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Physio-chemical environment, morphology, characterization and classification of soils associated with black spruce in Alaska

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INTRODUCTION

The boreal forest biome of the subarctic zone, along with that of the arctic zone, is expected to experience the greatest impact of global climate change (IPCC, 1992). The boreal forest, the dominant vegetation community in the subarctic zone, accounts for more than 22% of the terrestrial surface (Chapin III et al., 2000) of the earth and contains 30% of the world's total soil organic carbon (SOC) (Oechel et al., 1996; Post et al., 1982). Boreal forest covers 50% of the land area in Alaska (Van Cleve et al., 1991) with 44% dominated by black spruce (*Picea mariana* (P. Mill.) B.S.P.) (Damman and Johnston, 1980; Viereck et al., 1986), the most abundant tree species in Alaska (Zasada and Packee, 1995). Although black spruce-dominated forests are considered to be the climax in most of the North American boreal forest (Barbour and Billings, 2000), catastrophic events, especially fire, return the forest to earlier successional stages dominated by the deciduous species, such as trembling aspen (*Populus tremuloides* (Michx,), balsam poplar (*P. balsamifera* L.), and Alaska birch (*Betula neoalaskana* Sarg.), along with the coniferous species white spruce (*Picea glauca* (Moench) Voss). Whether black spruce will continue to dominate the climax forest remains to be seen.

The boreal forest in Alaska, with its discontinuous and "warm" permafrost, occupies much of the region of Alaska that will likely continue to experience the most intense effects of a warming climate (Osterkamp and Romanovsky, 1999). Nearly three-fourths of the soil organic carbon (SOC) in the boreal forest is estimated to be stored below ground (Apps et al., 1993; Ping et al., 2002). Turnover of this belowground organic carbon (OC) in upland soils determines the present and future role of boreal forest soils as sources or sinks of atmospheric C (Rapalee et al., 1998). Despite the importance of boreal forest terrestrial OC stocks, little data are available on stocks of SOC beyond the 20 cm depth in Alaska (Kane and Vogel, 2009 and Hollingsworth et al., 2008). The limited studies of SOC deeper than 20 cm in the soil profile (Ping et al., 1997) indicate that there will be significant stores of SOC exposed to changed conditions resulting from the thawing of discontinuous warm permafrost as the climate warms and the associated increased wildfire. These deeper stocks have been studied in arctic Alaska (Michaelson et al., 1996; Ping et al., 1997 and, 2008a), yet deeper carbon stores remain unquantified over the larger landscape of the boreal forest in Alaska.

In interior Alaska, black spruce forests commonly occupy north-facing slopes, toe slopes, and lowlands that are poorly drained with permafrost and commonly contain high SOC stores (Ping et al., 1997). Most soils associated with black spruce that have been previously studied in Alaska share common characteristics such as poor drainage, thickened surface organic horizons, and permafrost substrata. In the arctic tundra, a dynamic relationship exists between the thickness of the surface organic mat, soil temperature, and depth to permafrost (Kade and Walker, 2008; Ping et al., 2008a). However, based on the preliminary results from Permanent Sample Plots of the Forest Growth & Yield Program (Rosner, 2004), stands containing black spruce occur in many forest cover types and not just in the pure black spruce cover type, and they grow on a greater number of landforms, slope aspects, and soil types than suggested by the literature. Because of the vast acreage and the potentially high soil organic carbon (SOC) storage capacity of the boreal forest biome, a systematic study and understanding of the SOC stores and the related biogeochemical properties are crucial to both ecological modeling and land management. To date, most studies of surface SOC conducted across interior Alaska landscapes have not included subsoil at the depths that will be affected by long-term drainage changes brought about by thawing permafrost (Ping et al., 2002).

Wildfire is an integral, natural occurrence in boreal forest ecosystems (Kasischke and Stocks, 2000). Frequency of wildfires in the Alaska boreal forest, including communities with black spruce, ranges from 50-200 years (Viereck and Dyrness, 1979; Viereck and Schandelmeier, 1980). Wildfire is a primary control in forest succession patterns and thus significantly affects the storage of SOC (O'Neill et al., 1997; Viereck, 1983). Wildfire disturbs the surface organic horizon and causes increased soil temperatures and lowering of the permafrost table, with subsequent effects on soil moisture content and the deeper SOC stores. Slope movement due to the effects of fire on the permafrost table can mix and bury SOC to greater depths, which can lead to sequestration over the long term, delaying its release. Higher soil temperatures resulting from fire can increase the decomposition rate of soil organic matter (SOM) (O'Neill et al., 1997).

Fire also introduces a large pulse of charred material that may be chemically and biologically less active in the soil surface horizons (Goldberg, 1985; Harden et al., 1997). In boreal forest regions of Alaska, charcoal particles are commonly found in the lower organic horizons and underlying mineral horizons (Ping et al., 2005). Multiple layers of charred organic materials are commonly found in mineral horizons under black spruce stands, and such occurrences have been reported from the Nenana Valley near Healy (Bigelow, 1991) and the Caribou-Poker Creek Research Watershed study area (Ping et al., 2005). The boreal forest C balance is affected not only by the amount and turnover of charred material but also by changes to SOM chemical composition and its biological properties (Shindo, 1991; Kumada, 1983; Shindo et al., 1986; Haumaier and Zech, 1995). Hence, surface SOC stocks are vulnerable to the direct effects of fire and can be volatized, while deeper stocks are vulnerable to the indirect effects that fire can have on soil temperature and moisture, depending on the presence or absence of permafrost and the subsequent slope movement and physical burial/mixing effects that result in sequestration.

At high latitudes slope and aspect play an important role in the pattern of soil distribution (Rieger, 1983). Cold and wet permafrost-affected soils typically develop on north aspects and in lowlands while warm and dry permafrost-free soils develop on south aspects (Furbush and Schoephorster, 1977). Within the boreal forest biome of Alaska, permafrost is continuous to discontinuous and is commonly "warm," with mean annual temperatures less than 2ºC below freezing (Moore et al., 1993). This permafrost is very sensitive to climate change and its depth is very sensitive to and controlled by the fire cycle, with its subsequent changes to vegetation succession (Viereck, 1973), and resource management practices (Moore and Ping, 1989; Ping, 1987). Since high-latitude boreal forests in interior Alaska experience limited variation in annual precipitation—approximately 250 to 500 mm/year—SOC storage variability is largely attributed to landscape position (aspect and slope) that controls drainage and the vegetation succession stage as affected by fire.

Both C storage and soil classification can be expected to differ at each stage of succession over differing landscape positions and under different management systems. Soil classification will indeed change if the permafrost table recedes below 1 m. and as the soil moisture characteristics (soil drainage) change in response. These soil changes can occur over a relatively short period (5-10 years) and have been well documented (Ping et al., 1992; Moore et al., 1993). The soil may, in time, revert back to the climax stage, but this is totally dependent on soil and site factors such as particle size distribution, slope shape and aspect, pre- and post-disturbance drainage characteristics, and intensity of the original disturbance. Based on a study at the Caribou-Poker Creek Watershed in interior Alaska, Ping et al. (2005) found SOC store values ranging from 17 to 79 kg C m^{-2} in mineral soils to more than 130 kg C m^{-2} in organic soils. North-facing slopes have a tendency to be poorly drained due to the presence of permafrost at depths of <100 cm below the surface and have vegetation dominated by black spruce and mosses. The dominant soils are Historthels and Histoturbels with OC storage ranging from 50 to 120 kg C m^{-2}. This demonstrates the importance of whole profile stores and the deeper SOC in the boreal ecosystem and its significance in ecosystem modeling efforts. Recent studies have found good relationships between surface SOC stores (the organic layer and 15 cm of mineral soil) and soil temperature and plant community qualities for the black spruce forests of Alaska (Kane and Vogel, 2009; Hollingsworth et al., 2008), but deeper stores that could heavily affect C balance through both sequestration and respiration remain relatively unstudied. Thus, soils under black spruce forest show great potential for C storage, yet a systematic study to depth below the surface horizons across the boreal regions of Alaska is lacking. In this study, SOC stores of the whole soil profile from 52 black spruce sites were quantified to a depth of at least 1 m and the effects of SOC on soil biogeochemical properties were elucidated. This is the first study of its kind in Alaska to examine black spruce soils to depth as they occur over the larger landscape of interior and southcentral Alaska.

MATERIALS AND METHODS

In the text, all soil-related terminology follows the definitions in Schoeneberger et al. (2012), Soil Survey Staff (2014), and the Soil Terminology Glossary website: <www.soils.org/publications/soils-glossary/>

Physiographic Setting

The study sites cover an east-west span from longitude 141° W in the Tok-Northway area near the Alaska-Canada border to 160° W near Aniak and a north-south span from 61° N near Cook Inlet to 67° N in the southern foothills of the Brooks Range (Figure 1). The study sites are located across nine major land resource areas (MLRA) of Alaska (USDA-NRCS, 2006). Five sites are in the Interior Brooks Range Mountains (MLRA 234), 23 in the Interior Alaska Highlands (MLRA 231), nine in the Interior Alaska Lowlands (MLRA 229), seven in the Interior Alaska Mountains (MLRA 228), three in the Cook Inlet Lowlands (MLRA 224), two in the Yukon-Kuskokwim Coastal Plain (MLRA 238), one in the Copper River Basin (MLRA 227), one in the Upper Kobuk and Koyukuk Hills and Valleys (MLRA 233), and one in the Bristol Bay-Northern Alaska Peninsula Lowlands (MLRA 236). The locations and physiographic environments

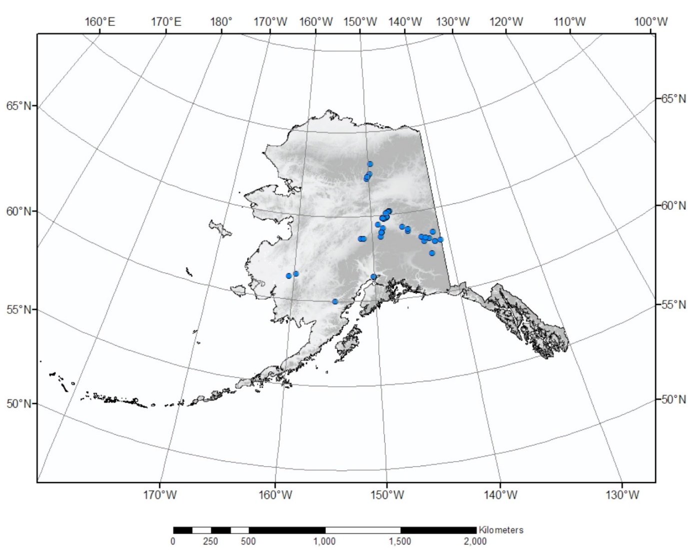

Figure 1. General locations of sampling sites of soils associated with black spruce

of the sample sites are summarized in Table 1. Detailed descriptions of each MLRA can be found in USDA Agriculture Handbook 296 (USDA-NRCS, 2006).

Soil-forming Environment

Parent Material and Age

The parent material of the soils in the study area in the Interior Alaska Highlands and Interior Alaska Lowlands, and southern foothills of the Brooks Range are Quaternary (0-1.8 MA BP) sedimentary deposits of loess, alluvium, and colluvium of varying thickness over bedrock (Viereck et al., 1986; Foster et al., 1994). In the Interior Alaska Highlands, loess deposits are widespread (Péwé, 1975). The loess sources are sediments from exposed floodplains of the braided Tanana and Yukon rivers and their tributaries. Although loess deposition currently continues in central and eastern Alaska at an estimated accumulation rate of 0.2-2.0 mm per year, most of the deposition occurred during the Illinoian (550-400 kA BP) and Wisconsinan (80-10 kA BP) glaciations of the Pleistocene (Péwé, 1975). Thicknesses of loess deposits can reach more than 60 m in some locations close to riverine sources (Péwé, 1975; Péwé and Reger, 1983a), thinning gradually over a 30-50 km range away from the source (Mulligan, 2004). The thickest deposits tend to occur on south-facing slopes and valley bottoms adjacent to rivers. Much of the loess deposited on summits and hill slopes has eroded downslope into valley bottoms, where it occurs as over-thickened, cumulative reworked deposits. During this process, organic debris is incorporated in the loess (Péwé and Reger, 1983a). Consequently, thick deposits of bedded or massive OM-rich silt occur on foot and toe slopes, and some of this organic-rich material is perennially frozen (Péwé, 1975; Péwé and Reger, 1983a). Most loess is highly micaceous due to the mineral content of the weathered mica schist and associated rock of the parent bedrock, and this mineralogy is reflected in the associated soils (Péwé, 1955; DeMent, 1962; Péwé, 1975). Chemically, the carbonate content varies from place to place, which is a reflection of source rock characteristics as well as differences in post-depositional weathering. This carbonate mainly occurs as secondary precipitate formed in the soil from the interaction of water and CO_2-enriched soil gases (from SOM degradation) and often occurs

Table 1. Physical environment of soils for the black spruce-study sites, Alaska

Site No.	Area, USDA/NRCS Pedon user ID or UAF ID	Lat. N Long. W *(degrees)*	Elevation *(m)*	MLRA[1]	Landform[2]	Landscape Position	Parent material	Slope *(%)*	Aspect *(degrees)*	Landcover type	Drainage	Presence of Permafrost *(cm)*	O Hor. Thkns *(cm)*
Outwash Plains & Terraces													
1	Coldfoot: DH181, S04AK185-009	67.334 150.145	347	234	alluvial fan	mid-slope	alluvium/outwash	0	---	PIMA 150 yrs old	well	N	16
2	Marion Ck.: DH180 UAF 7-8-07	67.325 150.137	351	234	outwash terrace	flat	alluvium /outwash	0	---	PIMA/ Lichen	well	N	6
3	Gold Creek: DH 197 UAF 7-8-08	67.510 149.843		233	outwash terrace	flat	alluvium /outwash	1		PIMA 105 yrs old	mod well	N	22
4	Coldfoot BLM 03AK290-006	67.323 150.148	351	234	outwash terrace	flat	alluvium /outwash	0	---	PIMA	mod. well	N	10
5	Delta, Moosehead 91AK240-003	64.019 145.124	383	229	outwash	flat	alluvium	1	20	PIMA	well	N	14
6	Healy: Usib 08-31 UAF 9-1-07	63.998 148.743	620	228	terrace	mid-slope	alluvium	8	145	PIMA	well	N	14
7	Delta: AH 1415 91AK240-002	63.907 145.124	369	229	outwash plain	flat	loess/ alluvium	1	20	PIMA	very poor	Y, 51	25
8	Tok Cutoff PSP S03AK176-008	63.156 143.215	592	229	outwash plain	flat	alluvium /outwash	0	---	PIMA	poor	Y, 49	34
9	Tok Forest Plot S02AK174-001	63.352 142.983	486	229	outwash plain	flat	alluvium /glacfluv	0	---	PIMA	well (thawed)	N	6
10	Pt. MacKenzie 91AK170004	61.425 150.137	34	224	outwash plain	flat	loess/ outwash	1	180	PIMA	well	N	7
11	Pt. MacKenzie 89AK170005	61.417 150.083	67	224	outwash plain	flat	Loess/ outwash	1	180	PIMA	well	N	8
Alluvium													
12	Healy: Usib 08-33 UAF 9-1-07	63.996 148.742	634	228	terrace	flat	alluvium	1	194	PIMA PIGL	poor	N	13
13	Carib. Poker Ck. UAF 201	65.152 147.487	217	231	alluvial fan	mid-slope	alluvium	8	190	PIMA	very poor	Y, 55	23
14	Tanana 58AK090-002	64.855 147.863	150	231	alluvial plain	flat	alluvium	0	---	PIMA 50 yrs old	poor (thawed)	N	13
15	Giest Rd 91AK090-004	64.858 147.882	145	231	alluvial plain	flat	alluvium	1	180	PIMA	very poor	Y, 38	23
16	Giest Rd. 91AK090-002	64.851 147.834	134	231	alluvial plain	flat	alluvium	1	180	PIMA/ POBA	poor	Y, 84	25
17	Happy Series S04AK090-001	64.806 148.418	127	229	alluvial plain	flat	alluvium	0	---	PIMA	poor	Y, 76	13
18	Windy Creek S04AK068-001	64.214 148.418	151	229	alluvial plain	flat	loess/ alluvium	0	---	PIMA	poor	Y, 60	22
19	Tanacross	64.443	130	229	alluvial	flat	loess/	0	---	PIMA	poor	Y, 71	27

	S04AK068-003	149.141			plain		alluvium						
20	Quartz Lake S04AK176-002	64.192 145.868	303	229	alluvial fan	flat	alluvium	0	---	PIGL/ PIMA	poor	Y, 44	16
21	Denali Park, Minchumina 00AK068-003	63.683 151.517	260	229	alluvial fan	flat	alluvium	1	315	PIMA	poor	Y, 75	21
22	Chatanika S04AK090-004	64.815 148.043	197	231	alluvial fan	toe slope	alluvium	2	190	PIMA	poor	Y, 42	15
Lake Basin, Lacustrine													
23	Klawasi 81AK260-010	62.398 142.485	735	227	basin	flat	lacustrine	13	304	PIMA	poor	Y, 54	23
Loess Upland													
24	Upper Kalskag S04AK050-001	61.347 160.588	37	238	hills	ridge	loess	2	92	Dwarf PIMA	poor	Y, 77	22
25	Himalaya Rd. S03AK090-001	65.103 147.882	445	231	hills	saddle	loess	9	360	PIMA	poor	Y, 70	22
26	Smith Lake 96AK090-001	64.869 147.857	169	231	Hills	back slope	loess	4	135	PIMA	poor	Y, 58	27
27	Smith Lake S03AK090-006	64.867 147.875	161	231	hills	toe slope	loess	6	214	PIMA	poor	Y, 70	37
28	Standard Ck S03AK090-010	64.804 148.331	420	231	hills	back slope	loess	4	105	PIMA	mod. well	N	16
29	Kantishna, 00AK068-012	63.677 151.15	398	228	hills	back slope	loess	7	270	PIMA	poor	Y, 36	24
30	Aniak S01AK175-001	61.527 159.778	27	238	hills	terrace	loess	2	270	PIMA Burn1980	sw poor	N	8
Loess/Residuum													
31	Carib. Poker Ck. UAF 203	65.176 147.523	383	231	hills	foot slope	colluvium	50	0	PIMA	poor	Y, 52	28
32	Carib. Poker Ck. UAF 204	65.175 147.523	394	231	hills	foot slope	colluvium	55	15	PIMA	poor	Y, 30	30
33	Carib. Poker Ck. UAF 205	65.195 147.497	760	231	hills	back slope	loess/ colluvium	14	345	PIMA	poor	Y, 40	19
34	Ft. Knox PSP S03AK090-007	65.175 147.363	741	231	hills	shoulder	residuum	6	128	PIMA	mod. well	N	17
35	Workman PSP S03AK090-002	65.094 147.851	490	231	hills	back slope	loess/ residuum	29	168	PIMA/ PIGL	well	N	14
36	Shoefly S03AK090-009	64.77 148.265	396	231	hills	shoulder	loess	29	3	PIMA/ *CACA*	well	N	14
37	Taylor MP 14 S04AK176-006	63.463 143.468	869	231	hills	ridgetop, summit	residuum	0	---	PIMA burned	somewhat poor	N	21
38	Healy, Usib. UAF 08-44	63.994 148.722	717	228	hills	saddle	residuum	10	223	PIMA BENA	somewhat poor	N	21

39	Healy, Usib. UAF 08-56	63.997 148.737	630	228	hills	terrace break	colluvium	37	154	PIMA BEGL	mod well	N	8
Tephra/Residuum													
40	S01AK176-001 Taylor Hwy	63.061 141.827	773	231	hills	back slope	tephra/ colluvium	6	90	PIMA 50 yrs old burned	well	N	10
41	White Alice S04AK176-003	63.061 141.026	740	231	hills	shoulder	tephra/ residuum	7	52	PIMA	well	N	11
42	Seismic Site S03AK240-010	63.604 141.83	711	231	hills	back slope	tephra/ residuum	14	270	PIMA	well	N	13
43	Big stump site S03AK240-011	63.056 141.827	713	231	hills	back slope	tephra/ residuum	14	180	PIMA	well	N	6
44	Nondalton 67AK070-002	59.983 154.85	107	236	hills	toe slope	tephra/ morane	15	135	PIMA/ Birch	well	N	10
Sand Dune													
45	Taylor MP 3.5 S01AK176-002	63.285 142.513	548	231	mand dune	shoulder	eolian sand	2	90	PIMA	excessive	N	10
Moraine													
46	Dalton MP 186 S04AK185-008	68.069 149.58	404	234	moraine	back slope	recess. moraine	6	225	PIMA/ lichen 95 yrs old	well	N	10
47	Coldfoot DH175 93AK185-010	67.2 150.27	137	234	moraine	back slope	moraine	2	136	PIMA/ PIGL	poor	Y, 51	39
48	Denali, Rock Ck 92AK068-003	63.727 148.841	744	228	hills	foot slope	loess/till	13	6	PIMA	very poor	Y, 47	27
49	Healy, Usibi. UAF 08-42	63.993 148.723	720	228	montane	back slope	colluvium /moraine	28	197	PIMA BEGL	mod well	N	12
Bogs and Lowlands													
50	Smith Lake 91AK090-003	64.867 147.855	152	231	hills	toe slope	loess/ alluvium	4	270	PIMA/ *Carex*	very poor	Y, 30	25
51	Smith Lake 96AK090-003	64.865 147.853	154	231	hills	toe slope	organics	4	360	PIMA	poor	Y, 37	30
52	Pt. MacKenzie 91AK170-005	61.426 150.139	32	224	bog		muck	0		PIMA/ moss	very poor	N	>100

[1] Major land resource area of Alaska (USDA-NRCS, 2006)
[2] Landscape position and drainage according to Schoeneberger et al. 2012

as finely disseminated, powdery residue in the soil itself as well as coatings on coarse fragments.

Interior Alaska sand dunes, eolian deposits, were formed by strong winds that occurred during the late Pleistocene and early Holocene (10-0 Ka) (Péwé, 1975; Dijkmans et al., 1986). These winds blew sand northward from the glacial outwash and floodplains of the Tanana River and its tributaries that drain the Alaska Range (Péwé, 1975) and the Yukon River and its tributaries. The resulting dune fields are found scattered over lowland areas (Fernald, 1965), including the valleys of the Tanana, Yukon, and Kuskokwim rivers (Péwé, 1975).

Most of interior Alaska was not glaciated except for small cirque glaciers in local mountainous highlands and valley glaciers extending northward from the Alaska Range and southward from the Brooks Range (Péwé and Reger, 1983a). Repeated glacial advances occurred from the late Tertiary into the Quaternary and not only strongly influenced the topography of the Brooks Range region but also left many of the surficial deposits observed in the mountains and the range's southern foothills (Hamilton, 1983). Glacial deposits including moraine and outwash are found in middle and upper Tanana River basin; glacial till and lacustrine deposits occur in the Copper River basin, and moraine and glacial outwash are widespread in the Cook Inlet Lowlands (Péwé, 1953; Péwé and Reger ,1983b). Most of these glacial-related deposits are of pre-Wisconsinan to late Wisconsinan age (Péwé, 1953; Péwé and Reger, 1983b). Glacial-derived parent materials in Alaska include a wide range of textures and particle sizes ranging from sandy loam to silt loam to loam. Glacial till and moraines contain gravel, cobblestones, and occasionally boulders throughout the deposit due to the mineral composition of rocks and the nature of their transport. The textures of glacial outwash range from gravelly sand to very gravelly sand to loamy sand.

Parent materials resulting from alluvial processes are common in the lowlands and valleys of the uplands of the study areas. The fluvial deposits have a wide range of textures, including silt, loams, fine to coarse sands, and rock fragments. Fluvial deposits in the Interior are confined to the lowlands or valley floors. In the Interior Alaska lowlands, the majority of depositional material overlying bedrock is fluvial (Péwé and Reger, 1983b). In the upper Tanana River valley and Cook Inlet Lowlands, fluvial and glaciofluvial sediments from the Alaska Range have accumulated as glacial outwash and alluvial fans for the last one-half of the Quaternary (Péwé, 1975; Péwé and Reger, 1983b). In the Middle Tanana Valley Lowlands, Quaternary deposits from the Alaska Range (Péwé and Reger, 1983a) range from 120-180 m thick (Péwé, 1975) and the Tanana River continues to carry and deposit fluvial material today (Mason and Begét, 1991).

In the Koyukuk Valley in the southern Brooks Range where three study sites are located, glacial scouring of high ridges transported various materials down to the valley floor. Flowing water has mixed and continues to mix glaciofluvial, alluvial, lacustrine, and till deposits and transport them downstream (Brown and Krieg, 1983; Hamilton, 1981, 1986). Alluvium from tributary streams and colluvial aprons formed fans and terraces (Hamilton, 1981, 1986) that buried many pre-Holocene glacial and fluvial deposits.

More than 100 volcanoes and volcanic fields occur on the Alaska Peninsula and throughout the Aleutian Islands, the Wrangell Mountains in eastern central Alaska, and isolated areas in southeastern and western Alaska (Péwé, 1975). These volcanoes deposited extensive and abundant quantities of ash throughout southern and central Alaska (Kellogg and Nygard, 1951; Péwé, 1975). In the Cook Inlet region, some moderately well-drained soils formed in tephra support black spruce (Clark, 2002). In central and eastern Alaska, tephra deposits are common as surficial deposits (Begét et al., 1991). White River ash is the most widely distributed ash in east-central Alaska (Péwé, 1975; Foster et al., 1994) and the ash from the northern lobe has been radiocarbon dated as 1890 years BP by Lerbekmo et al. (1975). Smith et al. (1999) examined soils derived from White River ash and two out of three of their study sites support black spruce forest. Rosner (2004) observed black spruce forest on tephra-derived soils in interior Alaska.

