Soil genesis in relation to glacial history in central Yukon

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ABSTRACT

Reconnaissance studies of soils on low-elevation McConnell (~30-12 ka), Reid (~150-80 ka) and pre-Reid (~2.6-0.2 Ma) glacial deposits were conducted in the 1970s and 1980s. We initiated a study in the summer of 2008 to assess whether the distinct morphological and clay mineral characteristics of these soil groups are also present at upland sites in south-central Yukon, approximately 25 km southwest of Carmacks. Soils at the pre-Reid sites are developed on weathered bedrock. Solum thickness at these sites exceeds the depth of the excavated pits (85-110 cm), and the solum has been strongly cryoturbated. Soils at the Reid and McConnell sites are developed on till with solum thicknesses of 50-75 cm and <50 cm respectively. These younger soils do not exhibit significant cryoturbation at depth. No significant differences in solum colour are apparent among the soil groups, and no clay skins were observed. Results of chemical and micromorphological analyses will be reported in 2009.

RÉSUMÉ

Des études de reconnaissance des sols sur des dépôts glaciaires de McConnell (~30-12 Ka), de Reid (~150-80 Ka) et antérieurs à la Glaciation de Reid (~2,6-0,2 Ma) à faible altitude ont été menées dans les années 1970 et 1980. À l'été 2008, nous avons lancé une étude visant à évaluer si les caractéristiques morphologiques et les minéraux argileux particuliers de ces groupes de sols sont également présents dans les hautes terres du centre sud du Yukon, environ 25 km au sud ouest de Carmacks. Les sols aux sites antérieurs à la Glaciation de Reid reposent sur un substratum rocheux altéré. L'épaisseur du solum à ces sites dépasse la profondeur des puits excavés (de 85 à 110 cm), et le solum a été fortement remanié par géliturbation. Les sols aux sites de Reid et de McConnell reposent sur un till, et l'épaisseur du solum y est de 50 à 75 cm et de plus de 50 cm, respectivement. Ces sols plus jeunes ne montrent aucun signe important de géliturbation en profondeur. Aucune différence significative n'est apparente dans la couleur du solum parmi les groupes de sols, et aucune pellicule argileuse n'a été observée. Les résultats des analyses chimiques et micromorphologiques seront présentés dans un rapport en 2009.

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INTRODUCTION

Soil genesis studies in central Yukon initially focussed on glacial deposits and have only recently begun to address soils formed on weathered bedrock in unglaciated regions of the territory. Foscolos *et al*. (1977), Tarnocai *et al*. (1985), Smith *et al*. (1986) and Tarnocai and Smith (1989) conducted the first studies of soil development on Quaternary deposits, shown in Figure 1 as the area of previous research. They characterized soils on glacial deposits of McConnell (~30-12 ka), Reid (~150-80 ka), and pre-Reid (~2.6-0.2 Ma) age, based largely on the model of Yukon glaciation proposed by Bostock (1966). The soils comprise a chronosequence, a series of related soils that differ primarily as a result of differences in time of formation. Stronger morphological development and distinctive clay mineralogy characterize soils on deposits of older glaciations. The only study of soils in central Yukon in the past 20 years showed that this model does not fully apply to soils on Yukon River terraces downstream from Ft. Selkirk, south of the areas studied in the 1970s and 1980s (Huscroft *et al*., 2006).

The study area was selected to capture a range of surface ages and includes soils developed on weathered bedrock. Studies of soil genesis and mineral weathering in unglaciated regions of the central Yukon are limited and thus data for comparing soils formed primarily from *in situ* weathered bedrock to soils previously identified on glaciated surfaces in the chronosequence is limited (Bond and Sanborn, 2006). Due to the paucity of data, it is not yet possible to relate soils formed in complex parent materials, including weathered bedrock, to the soil chronosequence developed from the study of glacial deposits. The examination in this study of upland soil derived from weathered bedrock may be relevant to the study of soils on unglaciated surfaces beyond the pre-Reid limit.

Recent research has better constrained the ages of the McConnell and pre-Reid glaciations. The McConnell Glaciation is late Wisconsinan (~30-11 ka) in age, and the oldest pre-Reid advance occurred at the end of the Pliocene (~2.6 Ma) (Froese *et al*., 2000). The age of the penultimate glaciation, however, has not yet been resolved. In the past, researchers have assigned it variously to marine oxygen isotope stages 4 (~58-75 ka), 6 (~127-195 ka), or 8 (~244-297 ka) (Bradley, 1999; Westgate *et al*., 2001; Huscroft *et al*., 2004; Ward *et al*., 2007). Recent surface exposure ages of 51-54 ka on penultimate drift thought to be a Reid-age deposit greater than marine oxygen isotope stage 4 indicates unresolved complexity in the glacial chronology (Ward *et al*., 2007).

This study examines soil development on surfaces of a variety of ages in order to assess the contribution of weathering to soil properties and pedogenic pathways at upland sites in central Yukon. The study area is south of the region of previous studies, thus the research provides new data on surface weathering and contributes to establishing the chronology of ice sheet glaciation with more certainty. Results of the study can be applied to surficial geology mapping where the ages of deposits are uncertain. This report provides preliminary results of the 2008 fieldwork component of the project. Synthesis and analytical results will be reported in 2009.

