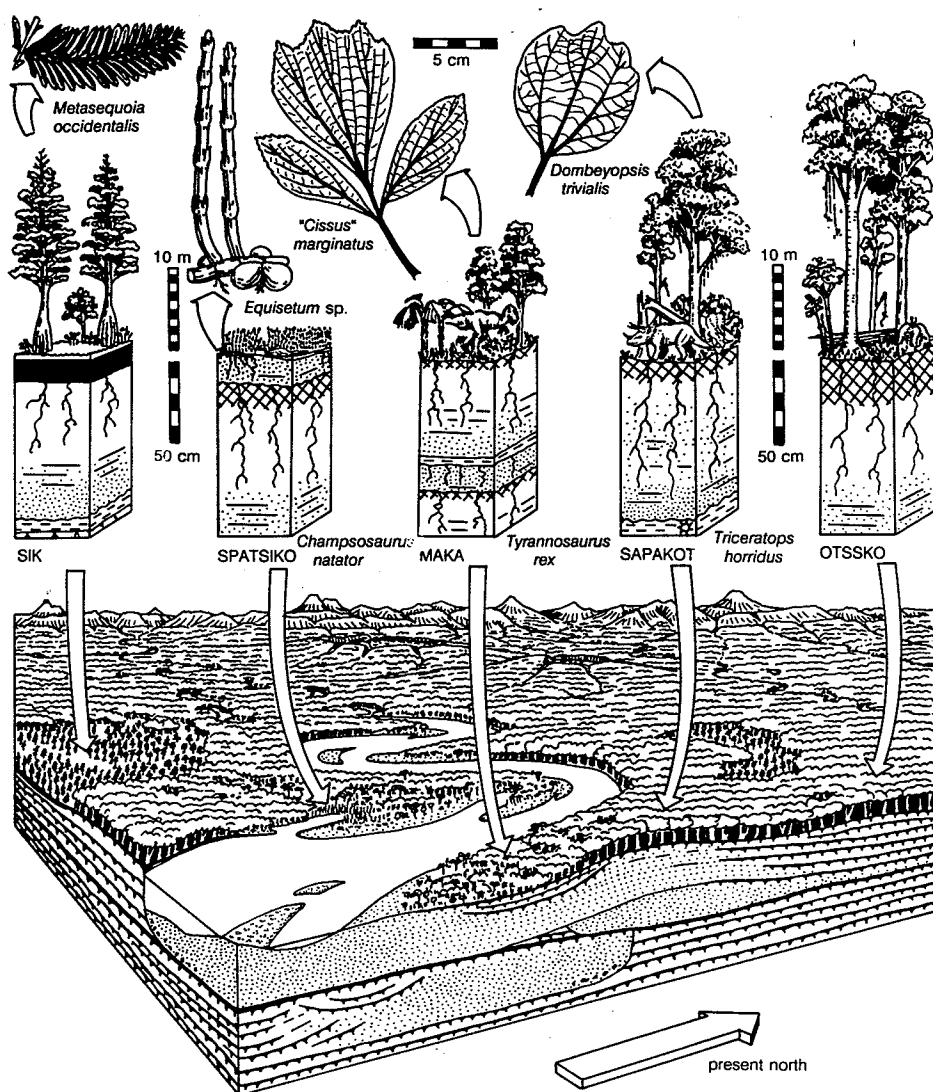


CHEMICAL AND PETROGRAPHIC DATA FOR PALEOSOLS ACROSS THE CRETACEOUS-TERTIARY BOUNDARY IN MONTANA by Gregory J. Retallack



Cretaceous deposition of Hell Creek Formation

Dept. Geological Sciences, Univ. Oregon,
Eugene, 97403

GSA DEPOSITORY ITEM 9425 to following paper
Retallack, G.J., 1994. A pedotype approach to latest Cretaceous and earliest Tertiary paleosols in eastern Montana. *Bulletin of the Geological Society of America*, v. 106, p. 1377-1397.

APPENDIX 1. Individual named Cretaceous and Tertiary paleosols in Bug Creek, Montana

Measured section	Section Level (m)	Paleosol Number	Name
Russell Basin Knoll	2.0	1	type Sapakot clay
	3.2	2	type Otssko clay
	3.3	3	type Spatsiko silty clay loam
	4.3	4	type Maka clay
	9.2	7	Sikahk coal thin surface phase
	12.0	11	Sik coal tonstein-bearing variant
Russell Basin Cliff	9.2	7	type Sikahk coal
	35.2	20	Sik coal stump-bearing variant
	37.4	23	type Sik coal
	40.8	24	Sik coal thick surface phase
	53.0	30	type Komono clay

Note: Paleosol numbers are the stratigraphic order of paleosols in the measured section.

APPENDIX 2. Munsell colors of selected Cretaceous and Tertiary paleosols in Bug Creek Montana