Climate

The interior boreal forest region of Alaska lies between approximately 63º and 67º north latitude and is characterized by a continental climate (Slaughter and Viereck, 1986; Bailey, 1996; Fralish and Franklin, 2002). Climatic data representative of the study area are presented in Table 2. The continental climate type shows great seasonal variation in temperature. Documented mean daily temperature ranges from -24.5°C in the coldest month, January, to +17.5°C in the warmest month, July (Van Cleve et al., 1991). Warmest air temperatures can exceed 30°C in June and July and plunge below -40°C in January and February. Annual mean temperature is approximately -3.5°C (www.wrcc.dri.edu/cgi-bin/cliMAIN.pl? accessed June 12, 2014).

Winter conditions dominate the seasons for six to seven or more months, typically from October through mid-April, and are accompanied by sub-freezing mean monthly temperatures (Bailey, 1996). The growing season in the Fairbanks area generally ranges from 70-120 days (USDA-NRCS, 2006) and the mean number of frost-free days is 97. In the Fairbanks area, mean annual snowfall is

Table 2. Mean annual temperature, precipitation, snowfall, and soil temperature data for selected sites in the Boreal Regions of Alaska

Location	Lat. N	Long. W	Elev	Mean Temperature				Precipitation		Nearby Soil		
				Annual	Max.	Min.	July	Total	Snowfall	MAST	MSST	MWST
	Degrees (◦)		m	°C				cm		°C		
Coldfoot	67.200	150.270	137	-6.8				38		-2.9		
Bettles	66.917	151.530	195	-5	-1	-10	15	35	210			
Central	65.567	144.817	292	-6	0	-12	15	26	126			
Caribou Peak	65.192	147.498	773	-1				37	69	0.4	1.7	-0.8
Caribou-Poker Cr.	65.155	147.487	218	-3				35	53	-2.3	-0.02	-4.7
Chena Hot Sprs.	65.050	146.050	365	-5	1	-11	12	36	166			
Fairbanks	64.783	147.867	132	-2	2	-8	16	27	165	-0.8		
Nenana	64.550	148.833	106	-4	1	-9	15	27	116			
Delta Jct.	64.000	145.733	390	-2	2	-7	15	29	111			
Healy	63.883	149.017	454	-1	4	-6	15	37	211		0.2	
Lake Minchumina	63.883	152.300	208	-4	1	-8	15	30	135			
Denali Park	63.717	148.967	637	0	2	-8	12	38	210			
Tanacross	63.400	143.317	472	-5	1	-12	13	25	78			
Northway	62.950	141.917	523	-6	0	-11	14	26	98			
Slana	62.717	143.917	737	-2	3	-8	13	39	146			
Aniak	61.567	159.533	26	-1	6	-7	12	20	60			

Source (all accessed Dec. 2016):
Aniak: http://www.weatherbase.com/weather/weather.php3?s=23207&refer=
Bettles: http://www.weatherbase.com/weather/weather.php3?s=47107&refer=
Caribou Peak: http://bnznet.lab.uaf.edu/vdv/vdv/historical.php
Caribou-Poker Creeks: http://bnznet.iab.uaf.edu/vdv/vdv/historical.php
Central: http://www.weatherbase.com/weather/weather.php3?s=664105&refer=
Chena Hot Sprs. http://www.weatherbase.com/weather/weather.php3?s=475105&refer=
Coldfoot: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak2103
Delta Junction: http://www.weatherbase.com/weather/weather.php3?s=16207&refer=
Denali Park: http://www.weatherbase.com/weather/weather.php3?s=877505&refer=
Fairbanks: http://www.weatherbase.com/weather/weather.php3?s=16207&refer=
Healy: http://www.weatherbase.com/weather/weather.php3?s=585305&refer=
Lake Minchumina: http://www.weatherbase.com/weather/weather.php3?s=64207&refer=
Nenana: http://www.weatherbase.com/weather/weather.php3?s=903605&refer=
Northway: http://www.weatherbase.com/weather/weather.php3?s=19207&refer=
Slana: http://www.weatherbase.com/weather/weather.php3?s=745805&refer=
Tanacross: http://www.weatherbase.com/weather/weather.php3?s=745805&refer=

approximately 1,650 mm; its water equivalent makes up about 35% of the total precipitation of 274 mm (www.wrcc.dri.edu/cgi-bin/cliMAIN.pl? accessed December 12, 2016). Monthly precipitation is low in the spring and early summer but increases in late summer.

Permafrost and Soils

Permafrost is defined by Washburn (1973) as "a thickness of soil or other superficial deposit, or even of bedrock, at a variable depth beneath the surface of the earth in which a temperature below freezing has existed continually for a long time." Most permafrost throughout the world is thousands of years old (Williams and Smith, 1989). Above the permafrost table, seasonal freezing and thawing of the uppermost ground layers occurs; this zone is referred to as the *active layer* and typically extends down 2 or 3 m into ground but can be shallower or deeper (Williams and Smith, 1989).

In Alaska, permafrost is present across 82% of the state and is divided into three general zones from north to south: continuous, discontinuous, and sporadic (Péwé, 1975). In the interior uplands and lowlands and the south slope of the Brooks Range, where many of the study sites are located, permafrost is discontinuous but widespread. Permafrost is generally absent from under hilltops and moderate to steep, well-drained, south-facing slopes that receive greater solar radiation (Brown and Krieg, 1983; Péwé and Reger, 1983a; White et al., 1999). It is also absent on active floodplains and especially the younger terraces along rivers (Péwé and Reger, 1983a); these are areas that experience active deposition of unconsolidated sediments and have yet to experience the full influence of climate on their ground thermal regime (Brown and Péwé, 1973).

Permafrost underlies areas that include alluvial fans, drainage-way bottoms in the uplands, valley bottoms, north-facing slopes, and wet lower slopes. These areas are typically colder because they receive less solar radiation and/or more moisture and, as a result, they have shallow active layers, particularly on colder lower slopes with wet, fine-grained material (Brown and Krieg, 1983). Active layer thickness in colder and wetter landforms ranges from 0.5 m to 1.2 m (Brown and Krieg, 1983; White et al., 1999). In silty soils derived from loess, ground ice commonly occurs as large masses, especially in redeposited silt in valley bottoms and on lower slopes. These ice masses are in the form of horizontal to vertical sheets, ice wedges, and irregularly shaped masses that range from less than 0.3 m to 15 m in length (Péwé and Reger, 1983a). Permafrost in coarser materials occurs as ice in the voids between grains and larger particles and as coatings on individual particles (Brown and Krieg, 1983). In the zone of discontinuous permafrost, such as interior Alaska, talik is known to occur in soils of deep silt deposit and also alluvial terraces (Davis, 2001). Talik is a layer or body of unfrozen ground occurring in a permafrost area due to a local anomaly in thermal, chemical, hydrological, or hydrochemical conditions (van Everdingen, 1998). However, most talik is more than 2 m below the mineral soil surface and thus beyond the depth required for the description of a pedon. Permafrost greatly influences the physical and chemical properties of soils. Differential thawing of permafrost can lead to much diversity in thermokarst terrain depending on surficial materials and the morphology and volume of ground ice (Jorgenson et al., 2001; Jorgenson and Osterkamp 2005). Thermokarsting is likely to result in reorganization of the vegetation community, altered soil hydrology, and patterns of SOC accumulation.

Soil formation occurs mainly in the active layer, where cold temperatures from permafrost slow soil-forming processes like translocation (Tedrow et al., 1958). As a physical barrier to water movement, permafrost impedes drainage and causes seasonal perched water and saturation of soil above the permafrost table; these conditions create a reducing soil environment where soil color features indicative of chemical changes, called redoximorphic features, occur (Everett et al., 1981; Ping et al., 2008a). A reducing environment coupled with cold temperatures inhibits decomposition of organic matter, which then accumulates in the soil (Ping et al., 1997). In addition to its impermeable nature, permafrost also acts as a physically restrictive layer to plant roots because of its cold temperatures; roots may then concentrate in the top mineral and organic soil horizons (Tryon and Chapin 1983).

Cryoturbation has long been recognized as an important soil process in permafrost-affected soils (Rieger, 1983; Tarnocai and Smith, 1992). Cryoturbation, collectively, refers to all soil movement that occurs due to frost action and includes soil heaving, sorting, mixing, wedging, and cracking (Washburn, 1973). The most apparent features that indicate cryoturbation are broken and irregular soil horizons (Tarnocai and Smith, 1992; Kimble et al., 1993; Ping et al., 1998). Recently, cryoturbation was recognized (Ping et al. 2008b) as the controlling mechanism of C sequestration in the arctic tundra because it mixes organic material into lower horizons (Michaelson et al., 1996; Bockheim et al., 1998; Ping et al., 1998). Mineral soils transported and mixed into the organic horizons at the surface affect soil chemistry and processes by providing mineral nutrients to the microbes and plant roots in the surface horizons. This influx of nutrients is beneficial to the microbes and facilitates root growth and life functions that contribute to physical and chemical soil weathering.

Vegetation

Yarie (1983), Viereck et al. (1993, 1986), Hollingsworth et al. (2008), and Gracz (2007) delineated black spruce vegetation communities that are specific to Alaska. Viereck et al. (1993) identified 31 pure black spruce communities and 31 mixed black spruce communities that contain white spruce, tamarack (*Larix laricina* (Du Roi) K. Koch), paper birch, and aspen as co-dominant species. Viereck et al. (1986) described broad, general black spruce communities for uplands and lowlands in Interior Alaska based on observations at the Washington Creek fire ecology research site (Van Cleve et al., 1983b; Viereck et al., 1983). They recognized three communities in the uplands and three in the lowlands. The upland communities include closed black spruce/*Pleurozium schreberi-Hylocomium splendens*, open black spruce/*Ledum groenlandicum-Vaccinium uliginosum*/*Pleurozium schreberi,* and open black spruce/*Ledum groenlandicum-Vaccinium uliginosum*/*Sphagnum.* The lowland communities include open black spruce/*Ledum groenlandicum*/*Hylocomium splendens,* open black spruce/*Ledum groenlandicum*/*Pleurozium schreberi,* and open black spruce/*Salix pulcha*/*Ledum groenlandicum*/*Sphagnum.*

A more recent study by Hollingsworth et al. (2008) in interior Alaska identifies three black spruce community types: *Picea mariana/Cetraria islandica* (acidic soil conditions)*, Picea mariana/Rosa acicularis/Equisetum* spp. (non-acidic soil conditions), and *Picea mariana/Tofieldia pusilla/Cetraria laevigata* (tree line). Gracz (2007) identified four black spruce communities on the Kenai Peninsula: *Picea mariana*/*Equisetum arvense-Betula nana* as a new type*; Picea mariana*/*Ledum palustre* ssp. *decumbens* in areas with deep peat*; Picea mariana*/*Equisetum sylvaticum-Ledum palustre* ssp. *decumbens* as a common type in lowlands; and *Picea mariana*/*Empetrum nigrum- Vaccinium vitis-idaea*. (www.kenaiwetlands.net/plant_community_classification_i.htm [accessed 11/06/13]). The understory components of a forest stand influence soil conditions and weathering. Two very important components of the black spruce forest understory, especially with regard to the soil, are mosses and lichens.

In the black spruce forests of interior Alaska, the dominant species of lichens present are *Peltigera aphthosa* (L.) Willd., *Cladonia rangiferina* (L.) Web., and *Cetraria islandica* (L.) Ach. on the lowland site types, and *Cladonia* spp., *Peltigera* spp., and *Nephroma arcticum* (L.) Torss. on upland site types (Viereck et al., 1986). Lichens are a source of nitrogen through nitrogen-fixation by the symbiotic cyanobacteria component (Alexander and Billington, 1986; Paul and Clark, 1996). Lichens found to be active nitrogen fixers in black spruce forests in interior Alaska include *Nephroma arcticum*, *Nephroma bellum* (Spring.) Tuck., *Peltigera aphthosa*, *Peltigera canina* (L.) Willd., *Peltigera polydactyla* (Neck.) Hoffm., *Peltigera scabrosa* Th. Fr., and *Peltigera spruia* (Ach.) DC (Alexander and Billington, 1986). Also, other chemicals produced by lichens often are involved in biogeochemical processes and thus influence pedogenesis.

Lichens produce organic acids, such as oxalic acid, many of which are strong chelators. The chelates combine with metallic compounds, such as iron (Fe) and aluminum (Al), and transport the metals through soil profiles (Jones, 1998). Oxalic acid, in addition to other organic acids produced by lichens, is a low molecular weight (LMW) organic acid that functions as a ligand that forms complexes with metals (Fox and Comerford, 1990; Fox, 1995). These organic acids can also affect phosphorus (P) availability. Phosphorus increases in the presence of LMW organic acids that form stable complexes with metals in a pattern of increasing P release with increases in LMW organic acid concentration (Fox and Comerford, 1992; Fox, 1995). The main mechanisms of this condition are through ligand exchange of P adsorbed onto clays and oxide surfaces, dissolution of oxide surfaces to which P is attached, and decreasing P adsorption capacity of the soil by complexing of LMW organic acids at the oxide surfaces, which blocks P sorption sites on mineral surfaces (Fox, 1995). In the case of oxalic acid, phosphate is increased as the oxalic acid chelates with Fe and Al. These metals commonly bond with phosphate, forming insoluble compounds (Jones, 1998).

Given the prevalence of lichens as a component in black spruce communities in interior Alaska, their influence on soils associated with such communities can be important depending on their abundance on a site. The mineral-dissolving properties of the organic acids produced by lichens and their role in pedogenesis are well known (Purvis, 2000; Stevenson, 1982). Dawson et al. (1984) studied the mobility of lichen compounds and their contribution to pedogenesis on the southern slopes of the Brooks Range. Communities examined were lichens, mixed spruce/lichens, and spruce forest, and all had a component of *Cladonia mitis*. Lichen compounds (e.g., usnic, rangiformic, and psoromic acids) were found at depth in the soil profiles examined. The results strongly imply that lichen compounds may contribute significantly to pedogenesis, specifically to the podzolization observed in these conifer woodland and alpine tundra soils in the southern Brooks Range.

In the black spruce forests of interior Alaska, the most important mosses are the feathermosses, specifically *Pleurozium schreberi* and *Hylocomium splendens*, and *Polytrichum commune* and *Sphagnum* spp. They influence other vegetation and soil through insulation of underlying soils and the interception of nutrients. Mosses also serve as nitrogen fixers through a symbiotic relationship with nitrogen-fixing bacteria such as cyanobacteria (Paul and Clark 1996; DeLuca et al., 2002).

Mosses often form continuous mats with extremely low thermal conductivities due to the high organic matter content that insulates the underlying soil. Organic matter has far less thermal conductivity than minerals, as illustrated by dry peat, whose thermal conductivity is an order of a magnitude lower than the lowest values reported for mineral soils (Gerrard, 1992; Williams and Smith, 1989). The moss layer acts as a selective filter to heat transport, which encourages heat loss while discouraging heat gain, resulting in lower soil temperatures and an increase in moisture content. The regulation of heat promotes further moss production and is believed to directly contribute to the development and perpetuation of permafrost on such affected sites, a process called paludification (Van Cleve and Viereck, 1981; Viereck, 1973; Viereck et al., 1986, 1993). Permafrost thawed in past studies that examined the removal of the forest floor and moss mat cover by both mechanical processes and wildfire (Dyrness, 1982; Swanson, 1996).

The second important effect that mosses have in black spruce forests is on the nutrient content of soils. Mosses are very efficient at absorbing nutrients that are deposited on their surfaces by rainfall, dust, throughfall, or decomposing litter (Oechel and Van Cleve, 1986). Mosses intercept incoming nutrients before vascular plants can access them and these nutrients only become available upon the death and decomposition of the mosses (Oechel and Van Cleve, 1986). Nutrients are thus released slowly because decomposition is inhibited due to the cold soil temperatures and often wet conditions. The nature of moss tissue itself further slows decomposition. Moss tissue decomposes at approximately 1-10% of the rate of vascular plant tissue (Oechel and Van Cleve, 1986).

Due to these conditions, mosses are effective competitors with vascular plants. The extent of this is such that decreases in forest tree productivity in older stands have been attributed to the increasing influences of mosses in these systems (Oechel and Van Cleve, 1986). At Washington Creek, north of Fairbanks, Van Cleve et al. (1983a) studied mosses and found them to have greater (18% or more) aboveground productivity than the black spruce trees themselves. Moss production was nearly four times greater than annual black spruce foliage production. Annual uptake of principal macronutrients (N, P, and Mg) was equal to and in some cases substantially greater than that of the aboveground parts of black spruce. Through these characteristics, mosses in black spruce boreal forests can greatly influence soil properties, most importantly soil temperature, moisture, and nutrient availability.

Black spruce roots grow mostly laterally and form a shallow mat-like mass from which the roots turn downward only at the ends (Pulling, 1918; Hare, 1954; Harlow and Harrar, 1968). Shallow rooting depths are typical for black spruce growing in bogs, swamps, peatlands, coarse-textured podzolized soils, and loamy upland soils (LeBarron, 1945; Vincent, 1965). Lateral spread of roots occurs at the moss-humus interface and the bulk of the root biomass is typically in the upper 20 cm of the organic horizons. This is particularly the case if the site is underlain with permafrost (Tryon and Chapin, 1983). Because low precipitation and low temperatures reduce soil weathering and release of nutrients from parent materials (Tyron and Chapin, 1983; Oechel and Van Cleve, 1986), black spruce allocates a large proportion of its root biomass to absorbing roots rather than support and conducting roots in order to better obtain nutrients (Tryon and Chapin, 1983).

Field Study

Site Selection and Field Sampling Protocol

Fifty-two sites were selected based upon major landforms dominated by black spruce stands. Eleven sites are on alluvial or outwash terraces (Sites 1-11), 11 sites are on lowlands with fine- to medium-textured alluvium or in transported loess (Sites 12-22), one site (Site 23) is on a lacustrine deposit, seven sites are on deep loess deposits on hilly uplands (Sites 24-30), nine sites are on residual or colluvial materials with a loess cap (Sites 31-39), five sites are on residual/colluvial materials with a tephra mantle (Sites 40-44), one site (Site 45) is on loess over a sand dune deposit, four sites (Sites 46-49) are on moraines or glacial till, and three sites (Sites 50-52) are in valley bottoms and bogs. Seventeen of the sites are located adjacent to previously established permanent sample plots (PSPs) of the University of Alaska Fairbanks Forest Growth and Yield Program. Ten sites are associated with USDA-NRCS/UAF soil climate monitoring project sites. Thirteen additional sites were identified from the database of the National Cooperative Soil Survey projects in interior Alaska. The locations of the sampling sites are shown in Figure 1. Site physical environments are summarized in Table 1.

Soil Characterization and Classification

At each study site, physiographic and environmental characteristics and soil profile descriptions were recorded according to the USDA National Soil Survey Center (NSSC) field guide (Schoeneberger et al., 2012). Soils pits were excavated at each site to a meter or greater depth or to the lithic or paralithic contact. Morphological properties were studied and soil samples were collected from each genetic horizon. In cryoturbated soils where the soil horizons are warped or discontinuous, the profile was drawn according to scale for estimating the proportions of each horizon (Ping et al., 2013). The soil samples from 32 of the study sites were jointly sampled or samples shared with the NSSC Laboratory in Lincoln, NE, for full characterization analysis. Nine samples were from the NSSC database, while for the remaining 23 study sites samples were analyzed at the University of Alaska Fairbanks Matanuska Experiment Farm in Palmer according to procedures of the Kellogg National Soil Survey Laboratory (KNSSL) (Soil Survey Laboratory Staff, 1996) unless otherwise noted. Soils from each study site were classified according to Soil Taxonomy (Soil Survey Staff, 2014).

Organic and mineral samples were air-dried and passed through a 2-mm sieve. Fractions >2 mm were weighed to determine percentage of coarse fragments, then converted to volumetric basis (Michaelson et al., 2013). Analyses were performed on air-dried samples and results corrected to a110°C dry basis based on weight loss when an air-dried subsample was dried to 110°C. Bulk density of mineral soils was determined using either Saran-coated clods or soil cores and reported on a110°C oven-dried basis. For bulk density of organic and some frozen soil horizons, a known or measured volume was cut with serrated knife and then dried (Michaelson et al., 1996; Ping et al., 2013). For soils with permafrost, core samples with known volume were taken with a hollow-core drill from the permafrost or frozen horizons and then shipped to the Palmer laboratory for determining bulk density and ice volume or water content. Particle size analysis was determined using the hydrometer methods.

Soil pH was measured in distilled water at a ratio of 1:1 for mineral soils, and for organic soils by soil paste or at a ratio of 1:5. Mineral soil subsamples were ground to approximately 0.425 mm (80 mesh) for total carbon (TC) and total nitrogen (TN) analysis by high-temperature combustion using a LECO CNS analyzer (Leco Corp., St. Joseph, MI, USA). For mineral soils with pH>5.5, total inorganic carbon (TIC) was determined from carbon dioxide released upon acidification with 1M HCl. Then total organic carbon (TOC) was determined by subtracting the TIC from the TC. Pedon organic C and TN storage were calculated using the equation of Michaelson et al. (2013): OC Storage (kg/m^2) = T* BD* (%OC/100) *(%volume <2mm/100)*10, (BD = bulk density, and T = cm horizon thickness.) The pedon C storage for pedons with cryoturbation was calculated using T as the percentage ratio determined from descriptive methods noted above (Kimble et al., 1993; Ping et al., 1997). For areas with detailed soil survey, C storage estimates were determined from data extracted from the NRCS / KNSSL database as updated in Michaelson et al. (2013).

Cation exchange capacity (CEC) and extractable bases were determined by using 1M ammonium acetate (NH_4OAc) at pH 7 extraction. The extracted base cations, calcium (Ca), potassium (K), magnesium (Mg), and sodium (Na) were determined by inductively coupled plasma optical emission spectrometer (ICP-OES). Extractable acidity was determined by using $BaCl_2$-triethanolamine, buffered to pH 8.3 through an automatic extractor (Soil Survey Laboratory Staff, 1996) followed by titration with dilute hydrochloric acid solution.

Iron (Fe) and aluminum (Al) were selectively extracted with buffered dithionite-citrate (Mehra and Jackson, 1960; McKeague and Day, 1966); ammonium oxalate [pH 3.5 for poorly crystalline and organically-bound Fe and Al, and amorphous silica (Si) (Fe_o, Al_o and Si_o)] (Blume and Schwertmann, 1969; Parfitt and Henmi, 1982); and sodium-pyrophosphate solution pH 10 [for organically bound Fe and Al (Fe_p and Al_p)] (Bascomb, 1968; McKeague et al., 1971) and extracts were analyzed by ICP-OES. The ratios of these amounts serve as proxy indices of the intensity of alteration, thus pedogenesis (Blume and Schwertmann, 1969; Parfitt and Henmi, 1982).

RESULTS AND DISCUSSION

Soil Landscape Relationships

Black spruce is commonly considered a species associated with cold and wet environments. Based on our Alaska data, forest stands dominated by black spruce are found in a broad range of landscapes, including alluvial fans, terraces, outwash plains, and on different aspect positions of hills and low mountains. Drainage conditions range from excessively to very poorly drained (Table 1). Consequently, there is a wide variation in soils formed under the black spruce stands. Well-drained soils that lack permafrost and support black spruce are formed in coarser-textured alluvium generally less than 50 cm deep over sandy or gravelly outwash, and also on recently formed floodplains (Sites 1-6 and 9-11). However, poorly drained soils with permafrost also form in depositional sequences such as those in the Tanana Basin (Sites 7, 8). Apparently, the cause of such a temperature difference is the thickness of organic layers that insulate the permafrost soils (Viereck et al., 1983). Poorly drained soils underlain with permafrost formed in deep silty deposits in the valley or bottomland positions (Sites 12-22).

Since wildfire is frequent in the boreal forest, especially in black spruce stands, there exists a dynamic relationship between soil drainage, active layer thickness, and even the disappearance of permafrost (Vierek et al., 1983), all of which affect changes in soil classification (Ping et al., 1992). As vegetation succession follows disturbance, the spruce forest will re-establish itself and the permafrost table will rise again. The reduction or disappearance of permafrost can be observed at sites in the Tok area of the upper Tanana River basin. An example here is Site 9. After it was burned in 1992, the soil became well-drained across a fire break.

Soil Physical and Morphological Properties

Soil physical and morphological properties of study sites are summarized in Supplement A.