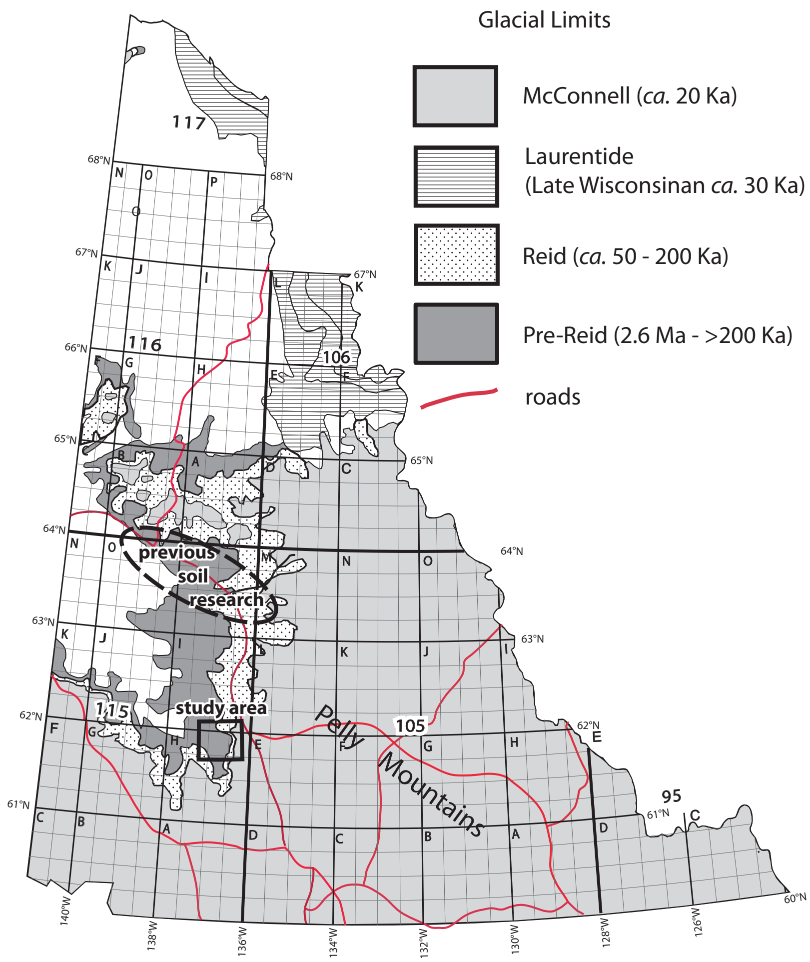

Figure 1. Glacial limits in Yukon and location of the study area (after Duk-Rodkin, 1999).

STUDY AREA

The study area is approximately 25 km southwest of Carmacks in central Yukon. Study sites are located on the Yukon Plateau in the southeast corner of the Carmacks (NTS 115I) map sheet and the northeast corner of the Aishihik Lake (NTS 115H) map sheet. Figure 1 shows the location of the study sites with respect to glacial limits and the area of previous study.

GEOLOGY

The study area overlies Early Jurassic Long Lake Suite porphyritic plutonic rocks that have intruded conglomerate. The Long Lake Suite comprises massive to weakly foliated, fine to coarse-grained, biotite, biotite-muscovite and biotite-hornblende quartz monzonite to granite (Gordey and Makepeace, 2001).

Bostock (1966) inferred that the area was glaciated during four advances of the Cordilleran Ice Sheet — from oldest to youngest, the Nansen, Klaza, Reid, and McConnell glaciations. The McConnell glacial limit is clearly delineated within the study area by conspicuous moraines, meltwater channels and ice-marginal features. Moraines and meltwater features of the Reid glaciation are above and beyond the McConnell limit and are much more subdued in character (Fig. 2; Hughes, 1990). Most rolling upland surfaces inside the Reid and McConnell limits are blanketed by till. In contrast, upland sites beyond the Reid limit are mantled by colluvium or weathered bedrock, with no till. In the Carmacks map area, evidence of glaciations beyond the Reid limit includes till, glaciofluvial landforms, glacial erosional landforms and drainage anomalies (Hughes, 1990; Jackson, 2000). Tors are common within these areas (Fig. 3), and cryoplanation terraces occur in the Aishihik Lake map sheet west of the study area (Hughes, 1990). The age of upland pre-Reid surfaces is unknown.

ECOREGION

The study sites are within the Boreal Cordillera ecoregion. The west margin of this ecoregion is delineated by the maximum extent of glaciation (Smith *et al*., 2004). The region is within the zone of discontinuous permafrost and is characterized by a continental climate with low precipitation (250-300 mm/year) and cool temperatures (mean annual temperature -4°C) (Smith *et al*., 2004). Study sites range in elevation from <1100 m asl (McConnell-age sites) to >1250 m asl (pre-Reid). Open boreal forest at lower elevations within the study area comprises *Picea mariana* and a ground cover of shrubs *(Ledum groenlandicum, Vaccinium vitis-idaea and Betula glandulosa*), lichens (dominated by *Cladina rangiferina, Cladina mitis* and *Cladonia spp.*) and mosses. Subalpine sites have patches of krummholtz *Picea mariana* and a dominant ground cover of lichens and shrubs. Alpine sites lack spruce and have areas of bare ground.

