not reproduced here). They indicate a lithologic discontinuity in parent material for nearly every one of the profiles at a depth of 40 to 90 cm. A silty surface layer is present in each of the profiles, thicker in those profiles closest to the coast, and is probably of eolian origin. A similar mantle has been observed in other areas along the coast of Oregon. The continental shelf and slope off the coast of Cape Blanco are 65 km wide and are characterized by submarine valleys, and benches or terraces (Byrne, 1962). This continental shelf, which was exposed during the lowering of sea level during glaciation is a possible source of loess material, carried by westerly winds (Patching, 1984). If this were the case, one would anticipate a downwind particle size decrease away from the loess source, the coastline. Figure 2.2 shows a decrease in percent fine sand and coarser, and an increase in silt content of the surface layers (to a depth of 40 cm) with distance from the coastline. A straight line correlation between silt and distance from source yields a correlation coefficient of $r = .794$; between fine sand & coarser material and distance, $r = -.78$. Pedon 42 was not included; it appears to be beyond the distance of major loess influence.

Organic carbon generally accumulates in the A horizon of a soil quite rapidly, then with time reaches a state where accumulation is equal to decomposition, and organic carbon content and distribution with depth remain constant, or decrease slightly over time (Birkeland, 1984). The soils of the WR and P1 surfaces have the highest organic carbon content of all the soils in the surface layer, but it decreases rapidly with depth (Figure 2.3). P3 soils show organic carbon distributed more gradually and deeper into the profile. The SD and G surfaces have lower organic carbon contents in the surface layers, but each of the spodic soils show a large accumulation of organic carbon in their Bh horizons.

Several studies have shown that extracts of Fe and Al


Whiskey Run and Pioneer 1

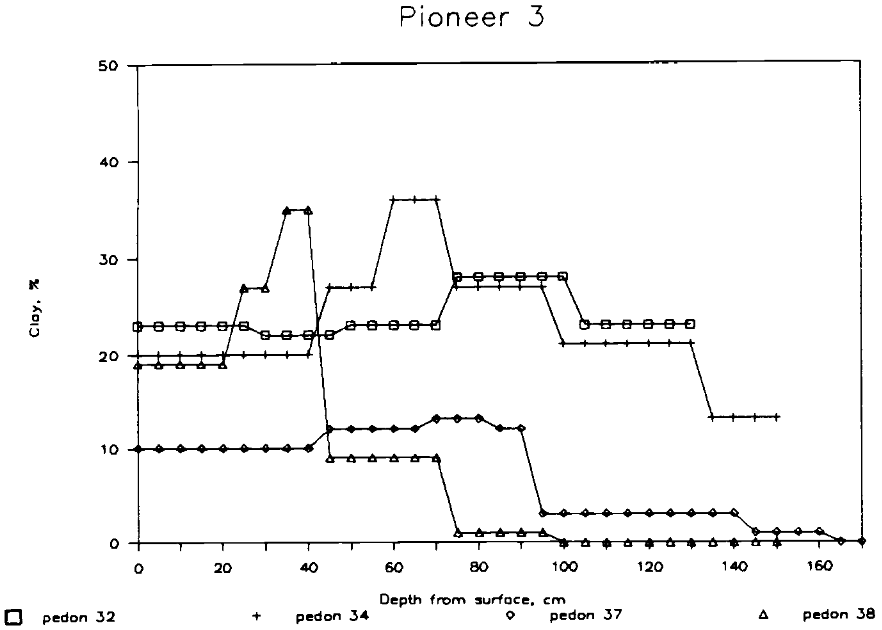
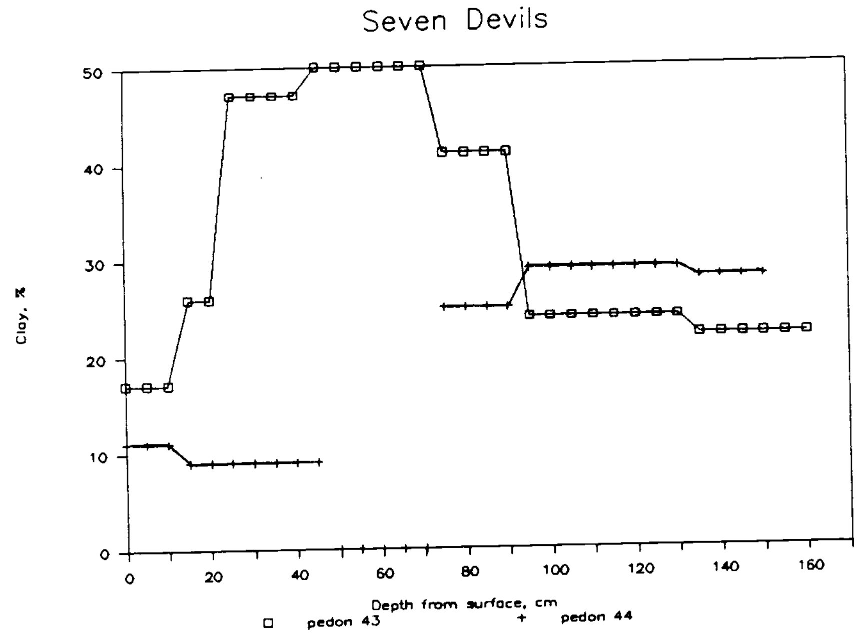

Pioneer 3

Figure 2.1. Clay content vs. soil depth



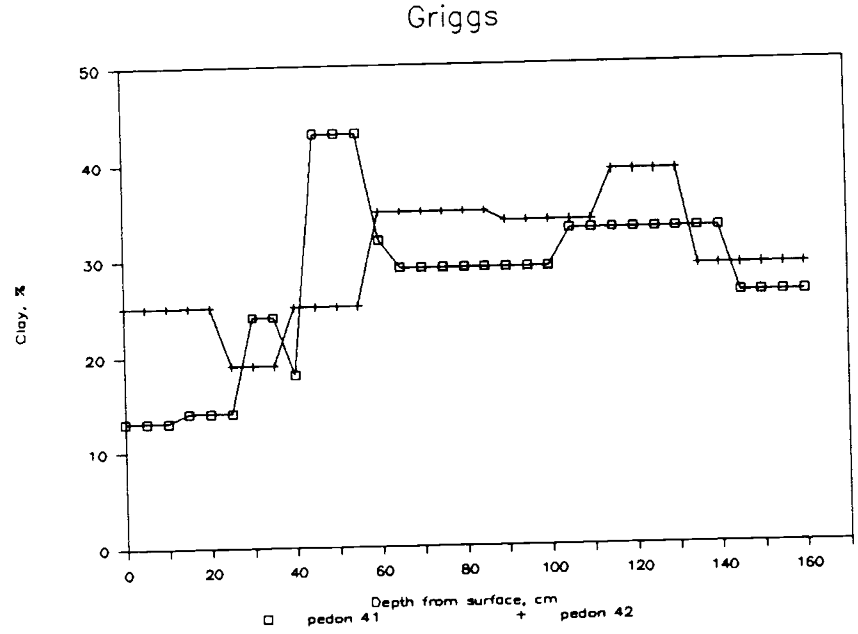


Figure 2.1. (Continued)

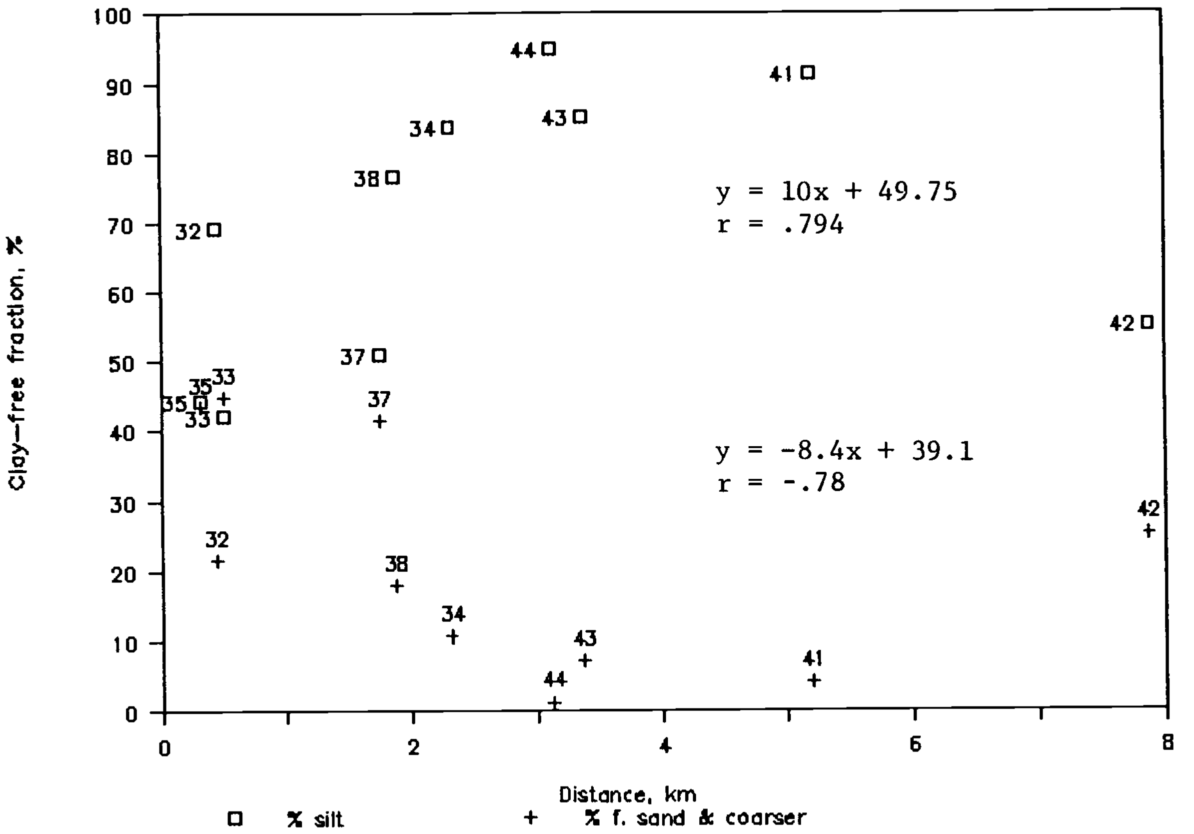
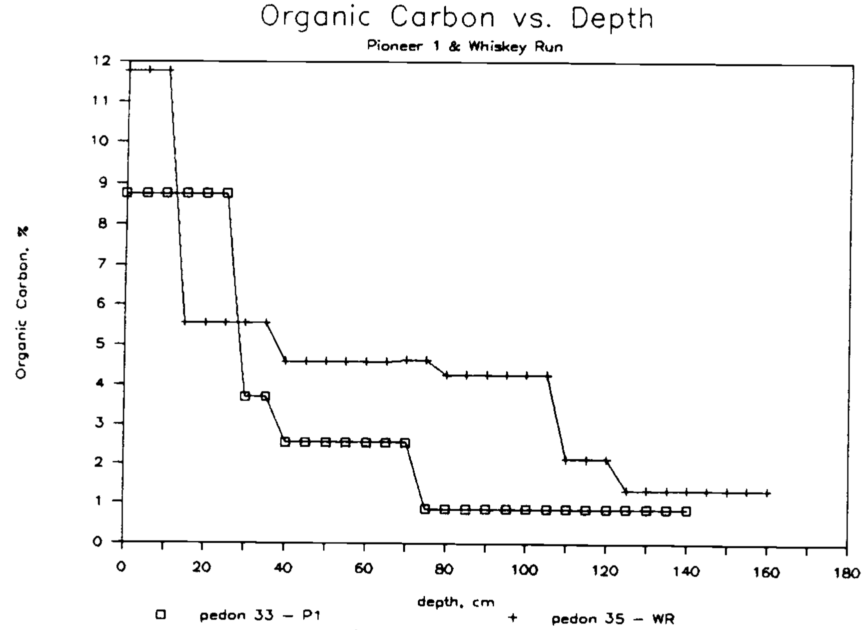


Figure 2.2. Silt, and fine sand & coarser *vs.* distance from loess source



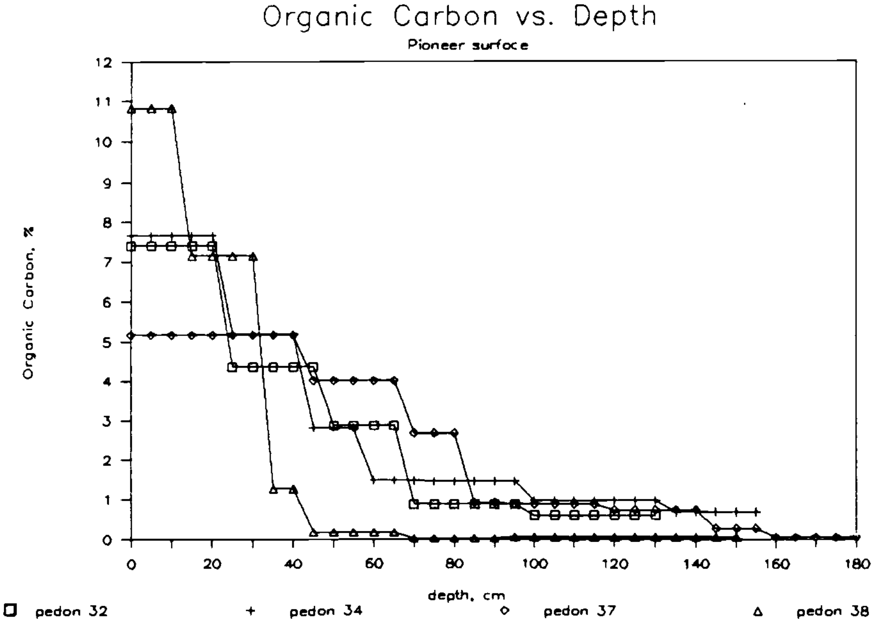
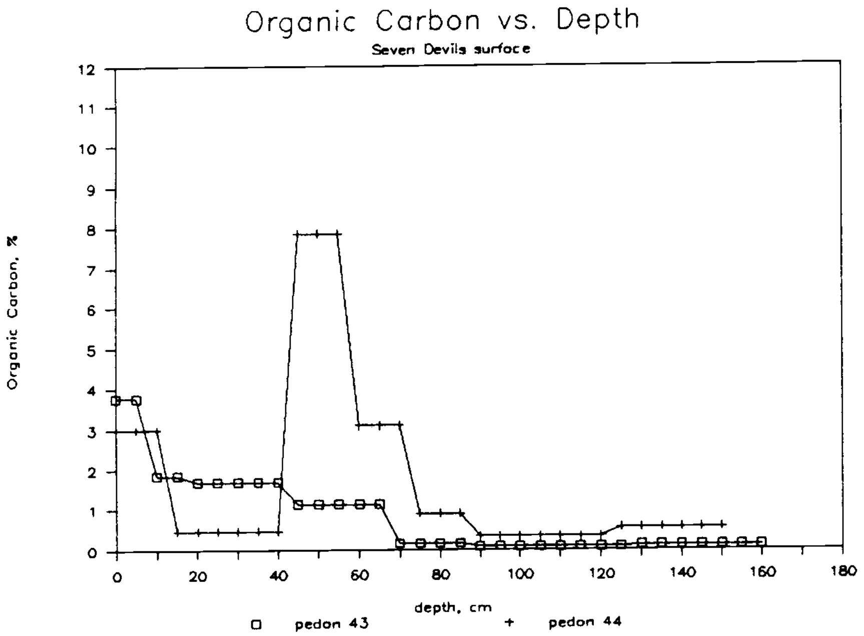


