Soil reconnaissance of the Fort Selkirk volcanic field, Yukon (115I/13 and 14)

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ABSTRACT

Valley-filling basalts of the Selkirk Volcanics north and west of the Pelly River-Yukon River confluence, range in age from early Pleistocene to Holocene. Soils formed on the older surfaces have complex parent materials reflecting early Pleistocene glaciation and significant loess accumulation. A diamicton overlying the early Pleistocene basalt is covered by up to 1 m or more of calcareous loess, and shows no field evidence of weathering or soil formation. Middle Pleistocene basalt has a similar depth of loess cover and appears fresh and unweathered. Lava flows originating on the south side of the Volcano Mountain cinder cone display vegetation ranging from discontinuous lichen and moss cover to white spruce-aspen forest. Soil profile development varies correspondingly from almost nil to reddish-brown Brunisolic soils with ~30 cm of B horizon, depending on substrate age and/or the presence of lapilli deposits overlying the flows.

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INTRODUCTION

The Fort Selkirk volcanic field in central Yukon has been active for more than four million years (Jackson *et al.*, 2008). Previous research has documented the history and products of its eruptive activity and interactions with glaciations and the Yukon River (Francis and Ludden, 1990; Jackson and Stevens, 1992; Jackson *et al.*, 1996; Trupia and Nicholls, 1996; Jackson, 2000; Huscroft *et al.*, 2004; Nelson *et al.*, 2009). These studies have not examined soil development on volcanic deposits despite the availability of radiometric dates that could potentially constrain the ages of volcanic soil parent materials. Although pedologists have begun to study Yukon soils formed on weathered bedrock (Bond and Sanborn, 2006; Smith *et al.*, 2009), none of this research has involved basalts and related volcanic rocks.

Logistics support provided by the Yukon Geological Survey in July, 2009, enabled a first reconnaissance of the soils of the Fort Selkirk area. This field report presents the key observations resulting from this initial work and suggests potential follow-up studies.

STUDY AREA

Although basaltic rocks of the Selkirk Volcanics occur both south and north of the Pelly-Yukon confluence, this study was only able to examine the latter area (Fig. 1) where three age groupings of lava flows have been delineated (for the thick basalt sequences exposed along the north side of the Yukon River, only the ages of the uppermost units are cited here).

Early Pleistocene basalt flows outcrop along the Pelly River upstream of its confluence with the Yukon River and extend along the north bank of the Yukon River to approximately 6 km downstream of Fort Selkirk (Fig. 1). The uppermost of these flows is dated at 1.36 ± 0.04 Ma (Nelson *et al.*, 2009) in a section with discontinuous till at the top. The latter is considered to have been deposited by a pre-Reid glaciation, consistent with an earlier report that the lava flow surface is “mantled with undulating drift deposits” northwest of Fort Selkirk and is striated near the Pelly River (Bostock, 1966).

A Middle Pleistocene flow centred on Black Creek (Fig. 1) was identified by Huscroft *et al.* (2004), who provided a $^{40}Ar/^{39}Ar$ age of 311 ± 32 ka, which has recently been recalculated as 441 ± 76 ka (L.E. Jackson, writ. comm., 2009). Downstream of Black Creek, this flow is partially overlain by gravels correlated with the Reid (penultimate) Glaciation, but its surface is otherwise devoid of erratics and other evidence of glacial overriding (Huscroft *et al.*, 2004). Based on new paleomagnetic evidence (Nelson *et al.*, 2009), the Reid glacial advance did not reach the Pelly-Yukon confluence (L.E. Jackson, writ. comm., 2009). The western limit of the most recent (McConnell) advance of the Cordilleran ice sheet is more than 50 km to the east (Duk-Rodkin, 2001). Surficial geology mapping indicates that both the Early and Middle Pleistocene flows in the study area are extensively covered by aeolian deposits (Jackson, 1997).

The youngest lava flows occur immediately north and south of Volcano Mountain (Fig. 1). Based on surface expression and vegetation cover, Jackson and Stevens (1992) infer three relative ages of flows south of Volcano Mountain and two to the north. Indirect limiting ages for the most recent flows are provided by radiocarbon dates from basal sediments in lava-dammed Leech Lake (*ca.* 4200 BP) and Caitlin Pond (*ca.* 7300 BP; Fig. 1). Jackson and Stevens (1992) also noted the presence of a lapilli blanket locally exceeding 0.5 m in thickness over the lava flow in the valley of Grand Valley Creek. The prominent cleft that bisects Volcano Mountain and the associated landslides north and south of the cinder cone are presumably created by this Holocene activity. Although the most extensive lava flows at Volcano Mountain are apparently Holocene, older volcanic surfaces may exist in the vicinity, notably at *‘Ancient Volcano Mountain’* approximately 2 km to the west. In addition, Nelson *et al.* (2009) suggests that flows higher up on Volcano Mountain could be old enough to belong to the Matuyama Reversed Chron (*i.e.,* >0.78 Ma).