SITE SELECTION

Figure 4 shows the locations of the 14 sites that were described in detail and sampled in this study. Sites are located in stable landscape positions where glacial sediments are most likely to be preserved and the most mature soils would be present. Criteria for site selection included an upland landscape position (>1000 m asl), gentle slopes (0-5°), west to southwest aspect, good drainage, weathered bedrock or till parent material, and either no permafrost or a thick active layer.

Figure 2. *Meltwater channel formed during the Reid glaciation.*

Figure 3. *Tor located beyond the Reid limit, adjacent to sample site Y08-10.*

FIELD OBSERVATIONS

PARENT MATERIALS

All soils are developed on complex parent materials. Silty White River tephra, which is approximately 1150 years BP (Clague *et al.*, 1995), is the uppermost parent material at all sites. It is discontinuous in some profiles and ranges up to a thickness of 25 cm. The colour of the tephra differs from light grey (10YR 7/1) to brown (10YR 4/3) in the Munsell Soil Colour Chart as a result of increasing alteration from the original parent material. The tephra is commonly cryoturbated.

Silty material typically directly underlies the tephra on surfaces of all ages, either as a distinct layer up to 10 cm

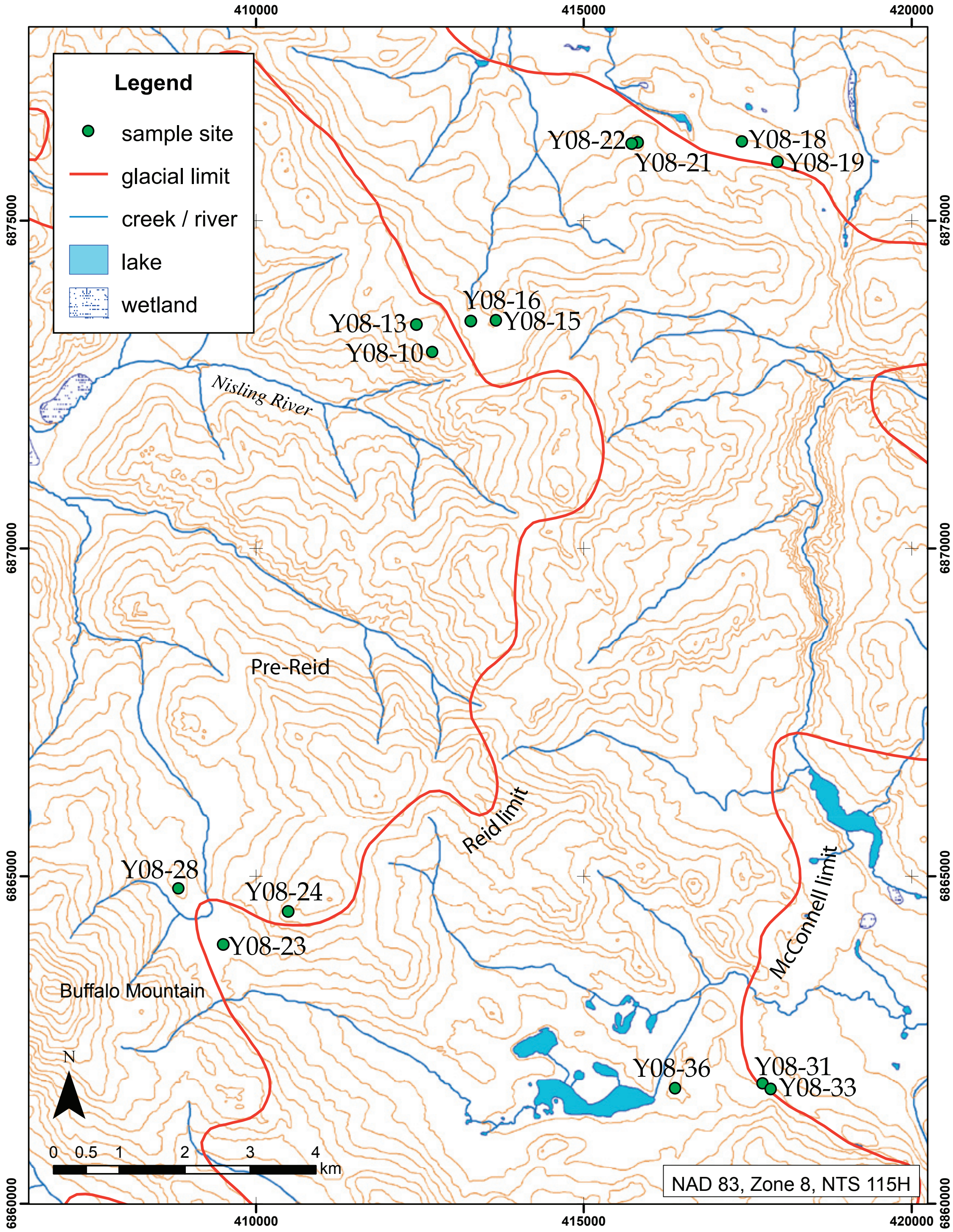

Figure 4. *Location of sample sites with respect to glacial limits.*

thick, or mixed with the underlying coarse material. This material is likely eolian in origin (loess). Significant downward translocation of silt within the soil profile is indicated by the presence of silt caps on coarse fragments in lower horizons. The silt caps were found in soils of all ages and are up to 2 cm thick (Fig. 5).

The main parent material at Reid and McConnell sites is till. The matrix of Reid till is generally sandier than that of the McConnell till. The main parent material at pre-Reid sites are weathered bedrock, formed primarily by *in situ* disintegration of intrusive bedrock (grus), and colluvium from frost action and slow downslope creep. No glacial deposits were observed at the pre-Reid sites.