Figure 2.3. Organic carbon vs. soil depth



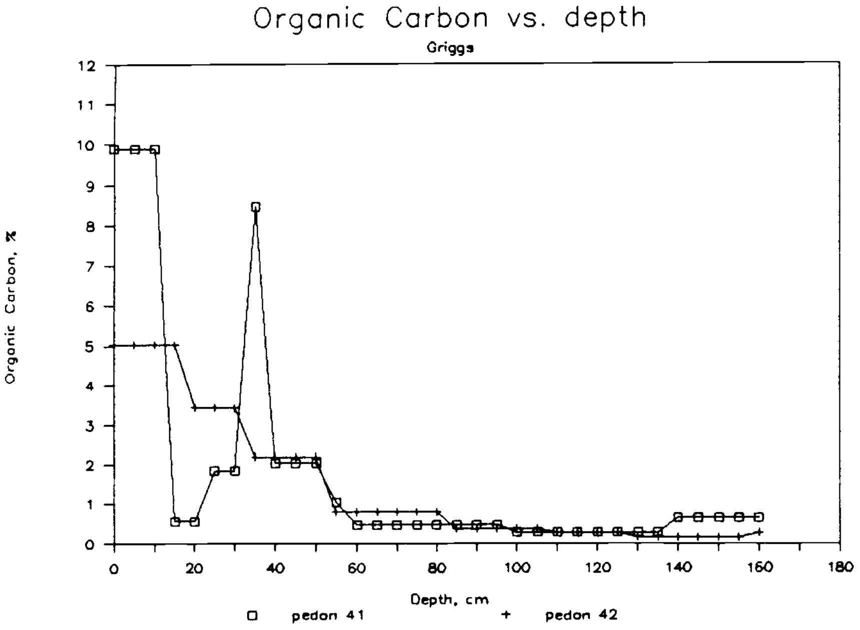


Figure 2.3. (Continued)

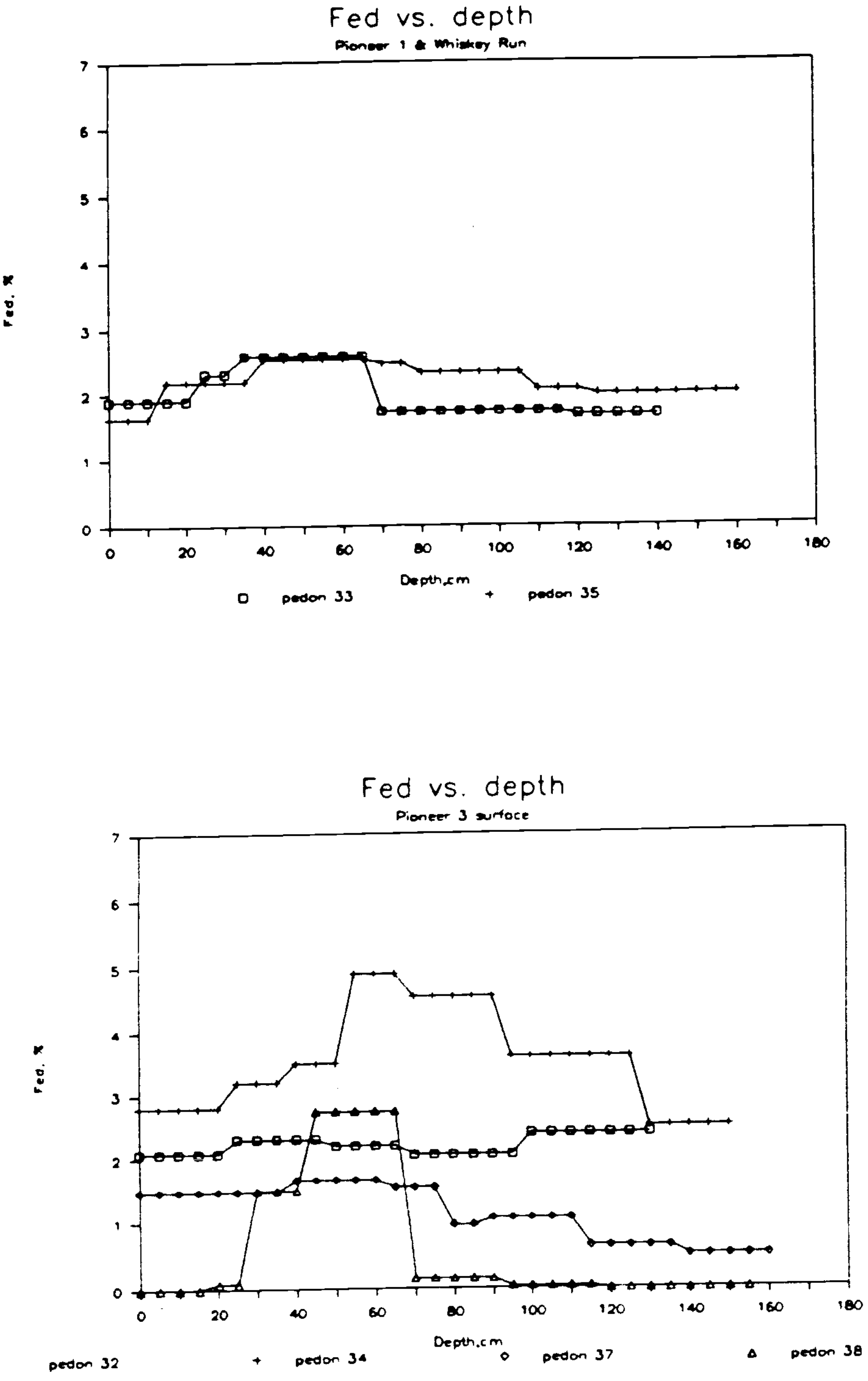
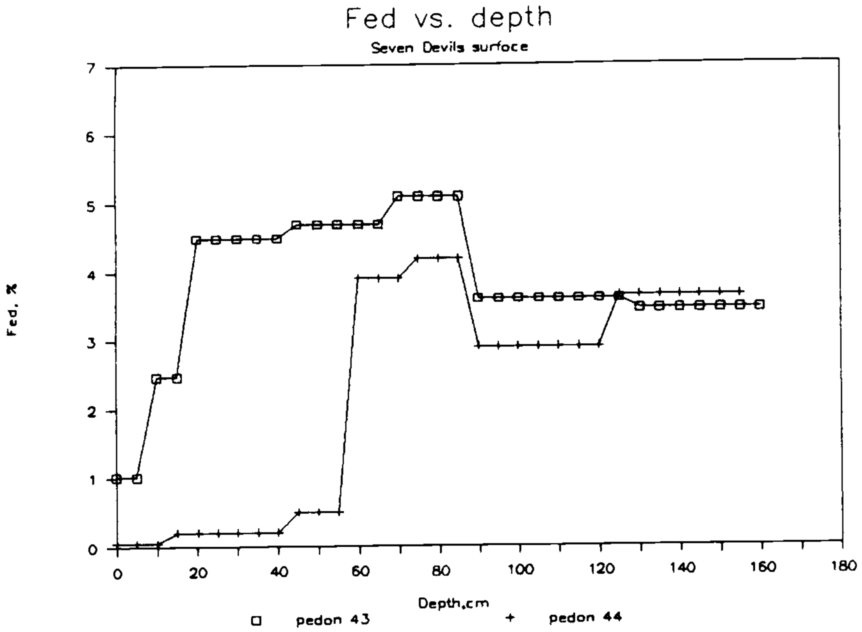


Figure 2.4. Dithionite extractable iron (Fe_d) vs. soil depth



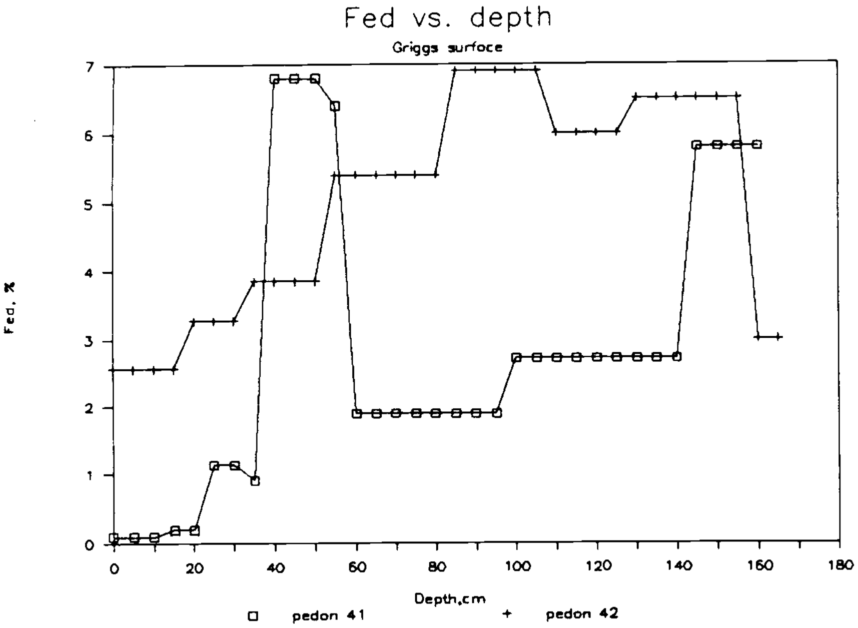


Figure 2.4. (Continued)

oxyhydroxides can be reliably related to soil age (McFadden & Hendricks, 1985; Arduino et al., 1984). Merritts (1987) found that iron extracted with dithionite-citrate (Fe_d) increased linearly with time across several sequences of terraces in California. She and other workers have found inconsistent trends with oxalate extracted iron (Fe_o), so in this study, only Fe_d is plotted with depth and compared. A clear progression of accumulation with depth is seen from the lower terraces to the higher terraces (Figure 2.4). As with clay, pedon 32 is more similar in pattern of Fe_d accumulation with depth to the P1 and WR surfaces than with the other soils on P3. The Spodosols on the P3, SD, and G terraces have lower amounts of Fe_d, but the progressive increase is shown by the more freely drained soils.

Variations with time

Profile weight of clay, summed to a depth of 130 cm and compared across the surfaces, shows a distinctive stair-step differentiation between the geomorphic surfaces (Figure 2.5). The Spodosols have consistently lower amounts of clay, but all the profiles reflect the trend of older, higher elevation terraces having greater cumulative profile weight of clay.

Free iron oxide, expressed as total profile weight of Fe_d, also shows a significant increase from lower to higher surfaces (Figure 2.6). The andic soils (pedons 32, 33, 35) all have nearly the same levels of Fe_d. The Spodosols show a distinctly smaller amount of accumulation of Fe_d than the Ultisols.