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
type Sapakot clay	A	R604	black (5Y2.5/2)	weathers brown to dark brown (7.5YR4/2)
	A	R605	pale olive (5Y6/4)	root traces dark grayish brown (10YR4/2): weathers light gray to gray (5Y6/1)
	Bw	R606	pale yellow (5Y7/3)	weathers light olive (5Y6/2)
	C	R608	olive gray (5Y5/2)	weathers light olive (5Y6/2)
	C	R609	light gray (5Y7/2)	weathers light gray (5Y7/1)
	Cg	R610	light gray (5Y7/2)	root traces very dark grayish brown (10YR3/2); pyrite nodules olive yellow (2.5Y6/6), with weathering rind of brownish yellow (10YR6/8)
type Ottsko clay	A	R598	dark grayish brown (2.5Y4.2)	root traces reddish brown (5YR5/3); joint faces yellowish brown (10YR5/4); gypsum crystals light gray (2.5Y7/2) to pale yellow (2.5Y7/4) around fossil twigs of yellow (10YR7/6); weathers light gray (5Y7/2)
	A	R599	olive gray (5Y4/2)	weathers light gray (5Y7/2)
	Bt	R600	dark olive gray (5Y3/2)	mangans dark bluish gray (5B4/1): weathers light olive gray (5G4/1)
	Bt	R601	dark olive gray (5Y3/2)	weathers light olive gray (5Y6/2)
	C	R602	very dark grayish brown (10YR3/2)	joint faces yellowish brown (10YR5/4): weathers light olive gray (5Y6/2)
	C	R603	very dark grayish brown (10YR3/2)	weathers light olive gray (5Y6/2)
type Spatsiko silty clay loam	A	R596	dark yellowish brown (10YR4/4 to 4/6)	weathers light olive gray (5Y6/2)
	A	R597	olive yellow (2.5Y6/4)	root traces dark brown (10YR3/3): joint faces yellowish red (10YR5/6): weathers light olive gray (5Y6/2)
shale,3.3m,knoll type Maka clay	-	R595	very dark gray (5Y3/1)	weathers light olive gray (5Y6/2)
	A	R592	very dark gray (5Y4/1)	weathers light gray (2.5Y7/2)
	A	R593	dark olive gray (5Y3/2)	clayey laminae of dark gray (5Y3/1), silty laminae of (very dark gray (5Y3/2): weathers light olive gray (5Y6/2)
	C	R594	light gray (2.5Y7/2)	clayey laminae light gray (5Y7/2): plant debris dark grayish brown (2.5Y4/2): weathers light gray (5Y7/2)
Otssko at 5.8m, knoll	A	none	gray (10YR5/1)	root traces very dark brown (10YR2/2) to black (10YR2/1): joint faces strong brown (7.5YR5/6): weathers light gray to gray (5Y6/1)
	Bt	none	very dark gray (5Y3/1)	root traces very dark gray (10YR3/1): weathers light olive gray (5Y3/1)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
	Cg	R591	gray (10YR5/1)	siderite nodule weathering rind strong brown (7.5YR4/6) with surface patina strong brown (7.5YR5/8)
	C	R590	dark grayish brown (10YR4/2)	weathers light yellowish brown (2.5Y6/4)
Otssko at 5.8m, cliff	A	none	very dark gray (5Y3/1)	weathers gray 5Y5/1
	Bt	none	olive gray (5Y5/2)	weathers gray (5Y5/1)
Maka at 6.3m, knoll	A	R582	olive gray (5Y4/2)	weathers light olive gray (5Y6/2)
	C	none	dark olive gray (5Y3/2)	weathers light olive gray (5Y6/2)
Maka at 7.6m, cliff	A	none	dark olive gray (5Y3/2)	weathers gray (5Y5/1)
	C	none	grayish brown (2.5Y5/2)	weathers gray (5Y5/1)
Sikahk coal thin surface phase	O	R576	dark bluish gray (5B3/1)	weathers bluish gray (5B6/1)
	A	R577	very dark grayish brown (10YR3/2)	weathers bluish gray (5B5/1)
	A	R578	light gray (2.5Y7/2)	root traces black (10YR2/1) and strong brown (7.5YR4/6); joint faces strong brown (7.5YR5/8); weathers light gray (5Y7/1)
	Bt	R579	light yellowish brown (2.5Y6/4)	root traces very dark grayish brown (10YR3/2), brown to very dark brown (7.5YR5/6) and strong brown (7.5YR5/6); sesquans strong brown (7.5YR5/6); weathers light gray to gray (5Y6/1)
	Bt	R580	light brownish gray (2.5Y6/2)	sesquans strong brown (7.5YR5/6); weathers gray (5Y5/1)
	C	R581	light yellowish brown (2.5Y6/4)	weathers light olive gray (5Y6/2)
type Sikahk coal	O	R541, R542	very dark gray (10YR3/1) to black (10YR2/1)	jarosite stain of yellow (5Y8/6); weathers dark gray (5Y4/1)
	A	R543, R544	dark grayish brown (2.5Y4/2)	root traces very dark brown (10YR2/2); weathers dark gray (5Y4/1)
	Bt	R545, R546	very dark grayish brown (2.5Y3/2)	sesquans yellowish brown (10YR5/6) and brownish yellow (10YR6/6); weathers gray (5Y5/1)
	C	R547, R548	olive gray (5Y5/2)	weathers gray (5Y5/1)
Sik at 8.0m, knoll	O	R572, R573	black (10YR2/1)	sesquans light olive brown (2.5Y5/6); weathers dark gray (2.5Y4/1)
	A	R574	dark gray (5Y4/1)	weathers gray (2.5Y5/1)
	C	R575	black (10Y2/1)	weathers dark gray (2.5Y4/1)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
Sik at 9.1m, cliff	O	R539	black (10YR2/1)	jarosite stain yellow (2.5Y8/8): weathers very dark gray (10YR3/1)
	A	none	very dark gray (10YR3/1)	root traces very dark grayish brown (2.5Y3/2): weathers grayish brown (2.5Y5/2)
	C	R540	grayish brown (10YR5/2)	weathers grayish brown (2.5Y5/2)
Sik at 8.9m, knoll	O	none	very dark gray (5Y3/1)	weathers gray (5Y5/1)
	A	none	olive gray (5Y7/2)	argillans dark yellowish brown (10YR4/4): weathers light gray to gray (5Y6/1)
Sik at 9.8m, cliff	C	R571	olive gray (5Y4/2)	weathers light gray (5Y7/1)
	O	none	black (7.5YR2/1)	layers brown to dark brown (7.5YR4/4): jarosite powder yellow (2.5Y8/8): weathers brown (7.5YR5/2)
shale, 10.2m, cliff	C	R538	black (10YR2/1)	weathers olive gray (5Y5/2)
	-	none	dark grayish brown (2.5Y4/2)	weathers grayish brown (2.5Y4/2)
Sik at 10.4m, knoll	O	R564	black (10YR2/1)	layers very dark grayish brown (10YR6/4): jarosite powder yellow (2.5Y8/8): weathers dark gray (10YR4/1)
	A	none	grayish brown (10YR5/2)	root traces dark yellowish brown (10YR4/4) and black (10YR2/1): sesquans brownish yellow (10YR6/6): weathers grayish brown (2.5Y5/2)
	C	none	grayish brown (2.5Y5/2)	root traces dark brown (10YR3/3): weathers light brownish gray (2.5Y6/2)
	C	none	light olive gray (5Y6/2)	root traces strong brown (7.5YR5/6): weathers light gray (5Y7/2)
	C	none	light olive gray (5Y6/2)	root traces dark yellowish brown (10YR3/6): burrows olive gray (5Y4/2): weathers light gray (5Y7/2)
	A	none	dark grayish brown (2.5Y4/2)	weathers light olive gray (5Y6/2)
Maka at 10.6m, cliff	C	none	dark grayish brown (2.5Y4/2)	weathers light olive gray (5Y6/2)
	O	R551	black (5Y2.5/1)	weathers very dark gray (5Y3/1)
Sik coal tonstein-bearing, in knoll	O	R552	olive gray (5Y5/2)	root traces dark grayish brown (10YR3/2): weathers olive gray (5Y4/2)
	O	R553	black (5Y2.5/1)	root traces very pale brown (10YR7/3): mangans dark bluish gray (5B3/1): weathers very dark gray (5Y3/1)
	A	R554	light gray (5Y7/2)	root traces and plant chaff very dark grayish brown (10YR3/2): weathers grayish brown (2.5Y6/2)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
	A	R555	grayish brown (2.5Y5/2)	weathers grayish brown (2.5Y6/2)
	C	R556	grayish brown (2.5Y5/2)	root traces dark yellowish brown (10YR4/4): weathers grayish brown (10YR6/2)
	C	R557	dark grayish brown (2.5Y4/2)	weathers grayish brown (2.5Y6/2)
	Cg	R558	dark grayish brown (2.5Y4/2)	weathers grayish brown (2.5Y6/2)
	Cg	R559	dark brown (7.5YR3/4)	samples of siderite nodules with mottles dark brown (7.5YR4/4) and weathering rind brownish yellow (10YR6/6)
	Cg	R560	grayish brown (2.5Y5/2)	weathers grayish brown (2.5Y5/2)
	Cg	R561	dark grayish brown (2.5Y4/2)	weathers grayish brown (2.5Y6/2)
	Cg	R562	yellowish brown (2.5Y5/2)	silty laminae pale brown (10YR6/3) and clayey laminae dark brown (10YR4/3): weathers dark gray (10YR4/1)
	Cg	R563	dark brown (7.5YR3/4)	samples of siderite nodules with mottles dark brown (7.5YR4/4) and weathering rind brownish yellow (10YR6/6)
Sik coal tonstein- bearing, in cliff	O	none	black (7.5YR2/1)	layers dark brown (7.5YR3/2): tonstein band very dark gray (5Y3/1), with root traces dark brown (7.5YR4/2): weathers light brownish gray (2.5Y6/1)
	A	none	dark grayish brown (2.5Y4/2)	silty laminae light gray (2.5Y7/2): root traces and plant chaff dark brown (10YR4/3): sesquans brownish yellow (10YR6/8): weathers light brownish gray (2.5Y6/1)
	C	none	pale olive (5Y6/3)	jarosite nodules yellow (10YR7/6): weathers light olive gray (5Y6/2)
shale, 12m knoll	-	R550	light gray (5Y7/2)	weathers light olive gray (5Y6/2)
sandstone, 12m cliff	-	none	light gray (5Y7/2)	jarosite nodules yellow (5Y6/2) and brownish yellow (10YR6/8): weathers light olive gray (5Y6/2)
sandstone, 12.8m	-	none	light gray (2.5Y7/2)	log nodule with weathering rind strong brown (7.5YR5/6): weathers light gray (2.5Y7/2)
sandstone, 14m	-	none	light brownish gray (2.5Y6/2)	weathers light gray (2.5Y7/2)
Sik at 16.4m	O	none	black (7.5YR2/1)	layers dark brown (7.5YR3/2): weathers very dark gray (10YR3/1)
	A	none	grayish brown (2.5Y5/2)	root traces very dark grayish brown (10YR3/2): weathers gray (5Y5/1)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
shale, 16.5 m	C	none	light gray (2.5Y6/2)	weathers light olive gray (5Y6/2)
	-	none	black (7.5YR2/1)	layers brown to dark brown (7.5YR4/2): weathers grayish brown (2.5Y5/2)
shale, 16.8 m	-	none	light brownish gray (2.5Y6/2)	weathers light gray (2.5Y7/2)
shale, 17 m	-	none	light olive gray (5Y6/2)	siderite nodular bands weather yellowish brown (10YR5/8): overall weathers light gray (5Y7/2)
sandstone, 18m	-	none	light gray (2.5Y7/2)	carbonaceous laminae brown (7.5YR5/4); pyritic nodules weathers yellow (2.5Y8/8 and 2.5Y7/8): weathers light gray (5Y7/2)
siltstone, 18.2m	-	none	light brownish gray (2.5Y6/2)	weathers light brownish gray (2.5Y6/2)
sandstone, 18.4m	-	none	light gray (2.5Y7/2)	weathers light gray (2.5Y7/2)
siltstone, 18.6m	-	none	light brownish gray (2.5Y6/2)	sideritic nodular band weathers yellowish brown (10YR5/8), with drab halo of light olive gray (5Y6/2); weathers light gray (5Y7/2)
sandstone, 18.9m	-	none	light gray (2.5Y7/2)	weathers light gray (2.5Y7/2)
shale, 19.4m	-	none	light brownish gray (2.5Y6/2)	sideritic nodular bands grayish brown (2.5Y5/2), weathering dusky red (2.5YR4/2), with weathering rind brown to dark brown (7.5YR4/4) and surface coating red (2.5YR3/2); weathers light olive gray (5Y6/2)
sandstone, 20.4m	-	none	light gray (2.5Y7/2)	carbonaceous partings with plant chaff dark grayish brown (10YR4/2); pyrite nodules weathered yellow (5Y8/6 and 2.5Y7/8): weathers light gray (2.5Y7/2)
siltstone, 20.6m	-	none	light brownish gray (2.5Y6/2)	sideritic band grayish brown (2.5Y5/2), with weathering rind brown to dark brown (7.5YR4/4) and surface film red (2.5YR5/2); weathers light olive gray (5Y6/2)
siltstone, 21.2m	-	none	light brownish gray (2.5Y6/2)	weathers light brownish gray (2.5YR6/2)
Maka at 21.9m	A	none	very dark gray (5Y3/1)	root traces light brown (7.5YR6/4) and brown (7.5YR5/4); weathers gray (5Y5/1)
	A	none	light olive gray (5Y6/2)	root traces strong brown (7.5YR5/6 & 5/8): weathers gray (5Y5/1)
	C	none	light brownish gray (2.5Y6/2)	root traces yellowish brown (10YR5/6); weathers gray (5Y5/1)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
Maka at 22.2m	A	none	dark grayish brown (2.5Y4/2)	plant chaff dark brown (7.5YR3/2) and strong brown (7.5YR5/6); weathers grayish brown (2.5Y5/2)
	C	none	olive gray (5Y7/2)	root trace strong brown (7.5YR5/8); weathers gray (5Y7/1)
Sik at 22.7m	O	none	black (7.5YR2/1)	weathers very dark gray (7.5YR3/1)
	O	none	dark brown (7.5YR3/2)	laminae brown to dark brown (7.5YR4/2); weathers brown (10YR5/3)
	O	none	black (7.5YR2/1)	weathers very dark gray (7.5YR3/1)
	A	none	pale brown (10YR6/3)	root traces brown (7.5YR5/4); sesquans yellowish brown (10YR5/8); weathers grayish brown (2.5Y5/2)
siltstone, 23.0m	A	none	very dark gray (10YR3/1)	laminar pyrite nodules yellow (2.5Y7/6); weathers grayish brown (2.5Y5/2)
	A	none	light brownish gray (2.5Y6/2)	root traces brownish yellow (10YR6/6); weathers grayish brown (2.5Y5/2)
	-	none	light brownish gray (2.5Y6/2)	plant chaff strong brown (7.5YR5/8) and dark brown (7.5YR3/2); sideritic band weathered strong brown (7.5YR5/8) and brownish yellow (10YR6/8); weathers light yellowish brown (2.5Y6/4)
siltstone, 23.5m	-	none	light yellowish brown (2.5Y6/4)	plant chaff brown (10YR5/3); weathers light yellowish brown (2.5Y6/4)
Maka at 24.1m	A	none	grayish brown (2.5Y5/2)	root traces strong brown (7.5YR5/6); weathers light brownish gray (2.5Y6/2)
sandstone, 24.2m	-	none	light olive gray (5Y6/2)	pyrite nodules yellow (5Y8/6); weathers light brownish gray (2.5Y6/2)
Maka at 24.6m	A	none	grayish brown (2.5Y5/2)	root traces dark grayish brown (10YR4/2); weathers light brownish gray (2.5Y6/2)
Sik at 25.4m	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers very dark gray (7.5YR3/1)
	A	none	brown (7.5YR5/4)	root traces dark brown (7.5YR3/2) and black (7.5YR2/1); weathers pale brown (10YR6/3)
	C	none	light gray (2.5Y7/2)	root traces dark grayish brown (10YR4/2); weathers light brownish gray (2.5Y6/2)
sandstone, 25.8m	-	none	light brownish gray (2.5Y6/2)	pyrite nodules yellow (10YR7/8), with weathering rind strong brown (7.5YR4/6) and surface yellow (5Y8/8); weathers light brownish gray (2.5Y6/2)
sandstone, 26.0m	-	none	light brownish gray (2.5Y6/2)	siderite nodules strong brown (7.5YR5/6); weathers light brownish gray (2.5Y6/2)
siltstone, 28.5m	-	none	dark grayish brown (2.5Y4/2)	siderite nodules vary dark grayish brown (2.5Y3/2), with weathering rind weak red