GENERAL OBSERVATIONS

Soils on surfaces of all three ages are Brunisols, with the exception of a single Cryosolic soil. Brunisols are soils with insufficient development to be classified as either Luvisols or Podzols (Soil Classification Working Group, 1998). No evidence of mottling was observed in any of the soil pits. Mottles are irregular patches or spots that differ in colour from the dominant horizon colour and result from oxidation-reduction reactions. The presence of mottles would indicate seasonal fluctuations in the water table.

Soil structure is poorly developed throughout the study area, except locally in finer materials. No clay skins were observed at the sites, although, as mentioned previously, silt caps are common. The lower surfaces of some rock fragments in McConnell and Reid soils have dark staining, probably from organic acids. The B-horizons of soils of all ages differ little in colour; nearly all have a Munsell hue of 10YR.

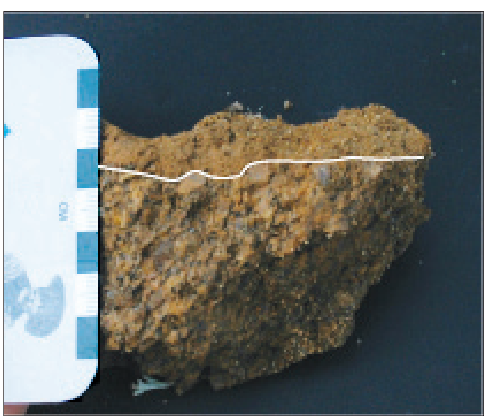

Figure 5. *Silt cap on weathered bedrock at pre-Reid site Y08-13.*

PRELIMINARY CHRONOSEQUENCE OBSERVATIONS

In a true soil chronosequence, all soil-forming factors except time (parent material, climate, topography, and biota) do not vary significantly. The chronosequence concept is not completely valid in this study because pre-Reid surfaces are not underlain by glacial sediment. Pre-Reid sites thus must be excluded from the chronosequence concept, but the study still provides insight into the character of high-elevation soils developed on weathered bedrock adjacent to previously glaciated areas. Due to differences in till matrix, Reid and McConnell sites do not constitute a true chronosequence, however, they can still be compared for studying time-related differences in soil formation.

McConnell soils

Soils at the four McConnell sites (Y08-18, Y08-19, Y08-31, Y08-33) are developed on thick till with a generally loamy matrix (loam is a mixture of sand, silt and clay). Figure 6 shows a McConnell moraine in a black spruce forest; the arrow indicates the approximate location of the soil pit shown in Figure 7. Table 1 provides descriptions of

Table 1. *Soil horizon notation. Description of soil horizon types as observed in field sites (Soil Classification Working Group, 1998).*

Organic horizons
F - moderately decomposed organic matter
m - abundant fungi present
i - incorporation of mineral component into organic layer
Mineral horizons
A - uppermost horizon(s) (not always present)
h - enriched in organic matter
e - bleached in appearance
B - middle horizon(s)
m - moderate degree of modification of parent material
BC - transitional horizon between B and C
C - original mineral parent material with only slight modification of chemical and/or physical properties
Additional modifiers applied to A, B or C horizons
b - buried
y - cryoturbated (disrupted by freeze/thaw activity)
j - indicates weak expression of the property that precedes it
II, III, IV - Roman numeral prefix identifies materials differing significantly in geological origin or texture
1, 2, 3 - Numeric suffix identifies horizon subdivision

abbreviations used for soil horizons. Table 2 provides an abbreviated summary of the soil profile description. Soils are classified as Orthic Dystric Brunisols or Eluviated Dystric Brunisols. They have a solum thickness (combined depth of the A and B horizons) of <50 cm and have moderate colouration in the till B horizon ranging from brown (10YR 5/3) to olive brown (2.5Y 4/3). The till parent material ranges from brown (10YR 5/3) to dark greyish brown (2.5Y 4/2).

The upper solum has a pH ($CaCl_2$) of <5.5[1]; pH is slightly higher in the lower solum and parent material (>5.5) in three of the four sites. Secondary carbonate was observed on the underside of clasts at site Y08-19 and

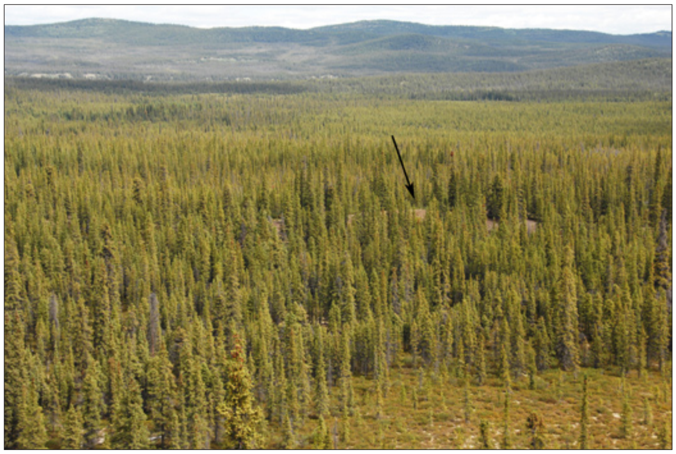

Figure 6. *McConnell landscape (site Y08-33). Arrow indicates location of soil pit.*