Previous studies document compositional differences between the basaltic lavas in the study area. The Volcano Mountain flows have a nephelinite (low silica) composition, while the Early and Middle Pleistocene flows are alkaline olivine basalts (high silica; Francis and Ludden, 1990; Nelson *et al.*, 2009). It is unclear whether such differences are large enough to influence the direction and rate of soil-forming processes. Non-volcanic geomorphic processes such as glacial erosion and deposition and contributions of aeolian materials could be much stronger influences on soil parent material composition.

Any comparison of soil formation on the three age groupings of lava flows in the study area needs to consider potential elevation-related differences in climate. The Early and Middle Pleistocene lava flows along the Yukon River lie almost entirely below 600 m

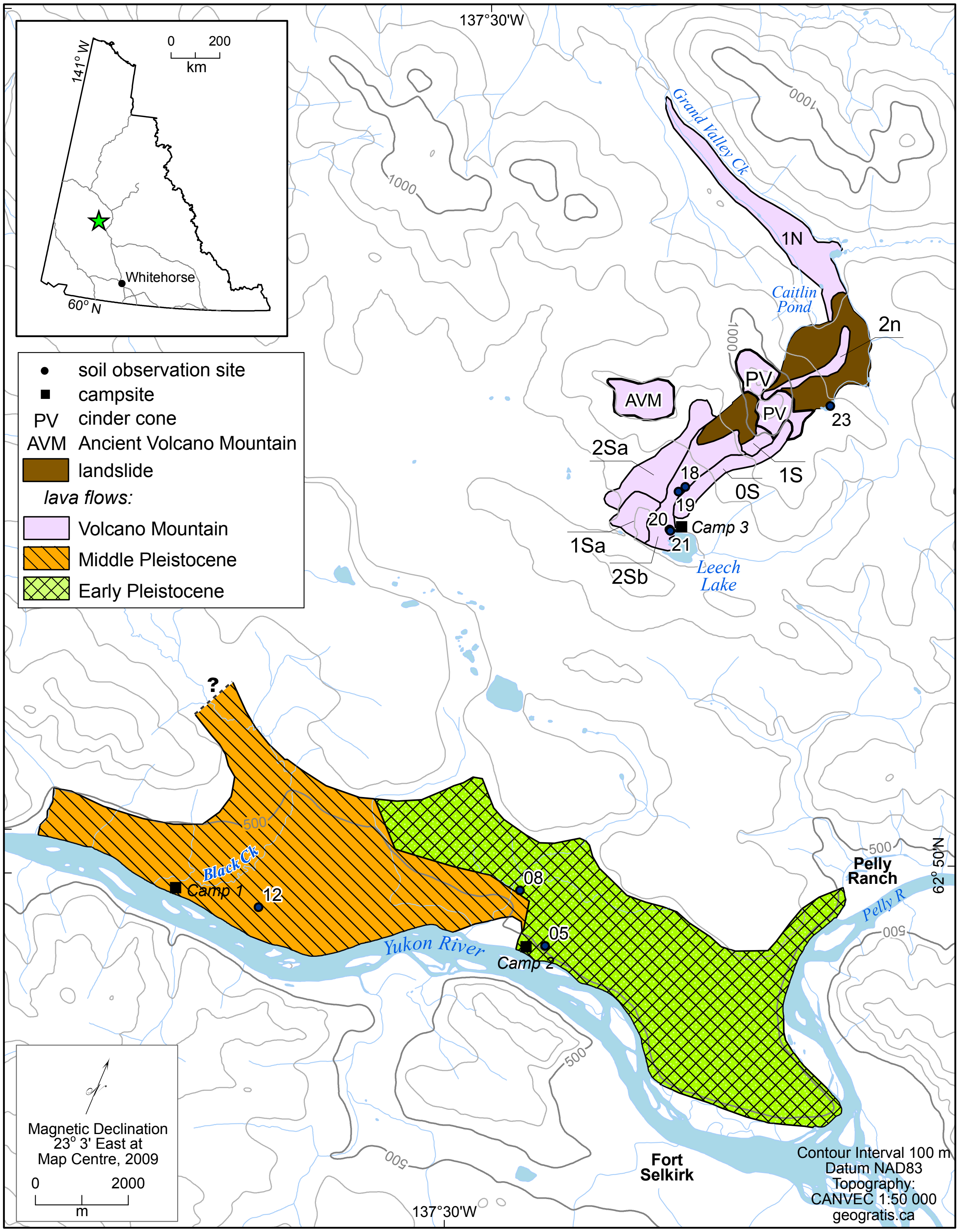

Figure 1. *Lava flows and soil study sites, northern portion of the Fort Selkirk volcanic field. Nomenclature and boundaries for units near Volcano Mountain are taken from Jackson and Stevens (1992). The extents of Middle and Early Pleistocene lava flows immediately north of the Yukon River are based on much smaller-scale mapping by Huscroft et al. (2004) and Nelson et al. (2009).*

elevation (Fig. 1). Long-term records from the nearby weather station at Pelly Ranch (elevation 454 m) indicate a cold, dry climate, with mean annual temperature of -3.9°C and mean annual precipitation of 310 mm (Environment Canada online climate data *http://climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html* [accessed November 15, 2009]). The younger lava flows near Volcano Mountain occur at higher elevations (700-1000+ m), so temperatures should be correspondingly lower.

At this high latitude — almost 63°N — slope aspect has an important influence on microclimate, permafrost distribution and vegetation patterns. The very gently sloping Early and Middle Pleistocene lava flows along the Yukon River have a generally south- to southwest-facing aspect, and the significant proportion of trembling aspen (*Populus tremuloides*) in the forest cover suggested that permafrost is absent (Perala, 1990) over much of these landforms. The flows originating on the south flank of Volcano Mountain have a pronounced southwest-facing slope aspect and should have a warmer microclimate than those on the north side of the mountain. Permafrost distribution in the study area has not been examined, but Jackson and Stevens (1992) did report a permafrost occurrence in the lapilli deposit in the valley of Grand Valley Creek.