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
siltstone, 29.0m	-	none	light brownish gray (2.5Y6/2)	(2.5YR4/2) to dusky red (2.5YR3/2); weathers grayish brown (2.5Y5/2) weathers light yellowish brown (2.5Y6/4)
sandstone, 29.8m	-	none	light gray (2.5Y7/2)	weathers light brownish gray (2.5Y6/2)
siltstone, 30.0m	-	none	light brownish gray (2.5Y6/2)	weathers light yellowish brown (2.5Y6/4)
siltstone, 30.3m	-	none	light gray (2.5Y7/2)	weathers light yellowish brown (2.5Y6/4)
Maka at 31.8m	A	none	light gray (2.5Y7/2)	root traces strong brown (7.5YR5/8); weathers light olive gray (5Y6/2)
	A	none	light gray (2.5Y7/2)	relict beds dark brown (7.5YR3/4) and strong brown (7.5YR4/6); weathers light olive gray (5Y6/2)
	A	none	light gray (2.5Y7/2)	root traces strong brown (7.5YR5/8); weathers light olive gray (5Y6/2)
	C	none	light brownish gray (2.5Y6/2)	weathers light brownish gray (2.5Y6/2)
Sik at 34.1 m	O	R522	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers very dark gray (5Y3/1)
	A	none	dark olive gray (5Y3/2)	weathers light gray (5Y7/2)
	A	none	olive gray (5Y5/2)	weathers into beds of brownish yellow (10YR6/8) and dark brown (10YR3/3)
	A	none	dark grayish brown (2.5Y4/2)	root traces dark brown (7.5YR3/2) and strong brown (7.5YR5/8); weathers gray to light gray (5Y6/1)
	A	none	dark grayish brown (2.5Y4/2)	root traces dark brown (10YR3/3) and yellowish brown (10YR5/8); weathers gray to light gray (5Y6/1)
	Bw	none	light gray (2.5Y7/2)	root traces yellowish brown (10YR5/4); weathers gray to light gray (5Y6/1)
	A	none	light brownish gray (2.5Y6/2)	root traces strong brown (7.5YR5/8); weathers light olive gray (5Y6/2)
	C	none	light gray (2.5Y7/2)	weathers light olive gray (5Y6/2)
Sik stump-bear.	O	R518	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); jarosite stain yellow (5Y8/8); weathers light brownish gray (2.5Y6/2)
	A	R519	grayish brown (2.5Y5/2)	root traces yellowish brown (10YR5/8); weathers light brownish gray (2.5Y6/2)
	A	R520	light gray (2.5Y7/2)	laminae grayish brown (2.5Y5/2); root traces strong brown (7.5YR5/8); weathers light brownish gray (2.5Y6/2)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
Sik at 35.6 m	C	R521	dark grayish brown (2.5Y4/3)	plant chaff strong brown (7.5YR5/8); weathers light brownish gray (2.5Y6/2)
	O	R516	dark brown (7.5YR3/2)	stumps black (7.5YR2/1); weathers dark gray (10YR4/1)
	A	R517	brown (10YR5/2)	plant chaff dark brown (7.5YR3/2); charcoal black (7.5YR2/1); weathers light yellowish brown (2.5Y6/4)
Maka at 35.7 m	C	none	grayish brown (10YR4/2)	leaves brown to dark brown (10YR4/2); weathers light brownish gray (2.5Y6/2)
	-	R515	light brownish gray (2.5Y6/2)	root traces strong brown (7.5YR4/6) and brownish yellow (10YR6/8); weathers light yellowish brown (2.5Y6/4)
type Sik coal	O	R505	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers very dark gray (5Y3/1)
	O	R506	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); root traces brown (7.5YR3/2); weathers very dark gray (5Y3/1)
	A	R507	light brown (7.5YR6/4)	mottles pink (7.5YR7/4) and strong brown (7.5YR5/8); weathers very pale brown (10YR7/3)
	A	R508	pale brown (10YR6/3)	root traces brown (7.5YR5/4) and pink (7.5YR7/4); weathers light gray (2.5Y7/2)
	Bw	R509	grayish brown (2.5Y6/2)	root traces strong brown (7.5YR5/8); weathers light olive gray (5Y6/2)
	C	R510	light brownish gray (2.5Y6/2)	plant chaff strong brown (7.5YR5/6) and brown (7.5YR5/4); joints light yellowish brown (2.5Y6/4) and strong brown (7.5YR5/6); weathers light olive gray (5Y6/2)
	C	R511	grayish brown (2.5Y5/2)	root traces yellowish brown (10YR5/6); joints dark yellowish brown (10YR4/6) and yellowish brown (10YR5/6); weathers light yellowish brown (2.5Y6/4)
	C	R512	light brownish gray (2.5Y6/2)	root traces light yellowish brown (2.5Y6/4); beds light yellowish brown (2.5Y6/4) and brownish yellow (10YR6/8); weathers light yellowish brown (10YR5/6)
	Cg	R513	light brownish gray (2.5Y6/2)	root traces strong brown (7.5YR5/8); beds brownish yellow (10YR6/8) and light yellowish brown (2.5YR6/4); weathers light yellowish brown (2.5YR6/4)
	Cg	R514	light brownish gray (2.5Y6/2)	siderite nodules with weathering rind strong brown (7.5YR5/6)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
sandstone, 37.3m	-	R504	light brownish gray (2.5Y6/2)	siderite bands brownish yellow (10YR6/8) and yellowish brown (10YR5/8); weathers light brownish gray (2.5Y6/2)
siltstone, 38.0m	-	none	light brownish gray (2.5Y6/2)	calcareous nodules gray (5Y5/1) with weathering rind reddish yellow (7.5YR6/8); weathers light brownish gray (2.5Y6/1)
shale, 38.2m	-	none	grayish brown (2.5Y5/2)	weathers grayish brown (2.5Y5/2)
siltstone, 38.5m	-	none	light gray (2.5Y7/2)	weathers light gray (2.5Y7/2)
shale, 38.7m	-	none	dark gray (10YR4/1)	weathers grayish brown (2.5Y4/2)
Maka at 38.8m	-	none	light gray (2.5Y7/2)	root traces brownish yellow (10YR6/6); weathers light brownish gray (2.5Y6/2)
siderite nodules, 39.0m	-	none	dark gray (5Y4/1)	weathers dark reddish brown (5YR3/2) and strong brown (7.5YR5/8)
sandstone, 39.2m	-	none	light gray (2.5Y7/2)	calcareous nodules weather yellowish brown (10YR5/4); matrix weathers light brownish gray (2.5Y6/2)
sandstone, 40.0m	-	none	light gray (2.5Y7/2)	weathers light brownish gray (2.5Y6/2)
Sik thick surface	O	R486	black (7.5YR2/1)	laminae brown (7.5YR5/4); weathers grayish brown (2.5Y5/2)
	O	R487	light brown (7.5YR6/4)	weathers grayish brown (2.5Y5/2)
	O	R488	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers grayish brown (2.5Y5/2)
	O	R489	light brown (7.5YR6/4)	weathers dark grayish brown (2.5Y5/2)
	O	R490	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers grayish brown (2.5Y5/2)
	O	R491	brown (7.5YR5/4)	weathers grayish brown (2.5Y5/2)
	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers grayish brown (2.5Y5/2)
	O	R492	pinkish gray (7.5YR6/2)	root traces brown to dark brown (7.5YR4/2); sesquans reddish yellow (7.5YR6/8); weathers grayish brown (2.5Y5/2)
	O	R494	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); sesquans strong brown (7.5YR4/6); weathers grayish brown (7.5YR4/6)
	A	R495	brown (7.5YR5/2)	weathers grayish brown (10YR5/2)
	A	R496	light brownish gray (10YR6/2)	weathers light brownish gray (10YR6/2)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
	A	R497	light gray (2.5Y7/2)	root traces dark grayish brown (10YR4/2) and brown to dark brown (10YR4/3); weathers brownish gray (2.5Y6/2)
	C	R498	light brownish gray (2.5Y6/2)	plant chaff brown (7.5YR5/2); weathers light brownish gray (2.5Y6/2)
	C	R499	light brownish gray (2.5Y6/2)	weathers light brownish gray (2.5Y6/2)
	C	R500	light brownish gray (2.5Y6/2)	weathers light brownish gray (2.5Y6/2)
	C	R501	grayish brown (2.5Y5/2)	weathers grayish brown (2.5Y5/2)
	C	R502	light yellowish brown (2.5Y6/4)	pyrite nodules brownish yellow (10YR6/4) and strong brown (7.5YR5/8); weathers light brownish gray (2.5Y6/2)
	C	R503	light yellowish brown (2.5Y6/4)	weathers light brownish gray (2.5Y6/2)
siltstone 42.3 m	-	R485	light brownish gray (2.5Y6/2)	weathers light yellowish brown (2.5Y6/4)
siltstone, 43.0m	-	none	light yellowish brown (2.5Y6/4)	siderite band strong brown (7.5YR5/8); weathers light yellowish brown (2.5Y6/4)
siltstone, 43.8m	-	none	yellow (2.5Y7/6)	weathers light yellowish brown (2.5Y6/4)
Sik at 45.3m	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2) and dark brown (7.5YR3/2); weathers dark gray (5Y4/1)
	A	none	grayish brown (2.5Y5/2)	root traces brown to dark brown (7.5YR4/2); sesquans brownish yellow (10YR6/8); weathers grayish brown (7.5Y5/2)
	Bw	none	light gray (2.5Y7/2)	root traces brown to dark brown (7.5YR4/2); weathers dark grayish brown (2.5Y6/2)
	C	none	light gray (2.5Y7/2)	weathers grayish brown (2.5Y5/2)
Sik at 45.9m	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers gray (10YR5/1)
	A	none	light brownish gray (10YR6/2)	root traces brown to dark brown (7.5YR3/2); laminae grayish brown (10YR5/2); weathers grayish brown (2.5Y5/2)
	Bw	none	light gray (10YR7/2)	root traces brown to dark brown (7.5YR4/2); weathers grayish brown (2.5Y5/2)
	C	none	very dark grayish brown (10YR3/2)	sesquans light brown (7.5YR6/4); weathers light olive gray (5Y6/2)
shale, 46.0m	-	none	dark gray (10YR4/1)	plant chaff brown to dark brown (7.5YR4/2); sesquans olive yellow (2.5Y6/6); weathers olive gray (5Y5/2)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
Sik at 47.6m	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers light brownish gray (10YR6/2)
	A	none	dark grayish brown (2.5Y4/2)	root traces dark brown (7.5YR3/2 and 7.5YR3/4); weathers light brownish gray (2.5Y6/2)
shale, 47.7m	-	none	very dark gray (10YR3/1)	plant debris dark brown (7.5YR3/2); logs black (7.5YR2/1); sesquans strong brown (7.5YR5/8); weathers light brownish gray (2.5Y6/2)
Sik at 48.9m	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers light brownish gray (2.5Y6/2)
	A	none	very dark gray (7.5YR3/1)	root traces dark brown (7.5YR3/2); weathers light brownish gray (2.5Y6/2)
	Bw	none	grayish brown (2.5Y5/2)	root traces strong brown (7.5YR4/6 and 7.5YR5/8); weathers light brownish gray (2.5Y6/2)
siltstone, 49.0m	-	none	dark grayish brown (2.5Y4/2)	logs black (7.5YR2/1); siderite nodules dark grayish brown (2.5Y4/2), with weathering rind dark reddish gray (5YR4/2) and strong brown (7.5YR5/8); weathers light brownish gray (2.5Y6/2)
siltstone, 49.1m	-	none	light brownish gray (2.5Y6/2)	weathers light brownish gray (2.5Y6/2)
sandstone, 49.3m	-	none	light gray (2.5Y7/2)	weathers strong brown (7.5YR5/6)
Maka at 50.9m	A	none	grayish brown (10YR5/2)	weathers light grayish brown (2.5Y6/2)
	A	none	light olive brown (2.5Y5/4)	root traces dark grayish brown (10YR4/2); weathers light brownish gray (2.5Y6/2)
	Bw	none	grayish brown (2.5Y5/2)	weathers light brownish gray (2.5Y6/2)
	C	none	light brownish gray (2.5Y6/2)	weathers light brownish gray (2.5Y6/2)
type Komono clay	A	R466	very dark grayish brown (10YR3/2)	leaves and logs very dark grayish brown (10YR3/2); weathers brownish gray (10YR6/2)
	A	R467	dark gray (10YR4/1)	root traces dark brown (7.5YR3/2) and yellow (10YR8/8); weathers light brownish gray (2.5Y6/2)
	A	R468	light brownish gray (2.5Y6/2)	root traces dark brown (7.5YR3/2); weathers light brownish gray (2.5Y6/2)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
	Bt	R469, R470	olive gray (5Y5/2)	root traces dark grayish brown (10YR3/2); sesquans brownish yellow (10YR6/8); weathers light brownish gray (2.5Y6/2)
	Bt	R471, R472	olive gray (5Y5/2)	sesquans olive yellow (2.5Y6/6 and 2/5Y6/8); weathers light brownish gray (2.5Y6/2)
shale 52.4 m	C	R473	olive gray (5Y5/2)	weathers light brownish gray (2.5Y6/2)
	-	R466	dark gray (10YR4/1)	claystone clasts light gray (2.5Y6/2); weathers light brownish gray (2.5Y6/2)
siltstone 52.5 m	-	R465	dark grayish brown (2.5Y4/2)	weathers light brownish gray (2.5Y6/2)
siltstone 52.6 m	-	R464	light yellowish brown (2.5Y6/4)	sesquans yellow (10YR7/8); weathers light brownish gray (2.5Y6/2)
Sik at 53.3m	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers light gray (2.5Y7/2)
	A	none	light gray (2.5Y7/2)	root traces dark brown (7.5YR3/2); weathers light gray (2.5Y7/2)
shale, 53.4m	-	none	dark grayish brown (10YR4/2)	weathers light gray (2.5Y7/2)
Sik at 55.7m	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers dark gray (10YR4/1)
	O	none	dark grayish brown (10YR4/2)	weathers brown (10YR5/3)
	O	none	black (7/5YR2/1)	laminae dark brown (7.5YR3/2); weathers light brownish gray (2.5Y6/2)
	O	none	brown (7.5YR5/2)	root traces dark brown (7.5YR3/2); weathers light brownish gray (2.5Y6/2)
	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); sesquans strong brown (7.5YR5/6); jarosite stain yellow (5Y8/6); weathers light brownish gray (2.5Y6/2)
	O	none	dark gray (10YR4/1)	root traces dark brown (7.5YR3/2); weathers grayish brown (2.5Y5/2)
	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); sesquans strong brown (7.5YR5/6); jarosite stain yellow (5Y8/6); weathers grayish brown (2.5Y5/2)
	O	none	brown (7.5YR5/2)	weathers light gray (10YR7/2)
	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); root traces very pale brown (10YR7/4); jarosite powder yellow (2.5Y8/6); weathers gray (10YR5/1)
	A	none	light brownish gray (2.5Y6/2)	weathers grayish brown (2.5Y5/2)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
	Bw	none	dark grayish brown (2.5Y4/2)	root traces dark brown (7.5YR3/2); weathers grayish brown (2.5Y5/2)
	C	none	grayish brown (2.5Y5/2)	weathers light gray (2.5Y7/2)
siltstone, 55.9m	-	none	light yellowish brown (2.5Y6/4)	siderite band dark grayish brown (2.5Y4/2), with weathering rind dark reddish gray (5YR4/2) and strong brown (7.5YR4/6 and 7.5YR5/8); weathers light brownish gray (2.5Y6/2)
siltstone, 56.4 m	-	none	grayish brown (2.5Y5/2)	weathers white (2.5Y8/2)
Maka at 57.7m	A	none	very dark grayish brown (10YR3/2)	logs black (7.5YR2/1); jarosite stain yellow (5Y8/6); weathers light brownish gray (10YR6/2)
	A	none	very dark grayish brown (10YR3/2)	plant chaff dark brown (7.5YR3/2); weathers light brownish gray (10YR6/2)
	A	none	light gray (2.5Y7/2)	root traces very dark grayish brown (10YR3/2); pyrite nodules yellow (5Y8/8) and brownish yellow (10YR6/8); weathers light brownish gray (10YR6/2)
	A	none	light brownish gray (2.5Y6/2)	weathers light gray (2.5Y7/2)
	Bw	none	very dark grayish brown (10YR3/2)	root traces dark brown (7.5YR3/2); sesquans strong brown (7.5YR5/6); weathers light gray (2.5Y7/2)
Sik at 57.9m	O	none	black (7.5YR2/1)	laminae dark brown (7.5YR3/2); weathers dark grayish brown (10YR4/2)
	A	none	grayish brown (10YR5/2)	root traces dark brown (7.5YR3/2); weathers light gray (10YR7/2)
sandstone, 58.0m	-	none	light gray (2.5Y7/2)	plant chaff dark brown (7.5YR4/2); jarosite stain yellow (2.5Y8/6); sesquans brownish yellow (10YR4/8); weathers light brownish gray (2.5Y6/2)
Maka at 59.5m	A	none	dark grayish brown (2.5Y4/2)	root traces dark yellowish brown (10YR4/4) and yellowish brown (10YR5/8); weathers light brownish gray (2.5Y6/2)
	Bw	none	grayish brown (2.5Y5/2)	weathering grayish brown (2.5Y5/2)
	Bw	none	light gray (5Y7/1)	root traces dark brown (10YR3/3) and yellowish brown (10YR5/8); weathers light gray (2.5Y7/2)

APPENDIX 2. Munsell colors continued

Paleosol	Hoz.	Spem.#	Fresh Color	Minor Colors
siltstone, 59.6m	-	none	light gray (2.5Y7/2)	siderite nodules grayish brown (2.5Y5/2), with weathering rind dark reddish brown (5YR3/2) and surface film of brownish yellow (10YR6/8); weathers light brownish gray (2.5Y6/2)
Maka at 61.0m	A	none	very dark grayish brown (2.5Y3/2)	weathers light yellowish brown (2.5Y6/4)
	C	none	very dark grayish brown (2.5Y3/2)	weathers light yellowish brown (2.5Y6/4)
siltstone, 61.2m	-	none	light brownish gray (2.5Y6/2)	siderite nodules grayish brown (2.5Y5/2), with weathering rind dark reddish brown (5Y4/2) and strong brown (7.5YR5/6); weathers light yellowish brown (2.5Y6/4)
sandstone, 62.0m	-	none	light gray (2.5Y7/2)	calcareous nodules weather brownish yellow (10YR6/6); matrix weathers pale yellow (2.5Y7/4)

Note: All colors were taken using a Munsell Color (1975) chart on rock samples within minutes of excavation, with exception of weathered colors that in some cases include a component of modern soil creep, given here to enable relocation in these colorful badlands outcrops. Paleosols are listed in stratigraphic order including equivalent paleosols in knoll and in cliff for lower 12 m of profile.