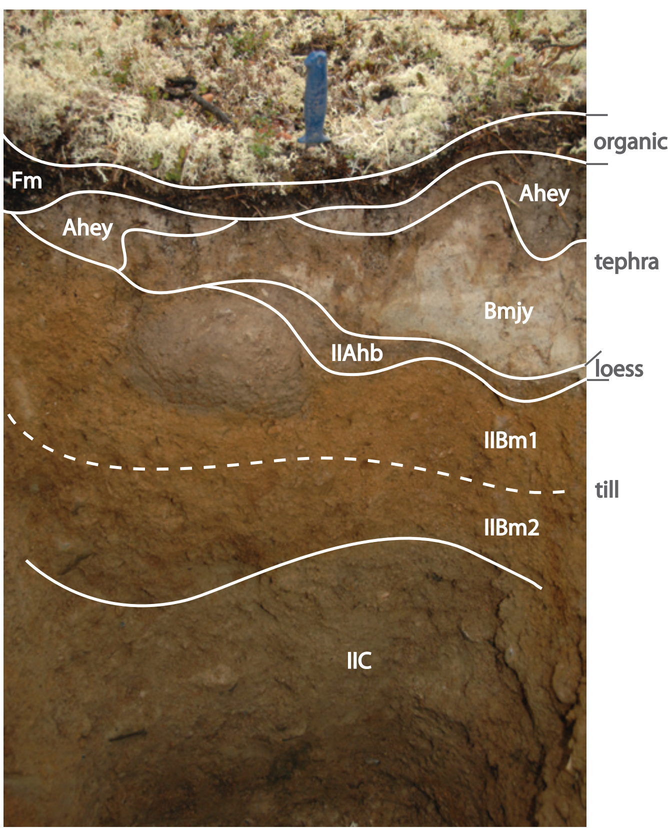

Figure 7. *Eluviated Dystric Brunisol formed in McConnell till at site Y08-33. The horizon parent material is labelled to the right of the photograph. Knife handle is 11 cm long.*

[1]Soil pH measurements used soil:water ratios of 1:1 for mineral and 1:2 for organic horizons and a soil:0.01 M $Cacl_2$ ratio of 1:2 for both mineral and organic horizons (Carter and Gregorich, 2008). The Canadian System of Soil Classification (1998) uses pH values determined in $CaCl_2$ for soil classification purposes because the ionic strength of this solution more closely resembles that found in natural soil solutions. The pH measurements in $CaCl_2$ normally provide slightly lower values by ~0.5-1.0 units than those determined in water.

Table 2. *Abbreviated description of soil at McConnell site Y08-33 (Fig. 7).*

Horizon	Depth (cm)	Abbreviated description	Coarse fragments (%) *
Fm	+4-0	organic horizon 2-5 cm thick; colour 10YR 2/1; pH (H_20) 4.87 and pH ($CaCl_2$) 4.15	n/a
Ahey	0-3	tephra; 0-14 cm thick; colour 10YR 7/1 and 10YR 5/3; pH (H_20) 4.87 and pH ($CaCl_2$) 3.92	0/0/0
Bmjy	3-19	tephra; 4-23 cm thick; colour 10YR 7/2 and 10YR 5/3; pH (H_20) 5.21 and pH ($CaCl_2$) 4.18	0/0/0
IIAhb	19-22	till with loess incorporated; 0-3 cm thick; colour 10YR 3/3; pH (H_20) 5.29 and pH ($CaCl_2$) 4.30	5/0/0
IIBm1	22-34	till; combined IIBm1 and IIBm2 horizons have total thickness of 24-37 cm; horizon separation based on minor colour difference (10YR 4/6 and 10YR 3/6); pH (H_20) 5.55/5.79 and pH ($CaCl_2$) 4.46/4.67	15/15/10
IIBm2	34-48		
IIC	48-≥107	till; colour 2.5Y 5/3; pH (H_20) 6.49 and pH ($CaCl_2$) 5.40; silt caps present with vesicular structure developing in some; volcanic boulders present; sandy silty matrix	20/30/10

*Coarse fragments (% by volume, estimated visually) refers to pebble (2-64 mm)/cobble (64-256 mm)/boulder (>256 mm).

Figure 8. Reid landscape (site Y08-15). Top arrow indicates Reid meltwater channel and lower arrow indicates location of soil pit.

within the matrix at site Y08-31. Cryoturbation features were noted in the tephra layer at only one McConnell site (Y08-33; Fig. 7). However, we purposely avoided areas where permafrost is present, thus this finding is not surprising. *In situ* disintegration of granitic rock fragments was noted at one site and is likely a result of both chemical and physical weathering.

Reid soils

Soils at six Reid sites (Y08-15, Y08-16, Y08-21, Y08-22, Y08-23, Y08-36) are developed on thick till or thin till over bedrock. Areas of thick Reid till are restricted to moraines (Fig. 8). Reid till in this area generally has a sandy matrix, although amounts of silt and clay in the parent material are variable.