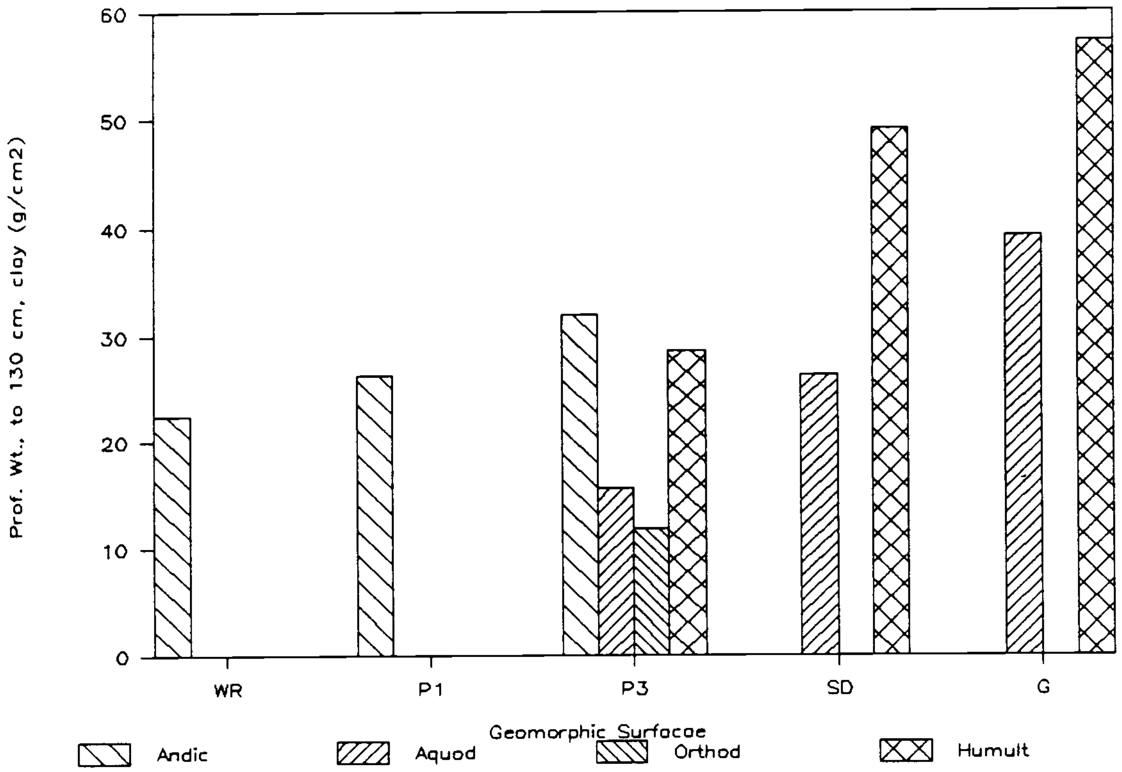


Figure 2.5. Clay, profile weight vs. geomorphic surface

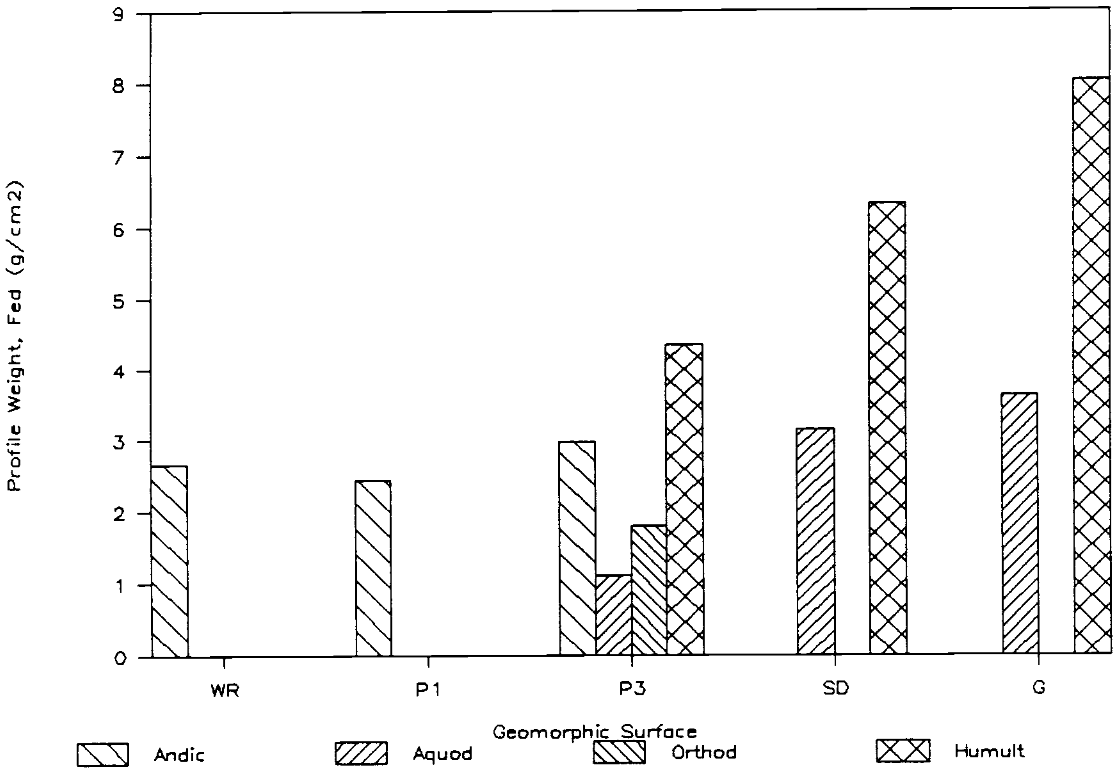


Figure 2.6. Dithionite extractable iron (Fe_d), profile weight summed to 130 cm, vs. geomorphic surface

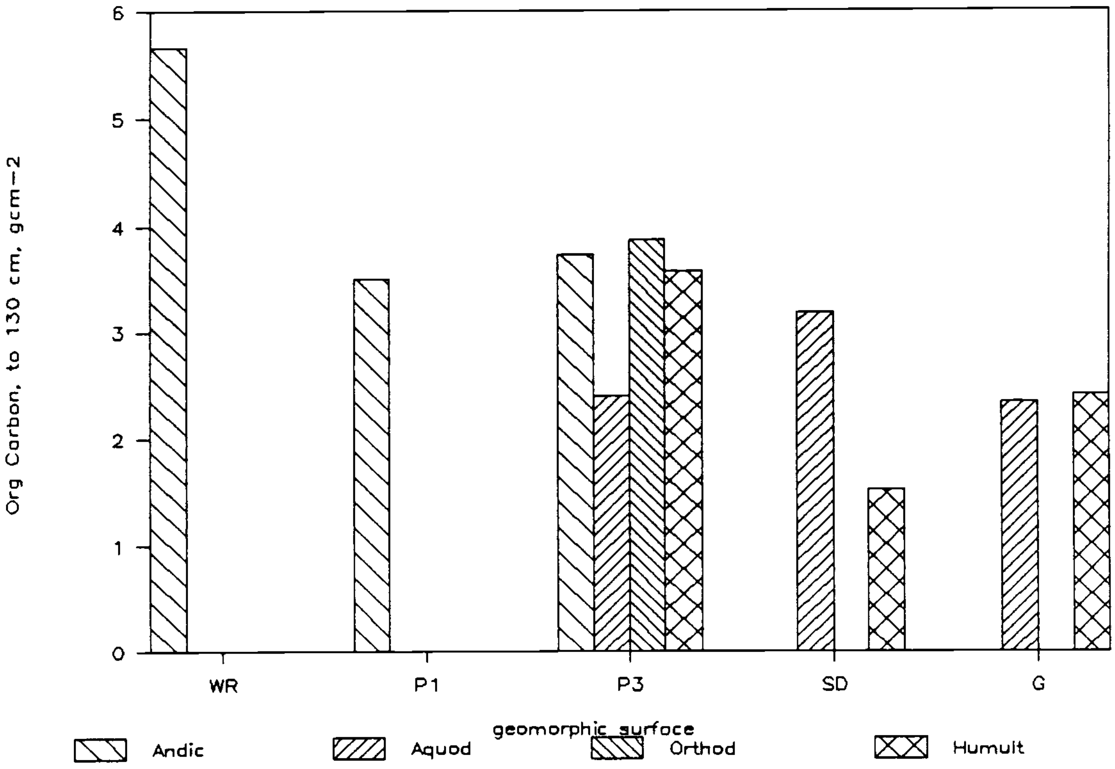


Figure 2.7. Organic carbon, profile weight, summed to 130 cm, vs. geomorphic surface

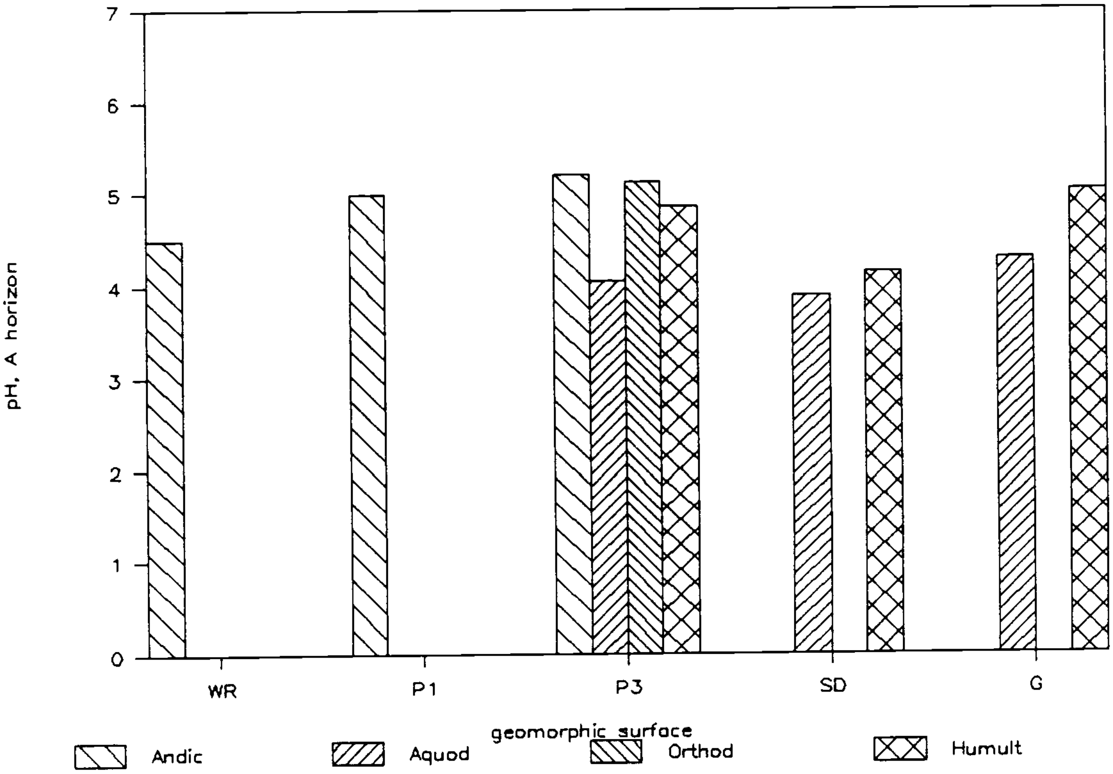


Figure 2.8. Soil pH, A horizon vs. geomorphic surface

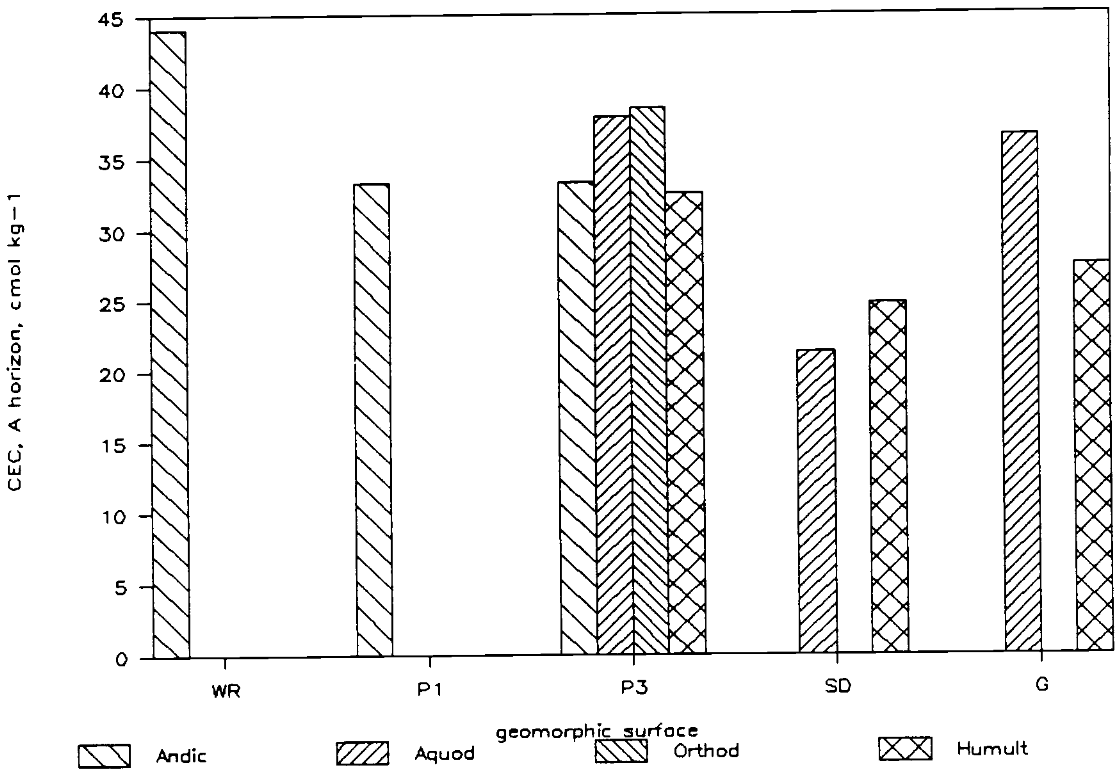


Figure 2.9. Cation exchange capacity (CEC), A horizon
_vs_. geomorphic surface

Organic carbon (Figure 2.7) shows a decrease in total profile accumulation with increasing age of surface, in part a reflection of Al-humus stability in the andic soils (Baham and Simonson, 1985). Soil pH showed no consistent trends with time, perhaps because some of the sites had been limed (Figure 2.8). Cation exchange capacity shows an overall decline with age of surface. The SD surface showed the lowest cation exchange capacities (Figure 2.9).

Morphological features of the profiles exhibit differences in amount of soil development with time (Table 1.3). Andic Humitropepts, with cambic horizons and development of thick A horizons, were found on the younger surfaces (WR, P1, and P3). Aquods, Orthods, and Humults occur on the intermediate (P3) surface. The spodic horizons of both the Aquods and the Orthods have ortstein indicating strongly developed spodic horizons. The Humults on P3 have weakly developed argillic horizons. Soils on the higher terraces (SD, G) are finer textured, and the Aquods show even more strongly expressed spodic horizons than those on P3. The Humults have moderately expressed argillic horizons that are redder in hue than those in the Humults on the P3 surface.

The time required to form each of these soil types varies. Inceptisols may form in slightly less than 1,000 years. While the podzolization process is rapid, it generally takes several thousand years to develop a spodic horizon enough to classify as a Spodosol. Argillic horizons in Ultisols may require 10,000 years or more to form (Birkeland, 1984). Spodosols with ortstein may take much longer to form, and will persist with little change (Jenny, 1969).