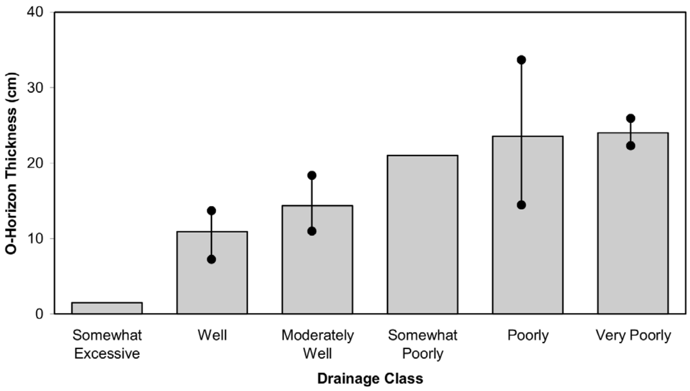

Figure 2. Thickness of organic horizons in soils under black spruce forest and its relationship with drainage in the boreal regions of Alaska

Soil Horizonation

In this study, soils formed under black spruce forest have measurable organic horizons regardless of landscape position. The thickness of the organic horizons varies from 6 cm on some of the well-drained sites to over 100 cm on a very poorly drained bog site (Table 1). This trend reflects the controlling and interacting effects of soil moisture and temperature regimes on SOM, and thus C accumulation, in the boreal region (Ping et al., 2002). On well-drained sites the thickness of the O horizon averaged 11.5 cm (n=26) with a range of 6 to 21 cm; these horizons remaining unsaturated during most of the growing season. Among these well-drained sites, soils formed in loess over residuum have thicker O horizons, on average 16 cm. On poorly drained sites, the thickness of the O horizons averaged 26 cm (n=25), with a range of 13 to 39 cm, and they are saturated during a considerable part of the growing season. In the very poorly drained bog (Site 52) the O horizon exceeded 100 cm. In upland areas, landscape position and slope aspect play an important role in OM accumulation (Ping et al., 2002, 2004). In the well-drained soils, decomposition of SOM is greater with depth, with a fibric (Oi; primarily undecomposed organic tissues) horizon occurring over a hemic, or Oe, horizon over a dark A horizon that is underlain with a yellowish-brown cambic horizon (Bw) (Supplement A). A hemic, or Oe, horizon is composed of both recognizable and unrecognizable organic materials that are being degraded by microbial and physical processes. Black sapric horizons (Oa; highly decomposed organic materials with no recognizable tissue structure remaining) and cryoturbated horizons (Oajj) were observed at four sites. Charcoal particles are abundant in most of these horizons with fire being the likely cause of the color the underlying A horizons. In poorly drained sites, the organic layer often consisted of a sequence of Oi, Oe and Oa horizons. Under the O horizons, some of these poorly drained soils have a mucky grayish A horizon and a few have Bw horizons over strongly mottled to gleyed (Bg or Bgjj) horizons, indicating variable to permanently poorly-drained conditions respectively through the season. Most of the poorly drained soils have permafrost within 1 m of the soil surface, and the permafrost layer is designated as Cf or Cgf horizon.

Soil Color

Soil color reflects the degree of OM decomposition and mineral weathering and the color of the parent material. The Oi horizons of both well-drained and poorly drained soils have yellowish to reddish hues but tending toward the latter (indicated by the dominance of 7.5YR hue as shown in Table 3). The plausible explanation of this difference is the dominance of moss fibers, which have a reddish hue after decomposition, in the poorly drained soils. Both Oe horizons have nearly the same color value but the ones on the poorly drained sites have lower chromas due to increased decomposition. A similar trend also is also observed in the Oa, but with lower chroma because of the lesser fiber content.

The 10YR hue dominates the A horizons of all drainage classes, but the poorly drained sites tend to have a more reddish hue, again most likely due to the presence of decomposed moss fiber, and a slightly lower value and chroma. The increased values and chromas of the B horizons, dominantly 10YR 4/3 and 4/4, indicate weak weathering and oxidation of iron-containing minerals. Most of the Bw horizons at the poorly drained sites have weak redoximorphic features, indicated by Fe concentrations and depletions in masses, which is indicative of fluctuating water table. The Bg horizons have either a gleyed matrix, as indicated by the 5Y hue, or strongly developed redoximorphic features, including Fe concentrations and depletions in pore linings.

Table 3. Soil colors of genetic horizons in different drainage classes in soils associated with black spruce in the boreal regions of Alaska

	Excessive, well, mod. well sites				Somewhat poor, poorly and very poorly			
Horizon	n	Hue	Value Ave./ Range	Chroma Ave./ Range	n	Hue	Value Ave. /Range	Chroma Ave./ Range
Oi	12	10YR, 42% 7.5YR, 25% 2.5YR, 17% 5YR, 16%	**3** 1-3	**2** 1-4	16	10YR, 18% 7.5YR, 44% 2.5YR, 17% 5YR, 31%	**3.4** 2-5	**3.2** 2-6
Oe	7	10YR, 43% 7.5YR, 43% 2.5YR, 14%	**2.6** 2-3	**2.3** 1-3	9	10YR, 67% 7.5YR, 11% 2.5YR, 11% 5YR, 11%	**2.7** 2-5	**1.5** 1-4
Oa, Oajj	4	10YR, 100%	**2** 2-3	**1.5** 1-3	11	10YR, 73% 7.5YR, 9% 2.5YR, 9% N, 9%	**2.2** 2-3	**1.1** 0-2
A, Ajj	12	10YR, 83% 7.5YR, 9% 2.5YR, 8%	**2.8** 2-4	**1.7** 1-4	8	10YR, 50% 7.5YR, 25% 2.5YR, 13% 5YR, 12%	**2.5** 2-3	**1.4** 1-2
Bw	32	2.5Y, 22% 10YR, 65% 7.5YR, 9% 5YR, 4%	**4.0** 2.5-5	**3.5** 2-6	5	2.5Y, 20% 10YR, 60% 7.5YR, 20%	**3.8** 3-4	**3.4** 3-4
Bg, Bgjj	4	5Y, 75% 2.5Y, 25%	**5.0** 2-5	**2.0** 1-4	20	5Y, 35% 2.5Y, 50% 10YR, 15%	**4.1** 3-5	**2.1** 1-4
C, Cr	15	2.5Y, 67% 10YR, 33%	**3.5** 2-5	**2.7** 2-4	9	2.5Y, 50% 10YR. 25% 5Y, 25%	**3.5** 2-4	**1.4** 1-2
Cf, Cgf	0				10	5Y, 40% 2.5Y, 30% 10YR, 20% Gley 2 10%	**3.6** 3-5	**2.1** 1-3

These features indicate desaturation during lowered permafrost tables during periods of warmer climate (Ping et al., 2008b). The common appearance of 2.5Y hue in the C and Cf horizons is mostly inherited from the parent materials, such as alluvial or deep loess deposits. The gleyed colors of some Cgf horizons, as indicated by the 5Y hue, are caused by the prolonged reducing environment of the permafrost.

Soil Texture

Soil texture at the study sites clearly reflects the origin of parent materials. Particle size distributions of each genetic horizon of all the pedons are given in Supplement A. Generally, soils formed in recent alluvial deposits over glaciofluvial or outwash materials in terraces in the major river valleys of the southern Brooks Range and Tanana Valley (Sites 1-9) have a coarser texture (sand, fine sandy loam, sandy loam) that is occasionally stratified with loamy sand, and clay contents range from 2-10%. The substrata (2C) are sand or gravelly sand. Those soils formed in the outwash plain of the Matanuska-Sustina Valley have a medium texture (silt loam or loam) resulting from loess mixed with volcanic ash (Sites 10 and 11). Soils formed in fine-textured alluvium and redeposited loess in the Tanana Valley have a predominantly silt loam texture with some having a very fine sandy loam and silt; clay contents are less than 10% (Sites 12-22). At Site 23, in the Copper River Basin, the soil formed in a loess mantle over a lacustrine deposit and has 60% clay and 6% fine sand in the 2C horizon.

Soils formed on summits, shoulder slopes, or exposed slopes on uplands generally have a thin mantle of loess or tephra over a very gravelly or very cobbly sandy loam substrate due to slope movement or formation over fractured bedrock (Sites 31-44). Initially, sand dune deposits are common along the upper Tanana River valley and invariably have a thin mantle of loess mixed with volcanic ash overlying the sand (Site 45). Soils formed on moraines of the southern Brooks Range, the upper Koyukuk River valley, and the Alaska Range (Sites 46-48) are loamy-skeletal in the control section (25-75 cm from the mineral soil surface); the one soil from the hilly upland north of the Alaska Range (Site 49) is sandy because of the sandstone bedrock. Soils formed in valley bottoms (Sites 50 and 51) are very poorly drained and have thick organic horizons at the surface and stratified organic horizons within the deep silty deposit. Site 52 is in muskeg with stunted black spruce, and lenses of tephra were found in the deep (>100 cm) organic deposit there.

Soil Structure and Consistency

Soil structure (geometric aggregation tendency of soil particles) for the mineral horizons of the well-drained and the poorly drained soils are compared in Table 4. Thirty-five percent of the A horizons of the well-drained soils have a granular structure indicative of bioturbation, and the remainder have subangular, platy, massive structures, which are more indicative of physical processes. For most A horizons, nomenclature is based on color only. In poorly drained A horizons, subangular blocky is the dominant structure type, followed by platy, lenticular, and massive with no granular structure. Presence of platy and lenticular structures reflects the effect ice lens formation during freezing (Ping et al. 2008a). Most E horizons have granular structure resulting from active root disturbance. Only one Bs horizon was observed and it was classified as single grained because of the sandy texture (lack of aggregation tendencies). The cambic (Bw) horizons of the well drained soils have a predominantly subangular blocky structure (54%) followed by platy, lenticular, and massive structures. The effect of frost action is evident in the formation of these structure types. But for the Bw horizons in poorly drained sites, platy structure becomes dominant flowed by massive, this indicates increased frost action at the cold and wet sites. Dominance of platy, massive and lenticular structures in the Bg, Bgjj horizons of all drainage

Table 4. Occurrences (%) of soil structures in mineral horizons of soils associated with black spruce in the boreal regions of Alaska (**bold** type for poorly drained sites)

Horizon (n)	granular	platy	subangular	lenticular	massive	Single gained	Ice wedge
A(17)	35	24	29	0	12	0	0
A, Ag, Ajj (7)	**0**	**29**	**43**	**11**	**11**	**0**	**0**
E (7)	43	29	11	0	11	0	0
Bs	0	0	0	0	0	100	0
Bw, BC (35)	9	20	54	11	6	0	0
Bw (8)	**0**	**50**	**13**	**0**	**37**	**0**	**0**
Bg (3)	0	66	0	34	0	0	0
Bg, Bgjj (17)	**0**	**40**	**24**	**6**	**30**	**0**	**0**
Bgf (7)	**0**	**43**	**0**	**0**	**57**	**0**	**0**
C, Cg (10)	0	10	20	0	0	70	0
C, Cg (6)	**17**	**17**	**33**	**0**	**33**	**0**	**0**
Cf, Cgf (15)	**0**	**7**	**0**	**33 w/ice lens**	**60**	**0**	**0**
Wf (1)	**0**	**0**	**0**	**0**	**0**	**0**	**100**

classes again demonstrates the effect of frost action, as freezing water forces the geometric alignment of aggregates (or lack thereof for massive structure) in subsoils. Massive structure resulting from pore ice is common in permafrost-affected horizons such as Bgf and Cf. The common appearance of lenticular structure in Bg, Cf and Cgf is the result of ice lens formation. One horizon the Wf/Cf, has mineral in a matrix of ice. The presence of permafrost (Bgf, Cf, Cgf) keys these soils into the Gelisol order (Soil Survey Staff, 2014).

Most of the structure types found in the nonfrozen horizons are weakly expressed in fine or medium grades, and either very friable or friable when moist. The coarse loamy horizons are generally nonsticky and nonplastic when wet because of the low clay contents. Coarse silty horizons generally have slightly sticky and slightly plastic wet consistency. Soils formed in the higher clay and higher calcium content lacustrine materials have strongly expressed fine granular and subangular structures with moderately sticky and plastic wet consistency.

Root Abundance and Depth

Black spruce is known for its shallow rooting depth. Most fine, medium, and coarse roots are concentrated in the organic horizons. Medium and fine roots penetrate into the upper mineral horizons (Supplement A). In this study common distribution is used to determine the rooting depth (Table 5). Common root restriction layers found in this study include textural discontinuity, permafrost, water table (Bw-Bg boundary), organic-mineral horizon boundary, and compact substratum (increase in bulk density of >40%). Textural discontinuity occurs in mostly well drained, stratified alluvial and outwash deposits resulting in an average rooting depth of 42 cm with 33 cm in the mineral soil. Permafrost limits the rooting depth to an average of 40 cm. However, the fine roots extended into the mineral horizons maybe encased in upper permafrost during the process of permafrost aggradation. A perched water table above permafrost also limits rooting depth, usually indicated by the Bw-Bg boundary. On the average, a majority of the rooting system under black spruce forest are limited to 40 cm below the surface of the organic horizon except one well drained site with a deep loess deposit where roots penetrate to more than 75 cm.

Soil Chemical Properties

Soil chemical properties are summarized in Supplement B.

Table 5. Root restricting layers in soils associated with black spruce in the boreal regions of Alaska (range of rooting depth in parenthesis)

Root restrictions	No. sites	Total rooting depth (cm)	Organic horizon (cm)	Root depth in mineral soils (cm)	Poorly drained %
Org.-Mineral layer boundary	4	20 (10-27)	20	0	25 (1/4)
Textural discontinuity	9	42 (35-80)	9 (6-16)	33	22 (2/9)
Compact substratum, bulk density +50%	2	37 (30-45)	23 (20-25)	14	100 (2/2)
Wetness (Bw-Bg boundary)	5	33 (21-55)	24 (14-37)	9	80 (4/5)
Permafrost	7	40 (26-60)	25 (15-34)	15	100 (7/7)
Data incomplete	2				
No restriction	1	75	15	60	0 (0/1)

Soil Reaction (pH) and Organic Matter Quality

In the black spruce forest of interior Alaska soil reaction varies with horizon, parent material, landscape position, and OM content (Supplement B). Soil reaction of organic horizons ranges from extremely acid to moderately acid (pH 3.5-6.0) due to the effect of organic acids released from the decomposition of SOM, thus soil pH increases with depth (Table 6). Generally, soils formed in thin mantle of loess or tephra over residuum have the most acidic reaction

Table 6. pH values of soils horizons from different parent materials in soils associated with black spruce in the boreal regions of Alaska

Soil horizon	Stream terrace	Outwash terrace	Alluvium	Loess upland	Loess/ residuum	Tephra/ residuum	Moraine	Bog
Oi	5.6	4.1 (6) (3.6-4.8)	4.2 (10) 3.9-6.0)	4.5 (7) (3.4-5.7)	3.5 (5) (3.2-3.7)	4.0 (5) (3.4-4.7)	4.7 (2)	4.7 (3) (3.9-5.7)
Oe, Oef	4.8	4.4 (4) (3.5-5.1)	5.6 (2)	5.3 (5) (4.2-6.1)			4.8 (2)	5.2 (4) (4.9-5.2)
Oa, OA, Oaf		5.0 (3) 4.6-5.2)	5.4 (6) (4.6-6.1)	5.9 (5) (5.4-6.5)	3.7 (2) 3.6-3.8)		6.0	5.7 (5) (5.0-6.5)
E, A, EA	6.2	5.1 (4) (3.9-6.1)	6.0 (5) (5.3-7.1)	4.4 (3) (4.1-4.7)		4.9 (8) (4.0-5.4)		
Bs, Bw		5.4 (10) (4.3-6.9)	6.5 (2) (6.0-6.9)	6.0 (4) (5.5-6.6)		6.1 (11) (5.1-6.7)	7.5	
Bg		5.5 (2) (4.6-5.9)	6.7 (11) (5.7-7.7)	6.5 (8) (5.1-7.4)	5.9		5.5	6.4 (1)
Cg, Bgf	8.1 **(7.9-8.2)**	6.6 (3) 4.9-6.8)	6.6 (7) (6.2-8.2)	8.1	5.4	6.2 (3) (6.0-6.3)	5.7	
2C, 2BC		5.6 (5) (4.6-6.2)			5.8	6.9 (3) (6.7-7.2)		
Cf, 2Cf		6.5 (4) (5.8-7.4)	7.1 (7) (5.8-8.2)	6.3 (8) (4.8-8.2)				5.7 (3) (5.1-6.4)
Pedon #	**1**	**2-11**	**12-22**	**24-30**	**31-39**	**40-44**	**46-49**	**50-52**

Table 7. Carbon stores in relationship to landscape/parent material, permafrost and cryoturbation in soils associated with black spruce forest in the boreal regions of Alaska

Presence of permafrost	Outwash	Deep Loess		Residuum, colluvium		Lake basin	Moraine	Bog
		Lowland/ alluvium	upland	loess cap	tephra			
	kgCm^{-2}(range), **%** of TOC in O horizon (range)							
No	**22.5** (7.1-44.7) **50%** (16-90% N=9	**28.8** (11.1-31.3) **37%** (13-62%) N=2	**21.8** (11.1-32.6) **35%** (31-40%) N=2	**16.8** (8.3-30.6) **56%** (42-80%) N=6	**15.4** (7.2-31.0) **46%** (32-70%) N=5		**15.5** (11.7-19.4) **61%** (53-70%) N=2	**147.3** 100%
Y, Orthels	**31.4** (31.3-31.5) 67% N=2	**36.0** (20.5-46.1) **60%** (20-80%) N=5	**58.9** (43.4-88.5) **60%** (36-79%) N=3	**19.9** **94%** N=1	**59.0** **60%** N=1	**20.5** **80%** N=1	**59.0** **60%** N=1	
Y, Turbels,		**45.6** (22.3-70.3) **61%** (16-66%) N=5	**45.0** (43.3-46.7) **54%** (53-55%) N=2	**33.4** **16%** N=1	**65.4** **79%** N=1		**65.4** **79%** N=1	
Y, Histels				**15.0** **26%** N=1				**96.2** (88-104) **33%** (24-41%)
No, Fibrist								**147.3** **100%**
Site nos.	1-11	12-22	24-30	31-39	40-44	23	46-49	50-52

because these soils are on high elevation and experience stronger leaching in addition to the mixing of acidic igneous bedrock in the solum. Soils formed in older outwash terraces have the next strongest acidity followed by soils formed in deep loess, morainal and most recent stream deposits. Generally, the pH values of the substratum, the residuum parent materials are acidic and the overlying loess is more neutral to slightly alkaline due to the presence of free carbonates, based on summation of extractable cations being greater than CEC (% base saturation Supplement B).

Organic Carbon Stores and Distribution Patterns

The general trend of OC distribution in the soil profile for the boreal forest soils is concentration of OC in surface organic horizons and upper mineral horizons and then a rapid decrease with depth; this reflect the limited water infiltration and thus the shallow rooting depth (Ping et al., 2009). This pattern changes for soils underlain with permafrost especially those with cryoturbation, where frost churns surface organic matter (O horizons) into the lower mineral horizons (Ping et al., 1998, 2008) and for those soils formed in fluvial deposits that have repeated layers of buried organics. When OC is expressed on a aerial-density basis, soils formed on toe slopes (Sites 50 and 51) under forest tundra communities had the highest OC stocks, an average of 104 kg m^{-2} and the well-drained and exposed slopes accumulated the lowest OC; 7.1 kg m^{-2} (Site 9) and 7.2 kg m^{-2} (Site 43), respectively (Table 7, Supplement B). The OC stores increase when permafrost is present and increase further with cryoturbation (Table 7). Also, distinct patterns of OC partitioning in the soil profile exist for the well drained and the poorly drained sites because of permafrost. On well-drained sites, about 50% of the total OC is stored in the surface organic horizons and the quantity increases two- to fourfold where permafrost is present (Table 7). The effects of permafrost on increasing OC stores due to the wet and cold conditions are demonstrated again. On well-drained upland sites, no such relationship was found between OC stores

Table 8. Soil horizon carbon nitrogen ratio (C/N) in relationship to landscape/parent material, permafrost in soils associated with black spruce forest, Alaska. Values given in **bold type** and range in parenthesis.

Soil horizon	Outwash	Deep Loess		Residuum, colluvium		Lake basin	Moraine	Bog
		alluvium	upland	loess cap	tephra cap			
Oi	**32.7** (29-38), n=4	**38** (27-54), n=8	**42.5** (30-62), n=6	**45** (34-51), n=5	**52** (39-60), n=3		**35** (31-38), n=2	**50** (39-61), n=2
Oe	**37** (32-45), n=3	**27** (21-39), n=6	**35** (28-52), n=4	**30** (24-45), n=6	**37.5** (37-38), n=2	**24**	**25** (19-30), n=2	**27** (24-29), n=5
Oa,	**25**	**23** (17-26), n=5	**21** (18-26), n=3	**31** (23-45)		**19**		**21.3** (18-24), n=3
A, OA	**15.3** (10-19), n=3	**22** (13-29), n=6	**16** (17-24), n=4	**23** (21-25), n=4	**26** (19-34), n=5			
E	**34**				**23** (13-31), n=4			
Bs	**20**							
Bw, BC	**14** (6-28), n=6		**18** (7-24), n=4	**14** (4-20), n=8	**18.6** (9-26), n=9	**18**	**7** (6-9), n=4	
Bg		**17** (10-37), n=12	**15** (9-19), n=3	**18** (5-25)				**18**
Bgf		**7.5** (4-18), n=5					**12**	
C, Cg		**15** (12-20), n=3		**8**	**7.5** (4-11), n=2			
Cgf, Cf		**14.5** (5-21), n=15	**20** (17-23), n=4	**6**			**13**	**15** n=2
2C	**7.5** (3-15), n=4	**19.5** (19-20), n=2		**4**	**12** (10-16), n=3	**15**		
Site nos.	1-11	12-22	24-30	31-39	40-44	23	46-49	50-52

and slope aspect. This is contrary to other reports (Furbush and Schoephorster, 1977; Mulligan et al., 2004; Ping et al., 2005) that reported the wetter and colder northfacing slopes accumulate more OC than the well-drained south slopes. When comparing well-drained sites only it is evident that drainage controls OC accumulation at a higher level than permafrost and drainage must be restricted first for slope aspect to significantly affect OC accumulation. A general relationship exists between OC stocks and overall organic horizon thickness and rooting depth such that in well-drained soils and those affected by permafrost without cryoturbation, nearly 70% of the total OC is stored in the surface organic horizons compared to soils with cryoturbation or stratified parent materials where only 50% is present in those uppermost horizons (Ping et al. 2009). Many previous forest soils studies have limited the sampling depth of soil to the upper 30 cm. Our results stress the importance of sampling the soil to a depth of 1 m or more or to lithic/paralithic contact for nutrient or ecological studies in order to avoid missing the "deeper" C and other significant nutrient pools.

Organic Carbon Quality

The carbon-to-nitrogen (C/N) ratio has been used as a general indicator of the degree of SOM decomposition, thus SOM quality. There is a general trend of decreasing C/N ratios with depth, reflecting the increased degree of humification of OM (Table 8). Among different landform/parent materials, the O horizons of soils with residual or colluvial slopes have the highest C/N ratios consistent with these soils, having more woody components in their forest floors. In general, the A horizons have higher C/N ratios than the B and Bg horizons. This is due to the influence of the abundance of charcoal particles mixed into the horizons, which gives it the appearance of an A horizon because of its dark color. Mostly, the frozen horizons (Bgf, Cgf) have relatively low C/N ratios (<8) as compared with that of the A and B horizons. It is likely due to SOM from the upper O horizons moving downward and/or in part to the preservation of in situ microbial biomass, both typically having low C/N ratios. Another explanation for ratios <6 is the downward movement of inorganic N resulting from the biogeochemical processes in overlying horizons. The humified OM has higher CEC (cation exchangeable capacity) than the relatively fresh detritus material (Oi and Oe). This may explain why there is better correlation between CEC and OC in mineral horizons than in organic horizons as discussed in the following section. There is also a noticeable relationship between C/N and drainage class (Table 8); the well-drained soil horizons have lower C/N because of the higher degree of decomposition that can take place. The organic horizons always have higher C/N because the SOM is relatively "fresh" (lack of post-mortem microbial processing) compared to OC in the mineral horizons.