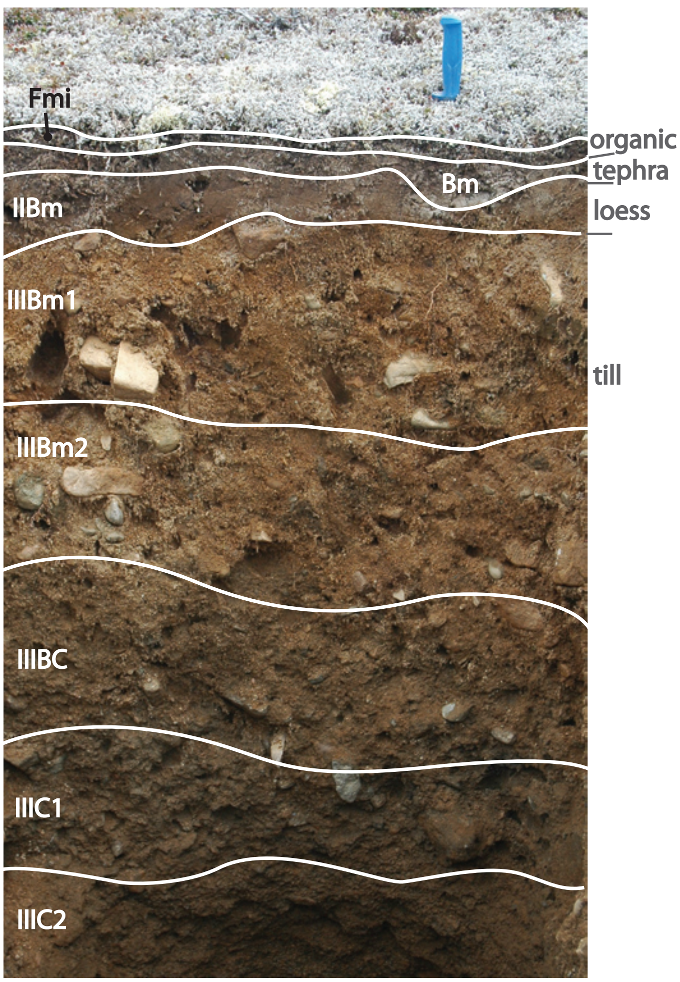

Figure 9. Orthic Dystric Brunisol formed in Reid till at site Y08-15. The horizon parent material is labelled to the right of the photograph. Knife handle is 11 cm long.

Table 3. Abbreviated description of soil at Reid site Y08-15 (Fig. 9).

Horizon	Depth (cm)	Abbreviated description	Coarse fragments (%) *
Fmi	+2-0	organic horizon 2-4 cm thick; colour 10YR 2/2; pH (H_20) 4.58 and pH ($CaCl_2$) 3.63	n/a
Bm	0-4	tephra-dominated; 3-6 cm thick; colour 10YR 4/3 and 10YR 7/2; pH (H_20) 4.59 and pH ($CaCl_2$) 3.60	0/0/0
IIBm	4-10	loess-dominated; 4-11 cm thick; colour 10YR 3/4; pH (H_20) 5.36 and pH ($CaCl_2$) 4.40	3/0/0
IIIBm1	10-36	till; 17-27 cm thick; colour 7.5YR 4/6; pH (H_20) 5.66 and pH ($CaCl_2$) 4.56	50/10/0
IIIBm2	36-60	till; 16-25 cm thick; colour 10YR 4/6; pH (H_20) 5.84 and pH ($CaCl_2$) 4.52	60/15/0
IIIBC	60-90	till; 20-37 cm thick; colour 10YR 5/4; pH (H_20) 5.75 and pH ($CaCl_2$) 4.55; occasional silt caps	60/20/0
IIIC1	90-119	till; 18-31 cm thick; colour 10YR 4/4; pH (H_20) 6.03 and pH ($CaCl_2$) 4.85; occasional silt caps	55/15/0
IIIC2	119-≥160	till; colour 10YR 4/3; pH (H_20) 6.25 and pH ($CaCl_2$) 5.02; sandy matrix.	50/0/0

*Coarse fragments (% by volume, estimated visually) refers to pebble (2-64 mm)/cobble (64-256 mm)/boulder (>256 mm).

Figure 10. *Weathered granitic clast at Reid site Y08-15.*

Soils are classified as either Orthic Dystric Brunisols or Eluviated Dystric Brunisols (Fig. 9; Table 3). All soils are acidic, with pH ($CaCl_2$) in the solum <5.5. The colour of the till component of the B horizon ranges from brown and strong brown (7.5YR 4/6 and 7.5YR 4/4) to olive brown (2.5Y 4/4), but is dominantly dark yellowish brown (10YR). The unweathered till ranges in colour from brown (10YR 5/3) to olive brown (2.5Y 4/4). *In situ* disintegration of granitic coarse fragments is common (Fig. 10). Cryoturbation at the six Reid sites is limited to the near-surface tephra.

Solum depths for Reid soils range from 50 to 75 cm, except at site Y08-36, where the solum thickness is only 36 cm. This site has been mapped as hummocky Reid moraine (Hughes, 1990), but it is located less than 1 km from the McConnell glacial limit. The solum thickness indicates that this profile is less developed than soils at the other Reid sites and is similar to the solum thickness of McConnell soils. It is possible that the limit of the McConnell glaciation is farther west than the present mapped limit, or that the hummocky moraine at the study site was deposited during a glacial advance separate from the McConnell and classic Reid advances. Field data are insufficient to establish whether either scenario is plausible, and laboratory analysis is required to elucidate the history of this site.