The andic soils near the Elk River (pedons 32, 33, and 35) on surfaces delineated as WR, P1, P2, and P3 have less differentiation in profile morphology, clay content, and free iron than the soils on the higher surfaces. This indicates that these soils may be much younger, and are probably on fluvial terraces. Pedon 32, on the intermediate P3 surface at similar elevations with Ultisols and Spodosols, has features more like the younger pedons 33 and 35. The andic soils do not seem to express changes with time, possibly because of stable metal-organic compounds, and the influence of proximity to the coast on climate and vegetation. We do not know how long they persist, or exactly which factors will change their stability.

Without absolute dates of the terraces at Cape Blanco, true quantitative comparisons of soil properties with soil age cannot be done. However, using Adams' (1984) estimated ages of terraces that were done at Cape Arago, and general estimates for the other terrace levels at Cape Blanco, a fairly linear relationship between age of surface and free iron oxide (Fe_d) content is seen (Figure 2.10). The well-drained soils, the Haplohumults and Humitropepts, exhibit a distinct increase of Fe_d content with time. The Aquods and Orthods, with their cemented ortstein layers that perch water, show only a slight increase with time. This may be a result of lateral movement of reduced iron out of the profiles.

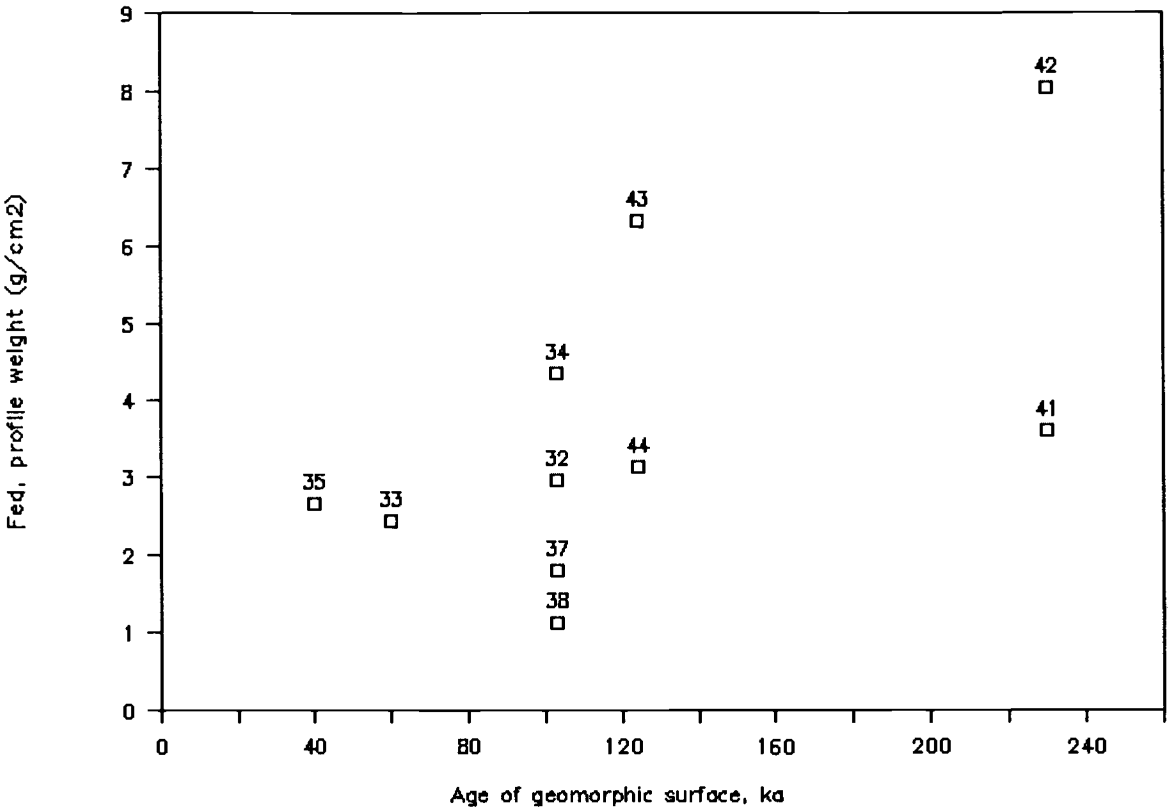


Figure 2.10. Dithionite extractable iron (Fe_d) vs. age of geomorphic surface (est, Adams, 1984)

Conclusions

In general, soil profile development, clay content, and dithionite-citrate extractable iron increase with age of the higher surfaces, and indicate progressively higher ages of the terraces from the WR to the G surfaces.

Soil types can be related to distinct landscape positions and terraces. Andepts or Andisols occur on the lower fluvial terraces (WR, P1, P2) and on the intermediate terrace in close proximity to the coast. The intermediate (P3) surface has well developed Spodosols with a cemented ortstein layer and Andeptic Haplohumults. At approximately 60 m elevation, it probably correlates to Griggs' (1945) Pioneer surface, based on the amount of soil profile development and the occurrence of Spodosols with ortstein (Nettleton et al. 1982). Highly weathered Spodosols and Ultisols occur on the SD and G surfaces. The amount of profile development, clay increases, and dithionite-citrate extractable iron (Fe_d) indicate that these soils are considerably older than those on the lower surfaces, and these surfaces probably correspond to Griggs' (1945) Seven Devils and higher marine terraces.

A mineralogical study may enhance understanding of the weathering processes involved in formation of the soils on these coastal terraces, particularly the andic soils. It may also provide information on source of the eolian material which blankets the terraces.

The availability of absolute dates would make possible more quantitative analysis of the soils data presented in this study.

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SUMMARY OF CONCLUSIONS

The occurrence and classification of the soils according to current U.S. Soil Taxonomy (Soil Survey Staff, 1975) were determined for the study area. Mineralogy data is not available at this time, so mixed mineralogy was assumed.

Soils on the lower terraces along the Elk River (WR, P1, P2) and on the intermediate terrace (P3) in close proximity to the coast, are loamy, mixed, isomesic Andic Humitropepts. Possible series names are Lint or Templeton, and Wolfer for those soils with higher gravel contents. These soils occur in well-drained landscape positions.

Soils on the intermediate (P3) terrace, in well-drained landscape positions, also include fine-loamy, mixed, isomesic Andeptic Haplohumults of no known series. In flat or depressional landscape positions there are fine-loamy/sandy, mixed, isomesic ortstein Typic Tropaquods similar to the Depoe series. On transitional landscape positions, coarse-loamy, mixed, isomesic, ortstein Typic Troporthods are found. These are similar to the Bandon or Nelscott series.

Similar soil-landscape patterns are found on the higher Seven Devils and Griggs surfaces. Fine-silty, mixed, isomesic ortstein Typic Tropaquods occur in poorly drained areas of both the SD and G surfaces. They may fit the Joeney series. In well-drained landscape positions, clayey, mixed, isomesic Typic Haplohumults are found on the SD surface, and fine-loamy, mixed, isomesic Typic Haplohumults on the G surface. Possible soil series are the Orford, and Edson, respectively.

The criteria for the proposed new order of Andisols was tested, and the soils on the lower terraces (WR, Pl, P2, and the coastal edge of P3) were found to meet the criteria, but weakly.

Changes in soil properties across the terraces indicate progressively older surfaces from the WR to the G surfaces. Amount of soil profile development, clay content, and dithionite-citrate extractable iron increase with age of surface. The soils on the WR, Pl, and P2 surfaces show lesser degree of development, and are probably younger, fluvial terraces.

Additional work in the study area, particularly mineralogical studies and dating of surfaces, would enhance understanding of soil forming processes and the tectonic activity of this part of the coast.

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APPENDICES

APPENDIX A

NARRATIVE PROFILE DESCRIPTIONS

Appendix A - Continued

Pedon No.: 32
Series: Lint or Templeton
Classification: medial, isomesic Typic Dystrandept
Lab Class.: loamy, isomesic Andic Humitropept
Location: NE1/4,NW1/4,Sect.18,T32S,R15W
100 feet West of fence next to stand of Spruce (Wahl farm)
Curry Co., Oregon
Phys. position: Pioneer 3
Elev. 160 ft. (49 m)
Slope: 0-1%
Vegetation: pasture grasses, scattered Sitka Spruce
Described by: DASH
Date: 8/12/87

A - 0 to 9 inches: dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; moderate fine granular structure; weakly smeary, slightly hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; common fine pores; few charcoal fragments, strongly acid; gradual smooth boundary.

AB - 9 to 19 inches: dark brown (10YR 3/3) loam, dark brown (10YR 4/3) dry; weak medium subangular blocky parting to weak fine granular; weakly smeary, slightly hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; common fine pores; few charcoal fragments; strongly acid; gradual smooth boundary.

BA - 19 to 28 inches: dark yellowish brown (10YR 3/4) loam; few medium prominent strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; common fine and very fine roots; few very fine pores; few charcoal fragments, strongly acid; clear smooth boundary.

Bw -28 to 39 inches: brownish yellow (10YR 6/6) loam-clay loam; common fine prominent yellowish red (5YR 4/6) and reddish yellow (5YR 6/8)mottles; massive in place, parting to weak medium subangular blocky structure; firm, slightly sticky, slightly plastic; few very fine roots; few very fine pores; strongly acid; abrupt smooth boundary.

BC - 39 to 51 inches: mottled: brownish yellow (10YR 6/6), pale brown (10YR 6/3), yellowish red (5YR 4/6), and reddish yellow (5YR 6/8) loam; massive; firm, slightly sticky, slightly plastic; weakly cemented pale brown (10YR 6/3) areas, dark red concretions; strongly acid; abrupt smooth boundary.

2C - 51 to 55 inches: variegated weathered gravels and sedimentary siltstone.

Appendix A - Continued

Pedon No.: 33
Series: Lint or Templeton
Classification: medial, isomesic Typic Dystrandept
Lab Class.: loamy, isomesic Andic Humitropept
Location: NE1/4,SW1/4,Sect.18,T32S,R15W
~50 ft East of gravel farm lane, 100 ft
North of fence; ~500 ft East of coastal bluff
Curry Co., Oregon
Phys. position: Pioneer 1
Elev. 85 feet (25 m)
Slope: 0-1%
Vegetation: pasture grasses
Described by: DASH
Date: 8/13/87

A - 0 to 9 inches: very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 4/3) dry; moderate fine granular structure; weakly smeary, slightly hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; few fine pores; very strongly acid; clear wavy boundary.

AB - 9 to 14 inches: dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; moderate fine granular structure; weakly smeary, slightly hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; few fine pores; strongly acid; clear wavy boundary.

BA & A - 14 to 27 inches: dark yellowish brown (10YR 3/4) loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; very friable, slightly sticky, slightly plastic; many very fine and few fine roots; few fine pores; moderately acid; clear wavy boundary.

Bw - 27 to 47 inches: yellowish brown (10YR 5/6) loam, weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; few fine and very fine roots; few fine pores; moderately acid; clear wavy boundary.

BC - 47 to 54 inches: dark yellowish brown (10YR 4/4) loam, weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; few fine roots; common fine pores; strongly acid; clear wavy boundary.

2C - 54 to 60 inches: dense, compacted rounded gravel and sand; massive; weakly cemented.

Appendix A - Continued

Pedon No.:	34
Series: ?	
Classification:	fine-loamy, isomesic Andic Tropohumult
Lab Class.:	fine-loamy, isomesic Andeptic Haplohumult
Location:	NE1/4,NW1/4,Sect. 17,T32S,R15W under center pivot,~200 ft South of fencerow; ~500 ft West of North end of large gravel pit, Curry Co., Oregon
Phys. position:	Pioneer 3 Elev. 165 ft (50 m)
Slope:	0-1%
Vegetation:	pasture grasses; previously wooded
Described by:	DASH
Date:	8/14/87

A - 0 to 9 inches: very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 3/3), crushed; moderate medium and fine granular structure; weakly smeary, friable, slightly sticky, slightly plastic; many fine and very fine roots; common very fine pores; charcoal fragments; very strongly acid; clear smooth boundary.

AB - 9 to 15 inches: very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 3/3), crushed; moderate medium granular structure; weakly smeary, friable, slightly sticky, slightly plastic; many fine and very fine roots; common very fine pores; charcoal fragments; strongly acid; clear smooth boundary.

BA - 15 to 22 inches: dark yellowish brown (10YR 4/4) loam, weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; common fine and many very fine roots; few fine and common very fine pores; 10 percent gravel; charcoal fragments; strongly acid; abrupt smooth boundary.

Bt1 - 22 to 28 inches: dark yellowish brown (10YR 4/6) clay loam; moderate medium subangular blocky structure; friable, slightly sticky, slightly plastic; common fine and very fine roots; few fine and common very fine pores; 5 percent gravel; few medium distinct clay films in pores and on ped faces; strongly acid; clear smooth boundary.

Bt2 - 28 to 37 inches: dark yellowish brown (10YR 4/6) loam; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; common fine roots; many fine and few medium pores; 10 percent gravel; common fine and medium distinct clay films in pores and on ped faces; strongly acid; clear wavy boundary.

BC - 37 to 52 inches: yellowish brown (10YR 5/6) gravelly loam; weak medium subangular blocky structure; firm, slightly sticky, slightly plastic; few fine roots; common fine pores; 15 percent gravel; few fine distinct clay films; strongly acid; clear irregular boundary.

C - 52 to 60 inches: yellowish brown (10YR 5/8) gravelly sandy loam; many medium and coarse distinct brown (10YR 5/3) mottles; massive; very firm, non-sticky, non-plastic; many fine pores; 50 percent gravel; very strongly acid.

Appendix A - Continued

Pedon No.:	35
Series: Wolfer	
Classification:	medial, isomesic, Typic Dystrandept
Lab Class.:	loamy-skeletal, isomesic, Andic Humitropept
Location:	SE1/4,SW1/4,Sect.18,T32S,R15W Just North of McKenzie house, ~300 ft East of coastal bluff Curry Co., Oregon
Phys. position:	Whiskey Run Elev 20 ft (6 m)
Slope:	0-1%
Vegetation:	pasture grasses
Described by:	DASH,MF
Date:	8/18/87

A1 - 0 to 6 inches: very dark brown (10YR 2/2) gravelly loam-fine sandy loam, brown (10YR 5/3) dry; moderate, medium granular structure; slightly hard, friable, non-sticky, non-plastic; many very fine and fine roots; 15 - 20 percent gravel; charcoal fragments; very strongly acid; clear smooth boundary.