METHODS

Field work was conducted on each of the three age groups of lava flows. Ground traverses involved checks with hand-augering to assess the thickness of surficial deposits and a limited number of soil pits on representative landscape positions. Soil description terminology is according to Expert Committee on Soil Survey (1983) and Green *et al.* (1993). Presence of carbonates was assessed in the field by reaction with 10% HCl. Soil horizon nomenclature (Table 1) and provisional soil classifications (Soil Classification Working Group, 1998) are assigned based on field observations. Soil reaction was measured in 0.01 M $CaCl_2$ (Carter and Gregorich, 2008) with an Orion 550A pH meter and combination electrode. Laboratory analyses for other properties (*e.g.,* carbon, particle-size distribution) are pending and results may alter these designations.

Table 1. *Selected notation for soil horizons (Green et al., 1993; Soil Classification Working Group, 1998).*

Organic horizons
L – fresh or slightly decomposed plant litter (*e.g.,* leaves, needles, twigs)
F – moderately decomposed organic matter
m – abundant fungi present
H – humified (strongly decomposed) organic matter
h – very few if any recognizable plant residues
Mineral horizons
A – uppermost horizon(s) (not always present)
e – bleached in appearance
h – enriched in organic matter
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
ca – enriched in secondary carbonates
k – containing primary (inherited) carbonates
R – consolidated bedrock
Additional modifiers applied to A, B or C horizons
u – disrupted or mixed by physical or biological processes (*e.g.,* treethrow)
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

FIELD OBSERVATIONS

EARLY PLEISTOCENE LAVA FLOWS

Although basalts form prominent cliffs along the Yukon River, bedrock is not encountered within 1 m of the surface in any of the five soil pits excavated on level to gently sloping sites near Camp 1. At site Y09-05 (Fig. 1), approximately 50 cm of predominantly silty Bm horizon, free of coarse fragments, overlie a dark-coloured sandy loam matrix-supported diamicton containing numerous basalt cobbles (Figs. 2, 3; Table 2). Secondary carbonate is abundant in a 15-25 cm thick horizon that appears to be a mixture of these two materials. The diamicton is moderately calcareous, and appears fresh and unweathered, as do the basalt cobbles in this material; there is no indication of a buried paleosol. While the upper silty material is most likely loess, the origin of the diamicton is unclear, but the overwhelming predominance of basalt coarse fragments suggests a local source.