Table 9. Correlation between cation exchange capacity (CEC) and extractable acidity (H^+) and carbon contents (%C) in different organic horizons of soils associated with black spruce in the boreal regions of Alaska

	y=CEC, x= %OC	**y= extra. H+, x=%OC**
All O horizons	y=0.5772x+63.601 R^2=0.0551	y=0.5535x +39.314 R^2=0.0645
Oi n=16	Y=0.0006x+77.057 R^2=0.0	y=0.5412x +31.84 R^2=0.0233
Oe n=11	y=2.0228x +22.785 R^2=0.4505	y=1.4192x +15.709 R^2=0.5371
Oa n=8	y=2.4652x +26.495 R^2=0.49	y=2.005x +11.5 R^2=0.481
Oe+Oa n=19	y=1.8263x +34.902 R^2=0.4002	y=1.3439x +22.381 R^2=0.4299
Oe+Oa+A n=30	y=2.319x +18.867 R^2=0.7607	y=1.7302x +9.1059 R^2=0.7707
A n=11	y=5.4012x +2.1656 R^2=0.937	y=0.947x +10.12 R^2=0.0972

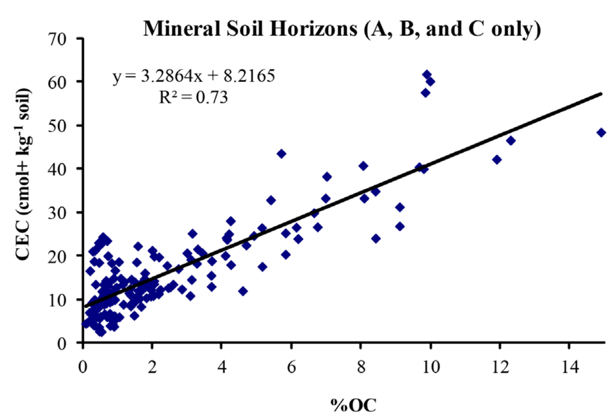

Figure 3. Correlations between CEC and %OC in mineral horizons of soils under black spruce forest in Alaska

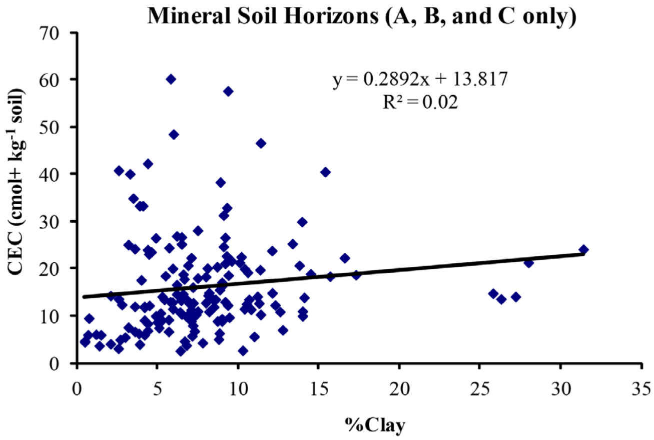

Figure 4. Correlations between CEC and %clay in mineral horizons of soils under black spruce forest in Alaska

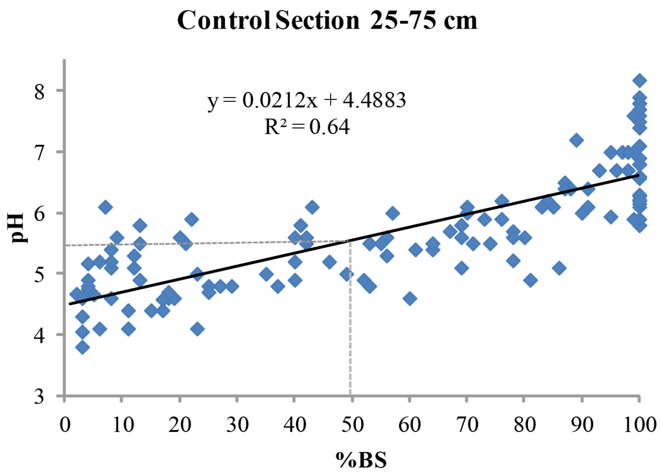

Figure 5. Relationship between soil reaction (pH) and percentage base saturation (%BS) of the soil cation exchange capacity in the soil control section of soil profiles

Relationships Between Organic Carbon Stores and Cation Exchange Capacity and Extractable Cations

Cation exchange capacity (CEC) is used as a measure of the soil exchange complex or its ability to retain cations. There is a very strong correlation between CEC, extractable acidity, and OC contents (Table 9). However, when these relationships are compared separately within the organic and the mineral horizon groups, the correlation between CEC and OC among the organic horizons is not significant. This is not surprising because within this group there is a wide range in degree of humification (indicated by Oi, Oe, Oa designations in increasing order of decomposition) and thus their wide range of C/N ratios (Table 9). However, there is a significant correlation between CEC and %OC in mineral horizons that have a relatively narrow range of C/N ratios (Figure 3), demonstrating the controlling role of SOM on CEC and the domination of available soil exchangeable sites by organic materials in these cold-region, relatively low-clay-content mineral soils. The extractable cations, especially Ca and Mg, are concentrated in the surface organic horizons, suggesting their close ties with biomass and also likely contributing to the stabilization of the OC. However, there is only a weak relationship between [Ca+Mg] and OC (R^2=0.249), possibly due to the presence of free carbonates, thus higher pH in some horizons that reflect drier conditions. This is not unexpected in the soil moisture regime for these soils or the diversity of SOM decomposition as indicated by the poor CEC-OC correlation above. Extractable K is very low and Na is below detection limits in some soils, likely because of its high solubility and or low levels in parent materials. The highest levels of K and Na are always in the surface organic horizons and the upper subsurface horizons, indicating that retention is a result of biocycling. The soil exchange complex usually includes both OM—mainly humus—and clay mineral components. However, in this study, no correlation was found between CEC and clay content (Figure 4, Table 9). This is similar to the situation reported for arctic tundra soils (Ping et al., 2002). The plausible explanation is that the origins of the clay minerals in arctic and subarctic Alaska are largely inherited from the parent materials rather than formed through pedogenic processes, likely due to the cold and relatively arid environment, and thus soils are low in pH-dependant exchangeable sites (DeMent, 1962; Borden, 2009). In Soil Taxonomy (Soil Survey Staff, 2014), the ratio of CEC to clay is used as a measure of the activity of clays for classification at the "family" level. Based on our results and previous studies, the validity of using CEC/clay ratio as a soil family criterion in the arctic tundra and subarctic forest soils is questionable due to masking-dominating effects of SOC.

Base saturation is the ratio of the sum of extractable bases to CEC, expressed as % and measured at pH 7. In soil with acid reaction, the extractable bases are leached or replaced with protons or exchangeable Al. Base saturation (%BS) is used in Soil Taxonomy to differentiate the Dystric (low BS, <50%) and

Typic or Haplic (BS>50%) great groups or subgroups of higher-level taxa (Soil Survey Staff, 2014). However, in these soils under black spruce, the break of pH to separate the two groups ranges between pH 5.0 to 5.5 (Figure 5), indicating the complexity of the interaction between the humus and cations.

Table 10. Extractable Fe and Al in soils associated with black spruce forest in Alaska.

Site No.	Horizon	Depth, cm	Fed,%	Fed-Feo/ Fed	Fep/Fed	(Feo-Fep) /Fed	Alo,%	Alp/Alo
4	E	10-12	1.28	0.15	0.46	0.39	0.19	0.68
Coldfoot	Bs	12-16	1.86	0.46	0.16	0.38	0.17	0.65
Outwash	Bw	16-20	1.31	0.55	0.19	0.26	0.16	0.63
terrace	Bg	20-29	0.76	0.03	0.57	0.40	0.23	0.65
	BC	29-57	1.33	0.57	0.16	0.27	0.14	0.50
	2C	57-80	1.33	0.70	0.15	0.15	0.10	0.20
5	A	14-20	1.50	0.32	0.67	0.01	0.32	0.95
Delta	Bw1	20-44	1.70	0.47	0.35	0.18	0.26	0.77
Loess	Bw2	44-88	1.50	0.33	0.52	0.15	0.18	0.55
outwash	C1	88-97	1.30	0.20	0.12	0.68	0.34	0.29
plain	2C2	97-140	0.60	0.00	1.00	0.00	0.13	0.77
16	Ag	25-33	1.0	0.32	0.40	0.28	0.08	1.00
Gesit Rd	Bg1	33-46	1.3	0.39	0.15	0.46	0.08	1.00
FBKS	Bg2	46-84	1.3	0.59	0.07	0.34	0.08	1.00
lowland	Bgf1	84-109	1.1	0.67	0.07	0.24	0.13	1.00
19	A	22-27	3.0	0.21	0.30	0.49	0.37	1.0
Tanacros	Bgjj	27-38	2.8	0.41	0.18	0.41	0.14	1.0
loess	Bgjj	38-71	3.0	0.49	0.14	0.37	0.14	0.71
lowland	Cf	71-100	3.1	0.55	0.13	0.32	0.13	0.77
28	BA	16-20	1.1	0.42	0.32	0.26	0.23	0.69
Standard Creek	Bw1	20-50	1.1	0.51	0.12	0.37	0.17	0.41
loess	Bw2	50-75	1.0	0.47	0.11	0.42	0.13	0.38
upland	Bw3	75-97	1.1	0.52	0.07	0.41	0.03	NZ5
	Bg	97-130	1.0	0.50	0.07	0.43	0.11	0.33
36	A	14-19	1.2	0.42	0.38	0.20	0.38	0.79
Shoefly	Bw1	19-37	2.1	0.42	0.10	0.48	0.80	0.48
Chena	Bw2	37-50	3.3	0.88	0.02	0.10	0.21	0.86
Ridge	2BC	50-62	1.2	0.73	0.05	0.22	0.13	0.38
40	A	10-13	0.8	0.34	0.31	0.35	--	--
Taylor	E	13-25	0.4	0.27	0.55	0.18	--	--
Hwy	Bw/E	25-35	2.3	0.76	0.04	0.20	--	--
	BC	35-49	2.2	0.83	0.03	0.14	--	--
	2C	49-90	2.0	0.85	0.04	0.11	--	--
46	Bw1	10-20	2.6	0.74	0.12	0.14	0.13	0.54
D-186	Bw2	20-35	2.7	0.76	0.07	0.17	0.14	0.36
moraine	Bw3	35-55	2.8	0.76	0.06	0.18	0.14	0.36
Coldfoot	Bw4	55-80	2.8	0.76	0.07	0.20	0.19	0.37
	2C	80-100	2.7	0.73	0.02	0.25	0.11	0.18

Table 11. Soil classification of soils associated with black spruce forest in Alaska

Site No.	Diagnostic surface horizon	Diagnostic subsurface horizon	Other diagnostic soil characteristics	Soil temperature regime/class	Soil classification at subgroup
1	Ochric epipedon, A, C	none	Sandy texture in control section	Cryic/subgelic	Typic Cryopsament
2		Cambic horizon,Bw	BS <50%	Cryic/subgelic	Typic Dystrocryept
3		Cambic horizon,Bg	depleted matrix cryoturbation	Cryic/subgelic	Turbic Gelaquept
4		Cambic horizon,Bw, Bg	BS <35%, redox depletion w/i 75 cm	Cryic/subgelic	Aquic Dystrocryept
5	Ochric epipedon, A	Cambic horizon,Bw	BS>50% in control section, redoximorphic features	Cryic/frigid	Aquic Haplocryept
6, 39		Spodic horizon,Bs		Cryic/subgelic	Entic Haplocryods
7, 15, 16, 23, 25, 26, 29, 48	Histic epipedon >20 cm	Cambic horizon, Bw, Bg	permafrost w/i 1m; gelic material , Cgf, Cf	Gelic/subgelic	Typic Historthels
8, 21	Histic epipedon >20 cm	Cambic horizon, Bw, Bg,	permafrost at 51 cm, Cf gelic material, irregular decrease OC%	Gelic/subgelic	Fluvaquentic Historthels
9		Cambic horizon, Bw	Redox depletion, permafrost thawed	Cryic/subgelic	Aquic Haplorthel, thawed phase
10, 12, 30	Ochric epipedon	Cambic horizon, Bg, Bw	Redox depletion Bg	Cryic/frigid, subgelic	Typic Cryaquepts
11		Spodic horizon, Bs	Andic material 8-41 cm	Cryic/frigid	Andic Cryorthod
13,18, 19,24, 27, 47	Histic epipedon >20 cm	Cambic horizons, Bgjj	permafrost w/i 1m;cryoturbation, Ajj, Bgf, Bw/Oafjj	Gelic/subgelic	Typic Histoturbels
14	Ochric epipedon,		irregular decrease OC%	Cryic/subgelic	Typic Cryofluvent
17			irregular decrease OC% permafrost at 76 cm	Cryic/subgelic	Fluvaquentic Aquorthels
20	Mollic epipedon		Permafrost w/i 1m,cryoturbation, Afjj	Gelic/subgelic	Typic Molliturbel
22		Cambic horizon, Bgjj	Permafrost w/i 1m,cryoturbation, gleyed matrix	Gelic/subgelic	Typic Aquiturbels
28		Cambic horizon, Bw	BS>50% in control section Redoximorphic features	Cryic/subgelic	Aquic Haplogelepts
31	Histic epipedon >40% OM in <75% of profile in top 50 cm	Cambic horizon, Bg	Permafrost at 52 cm, cryoturbation, Bg/Oejj/ Bg/Oefjj,	Gelic/subgelic	Ruptic Histoturbels
32	Folist epipedon >20 cm	Cambic horizon, Bg	Permafrost at 50 cm, lithic contact <50 cm	Gelic/subgelic	Lithic Folistel
33	Histic epipedon >18 cm	Cambic horizon ,Bg	Permafrost at 40 cm, paralithic contact <40 cm, Cryoturbation, Oajj	Gelic/subgelic	Lithic Histoturbel
34, 35		Cambic horizon, Bw	BS<50%	Cryic/subgelic	Typic Dystrogelepts
36	Ochric epipedon, A	Cambic horizon, Bw	Paralithic contact <50 cm	Cryic/subgelic	Lithic Haplogelept
37	Folistic epipedon	Cambic horizon, Bw	Gleyed horizon with redoximorphic features	Cryic/subgelic	Lithic Gelaquept
38	Ochric epipedon A	Cambic horizon, Bg		Cryic/ subgelic	Typic Geleaquept
40, 41, 42, 43		Cambic horizon, E, Bw	Andic properties (E)	Cryic/frigid	Vitrandic Haplocryepts
44		Spodic horizon, Bh, Bs	Albic horizon, E Depleted matrix	Cryic/frigid	Typic Cryaquod
45	Ochric epipedon A		Sandy control section	Cryic/frigid	Vitrandic Cryopsamment
46		Cambic horizon, Bw	BS>50% in control section	Cryic/subgelic	Typic Haplogelept
49			Sandy control section	Cryic/subgelic	Typic Gelorthent
50, 51	Histic epipedon Oi, Oa, Oaf		Permafrost, Oef, Oaf, Cf, Wf/Cf	Gelic/subgelic	Terric Sapristels
52	Histic epipedon Oi, Oe, Oa,			Cryic/frigid	Typic Cryofibrist

The Role of Extractable Iron and Aluminum in Pedogenesis and Carbon Stabilization

The weathering intensity at the study sites varies with climate, vegetation community, fire regime, and parent material mineralogy. The Fe and Al extracted by different solutions are commonly used as indices of this intensity. Iron extracted by dithionite-citrate (Fed) is essentially the sum of pedogenically altered (weathered) Fe components, including Fe associated with fine crystalline, amorphous, and organically bound phases. Aluminum extracted by acid oxalate (Alo) is the sum of pedogenically altered (weathered) Al components, including Al associated with amorphous and organically bound phases, which are extracted by sodium pyrophosphate (Alp). The Alo values are generally low (<0.5%) in the mineral horizons because of the higher base saturation, as the greatest portion of the Al tends to be in complexes with humus, producing a higher Alp/Alo ratio value. Thus, extractable Al results were not particularly useful in interpreting environmental effects. The highest amount of Fed (mean 2.0%, range 1.6-3.3%) shows up in older parent materials such as the early Holocene coarse-textured deposit on older terraces in the upper Koyukuk Valley (Table 10, Sites 4 and 46) and the residual materials derived from mica schist bedrock (Sites 33 and 36). Soils formed in deep loess have little variation in Fed content with depth due to the syngenetic nature of loess deposition. The more recent sandy fluvial deposits have the lowest mean Fed content at <0.6%. It is especially notable that a relatively high amount of Fed corresponds to the incipient spodic profile in the coarse-textured soils at the farthest north reaches of the Koyukuk Valley in the Brooks Range (Site 4). The relatively stronger weathering intensity is attributed to its lichen (*Cladonia* spp.) understory and higher annual precipitation. At similar latitudes of the southern Brooks Range, Dawson at el. (1984) studied the effects of *Cladonia mitis* on soil formation and found that organic acids such as usnic acids and other soluble lichen compounds contribute to the mobilization and transport of soluble ions in the soil, thus enhancing development of spodic properties under prevailing cold and humid conditions.

Stages of weathering can also be determined by the proportion of Fe in the fine crystalline form to Fed. This is done by subtracting the Feo value, which represents Fe in amorphous and organically bound forms from the Fed. In the well-drained site (Site 36), the proportion of fine crystalline Fe compounds (Fed-Feo)/Fed increases with depth as the organically bound and amorphous forms decrease and Fed increases. This trend illustrates the dominance of biochemical processes at the upper part of the profile, catalyzed by an abundance of humus and the dominance of geochemical processes in the lower part of the profile as OM decreases. However, this trend was also observed at Sites 16 and 19, which are poorly drained due to permafrost. There are two explanations for this: (1) these soils experience periodic aeration (oxidation) due to fire cycles, or (2) they were previously well-drained but gradually became encased in permafrost due to shifts in insulation caused by vegetation succession. At Site 36, increasing Fed with depth indicates some downward translocation of weathered compounds. But in the poorly drained permafrost sites (16 and 19), the Fed contents stay nearly constant with depth, which indicates uniform parent material (loess) mineralogy and the lack of translocation due to the constantly frozen state.

In residual and older moraine deposits, ages estimated to be >7,000 years old (Sites 33 and 46 respectively), more than 75% of the extractable Fe is in finely crystallized phases, reflecting the response to the greater time factor. However, in Site 33, soils formed in younger tephra (Lerbekmo et al., 1975) and the A and E horizons contained <34% of all extractable Fe in a crystalline form and most was in a complex with humus (high Feo values). In the same profile, the subsoils formed in older residuum (2BC and 2C) had more than 80% of the extractable Fe is in finely crystallized phases. With low rates of weathering, these two sequences of parent materials retain their distinct character.

Soil Classification

Soils associated with black spruce forest in the boreal regions of Alaska belong to four soil orders: Entisols, Inceptisols, Spodosols, and Gelisols (Soil Survey Staff, 2014; Table 11). The Entisols are those formed in sandy outwash (Site 1), fluvial deposits (Site 14) and sandy parent materials (Sites 45, 49) that lack diagnostic horizons except for a thin ochric epipedon. The Inceptisols are those with a cambic horizon (Bw and Bg) and some with a histic and/or ochric epipedons. Since all the Entisols and Inceptisols have cryic soil temperature regimes, they are all in the cryic suborder or great group. But for Sites 34-36 and 46 the MAST is <0°C and the MSST is <4°C under the organic horizons (Ping, unpublished data), so the soil keys into the Gelept suborder. The Spodosols are those that show evidence of translocation of metal-humus complexes forming the E-Bs sequum (Sites 6, 11, and 39). The Gelisols are those with MAST <0°C and permafrost within 1 m. In Gelisols, those sites with cryoturbated features and permafrost within 2 m key into the Turbel suborder. However, Turbels in the boreal forest are not as common as in the arctic tundra zone (Ping et al., 1998, 2008) because of the insulation effects of the organic horizon, so most Gelisols in the boreal forest are Orthels.

In boreal regions there is a unique feature called "hanging bogs," which occur on steep north-facing slopes dominated by black spruce and with a thick (>30 cm) organic horizon consisting mostly of mosses (Sites 31 and 32). These soils have thin mineral horizons because of erosion caused by repeated fire and slope movement (Wu, 1984) and thus have been previously classified as Histoturbels or Histels (Ping et al., 2002). However, based on many field observations from the NRCS soil surveys in the boreal regions, these organic horizons do not meet the criteria for a histic epipedon because they cannot maintain prolonged saturation on slopes over 25%. Therefore, these organic horizons are folistic rather than histic epipedon, i.e., composed mainly of fibric organic materials without evidence of long-term saturation. In the revised classification of Gelisols (Soil Survey Staff, 2014), those formerly classified as Histoturbels are correlated to Aquiturbels, and the Histels with folistic epipedons are keyed into the Folistels great group.

In the permafrost-free soils, the mean annual soil temperature (MAST) is <8°C and the soils have a frigid soil temperature class. But in the permafrost-affected sites the MAST ranges from <0°C to >-4°C, so they are in the subgelic soil temperature class. Most of the soils in the subarctic, as in this study, and those in the arctic tundra (Ping et al., 1998; 2004) have superactive reactivity class because of the high CEC/%clay ratio. But, as pointed out in the previous discussion, in these settings organic matter, rather than clay minerals, tends to control the exchange sites. Thus, the validity of this reactivity class in the cold soils is questionable because of the low weathering intensity and lack of pedogenic clay minerals (Borden, 2010).

CONCLUSION

This study provides the geographic database of the distribution and properties of soils formed under black spruce stands. These soils formed in a wide variety of parent materials on landscapes from lowlands, outwash plains, fluvial terraces, and hilly uplands. The soil temperature regimes range from frigid to subgelic and soil moisture regimes range from aquic to udic, with drainage classes ranging from excessively to very poorly drained. These soils are generally weakly developed. Organic horizons with thicknesses ranging from 10 to >40 cm are a common feature to these soils. Soil organic matter or humus exerts the controlling role in biochemical weathering and biocycling of nutrients in the surface and subsurface horizon. Both thickness of organic horizons and total SOC stores correspond with soil moisture regimes, and the higher SOC stores are associated with poorly drained sites. In general, the O horizons account for 60-75% of the total SOC stores, but cryoturbated soils have a relatively higher proportion stored in the subsoil. Permafrost, when present in boreal regions, exerts strong control on OC stores because of the wet and cold conditions, just as in arctic tundra. Thus, soil sampling to a limited depth may miss anywhere from 20-50% of the total SOC stores in the boreal forest.

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Supplement A. Selected morphological and physical properties of study soils associated with black spruce forest sites

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m-3
	cm			----------%----------							%	Mg m-3
Outwash Plains & Terraces												
1. Coldfoot DH181: Sandy, mixed, superactive, subgelic Typic Cryopsamment (S04AK185009)												
Oi	0-10	10YR2/1	PT	nd	nd	n			3F, M, 1C	AS		0.37
Oe	10-16	7.5YR4/1	MK PT	nd	nd	nd			3VF,F,M, 1C	AS		0.30
A	16-27	10YR4/1, cmd7.5YR5/8	VFSL	44	48	8	1M,CSBK 1FPL	FR SO SP	3VF,F,M, 1C; 3FCP	AS		1.06
AC	27-39	10YR4/1	FSL	76	22	2	1M,CSBK	FR SO SP	2VF,F, 1M	AS	tr	1.38
C1	39-73	10YR3/1	FS	94	6	tr	SG	L SO PO	1VF,F,M	AS	tr	1.09
C2	73-115	10YR3/1	FS	95	5	tr	SG	L SO PO	1VF,F,M	AS	1	1.09
2C3	115-130	--	XGS	90	10	tr	SG	L SO PO	--	--	76	1.11
2. Marion Creek DH180: Coarse-loamy, mixed, active, subgelic Typic Dystrogelept (UAF: 7-8-07)												
Oi	0-3		PT	nd	nd	nd				AW	0	0.15
Oe /AE	3-6	7.5YR 2.5/3	PT MK SL	58	37	5	1MGR		2F,M, 1C	AI	0	1.00
Bw1	6-12		SL	60	33	7	1MSBK	VFR SO PO	2F,M	CS	1	1.09
Bw2	12-28		SL	40	51	9	1MSBK	VFR SO PO	1F	CS	2	1.25
BC	28-43		SL	28	64	8	SG	L SO PO		CS	5	1.09
2C	43-100		CBVS	70	26	4	SG	VFR SO PO		--	34	1.42
3. Gold Creek: Loamy-skeletal, mixed, subgelic Turbic Gelaquept (UAF: 7-8-08)												
Oi	0-14											.40
Oajj	14-19										2	0.37
Bgjj	19-23			39	51	10					38	1.24
Bw/Oajj	23-32			37	52	11					18	1.46
2Bwb	32-41			49	44	7					68	0.88
2C	41+			62	33	5					79	1.18
4. Coldfoot BLM: Coarse-loamy over sandy or sandy-skeleton, mixed, superactive, subgelic Aquic Dystrocryept (S03AK290006)												
Oi	0-5	7.5YR3/2	PT				-	nd	3VF,F, 1M	AS		0.28
Oa	5-10	7.5YR2.5/3	MK				-	nd	3VF,F,1M;1C	AS		0.62
E	10-12	2.5Y4/1,5/1	FSL	66	31	3	M	VFR SO PO	1F; 1FCP	AI		1.09
Bs	12-16	5YR3/3 (60%); 2.5YR3/4	LS	44	47	9	SG	L SO PO	1F	AI		1.43
Bw	16-20	10YR3/2	LS	45	48	7	M	VFR SO PO	tr	AI		1.36
Bg	20-29	5Y5/1	VFSL	19	75	6	M	VFR SS SP	0	CW		1.22
BC	29-57	2.5Y4/2	FSL	20	70	10	1MPL	VFR SO PO	0	AI	2	1.27
2C	57-80	variegated	XKS	24	67	9	SG	L SO PO	0	CS	51	1.37
R	80+	nd										
5. Delta, Moosehead: Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Aquic Haplocryept (91AK240003, 91P0962)												
Oi	0-7	10YR3/4	PT,85%R				--	--	3VF,F, 2M	AS		0.12
OA	7-14	10YR2/2	MK				--	--	3VF,F,2M,C	AW		0.57