A2 - 6 to 15 inches: very dark brown (10YR 2/2) gravelly loam, dark brown (10YR 4/3) dry; weak medium granular structure; slightly smeary, slightly hard, friable, slightly sticky, slightly plastic; many fine and common very fine roots; 15 - 20 percent gravel; charcoal fragments;strongly acid; gradual smooth boundary.

AB - 15 to 26 inches: very dark brown (10YR 2/2) gravelly loam, dark brown (10YR 4/3) dry; moderate fine and medium subangular blocky structure, parting to weak, medium granular; slightly smeary, slightly hard, friable, slightly sticky, slightly plastic; common very fine and fine roots; 20 - 25 percent gravel; charcoal fragments; strongly acid; clear smooth boundary.

BA1 - 26 to 31 inches: very dark grayish brown (10YR 3/2) gravelly loam, dark brown (10YR 4/3) dry; weak medium granular structure; slightly smeary, slightly hard, friable, slightly sticky, slightly plastic; common very fine and fine roots; 20 - 25 percent gravel; charcoal fragments; strongly acid; clear smooth boundary.

BA2 - 31 to 43 inches: very dark brown (10YR 2/2) gravelly loam; weak fine and medium subangular blocky structure parting to weak medium granular; slightly smeary, slightly hard, friable, slightly sticky, slightly plastic; few very fine and fine roots; 15 percent gravel; charcoal fragments; moderately acid; abrupt smooth boundary.

Bw - 43 to 49 inches: dark brown (10YR 3/3) gravelly loam; weak medium and coarse subangular blocky structure;slightly smeary, slightly hard, friable, slightly sticky, slightly plastic; few fine roots; 20 - 25 percent gravel; moderately acid; clear wavy boundary.

C - 49 to 64 inches: yellowish brown (10YR 5/6) gravelly loam; massive; smeary, slightly hard, friable, slightly sticky, slightly plastic; few fine roots; 25 - 35 percent gravel; moderately acid.

Appendix A - Continued

Pedon No.: 37
Series: Bandon ? or Nelscott ?
Classification: fine-loamy, shallow, ortstein, Typic Troporthod/Andisol
Lab Class.: Coarse-loamy, isomesic, ortstein Typic Troporthod
Location: SW1/4,NW1/4,Sect.31,T31S,R15W
~200 ft West of fence around cranberry bog
~200 ft North of farm lane
Curry Co., Oregon
Phys. position: Pioneer 3
Elev 220 ft (67 m)
Slope: 0-2%
Vegetation: Pasture grasses
Described by: DASH,HH
Date: 8/19/87

A1 - 0 to 15 inches: black (10YR 2/1) silt loam, dark brown(10YR 4/3) dry; moderate medium granular structure; weakly smeary, slightly hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; common fine pores; strongly acid; clear smooth boundary.

A2 - 15 to 25 inches: very dark brown (10YR 2/2) silt loam, yellowish brown(10YR 5/4) dry; weak medium subangular blocky structure parting to weak medium granular; weakly smeary, slightly hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; common fine pores; very strongly acid; clear smooth boundary.

E/A - 25 to 32 inches: dark yellowish brown (10YR 4/4) and very dark brown (10YR 3/2) silt loam; weak medium subangular blocky structure; weakly smeary, slightly hard, friable, slightly sticky, slightly plastic; common fine and very fine roots; common very fine and few fine pores; very strongly acid; abrupt wavy boundary.

2E - 32 to 36 inches: light yellowish brown (10YR 6/4) loam; few fine distinct strong brown (7.5YR 5/6) weakly cemented mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; few fine and very fine roots; common very fine and fine pores; strongly acid; abrupt wavy boundary.

2Bsm1 - 36 to 56 inches: yellowish brown (10YR 5/6) loamy sand; common fine prominent strong brown (7.5YR 5/8) mottles, and few medium strong brown (7.5YR 4/6) cemented layers; massive, parting to moderate medium prismatic structure; very hard, firm; strongly cemented; few fine roots in channels; few fine pores; strong brown (7.5YR 4/6) films on prism surfaces; strongly acid; clear smooth boundary.

2Bsm2 - 56 to 63 inches: yellowish brown (10YR 5/6) loamy sand; few fine prominent yellowish red (5YR 5/6) mottles; massive; hard, firm; weakly cemented; few fine roots in channels; few fine pores; very strongly acid; clear smooth boundary.

2Bsm3 - 63 to 70 inches: light yellowish brown (2.5Y 6/4) sand; yellowish red (5YR 4/6) cemented layer, 1 1/2 inches thick at top of horizon; massive; hard, friable; weakly cemented; very strongly acid; abrupt smooth boundary.

3C - 70 to 75 inches: light gray (10YR 7/1) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; firm, slightly sticky, plastic; few fine and very fine roots; many fine and very fine pores; very strongly acid. Note: Auger boring to an additional 60 inches; stratified gray sand.

Appendix A - Continued

Pedon No.:	38
Series: Depoe	
Classification:	Fine-silty, shallow, ortstein Typic Tropaquod
Lab Class.:	Fine-loamy/sandy, isomesic ortstein Typic Tropaquod
Location:	NE1/4,NW1/4,Sect.31,T31S,R15W ~25 ft North of cranberry bog & State Park boundary Curry Co., Oregon
Phys. position:	Pioneer 3 - in low lying flat; depressional landscape Elev 220 ft (67 m)
Slope:	0-2%
Vegetation:	Shore pine, salal, ferns, elderberry(?), rhododendrons
Described by:	DASH,HH
Date:	8/20/87

O - 8 to 0 inches: roots, decomposed leaves, root mat, loose litter.

A1 - 0 to 4 inches: very dark brown (10YR 2/2) silt loam, gray (10YR 5/1), dry; moderate medium granular structure; friable, non-sticky, slightly plastic; many fine and medium and few coarse roots; common fine pores; extremely acid; abrupt smooth boundary.

A2 - 4 to 8 inches: black (10YR 2/1) silt loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; friable; non-sticky, slightly plastic; common fine and very fine roots; common fine pores; extremely acid; clear smooth boundary.

E - 8 to 12 inches: gray (10YR 5/1) silty clay loam; common fine and medium distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; firm, slightly sticky, plastic; few fine and very fine roots; few fine pores; extremely acid; abrupt smooth boundary.

E/B - 12 to 17 inches: light brownish gray (2.5Y 6/2) / weakly cemented brownish yellow (10YR 6/8) silty clay loam; moderate fine and medium subangular blocky structure; firm, slightly sticky, slightly plastic; few fine and very fine roots; few fine pores; pockets of dark brown (7.5YR 3/2) material in root channels; very strongly acid; abrupt wavy boundary.

2Bsml - 17 to 27 inches: strong brown (7.5YR 5/8) sandy loam; common medium distinct very pale brown (10YR 7/4) mottles; moderate very coarse platy structure parting to weak medium angular blocky; extremely firm in place; common fine roots on surfaces of plates; few fine pores; strongly cemented, especially in the upper part of horizon; yellowish brown (10YR 5/4) coatings on upper surfaces of plates; very strongly acid; abrupt irregular boundary.

2Bsm2 - 27 to 37 inches: light olive brown (2.5Y 5/4) loamy sand; strong brown (7.5YR 5/8) in the upper 2 to 3 inches; weak coarse prismatic structure; firm in place, extremely firm in the upper part of horizon; few fine roots; few fine pores; weakly cemented, but very strongly cemented in upper 2 inches; yellowish red (5YR 5/8) coatings on upper surfaces of plates; very strongly acid; clear smooth boundary.

2BC - 37 to 48 inches: grayish brown (2.5Y 5/2) sand; few fine distinct yellowish brown (10YR 5/4) mottles; massive; prismatic structure; firm in place; few medium decomposing roots; very strongly acid; abrupt smooth boundary.

2C - 48 to 60 inches: olive gray (5Y 4/2) sand; loose; single grain; few medium decomposing roots; very strongly acid.

Appendix A - Continued

Pedon No.: 41
Series: Joeney
Classification: Fine-silty, shallow, ortstein Typic Tropaquod
Location: SW1/4,NW1/4,Sect.15,T32S,R15W
Grassy Knob Rd., 100 ft East of power line ,
in cutover area, 25 ft North of road
Curry Co., Oregon
Phys. position: Griggs
Elev 580 ft (175 m)
Slope: 0-2%
Vegetation: Shore pine, Port Orford cedar, red fir
salal, bracken fern, huckleberry, grasses, gorse bush
Described by: DASH,GHS,BH
Date: 9/1/87

A - 0 to 5 inches: black (10YR 2/1) silt loam, gray (7.5YR 5/0), dry; moderate medium granular structure; friable; many fine, very fine, and medium roots; fine charcoal fragments; extremely acid; abrupt smooth boundary.

E - 5 to 10 inches: light brownish gray (10YR 6/2) silt loam, light gray (10YR 7/1) dry; weak medium platy structure; hard, friable; common fine and medium roots, concentrated in krotovinas; few fine tubular and interstitial pores; fine charcoal fragments; many vertical krotovinas and root channels; few medium distinct strong brown (7.5YR 5/6) concretions in some areas; extremely acid; clear wavy boundary.

BE - 10 to 14 inches: mottled: dark yellowish brown (10YR 4/6), yellowish brown (10YR 5/4), and strong brown (7.5YR 5/6) silt loam; massive; hard, friable, slightly sticky, slightly plastic; few fine and medium roots; few fine tubular pores;reddish brown (5YR 4/4) cemented thin pans; very strongly acid; abrupt wavy boundary.

Bh - 14 to 15 inches: very dark brown (10YR 2/2); silt loam; weak fine platy parting to weak fine granular; hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; common fine distinct strong brown (7.5YR 5/6) concretions; very strongly acid.

2Bsm1 - 15 to 21 inches: yellowish brown (10YR 5/6) silty clay loam; massive; extremely hard, extremely firm; few fine and medium roots; few fine tubular and interstitial pores; reddish brown (5YR 4/4) indurated pan; very strongly acid; abrupt smooth boundary.

2Bsm2 - 21 to 24 inches: yellowish brown (10YR 5/8) silty clay loam; massive; extremely hard, extremely firm; few fine and medium roots; few fine tubular and interstitial pores; reddish brown (5YR 4/4) indurated nodules; thin bands of gray material; very strongly acid; abrupt wavy boundary.

2C1 - 24 to 39 inches: yellowish brown (10YR 5/6) silty clay loam; many medium and coarse distinct very pale brown (10YR 7/3) mottles; weak fine platy parting to weak fine subangular blocky structure; firm, sticky, plastic; few fine roots; few fine tubular and interstitial pores; charcoal fragments; very strongly acid; diffuse smooth boundary.

2C2 - 39 to 56 inches: yellowish brown (10YR 5/6) silty clay ; many medium distinct very pale brown (10YR 7/3) (accumulation of gibbsite?) and few medium distinct light brownish gray (10YR 6/2) mottles; weak coarse subangular blocky structure; firm, very sticky, plastic; few fine pores; few fine manganese concretions; charcoal fragments; very strongly acid; abrupt wavy boundary.

2C3 - 56 to 62 inches: dark yellowish brown (10YR 4/6) silty clay loam; massive; sticky, plastic; thin cemented yellowish red (5YR 4/6) band in upper part of horizon; charcoal fragments; very strongly acid.

Appendix A - Continued

Pedon No.:	42
Series: Edson ?	
Classification:	Fine-loamy, isomesic, Typic Haplohumults
Location:	NE1/4,NW1/4,Sect.25,T32S,R15W, Curry Co., Oregon ~0.1 mi. North of Grassy Knob Rd., from end of County Rd., in woods, just East of logging road
Phys. position:	Griggs Elev 760 ft (230 m)
Slope:	3%
Vegetation:	hemlock, fir, cedar, alder
Described by:	DASH,GHS,BH
Date:	9/2/87

O - 1 to 0 inches: mosses, leaves, twigs, needles.

A - 0 to 7 inches: dark yellowish brown (10YR 4/4) loam, yellowish brown (10YR 5/4), dry; strong fine and medium granular structure; friable, slightly plastic; many fine and very fine, common medium, and few coarse roots; many fine and very fine tubular and interstitial pores; very strongly acid; abrupt wavy boundary.

2BA - 7 to 13 inches: strong brown (7.5YR 4/6) loam - silt loam; strong fine subangular blocky structure; friable, slightly plastic; many fine and medium, and few coarse roots; many fine and very fine tubular and interstitial pores; charcoal fragments; small rounded concretions; strongly acid; clear smooth boundary.

2Bt1 - 13 to 21 inches: strong brown (7.5YR 4/6) loam; moderate fine subangular blocky structure; friable, slightly sticky, plastic; many fine and medium, few coarse roots; many fine and few medium tubular and interstitial pores; few fine charcoal fragments; very strongly acid; clear smooth boundary.

2Bt2 - 21 to 33 inches: yellowish red (5YR 5/6) silty clay loam; moderate fine subangular blocky structure; friable, sticky, plastic; common fine and few medium roots; many fine and medium tubular pores; few fine charcoal fragments; few fine distinct clay films in pores and on ped faces; very strongly acid; clear smooth boundary.

3Bt3 - 33 to 44 inches: yellowish red (5YR 5/8) sandy clay loam - clay loam; weak medium subangular blocky structure; firm in place, slightly sticky, slightly plastic; few fine and medium roots; common fine and medium tubular pores; common weathered sandstone fragments; common fine distinct clay films in pores and on ped faces; very strongly acid; clear smooth boundary.

3Bt4 - 44 to 52 inches: yellowish red (5YR 5/8) clay loam; weak coarse subangular blocky structure; firm in place, sticky, plastic; few fine roots; common medium tubular pores; common fine distinct clay films in pores and on ped faces; very strongly acid; gradual smooth boundary.