APPENDIX 3. Textures (volume percent) from point counting petrographic thin sections and calcareousness from reaction with dilute acid of Cretaceous and Tertiary paleosols in Bug Creek, Montana.

Paleosol	Horizon	Specimen Number	Calcareousness	Percent Clay	Percent Silt	Percent Sand	Texture
type Sapakot clay	A	R604	2	66.6	28.6	4.8	clay
	A	R605	2	65.4	27.6	4.8	clay
	Bw	R606	4	57.2	34.4	8.4	clay
	Bw	R607	3	51.6	35.8	12.6	clay
	C	R608	3	57.8	35.2	7.0	clay
	C	R609	3	51.6	42.6	5.8	silty clay
	Cg	R610	3	36.0	52.6	11.4	silty clay loam
type Ottsko clay	A	R598	3	55.0	39.0	5.8	clay
	A	R599	3	53.6	39.6	6.8	silty clay
	Bt	R600	3	67.4	30.8	1.8	clay
	Bt	R601	3	75.8	23.0	1.2	clay
	C	R602	3	69.0	30.8	0.2	clay
	C	R603	3	53.2	44.0	2.8	silty clay
type Spatsiko silty clay loam	A	R596	3	29.8	54.2	16.0	silty clay loam
	A	R597	3	39.0	42.4	18.6	silty clay loam
shale at 3.3 m	-	R595	1	66.0	33.8	0.2	clay
type Maka clay	A	R592	1	61.6	34.6	3.8	clay
	A	R593	1	46.0	51.4	2.6	silty clay
	C	R594	3	47.2	48.2	4.4	silty clay
siderite nodule at 4.4 m	-	R591	1	56.6	36.6	6.8	clay
siltstone at 4.4 m	-	R590	5	79.4	19.0	1.6	clay
Maka, 6.5 m, knoll	A	R582	1	74.8	24.0	1.2	clay
Maka, 6.5 m, cliff	A	R549	1	80.6	18.6	0.8	clay
Sikahk coal thin surface phase	O	R576	1	57.0	39.8	3.2	peat
	A	R577	1	61.2	35.2	3.6	clay
	A	R578	1	66.8	29.8	3.4	clay
	Bt	R579	1	74.4	23.6	2.0	clay
	Bt	R580	1	66.2	33.2	0.6	clay
	C	R581	2	63.2	34.6	2.2	clay
	C	R548	2	74.8	23.8	1.4	clay
type Sikahk coal	O	R541	1	47.4	26.8	25.8	peat
	A	R542	1	67.4	28.0	3.6	clay
	A	R543	1	71.0	27.2	1.8	clay
	A	R544	1	80.0	18.6	1.4	clay
	Bt	R545	1	82.2	16.0	1.8	clay
	Bt	R546	1	79.0	20.2	0.8	clay
	C	R547	1	73.2	24.6	2.2	clay
	C	R548	2	74.8	23.8	1.4	clay
	C	R548	2	74.8	23.8	1.4	clay
Sik at 8.0 m in knoll	O	R572	1	56.4	28.6	15.0	peat
	O	R573	1	81.8	17.8	0.4	clay
	A	R574	1	82.6	16.6	0.8	clay
	C	R575	2	83.2	16.2	0.6	clay

APPENDIX 3. continued.

Paleosol	Horizon	Specimen Number	Calcareousness	Percent Clay	Percent Silt	Percent Sand	Texture
shale, 8.2 m in knoll	-	R571	1	84.2	14.4	1.4	clay
Sik at 8.0 m in cliff	O	R539	1	79.0	19.0	2.0	peat
	C	R540	1	72.2	22.8	5.0	clay
shale, 8.3 m in cliff	-	R538	1	74.8	21.6	3.6	clay
Sik at 10 m in knoll	O	R564	1	35.2	3.4	61.4	peat
Sik coal tonstein-bearing	O	R551	1	48.2	9.2	42.6	peat
	O	R552	1	80.6	18.0	1.6	clay
	O	R553	1	28.8	24.2	47.0	peat
	A	R554	2	54.6	39.0	6.4	clay
	A	R555	1	53.4	35.2	11.4	clay
	C	R556	2	51.8	43.8	4.2	silty clay
	C	R557	2	40.6	52.0	7.4	silty clay
	Cg	R558	2	37.4	55.0	7.6	silty clay loam
	Cg	R559	4	81.4	18.4	1.2	clay
	Cg	R560	2	35.8	53.6	10.6	silty clay loam
	Cg	R561	2	50.6	45.0	4.4	silty clay
	Cg	R562	2	43.8	41.8	14.4	silty clay
	Cg	R563	4	75.0	24.8	1.2	clay
shale at 12 m in knoll	-	R550	1	57.8	34.4	7.8	clay
Sik stump-bearing phase	O	R518	1	17.0	2.8	80.2	peat
	A	R519	1	55.8	42.4	1.8	silty clay
	A	R520	2	56.6	43.0	0.4	silty clay
	C	R521	2	67.8	30.0	2.2	clay
Sik at 35.6 m	O	R516	1	75.6	24.4	0	peat
	A	R517	1	40.4	58.6	1.0	silty clay
shale at 35.7 m	-	R515	2	65.0	33.6	1.4	clay
type Sik coal	O	R506	1	55.0	41.6	3.4	peat
	A	R507	1	50.2	44.8	5.0	silty clay
	A	R508	1	48.0	45.0	7.0	silty clay
	Bw	R509	1	50.6	45.2	4.2	silty clay
	C	R510	1	45.2	43.4	11.4	silty clay
	C	R511	1	52.2	43.6	4.2	silty clay
	C	R512	2	48.2	42.0	9.8	silty clay
	Cg	R513	4	44.6	53.6	1.8	silty clay
	Cg	R514	2	42.0	53.8	4.2	silty clay
siltstone at 37.3 m	-	R504	1	60.0	36.8	3.2	clay
Sik thick surface phase	O	R486	1	63.8	19.4	16.8	peat
	O	R487	1	63.4	28.8	7.8	clay
	O	R488	1	46.8	13.0	40.2	peat
	O	R489	1	71.4	24.2	4.4	clay
	O	R490	1	45.4	1.6	53.0	peat
	O	R491	1	64.8	13.8	21.4	clay

APPENDIX 3. continued.

Paleosol	Horizon	Specimen Number	Calcareousness	Percent Clay	Percent Silt	Percent Sand	Texture
	O	R492	1	69.8	18.2	11.8	peat
	O	R494	1	63.8	21.6	14.6	peat
	A	R495	1	43.0	46.6	10.4	silty clay
	A	R496	1	33.6	52.4	14.0	silty clay loam
	A	R497	1	46.2	39.8	14.0	clay
	C	R498	2	57.2	36.4	6.4	clay
	C	R499	2	49.4	42.8	7.8	silty clay loam
	C	R501	2	41.0	52.2	6.8	silty clay
	C	R502	2	47.6	45.2	7.2	silty clay
	C	R503	2	63.4	34.2	2.4	clay
siltstone at 42.3 m	-	R485	2	69.2	25.6	5.2	clay
type Komono clay	A	R467	1	78.8	20.2	1.0	clay
	A	R468	1	68.2	28.2	3.6	clay
	Bt	R469	1	63.8	35.2	1.0	clay
	Bt	R470	1	66.0	33.0	1.0	clay
	Bt	R471	1	66.8	32.2	1.0	clay
	C	R472	2	68.6	29.8	1.6	clay
	C	R473	2	64.6	32.0	3.4	clay
shale at 52.4 m	-	R466	2	63.8	32.8	3.4	clay
siltstone at 52.5 m	-	R465	2	59.0	40.0	1.0	clay
siltstone at 52.6 m	-	R464	2	35.6	48.4	16.0	silty clay loam

Note: Relative scale of calcareousness (1-5) by reaction with 1.2M (10% of standard solution) HCl is from Retallack (1988, 1990). Standard error ($\pm 1\sigma$) of these 500-point counts is about 2 volume % (Van der Plas & Tobi 1965; Murphy 1983). Counts were made with a Swift automatic point counter by G.J. Retallack. Textures of peaty samples (all those with more than 10% organic carbon) reflect size distribution of coal macerals as well as mineral grains.

APPENDIX 4. Mineral composition (volume percent) by point counting of petrographic thin sections of Cretaceous and Tertiary paleosols in Bug Creek, Montana.

Paleosol	Hori- zon	Spem. No.	Clay & Org- Micrite anic	Cal- cite	Feld- spar	Mica	Rock Frag.	Oth- er	Opa- que	Quartz	
type Sapakot clay	A	R604	67.0	1.2	0	1.0	1.0	10.4	0.4	4.6	14.4
	A	R605	64.2	0.6	0	2.2	1.6	11.4	0	3.8	16.2
	Bw	R606	57.2	0.6	0	2.6	1.8	14.8	0.2	3.6	19.2
	Bw	R607	51.6	0.8	0.6	4.4	1.6	18.0	0.6	5.6	16.8
	C	R608	58.4	0.6	0.4	5.0	2.0	15.4	0.6	3.0	14.6
	C	R609	53.8	0.4	2.0	6.4	3.8	12.2	0.6	3.8	17.0
	Cg	R610	36.0	0.4	11.0	1.4	3.6	12.8	1.0	4.2	29.6
type Ottsko clay	A	R598	55.6	0.8	0	10.2	2.2	9.2	0	1.8	20.2
	A	R599	53.8	1.8	0	6.0	2.6	9.6	0.2	5.6	19.2
	Bt	R600	67.4	0.4	0	7.6	1.0	3.0	0	8.4	11.6
	Bt	R601	78.4	1.2	0	3.6	1.2	4.4	0.2	3.2	7.8
	C	R602	71.4	2.2	0	5.0	1.6	10.4	0.4	1.8	7.2
	C	R603	54.6	0	1.0	3.8	2.8	19.8	0.8	9.2	8.0
type Spatsiko silty clay loam	A	R596	30.6	1.8	0	30.6	4.6	12.8	0	4.4	15.2
	A	R597	39.2	0.4	0	14.0	2.8	21.6	0.6	3.2	18.0
shale at 3.3 m	-	R595	64.0	2.2	0	15.4	5.4	4.4	0	2.4	6.2
type Maka clay	A	R592	62.4	1.4	0.8	3.6	2.6	10.4	0.8	3.4	14.6
	A	R593	45.0	0.4	6.8	7.2	4.2	16.6	0.2	3.0	16.6
	C	R594	48.2	1.0	2.6	19.6	4.8	7.8	0	3.6	12.4
siderite nodule at 4.4 m	-	R591	56.2	2.6	1.4	4.2	4.0	11.2	0.2	4.2	16.0
siltstone at 4.4 m	-	R590	79.8	2.6	3.2	0.4	0	4.6	0.4	1.8	7.2
Maka at 6.5 m, knoll	A	R582	74.2	0.8	0	5.6	0.8	3.2	0.2	1.0	14.2
Maka at 6.5 m, cliff	A	R549	79.6	0.2	0	3.4	1.6	6.0	0	1.2	8.0
Sikahk coal thin surface phase	O	R576	58.4	12.4	0	6.2	0.4	3.8	0.2	1.0	17.6
	A	R577	61.6	1.2	0.2	7.2	1.2	7.4	0.4	6.6	14.2
	A	R578	68.6	1.0	0	7.2	0.8	7.8	0	1.6	13.0
	Bt	R579	73.2	0.6	0	2.8	1.8	7.2	0.2	0.4	13.8
	Bt	R580	67.2	1.0	0	4.4	1.4	9.0	0.2	3.6	13.2
	C	R581	61.8	1.6	0	4.4	1.2	11.0	0.2	7.2	12.6
	C	R541	46.8	33.0	0	1.6	0	5.6	0	1.8	11.2
type Sikahk coal	A	R542	67.8	6.6	0	3.0	0.2	10.0	0.4	1.0	11.0
	A	R543	73.0	1.6	0	3.0	1.0	9.0	0.2	2.8	9.4
	A	R544	79.2	0.4	0	3.8	0.6	7.4	0	0.6	8.0
	Bt	R545	83.4	0.2	0	3.0	0	5.8	0.2	2.4	5.0
	Bt	R546	78.6	0.4	0	4.2	0.2	9.0	0	0.6	7.0
	C	R547	75.0	1.4	0	4.0	2.4	6.0	0	2.0	9.2
	C	R548	75.8	0.8	0	5.4	1.8	6.2	0	2.0	8.0
	C	R548	75.8	0.8	0	5.4	1.8	6.2	0	2.0	8.0
Sik at 8.0 m in knoll	O	R572	57.8	25.4	0	4.2	0.4	2.4	0.4	1.4	8.0
	O	R573	80.6	2.2	0	8.0	0	3.6	0.2	1.4	4.0
	A	R574	82.0	0.4	0	3.6	0.6	3.8	0.2	2.6	6.8
	C	R575	82.0	2.4	0	3.0	0.6	2.4	0	5.4	4.2
shale, 8.2 m in knoll	-	R571	85.0	1.0	0	2.0	0	3.4	0.2	5.2	3.2

APPENDIX 4. continued.