Elsewhere on this landform, the uppermost 40-100 cm of soil profiles appear similar in colour and texture to the Bm horizons noted at Y09-05. Although diamicton was not encountered at the other examined sites, materials

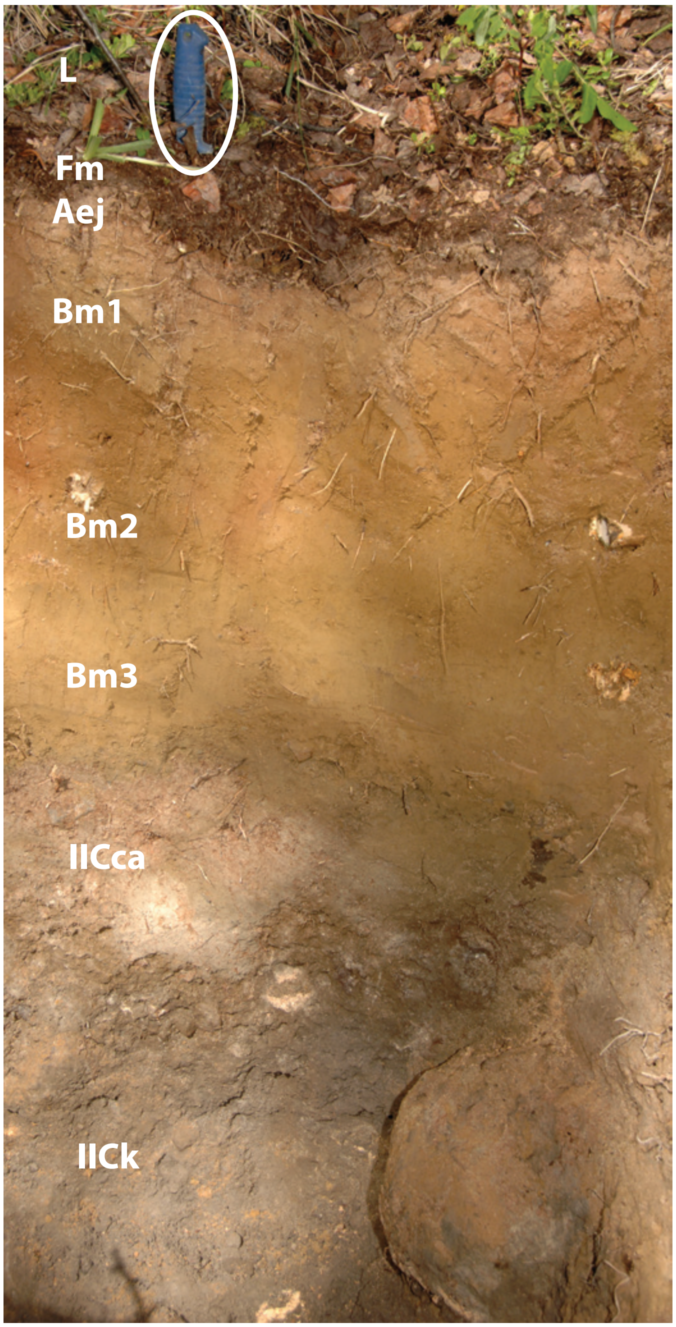

Figure 2. *Eluviated Eutric Brunisol at site Y09-05. Knife handle (circled; see Table 2) for scale is 11 cm long.*

Table 2. *Description of Eluviated Eutric Brunisol at site Y09-05 (62°48'54.1"N, 137°27'42.9"W).*