3BC - 52 to 63 inches: yellowish red (5YR 5/8) sandy loam; massive; firm in place; few fine and very fine roots; many fine and very fine pores; very strongly acid.

3Cr - 63+

Appendix A - Continued

Pedon No.: 43
Series: Orford
Classification: Clayey, isomesic, Typic Haplohumult
Location: NW1/4,SE1/4,Sect.28,T32S,R15W, Curry Co., Oregon approx. 1.25 miles East on Hensley Hill Rd. from intersection,~0.3 mi North of Hensley Hill Rd., in woods, next to X-mas tree fields
Phys. position: Seven Devils
Elev 380 ft (115 m)
Slope: 1-2%
Vegetation: Western hemlock
Described by: DASH, GHS, BH
Date: 9/3/87

0 - 3 to 0 inches: partially decomposed organic material

EA - 0 to 3 inches: dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3), dry; weak fine platy structure; friable, slightly sticky, slightly plastic; many fine and medium and few coarse roots; few fine interstitial pores; extremely acid; clear wavy boundary.

BE - 3 to 8 inches: strong brown (7.5YR 5/6) silty clay loam; few coarse prominent yellowish red (5YR 4/8) mottles; weak medium subangular blocky structure; friable, sticky, plastic; many fine and medium and few coarse roots; few fine and medium interstitial pores; charcoal fragments; very strongly acid; clear smooth boundary.

Bt1 - 8 to 17 inches: strong brown (7.5YR 5/6) silty clay loam; strong fine subangular blocky structure; friable, sticky, plastic; many fine and medium and few coarse roots; common fine and medium tubular and interstitial pores; common earthworm cavities; few fine faint clay films on ped faces; very strongly acid; gradual smooth boundary.

Bt2 - 17 to 26 inches: yellowish brown (10YR 5/8) silty clay; moderate fine subangular blocky structure; friable, very sticky, very plastic; common fine and medium and few coarse roots; many fine and medium tubular and interstitial pores; common fine and medium distinct dark brown (7.5YR 4/4) clay films on ped faces; very strongly acid; gradual smooth boundary.

BC - 26 to 36 inches: yellowish brown (10YR 5/8) silty clay; common fine prominent strong brown (7.5YR 5/6) and very pale brown (10YR 7/4) mottles; weak medium subangular blocky structure; firm in place, very sticky, plastic; few fine roots; common fine distinct continuous clay films; very strongly acid; clear smooth boundary.

2C1 - 36 to 52 inches: brownish yellow (10YR 6/8) loam; common medium faint yellowish brown (10YR 5/8) mottles; massive; firm in place, slightly plastic; few fine roots; very strongly acid; clear smooth boundary.

2C2 - 52 to 63 inches: yellowish brown (10YR 5/6) sandy loam; massive; firm in place, slightly plastic; few fine roots; very strongly acid.

Appendix A - Continued

Pedon No.: 44
Series: Joeney ?
Classification: fine-silty, isomesic, shallow ortstein Typic Tropaquod
Location: NW1/4,SE1/4,Sect.28,T32S,R15W, Curry Co., Oregon
Hensley Hill Rd., in woods East of last
X-mas tree field, in swale
Phys. position: Seven Devils
Elev 380 ft (115 m)
Slope: 0-1%
Vegetation: Western red cedar, Western hemlock, pine; salal, evergreen huckleberry, gorse
Described by: DASH, GHS, BH
Date: 9/3/87

A - 0 to 6 inches: gray (10YR 5/1) silt loam, light gray (10YR 6/1), dry; massive, parting to weak fine platy structure; friable, plastic; many fine, medium, and few coarse roots; extremely acid; abrupt wavy boundary.

E - 6 to 17 inches: light gray (10YR 6/1) silt loam, light gray (10YR 7/1) dry; common medium distinct strong brown (7.5YR 4/6) mottles; moderate fine platy structure; very hard, friable, slightly plastic; common fine concretions; weakly cemented; extremely acid; abrupt wavy boundary.

Bhsm - 23 to 29 inches: yellowish brown (10YR 5/8) silt loam, common medium distinct pale brown (10YR 6/3) mottles; weak coarse platy structure; extremely hard, very firm; few fine and medium roots; multiple layers of black (10YR 2/1) Bh material; strongly acid; abrupt smooth boundary.

Bsm - 23 to 29 inches: yellowish brown (10YR 5/6) silt loam; common fine prominent red (2.5YR 4/6) mottles on surfaces of peds, common medium distinct light brownish gray (10YR 6/2) mottles; weak coarse platy; extremely hard, firm, slightly sticky, slightly plastic; few very fine pores; organic stains and red colors on faces of plates; thin indurated pan in upper part of horizon; strongly acid; clear smooth boundary.

BC - 29 to 36 inches: yellowish brown (10YR 5/6) silty clay loam; common medium prominent red (2.5YR 4/8) and few medium distinct light brownish gray (10YR 6/2) mottles; weak coarse angular blocky structure; firm, sticky, plastic; few fine and medium roots; weakly cemented in places; strongly acid; clear smooth boundary.

C1 - 35 to 50 inches: yellowish brown (10YR 5/6) silty clay loam; many medium distinct light brownish gray (10YR 6/2) and common fine prominent strong brown (7.5YR 5/6) mottles; massive; friable, sticky, plastic; very strongly acid; gradual smooth boundary.

C2 - 50 to 60 inches: light brownish gray (10YR 6/2) silty clay loam; many medium distinct yellowish brown (10YR 5/6) and few fine prominent white (10YR 8/2) mottles; massive; friable, sticky, plastic; white concretions; very strongly acid.

APPENDIX B

CHEMICAL AND PHYSICAL PROPERTIES OF THE SOILS

Appendix B - Continued
Table B.1. Physical properties of the soils, Curry Co., Oregon

Horiz.	Depth (cm)	Bulk Density (Mg m-3)		Texture sand (%)	silt (%)	clay (%)	class	Water Retention -1.5 MPa, % (moist)	(dry)	WR clay ratio
LINT or TEMPLETON										
Profile No. 32 -- Andic Humitropept, loamy, isomesic--------------------										
A	0 - 23	0.92	0.72	26	51	23	sil	24.1	25.5	1.1
AB	23 - 48	0.97	0.67	21	57	22	sil	26.2	23.7	1.1
BA	48 - 71	0.95	0.62	24	53	23	sil	19.0	20.7	0.9
Bw	71 - 99	1.09		29	44	28	cl	20.3	19.0	0.7
BC	99 -130			39	38	23	l	16.6	14.3	0.6
2C	130-140									
LINT or TEMPLETON										
Profile No. 33 -- Andic Humitropept, loamy, isomesic--------------------										
A	0 - 23	0.93	0.80	47	32	22	l	25.6	22.2	1.0
AB	23 - 36	0.88		44	34	22	l	15.0	14.9	0.7
BA/A	36 - 69	0.81		44	36	20	l	16.3	14.4	0.7
Bw	69 -119	1.01		49	29	22	scl-l	13.1	12.4	0.6
BC	119-137	1.12		55	24	21	scl-sl	12.5	12.2	0.6
2C	137-152									
Profile No. 34 - Andeptic Haplohumult, fine-loamy, isomesic-------------										
A	0 - 23	0.91	0.69	14	66	20	sil	27.5	24.6	1.2
AB	23 - 38	0.90	0.83	12	68	20	sil	29.8	21.9	1.1
BA	38 - 56	0.95	0.69	10	63	27	sicl-si	27.8	23.0	0.8
Bt1	56 - 71	0.89		13	51	36	sicl	18.2	25.4	0.7
Bt2	71 - 94	0.49		27	46	27	gr-l-cl	21.4	23.9	0.9
BC	94 -132			51	28	21	gr-scl-	23.0	14.0	0.7
C	132-152			70	17	13	gr-sl		8.8	0.7
WOLFER										
Profile No. 35 -- Andic Humitropept, loamy, isomesic--------------------										
A1	0 - 15	0.75	0.68	49	33	18	gr-l	23.7	25.7	1.5
A2	15 - 38	0.66	0.90	43	37	20	gr-l	25.0	20.9	1.0
AB	38 - 66	0.64	0.81	42	38	21	gr-l	21.3	17.8	0.9
BA1	66 - 79	0.75		43	39	18	gr-l	22.5	15.2	0.8
BA2	79 -109	1.33		42	40	18	gr-l	26.7	17.6	1.0
Bw	109-125			43	38	19	gr-l	19.7	12.0	0.6
C	125-163			43	41	16	gr-l		11.5	0.7
BANDON-NELSCOTT?										
Profile No. 37 - Typic Troporthod, coarse-loamy, isomesic, ortstein------										
A1	0 - 38	0.96	0.77	44	46	10	l	20.9	16.6	1.6
A2	38 - 64	0.91		45	43	12	l	21.2	12.3	1.0
E/A	64 - 81			47	41	13	l	17.2	10.5	0.8
2E	81 - 91			50	39	12	l	13.6	9.3	0.8
2Bsm1	91 -117			94	4	3	fs	18.1	8.9	3.2
2Bsm1	117-142			93	4	3	fs	16.3	6.3	2.2
2Bsm2	142-160			98	1	1	fs		3.1	3.4
2Bsm3	160-178			98	2	0	fs		2.9	7.2

Appendix B - Continued

Table B.1. (Continued)

			Texture				Water Retention		WR
Horiz.	Depth	Bulk Density	sand	silt	clay	class	-1.5 MPa, %		clay
	(cm)	(Mg m-3)	(%)	(%)	(%)		(moist)	(dry)	ratio
DEPOE?									
Profile No. 38 - Typic Tropaquod, fine-loamy/sandy, isomesic, ortstein---									
A1	0 - 10	1.01	15	66	19	sil		18.1	0.9
A2	10 - 20	1.09	18	63	19	sil		10.6	0.5
E	20 - 31	1.23	17	56	27	sil-sicl		11.2	0.4
E/B	31 - 43	1.15	20	46	35	cl-sicl		19.6	0.6
2Bsm1	43 - 69		77	15	9	fsl-lfs		14.3	1.6
2Bsm2	69 - 94		94	5	1	fs		2.5	2.3
2BC	94 -122		98	1	0	fs		1.5	5.0
2C	122-152		99	1	0	fs			ERR
JOENEY?									
Profile No. 41 - Typic Tropaquod, fine-silty, isomesic, ortstein--------									
A	0 - 13	0.90	11	77	13	sil		19.7	1.6
E	13 - 25		4	83	14	sil		4.7	0.3
BE	25 - 37	1.09	5	71	24	sil		11.2	0.5
Bh	37 - 38		13	69	18	sil		21.8	1.2
2Bsm1	38 - 53		12	46	43	sic		28.8	0.7
2Bsm2	53 - 61		13	55	32	sicl		23.7	0.7
2C1	61 - 99	1.03	8	63	29	sicl		22.4	0.8
2C2	99 -142	1.01	8	59	33	sicl		22.6	0.7
2C3	142-158		8	66	26	sil		18.0	0.7
EDSON?									
Profile No. 42 - Typic Haplohumult, fine-loamy, isomesic----------------									
A	0 - 18	0.79	38	38	25	l		13.4	0.5
2BA	18 - 33	1.10	33	49	19	l-sil		11.9	0.6
2Bt1	33 - 53	1.28	31	44	25	l		14.1	0.6
2Bt2	53 - 84	1.49	33	31	35	cl		15.3	0.4
3Bt3	84 -112		53	13	34	scl		12.4	0.4
3Bt4	112-132	1.24	52	9	39	sc		13.6	0.4
3BC	132-160		62	10	29	scl		10.0	0.3
3Cr	160.0+		43	8	49	c		16.6	0.3
ORFORD									
Profile No. 43 - Typic Haplohumult, clayey, isomesic--------------------									
EA	0 - 8		14	69	17	sil		11.5	0.7
BE	8 - 20	1.18	8	66	26	sil-sicl		11.7	0.4
Bt1	20 - 43	1.25	9	44	47	sic		19.7	0.4
Bt2	43 - 66	1.25	14	35	50	c		22.1	0.4
BC	66 - 91	1.21	28	31	41	c-cl		17.0	0.4
2C1	91 -132		60	16	24	scl		9.3	0.4
2C2	132-160		65	12	22	scl-sl		9.5	0.4

Appendix B - Continued

Table B.1. (Continued)

			Texture				Water Retention		WR
Horiz.	Depth	Bulk Density	sand	silt	clay	class	-1.5 MPa, %		clay
	(cm)	(Mg m-3)	(%)	(%)	(%)		(moist)	(dry)	ratio
JOENEY?									
Profile No. 44 - Typic Tropaquod, fine-silty, isomesic, ortstein---------									
A	0 - 15	1.47	5	84	11	silt		4.5	0.4
E	15 - 43		4	87	9	silt		3.7	0.4
Bhsm	43 - 58				***			19.1	ERR
Bsm	58 - 74				***			20.8	ERR
BC	74 - 91		9	66	25	sil		22.4	0.9
C1	91 -127		12	59	29	sicl		21.9	0.7
C2	127-152		26	46	28	cl-l		16.6	0.6