Paleosol	Hori- zon	Spem. No.	Clay & Org- Micrite anic	Cal- cite	Feld- spar	Mica	Rock Frag.	Oth- er	Opa- que	Quartz		
Sik at 8.0 m in cliff	O	R539	78.4	1.0	0	3.2	0.2	6.4	0.4	4.0	6.4	
	C	R540	70.4	7.4	0	1.6	0.4	6.0	0.6	2.6	11.0	
shale, 8.3 m in cliff	-	R538	75.8	1.0	0	3.0	0.4	8.6	0.2	3.4	7.6	
Sik at 10 m in knoll	O	R564	35.2	61.0	0	0	0.8	1.2	0	0.2	1.6	
Sik coal tonstein-bearing	O	R551	48.2	42.6	0	1.2	0.4	2.4	0	0.2	5.0	
	O	R552	80.4	0.6	0	3.8	5.4	6.0	0	0	3.8	
	O	R553	28.6	42.8	0	8.4	2.0	4.6	0	0.2	13.4	
	A	R554	55.4	0.8	0	6.4	5.0	7.2	0	4.8	20.4	
	A	R555	53.6	5.4	1.6	6.4	4.4	10.0	0	1.4	17.2	
	C	R556	53.0	4.8	0.8	7.4	3.0	18.2	0	3.8	9.0	
	C	R557	39.2	1.6	4.4	8.2	5.0	21.6	0.2	3.0	16.8	
	Cg	R558	37.6	4.6	3.8	5.2	3.8	15.0	0	2.4	27.6	
	Cg	R559	81.4	0.4	0.4	5.2	1.0	8.4	0	0	3.2	
	Cg	R560	35.2	0.2	4.6	10.2	5.4	11.4	0	3.6	29.2	
	Cg	R561	50.2	3.0	4.2	10.6	4.4	9.4	0	3.8	14.4	
	Cg	R562	45.2	3.2	4.0	11.0	5.0	9.4	0	3.4	18.0	
	Cg	R563	75.0	0	11.2	2.2	1.0	4.8	0	0	5.8	
shale at 12 m in knoll	-	R550	58.6	1.6	2.4	6.6	2.8	12.2	0.2	1.4	14.2	
Sik stump-bearing phase	O	R518	17.0	80.2	0	0.2	0.2	0	0	0	2.4	
	A	R519	56.6	1.6	1.4	7.0	3.2	15.2	0	4.4	10.6	
	A	R520	57.6	1.4	3.6	4.6	2.6	12.6	0	4.6	13.0	
	C	R521	69.2	0.6	0.8	11.6	2.0	7.2	0	4.0	4.6	
Sik at 35.6 m	O	R516	75.6	6.4	0	8.4	0	3.8	0.2	1.0	4.6	
	A	R517	40.4	0.4	2.0	8.0	4.8	16.4	0	8.4	19.6	
shale at 35.7 m	-	R515	64.8	1.2	0.8	10.4	3.0	5.2	0	6.2	8.4	
Sik coal type Sik coal	O	R506	54.6	8.6	0	3.2	3.2	8.2	0	2.6	19.6	
	A	R507	51.2	2.6	0	7.4	4.0	10.2	0	4.8	19.8	
	A	R508	47.8	2.6	1.0	4.6	3.2	13.4	0	2.6	24.8	
	Bw	R509	49.3	2.6	2.0	4.6	2.2	10.8	0.2	4.4	23.8	
	C	R510	45.4	1.8	2.6	8.4	2.6	22.6	0	2.0	14.6	
	C	R511	50.8	1.4	5.0	8.0	3.8	17.4	0.4	2.8	10.4	
	C	R512	47.6	1.6	1.6	11.6	1.8	14.0	0	5.0	16.8	
	Cg	R513	44.2	2.0	11.8	8.0	2.4	20.6	0	3.8	7.2	
	Cg	R514	41.8	0.2	5.4	13.4	2.2	14.4	0.2	1.4	21.0	
	siltstone at 37.3 m	-	R504	60.6	4.2	0	5.6	2.2	6.4	0	5.2	15.8
	Sik thick surface phase	O	R486	65.6	20.4	0	4.8	0	4.4	0	0.2	4.6
		O	R487	64.0	7.0	0	6.8	1.2	4.6	0.2	1.0	15.2
		O	R488	47.0	35.4	0.8	4.8	0.4	5.2	0.2	0	6.2
		O	R489	70.4	4.0	0	9.0	0.2	5.6	0.8	0.8	9.2
O		R490	45.4	52.0	0	0.6	0	0.6	0	0.2	1.2	
O		R491	64.2	26.8	0	1.6	0	3.6	0.2	0.4	3.2	
O		R492	70.0	21.2	0	2.8	0.2	3.6	0.2	0	2.0	

APPENDIX 4. continued.

Paleosol	Hori- zon	Spem. No.	Clay & Org- Micrite anic	Cal- cite	Feld- spar	Mica	Rock Frag.	Oth- er	Opa- que	Quartz	
	O	R494	64.6	23.2	0	3.0	0	5.6	0.2	0	3.4
	A	R495	42.8	20.8	0	6.6	1.6	11.8	0	0.4	16.0
	A	R496	33.0	0	0	9.6	2.6	23.6	0.4	2.6	28.2
	A	R497	44.4	2.2	0.2	5.6	4.8	14.2	0.6	3.2	24.8
	C	R498	58.8	0.8	1.4	7.0	2.0	13.0	0.4	1.0	15.6
	C	R499	50.6	5.6	1.0	7.4	2.8	12.6	0	1.6	18.4
	C	R501	41.2	0.8	11.6	7.8	2.8	13.0	0.4	0.6	21.8
	C	R502	46.4	1.8	13.2	7.4	3.6	10.0	0.6	0.4	16.6
	C	R503	62.0	0	2.8	5.0	3.4	5.6	0.4	4.6	16.2
siltstone at 42.3 m type Komono clay	-	R485	69.8	7.8	0	5.6	0.4	8.2	0.4	1.0	6.8
	A	R467	82.0	2.8	0	2.2	1.4	0.6	0	2.2	8.8
	A	R468	68.0	1.0	0	1.8	3.4	7.0	0	5.8	13.0
	Bt	R469	65.6	1.4	0	0.8	2.8	6.0	0.2	2.6	20.6
	Bt	R470	67.2	0.2	0	1.8	2.6	5.6	0.2	5.8	16.0
	Bt	R471	67.2	0.8	0	1.2	3.6	5.8	0.2	5.2	16.0
	C	R472	67.6	0	0.2	2.4	2.8	6.0	0.2	2.2	18.6
	C	R473	64.8	0.6	1.2	1.6	1.8	8.0	1.2	5.0	15.8
shale at 52.4 m	-	R466	62.8	6.2	1.4	6.2	2.8	2.4	0	3.8	14.2
siltstone at 52.5 m	-	R465	61.6	0.6	4.6	10.8	3.4	2.2	0.4	4.8	11.6
siltstone at 52.6 m	-	R464	36.2	0	7.2	4.2	3.8	7.4	0	4.2	37.0

Note: Paleosol names, counts and error as for Appendices 1 and 2. Counts were by G. J. Retallack. Organic includes recognizable fragments of fossil roots, leaves, spores or pollen. These are opaque but distinguishable from opaque oxides by their irregular outline. Calcite is largely rock fragments of limestone, but there also is minor sparry and micritic cement. Mica is mainly biotite, but there also are traces of muscovite. Rock fragments are mostly volcanic, with some chert, shale and schist. The category "other" includes mainly mafic minerals of silt size, mainly hornblende.

APPENDIX 5. Major element chemical analyses by AA, loss on ignition (LOI), organic carbon (all weight percent), and bulk density (g/cc) of Cretaceous and Tertiary paleosols from Bug Creek, Montana.