Horizon	Depth (cm)	Description
L	4-3	Deciduous leaf litter; abrupt, smooth boundary; 1 cm thick; pH 5.50.
Fm	3-0	Black (7.5YR 2.5/2 m); partially decomposed organic matter; moderate, non-compact matted; loose; abundant fungal mycelia; abundant very fine roots; abrupt, wavy boundary; 2-4 cm thick; pH 6.19.
Aej	0-4	Brown (7.5YR 5/3 m); silt loam; weak, fine, subangular blocky; very friable; abundant, very fine and fine, and plentiful, medium and coarse roots; clear, wavy boundary; 2-5 cm thick; pH 4.63.
Bm1	4-25	Dark yellowish brown (10YR 4/4 m), brown (7.5YR 4/4 m); silt loam; moderate, fine and medium platy; very friable; abundant, very fine and fine, and plentiful, medium and coarse roots; gradual, irregular boundary; 15-25 cm thick; pH 5.90.
Bm2	25-45	Brown (10YR 4/ 3 m); silt loam; moderate, fine and medium platy; very friable; plentiful, very fine and fine roots; clear, wavy boundary; 18-25 cm thick; pH 6.36.
Bm3	45-52	Olive brown (2.5Y 4/3 m); loamy sand; single grain; very friable; few, very fine and fine roots; abrupt, irregular boundary; 5-12 cm thick; pH 7.26.
IICca	52-70	Dark greyish brown (2.5Y 4/2 m), pale yellow (2.5Y 7/3 m); silt loam; weak, medium platy; friable; plentiful, very fine and fine roots (concentrated in upper 10 cm of horizon); 20% gravels and 10% cobbles, subrounded and subangular; strongly effervescent; streaked and spotted, many fine and medium secondary carbonates in matrix, with 1-2 mm thick carbonate coatings on undersides of most coarse fragments; gradual, wavy boundary; 15-25 cm thick; pH 7.80.
IICk	70-105+	Very dark grey (2.5Y 3/1 m); sandy loam; massive; friable; few, very fine and fine roots; 20% gravels and 10% cobbles, subrounded and subangular; moderately effervescent; pH 7.76.

Figure 3. *Basalt cobbles collected from diamicton at site Y09-05. Light-coloured surfaces of some cobbles are secondary carbonate coatings (arrows).*

become sandier at depth, perhaps indicating fluvial deposits as at site Y09-08 on a terrace above a small unnamed stream (Fig. 1).

Based on the measured pH values and the shallow depth to carbonates, all of these soils are provisionally classified as Orthic Eutric Brunisols, indicating that pH values are above 5.5 within some part or all of the uppermost 25 cm of the B horizon (Soil Classification Working Group, 1998).

MIDDLE PLEISTOCENE LAVA FLOWS

Eight soil inspections were made east of the confluence of Black Creek and the Yukon River. This lava flow displays 1-2 m of relief, with a gently undulating surface expression. On the local high points, basalt occasionally outcrops or is often within 20-30 cm of the surface, covered by silty aeolian material with no coarse fragments other than occasional angular fragments of the underlying basalt. Where this silty material is thicker (up to 1 m or more), secondary carbonates are usually encountered at ~50 cm depth. The pH values are high enough for soils to be classified as Eutric Brunisols (Table 3).

Contacts with the underlying basalt are usually abrupt, or with a thin transitional zone of basalt fragments mixed with calcareous fines derived from the aeolian materials above, as at site Y09-12 (Fig. 4; Table 3). The bedrock is hard, dark-coloured, and shows no evidence of formation of weathering rinds, or accumulation of weathering products, or translocated clay in fractures or other voids. Consistent with previous work (Huscroft *et al.*, 2004), no evidence of erratics on the soil surface, or glacial till overlying the bedrock is found.

Table 3. *Description of Orthic Eutric Brunisol at site Y09-12 (62°49'13.1"N, 137°34'59.9"W).*

Horizon	Depth (cm)	Description
L	5-4	Deciduous leaf litter (aspen); 1 cm thick; pH 5.50.
Fm	4-0	Dark brown (7.5YR 3/2 m); partially decomposed organic matter; moderate, non-compact matted; friable; felty; abundant fungal mycelia; abundant very fine, fine and medium roots; abrupt, wavy boundary; 3-5 cm thick; pH 5.65.
Bmu1	0-30	Brown (7.5YR 4/3 m), yellowish brown (10YR 5/4 m); silt loam; weak, fine and medium platy; very friable; plentiful very fine, fine, medium and coarse roots; clear, broken boundary; 20-35 cm thick; pH 6.30.
Bmu2	30-50	Olive brown (2.5YR 4/4 m); silt loam; moderate, fine and medium subangular blocky; friable; plentiful very fine, fine, and medium roots; clear, smooth boundary; 10-35 cm thick; pH 7.10.
Cca	50-90	Greyish brown (2.5Y 5/2 m); silt loam; moderate, fine and medium subangular blocky; friable; plentiful, very fine and fine roots; strongly effervescent; common, fine, streaked and spotted, random and irregular, friable, grey (10YR 6/1 m) secondary carbonates; clear, wavy boundary; 35-45 cm thick; pH 7.90.
IICca	90-105	Olive brown (2.5 Y 4/3 m); very fine sandy loam; massive; friable; few, very fine and fine roots; 10% angular and subangular gravels, 30% angular and subangular cobbles (all are basalt); strongly effervescent; many, medium, spotted, irregular, friable, light yellowish brown (10YR 6/4 m) secondary carbonates; pH 7.97
R	105+	Basalt bedrock.