Table B.2. Chemical properties of the soils, Curry Co., Oregon

Horizon	Depth	pH			Exch cations							
	(cm)	water 1:1	CaCl2	KCl 1:1	K	Ca	Mg	Na	Sum	Exch H+	CEC,8.2	Org C
					cmol kg-1							%
LINT or TEMPLETON												
Profile No. 32 -- Andic Humitropept, loamy, isomesic												
A	0 - 23	5.21	4.65	4.34	0.51	1.70	1.03	0.64	3.88	29.40	33.28	7.40
AB	23 - 48	5.35	4.65	4.49	0.31	0.80	0.43	0.38	1.92	27.03	28.95	4.37
BA	48 - 71	5.35	4.76	4.58								2.87
Bw	71 - 99	5.06	4.59	4.72								0.89
BC	99 -130	5.15	4.64	4.64								0.61
LINT or TEMPLETON												
Profile No. 33 -- Andic Humitropept, loamy, isomesic												
A	0 - 23	5.00	4.31	4.19	0.29	1.80	0.73	0.52	3.34	30.00	33.34	8.75
AB	23 - 36	5.50	4.78	4.58	0.22	1.50	0.65	0.5	2.87	26.41	29.28	3.70
BA/A	36 - 69	5.63	4.86	4.73								2.55
Bw	69 -119	5.64	4.90	4.79								0.86
BC	119-137	5.25	4.58	4.39								0.86
Profile 34 -- Andeptic Haplohumult, fine-loamy, isomesic												
A	0 - 23	4.86	4.55	4.26	0.18	3.20	0.74	0.51	4.63	27.92	32.55	7.66
AB	23 - 38	5.10	4.60	4.32	0.2	1.90	0.6	0.45	3.15	25.84	28.99	5.20
BA	38 - 56	5.23	4.71	4.42								2.81
Bt1	56 - 71	5.42	4.85	4.66								1.49
Bt2	71 - 94	5.54	5.09	4.95								1.47
BC	94 -132	5.13	4.90	4.96								0.99
C	132-152	5.03	4.90	4.89	0.08	0.70	0.27	0.4	1.45	11.88	13.33	0.7
WOLFER												
Profile 35 -- Andic Humitropept, loamy, isomesic												
A1	0 - 15	4.50	4.30	3.85	0.21	2.30	1.04	0.35	3.9	40.10	44.00	11.77
A2	15 - 38	5.18	4.40	4.29	0.12	1.60	0.64	0.46	2.82	31.19	34.01	5.55
AB	38 - 66	5.52	4.64	4.42								4.59
BA1	66 - 79	5.51	4.70	4.49								4.63
BA2	79 -109	5.59	4.75	4.57								4.27
Bw	109-125	5.64	4.82	4.62								2.14
C	125-163	5.62	4.88	4.69								1.34
BANDON-NELSCOTT?												
Profile No. 37 -- Typic Troporthod, coarse-loamy, isomesic, ortstein												
A1	0 - 38	5.13	4.26	4.21	0.38	1.70	0.82	0.46	3.36	35.11	38.47	5.17
A2	38 - 64	5.25	4.28	4.36								4.02
E/A	64 - 81	4.99	4.25	4.39								2.68
2E	81 - 91	5.22	4.39	4.64								0.93
2Bsm1	91 -117	5.29	4.79	66.00								0.89
2Bsm1	117-142	5.18	4.93	5.10								0.74
2Bsm2	142-160	4.92	4.88	5.13								0.29
2Bsm3	160-178	4.94	4.90	5.08								0.06

Appendix B - Continued

Table B.2. (Continued)

		pH			Exch cations							
Horizon	Depth				K	Ca	Mg	Na	Sum	Exch H+	CEC,8.2	Org C
	(cm)	water 1:1	$CaCl_2$	KCl 1:1	cmol kg^{-1}							%
DEPOE?												
Profile No. 38 -- Typic Tropaquod, fine-loamy/sandy, isomesic												
A1	0 - 10	4.05	3.25	3.02	0.32	1.00	2.23	0.5	4.05	33.86	37.91	10.82
A2	10 - 20	4.03	3.25	3.16	0.15	0.50	0.5	0.43	1.58	30.00	31.58	7.15
E	20 - 31	4.27	3.44	3.39								1.82
E/B	31 - 43	4.79	3.93	4.03								1.28
2Bsm1	43 - 69	4.99	3.85	4.07	0.05	0.50	0.25	0.61	1.41	9.00	10.41	0.19
2Bsm2	69 - 94	4.45	4.85	4.85								0.03
2BC	94 -122	4.50	4.68	4.91								0.06
2C	122-152	4.57	4.75	4.85								0.06
JOENEY?												
Profile No. 41 -- Typic Tropaquod, fine-silty, isomesic, ortstein												
A	0 - 13	4.29	3.60	3.23	0.21	1.10	1.65	0.52	3.48	33.01	36.49	9.90
E	13 - 25	4.20	3.50	3.43	0.05	0.40	0.27	0.26	0.98	9.90	10.88	0.57
BE	25 - 37	4.73	4.00	3.98								1.85
Bh	37 - 38	4.83	4.10	4.11								8.49
2Bsm1	38 - 53	4.95	4.31	4.29								2.04
2Bsm2	53 - 61	4.90	4.48	4.41	0.08	0.50	0.27	0.39	1.24	21.91	23.15	1.06
2C1	61 - 99	4.86	4.31	4.36								0.48
2C2	99 -142	4.93	4.17	4.11								0.29
2C3	142-158	4.82	4.25	4.22								0.66
EDSON?												
Profile No. 42 -- Typic Haplohumult, fine-loamy, isomesic												
A	0 - 18	5.03	4.28	4.13	0.13	1.70	0.6	0.43	2.86	24.61	27.47	5.04
2BA	18 - 33	5.30	4.47	4.53	0.1	1.10	0.31	0.55	2.06	23.41	25.47	3.45
2Bt1	33 - 53	4.85	4.58	4.60								2.19
2Bt2	53 - 84	5.03	4.35	4.29								0.81
3Bt3	84 -112	4.91	3.95	4.23								0.38
3Bt4	112-132	5.01	4.24	4.27								0.28
3BC	132-160	4.97	4.26	4.15	0.07	0.60	0.31	0.36	1.34	6.00	7.34	0.16
3Cr	160.0+	4.83	4.19	4.09								0.28
ORFORD												
Profile No. 43 -- Typic Haplohumult, clayey, isomesic												
EA	0 - 8	4.15	3.52	3.26	0.23	1.60	1.08	0.58	3.49	21.31	24.80	3.77
BE	8 - 20	4.68	3.95	3.78	0.16	0.70	0.49	0.45	1.8	17.71	19.51	1.85
Bt1	20 - 43	5.01	4.23	4.03								1.69
Bt2	43 - 66	4.91	4.16	3.89								1.13
BC	66 - 91	4.93	4.24	3.98								0.16
2C1	91 -132	4.86	4.17	4.11								0.09
2C2	132-160	4.89	4.22	4.08	0.11	0.60	0.31	0.51	1.53	7.50	9.03	0.13

Appendix B - Continued
Table B.2. (Continued)

		pH			Exch cations							
Horizon	Depth				K	Ca	Mg	Na	Sum	Exch H+	CEC,8.2	Org C
	(cm)	water 1:1	CaCl2	KCl 1:1	cmol kg-1							%
JOENEY?												
Profile No. 44 -- Typic Tropaquod, fine-silty, isomesic, ortstein												
A	0 - 15	3.89	3.01	2.82	0.11	0.60	0.77	0.36	1.84	19.51	21.35	2.99
E	15 - 43	4.41	3.66	3.60	0.07	0.50	0.2	0.34	1.11	7.50	8.61	0.47
Bhsm	43 - 58	4.93	4.17	4.09								7.86
Bsm	58 - 74	5.18	4.82	4.85	0.06	0.30	0.15	0.3	0.81	30.01	30.82	3.1
BC	74 - 91	5.08	4.43	4.24								0.91
C1	91 -127	5.03	4.11	3.93								0.34
C2	127-152	4.73	4.39	4.33								0.56

Appendix B - Continued

Table B.3. Iron, aluminum, and silica extracts of the soils, Curry Co., Oregon

Horizon	Depth (cm)	Alp (%)	Fep (%)	Sip (%)	Alo (%)	Feo (%)	Sio (%)	ox. extr %trans 465nm	Al,d-c (%)	Fe,d-c (%)	Al,KCl (cmol/kg)
LINT or TEMPLETON											
Profile 32 -- Andic Humitropept, loamy, isomesic											
A	0 - 23	1.18	0.84	0.20	1.36	1.28	0.13	51.8	1.20	2.08	2.00
AB	23 - 48	1.24	2.04	0.21	1.38	1.34	0.17	64.5	1.40	2.30	1.45
BA	48 - 71	0.91	1.12	0.08	1.42	1.32	0.24	75.5	1.35	2.20	1.22
Bw	71 - 99	0.53	1.04	0.04	1.51	1.10	0.39	96	1.29	2.05	0.67
BC	99 -130	0.42	0.34	0.06	1.26	0.94	0.38	96.5	1.04	2.38	0.67
LINT or TEMPLETON											
Profile 33 -- Andic Humitropept, loamy, isomesic											
A	0 - 23	0.92	0.30	0.15	0.97	1.24	0.08	51	0.98	1.89	2.34
AB	23 - 36	0.95	0.32	0.12	1.34	1.24	0.19	57	1.49	2.30	0.89
BA/A	36 - 69	0.73	0.60	0.07	1.43	1.32	0.24	72	1.51	2.58	0.56
Bw	69 -119	0.43	0.36	0.10	0.84	1.10	0.14	91	0.95	1.72	0.44
BC	119-137	0.39	0.32	0.12	0.65	0.96	0.09	92	0.81	1.67	1.00
Profile 34 -- Andeptic Haplohumult, fine-loamy, isomesic											
A	0 - 23	1.11	1.64	0.17	1.15	0.92	0.10	50	1.18	2.79	1.78
AB	23 - 38	1.15	1.28	0.20	1.21	1.08	0.13	56	1.31	3.20	1.78
BA	38 - 56	0.93	0.60	0.18	1.19	1.08	0.19	77.2	1.38	3.50	1.33
Bt1	56 - 71	0.74	0.32	0.13	1.28	2.22	0.20	88.2	1.54	4.90	0.44
Bt2	71 - 94	0.45	0.26	0.06	1.68	2.16	0.39	87.5	1.74	4.55	0.11
BC	94 -132	0.32	0.14	0.05	1.55	1.58	0.43	94.5	1.54	3.60	0.11
C	132-152	0.30	0.24	0.05	1.04	0.88	0.34	96.5	1.24	2.49	0.22
WOLFER											
Profile 35 -- Andic Humitropept, loamy, isomesic											
A1	0 - 15	0.70	0.84	0.11	0.68	0.70	0.05	53.5	0.87	1.62	3.45
A2	15 - 38	0.99	0.98	0.13	1.26	1.16	0.15	49.5	1.40	2.18	2.00
AB	38 - 66	0.96	0.52	0.15	1.15	1.28	0.12	64	1.25	2.53	1.22
BA1	66 - 79	0.90	1.06	0.16	1.31	1.52	0.15	60.5	1.13	2.47	1.00
BA2	79 -109	0.94	0.48	0.11	1.28	1.22	0.19	66.5	1.24	2.32	0.89
Bw	109-125	0.64	0.56	0.06	1.14	1.26	0.20	83	1.17	2.06	0.78
C	125-163	0.56	0.30	0.06	1.10	1.28	0.24	89.2	1.06	1.99	0.56
BANDON-NELSCOTT?											
Profile 37 -- Typic Troporthod, coarse-loamy, isomesic, ortstein											
A1	0 - 38	0.97	0.64	0.10	1.00	0.82	0.05	31	1.04	1.48	2.67
A2	38 - 64	1.15	0.34	0.14	1.31	0.68	0.13	40	1.52	1.65	2.11
E/A	64 - 81	0.92	0.26	0.11	1.13	0.72	0.17	63	1.27	1.54	1.56
2E	81 - 91	0.51	0.32	0.05	1.04	0.80	0.28	88	0.93	0.96	0.67
2Bsm1	91 -117	0.45	0.14	0.04	1.91	1.28	0.66	86.5	1.15	1.06	0.11
2Bsm1	117-142	0.39	0.16	0.04	1.59	0.78	0.61	87	0.86	0.63	0.11
2Bsm2	142-160	0.24	0.06	0.03	0.80	0.72	0.24	97	0.43	0.49	0.11
2Bsm3	160-178	0.21	0.13	0.04	0.54	0.40	0.16	98	0.31	0.28	0.11

Appendix B - Continued
Table B.3. (Continued)

Horizon	Depth (cm)	Alp (%)	Fep (%)	Sip (%)	Alo (%)	Feo (%)	Sio (%)	ox. extr %trans 465nm	Al,d-c (%)	Fe,d-c (%)	Al,KCl (cmol/kg)
DEPOE?											
Profile 38 -- Typic Tropaquod, fine-loamy/sandy, isomesic, ortstein											
A1	0 - 10	0.15	0.10	0.05	0.16	0.11	0.01	88.5	0.14	-0.02	4.11
A2	10 - 20	0.26	0.07	0.05	0.26	0.08	0.01	84.5	0.18	-0.06	7.23
E	20 - 31	0.27	0.07	0.13	0.24	0.07	0.01	72	0.20	0.08	10.23
E/B	31 - 43	0.57	0.00	0.11	0.62	0.18	0.06	78.5	0.77	1.49	5.11
2Bsm1	43 - 69	0.16	0.19	0.06	0.18	0.11	0.03	100	0.54	2.73	1.56
2Bsm2	69 - 94	0.14	0.06	0.04	0.39	0.17	0.18	100	0.24	0.15	0.11
2BC	94 -122	0.10	0.02	0.03	0.37	0.10	0.15	100	0.06	0.03	0.11
2C	122-152	0.07	0.01	0.02	0.26	0.06	0.12	100	0.03	-0.10	0.11
JOENEY?											
Profile 41 -- Typic Tropaquod, fine-silty, isomesic, ortstein											
A	0 - 13	0.22	0.15	0.03	0.19	0.19	0.00	85.5	0.16	0.10	4.56
E	13 - 25	0.10	0.10	0.05	0.09	0.18	0.00	91	0.03	0.20	4.67
BE	25 - 37	0.51	0.49	0.11	0.53	0.54	0.02	52.5	0.62	1.14	4.45
Bh	37 - 38	1.55	0.56	0.13	2.18	1.00	0.25	3	2.27	0.91	4.34
2Bsm1	38 - 53	0.91	0.84	0.16	1.05	0.84	0.09	77.2	2.20	6.80	2.45
2Bsm2	53 - 61	0.52	0.98	0.07	1.34	1.82	0.27	93.5	1.78	6.40	1.11
2C1	61 - 99	0.40	0.26	0.05	1.07	0.80	0.25	99	0.79	1.89	1.89
2C2	99 -142	0.40	0.28	0.11	0.64	0.74	0.08	99.5	0.79	2.71	4.45
2C3	142-158	0.56	0.54	0.14	0.85	2.54	0.10	95.5	1.32	5.80	2.56
EDSON?											
Profile 42 -- Typic Haplohumult, fine-loamy, isomesic											
A	0 - 18	0.46	0.49	0.05	0.51	0.48	0.02	64	0.83	2.56	2.22
2BA	18 - 33	0.97	0.46	0.09	1.16	0.76	0.13	62.8	1.43	3.27	1.22
2Bt1	33 - 53	0.67	0.30	0.09	0.76	0.48	0.08	82	1.28	3.85	1.00
2Bt2	53 - 84	0.31	0.54	0.04	0.28	0.21	0.02	96.5	1.17	5.40	1.45
3Bt3	84 -112	0.17	0.34	0.03	0.19	0.16	0.02	99	1.34	6.90	1.22
3Bt4	112-132	0.10	0.15	0.02	0.20	0.20	0.02	99.2	1.09	6.00	1.00
3BC	132-160	0.09	0.07	0.03	0.15	0.16	0.02	100	1.27	6.50	0.89
3Cr	160.0+	0.08	0.05	0.02	0.17	0.06	0.01	100	0.61	3.00	1.11
ORFORD											
Profile 43 -- Typic Haplohumult, clayey, isomesic											
EA	0 - 8	0.18	0.41	0.04	0.15	0.38	0.01	74.8	0.25	1.02	3.89
BE	8 - 20	0.34	0.79	0.06	0.26	0.63	0.02	82.2	0.54	2.47	4.11
Bt1	20 - 43	0.56	0.74	0.08	0.54	0.38	0.02	87.5	1.19	4.50	4.11
Bt2	43 - 66	0.38	0.59	0.07	0.33	0.36	0.03	95	1.15	4.70	5.56
BC	66 - 91	0.15	0.12	0.03	0.30	0.50	0.04	100	1.11	5.10	3.56
2C1	91 -132	0.08	0.06	0.03	0.17	0.21	0.02	100	0.81	3.60	1.89
2C2	132-160	0.10	0.07	0.03	0.18	0.17	0.02	100	0.79	3.45	2.22