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							%	*Mg m^{-3}*
A	14-20	10YR2/1; 30% MCD7.5YR3/4; 1%FF10YR5/2	VFSL	31	65	4	1THPL, 1FGR	VFR SO PO	2VF,F,1C	AI		0.72
Bw1	20-44	65% 10YR4/3; 30% CD75YR4/4;1% FP2.5Y5/2	VFSL	47	50	3	1THPL, 1FGR	VFR SO PO	1VF,F	CW	1	1.25
Bw2	44-88	10YR4/3; 30% MCD7.5YR4/4; 1%FF10YR5/2	LVFS	52	45	3	1CSBK 1THPL	VFR SO PO		AS		1.49
C1	88-97	10YR4/3;11%MD7.5YR4/4;1%FD2.5Y5/2	VFSL	59	40	1	1CSBK	VFR SO PO		AS	2	1.44
2C2	97-140	10YR3/3	VGS	93	6	1	SG	L SO PO			55	1.65
6. Healy, Usib. 8-31: Sandy, mixed, subgelic Entic Haplocryod (UAF 9-1-07)												
Oi/Oe	0-14	7.5YR2.5/3(79%) 10YR2/2(81%)	MKPT				1CGR	VF	3VF,V,2M	CS		0.10
E/A	14-18	7.5YR3/1-A 10YR4/2-E	SIL				-	FR SO SP	1VF,F,M	AS		0.72
Bs	18-36	7.5YR3/4 7.5YR5/8	SL				1FSBK	VFR SO PO	2VF,F,2M	CS		1.23
BC	36-68	10YR4/6 10YR5/6	LS				-	L SO PO	2VF,F	AS	1.2	1.39
C	68-71		S				-	L SO PO	1VF,F	AS	5.3	1.30
7. Delta, AH 1415: Loamy, mixed, superactive, subgelic Typic Historthel (91AK240002)												
Oi	0-14	7.5YR4/4	PT, 80%Rb				--	--	3VF,F, 1M	AS		0.25
Oa	14-25	10YR2/1	MK, 3%Rb				--	--	3VF,F, 1M	AS		0.81
A	25-30	10YR3/2; 1%FP5Y4/2	VFSL	28	67	5	M, 1THPL	FR SO PO	2VF,F	AB		1.10
Bw	30-51	10YR4/3	FSL	43	52	4	M,1THPL	FR SO PO	1F	CS		1.55
2Bwf	51-64	10YR4/4; 1%CD 7.5YR4/4	GRVFSL	38	58	4	M, 1THPL	VFI SO PO	--	CS		1.62
2BC	64-100	10YR4/4; 30% CP7.5YR4/4	GRVSL	77	21	2	M,1THPL	VFI SO PO	--			1.58
8. Tok Cutoff PSP: Sandy, mixed, superactive, subgelic Fluvaquentic Historthel (S03AK176008)												
Oi	0-13	2.5YR3/1	PT						3VF,F,2M,1C	AS		0.01
Oe	13-23	2.5YR2.5/1	PTMK						3VF,F,2M,1C	CS		0.23
Oa	23-34	2.5YR2.5/1	MK						3VF,F	AS		0.46

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							%	*Mg m^{-3}*
Bw	34-49	7.5YR5/6; 35% 2.5YR3/6 mottles; 10YR3/2; 2.5Y5/2	FSL	31	59	10	1FLent	FI SO SP	3VF,F	AW		1.29
2Bgf	49-58	10YR4/4; 2.5YR3/4; Gley1 3/5GY	GRS αα3+	77	19	4	M	EFI SO PO		AW	8	1.35
2Cf1	58-80	7.5YR3/1; 2.5YR2.5/2-30%	COS, αα+ 30%SL	88	9	3	M	EFI SO PO		AS	25	1.38
9 . Tok Forest Plot: Coarse-loamy over sandy or sandy-skeletal, mixed, active, subgelic Aquic Haplorthel (thawed) (S02AK174001; 02N1035)												
Oi	0-4	10YR3/2	PT	nd	nd		--	--	3F,2M;2CCP	AB		0.1
Oe	4-6	10YR2/2	MKPT				--	--	3F,2M	AB		0.27
A	6-9	10YR2/2	SL	36	56	8	1,2MGR	FR MS MP	2F,M;3F,MCP	AB		0.99
Bw	9-14	10YR3/3	SL	44	46	10	CPL,SBK	FR MS MP	2F,M;1MCP	CW		1.43
BC	14-39	2.5Y3/3	LS	77	20	3	1MABK	VFR SO PO	2F,M	CW		1.68
C1	39-50	2.5Y3/3	S	80	17	3	SG	L SO PO	2F	CW	1	1.84
2C2	50-62	5Y3/2	SL	49	44	7					3	1.70
3C3	62-100	variegated	VGS				SG	L SO PO			60	
10. Pt. MacKenzie: Coarse-loamy over sandy or sandy-skeletal, mixed, acid Typic Cryaquept (91AK170004)												
Oe	0-8	7.5YR3/2	MKPT	--	--	--	-	65%RUB	3VF.F,M	AS		0.43
A	8-13	10YR3/3	SIL	44	52	4	1FMGR	VFR SO NO	2VF,F, 1M	AW		0.89
Bw	13-28	10YR5/4; 5/1	L	51	47	2	1MSBK	VFR SS SP	2VF,F, 1M	CW		1.48
Bg	28-58	2.5Y5/2, 7/5YR3/4; 4/6	L	38	57	5	1THPL	VFR SS SP	1VF,F	AB		1.45
2Cg	58-74	5Y4/2,7.5YR3/4	FSL	57	41	2	M	VFR SO PO	1VF,F	AW		1.60
3C	74-84	10YR6/2, 2.5Y3/2	VGS	91	8	1	SG	L SO PO			58	0.95
11 . Pt. MacKenzie: Coarse-loamy over sandy or sandy-skeletal, mixed, frigid Andic Cryorthod (89AK170005)												
Oe	0-8	5YR3/2	MKPT						3F,M	AW		0.99
E/A	8-11	5YR3/1 (40%) 7.5YR4/0	SIL	37	59	4	1FGR	VFR SO PO	3F,M	AI		0.75
Bs1	11-17	5YR5/8	SIL	32	64	4	1MSBK	VFR SO PO	2VF,F, 1M	CW		0.92
Bs2	17-28	5YR4/4	SIL	28	65	7	1MSBK	VFR SO PO	1VF,F	AI		0.83
Bs3	28-38	10YR4/4, 4/3	SIL	20	75	5	1MSBK	VFR SO PO	1VF,F	AS		1.38
BC	38-41	2.5Y4/4	SIL	29	69	2	1MSBK	VFR SO PO	1VF,F	CW	7	1.11
2BC1	41-53	2.5Y5/4	LCOS	81	18	1	SG	L SO PO	1VF	GS	65	1.59
2BC2	53-108		COS	96	4	tr	SG	L SO PO			57	-

Alluvium

12 . Healy, Usib. 08-33: Coarse-loamy, mixed, acid, frigid Typic Cryaquept (UAF 9-1-07)

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							*%*	*Mg m^{-3}*
OA	3-13	2.5YR2.5/1	MKSL				1MSBK		3VF,F,M,1C	AI	40	0.78
A	13-31	7.5YR3/3	GLS				1MSBK	L SO PO	3VF,F,M,1C	AS	20	1.40
Bg	31-47	10YR4/3-40% 2.5Y4/3-40% 7.5YR3/2-20%	SL				2VF,F,M	VFR SO PO	2VF,F,1M	AS	10	1.44
Bw	47-74	10YR4/2 10YR4/6-20%	SL				-	VFR SO PO	-	-	10	1.40
BC	74-90	10YR4/1-matrix 10YR4/6-in pore linings	SL				1MSBK	VFR SO PO	1VF	AS	4.3	1.33
13 . Caribou Poker Creek: Coarse-silty, mixed, superactive subgelic Typic Histoturbel (UAF 201)												
Oi	0-8	10YR4/6,4/4	PT						3VF,F,2M	CS		0.03
Oe	8-16	7.5YR2.5/3	PTMK				1MPL		3VF,F,2M,1C	AS		0.03
Oa	16-23	7.5YR2.5/1	MK				(sat.)		2VF,F,1M	AS		0.05
Bg/Ajj	23-36	5Y3/3,4/2; 10YR3/3	Bg-SIL A-MKSIL				(sat.)	nd SS SP	1VF,F	AS		0.52
Bg2	36-55	5Y3/2	SIL				3VTNPL	VFI SS SP				0.86
Cf	55-107	5Y4/1	SIL				3VNPL	XR SS SP				1.32
14. Tanana: Coarse-silty, mixed, superactive, subgelic Typic Cryofluvent (58AK090002; 40A0650) (thawed)												
Oi	0-13	10YR2/2	PT	nd nd nd		nd	3VF,F; 1FCP	AS		0.49		
A	13-21	10YR3/2	SIL	8	77	15	1VTHPL,1F GR	FR SS SP	3VF,F; 1FCP	CS		0.74
C1	21-41	5Y4/1; 21%md 7.5YR3/2	SI	4	80	16	1VFPL	FR SO PO	3VF,F	CS		1.18
C2	41-66	2.5Y4/2; 3%MF2.5Y4/3	SIL	4	80	16	1VFPL	FR SO SP	1VF	GS		1.37
C3	66-100	2.5Y4/2	SIL	16	75	9	1VFPL	VFR SO SP	1VF			1.51
15. Geist Rd.: Coarse-silty, mixed, nonacid, subgelic Typic Historthel (91AK090004; 91P0971)												
Oi	0-13	5YR3/2	PT,90%RB	nd	nd	nd			3VF,F,2M	AS		0.33
Oa	13-23	N2/0	MK,5%RB	nd	nd	nd			3VF,F,2M	AS		0.27
Bw	23-28	7.5YR4/4	SIL	17	76	7	1MSBK	VFR SO PO	2VF,F; LENS CP. 10YR2/1	AI		1.14

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							*%*	*Mg m^{-3}*
Bg	28-38	2.5Y4/2;11%FD5Y4/1; 30% CP7.5YR4/4; 1FPL 2.5Y5/1	SIL	16	75	9	1FPL	VFR SO PO	1F	AS		1.48
Cgf	38-100	2.5y4/2; 1%FD5Y4/1	SIL, OM 40-68cm	20	71	9	M, F ice lens	VFI SO PO				1.25
16. Geist Rd.: Coarse-silty, mixed, superactive, subgelic Typic Historthel (91AK090002; 91P0969)												
Oi	0-15	5YR3/2	PT, 85%Rb	nd	nd	nd	--	--	3VF,F, 2M,C	AS		0.37
Oa	15-25	10YR2/1	MKSIL	nd	nd	nd	--	--	3VF,F, 2M,C	AS		0.28
Ag	25-33	10YR2/1; 50% 2.5Y4/2; 20% MP7.5YR5/6Fe	SIL	15	71	14	1ThPL	FR SS SP	3VF,F, 1M	AS		1.20
Bg1	33-46	2.5Y4/2;30% MP 7.5YR5/6 Fe	SIL	12	79	9	M	FR SS SP	1VF,F	GS		1.58
Bg2	46-84	2.5Y4/2; 30%CP 7.5YR4/6	SIL	14	77	9	1ThPl	VFR SS SP	1VF,F	AS		1.69
Bgf1	84-109	5Y4/2;30%CP 7.5YR4/6	SIL	nd	nd	nd	M, 1ThPL	VFI SS PO				1.57
Bgf2	109-155	5Y4/1; 30%MP 5YR4/6, 1%Fe-Mn	SIL	nd	nd	nd	1ThPL	VFI SS PO				1.32
17. Happy series: Coarse-silty, mixed, superactive, subgelic Fluvaquentic Aquorthel (S04AK090-001, 04N0968) *[ash influence in C2]*												
Oe	0-6	7.5YR2.5/2	MKPT	nd	nd	nd	nd	nd	3VF,F,M,C	AS		0.37
C/Oe	6-13	2.5Y5/3, 10YR 2/1; 15%FF2.5Y5/1	SIL MKPT	6	88	6	M	VFR SS SP	3VF,F,M,C	AS		1.11
C1	13-25	2.5Y4/3; 2%FP 7.5YR4/6 Fe-; 15%FF2.5Y5/1	SIL	25	68	7	1MSBK	FR SO PO	2VF,F,M	GW		1.21
C2	25-51	2.5Y4/3; 2%FP7.5YR4/6; 2%FF2.5Y5/1	SIL	21	74	5	1MPL	FR SO PO	2VF,F, 1M	CS		1.22
C3/O'	51-76	2.5Y4/3, 10YR3/3; 3%FP7.5YR5/2; 7%FF2.5Y5/1	SI	11	82	7	M	FR SS SP	1VF,F,M	CS		1.0
Cf	76-120		Si	11	82	7	M	VFI				1.36
18. Windy Creek, S. Anderson: Coarse-silty, mixed, active, subgelic Typic Histoturbel (S04AK068-001, 04N0964)												

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m-3
	cm			----------%----------							%	*Mg m-3*
Oi	0-13	7.5YR 4/3	PT	52% rb	--	--	3VF,F,M, C	AS		0.28		
Oe	13-22	10YR3/1	MKPT	32% rb	--	--	3VF,F,M, C	AS		0.37		
Oa	22-28	10YR2/1	MK SI	6	83	11	1MGR	VFR SS SP	3VF,F,M, 1C	AS		0.79
Bgjj	28-60	10YR5/410%FM7.5YR 5/6; 30% MC2.5Y5/1	SI	4	85	11	1MSBK	FR SS SP	2VF,F, 1M	CS		1.49
Cgf1	60-80		SI	6	85	9	M	EF				1.38
Cgf2	80-120		SI	9	82	9	M	EF			2	1.30
19. Tanacross: Fine-silty, mixed over mixed, superactive, subgelic Typic Histoturbel (S04AK068-003, 04N0966)												
Oi	0-10	7.5YR5/6	PT	nd	nd	nd	--	--	--	CW		0.27
Oa	10-22			nd	nd	nd						0.39
AO	22-27	10YR3/1	SIL	3	47	50	1CPL	FI SO SP	2VF,F	CW		0.61
Bgjj1	27-38	10YR3/2; 2.5Y3/2; 2MP7.5YR5/6	SIL	5	69	26	M	FI SO SP		AW		1.53
Bgjj2	38-71	2.5Y3/2; 3CP10YR5/8	SIL	7	67	26	M	EH				1.46
Cf	71-100			8	65	27	M	EH				1.10
20. Quartz Lake: Coarse-loamy, mixed, superactive, subgelic Typic Molliturbel (S04AK176-002)												
Oi	0-16	7.5YR5/6	PT	-	-	-	--	--	3VF,F,M, 1C	AS		0.47
A1	16-30	7.5YR2.5/1	MK VFSL	17	73	10		FR SO SP	1F,MSBK 1FGR			0.91
A2	30-44	2.5YR2.5/1	MK VFSL	18	76	6	1F,MSBK	FR SO SP	2VF,F; 3VF,FCP	AW		0.90
Afjj	44-80	5YR2.5/1, 4/4	MK SIL	18	73	9	M	EF SS SP	3CP	AI		1.13
Cf	80-100	10YR4/1, 3/1 10% 10YR5/8 PL; 5%10YR2/1CP	FSL	34	59	7	M	EF SS SP				1.30
21. Denali Park, Minchumina Basin: Coarse-loamy, mixed, nonacid, superactive, subgelic Fluvaquentic Historthel (00AK068-003)												
Oi	0-10	5YR2/2	PT	nd	nd	nd			2VF,F,M,C	CS		0.23
Oa	10-21	10YR2/1	MK	nd	nd	nd			2VF,F,M,C	AS		0.54
Cg1	21-58	5Y4/1, 2.5Y4/4	S, SI	33	62	5	PL	VFR SO PO	2VF,F	AS	tr	1.41
Oab	58-62	10YR2/1	MK	nd	nd	nd		VFR SO PO		AS		0.67
Cg2	62-75	5Y4/1; 25% 2.5Y4/2; 2.Y4/4	S, SI	27	66	7	PL	VFR SO PO		CS		1.49

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							*%*	*Mg m^{-3}*
Cf	75-125	5Y2/1	S, SI	72	24	4		VFR SO PO		CS		1.48
2Cf	125-150	5Y2/1	EGLCOS	77	18	5		L SO PO			76	1.60
22. Chatanika: Coarse-silty, mixed, superactive, subgelic Typic Aquiturbels (04AK090-004)												
Oi	0-10	10YR3/2	PT	80% rb					2F,M	CW		0.33
Oe	10-15	10YR3/2	MKSIL	28% rb			M	FR SO PO	2F,1M	CI		0.38
Bgjj1	15-29	2.5Y5/2; 10YR3/2	SIL, MKSIL	7	83	10	M	FR SO PO	2F,1M	CI		1.22
Bgjj2	29-42	2.5Y5/2; 2MP7.5YR4/4 c 10YR3/3 mass	SIL	8	84	8	1MPL	VFR SO PO	1F	CS		1.26
Cf	42-130	2.5Y5/2; 1MP7.5YR4/4 c; 2MF2.5Y5/1 dep	SIL	11	81	8	M frozen	EF				1.13
Lake Basin, Lacustrine												
23. Klawasi: Clayey, mixed, nonacid, active, subgelic Typic Historthel (81AK261-010, 81P0688)												
Oe	0-13	10YR2/1	PTMK	70%R b					3	CS		0.32
Oa	13-23	10YR2/1	MK, streaks of MKSIL	<5% Rb; Ah at base			3VF,F	AS		0.69		
Bw	23-26	10YR4/3	SIL	28	55	17	1VFSBK	VFR SS SP	2F	AS		1.78
2C1	26-38	2.5Y4/2; 1%, 1F, MD 7.5YR4/4	SIC	***14***	***40***	***46***	3F,MGR 3VFSBK	FR MS MP	1F	CS	4	1.53
2C2	38-54	2.5Y4/2	C	***6***	***35***	***59***	3VFSBK 3F,MGR	FR MS MP	1F	AS	2	1.54
2C3f	54-60	2.5Y4/2	C	6	30	64	M	FR MS MP	1F	AS	1	1.37
Loess Upland												
24. Upper Kalskag: Silty, mixed, subgelic Typic Histoturbel, (S04AK050-001)												
Oe	0-22		MKPT	nd	nd	nd				CW		0.54
A	22-30		SIL	25	71	4		EF SO PO		AB		0.96
Bjj1	30-59		SIL	5	88	7		EF SO PO		CW		1.19
Bjj2	59-77		SIL	7	88	5		FR SO PO		AW		1.46
Cf	77-100		SIL	6	88	6		EF SO PO				1.37

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m-3
	cm			----------%----------							*%*	*Mg m-3*
25. Himalaya Rd. PSP: Coarse-silty, mixed, superactive, subgelicTypic Historthel (S03AK090-001, 04N0260)												
Oi	0-22	7.5YR3/3	PT	nd	nd	nd	na	na		AS		0.26
A	22-33	7.5YR2.5/1 60% 10YR3/2	MKSIL	17	69	13	2MSBK	FR SS SP	3VF,F,M,1C	AW		1.02
Bg1	33-45	5Y5/2, 40%; 10YR4/4, 40% 2.5Y5/3. 20%	SIL	6	82	12	2THPL	FI SS SP	2VF,F,1M	CS		1.55
Bg2	45-59	5Y5/2, 30%; 10YR4/4, 40% 2.5Y5/3. 30%	SIL	12	77	11	M frozen	VFI SS SP		CS		1.50
BCg	59-70	5Y5/1, 60% 2.5Y4/4	SIL	11	80	9	M frozen	VFI SS SP		AS		1.38
Cgf1	70-90	Gley2 4/5B, 70% 10YR4/4	SIL	8	81	11	3VTH lent	EFI SS SP	1F2CDEnTubPores	CS	>60% ice lens	1.33
Cgf2	90-104	5Y4/1, 70%; 2.5Y4/4, 10% 10YR4/6, 20%	SIL	9	83	8	2VTH, Lent	EFI SS SP	1FDenTub Pore		>60% ice lens	1.17
26. Smith Lake: Coarse-silty, mixed, superactive, subgelic Typic Historthel (96AK090-001; 96P0365)												
Oi	0-15	5YR3/3	PT	nd	nd	nd	1CPL		3VF,F,M,C	AS		0.32
Oe	15-27	10YR2/1	MK	nd	nd	nd	1CPL;1VF,F GR		3F	AW		0.42
Bg1	27-42	2.5Y4/2; 30% 10YR3/2; 1%1FF10YR4/4; 3%CF10YR5/1	SIL,SICL	14	76	10	3THPL	FR SS SP	3F	AW		1.52
Bg2	42-58	2.5Y3/2	SIL	21	71	8	3FPL	FR SS SP	1F	AW		1.58
Bgf	58-80	2.5Y5/4; 1%CP5Y4/1	SIL	24	70	6	3FPL;50% ice lens	VFI SS SP		CS		1.69
Cf	80-110	2.5Y5/4; 2%CPlr 10YR6/6, 5/4; 1%CPlr5Y4/1	SIL	20	75	5	3VFPL; 50% ice lens	VFI				1.62
27. Smith Lake: Coarse-silty, mixed, superactive, subgelic Typic Histoturbel (S03AK090-006; 04N0279)												
Oi	0-12	10YR3/6; 7.5YR2.5/3	PT	nd					3VF,F,M,1C	AS		0.01
Oe	12-24	10YR2/1	PTMK	nd					3VF,F,2M 3F,M CP	CS		0.11

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							*%*	*Mg m^{-3}*
Oa	24-37	10YR2/1	MK	nd			2CPL	FR SO PO	3VF,F; 3F CP	AW		0.40
Bg/Ajj	37-55	2.5Y3/3 60%, 2.5Y2.5/1	MKSIL	16	76	8	1MPL	FR SS SP	3VF,F	AW		1.12
Bg	55-70	2.5Y3/2, 40%; 30%10YR4/4, 2/1 2.5Y3/3, 25%	SIL	14	77	9	2THPL	VFR SS SP		AS		1.25
Bw/Oafjj	70-80	2.5Y3/3, 70% 10YR2/1	MKSIL	17	75	8	2VTHPL frozen	FI SS SP		AS		1.30
Cf	80-100	-	SIL	24	69	7	3VTHPL/LP	EF SS SP				1.35
28. Standard Creek: Coarse-silty, mixed, superactive, subgelic Aquic Haplogelept (S03AK090-010; 04N0281)												
Oi	0-12											0.06
Oe	12-16	10YR3/2	MKPT						2F,M,C; 2CCP	CW		0.08
BA	16-20	10YR5/6, 50%; 7.5YR4/3, 40% 10YR2/1	SIL	11	79	10	1THPL	VFR SS SP	3VF,F,M, 1C 2M,C CP	CW		0.77
Bw1	20-50	2.5Y5/3	SIL	14	79	7	1THPL	VFR SS SP	2F,M; 3F,M CP	CS		1.32
Bw2	50-75	2.5Y5/4, 60% 5Y6/1, 40% mass w/PL	SIL	16	79	5	1THPL	VFR SS SP	2F,M; 2F chanel/OM 3F,M CP	CS		1.42
Bw3	75-97	10YR5/6, 60%	SIL	15	81	4	1THPL	FR SS SP	1F;			1.39
Bg	97-130	2.5Y5/4, 60%; 5Y5/1, 30%; 7.5YR5/6	SIL	11	79	10	1MPL	FR SS SP	1F root channel			1.36
29. Kantishna: Coarse-silty, mixed, active, nonacid, subgelic Typic Historthel (00AK068-012; 01P0012)												
Oi	0-16	10YR3/4, 70% 10YR2/1	PT	nd			nd	nd	2VF,F,M,C	CS		0.32
Oe	16-24	10YR2/1	MKPT						2VF,F,M,C	CS		0.30
C/A	24-36	2.5Y3/2, 65% 10YR2/2	SI	6	88	6		VFR SO PO	2VF,F	AS		0.93
Cf1	36-88	10YR3/2	SI	6	85	9						0.68
Cf2	88-145	10YR3/2	SI	5	86	9						0.55
30. Aniak: Coarse-silty, mixed, superactive, nonacid, fsubgelic Typic Cryaquept (S01AK175-001; 01N1175)												
Oi	0-3	7.5YR3/2	PT						3F,M	AS		0.26
Oa	3-8	10YR3/2	MK,15% Rb				M	FR SO PO	3VF,F,2M	AW		0.40

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m-3
	cm			----------%----------							%	*Mg m-3*
AE	8-13	10YR3/2, 50% 2.5Y5/2	SIL	34	60	6	1FGR	FR SO PO	2F,M	AW		0.69
Bg	13-18	7.5YR2.5/3, 70% 5Y4/1	SIL	34	63	3	1THPL	VFR SO PO	2F	AI		0.62
BC	18-56	10YR4/2; 7.5YR4/3, 30%	SIL	15	78	7	1THPL	VFR SO PO	Fe-Mn conc.	CS		
BCg	56-114	2.5Y4/2; 10YR4/6, 5Y4/1, 12% depl	SI	19	80	1	1THPL	VFR SO PO	Fe-Mn conc. Equisetum	AS		1.34
C	114-200	10YR4/4, 60% 10YR4/6, 30% 5Y4/1, depl	SIL	16	77	7	2M Retuculate	FR SS SP	F Equs. Root chan. Fe depl.			1.32
Loess/Residuum												
31. Caribou Poker Creek: Coarse-loamy, mixed, superactive, subgelic Ruptic Histoturbel (UAF 203)												
Oi	0-16	7.5YR4/4	PT						3VF,F,2M	AS	0	0.07
A/Oejj	16-28	7.5YR2.5/2 10YR2/2	SIL/PTMK	46	50	4		FR SS SP	2VF,F	AI	0	0.47
Oe/Bgjj	28-43	7.5YR2.5/3 10YR2/2	PTMK/SIL				1MPL	FR SS SP	1VF,F	AI	0	0.41
Oejj	43-52	7.5YR3/3	MKPT				1MPL		1VF,F	AI	0	0.22
Bg/Oefjj	52-70	10YR2/2	STMKSL	55	42	3	1MPL	FR SS PO		AS	0	0.40
Rf	70+											
32. Caribou Poker Creek: Coarse-loamy, mixed, superactive, subgelic Lithic Folistel (UAF 204)												
Oi	0-14	7.5YR4/6	PT						3VF,F,2M	AS	0	0.04
Oe	14-18	10YR2/1	PTMK						3VF,F,1M	CW	0	0.07
AO	18-23	10YR3/2	MKSIL	39	58	3		FR SS SP	1F	AI	0	0.29
Oejj	23-30	7.5YR3/2	PTMK				3TNPL	VFR SS PO		AI	0	0.18
Bg/Oajj	30-55	10YR3/3	CHMKSIL	59	35	6	3TNPL	FR SS SP			65 Ch	0.42
Rf	55+											
33. Caribou Poker Creek: Loamy-skeletal, mixed, superactive, subgelic Lithic Histoturbel (UAF 205)												
Oe	0-15	7.5YR3/4	MKPT						3VF,F, 2M	CI	0	0.20
Oajj	15-19	10YR2/1	MK				M, sat'd	VFR SO PO	3VF,F, 1M	AI	0	0.39
Bg	19-40	5Y4/2; 2.5Y4/4, 5%	CNVL	42	45	14	M, sat'd	FI MS SP	1F	CW	55	1.80
Crf	40-50	5Y4/2	FLXL	42	45	14	M, frozen	EF SS SP			70	1.74
34. Ft. Knox PSP: Coarse-loamy, mixed, superactive, subgelic Typic Dystrogelept (S03AK090-007; 04N0277)												
Oi	0-10	5YR3/3	PT	nd			3VF,F,2M,1		3VF,F,2M,1C	AW		0.04