VOLCANO MOUNTAIN LAVA FLOWS

Although a traverse was made from the summit (1239 m) of Volcano Mountain easterly to a small drained pond at site Y09-23, detailed soil inspections were restricted to the flows on the south side of the cinder cone (Fig. 1). Two inspections sites are near the terminus of the sparsely vegetated flow designated as 2Sb by Jackson and Stevens (1992). Site Y09-20 is typical of much of the southern portion of this landform, with only lichens and mosses partially covering an angular, blocky surface of the lava

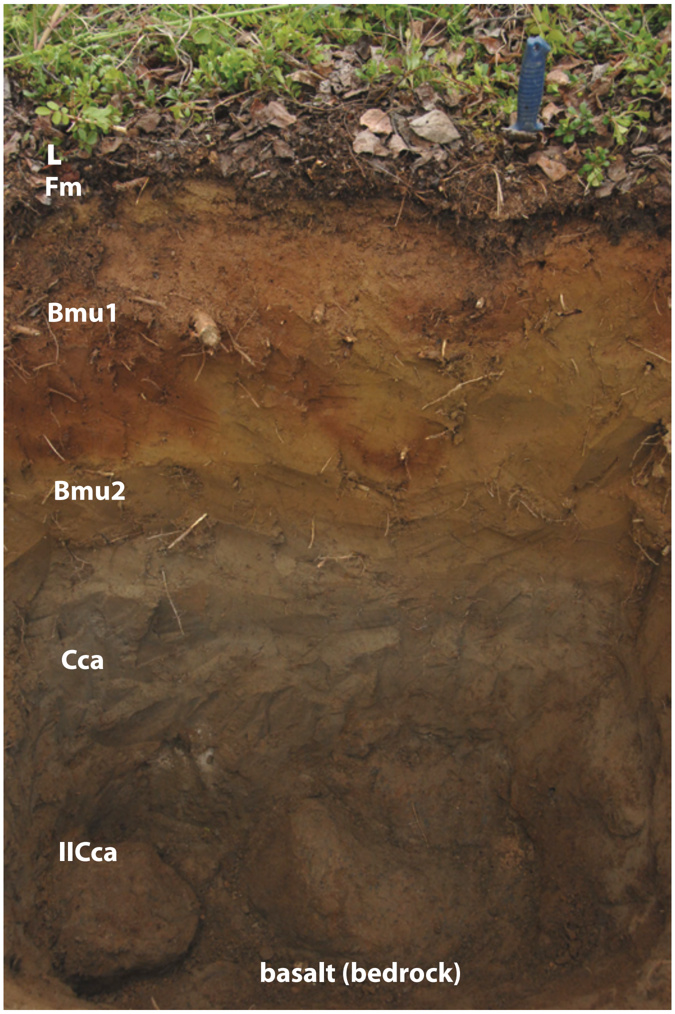

Figure 4. *Orthic Eutric Brunisol soil at site Y09-12.*

Figure 5. *Site view of Y09-20 on Holocene lava flow.*

Figure 6. *Close-up view of basalt flow surface at Y09-20; lichen removed to show limited accumulation of organic matter and mineral soil.*

flow (Fig. 5). Underneath this cover, little or no soil has accumulated (Fig. 6) despite the estimated age of *ca.* 4200 BP for this flow. Occasional linear depressions up to 1 m deep in the flow surface serve as more efficient traps for organic detritus and may have clumps of paper birch (*Betula papyrifera*) or aspen (Fig. 7). For example, at Y09-21 these microsites have thicknesses of organic matter that can equal or exceed that of the mineral soil (Fig. 8; Table 4). Based on the thickness of the organic horizons, and the fragmental character of the contact with the underlying basalt, this soil would be classified as a Hemic Folisol. This type of organic soil, consisting of a forest floor resting directly on intact or fragmented bedrock, is unusual in Yukon; most documented occurrences are in coastal British Columbia (Fox *et al.*, 1987).