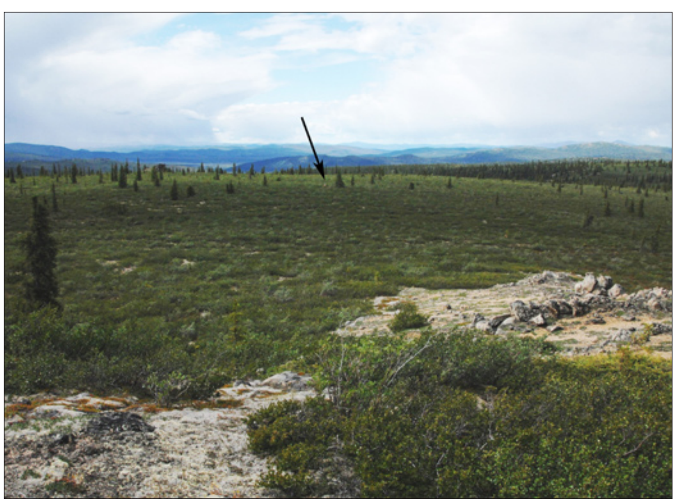

Figure 11. *Pre-Reid landscape (Y08-13). Arrow indicates location of soil pit.*

Pre-Reid soils

Soils at four pre-Reid sites (Y08-10, Y08-13, Y08-24, Y08-28) are developed on bedrock. They are dominated by angular coarse fragments, and the matrix is sandy except where finer sediment has accumulated in silt caps. The soils are Brunisolic Dystric Cryosols, Eluviated Dystric Brunisols and Orthic Dystric Brunisols. Figure 11 shows the landscape and vegetation associated with the Eluviated Dystric Brunisol shown in Figure 12, and an

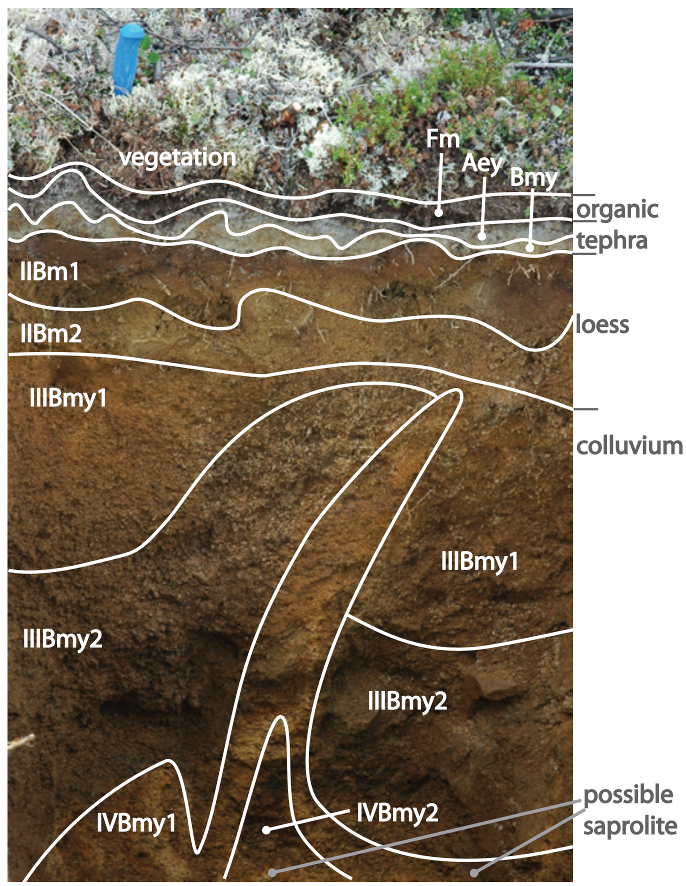

Figure 12. *Eluviated Dystric Brunisol formed in weathered bedrock at pre-Reid site Y08-13. The horizon parent material is labelled to the right of the photograph. Knife handle is 11 cm long.*

abbreviated profile description is given in Table 4. Unlike Reid and McConnell soils, all pre-Reid soils are strongly cryoturbated throughout the entire solum thickness. Cryosols are characterized as having permafrost within 1 m of the surface, or within 2 m of the surface if the solum is strongly cryoturbated (Soil Classification Working Group, 1998). Evidence for permafrost within 2 m of the surface was confirmed at only one site (Y08-10). We were unable to excavate pits at the pre-Reid sites to more than 1.1 m depth, thus some soils designated as Brunisolic soils may actually be Cryosols. The pre-Reid sites have the thickest sola and extend deeper than the bottoms of the excavated pits (85-110 cm). B horizon colours range from reddish yellow (5YR 6/8) to olive brown (2.5Y 4/4), but are dominantly yellowish brown (10YR), with only single examples of each of the extreme hues. All soils are acidic with pH ($CaCl_2$) in the solum <5.5.