Paleosol	Hz	Spem	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	LOI	Total	C	g/ cc org.
error (σ)	-	all	0.25	0.02	0.17	0.15	0.08	0.05	0.10	0.05	0.01	.005	.004	-	-	0.009	0.05
type Sapakot clay	A	R604	62.48	0.72	16.36	2.91	0.71	0.02	1.05	0.41	1.28	1.75	0.05	11.64	99.38	3.98	1.98
	A	R605	63.50	0.55	16.65	4.37	0.26	0.01	1.09	0.35	1.34	1.87	0.03	8.41	98.43	0.42	2.09
	Bw	R606	66.63	0.52	15.15	3.94	0.66	0.02	1.20	0.46	1.57	2.15	0.06	6.93	99.29	0.27	2.00
	Bw	R607	66.75	0.52	15.18	3.64	0.56	0.02	1.19	0.52	1.63	2.23	0.11	6.95	99.30	0.37	2.12
	C	R608	68.26	0.43	14.19	3.77	0.42	0.02	1.33	0.39	1.27	2.47	0.06	6.37	99.00	0.42	2.16
	C	R609	68.47	0.51	13.89	3.91	0.31	0.02	1.55	0.34	1.21	2.52	0.10	6.56	99.39	0.27	2.15
	Cg	R610	63.26	0.38	10.78	1.98	0.80	0.04	3.91	4.35	1.49	2.22	0.16	9.78	99.15	0.32	2.07
type Ottsko clay	A	R598	65.13	0.60	16.09	3.84	0.47	0.01	1.02	0.33	1.67	1.89	0.08	8.06	99.19	0.80	2.00
	A	R599	60.29	0.60	16.92	4.98	0.66	0.02	1.40	0.41	1.77	1.98	0.03	9.51	98.57	0.32	1.99
	Bt	R600	59.10	0.58	16.67	7.15	0.22	0.28	1.56	0.47	1.60	2.13	0.12	8.93	98.81	0.53	2.07
	Bt	R601	59.02	0.65	17.32	5.75	0.75	0.03	1.57	0.44	1.57	2.17	0.07	9.75	98.91	0.58	2.05
	C	R602	62.38	0.82	14.72	2.53	0.66	0.01	0.92	0.54	1.37	1.70	0.13	12.92	98.70	6.20	1.92
type Spatsiko silty clay loam	A	R596	56.71	0.41	14.15	13.14	0.19	0.59	1.47	0.79	1.56	1.63	0.22	8.46	99.52	0.42	1.97
shale at 3.3 m	-	R597	71.36	0.46	14.30	2.80	0.42	0.02	0.87	0.46	1.85	1.96	0.03	4.94	99.47	0.42	2.03
type Maka clay	-	R595	56.72	0.42	16.44	4.22	0.80	0.04	2.88	1.98	1.43	1.98	0.15	11.82	99.88	0.69	2.12
	A	R592	63.54	0.47	15.31	4.04	0.89	0.03	1.99	0.57	1.34	2.60	0.15	8.17	99.10	1.27	2.11
	A	R593	60.21	0.43	13.88	3.08	0.85	0.04	3.45	3.28	1.42	2.13	0.16	10.94	99.87	0.74	2.00
nodule at 4.4 m	-	R591	14.23	0.19	4.76	11.25	27.87	1.51	2.76	5.49	0.48	0.62	0.62	28.90	98.68	1.54	3.01
siltstone at 4.4 m	-	R590	63.48	0.59	15.92	3.63	1.13	0.03	1.67	0.73	1.66	2.25	0.20	7.78	99.07	1.54	2.02
Maka, 6.5 m, knoll	A	R582	65.05	0.52	16.09	4.04	0.85	0.03	1.40	0.57	1.90	2.15	0.15	6.74	99.49	0.53	2.02
Maka, 6.5 m, cliff	A	R549	61.90	0.69	16.91	4.41	0.37	0.01	1.30	0.21	1.56	2.20	0.04	10.32	99.92	0.59	2.15
Sikahk coal thin surface phase	O	R576	77.02	0.67	12.52	0.97	0.42	0.01	0.41	0.16	0.80	0.99	0.06	6.38	100.41	0.42	2.11
	A	R577	71.85	0.57	15.04	1.76	0.40	0.01	0.59	0.19	1.05	1.31	0.02	7.13	99.92	0.37	2.26
	A	R578	63.23	0.55	17.72	3.78	0.38	0.01	0.96	0.24	1.43	1.52	0.02	9.53	99.37	0.48	2.10
	Bt	R579	59.62	0.57	18.51	5.42	0.09	0.01	1.11	0.26	1.56	1.56	0.02	10.89	99.62	0.48	2.09
	Bt	R580	66.16	0.53	16.31	3.95	0.14	0.02	0.99	0.35	1.92	1.95	0.06	7.96	100.34	0.42	2.07
	C	R581	65.86	0.57	15.62	3.89	0.80	0.02	1.23	0.52	1.98	2.06	0.16	6.91	99.62	0.37	2.01
type Sikahk coal	O	R541	47.60	1.13	11.04	4.82	0.59	0.01	0.95	0.68	1.37	1.78	-	29.02	98.99	20.79	1.59
	A	R542	68.86	0.94	13.04	1.51	0.64	0.01	1.22	0.10	0.62	1.90	0.08	11.21	100.13	4.10	1.91
	A	R543	62.87	0.49	17.85	5.18	0.07	0.01	1.20	0.10	1.21	0.97	-	10.43	100.38	-	2.16
	A	R544	60.65	0.61	17.58	5.33	0.14	0.01	1.18	0.10	1.18	1.11	0.04	11.21	99.14	0.43	2.12
	Bt	R545	61.03	0.59	16.81	5.61	0.20	0.01	1.29	0.13	1.33	1.61	0.03	10.50	99.14	0.49	2.12
	Bt	R546	61.60	0.65	16.57	5.68	0.21	0.01	1.31	0.15	1.41	1.78	0.04	9.95	99.36	0.43	2.09
	C	R547	61.07	0.67	16.49	5.18	0.39	0.01	1.37	0.20	1.55	2.01	0.04	9.87	98.85	0.38	2.14
	C	R548	62.01	0.70	16.76	4.88	0.48	0.01	1.41	0.25	1.57	2.12	0.05	9.86	100.10	0.59	2.13
Sik, 8.0 m, knoll	O	R572	65.18	0.97	16.47	2.31	0.59	0.01	1.28	0.40	1.07	1.77	-	9.48	99.53	2.49	2.11
	O	R573	65.61	0.51	16.72	2.69	0.24	0.01	1.30	0.28	0.91	1.97	0.04	8.78	99.06	1.06	2.10
	A	R574	66.70	0.43	15.91	2.37	0.33	0.01	1.31	0.30	0.87	2.28	0.02	8.49	99.02	0.64	2.15
	C	R575	66.96	0.33	16.27	2.36	0.38	0.01	1.25	0.24	0.78	2.51	0.02	8.09	99.14	0.37	2.17
shale, 8.2 m, knoll	-	R571	62.68	0.62	16.51	3.36	0.37	0.01	1.43	0.26	1.07	2.29	0.06	10.64	99.30	0.85	2.13
Sik, 8.0 m, cliff	O	R539	62.92	0.62	16.22	3.58	0.43	0.01	1.54	0.17	0.92	1.50	0.10	11.26	99.27	2.23	2.08
	C	R540	66.44	0.44	15.59	2.96	0.23	0.01	1.47	0.07	0.88	2.47	-	10.08	100.64	2.43	1.98
shale, 8.3 m in cliff	-	R538	63.07	0.55	16.88	3.11	0.37	0.01	1.47	0.16	0.94	1.66	0.07	10.72	99.01	0.95	2.04
Sik, 10 m knoll	O	R564	38.23	0.73	11.65	2.86	1.65	0.13	1.57	1.14	1.99	1.75	1.29	36.84	99.83	19.76	1.71
Sik coal tonst.bear.	O	R551	40.19	1.11	13.55	2.72	1.65	0.02	1.64	1.83	2.12	0.62	-	32.90	98.35	18.30	1.36
	O	R552	54.42	0.26	18.33	5.44	0.05	0.01	2.61	0.56	1.90	0.48	0.09	14.82	98.97	0.38	2.02

APPENDIX 5. continued.

Paleosol	Hz No.	Spem	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	LOI	Total	C	g/ cc org.
	O	R553	50.64	0.75	16.08	1.39	1.39	0.01	1.08	0.83	2.58	1.98	-	23.18	99.91	11.40	1.81
	A	R554	59.97	0.61	15.90	3.97	0.59	0.03	2.39	1.29	2.08	1.55	0.17	11.08	99.43	1.08	1.92
	A	R555	59.95	0.59	15.20	4.22	0.43	0.04	2.39	1.39	2.10	1.43	0.14	11.64	99.52	1.24	1.95
	C	R556	59.89	0.67	15.03	5.14	0.59	0.04	2.53	1.29	2.04	1.59	0.21	9.93	98.95	1.19	2.00
	C	R557	56.61	0.53	14.85	5.67	0.47	0.09	2.71	1.83	1.94	1.57	0.19	12.31	98.77	1.08	1.97
	Cg	R558	57.10	0.53	14.91	5.96	0.56	0.09	2.55	1.49	1.91	1.65	0.20	11.93	98.88	1.73	2.03
	Cg	R560	59.20	0.40	14.88	4.57	0.61	0.06	2.30	1.50	2.00	1.47	0.17	11.29	98.45	0.80	2.03
	Cg	R561	58.12	0.60	16.51	5.32	0.52	0.11	2.34	1.04	1.84	2.23	0.31	10.26	99.20	1.33	1.91
	Cg	R562	59.31	0.38	14.61	4.78	0.52	0.07	2.16	2.19	1.96	1.44	0.19	10.76	98.37	0.48	2.04
	Cg	R563	21.03	0.19	5.63	46.71	0	1.80	2.09	2.20	0.78	0.70	0.61	16.45	98.19	0.69	2.27
shale, 12 m, knoll	-	R550	60.20	0.61	14.83	4.63	0.75	0.05	2.70	1.74	1.95	2.12	0.24	8.80	98.62	0.92	1.89
Sik at 34.1 m	O	R522	33.70	1.67	17.56	0	0.54	0.01	0.55	1.32	1.44	1.09	-	42.25	100.13	33.40	1.46
Sik stump-bearing	O	R518	14.11	0.48	6.76	0	0.91	0.01	0.76	1.33	1.52	0.20	-	72.98	99.06	70.80	1.19
	A	R519	64.66	0.63	15.63	3.02	0.69	0.03	1.74	0.62	1.80	2.32	0.22	6.90	98.26	0.74	2.02
	A	R520	58.51	0.55	14.29	3.65	0.25	0.03	3.67	3.23	1.61	2.28	0.17	10.34	98.58	0.69	1.94
	C	R521	61.57	0.61	16.10	4.14	0.32	0.02	2.21	0.84	1.56	2.61	0.23	8.08	98.29	0.85	1.89
Sik at 35.6 m	O	R516	54.03	0.63	15.41	3.39	0.91	0.03	2.03	0.60	1.61	2.73	0.42	17.27	99.06	10.49	1.28
	A	R517	65.65	0.58	15.12	4.28	0.21	0.02	1.46	0.41	1.70	2.24	0.24	7.17	99.08	1.22	1.93
shale at 35.7 m	-	R515	61.92	0.61	16.64	4.68	0.11	0.03	2.17	0.53	1.67	3.00	0.19	8.00	99.55	0.85	1.53
type Sik coal	O	R505	39.35	-	10.37	0.07	0.60	0.01	0.64	1.34	1.53	1.09	-	43.66	98.66	25.74	1.50
	O	R506	5.73	0.28	4.20	0.42	0	0	0.34	0.60	1.77	0.40	-	84.63	98.37	51.40	1.81
	A	R507	66.79	0.63	15.35	2.22	0.11	0.01	1.18	0.29	1.75	2.19	0.04	8.50	99.06	2.12	1.84
	A	R508	64.26	0.53	15.70	3.79	0.16	0.02	1.91	0.61	1.95	2.21	0.18	7.62	98.94	0.69	1.86
	Bw	R509	66.64	0.59	14.82	3.50	0.37	0.02	1.83	0.59	1.96	2.28	0.18	6.87	99.65	0.80	1.84
	C	R510	54.33	0.47	11.83	9.95	0	0.30	3.41	3.44	1.67	1.82	0.20	11.61	99.03	0.74	1.77
	C	R511	60.45	0.50	12.60	4.28	0.16	0.09	3.50	3.29	1.81	1.87	0.17	10.55	99.27	0.48	1.78
	C	R512	54.51	0.57	13.37	6.85	0.05	0.21	3.58	3.22	1.79	2.05	0.20	11.81	98.21	0.69	1.88
	Cg	R513	58.03	0.62	14.60	4.84	0.16	0.07	3.54	2.80	1.64	2.33	0.18	10.54	99.35	0.69	1.87
	Cg	R514	54.77	0.54	13.30	5.90	0.05	0.16	3.90	3.56	1.68	2.06	0.18	11.86	98.16	0.58	1.93
siltstone at 37.3 m	-	R504	59.68	0.54	14.18	3.38	0.35	0.03	3.50	3.08	1.82	2.34	0.21	9.86	98.97	1.11	1.87
Sik thick surface	O	R486	41.07	1.24	15.08	0.61	0	0.01	0.53	1.84	2.17	2.38	-	34.70	99.63	33.40	1.56
	O	R487	54.70	0.97	20.29	0.38	0.15	0.01	0.33	0.66	1.38	1.80	-	18.10	98.77	5.51	1.67
	O	R488	8.94	0.33	6.46	0.34	0	0.01	0.57	1.80	1.84	0.02	-	79.97	100.28	79.40	1.51
	O	R489	64.18	0.31	20.01	0.44	0	0.01	0.29	0.33	1.88	3.50	-	7.59	98.54	2.81	1.82
	O	R490	16.41	0.50	7.41	0.32	0	0.01	0.40	1.06	1.74	1.19	-	71.27	100.31	70.40	1.42
	O	R491	38.01	0.38	10.89	0.32	0	0.01	0.32	0.68	1.69	1.96	-	45.03	99.29	43.60	1.47
	O	R492	9.19	0.23	6.98	0.39	0	0.01	0.51	1.00	1.82	0.05	-	78.77	98.95	72.20	1.53
	O	R494	2.10	0.18	2.07	0.30	0	0.01	0.36	0.56	1.97	0.01	-	89.01	96.57	74.80	1.48
	A	R495	52.40	1.14	14.11	5.51	0.10	0.01	1.16	0.59	1.69	1.96	-	20.52	99.19	10.44	1.70
	A	R496	70.13	0.66	14.68	2.46	0	0.01	1.15	0.48	1.96	1.87	0.21	6.07	99.68	0.27	2.09
	A	R497	69.04	0.50	13.57	3.57	0	0.01	1.17	0.99	2.01	2.20	0.20	6.83	100.09	0.53	1.92
	C	R498	63.47	0.61	15.46	4.03	0	0.03	2.52	1.23	2.02	2.16	0.18	8.57	100.28	0.69	1.92
	C	R499	62.38	0.48	13.20	3.93	0.10	0.05	3.27	2.82	1.97	1.92	0.16	9.80	100.08	0.74	1.91
	C	R500	61.89	0.51	13.16	4.31	0.05	0.05	3.32	2.86	2.00	2.05	0.16	9.93	100.29	0.80	1.86
	C	R501	63.43	0.40	12.18	3.06	0.05	0.04	3.54	3.72	1.89	1.83	0.14	9.82	100.10	0.21	1.89
	C	R502	62.91	0.43	12.46	2.96	0.20	0.04	3.63	3.71	1.95	1.85	0.15	9.78	100.07	0.32	1.91
	C	R503	63.24	0.47	12.63	2.86	0.40	0.04	3.41	3.50	1.96	1.87	0.14	9.68	100.20	0.37	1.87
siltstone at 42.3 m	-	R485	63.25	0.61	16.17	4.30	0	0.03	2.15	0.86	1.91	2.47	0.24	8.32	100.31	1.08	1.97

APPENDIX 5. continued.