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m-3
	cm			----------%----------							%	*Mg m-3*
							C					
OA	10-17	7.5YR2.5/1	MKSIL	13	77	10	2FGR	FR SS SP	2VF,F,M	AS	5	0.54
Bw1	17-35	10YR4/4	SL	31	62	7	2MSBK	VFR SS SP	1VF,F,M	CW	12	1.15
Bw2	35-68	2.5Y4/4	GSL	19	70	11	2MSBK	FR SS SP	1F,M	CW	17	1.16
Cr	68-80	2.5Y5/4	XCHL					FR SS SP	--		75 CN	nd
35. Workman PSP: Coarse-loamy, mixed, superactive, subgelic Typic Dystrogelept (S03AK090-002; 04N0261)												
Oi	0-14	7.5YR3/3	PT	na	na	na			3VF,F,M,2C	AW		0.09
A	14-21	10YR3/2, 60% 10YR4/2	CHSIL	34	54	12	1MGR 1FSBK	FR SS SP	3VF,F,1M	AS	30, CHN	1.14
Bw1	21-30	2.5Y5/3	GSL	41	49	10	1MSBK 1MLENT	VFR SS SP	3F, 1M	CS	30 GR	1.68
Bw2	30-51	2.5Y5/3	GSL	40	53	7	2MLENT	FR SS SP	2F,M	CS	20	1.67
BC	51-98	10YR4/3, 60% 2.5Y5/3	GSL	34	57	9	2MLENT	FR SS SP	1F		25GR 10CB	1.56
CR	98-120	2.5Y5/3	ECHSL	38	49	13		VFR SO PO			65 CHN	1.38
36. Shoefly: Coarse-loamy, mixed, superactive, subgelic Lithic Haplogelept (S03AK090-009, 04N0280)												
Oe	0-14	7.5YR3/3	MKPT	60% rubbed fiber					3VF, F, M,1C	AS		0.07
A	14-19	10YR3/2	SIL	6	85	9	1FSBK 2MGR	FR SS SP	3VF,F,1M	AS	1	0.51
Bw1	19-37	10YR4/6	SIL	11	85	3	1MSBK; 1MPL	FR SS SP	3VF,F,1M	CW	1	1.02
Bw2	37-50	2.5Y5/4	SIL	25	71	4	1MSBK;	FR SS SP	2VF,F	GS	15	1.27
BC	50-62	2.5Y5/4	VCHSIL	36	60	4	1MSBK	FR SS SP	2VF,F	AW	40CH,	1.50
Cr	62-70	10YR3/4	ECHSL				0	FR SO PO	1VF,F		75 CH	-
37.Taylor MP 14, PSP421: Coarse-loamy, mixed, superactive, subgelic Lithic Gelaquept (S04AK176-006, 05N0099) [ashy. influence]												
Oa	0-3	10YR2/1	Charcoal									0.05
Oi	3-12	2.5YR2.5/1	PT	84%, 48% rubbed					3VF,F,1M,C	AW		0.30
Oe	12-21	2.5YR2.5/1	PTMK	42%, 20% rubbed			3FGR		3VF,F	AS		0.37
Bw	21-29	10YR4/4	GSL	38	52	10	1F,MSBK	FI SS SP	3VF	CS	14	0.50
Bg	29-42	7.5YR4/3; 5YR4/6; G 1 4/10Y; 2.5YR3/6	SL	35	57	8	2F,M Lent	FI SO PO	1VF,F	CI	11	1.19
CR	42-62	7.5YR4/6	ECHSL	88	7	5		FR SO SP			93	1.69
38. Healy, Usib. 08-44: Coarse-loamy, mixed, subgelic Typic Gelaquept (UAF 8-31-07)												
Oa	2-21	7.5YR2.5/1	MKSL						3VF,F,M, 1C	AW	10	0.56
A	21-38	10YR3/3	SL					SO PO	3VF,F,1M	AS	1	1.17

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							%	*Mg m^{-3}*
Bg	38-75	2.5Y4/1	FSL					SS SP	2VF,F	CS	1	1.40
BC	75-95	10YR4/2	GSL					SS SP	1VF,F	CS	7.2	1.59
39. Healy, Usib. 08-56: Sandy, mixed, subgelic Entic Haplocryod (UAF 9-1-07)												
Oi/Oe	0-8	10YR2/2, 10YR2/2	PTMK						3VF,F,M,1C	AS	<0.1	0.74
A/E	8-16	10YR2/1, 10YR2/2, 10YR5/1, 10YR4/6	MKSL				1MGR,1SBK		2VF,F	AS	9	1.29
Bs	16-24		LS				1FSBK	VF SO PO	2VF,F	CS	13	1.26
BC	24-34		LS						1F	CS	12	1.37
Tephra/Residuum												
40. Taylor Highway: Ash over loamy-skeletal, glassy over mixed, active, subgelic Vitrandic Haplocryept (S01AK176001; 02N0081)												
Oi	0-10		PT						3F,2M,1C	AS	--	0.26
A	10-13	10YR2/1	MKFS	15	76	9	M	VFR SO PO	3VF,F,2M,1C	AW	--	0.71
E	13-25	10YR6/3, 30%; 10YR5/4, 7/1	VFS	24	72	4	1THPL	VFR SO PO	2VF,F,1M,C	AI	1	1.12
Bw/E	25-35	10YR4/3, 70%; 2.5Y4/2	GSL	32	62	6	1FSBK	FR SS SP	2F,1M	CS	25	1.60
BC	35-49	10YR4/3	GSL	31	62	7	1MSBK	FR SS SP	1F	CS	40	1.59
2C1	49-70	10YR4/3; 5% E 10YR7/1	VGSL	30	61	9	1MSBK	FR SS SP	2F root remains; (2F Vesicular)	CS	41	1.62
2C2	70-90	2.5Y3/2	VGSL	32	62	6	2MSBK	FR SS SP	2F root remains; (3F Vesicular)	CS	53	1.59
41. White Alice: Ash over coarse-loamy, glassy over mixed, active, frigid Vitrandic Haplocryept (S04AK176-003)												
Oi	0-11	5YR2.5/2	PT	na	na	na			3VF,F,1M,C	AW	0	0.06
E	11-19	10YR4/3	VFSL	24	67	9	1VF,FGR	VFR SO SP	3VF,F,1M	AI	19	1.21
Bw	19-36	10YR4/4	SL	26	68	6	1F,MSBK	FR SS SP	3VF,F	AW	18	1.35
Ab	36-44	10YR4/3	FSL	25	68	7	2F,MSBK	FR SO SP	3VF,2F; CP	AS	7	1.34
Bwb1	44-56	10YR4/4	SL	28	65	7	1F,MSBK	FR SS SP	1VF,F	CI	30	1.37
Bwb2	56-67	10YR4/3	SL	30	61	9	1F,MSBK	FR SS SP		CS	36	1.36
2Cr	67-100	2.5Y4/3	VKSL	37	57	6	3FLent; 1FGR	FR SS SP			46	1.38
42. Seismic Site: Ash over loamy, mixed, superactive, subgelic Vitrandic Haplocryept (S03AK240-010; 04N0264)												
Oi	0-13		PT				nd	nd	3VF,F,M,1C	AS		0.13
E/A	13-21	10YR6/2, 60% 10YR5/3	SIL	18	73	9	1MSBK 1MGR	VFR SS SP	3VF,F,M	AW	0.1	0.98
Bw1	21-40	10YR4/4	SIL	27	68	5	1MLent	FR SS SP	3F,2M	CS	15.3	1.63

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							*%*	*Mg m^{-3}*
Bw2	40-54	10YR4/3	GSIL	25	70	6	2MGR 1MSBK 1MLent	FR SS SP	2F,M	CS	36.8	1.57
2BC	54-70	10YR4/3	EGSIL	30	66	4	M	FR SS SP	1F	AW	54.7	1.27
R	70+						nd	nd	(igneous)			
43. Big Stump Site: Ash over loamy, mixed, active, subgelic Vitrandic Haplocryept (S03AK240-011; 04N0265)												
Oi	0-6										--	0.12
A	6-15	10YR5/2	SI	23	70	7	M	VFR SO PO	3F,M,2C		-	0.82
E	15-28	10YR7/4	SI	22	71	7	1MPL	VFR SO PO	3F,M,2C		2	0.96
Bw1	28-50	7.5YR3/4	SIL	24	62	14	1F,MPL; 2VFLent	VFR SS SP	3F,2M		31	1.27
2Bw2	50-85	10YR4/3	EKSL	28	44	28	1MLent	FR MS MP	CP LAYER		71-C	1.67
CR	85+											
44. Nondalton: Coarse-silty, mixed, superactive, frigid Typic Cryaquod (67AK070-002; 40A5508)												
Oe	0-10	2.5YR2/2	PTMK							AS		0.45
E	10-15	10YR4/1, 2.5YR2/2 10YR4/3	SIL MKSIL FS	51	41	8	1TH PL	FR 1SMR		AI		0.63
Bh	15-23	10YR2/1	SIL				2VF GR	FR		CI		0.68
Bs	23-33	2.5YR3/4	SIL				1VF GR	FR 1 SMR		CW		0.88
BC	33-43	7.5YR4/4	SIL				1VTH PL	FR 1 SMR		AW		1.33
2C	43-86	5Y4/3	GRSL	67	31	2	1TH PL	L SO PO			70	1.68
Sand Dune												
45. Taylor MP 3.5: Sandy, mixed, active, frigid Vitrandic Cryopsamment (S01AK176-002; 02N0082)												
Oi1	0-7	7.5YR4/4	PT						3F,M	AS		
Oi2	7-10	10YR3/2	PTS				2FPL	VFR SO PO	3F,M,1C	AW		0.34
A	10-19	10YR4/4	VFSL	29	67	4	1FSBK 1MGR	VFR SO PO	2F,M,1C 30% Char	AI		0.7
E	19-27	10YR6/3,50% 10YR6/1, 30% 5Y4/1	LVFS	37	60	3	M	VFR SO PO	2F,M,1C 20% Char CP in pockets	AI		0.67
Bw	27-39	10YR4/4	LFS	68	28	4	1MSBK	VFR SO PO	2F,1M	CW		1.08
C1	39-49	2.5Y3/3	S	97	2	1	SG	L SO PO	2F	CS		1.78
C2	49-100	2.5Y3/2	S	99	tr	1	SG	L SO PO	1F			1.52
Moraine												

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							*%*	*Mg m^{-3}*
46. Dalton Highway MP 186.9: Loamy-skeletal, mixed, superactive, subgelic Typic Haplogelept (S04AK-185-008; 05N0091)												
Oi	0-5	7.5YR2.5/2	PT		96% fiber 80% rubbed		3VF,F,1M	AS	--	0.49		
Oe	5-10	10YR2/2	MKPT		84% fiber 76% rubbed		3VF,F,2M,1 C	CS	-	0.50		
Bw1	10-20	7.5YR4/2	VGSL	45	48	7	1MSBK 2VF,FGR	FR SS SP	3VF,F	AS	-	1.44
Bw2	20-35	10YR4/3	GSL	36	55	9	1F,MSBK 2VF,FGR	FR SS SP	1VF,F	AS	41	1.43
Bw3	35-55	10YR4/4	GFSL	36	55	9	2VF,FGR	FR SS SP	1VF,F	AS	38	1.46
Bw4	55-80	10YR4/3	GSIL	25	64	11	1MSBK 2VF,FGR	FR SS SP	1VF,F	AW	43	1.48
C	80-100	10YR4/2	EGSIL	45	46	9		FR SS SP			70	1.34
47. Coldfoot DH 175: Coarse-loamy, mixed, superactive, subgelic Typic Histoturbel (93AK185-010; 93P0617)												
Oi	0-20	7.5YR4/4	PT						3VF,F,2M,1C	AS		0.34
Oe	20-34	5YR2/1, 10YR5/4	MKPT				2MPL		3VF,F,M,1C	AS		0.28
Oa	34-39	7.5YR3/2	MK						3VF,F,M,1C	AW		0.41
Bgjj	39-51	5Y4/1, 50% 2.5Y5/3 , 7.5YR4/6	SIL	23	64	13	1MPL	FR SS SP	1VF,F,M	CW	5	1.49
Cgf	51-100	5Y4/1, 2.5Y5/3	SIL	24	64	12	2CPL, Lent	VFI SS SP			7	0.98
48. Denali Park, Rock Creek: Coarse-loamy, mixed, superactive, subgelic Typic Historthel (92AK068-003; 92P1087)												
Oi	0-15	10YR4/6; 7.5YR4/6 40%	PT, 90% rb						3VF,F,M,2C	AW		0.30
Oe	15-21	10YR2/2	MKPT,40%						3VF,F,M,2C	AI		0.41
Oa	21-27	7.5YR3/2	MK, 5% rb						3VF,F,2M,C	AB		0.49
Bg	27-40	10YR4/3, 5Y4/1, 5% 7.5YR4/4, 30%	L	33	52	15	2MGR	VFR SO PO	3VF,F,2M	AB	10	1.13
Cgf1	40-47	5Y4/1; 10YR5/6, 21%	SL	35	54	11	M, 70% Ice lens	EFI SO PO	2VF,F	CW	10	1.51
Cgf2	47-100	5Y5/1, 5RY4/1, 20% 7.5YR5/6, 5%	GSL	34	55	11	1THPL	FI SO PO	2VF,F	--	25	1.37
49. Healy, Usib. 08-42: **Sandy, mixed, subgelic Typic Gelorthent (UAF 8-31-07)**												
Oe/Oa	0-12	7.5YR2.5/1, 10YR2/2	PTMK				1MGR	FR SO PO	3VF,F,M	AS	<0.1	0.39
Bw	12-20	7.5YR4/4	LS						3VF,F,2M	AS	10	1.22
BC	20-40	2.5Y4/3	GS						1VF,F	CW	25	1.23

Site & Horizon	Depth	Munsell Color –Moist	Field Texture†	Sand	Silt	Clay	Structure	Moist Consistence	Roots	Boundary	Rock Fragment >2mm	Bulk Density Mg m^{-3}
	cm			----------%----------							%	*Mg m^{-3}*
C1	40-75	2.5Y5/2	S							CS	<0.1	1.43
C2	75-89	10YR5/6, 2.5Y4//2-	L				3FSBK			CS		1.57
		40%,2.5Y5/2									0.5	
Oab	89-95	10YR2/1	MK							AS	6.5	1.01
Ab	95-100	10YR4/2	S							CS	5.0	1.34
Bogs and Lowlands												
50. Smith Lake: Euic, subgelic Terric Sapristel (91AK090-003; 91P0970)												
Oi	0-10	5YR3/2	PT		90%Rubbed			3VF,F		CS		0.30
Oa	10-23	10YR2/2	MK		15% Rubbed			3VF,F,1M		AS		0.89
C	23-30	2.5Y3/2	SIL,mixed	18	75	7	M	VFR SO PO	1VF	AS		
			Oe									1.15
Oaf	30-38	10YR3/2	MK		10% Rubbed			3VF,M dead		CS		0.88
Oef	38-53	7.5YR3/2	MKPT		40% Rubbed			3VF,M dead		AS		0.50
Cf	53-100	5Y3/2	VFSL	48	47	5	M	VF SO PO	3VF,M dead			1.45
51. Smith Lake: Euic, subgelic Terric Sapristel (96AK090-003; 96P0367)												
Oi	0-16	10YR5/6	PT						3F,M,2C	AS		0.27
Bg	16-23	2.5Y4/3	SIL	32	63	5	1F,MSBK	VFR SS PO	3VF	AS		1.59
							1F,MGR					
Oa	23-37	10YR2/1	MK				M		3VF	CS		0.74
Oaf	37-47	10YR2/1	MKSIL	30	64	6	M	VFR SO PO	2VF	CS		0.89
Cf1	47-54	2.5Y3/2	SIL	22	66	12	M, frozen	VFR SO PO	1VF	CS		0.79
Wf/Cf2	54-74	2.5Y3/2	SIL				M, frozen	VFR SO PO				0.79
			70%icelens									
52. Pt. MacKenzie: Euic, frigid, Typic Cryofibrist (91AK170-005)												
Oi	0-29	10YR3/4	PT	95%, 90%rubbed					3VF,F	AW		0.39
Oe1	29-47	10YR2/2	PTMK	90%, 20% rubbed					3VF,F			0.15
Oa	47-79	10YR2/2	MK	80%, 15% rubbed					3VF,F		20 wood	0.40
Oe2	79-97	5YR3/2	MKPT	90%, 25% rubbed					3VF,F			0.57
Oe3	97-148	5YR3/2	MKPT	95%, 65% rubbed					3VF,F			0.20
O'	148-165	5YR3/2	PT	95%, 85% rubbed					3VF,F			0.35

†Note: Abbreviations for soil morphological properties according to Schoeneberger et al. (2012) given in USDA-NRCS data base or UAF files and BD from Michaelson et al. (2013):

Field texture: PT: peat; MK PT: mucky peat; (Rb:Rubbed fiber); COS: coarse sand; VFSL: very fine sandy loam; GRVSL: very gravelly sandy loam; CBVSL: very cobbly sandy loam; GS PT: grassy peat; FSL: fine sandy loam; SIL: silt loam; PF-SIL: permanently frozen silt loam; CH MK: channery muck; ST MK SL: stony mucky sandy loam; CHSL: channery sandy loam; CHVSL: very channery sandy loam; CHVL: very channery loam; CBVSL: very cobbly sandy loam; GRVL: very gravelly loam. Particle size distribution, nd: not determined. αα+ αα3+ is weak and strong reaction to αα Dipyridyl solution for presence of reduced iron.

Structure, 1THPL: weak thin platy; 2THPL: moderate, thin platy; 3TNPL: strong, thin platy; 3VNPL: strong very thin platy; 1MPL: weak, medium platy; 1FGR: weak, fine granular; 1FABK: weak fine angular blocky; 1FSBK: weak, fine subangular blocky; 2FSBK: moderate, fine subangular blocky; 2MSBK: moderate, fine subangular blocky; M: massive; 3VN ICE: strong very thin ice lens; Lent; lenticular.

Consistence, VFR: very friable; FR: friable; FI: firm; VFI: very firm; VR: very rigid; EH: extremely hard; EF: extremely firm; MS: moderately sticky; MP: moderately plastic; SS: slightly sticky; SP: slightly plastic.

Roots, 3: many; 2: common; and 1: few; VF: very fine; F: fine: M: medium; and C: coarse; RC: root channels; RR: root remains; CP:charcoal particles.

Boundary, AI: abrupt irregular; AS: abrupt smooth; CS: clear smooth; CW: clear wavy; DS: diffused smooth; GS: gradual smooth.

Supplemental B. Selected chemical properties of soils associated with black spruce forest sites

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		-------------------- Cmol+ kg^{-1}				--------------------		%	kg m^{-2}	-------------------------- %				----------------------		
Outwash Plains and Terraces																			
1. Coldfoot DH181: Sandy, mixed, superactive, subgelic Typic Cryopsamment (S04AK185009)																			
Oi	0-10	5.63	36.2	1.31	110.0	5.6	0.0	0.0	90.3	40.7	100	44.7	0.6						28
Oe	10-16	4.76	47.6	1.37	97.3	6.5	3.1	0.0	115.5	66.6	100	O[49%]	0.2						35
A	16-27	6.22	2.30	0.28	33.8	1.0	0.0	0.0	6.6	6.4	100		1.7	0.51	0.31	0.08	0.03	0.04	8
AC	27-39	7.90	1.90	0.20	37.1	0.6	0.0	0.0	2.1	0.1	100		1.3	0.31	0.04	0.05	0.01	0.04	10
C1	39-73	8.18	1.93	0.25	34.1	0.5	0.0	0.0	0.7	0.0	100		1.1	0.36	0.01	0.04	<.01	0.03	8
C2	73-115	8.24	1.88	0.37	30.2	0.5	0.0	0.0	1.2	0.0	100		1.0	0.29	0.01	0.04	<.01	0.02	5
2C3	115-130	8.27	1.73	0.27	31.6	0.5	0.0	0.0	0.7	0.0	100		0.9	0.24	0.01	0.03	0.01	0.02	6
2. Marion Creek DH180: Coarse-loamy, mixed, active, subgelic Typic Dystrogelept (UAF: 7-8-07)																			
Oi	0-3	4.01	32.7	1.07	6.81	2.21	0.61	0.05	73.7		13	9.2							31
Oe /AE	3-6	4.05	3.02	0.13	0.40	0.20	0.04	0.02	21.7		3	O[16%]	0.96	0.68	0.37	0.15	0.08	<.01	23
Bw1	6-12	4.66	0.90	0.05	0.12	0.03	0.01	0.01	3.8		5		1.93	1.08	0.52	0.18	0.09	<.01	20
Bw2	12-28	4.61	0.89	0.09	0.10	0.02	0.01	0.01	5.1		3		1.81	0.95	0.53	0.28	0.15	<.01	10
BC	28-43	4.75	0.86	0.09	0.12	0.02	0.01	0.01	4.3		4		1.87	0.78	0.34	0.23	0.10	<.01	9
2C	43-100	4.58	0.57	0.04	0.25	0.03	0.00	0.01	1.7		17		1.38	0.51	0.15	0.15	0.05	<.01	15
3. Gold Creek: Loamy-skeletal, mixed, subgelic Turbic Gelaquept (UAF: 7-8-08)																			
Oi	0-14	5.53	46.3	1.68	127.3	10.6	1.21	0.06	127.0		100	25.6							25.6
Oajj	14-19	5.64	40.4	1.55	179.4	10.3	0.27	0.07	175.4		100	O[90%]							28
Bgjj	19-23	5.90	3.30	0.18	26.5	2.09	0.02	0.03	21.6		100		1.62	1.26	0.64	0.21	0.10	0.11	26
Bw/Oajj	23-32	6.15	1.20	0.07	12.9	1.37	0.02	0.01	14.1		100		1.81	1.18	0.52	0.24	0.10	0.08	18
2Bwb	32-41	6.28	1.79	0.11	16.4	1.52	0.01	0.03	16.1		100		1.66	1.18	0.47	0.26	0.11	0.12	17
2C	41+	6.57	1.37	0.11	11.6	1.27	0.01	0.02	9.7		100		1.56	1.18	0.27	0.21	0.08	0.10	16
4. Coldfoot BLM: Coarse-loamy over sandy or sandy-skeleton, mixed, superactive, subgelic Aquic Dystrocryept (S03AK290006)																			
Oi	0-5	3.6	32.7	0.92	6.5	2.8	0.9	0.2	75.1	69.9	14	16.6	nd	nd	nd	nd	nd		36
Oa	5-10	3.5	17.7	0.69	1.6	0.9	0.2	0.1	60.5	73.1	5	O[61%]	nd	nd	nd	nd	nd		25
E	10-12	3.9	4.2	0.16	0.5	0.2	tr	tr	25.1	19.8	3		1.28	1.09	0.59	0.19	0.13		34
Bs	12-16	4.3	1.5	0.08	0.1	tr	tr	tr	6.3	8.4	3		1.86	1.38	0.6	0.17	0.11		20