Figure 7. *Basalt flow surface with linear depression occupied by paper birch and aspen and with localized thicker accumulation of organic matter and mineral soil.*

Table 4. *Description of Hemic Folisol at Site Y09-21 (62°53'45.3"N, 137°24'56.6"W).*

Horizon	Depth (cm)	Description
L	15-10	Birch leaf litter; pH 4.72.
Fm	10-5	Very dark brown (7.5YR 2.5/2 m); partially decomposed organic matter; moderate, non-compact matted; friable; felty; abundant mycelia; abundant very fine, fine and medium roots; pH 4.18.
Hh	5-0	Black (7.5YR 2.5/1 m); granular; friable; abundant, very fine, fine and medium roots; pH 4.49.
Bm	0-15	Dark yellowish brown (10YR 4/4 m); silt loam; abundant, very fine, fine and medium roots; 80% angular basalt fragments; abrupt, irregular boundary; pH 4.96.
R	15+	Basalt bedrock.

Farther north, we examined two sites near the eastern edge of flow 2Sb (Fig. 1). At site Y09-19, a sloping surface (10% slope, southwest aspect) has stronger vegetation and soil development than at the two previous sites, with about 20% canopy cover by black and white spruce (*Picea mariana, P. glauca*) and aspen, and a continuous moss and lichen groundcover. Fragmentation of the basalt enables digging with hand tools to >30 cm, and the uppermost portion of the Bm horizon has a noticeably silty texture, suggesting incorporation of some aeolian materials (Fig. 9; Table 5). Abundant roots are still present at the bottom of this shallow excavation, and along with fungal mycelia form mat-like arrays over the rock fragment surfaces (Fig. 10).

Only a short distance to the northeast, a denser vegetation cover indicates a possible transition to an older landform. The soil at this site (Y09-18) is strikingly different, with much thicker forest floors (15 *vs.* 6 cm) and B horizons forming in lapilli overlying basalt (Fig. 11; Table 6). This surface may correspond to the OS flow designated by Jackson and Stevens (1992), although the occurrence of lapilli on this feature is not previously reported. Since the lapilli deposit is absent at site Y09-19, it presumably predates the 2Sb flow. Although the soil at Y09-19 would therefore be older than at Y09-18, mineral horizon pH values are higher in the former (Tables 5, 6), perhaps reflecting a greater aeolian contribution to the B horizon.

Figure 8. *Hemic Folisol at site Y09-21 formed under paper birch and scattered shrubs.*

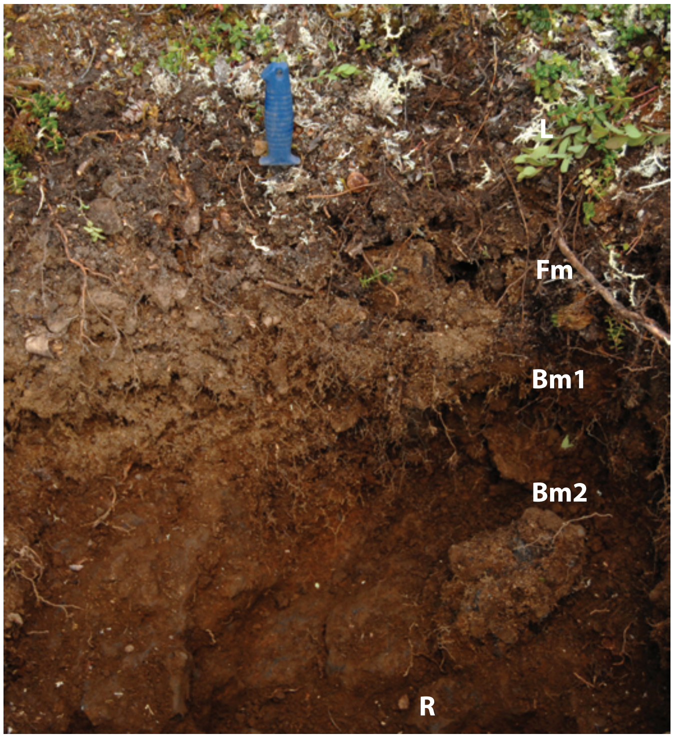

Figure 9. *Orthic Dystric Brunisol at site Y09-19.*

Table 5. *Description of Orthic Dystric Brunisol at Site Y09-19 (62°54'12.6"N, 137°24'46.6"W).*

Horizon	Depth (cm)	Description
L	6-5	Lichen and moss with intermingled spruce needle litter; abrupt, wavy boundary; 1 cm thick.
Fm	5-0	Very dark greyish brown (10YR 3/2 m); partially decomposed organic matter; strong, non-compact matted; friable; abundant mycelia; abundant very fine, fine, medium and coarse roots; abrupt, wavy boundary; 3-7 cm thick; pH 4.94.
Bm1	0-8	Brown (10YR 5/3 m); silt loam; weak, fine subangular blocky; very friable; abundant, very fine, fine and medium roots; 80% angular basalt fragments (40% gravel, 40% cobbles); clear, wavy boundary; 5-10 cm thick; pH 4.33.
Bm2	8-35	Brown (7.5YR 4/4 m); sandy loam; single grain; very friable; abundant, very fine, fine and medium roots; 80% angular basalt fragments (40% gravel, 40% cobbles); abrupt, irregular boundary; 15-30 cm thick; pH 5.07.
R	35+	Basalt bedrock.