Paleosol	Hz	Spem	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	Mno	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	LOI	Total	C	g/ cc
	No.															org.	
type Komono clay	A	R467	65.00	0.51	17.53	3.03	0.05	0.01	1.57	0.05	0.74	3.09	0.09	8.18	99.85	0.81	2.20
	A	R468	67.16	0.33	16.82	3.36	0.05	0.01	1.27	0.04	0.74	2.88	0.02	7.71	100.39	0.38	2.22
	Bt	R469	69.96	0.31	15.20	3.11	0.25	0.01	1.28	0.05	0.93	3.10	0.03	6.05	100.28	0.22	2.17
	Bt	R470	70.64	0.37	15.13	2.67	0.15	0.01	1.20	0.07	0.94	3.28	0.04	5.74	100.24	0.16	2.06
	Bt	R471	64.61	0.41	17.21	4.20	0.35	0.01	1.63	0.06	0.75	3.60	0.05	7.44	100.32	0.22	2.11
	C	R472	65.99	0.46	17.16	3.76	0.25	0.01	1.36	0.09	0.90	2.58	0.07	7.70	100.33	0.22	2.17
	C	R473	67.76	0.38	15.13	3.35	0.60	0.01	1.64	0.12	0.99	3.20	0.12	6.49	99.79	0.27	2.15
shale at 52.4 m	-	R466	63.84	0.53	16.57	3.31	0.35	0.02	1.87	0.14	0.90	3.36	0.42	8.48	99.79	1.51	2.11

Note: For Appendices 4, 5, and 6, dashes (-) signify analyses not attempted and zeroes (0) are values beyond detection. Analyses were from from atomic absorption at the University of Oregon, Eugene by Christine McBirney. Most organic carbon values were determined from the Walkley-Black titration, but those over 10% were by ignition, in the Soil Testing Laboratory, Oregon State University, Corvallis, by Donald Horneck. Bulk density was calculated by weighing paraffin-coated clods in and out of water at the University of Oregon, Eugene, by Gregory J. Retallack. Errors were estimated from 10 replicate analyses of standard rock W2 for atomic absorption, from 50 replicates of a standard soil for Walkley-Black titration and from 10 replicates of rock R602 for bulk density.

APPENDIX 6. Trace element analyses (ppm) by AA of Cretaceous and Tertiary paleosols from Bug Creek, Montana.

Paleosol	Hor.	Spem No.	Ba	Co	Cr	Cu	Li	Ni	Rb	Sr	Zn
error(σ)	-	all	12	1	2	2	1	1	2	4	3
type Sapakot clay	A	R604	458	10	93	57	51	43	95	114	103
	A	R605	463	15	96	38	37	34	97	206	102
	Bw	R606	549	13	80	42	43	37	84	106	113
	Bw	R607	573	11	80	40	37	39	88	111	91
	C	R608	482	5.7	69	33	35	28	140	87	75
	C	R609	597	10	69	26	37	32	127	114	76
	Cg	R610	470	3.0	45	24	32	25	93	103	75
type Ottsko clay	A	R598	790	13	91	45	30	39	97	196	106
	A	R599	633	18	99	48	36	46	88	118	115
	Bt	R600	862	21	96	51	37	53	94	261	119
	Bt	R601	633	19	100	57	37	48	102	107	141
	C	R602	856	7.1	88	53	40	30	79	277	99
	A	R596	506	21	50	24	31	116	60	208	98
type Spatsiko silty clay loam	A	R597	693	5.7	67	20	28	32	77	151	65
shale at 3.3 m	-	R595	500	7.1	53	36	36	32	86	126	92
type Maka clay	A	R592	621	8.5	76	44	38	28	140	172	89
	A	R593	524	8.5	54	33	32	25	93	139	97
nodule at 4.4 m	-	R591	512	7.1	28	26	19	23	28	166	43
siltstone at 4.4 m	-	R590	669	14	88	46	39	48	90	142	115
Maka, 6.5 m	C	R582	766	15	92	49	38	53	89	123	124
Sikahk coal thin surface phase	O	R576	422	0	59	19	75	25	43	54	35
	A	R577	470	3.0	75	13	55	28	52	60	40
	A	R578	530	13	97	24	36	34	64	188	93
	Bt	R579	452	18	103	32	35	44	68	77	89
	Bt	R580	663	14	92	43	30	39	72	122	109
	C	R581	633	13	85	37	34	44	81	120	104
	O	R541	510	2.8	69	48	33	55	92	267	43
	A	R542	519	2.8	76	32	64	29	122	66	42
type Sikahk coal	A	R543	316	16	88	18	46	37	44	36	99
	A	R544	267	15	94	30	37	45	59	30	101
	Bt	R545	444	12	94	51	30	47	80	55	99
	Bt	R546	743	14	94	57	29	52	85	118	114
	C	R547	547	11	94	53	34	42	94	74	126
	C	R548	556	8.5	92	59	36	34	96	67	108
	O	R572	360	5.1	79	65	78	31	98	85	64
	O	R573	554	7.1	81	36	130	28	117	110	69
Sik, 8.0 m, knoll	A	R574	374	3.0	75	19	76	23	120	61	55
	C	R575	434	3.0	79	18	52	16	151	60	39
shale, 8.2 m, knoll	-	R571	370	5.1	79	30	65	31	131	63	66
Sik, 8.0 m, cliff	O	R539	603	8.5	75	26	56	26	88	96	93
	C	R540	487	9	74	42	50	27	123	55	54
shale, 8.3 m in cliff	-	R538	407	7.4	70	20	68	26	97	60	72

APPENDIX 6. continued.

Paleosol	Hor.	Spem No.	Ba	Co	Cr	Cu	Li	Ni	Rb	Sr	Zn
Sik, 10 m knoll	O	R564	1019	40	91	63	29	153	75	352	86
Sik coal tonst.bear.	O	R551	1013	1.0	1.7	22	16	17	21	341	78
	O	R552	379	4.0	4.4	4	17	9.3	11	76	57
	O	R553	734	4.0	31	22	26	24	53	287	93
	A	R554	612	14	76	37	26	60	56	154	96
	A	R555	622	8.5	64	32	25	57	55	246	90
	C	R556	631	8.5	75	39	25	39	58	181	95
	C	R557	615	11	77	43	25	37	58	271	99
	Cg	R558	573	11	79	42	26	39	63	173	108
	Cg	R560	615	7.1	63	28	25	28	52	184	87
	Cg	R561	784	13	96	51	37	44	90	146	105
	Cg	R562	633	7.1	61	25	24	41	49	193	89
	Cg	R563	482	10	43	22	20	21	31	754	48
shale, 12 m, knoll	-	R550	724	12	76	44	28	44	84	186	136
Sik at 34.1 m	O	R522	575	6.3	17	18	45	22	23	395	27
Sik stump-bearing	O	R518	99	0	18	11	15	32	7	337	12
	A	R519	650	22	85	38	35	59	89	131	128
	A	R520	631	11	74	40	33	67	91	125	115
	C	R521	650	12	87	42	36	77	114	99	141
Sik at 35.6 m	O	R516	1079	8.5	96	66	31	31	120	118	92
	A	R517	603	5.1	71	32	26	22	83	99	67
shale at 35.7 m	-	R515	640	15	89	38	37	49	125	87	139
type Sik coal	O	R505	983	0	20	30	39	0	28	479	39
	O	R506	629	0	4	2	14	0	5	237	33
	A	R507	537	2.8	69	24	29	14	97	81	41
	A	R508	715	9.7	93	40	35	37	85	123	100
	Bw	R509	584	11	86	36	33	37	89	113	90
	C	R510	510	15	71	53	26	55	73	167	91
	C	R511	575	2.8	63	25	24	34	67	134	69
	C	R512	603	7.4	79	49	28	44	78	157	95
	Cg	R513	650	15	82	47	33	54	91	126	102
	Cg	R514	584	12	78	48	31	49	80	149	99
siltstone at 37.3 m	-	R504	675	4.5	75	35	29	44	86	133	91
Sik thick surface	O	R486	1472	1.3	14	17	39	0	43	729	19
	O	R487	1161	4.5	15	19	55	5.5	35	308	21
	O	R488	451	0	13	9	15	0	0	426	21
	O	R489	2049	10	12	13	64	7.2	145	542	23
	O	R490	895	0	17	17	9	0	21	395	22
	O	R491	1783	0	7	11	15	0	68	500	18
	O	R492	107	0	4	12	24	0	1	279	25
	O	R494	36	0	7	2	5	0	0	395	55
	A	R495	489	4.5	99	60	23	19	73	69	78
	A	R496	462	2.4	67	19	27	12	57	107	52

APPENDIX 6. continued.

Paleosol	Hor.	Spem No.	Ba	Co	Cr	Cu	Li	Ni	Rb	Sr	Zn
	A	R497	569	3.4	66	28	20	20	67	287	60
	C	R498	826	17	93	41	31	92	79	138	207
	C	R499	631	7.7	78	34	25	40	70	145	90
	C	R500	613	10	78	38	26	54	75	133	93
	C	R501	613	1.3	62	20	20	25	60	151	67
	C	R502	631	3.4	65	20	20	29	60	141	73
	C	R503	640	4.5	69	24	20	27	59	168	76
siltstone at 42.3 m type Komono clay	-	R485	658	11	96	42	37	45	87	114	119
	A	R467	391	7.7	85	29	61	22	155	24	77
	A	R468	338	10	83	26	34	19	139	24	103
	Bt	R469	418	7.7	77	23	34	20	142	58	69
	Bt	R470	445	7.7	76	21	34	20	148	41	70
	Bt	R471	400	14	93	56	43	32	168	38	123
	C	R472	462	11	92	35	43	29	135	35	101
	C	R473	507	14	80	36	42	47	136	37	119
shale at 52.4 m	A	R466	462	8.8	83	36	43	25	153	51	94

Note: These analyses also by Christine McBirney, using atomic absorption, with errors from 10 replicates of standard rock W2.

APPENDIX 7. Chemical analyses by INAA of Cretaceous and Tertiary paleosols in Bug Creek, Montana.

Element, % error	type Otssko clay paleosol				type Sikahk coal paleosol				type Komono clay		
	C R602	Bt R601	Bt R599	A R598	C R547	Bt R545	O R524	O R541	C R473	Bt R471	A R468
weight percent											
FeO, 5	2.87±.01	5.68±.02	4.96±.02	4.07±.01	4.93±.02	5.31±.02	1.93±.01	4.82±.01	3.48±.02	4.04±.05	3.01±.01
Na ₂ O, 3	1.35±.01	1.57±.01	1.70	1.73±.01	1.62±.01	1.42±.01	0.66±.01	1.37±.01	1.06±.01	0.80±.01	0.82±.01
K ₂ O, 15	1.70±.02	1.80±.02	1.60±.01	2.30±.03	2.50±.04	1.70±.03	2.20±.03	1.80±.04	n.d.	n.d.	3.30±.05
parts per million											
Sc, 3	13.6±.01	16.6±.02	14.9±.02	13.9±.01	16.1±.02	16.7±.02	12.1±.01	11.2±.01	12.7±.02	14.6±.06	14.2±.01
Cr, 10	88.4±.07	92.6±.10	99.4±.08	93.0±.08	95.6±.11	96.3±.12	63.3±.07	60.3±.08	70.0±.11	80.3±.12	73.2±.08
Co, 5	8.19±.06	16.2±.01	16.0±.08	11.9±.07	10.3±.08	11.8±.09	5.49±.05	7.35±.06	16.0±.11	13.0±.45	9.61±.06
Ni, 12	< 110	79±14	43±8	< 110	47±11	< 140	44±10	46±9	< 150	51±13	< 72
Zn, 15	87±2	112±3	98±2	88±2	93±3	61±3	57±1	72±2	114±3	131±3	75±2
As, 5	13.9±.4	6.4±.04	5.8±.02	10.2±.05	2.1±.04	3.9±.04	2.8±.05	40.7±.07	5.0±.06	53.4±.08	18.9±.06
Sb, 5	4.02±.08	1.59±.06	1.36±.05	1.47±.06	1.43±.07	1.67±.08	1.02±.05	12.2±.13	1.49±.07	3.31±.07	2.49±.06
Se, 5	2.2±.03	< 420	1.3±.03	1.5±.02	< 450	1.9±.04	1.8±.02	3.0±.03	< 420	< 450	1.8±.02
Rb, 10	61±2	83±3	72±3	82±3	77±3	75±4	92±2	74±3	117±4	158±6	120±3
Cs, 5	6.02±.08	7.27±.01	6.29±.08	6.48±.08	7.65±.11	7.62±.12	13.9±.07	8.53±.09	9.63±.12	13.7±.12	12.0±.08
Sr, 12	277±26	< 450	87±20	149±28	< 420	< 510	122±24	530±29	< 360	< 450	< 330
Ba, 10	689±38	613±37	641±24	729±38	550±38	482±38	519±35	1050±42	479±37	509±42	370±34
La, 3	30.0±.02	26.4±.02	27.2±.01	27.8±.02	25.1±.02	21.2±.02	36.0±.02	35.7±.02	41.4±.03	47.9±.03	26.5±.02
Ce, 7	63.6	50.6	55.9	53.6	45.9	39.9	69.3	67.3	79.8	87.3	49.8
Nd, 12	28.0	24.3	27.1	26.2	21.2	15.0	29.7	31.5	35.4	41.4	21.0
Sm, 5	5.44±.02	4.98±.02	5.21±.01	5.19±.02	4.19±.02	3.25±.02	6.38±.02	7.39±.03	7.19±.03	8.53±.03	4.07±.02
Eu, 5	1.21±.02	1.13±.02	1.26±.02	1.21±.02	0.91±.02	0.64±.02	1.26±.02	1.59±.02	1.42±.02	1.56±.02	0.76±.01
Tb, 5	0.81±.03	0.66±.04	0.69±.03	0.70±.03	0.51±.04	0.39±.04	0.88±.03	0.97±.03	1.00±.04	0.90±.04	0.59±.03
Yb, 5	2.44±.08	2.31±.09	2.20±.05	2.19±.08	1.84±.09	1.70±.08	3.18±.08	2.67±.01	3.29±.08	3.50±.11	2.61±.09
Lu, 5	0.38±.02	0.32±.02	0.33±.01	0.32±.01	0.25±.02	0.24±.02	0.46±.01	0.38±.02	0.53±.02	0.51±.02	0.40±.01
Hf, 5	5.39±.06	3.83±.08	4.27±.06	4.71±.06	3.99±.08	4.11±.09	4.08±.06	3.44±.06	5.44±.09	4.87±.09	5.33±.06
Ta, 5	0.85±.02	0.76±.03	0.78±.02	0.79±.03	0.81±.03	0.84±.03	0.90±.02	0.56±.02	0.95±.03	1.04±.04	1.08±.03
W, 12	< 4.8	1.8±.04	< 3.3	< 7.2	< 7.5	3.6±.08	< 7.2	< 6.3	< 8.4	< 11	< 9.3
Hg, 5	< 0.1	< 0.17	< 0.093	< 0.13	< 0.16	< 0.17	0.05±.01	0.05±.01	< 0.13	< 0.16	< 0.096
Th, 5	10.0±.01	8.7±.01	8.5±.01	8.9±.01	8.9±.01	8.9±.01	10.6±.01	7.3±.01	12.2±.01	13.9±.01	13.5±.01
U, 7	4.55±.25	3.00±.23	3.38±.16	4.62±.26	3.47±.27	4.25±.27	6.19±.25	7.85±.33	3.32±.26	3.94±.33	4.02±.25