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		-------------------- Cmol+ kg^{-1} --------------------						%	kg m^{-2}	------------------------- % -----------------------						
Bw	16-20	4.8	0.5	0.06	0.1	tr	tr	tr	2.6	4.6	4		1.31	0.6	0.26	0.16	0.1		8
Bg	20-29	4.6	1.9	0.09	0.3	0.1	tr	tr	13.5	11.7	3		0.76	0.74	0.43	0.23	0.15		20
BC	29-57	4.9	0. 5	0.06	0.1	tr	tr	tr	2.7	3.7	4		1.33	0.58	0.22	0.14	0.07		8
2C	57-80	5.4	0.4	0.05	0.4	0.2	tr	tr	1	1.6	56		1.33	0.4	0.12	0.1	0.05		8
5. Delta, Moosehead: Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Aquic Haplocryept (91AK240003, 91P0962)																			
Oi	0-7	3.9	27.6		8.0	4.2	1.3	0.4	65.5	51.8	21	28.1	0.7	0.28	0.3	0.11	0.1	0.01	
OA	7-14	4.6	7.4		11.5	2.3	0.2	0.4	36.6	37.3	39	O[19%]	1.2	0.77	0.8	0.24	0.2	0.04	
A	14-20	5.0	7.0		14.9	2.4	0.1	0.3	33.3	14.5	53		1.5	1.03	0.9	0.32	0.3	0.05	
Bw1	20-44	5.6	2.1		6.1	1.2	0.1	0.2	13.6	12.8	56		1.7	0.91	0.6	0.26	0.2	0.09	
Bw2	44-88	6.1	0.3		4.3	1.7	0.1	0.2	7.6	4.4	83		1.5	1.02	0.2	0.18	0.1	0.13	
C1	88-97	6.1	0.42		3.1	0.7	0.1	0.2	6.0	5.9	70		1.3	1.08	0.2	0.34	0.1	0.30	
2C2	-140	6.1	0.16		1.3	0.3	--	0.2	2.2	2.6	82		0.6	0.74	0.1	0.13	0.1	0.09	
6. Healy: Usib. 8-31: Sandy, mixed, subgelic Entic Haplocryod (UAF 9-1-07)																			
Oi/Oe	0-14	3.49	44.53	1.12								11.3							40
E/A	14-18	4.10	6.95	0.22								O[54%]							32
Bs	18-36	4.72	0.88	0.04															22
BC	36-68	4.80	0.26	<0.01															-
C	68-71	5.26	0.33	<0.01															-
7. Delta, AH 1415: Loamy, mixed, superactive, subgelic Typic Historthel (91AK240002)																			
Oi	0-14	4.3	36.3		19.9	5.7	2.5	0.8	83.0	63.4	35	31.3	0.6	0.36		0.16		0.01	
Oa	14-25	5.1	9.7		17.0	3.6	0.3	0.4	40.0	37.1	53	O[68%]	1.2	0.70		0.26		0.03	
A	25-30	5.5	5.2		9.1	1.8	0.1	0.1	26.5	23.7	41		1.8	1.19		0.41		0.06	
Bw	30-51	5.6	1.6		3.6	1.0	0.1	0.2	11.8	11.8	41		1.6	0.71		0.31		0.09	
2Bwf	51-64	5.8	0.7		2.5	0.9	0.1	0.2	9.1	9.9	41		2.0	0.82		0.40		0.14	
2BC	-100	5.8	0.3		1.4	0.6	0.1	0.1	4.1	4.9	55		1.0	0.36		0.20		0.07	
8. Tok Cutoff PSP: Sandy, mixed, superactive, subgelic Fluvaquentic Historthel (S03AK176008)																			
Oi	0-13	4.17	44.5	0.98	35.6	8.4	3.9	0.1	81	77.8	59	31.5	--	--	--	--	--	--	45
Oe	13-23	5.01	34.7	0.88	81.5	10.8	0.6	0.1	116	70.8	80	O[67%]	--	--	--	--	--	--	39
Oa	23-34	5.22	24.9	0.98	73.5	8.3	0.4	0.1	1.5	59.7	78		--	--	--	--	--	--	25
Bg1	34-49	5.94	2.1	0.1	16.2	2.5	0.2	tr	20	8.9	95		0.90	0.82	0.31	0.18	0.06	0.08	21
2Bgf	49-58	6.19	0.9	0.05	5.4	0.9	0.1	tr	6.3	1.9	100		0.53	0.37	0.11	0.07	0.03	0.03	18
2Cf1	58-80	6.68	0.2	0.01	3.4	0.6	tr	tr	2.8	1.2	100		0.55	0.32	0.08	0.05	0.02	0.02	20
2Cf2	-100	6.32	2.1	0.11	12.5	1.5	0.1	0.1	10.7	1.0	100		0.35	0.32	0.14	0.11	0.05	0.04	19

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		--------------------- *Cmol+ kg⁻¹*				---------------------		%	*kg m⁻²*	--------------------------- %					-----------------------	
9. Tok Forest Plot: Coarse-loamy over sandy or sandy-skeletal, mixed, active, subgelic Aquic Haplorthel (thawed) (S02AK174001; 02N1035)																			
Oi	0-4	4.8	45.42	1.55	51.1	7.5	4.5	0.3	86.8	61.7	73	7.1		0.04		0.03		0.04	29
Oe	4-6	4.9	27.26	0.80	31.6	4.7	2.4	0.4	62.6	45.6	62	O[46%]		0.26		0.15		0.03	34
A	6-9	6.1	4.10	0.21	12.9	2.0	0.5	0.1	20.1	13.3	77		1.6	0.66		0.25		0.06	19
Bw	9-14	6.8	0.88	0.08	9.7	2.6	0.3	0.1	11.5	5.8	100		1.8	0.79		0.10		0.10	12
BC	14-39	6.9	0.27	0.04	4.9	1.4	0.2	0.1	5.5	2.2	100		1.3	0.71		0.09		0.09	6
C1	39-50	6.8	0.18	0.06	4.4	1.3	0.3	0.1	5	13.0	100		1.2	0.72		0.10		0.10	3
2C2	50-62	7.4	0.23	0.06	6.5	2.8	0.3	0.2	7.8	0.2	100		1.5	0.60		0.15		0.15	4
3C3	62-100	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd		nd		nd	
10. Pt. MacKenzie: Coarse-loamy over sandy or sandy-skeletal, mixed, acid Typic Cryaquept (91AK170004)																			
Oe	0-8	3.7	39.5	1.04	8.8	4.3	2.4	0.7	98.7	114.2	16	38.9	0.5	0.34	0.2	0.21	0.1	0.03	38
A	8-13	5.0	8.09	0.31	1.3	0.6	0.2	0.2	33.3	416	7	O[31%]	1.3	0.97	0.7	0.63	0.4	0.13	26
Bw	13-28	5.1	2.05	0.11	0.8	0.1	0.1	0.1	14.3	25.0	8		1.6	1.13	0.7	1.03	0.5	0.27	19
Bg	28-58	5.2	1.54	0.09	0.5	0.1	0.1	0.1	10.6	19.4	8		2.2	1.72	0.7	1.08	0.4	0.31	17
2Cg	58-74	5.1	4.22	0.05	0.5	0.1	0.1	0.1	6.5	11.0	12		1.1	0.73	0.3	0.61	0.2	0.27	
3C	74-84	5.3	3.78	0.02	0.2	tr	tr	tr	2.8	4.1	7		0.7	0.52	0.1	0.25	0.1	0.12	
11. Pt. MacKenzie: Coarse-loamy over sandy or sandy-skeletal, mixed, frigid Andic Cryorthod (89AK170005)																			
Oe	0-8	5.0	34.9	1.86	35.6	8.2	2.2	0.4	99.2	69.8	47	26.9							19
E/A	8-11	4.3	9.63		6.1	0.8	0.1	0.2	34.9	35.4	21	O[67%]	0.7	0.55	0.6	0.36	0.3	0.02	-
Bs1	11-17	5.5	4.57		2.7	0.3	tr	0.1	24.2	37.9	13		2.3	2.08	0.9	2.49	0.9	0.81	-
Bs2	17-28	5.6	2.76		1.0	0.1	tr	0.1	13.5	24.0	9		2.3	1.94	0.4	2.12	0.5	0.94	-
Bs3	28-38	5.8	0.78		0.9	0.3	-	0.1	10.0	14.3	13		2.0	1.41	0.1	1.02	02	0.51	-
BC	38-41	5.6	0.52		0.8	0.3	-	0.1	6.0	11.5	20		1.0	0.66	0.1	0.95	0.2	0.40	-
2BC1	41-53	5.9	0.24		0.5	0.2	-	0.1	3.7	13.3	22		0.6	0.33	0.1	0.52	0.2	0.22	-
2BC2	53-108	5.7			0.5	0.1	-	0.1	2.3	2.2	30		0.4	0.23	0.1	0.24	0.1	0.10	-
Alluvium																			
12 . UAF-USB 08-33: Coarse-loamy, mixed, acid, frigid Typic Cryaquept																			
OA	3-13	3.93	9.72	0.39								26.4							25
A	13-31	4.50	2.57	0.10								O[13%]							26
Bg	31-47	4.86	2.46	0.08															31
Bw	47-74	4.75	1.62	0.05															31
BC	74-90	4.95	1.28	0.05															24
13. Caribou Poker Creek: Coarse-silty, mixed, superactive, subgelic Typic Histoturbel (UAF 0201)																			

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		--------------------- *Cmol+ kg⁻¹*				---------------------		%	*kg m⁻²*	--------------------------- %					-----------------------	
Oi	0-8	4.1	48.90	0.90	28.8	12.4	2	0.1	96	93	45	22.3							54
Oe	8-16	4.4	44.1	1.8	29.8	10.1	0.5	0.1	112	96	36	O[16%]							25
Oa	16-25	4.5	36.5	1.5	21.0	6.7	0.3	0.1	100	105	28								24
Bg1/Ajj	25-36	4.8	4.6	0.2	4.7	1.5	0.1	0.1	12	19	53		0.48	0.86	0.17	0.26	0.17	0.11	23
Bg2	36-55	4.9	3.7	0.1	4.1	1.0	0.1	0.1	13	11	40		0.58	0.95	0.10	0.18	0.10	0.10	37
Cgf	55-100	5.3	1.6	0.1	4.6	1.3	0.1	0.1	12	9	51		0.39	0.65	0.09	0.17	0.09	0.09	16
14. Tanana: Coarse-silty, mixed, superactive, subgelic Typic Cryofluvent (58AK090002, 40A0650) (thawed)																			
Oi	0-13	5.40	30.42	1.21								31.3							30
A	13-21	5.70	9.62	0.40	24.3	11.8	0.5	0.3	40.5	27.2	91	O[62%]	1.9						29
C1	21-41	6.90	1.35	0.08	14.7	7.6	0.1	0.4	22.3	6.4	100		1.7						20
C2	41-66	7.70	0.59	0.05	13.6	5.6	0.1	0.3	18.4	2.8	100		1.5						14
C3	66-100	7.80	0.30	0.03	9.8	3.4	0.1	0.2	11.9	1.6	100		1.1						12
15. Geist Rd.: Coarse-silty, mixed, nonacid, subgelic Typic Historthel (91AK090004; 91P0971)																			
Oi	0-13	6.00	40.19		35.2	34.0	1.7	0.1	101.7	68.4	70	34.7	0.3	0.13	0.1	0.06	0.1	0.01	
Oa	13-23	6.00	27.07		68.4	40.7	0.2	0.3	122.3	39.7	90	O[73%]	0.9	0.65	0.5	0.26	0.2	0.03	
Bw	23-28	6.20	3.15		12.8	6.3	0.0	0.1	25.2	15.7	76		1.4	1.19	0.6	0.46	0.2	0.15	
Bg	28-38	7.00	1.55		12.0	5.7	0.0	0.0	18.6	4.0	95		0.9	0.52	0.2	0.15	tr	0.07	
Cgf	38-100	7.60	0.93		11.4	4.9	0.1	0.1	16.7	1.9	99		1.2	0.7	0.2	0.14		0.1	
16. Geist Rd.: Coarse-silty, mixed, superactive, subgelic Typic Historthel (91AK090002; 91P0969)																			
Oi	0-15	4.5	35.8		29.4	12.4	2.1	0.4	86.5	77.3	51	38.6	0.5	0.29	0.2	0.12	0.2	0.02	
Oa	15-25	5	23.5		38.7	14.1	0.9	0.6	90.4	75.9	60	O[69%]	1.5	1.04	1.0	0.24	0.3	0.03	
Ag	25-33	5.4	3.00		8.1	4.1	0.2	0.2	20.7	11.5	61		1.0	0.68	0.4	0.16	0.1	0.05	
Bg1	33-46	7.2	0.69		7.3	4.1	0.1	0.1	13.0	3.3	89		1.3	0.80	0.2	0.15	0.1	0.08	
Bg2	46-84	7.5	0.37		8.3	5.3	0.1	Tr	13.5	2.3	100		1.3	0.54	0.1	0.12	Tr	0.08	
Bgf1	84-109	7.7	0.34		7.2	3.2	Tr	Tr	10	1.2	100		1.1	0.37	0.1	0.09	Tr	0.08	
Bgf2	-155	5.9	0.73		11.1	4.0	0.1	tr	13.2	1.9	100		1.4	0.65	0.2	0.12	tr	0.11	
17. Happy series: Coarse-silty, mixed, superactive, subgelic Fluvaquentic Aquorthel (S04AK090-001, 04N0968) *[ash influence in C2]*																			
Oe	0-6	5.6	35.4	1.27	61.6	9.9	2.3	--	71.0	58.5	100	40.2	0.4						28
C/Oe	6-13	5.2	3.13	0.15	8.2	2.6	0.2	--	14.6	17.3	75	O[20%]	0.7	0.47	0.4	0.08	0.1	0.02	21
C1	13-25	6.3	1.83	0.10	9.4	2.0	0.1	--	10.4	7.1	100		0.8	0.50	0.3	0.08	0.1	0.03	18
C2	25-51	6.2	1.52	0.10	8.9	1.9	0.1	--	9.7	6.3	100		0.7	0.49	0.3	0.08	0.1	0.03	16
C3/O	51-76	6	4.26	0.21	13.8	3.8	0.1	--	18.0	15.2	98		0.9	0.56	0.5	0.13	0.2	0.03	20
Cf	76-120	5.8	1.96	0.12	6.8	2.2	0.1	--	10.8	10.7	84		0.9	0.56	0.4	0.13	0.2	0.03	16

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		--------------------- Cmol+ kg^{-1} ---------------------						%	kg m^{-2}	--------------------------- % -----------------------						
18. Windy Creek, S. Anderson: Coarse-silty, mixed, active, subgelic Typic Histoturbel (S04AK068-001, 04N0964)																			
Oi	0-13	4.7	45.9	1.48	32.4	10.1	3.6	--	61.2	105.7	75	44.1	--	--	--	--	--	--	31
Oe	13-22	5.2	35.4	1.43	48.1	14.1	1.0	--	97.5	100.9	65	O[66%]	--	--	--	--	--	--	25
Oa	22-28	5.3	12.3	0.96	19.3	6.7	0.2	--	46.6	57.5	56		1.6	1.16	0.5	0.31	0.3	0.03	13
Bgjj	28-60	6.6	0.74	0.15	7.4	3.3	0.1	--	10.3	5.9	100		1.3	0.88	0.3	0.13	0.1	0.06	5
Cgf1	60-80	6.9	0.61	0.15	7.3	3.1	0.1	--	8.9	5.2	100		1.2	0.80	0.2	0.12	0.1	0.06	4
Cgf2	80-120	6.8	0.78	0.16	8.0	3.1	0.1	--	9.4	5.1	100		1.2	0.75	0.2	0.11	0.1	0.06	5
19. Tanacross: Fine-silty, mixed, superactive, subgelic Typic Histoturbel (S04AK068-003, 04N0966)																			
Oi	0-10	5.20	48.0	1.29	49.4	24.2	2.6	0.0	98.6	110.9	77	48.5		0.25	0.1	0.07	0.1	--	37
Oa	10-22		33. 8	1.33	92.7	26.8	0.5	--	121.6	84.6	99	O[74%]		2.24	0.8	0.31	0.3	0.03	25
AO	22-27	6.10	22.7	1.02	58.2	20.8	0.3	tr	86.7	65.5	91		3.0	2.37	0.7	0.37	0.4	0.04	22
Bgjj1	27-38	6.40	1.66	0.11	8.2	4.0	0.2	0.0	13.6	12.7	91		2.8	1.65	0.5	0.14	0.2	0.05	16
Bgjj2	38-71	6.10	1.78	0.15	11.9	5.0	0.2	0.0	14.8	8.9	100		3.0	1.53	0.4	0.14	0.1	0.07	12
Cf	71-100	6.80	1.49	0.16	12.0	4.9	0.2	0.0	14.1	7.9	100		3.1	1.41	0.4	0.13	0.1	0.08	9
20. Quartz Lake: Coarse-loamy, mixed, superactive, subgelic Typic Molliturbel (S04AK176-002)																			
Oi	0-16	4.5	24.5	0.63	34.1	10.9	2.5	0.2	67	37.4	71	70.3	nd	nd	nd	nd	nd		40
A1	16-30	7	9.85	0.41	42.9	12.4	0.2	0.2	57	15.1	98	O[26%]	0.65	0.65	0.37	0.15	0.07		24
A2	30-44	7	9.99	0.44	46.4	12.7	0.2	0.2	60.2	6.6	99		0.85	1.1	0.53	0.27	0.15		23
Afjj	44-80	7.1	5.41	0.26	32.6	9.0	0.2	0.2	32.9	10.8	100		0.68	0.76	0.47	0.2	0.08		20
Cf	80-100	6.9	1.85	0.10	12.2	3.4	0.1	0.2	13.3	4.5	100		0.76	0.79	0.23	0.17	0.09		18
21. Denali Park, Minchumina Basin: Coarse-loamy, mixed, nonacid, superactive, subgelic Fluvaquentic Historthel (S00AK068-003)																			
Oi	0-10	4.8	39.0	1.43	46.6	7.0	2.2	--	89	75.4	63	46.1							27
Oa	10-21	5.3	27.9	1.09	112.2	7.2	0.1	--	113	61.3	100	O[55%]							26
Cg1	21-58	7.8	1.39	0.09	38.7	0.7	--	--	9	2.5	100		0.8	0.44		0.17		0.25	17
Oab	58-62	7.4	14.4	0.86	131.6	3.4	--	--	81	16.6	100			0.92		0.29		0.27	17
Cg2	62-75	8.0	1.17	0.11	24.4	1.0	tr	--	9	3.6	100		0.9	0.53		0.29		0.42	11
Cf	75-125	8.2	0.79	0.06	28.6	0.3	--	--	4	1.3	100		0.5	0.27		0.11		0.19	13
2Cf	-150	8.0	0.88	0.08	11.1	tr	--	--	6	3.5	100		0.7	0.32		0.47		0.35	11
22. Chatanika: Coarse-silty, mixed, superactive, subgelic Typic Aquiturbel (S04AK090-004)																			
Oi	0-10	4.5	40.2	1.00	14.3	6.2	3.4	--	61.3	88.9	39	43.3	0.6	0.22	0.2	0.07	0.1	--	40
Oe	10-15	5.2	30.4	1.30	67.8	11.5	0.4	--	109.5	92.9	73	[44%]	0.7	0.53	0.6	0.26	0.4	0.01	23
Bgjj1	15-29	5.7	3.11	0.20	12.2	2.6	0.1	--	19.2	17.8	78		0.8	0.60	0.6	0.15	0.2	0.03	16
Bgjj2	29-42	5.8	1.78	0.11	11.7	2.7	Tr	--	12.8	11.2	100		0.7	0.67	0.6	0.11	0.2	0.03	16

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		-------------------- *Cmol+ kg⁻¹*					--------------------	%	*kg m⁻²*	------------------------- %					----------------------	
Cf	42-102	6.3	1.38	0.08	9.0	2.1	tr	--	11	7.8	100		0.9	0.74	0.4	0.11	0.2	0.04	18
Lake Basin, Lacustrine																			
23. Klawasi: Clayey, mixed, nonacid, active, subgelic Typic Historthel (S81AK260-010, 81P0688)																			
Oe	0-13	6.2	22.1	1.05	82.8	25.7	1.2	0.4	113.6	44.1	97	20.5	0.7		0.4		0.2		24
Oa	13-23	6.5	10.5	0.63	49.0	12.7	0.2	0.2	68.8	26.5	90	O[80%]	0.7		0.5		0.2		19
Bw	23-26	6.7	0.84	0.05	12.4	5.2	0.3	0.1	18.7	4.6	96		0.9		0.1		tr		18
2C1	26-38	7.1	0.73	0.06	23.8	8.9	0.4	0.5	32.8	5.8	100		1.1		0.1		tr		15
2C2	38-54	7.8	0.73	0.06	29.2	8.1	0.4	0.3	32.3	3.1	100		1.1						
2C3f	54-60	8.1	0.62	0.06	51.8	6.5	0.5	0.4	25.1		100		0.8						
Loess Upland																			
24. Upper Kalskag: Coarse-silty, mixed, subgelic Typic Histoturbel, (S04AK050-001)																			
Oe	0-22	4.9	21.8	0.86	4	0.9	0.1		42.3	127.9	12	46.7							25
A	22-30	5.4	6.19	0.22	1.4	0.3	0.1		24.0	59.1	8	O[55%]	2	1.95		1.39		0.46	29
Bjj1	30-59	5.5	3.09	0.12	1.6	0.5	0.2		10.9	20.7	21		0.7	0.62		0.55		0.18	27
Bjj2	59-77	5.7	1.38	0.10	1.8	0.7	0.2		8.5	14.6	32		1.1	0.81		0.51		0.2	14
Cf	77-100	5.6	0.63	0.05	1.8	0.7	0.2		6.7	10.3	40		0.8	0.53		0.32		0.11	12
25. Himalaya Rd.PSP: Coarse-silty, mixed, superactive, subgelic Typic Historthel (S03AK090-001, 04N0260)																			
Oi	0-22	3.4	48.6	1.18	4	2.9	2	0.2	76.4	40.2	12	43.4	nd	nd	nd	nd	nd	nd	62
A	22-33	4.1	5.77	0.31	4.7	0.9	0.1	0.1	25.3	31.8	23	O[66%]	0.92	1.18	0.65	0.44	0.26	0.14	19
Bg1	33-45	5.1	1.04	0.11	10.3	2.4	0.1	0.1	14.9	11.1	86		0.94	1.07	0.28	0.36	0.1	0.21	14
Bg2	45-59	6.2	0.64	0.08	11.1	2.4	0.1	0.1	13.5	5.1	100		0.84	1.01	0.17	0.26	0.05	0.21	10
BCg	59-70	6.7	0.70	0.07	12.2	2.5	0.1	0.1	12.3	3.9	100		0.85	0.93	0.17	0.23	0.04	0.2	12
Cgf1	70-90	6.8	0.72	0.08	15.1	2.6	0.1	0.1	5.6	3.3	100		0.69	0.96	0.18	0.27	0.04	0.24	10
Cgf2	90-104	7.2	1.18	0.13	17	2.6	0.1	0.1	13.5	4.0	100		0.6	0.76	0.17	0.21	0.05	0.18	10
26. Smith Lake: Coarse-silty, mixed, superactive, subgelic Typic Historthel (96AK090-001; 96P0365)																			
Oi	0-15	4.0	42.2	1.15	31.6	9.5	2.2	0.1	105.9	97.5	41	44.9	0.6						37
Oe	15-27	5.8	31.0	1.20	99.7	25.2	0.3	0.2	157.5	73.8	80	O[79%]	1.4	0.72		0.41		0.08	26
Bg1	27-42	7.0	2.00	0.12	14.4	5.9	0.1	0.1	21.3	6.0	96		1.8	1.08		0.58		0.03	16
Bg2	42-58	7.4	0.89	0.08	10.3	4.6	0.1	0.1	14.9	3.1	100		1.7	0.64		0.15		0.06	12
Bgf	58-80	8.1	0.26	0.04	8.4	3.5	0.2	0.1	9.2	0.5	100		1.5	0.49		0.11		0.06	6
Cf	80-110	8.2	0.33	0.05	16.8	4.4	0.2	0.1	8.7		100		1.5	0.25		0.08		0.06	7
27. Smith Lake: Coarse-silty, mixed, superactive, subgelic Typic Histoturbel (S03AK090-006; 04N0279)																			
Oi	0-12	5.3	49.3	1.14	44.4	23.4	3.1	0.3	81.5	69.1	47	43.3	nd	nd	nd	nd	nd	nd	43