Table 4. *Abbreviated description of soil at pre-Reid site Y08-13 (Fig. 12).*

Horizon	Depth (cm)	Abbreviated description	Coarse fragments (%)*
Fm	+6-0	organic horizon; 4-10 cm thick; colour 10YR 2/2; pH (H_20) 4.64 and pH ($CaCl_2$) 3.77	n/a
Aey	0-3	tephra; 2-4 cm thick; colour 10YR 6/3; pH (H_20) 4.58 and pH ($CaCl_2$) 3.64	0/0/0
Bmy	3-8	tephra; 2-6 cm thick; colour 10YR 6/3 and 10YR 5/6; pH (H_20) 4.99 and pH ($CaCl_2$) 4.14	0/0/0
IIBm1	8-13	loess; 5-9 cm thick; colour 10YR 4/4; pH (H_20) 5.47 and pH ($CaCl_2$) 4.37	5/0/0
IIBm2	13-20	loess; 6-10 cm thick; colour 10YR 3/6; pH (H_20) 5.74 and pH ($CaCl_2$) 4.79	5/0/0
IIIBmy1	20-66	colluvium; discontinuous; colour 10YR 4/6; pH (H_20) 5.90 and pH ($CaCl_2$) 4.74	65/15/0
IIIBmy2	20-90	colluvium; discontinuous; colour 10YR 4/6; pH (H_20) 5.90 and pH ($CaCl_2$) 4.73	65/25/0
IVBmy1	23-≥110	possible saprolite; discontinuous; colour 10YR 5/8 and 7.5YR 5/8; pH (H_20) 5.90 and pH ($CaCl_2$) 4.65	75/5/0
IVBmy2	83-≥110	possible saprolite; discontinuous; colour 10YR 6/8 and 7.5YR 6/8; pH (H_20) 6.13 and pH ($CaCl_2$) 5.08	75/5/0

*Coarse fragments (% by volume, estimated visually) refers to pebble (2-64 mm)/cobble (64-256 mm)/boulder (>256 mm).

DISCUSSION

McConnell and Reid soils are Brunisols formed on till, and pre-Reid soils are Brunisols and Cryosols developed on weathered bedrock. As expected, solum depth increased with surface age. However, other criteria identified in past studies as useful for differentiating soils developed on glacial deposits of different age, such as presence or absence of clay skins, colour of the B horizon, and presence or absence of weathered clasts, were found to not be reliable field indicators of soil age in this study. The reason may be that the sites are sufficiently geomorphically active that episodic or continuous removal of soil materials occurs before these morphological features can develop.

The interaction of confounding site factors, such as soil texture and elevation, may also lead to less dramatic morphological development than would be expected between sites based on age differences alone. The decreasing rate of weathering associated with more severe climates at higher elevation may be sufficient to reduce the morphological expression of soil development. The maximum relief between sites is approximately 350 m. The production of clay may be limited at these high elevation sites. Additional analysis of clay mineralogy will determine whether clays are present within the profiles.

Disintegrated coarse fragments of granite were observed in soils developed on till. Although overall they appear to be more common at Reid sites, their presence or absence cannot be used to confidently differentiate between McConnell and Reid-age surfaces because they were present in both.

Only pre-Reid soils are strongly cryoturbated throughout the full solum depth. This cryoturbation is likely due, in part, to a longer soil history with greater exposure to freeze-thaw activity than McConnell and Reid sites. However, because sites were preferentially selected to avoid permafrost, the lack of cryoturbation in the sola of these younger soils does not indicate its absences in other parts of the landscape. Small changes in aspect, thickness of organic matter layer, and other soil features lead to an irregular distribution of permafrost. Although no periglacial features were observed in till horizons, cryoturbation was noted in horizons containing tephra at some Reid and McConnell sites. Different material types will be affected by freeze-thaw processes in different ways. For example, the silty texture of the tephra has a greater water-holding capacity than the coarser textured till and will thus be more susceptible to cryoturbation.

McConnell till appears to be less acidic than Reid till. Because of the small number of our sites, it is unclear if this difference is a result of the duration and/or intensity of weathering, or lithological differences.

FURTHER WORK

This study is the field component of an MSc research project. The laboratory component of the project will be completed in 2009. Chemical and mineralogical characteristics of the soils will be quantified to elucidate differences in pedological pathways that are not obvious from field evidence. These additional characteristics include particle size distribution, clay mineralogy, and soil micromorphology. The micromorphology of the soils will be determined from intact soil samples collected in the field. Samples will be analyzed for extractable iron and aluminum to characterize weathering products, and major and trace element concentrations will be measured to calculate weathering indices.

CONCLUSION

Field work suggests that solum depth is the best criterion for differentiating upland soils developed on McConnell (<50 cm) and Reid (50-75 cm) surfaces in the study area. Other criteria identified in past studies as useful for differentiating soils developed on glacial deposits of different age, such as B horizon colour, clay skins, weathered clasts and periglacial features, were not reliable indices in this study. Preliminary results suggest that observable field characteristics may be insufficient to characterize Reid and McConnell upland surfaces with certainty. Laboratory analyses may be required to identify chemical or mineralogical signatures that distinguish soils of different ages at glaciated upland sites in central Yukon. While the excellent preservation of McConnell and Reid landforms makes this area suitable for comparing upland soils developed on middle and late Pleistocene glacial deposits, we found it difficult to find parent materials of similar texture, and the differences in texture that we document may affect soil development.

Pre-Reid soils were developed on weathered bedrock; although composed of different parent materials, the pre-Reid and younger soils have similar colouration. Estimates of solum thickness at pre-Reid sites were limited by the excavated depth of the pits (<100 cm). Unlike at McConnell and Reid sites, periglacial features are common throughout the solum thickness. Because our sampling protocol preferentially selected unfrozen sites, the lack of periglacial features in younger soils is likely not representative of the entire landscape. Although the oldest pre-Reid glaciation is well dated to 2.6 Ma, the age of the pre-Reid surfaces in our study area is unknown.

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