Note: These analyses from Instrumental Neutron Activation Analysis are by A.G. Johnston, and were Oregon State University Radiation Center Project number 799. The figures beside the elements and oxides are percent standard deviation based on repeated counts of appropriate standards, and may be a better indication of uncertainty than standard deviations given in table as \pm from counting statistics. Total iron is given as FeO. The symbol < indicates maximum likely value from low peaks, from which statistically meaningful values could not be obtained.

APPENDIX 8. Molecular weathering ratios of Cretaceous and Tertiary paleosols in Bug Creek, Montana.

Paleosol	Hz	Specimen No.	Na_2O	$\text{CaO}+\text{MgO}$	Al_2O_3	Al_2O_3	Ba	FeO
			K_2O	Al_2O_3	SiO_2	$\text{CaO}+\text{MgO}+$ $\text{Na}_2\text{O}+\text{K}_2\text{O}$	Sr	Fe_2O_3
type Sapakot clay	A	R604	1.11	0.21	0.15	2.21	2.56	0.54
	A	R605	1.09	0.20	0.15	2.18	1.43	0.13
	Bw	R606	1.11	0.26	0.13	1.72	3.30	0.37
	Bw	R607	1.11	0.26	0.13	1.68	3.29	0.34
	C	R608	0.78	0.29	0.12	1.60	3.53	0.25
	C	R609	0.73	0.33	0.12	1.50	3.34	0.18
	Cg	R610	1.02	1.65	0.10	0.48	2.91	0.90
type Ottsko clay	A	R598	1.34	0.20	0.15	2.02	2.57	0.27
	A	R599	1.35	0.25	0.17	1.81	3.42	0.29
	Bt	R600	1.14	0.29	0.17	1.71	2.11	0.07
	Bt	R601	1.10	0.28	0.17	1.79	3.77	0.29
	C	R602	1.22	0.22	0.14	1.99	1.97	0.58
type Spatsiko silty clay loam	A	R596	1.45	0.36	0.15	1.49	1.55	0.03
	A	R597	1.43	0.21	0.12	1.74	2.93	0.33
shale at 3.3 m	-	R595	1.10	0.66	0.17	1.07	2.53	0.42
type Maka clay	A	R592	0.78	0.40	0.14	1.38	2.30	0.49
	A	R593	1.01	1.06	0.14	0.72	2.41	0.61
nodule, 4.4 m	-	R591	1.12	0.35	0.15	1.48	3.01	0.69
siltstone, 4.4 m	-	R590	1.18	3.56	0.20	0.26	1.97	5.51
Maka, 6.5m, knoll	A	R582	1.34	0.28	0.15	1.60	3.97	0.47
Maka, 6.5m, cliff	A	R549	1.08	0.22	0.16	1.96	5.71	0.19
Sikahk coal thin surface phase	O	R576	1.23	0.11	0.10	3.37	4.99	0.96
	A	R577	1.22	1.12	0.12	3.02	5.00	0.51
	A	R578	1.43	0.16	0.17	2.58	1.80	0.22
	Bt	R579	1.52	0.18	0.18	2.45	3.74	0.04
	Bt	R580	1.50	0.19	0.15	1.94	3.47	0.08
	C	R581	1.46	0.26	0.14	1.64	3.37	0.46
	C	R548	1.13	0.24	0.16	1.88	5.29	0.22
type Sikahk coal	O	R541	1.17	0.33	0.14	1.41	1.22	0.27
	A	R542	0.50	0.25	0.11	2.06	5.02	0.94
	A	R543	1.90	0.18	0.12	2.85	5.60	0.03
	A	R544	1.62	0.18	0.17	2.79	5.68	0.06
	Bt	R545	1.26	0.21	0.16	2.26	5.15	0.08
	Bt	R546	1.20	0.22	0.16	2.12	4.02	0.08
Sik, 8.0 m, knoll	C	R547	1.17	0.23	0.16	1.92	4.71	0.17
	C	R548	1.13	0.24	0.16	1.88	5.29	0.22
	O	R572	0.92	0.24	0.15	2.16	2.70	0.57
	O	R573	0.70	0.23	0.15	2.25	3.21	0.20
	A	R574	0.58	0.24	0.14	2.05	3.91	0.31
shale 8.2m knoll-	C	R575	0.47	0.22	0.14	2.13	4.61	0.36
	-	R571	0.71	0.25	0.16	1.98	3.75	0.24

APPENDIX 8. continued.

Paleosol	Hz	Specimen No.	Na ₂ O	CaO+MgO	Al ₂ O ₃	Al ₂ O ₃	Ba	FeO	
			K ₂ O	Al ₂ O ₃	SiO ₂	CaO+MgO+ Na ₂ O+K ₂ O	Sr	Fe ₂ O ₃	
Sik 8.0 m cliff	O	R539	0.93	0.26	0.15	2.21	4.01	0.27	
	C	R540	0.54	0.25	0.10	1.95	5.65	0.17	
shale 8.3 m cliff	-	R538	0.86	0.24	0.16	2.30	4.33	0.26	
Sik 10 m knoll	O	R564	1.73	0.52	0.18	1.04	1.85	1.28	
Sik coal ton.b.	O	R551	5.20	0.55	0.20	1.16	1.90	1.35	
	O	R552	6.02	0.42	0.20	1.63	3.18	0.02	
	O	R553	1.98	0.26	0.19	1.51	1.63	2.22	
	A	R554	2.04	0.53	0.15	1.16	2.54	0.33	
	A	R555	2.23	0.56	0.15	1.12	1.61	0.23	
	C	R556	1.95	0.58	0.15	1.09	2.22	0.26	
	C	R557	1.88	0.69	0.15	0.99	1.45	0.18	
	Cg	R558	1.76	0.61	0.15	1.06	2.11	0.21	
	Cg	R560	2.07	0.57	0.15	1.11	2.13	0.30	
	Cg	R561	1.25	0.47	0.17	1.25	3.43	0.22	
	Cg	R562	2.07	0.65	0.15	1.03	2.09	0.24	
	Cg	R563	1.69	1.65	0.16	0.50	0.41	0	
	shale 12m knoll	-	R550	1.40	0.67	0.15	0.96	2.48	0.36
Sik at 34.1 m	O	R522	2.01	0.22	0.31	2.39	0.93	120.06	
Sik stump-bear.	O	R518	11.55	0.64	0.28	0.96	0.19	202.32	
	A	R519	1.18	0.35	0.14	1.42	3.17	0.51	
	A	R520	1.07	1.06	0.14	0.71	3.22	0.15	
	C	R521	0.91	0.44	0.15	1.29	4.19	0.18	
Sik at 35.6 m	O	R516	0.90	0.40	0.17	1.30	5.83	0.60	
	A	R517	1.15	0.29	0.14	1.57	3.89	0.11	
shale at 35.7 m	-	R515	0.85	0.39	0.16	1.34	4.69	0.05	
type Sik coal	O	R505	2.13	0.39	0.16	1.34	1.31	19.05	
	O	R506	6.73	0.46	0.43	0.79	1.67	0	
	A	R507	1.21	0.23	0.14	1.75	4.23	0.11	
	A	R508	1.34	0.38	0.14	1.36	3.71	0.09	
	Bw	R509	1.31	0.38	0.13	1.30	3.30	0.23	
	C	R510	1.39	1.26	0.13	0.60	1.94	0	
	C	R511	1.47	1.18	0.12	0.64	2.74	0.08	
	C	R512	1.33	1.12	0.14	0.67	2.45	0.02	
	Cg	R513	1.07	0.96	0.15	0.76	3.29	0.07	
	Cg	R514	1.24	1.23	0.14	0.62	2.50	0.02	
	siltstone 37.3 m	-	R504	1.18	1.02	0.14	0.71	3.23	0.23
	Sik thick surface	O	R486	1.39	0.31	0.22	1.39	1.29	0
		O	R487	1.17	0.10	0.22	3.24	2.40	0.88
		O	R488	139.83	0.73	0.43	0.83	0.67	0
O		R489	0.82	0.07	0.18	2.44	2.41	0	

APPENDIX 8. continued.

Paleosol	Hz	Specimen No.	Na_2O	$\text{CaO}+\text{MgO}$	Al_2O_3	Al_2O_3	Ba	FeO
			K_2O	Al_2O_3	SiO_2	$\text{CaO}+\text{MgO}+$ $\text{Na}_2\text{O}+\text{K}_2\text{O}$	Sr	Fe_2O_3
	O	R490	2.22	0.40	0.27	1.05	1.45	0
	O	R491	1.31	1.19	0.17	1.57	2.28	0
	O	R492	55.32	0.45	0.45	1.13	0.24	0
	O	R494	299.41	0.93	0.58	0.40	0.06	0
	A	R495	1.31	0.28	0.16	1.58	4.52	0.04
	A	R496	1.59	0.26	0.12	1.63	2.75	0
	A	R497	1.39	0.35	0.12	1.29	1.26	0
	C	R498	1.42	0.56	0.14	1.08	3.82	0
	C	R499	1.56	1.01	0.12	0.71	2.78	0.06
	C	R500	1.48	1.03	0.13	0.69	2.94	0.03
	C	R501	1.57	1.29	0.11	0.59	2.59	0.04
	C	R502	1.60	1.28	0.12	0.59	2.86	0.15
	C	R503	1.59	1.19	0.12	0.62	2.43	0.31
siltstone 42.3 m	-	R485	1.17	0.43	0.15	1.26	3.68	0
type Komono	A	R467	0.36	0.23	0.16	2.03	10.39	0.04
clay	A	R468	0.39	0.20	0.15	2.21	8.98	0.03
	Bt	R469	0.46	0.22	0.13	1.85	4.60	0.18
	Bt	R470	0.44	0.21	0.13	1.83	6.92	0.12
	Bt	R471	0.32	0.25	0.16	1.84	6.72	0.19
	C	R472	0.53	0.21	0.15	2.18	8.42	0.15
	C	R473	0.47	0.29	0.13	1.60	8.74	0.40
shale 52.4 m	-	R466	0.41	0.30	0.15	1.64	5.78	0.24

Note: Molecular weathering ratios were calculated from AA data only by converting weight percent values (from Appendices 5 and 6) to moles using molecular weights (Retallack, 1990).

REFERENCES

- Munsell Color, 1975, *Munsell soil color charts*. Munsell, Baltimore, 24 pp
- Murphy, C.P., 1983, Point counting pores and illuvial clay in thin section. *Geoderma* 31, 133-150
- Retallack, G.J., 1988, Field recognition of paleosols, in J. Reinhardt and W. Sigleo, editors, *Paleosols and weathering through geologic time: principles and applications: Special Paper of the Geological Society of America* 216, p. 1-21.
- Retallack, G.J., 1990, *Soils of the past: an introduction to paleopedology*. Unwin-Hyman, London, 512 pp.
- Van der Plas, L. and Tobi, A.C., 1965, A chart for judging the reliability of point counting results. *American Journal of Science* 263, 87-90.