Site Horizon	Depth	pH† H2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		-------------------- *Cmol+ kg⁻¹*					--------------------	%	*kg m⁻²*	-------------------------- %					-----------------------	
Oe	12-24	6.1	45.3	1.94	90.8	39	1.5	1	133.4	73.3	99	O[53%]	nd	nd	nd	nd	nd	nd	23
Oa	24-37	5.9	30.8	1.68	75	29.6	0.2	0.8	127.2	74.3	83		nd	nd	nd	nd	nd	nd	18
B/Ajj	37-55	5.9	4.25	0.25	20.3	5.4	tr	0.3	28.1	11.3	93		0.70	0.90	0.40	0.36	0.17	0.20	17
Bg	55-70	5.9	2.75	0.15	14.1	4.1	tr	0.2	17.1	10.8	100		0.82	1.04	0.34	0.36	0.14	0.22	18
Bw/Ojjf	70-80	6.9	3.28	0.15	15.2	4.2	0.1	0.2	18.3	1.8	100		0.81	0.95	0.2	0.26	0.07	0.19	21
Cf	80-100	7.3	0.84	0.04	10	3.2	0.1	0.2	9.7	1.6	100		0.96	1.06	0.17	0.23	0.05	0.19	23
28 Standard Creek: Coarse-silty, mixed, superactive, subgelic Aquic Haplogelept (S03AK090-010; 04N0281)																			
Oi	0-12	5.3	44.1	1.14	52.8	5.8	2.8	Tr	80.1	56	77	11.1	0.3	0.21		0.10		0.02	39
Oe	12-16	4.4	38.1	0.73	21.3	4.5	0.8	0.1	76.1	123	35	O[40%]							52
BA	16-20	4.3	4.70	0.19	4.5	1.8	0.2	Tr	22.5	20.1	26		1.1	0.64	0.35	0.23	0.16	0.05	24
Bw1	20-50	5.5	0.61	0.03	6.0	2.2	0.1	0.1	10.6	5.7	79		1.1	0.54	0.13	0.17	0.07	0.07	24
Bw2	50-75	6.1	0.29	0.01	6.8	2.5	0.1	0.1	7.5	2.7	100		1.0	0.53	0.11	0.13	0.05	0.09	20
Bw3	75-97	6.6	0.25	0.04	6.4	2.6	0.1	0.1	6.9	1.9	100		1.1	0.53	0.08	0.03	0.03	0.11	7
Bg	97-130	6.9	0.23	0.03	5.7	2.6	0.1	0.1	6.7	1.2	100		1.0	0.50	0.07	0.11	0.03	0.11	9
29. Kantishna: Coarse-silty, mixed, active, nonacid, subgelic Typic Historthel (S00AK068-012; 01P0012)																			
Oi	0-16	4.1	41.9	1.02	18.4	10.0	3.8	0.5	96.0	103.7	34	88.5	0.2	0.16		0.14		0.02	41
Oe	16-24	4.2	43.8	1.18	21.0	7.0	1.7	0.5	98.2	100.6	31	O[36%]	1.1	0.96		0.28		0.02	37
C/A	24-36	4.7	6.75	0.36	3.7	1.0	Tr	0.2	26.7	34.0	18		1.4	0.99		0.27		0.04	19
Cf1	36-88	4.8	5.83	0.30	4.1	0.7	0.1	0.2	20.4	25.0	25		0.8	0.53		0.23		0.04	20
Cf2	88-145	4.7	9.11	0.44	7.1	1.1	0.1	0.2	31.3	32.6	27		1.3	0.81		0.25		0.04	21
Loess/Residuum																			
30. Aniak: Coarse-silty, mixed, superactive, nonacid, subgelic Typic Cryaquept (S01AK175-001; 01N1175)																			
Oi	0-3	4.4	40.3	1.24	12.8	4.4	1.7	0.3	79.1	67.1	24	32.6							33
Oa	3-8	4.4	34.7	1.16	8.3	2.4	0.7	0.6	82.4	87.2	15	O[31%]							30
AE	8-13	4.9	9.11	0.28	2.3	0.5	0.1	0.2	26.9	38.7	12		0.5	0.38	-	0.66		0.07	32
Bg	13-18	5.2	8.06	0.24	1.8	0.4	0.1	0.2	40.8	64.1	6		0.6	6.05	-	1.65		0.44	34
BC	18-56	5.3	2.18	0.11	0.9	0.2	0.1	0.1	11.3	17.1	12		0.6	0.38	-	0.67		0.18	20
BCg	56-114	5.5	0.51	0.05	0.9	0.2	0.1	0.1	6.1	8.5	21		0.8	0.44	-	0.40		0.14	9
C	-200	6.0	0.35	0.05	4.6	2.0	0.1	0.2	9.9	5.5	70		1.2	0.84	-	0.16		0.07	6
31. Caribou Poker Creek: Coarse-loamy, mixed, superactive, subgelic Ruptic Histoturbel (UAF 203)																			
Oi	0-16	4.3	46.4	1.0	--	--	--	--	--	122.0	--	33.4	--	--	--	--	--	--	46
A/Oejj	16-28	4.6	11.9	0.50	6.8	0.9	0.1	0.1	42	52.0	19	O[16%]	0.88	0.98	0.81	0.49	0.42	0.08	24
Oe/Bgjj	28-43	5.0	18.1	0.80	10.0	1.1	0.1	0.1	49	16.0	23		0.79	1.02	0.86	0.60	0.55	0.07	23

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		-------------------- Cmol+ kg^{-1}					--------------------	%	kg m^{-2}	-------------------------- %					-----------------------	
Oejj	43-52	4.8	16.6	0.70	15.0	1.7	0.1	0.1	63	66.0	27		0.96	1.18	1.01	0.71	0.65	0.04	24
Bg/Oejj	52-70	4.2	9.80	0.40	6.6	0.8	0.1	0.1	40	51.0	19		0.66	0.78	0.69	0.53	0.51	0.06	24
Rf	55+																		
32. Caribou Poker Creek: Coarse-loamy, mixed, superactive, subgelic Lithic Folistel (UAF 204)																			
Oi	0-14	4.1	47.3	1.0	--	--	--	--	--	216	--	15.0	--	--	--	--	--	--	47
Oe	14-18	4.0	46.1	1.3	--	--	--	--	--	97	--	O [26%]	0.35	0.35	0.27	0.23	0.24	0.01	31
A	18-23	4.3	12.6	0.5	4.2	1.3	0.1	0.1	43	66	13		0.59	0.66	0.53	0.35	0.32	0.01	25
Oe'	23-30	4.1	30.1	1.1	5.8	1.4	0.1	0.1	68	91	11		1.09	1.27	1.14	0.55	0.54	0.01	27
Bg/Oajj	30-55	4.1	14.9	0.60	2.4	0.5	0.1	0.1	48	78	6		1.06	1.31	1.14	0.62	0.57	0.01	25
Rf	55+																		
33. Caribou Poker Creek: Loamy-skeletal, mixed, superactive, subgelic Lithic Histoturbel (UAF 205)																			
Oe	0-15	4.2	44.9	1.00	16.3	4.9	1.2	0.4	111		20	19.9	--	--	--	--	--	--	45
Oajj	15-19	4.2	34.2	1.50	18.2	4.4	0.6	0.2	100		23	O [94%]	--	--	--	--	--	--	23
Bg	19-40	5.7	0. 50	0.10	5.0	1.5	0.1	0.1	10		67		0.47	0.56	0.13	0.15	0.07	0.06	5
Crf	40-50	6.1	0. 60	0.10	5.5	1.9	0.1	0.1	11		70		0.63	0.58	0.11	0.14	0.07	0.05	6
34. Ft. Knox PSP: Coarse-loamy, mixed, superactive, subgelic Typic Dystrogelept (S03AK090-007; 04N0277)																			
Oi	0-10	3.47	46.3	0.90	5.8	3.6	1.1	0.1	86.4	67.5	12	18.3	nd	nd	nd	nd	nd	nd	51
OA	10-17	3.56	22.0	0.49	1.6	1	0.3	tr	66.5	56.9	4	O [52%]	0.82	0.74	0.65	0.49	0.42	0	45
Bw1	17-35	4.67	2.43	0.13	0.3	0.1	tr	tr	17.8	22.6	2		1.74	1.6	0.77	0.96	0.66	0.17	18
Bw2	35-68	5.17	1.37	0.08	0.4	0.1	tr	tr	12.6	14.8	4		1.43	1.13	0.33	0.79	0.4	0.21	17
Cr	68-80	ns	ns	ns	ns	ns	ns	ns	ns	ns	nd		ns	ns	ns	ns	ns	ns	
35. Workman PSP: Coarse-loamy, mixed, superactive, subgelic Typic Dystrogelept (S03AK090-002; 04N0261)																			
Oi	0-14	3.2	41.1	0.84	1.3	1.2	0.7	0.1	72.0	42.2	4	8.3	nd	nd	nd	nd	nd	nd	49
A	14-21	3.8	2.19	0.10	0.1	0.2	0.1	tr	19.8	20.1	3	O [42%]	1.11	0.95	0.31	0.29	0.16	0.05	22
Bw1	21-30	4.4	0.80	0.06	0.7	0.3	0.1	tr	9.7	10.9	11		1.28	0.91	0.3	0.26	0.13	0.05	13
Bw2	30-51	4.4	0.43	0.04	0.8	0.4	0.1	tr	8.0	9.5	17		1.35	0.76	0.22	0.21	0.12	0.04	10
BC	51-98	4.8	0.33	0.04	2.1	1	0.1	tr	8.9	8.7	37		1.73	0.62	0.14	0.22	0.1	0.06	8
Cr	-120	5.4	0.20	0.05	4.8	2.2	0.1	0.1	7.0	4.0	100		1.57	0.72	0.11	0.14	0.05	0.06	4
36. Shoefly: Coarse-loamy, mixed, superactive, subgelic Lithic Haplogelept (S03AK090-009, 04N0280)																			
Oe	0-14	3.6	39.8	1.45	8.3	4.7	1.1	tr	79.2	107.8	18	9.2	nd	nd	nd	nd	nd	nd	27
A	14-19	5.6	7.02	0.32	1.0	1.1	0.1	tr	28.1	40.4	8	O [42%]	1.2	0.70	0.46	0.38	0.30	0.04	22
Bw1	19-37	4.1	1.40	0.08	0.7	0.4	0.1	tr	11.2	19.6	11		2.1	1.17	0.17	0.80	0.38	0.24	17
Bw2	37-50	5.5	0.41	0.03	3.1	1.1	0.1	tr	7.7	7.4	55		3.3	0.40	0.08	0.21	0.18	0.08	13

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		-------------------- Cmol+ kg^{-1}				--------------------		%	kg m^{-2}	-------------------------- %					-----------------------	
BC	50-62	5.8	0.30	0.03	5.3	1.9	0.1	0.1	6.4	7.3	100		1.2	0.32	0.06	0.13	0.05	0.05	10
Cr	62-70	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd	nd	
37. Taylor MP 14, PSP421: Coarse-loamy, mixed, superactive, subgelic Lithic Gelaquept (S04AK176-006, 05N0099) [ashy influence]																			
Oa	0-3	6.0	47.0	1.59	38.8	7.6	5.6	0.1	48.13	62.8	100	18.1	nd	nd	nd	nd	nd	nd	30
Oi	3-12	3.6	46.3	0.94	12.8	6.8	3.2	0.1	66.2	104.1	35	O [67%]	nd	nd	nd	nd	nd	nd	49
Oe	12-21	3.7	27.3	0.75	4.1	1.2	0.7	tr	45.3	70.3	13		nd	nd	nd	nd	nd	nd	36
Bw	21-29	4.4	6.65	0.25	2.5	0.7	0.2	0.1	21.6	35.3	16		1.7	0.70	0.52	0.33	0.28	0.02	27
Bg	29-42	5.9	0.67	0.03	5.9	2.8	0.1	0.1	8.7	6.4	100		1.4	0.60	0.15	0.09	0.05	0.04	24
CR	42-62	5.8	0.29	0.02	1.8	1.0	0.1	tr	4.2	4.1	69		3.0	0.17	0.10	0.05	0.05	0.01	15
38. Healy, Usib. 08-44: Coarse-loamy, mixed, subgelic Typic Gelaquept (UAF 8-31-07)																			
Oa	2-21	4.32	15.08	0.57								30.6							27
A	21-38	4.57	3.65	0.14								O[52%]							26
Bg	38-75	4.65	0.95	0.06															17
BC	75-95	5.38	0.89	0.04															20
39. Healy, Usib. 08-56: Sandy, mixed, subgelic Entic Haplocryod (UAF 9-1-07)																			
Oi/Oe	0-8	3.74	21.94	0.69								16.2							32
A/E	8-16	3.72	1.19	0.04								O[80%]	0.34	0.39	0.17	0.12	0.09	0.04	31
Bs	16-24	4.13	1.36	0.05									0.69	0.83	0.32	0.24	0.16	0.06	29
BC	24-34	4.33	0.78	0.01									0.44	0.46	0.12	0.26	0.19	0.06	56
Tephra/Residuum																			
40. Taylor Highway: Ash over loamy-skeletal, glassy over mixed, active, subgelic Vitrandic Haplocryept (S01AK176-001; 02N0081)																			
Oi	0-10	3.9	45.3	1.17	20.3	4.8	3.3	0.3	92.7	108.2	31	16.7	--	--	--	--	--	--	39
A	10-13	4.8	6.14	0.33	5.6	1.3	0.6	0.2	26.6	29.0	29	O[70%]	0.8	0.53		0.25		0.03	19
E	13-25	5.4	1.05	0.06	1.6	0.4	0.2	0.3	6	8.4	42		0.4	0.29		0.22		0.08	19
Bw/E	25-35	5.5	0.47	0.02	9.9	2.8	0.3	0.2	18.5	9.3	71		2.3	0.55		0.10		0.04	21
BC	35-49	6.2	0.33	0.02	11.7	3.4	0.3	0.3	18.8	7.4	84		2.2	0.38		0.08		0.04	14
2C1	49-70	6.7	0.29	0.03	14.2	4.6	0.4	0.5	21.1	4.4	93		2.3	0.34		0.09		0.06	10
2C2	70-90	6.9	0.21	0.01	11.1	3.2	0.3	0.4	16.6	3.3	90		1.7	0.28		0.08		0.04	16
41. White Alice: Ash over coarse-loamy, glassy over mixed, active, frigid Vitrandic Haplocryept (S04AK176-003)																			
Oi	0-11	3.8	47.6	0.85	11.7	8.0	4.6	Tr	23.0	19.6	100	9.9	nd	nd	nd	nd	nd	nd	56
E	11-19	4.6	3.69	0.12	6.9	2.4	0.3	Tr	15.5	22.0	62	O[34%]	0.80	0.65	0.22	0.25	0.11	0.07	31
Bw	19-36	5.6	0.73	0.03	11.5	4.1	0.2	0.1	20.0	9.4	80		1.17	0.89	0.16	0.23	0.06	0.10	23
Ab	36-44	6.0	0.95	0.04	6.2	2.3	0.2	0.1	12.7	7.0	70		0.49	0.54	0.15	0.22	0.07	0.08	25

Site Horizon	Depth	pH† H₂O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H⁺	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		-------------------- Cmol+ kg^{-1}				--------------------		%	kg m^{-2}	-------------------------- % ----------------------						
Bwb1	44-56	6.7	0.46	0.02	15.3	5.9	0.3	0.2	22.3	5.3	98		1.14	0.68	0.09	0.16	0.03	0.09	25
Bwb2	56-67	6.7	0.51	0.03	15.3	5.8	0.3	0.3	22.7	4.5	96		1.09	0.49	0.07	0.14	0.03	0.08	17
2Cr	67-100	7.2	0.14	0.01	16.7	5.6	0.3	0.3	27.4	2.8	84		0.99	0.22	0.04	0.08	0.03	0.03	10
42. Seismic Site: Ash over loamy, mixed, superactive, subgelic Vitrandic Haplocryept (S03AK240-010; 04N0264)																			
Oi	0-13	3.4	31.6	0.86	2.4	2	1.2	0.3	59.0	30.3	10	12.3	nd	nd	nd	nd	nd	nd	37
E/A	13-21	4.0	4.92	0.23	2.5	1.1	0.3	0.2	24.7	18.6	17	O[44%]	1.0	0.57	0.28	0.29	0.15	0.07	22
Bw1	21-40	5.1	0.70	0.04	11.9	4	0.2	0.2	23.5	9.6	69		1.5	0.45	0.15	0.20	0.09	0.07	17
Bw2	40-54	5.9	0.58	0.07	18	7.1	0.2	0.4	24.4	6.0	100		1.5	0.43	0.13	0.15	0.05	0.07	9
BC	54-70	6.2	0.46	0.03	17	6.8	0.2	0.4	23.1	4.2	100		2.0	0.42	0.12	0.14	0.05	0.08	16
43. Big Stump Site: Ash over loamy, mixed, active, subgelic Vitrandic Haplocryept (S03AK240-011, 04N0265)																			
Oi	0-6	4.7	33.4	0.88	6.6	2.3	2.3	--	51.2	83.0	22	7.2							38
A	6-15	5.4	1.64	0.06	2.1	0.8	0.4	0.1	10.3	11.7	33	O[32%]	0.6	0.26		0.18	0.06		30
E	15-28	5.6	0.78	0.06	10.6	4.2	0.3	0.1	6.8	5.9	100		0.7	0.24		0.14	0.05		13
Bw1	28-50	5.9	0.75	0.04	13.9	5.9	0.2	0.1	13.9	7.0	100		1.6	0.40		0.16	0.08		18
2Bw2	50-85	6.4	0.35	0.04	11.4	5.1	0.3	0.1	21.3	5.1	79		1.2	0.22		0.17	0.07		10
CR	85+																		
44. Nondalton: Coarse-silty, mixed, superactive, frigid Typic Cryaquod (67AK070-002; 40A5508)																			
Oe	0-10		35.6	-	8.5	3.1	1.8	0.3	95.6	89.2	14	31							
E	10-15		8.34	-	0.1	0.2	0.2	0.2	24.1	34.1	3	O[52%]		0.5	0.2	0.3	0.2		
Bh	15-23		9.84	-	0.1	0.1	0.1	0.1	61.8	75.9	1			1.2	1.1	2.8	1.1		
Bs	23-33		5.57	-	0.3	0.1	0.1	0.1	43.6	60	1			1.1	0.7	3	0.7		
BC	33-43		1.10	-	0.7	0.1	0.1	0.2	11.5	20.4	10			0.7	0.1	1.5	0.1		
2C	43-86		0.14	-	0.6	0.1	0.1	0.2	4.2	4.6	24			0.4		0.4			
Sand Dune																			
45. Taylor MP 3.5: Sandy, mixed, active, frigid Vitrandic Cryopsamment (S01AK176-002; 02N0082)																			
Oi	0-10	4.2	40.2	0.67	19.2	3.9	1.8	0.4	71.6	70.9	35	22.5							60
A	10-19	4.6	5.2	0.15	0.6	0.3	0.3	0.2	17.6	22.9	8	O[64%]	1.1	.0.46		0.41		0.08	34
E	19-27	4.9	2.9	0.10	1.1	0.2	0.2	0.1	12.4	16.0	13		0.8	0.40		0.53		0.17	29
Bw	27-39	6.1	1.7	0.06	2.3	0.6	0.3	0.4	8.4	10.7	43		1.6	0.56		0.64		0.26	26
C1	39-49	6.0	0.1	0.01	1.9	0.4	0.2	0.2	4.7	2.8	57		0.9	0.27		0.27		0.12	11
C2	49-100	6.3	0.1	0.02	2.8	0.4	0.2	0.1	4.5	1.9	78		0.8	0.36		0.13		0.07	4

Moraine

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		-------------------- *Cmol+ kg^{-1}*				--------------------		*%*	*kg m^{-2}*	-------------------------- *%*				-----------------------		
46. Dalton Highway MP 186.9: Loamy-skeletal, mixed, superactive, subgelic Typic Haplogelept (S04AK185-008; 05N0091)																			
Oi	0-5	4.8	30.1	0.97	64.2	6.5	1.6	0.1	91.7	53.3	79	19.4	1.1	nd	nd	nd	nd	nd	31
Oe	5-10	4.8	24.8	0.82	32.3	3.9	0.5	tr	37.3	33.3	79	O[70%]	1.8	nd	nd	nd	nd	nd	30
Bw1	10-20	6.8	1.22	0.15	11.9	1.3	tr	tr	12.6	3.5	100		2.6	0.68	0.32	0.13	0.07	0.05	8
Bw2	20-35	7.6	0.75	0.12	10.0	1.0	tr	tr	5.6	4.1	100		2.7	0.66		0.14		0.06	6
Bw3	35-55	7.7	0.60	0.10	13.2	1.1	tr	tr	11.5	2.9	100		2.8	0.68	0.18	0.14	0.05	0.07	6
Bw4	55-80	7.9	0.71	0.07	11.2	1.0	tr	Tr	10.9	2.1	100		2.8	0.77	0.22	0.19	0.07	0.08	10
C	80-100	8.2	0.67	0.13	33.6	1.1	tr	tr	5.8	0.6	100		2.7	0.73	0.04	0.11	0.02	0.08	5
47. Coldfoot DH175: Coarse-loamy, mixed, superactive, subgelic Typic Histoturbel (93AK185-010; 93P0617)																			
Oi	0-20	4.6	38.9	1.22	45.3	14.6	0.5	--	102.6	81.2	59	65.4		0.17		0.05			32
Oe	20-34	4.9	47.3	2.76	94.6	13.5	1.0	--	135.1	82.7	81	O[79%]		0.20		0.05			17
Oa	34-39	6.0	31.8	1.94	97.3	11.3	0.1	0.5	120.9	51.9	90			0.91		0.16			16
Bgjj	39-51	5.5	2.03	0.19	4.9	0.7	tr	0.2	10.9	8.9	53		1.4	0.57		0.09			11
Cgf	51-100	5.7	2.23	0.22	7.0	0.8	tr	0.2	12.3	8.8	65		2.0	0.65		0.08			10
48. Denali Park, Rock Creek: Coarse-loamy, mixed, superactive, subgelic Typic Historthel (92AK068-003; 92P1087)																			
Oi	0-15	4.1	43.7	--	25.6	8.0	3.2	0.4	105.6	97.5	35	59.0						0.30	--
Oe	15-21	4.9	32.2	--	6.3	1.3	0.2	0.4	64.7	59.4	13	O[60%]						0.41	--
Oa	21-27	4.6	25.1	--	7.8	1.8	0.3	0.4	57.8	47.1	18							0.49	--
Bg	27-40	4.7	3.71	--	3.7	0.8	tr	0.2	18.9	19.4	25		1.0	0.79	0.5	0.26	0.3	1.13	--
Cgf1	40-47	5.0	2.46	--	3.4	0.9	0.1	0.1	12.7	12.4	35		1.1	0.86	0.6	0.23	0.1	1.51	--
Cgf2	47-100	5.2	2.18	--	3.9	1.1	tr	0.2	11.4	9.3	46		11.1	1.03	0.5	0.23	0.1	1.37	--
49. Healy, Usib. 08-42: Sandy, mixed, subgelic Typic Gelorthent (UAF 8-31-07)																			
Oe/Oa	0-12	3.97	13.30	0.46								11.7							29
Bw	12-20	4.91	1.07	0.02								O[53%]							46
BC	20-40	5.07	0.30	<0.01															-
C1	40-75	4.71	0.23	0.01															18
C2	75-89	4.59	0.24	0.01															16
Oab	89-95	4.78	3.81	0.12															32
Ab	95-100	5.73	0.27	0.01															
Bog, Lowlands																			
50. Smith Lake: Euic, subgelic Terric Sapristel (91AK090-003; 91P0970)																			
Oi	0-10	5.7	44.4	-	34.2	22.7	1.4	0.3	67.0	39.4	87	104.6	0.2	0.11	0.1	0.03	tr	0.01	--
Oa	10-23	5.5	26.0	-	52.0	20.7	--	0.3	98.1	60.3	74	O[41%]	1.5	1.20	1.1	0.26	0.2	0.04	--

Site Horizon	Depth	pH† H_2O	OC	TN	Extractable Cations Ca	Mg	K	Na	CEC	Exch H^+	BS	C-Stores	Fe_d	Fe_o	Fe_p	Al_o	Al_p	Si_o	C/N
	cm		-------%-------		------------ *Cmol+ kg^{-1}*				------------		%	*kg m^{-2}*	------------ %				------------		
C	23-30	5.6	3.44	-	10.5	3.8	--	Tr	20.7	8.5	69		0.5	0.40	0.3	0.15	0.1	0.05	--
Oaf	30-38	5.4	26.7	-	48.6	13.9	--	0.2	98.1	65.9	64		1.1	0.87	0.9	0.42	0.4	0.03	--
Oef	38-53	5.8	34.9	-	62.6	17.3	tr	0.2	39.3	73.8	100		1.1	0.88	0.9	0.42	0.4	0.01	--
Cf	53-100	5.1	1.97	-	5.3	2.2	tr	--	12.2	5.9	61		0.2	0.14	0.1	0.09	tr	0.03	--
51. Smith Lake: Euic, subgelic Terric Sapristel (96AK090-003; 96P0367)																			
Oi	0-16	3.9	48.1	1.23	21.2	11.9	3.6	0.2	99.1	93.8	37	87.9	0.1	0.12		0.07		0.01	39
Bg	16-23	6.4	1.74	0.10	8.5	3.5	0.1	0.1	14.1	5.7	87	O[24%]	1.0	0.47		0.09		0/05	18
Oa	23-37	6.1	39.2	1.74	131.2	30.6	0.2	0.5	191.2	65.8	85			0.39		0.22		0.02	23
Oaf	37-47	6.5	17.5	0.96	53.8	13.3	0.1	0.2	77.2	39.1	87		0.8	0.59		0.31		0.03	18
Cf1	47-54	6.4	4.15	0.27	15.8	4.8	0.1	0.2	23.8	12.3	88		0.2	0.11		0.18		0.03	15
Wf/Cf2	54-74		4.15	0.27									nd	nd					15
52. Pt. MacKenzie: Dysic, Typic Cryofibrist (91AK170-005)																			
Oi	0-29	4.6	47.6	0.78	63.5	13.0	0.8	0.6	129	79.3	60	147.3	0.6	0.34	0.4	0.09	0.1	0.02	61
Oe1	29-47	4.9	48.1	1.66	49.2	5.8	0.1	0.5	106	83.1	52	O[100%]	0.6	0.40	0.4	0.27	0.3	0.02	29
Oa	47-79	5.0	43.8	1.80	41.8	4.4	0.1	0.4	96	81.6	49		0.6	0.35	0.4	0.38	0.4	0.03	24
Oe2	79-97	5.2	20.2	0.76	17.8	1.6	0.1	0.3	49	60.9	40		0.2	0.15	0.1	0.64	0.6	0.04	27
Oe3	97-148	5.0	49.4	1.93	47.7	4.2	0.1	0.5	106	77.7	50		0.5	0.28	0.3	0.38	0.5	0.02	26
O’	148-165	5.0	54.3	1.90	68.2	6.3	0.1	0.5	132	85.5	57		0.8	0.27	0.4	0.15	0.3	0.02	29

† pH in water, OC = organic carbon, TN = total nitrogen, extractable cations = calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na), CEC = cation exchange capacity, Ex.[H+] = exchangeable hydrogen ion or acidity, BS = base saturation of the exchange capacity, C-stores = kilograms of organic carbon to sampling depth and O[%] is the percentage of the total C-stores contained in the surface organic horizons, (Fe_d, Al_d) = iron and aluminum dissolved by citrate-dithionite, (Fe_o, Al_o, and Si_o) = iron, aluminum and silica dissolved by oxalate, (Fe_p, Al_p) = iron and aluminum dissolved by sodium pyrophosphate, and C/N = ratio of total organic carbon to total nitrogen. For methods refer to the Methods section above.