Appendix B - Continued
Table B.3. (Continued)

Horizon	Depth (cm)	Alp (%)	Fep (%)	Sip (%)	Alo (%)	Feo (%)	Sio (%)	ox. extr %trans 465nm	Al,d-c (%)	Fe,d-c (%)	Al,KCl (cmol/kg)
JOENEY?											
Profile 44 -- Typic Tropaquod, fine-silty, isomesic, ortstein-------------------------											
A	0 - 15	0.05	0.04	0.02	0.04	0.08	0.00	100	0.04	0.05	1.67
E	15 - 43	0.05	0.08	0.03	0.05	0.12	0.00	90.2	0.04	0.21	2.67
Bhsm	43 - 58	1.58	0.36	0.06	3.29	0.94	0.69	2.1	1.95	0.50	4.00
Bsm	58 - 74	0.68	0.20	0.04	4.03	1.68	1.46	64.2	2.07	3.90	0.33
BC	74 - 91	0.43	0.22	0.04	1.22	1.02	0.29	93.8	1.31	4.20	1.89
C1	91 -127	0.31	0.28	0.06	0.53	0.72	0.05	100	0.68	2.89	5.89
C2	127-152	0.29	0.16	0.04	1.39	1.20	0.47	95.2	1.08	3.64	1.33

Appendix B - Continued
Table B.4. Particle size distribution analysis

Horizon	Depth (cm)	VCS (%)	CS (%)	MS (%)	FS (%)	VFS (%)	SAND (%)	CO SI (%)	FI SI (%)	TOT SI (%)	CLAY (%)	TEXT
LINT or TEMPLETON												
Profile 32 -- Andic Humitropept, loamy, isomesic												
A	0 - 23	3	3.8	2.7	11.4	5.2	26.1	9.4	41.8	51.2	22.7	sil
AB	23 - 48	2.3	2.3	1.9	10	4.7	21.1	13.9	42.6	56.5	22.4	sil
BA	48 - 71	2	2.3	2.1	12.6	5.2	24.1	17.1	35.8	52.9	23	sil
Bw	71 - 99	1.3	2.9	3.2	15.6	5.6	28.6	16.1	27.8	43.9	27.5	cl
BC	99 -130	2.2	3.6	3.4	24.4	5.6	39.2	9.6	28.4	38	22.8	l
LINT or TEMPLETON												
Profile 33 -- Andic Humitropept, loamy, isomesic												
A	0 - 23	8.9	7.1	4.3	20.4	6	46.6	7.1	24.6	31.7	21.7	l
AB	23 - 36	5.7	6.4	4.2	21.1	6.5	43.8	7	27.2	34.1	22.1	l
BA/A	36 - 69	5.4	6.5	4.4	21.7	6.2	44.3	9.3	26.3	35.6	20.2	l
Bw	69 -119	8.9	8.2	4.5	21.5	5.9	49.1	7.1	21.6	28.7	22.2	scl-l
BC	119-137	9.4	9.7	5.8	24.7	5.9	55.4	7.2	16.5	23.7	20.9	scl-sl
Profile No. 34 -- Andeptic Haplohumult, fine-loamy, isomesic												
A	0 - 23	4.1	2.9	1.4	2.7	3.1	14.1	9.6	56.5	66	19.9	sil
AB	23 - 38	1.9	2.3	1.5	2.8	3.2	11.6	14.9	53.4	68.3	20.2	sil
BA	38 - 56	1.6	2.1	1.3	2.7	2.3	10	12.3	50.6	62.9	27.1	sicl-sil
Bt1	56 - 71	3	3.4	1.9	2.7	2.4	13.4	8.8	41.8	50.6	36	sicl
Bt2	71 - 94	15.2	4.7	2.3	3	1.9	27.1	6.7	39.6	46.3	26.6	gr-l-cl
BC	94 -132	21.1	15.6	6.5	5.2	2.2	50.5	5.5	22.6	28.1	21.4	gr-scl-l
C	132-152	30.7	24.6	8.7	4.7	1.6	70.2	2.5	14.7	17.2	12.6	gr-sl
WOLFER												
Profile No. 35 -- Andic Humitropept, loamy, isomesic												
A1	0 - 15	8.1	7.6	6.5	20.8	6.1	49.1	5.6	27.8	33.4	17.5	gr-l
A2	15 - 38	10.9	6.5	3.4	17	5.2	42.9	6.9	30.2	37.1	20	gr-l
AB	38 - 66	8.7	6.5	3	18	5.6	41.8	8.2	29.4	37.7	20.5	gr-l
BA1	66 - 79	10.8	6.9	2.8	16.7	5.5	42.8	7.6	31.2	38.8	18.4	gr-l
BA2	79 -109	9.9	6.4	2.9	16.6	5.7	41.5	8.8	31.6	40.4	18.1	gr-l
Bw	109-125	9.9	6.6	3.1	17.2	5.8	42.6	8.2	30	38.2	19.3	gr-l
C	125-163	7.7	6.1	3.1	18.5	7.2	42.6	11.1	29.9	41	16.4	gr-l
BANDON-NELSCOTT?												
Profile No. 37 -- Typic Troporthod, coarse-loamy, isomesic, ortstein												
A1	0 - 38	1.3	1.3	1.4	34.6	5.5	44.1	10.1	35.6	45.7	10.2	l
A2	38 - 64	0.6	0.9	1.3	37.4	4.6	44.8	11.1	32	43.1	12.1	l
E/A	64 - 81	0.4	0.8	1.2	39.6	4.7	46.7	10.3	30.4	40.7	12.6	l
2E	81 - 91	0.5	1	1.1	41.9	5.1	49.5	9.3	29.5	38.8	11.6	l
2Bsm1	91 -117	0.2	0.6	2	88.7	2.1	93.5	0.2	3.4	3.6	2.8	fs
2Bsm1	117-142	0.1	0.6	1.3	88.8	2.1	92.8	0.5	3.7	4.3	2.9	fs
2Bsm2	142-160	0	0.1	0.9	95.6	1.1	97.7	0	1.6	1.4	0.9	fs
2Bsm3	160-178	0	0.2	1.2	95.2	1.4	97.9	0	2	1.8	0.4	fs

Appendix B - Continued
Table B.4. (Continued)

Horizon	Depth (cm)	VCS (%)	CS (%)	MS (%)	FS (%)	VFS (%)	SAND (%)	CO SI (%)	FI SI (%)	TOT SI (%)	CLAY (%)	TEXT
DEPOE?												
Profile No. 38 -- Typic Tropaquod, fine-loamy/sandy, isomesic												
A1	0 - 10	0.9	0.7	0.6	9.2	3.8	15.1	15	50.6	65.6	19.3	sil
A2	10 - 20	0.2	0.8	1	12.4	3.2	17.6	15.4	47.7	63.1	19.4	sil
E	20 - 31	0.1	0.1	0.4	13.6	2.6	16.7	15.4	41	56.4	26.8	sil-sicl
E/B	31 - 43	0.1	0.1	0.3	15	4.5	19.8	13.1	32.4	45.6	34.6	cl-sicl
2Bsm1	43 - 69	1.7	3.7	2.7	60	8.7	76.8	5.5	9	14.5	8.7	fsl-lfs
2Bsm2	69 - 94	0.2	1.1	4.4	85.8	2.8	94.3	1.6	3	4.6	1.1	fs
2BC	94 -122	0	2.3	6.3	89.3	0.5	98.4	0.7	0.6	1.3	0.3	fs
2C	122-152	0.1	2.3	9.7	87.1	0.1	99.3	0.1	0.7	0.7	0	fs
JOENEY?												
Profile No. 41 -- Typic Tropaquod, fine-silty, isomesic, ortstein												
A	0 - 13	1.7	1.6	0.6	2.3	4.3	10.5	17.3	59.4	76.7	12.8	sil
E	13 - 25	0.1	0.1	0.2	0.8	2.4	3.6	24.0	59.0	83.0	13.5	sil
BE	25 - 37	0.6	0.4	0.2	0.9	2.8	5.0	22.5	48.7	71.2	23.8	sil
Bh	37 - 38	3.3	2.8	1.2	2.1	3.5	12.8	17.3	51.6	68.9	18.3	sil
2Bsm1	38 - 53	1.5	2.7	1.5	2.7	3.1	11.5	15.1	30.5	45.7	42.8	sic
2Bsm2	53 - 61	2.3	3.9	1.4	2	3.1	12.7	19.1	35.9	55.0	32.3	sicl
2C1	61 - 99	1.5	1.2	0.5	1.1	3.1	7.5	20.7	42.8	63.4	29.1	sicl
2C2	99 -142	0.8	0.8	0.5	1.8	4.5	8.4	15.1	43.9	59.0	32.6	sicl
2C3	142-158	0.6	1.1	0.6	1.7	4.2	8.2	17.3	48.7	66.0	25.8	sil
EDSON?												
Profile No. 42 -- Typic Haplohumult, fine-loamy, isomesic												
A	0 - 18	1.4	4.6	9.7	16.0	6.2	38.0	2.8	34.7	37.5	24.5	l
2BA	18 - 33	0.6	3.6	9.4	13.9	5.1	32.5	6.7	42.2	48.9	18.5	l-sil
2Bt1	33 - 53	0.5	2.2	10.6	13.2	4.5	31.1	8.1	35.7	43.9	25.0	l
2Bt2	53 - 84	0.7	3.0	13.0	13.2	3.5	33.4	7.0	24.5	31.5	35.1	cl
3Bt3	84 -112	5.1	10.0	23.2	12.9	2.1	53.2	1.7	11.4	13.2	33.6	scl
3Bt4	112-132	0.4	10.1	22.3	17.3	2.0	52.1	0.4	8.8	9.2	38.8	sc
3BC	132-160	2.2	22.0	19.8	15.7	2.0	61.8	0.9	8.7	9.6	28.6	scl
3Cr	160.0+	0.7	13.7	11.1	14.9	2.3	42.8	0.0	8.5	8.0	49.3	c
ORFORD												
Profile No. 43 -- Typic Haplohumult, clayey, isomesic												
EA	0 - 8	0.6	2.4	1.8	4.4	4.8	14.0	18.1	50.4	68.5	17.5	sil
BE	8 - 20	0.2	0.7	1.4	2.8	2.7	7.8	16.0	50.0	66.1	26.1	sil-sicl
Bt1	20 - 43	0.2	0.4	1.9	3.4	3.0	8.9	14.3	29.6	43.9	47.2	sic
Bt2	43 - 66	0.4	0.8	4.1	6.2	2.6	14.2	10.6	24.8	35.4	50.4	c
BC	66 - 91	0.3	1.8	10.3	12.7	3.2	28.3	9.3	21.4	30.6	41.0	c-cl
2C1	91 -132	2.1	7.6	20.8	24.3	4.8	59.7	6.1	9.8	15.9	24.4	scl
2C2	132-160	1.2	9.1	23.5	27.2	4.5	65.5	3.6	8.7	12.2	22.3	scl-sl

Appendix B - Continued
Table B.4. (Continued)

Horizon	Depth (cm)	VCS (%)	CS (%)	MS (%)	FS (%)	VFS (%)	SAND (%)	CO SI (%)	FI SI (%)	TOT SI (%)	CLAY (%)	TEXT
JOENEY?												
Profile No. 44 -- Typic Tropaquod, fine-silty, isomesic, ortstein----------------------------												
A	0 - 15	0.1	0.3	0.2	0.8	3.3	4.8	20.1	64.1	84.3	11.0	silt
E	15 - 43	0.0	0.1	0.2	0.9	3.2	4.5	26.4	60.6	86.9	8.6	silt
Bhsm	43 - 58											
Bsm	58 - 74											
BC	74 - 91	0.4	1.8	0.8	1.3	4.4	8.7	19.9	45.9	65.8	25.5	sil
C1	91 -127	1.0	1.7	1.3	3.1	4.9	12.0	16.2	42.3	58.5	29.5	sicl
C2	127-152	3.8	7.7	2.7	6.0	5.9	26.0	7.7	38.3	46.0	28.0	cl-l