Figure 10. *Close-up view of basalt fragments from B horizon of soil at Y09-19, showing fine roots and fungal mycelia forming mats over rock surfaces.*

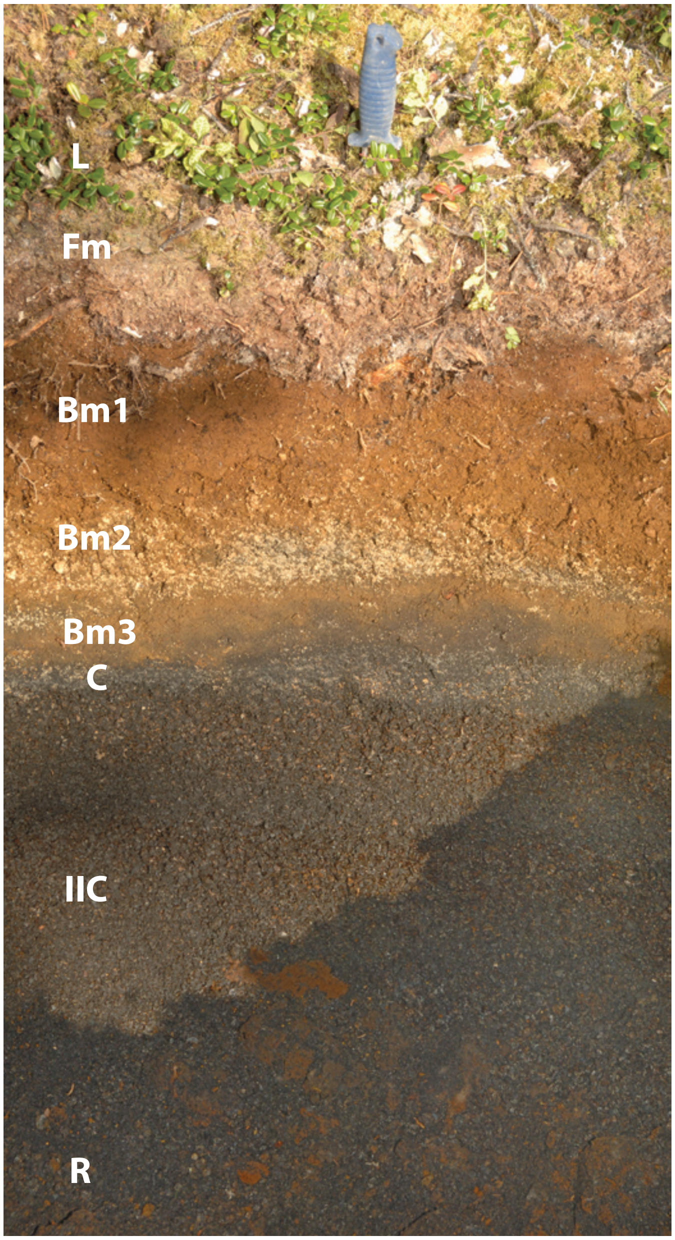

Figure 11. *Orthic Eutric Brunisol soil at site Y09-18.*

Table 6. *Description of Orthic Eutric Brunisol at Site Y09-18 (62°54'16.1"N, 137°24'36.6"W)*

Horizon	Depth (cm)	Description
L	15-13	Feathermoss with intermingled spruce needle litter; abrupt, wavy boundary; 2-4 cm thick.
Fm	13-0	Very dark brown (7.5YR 2.5/2 m); partially decomposed organic matter; moderate, non-compact matted; friable; felty and fibrous; abundant mycelia; abundant very fine, fine and medium roots; abrupt, wavy boundary; 10-15 cm thick; pH 4.31.
Bm1	0-15	Dark brown (7.5YR 3/4 m); sandy loam; weak, fine subangular blocky; very friable; plentiful very fine, fine and medium roots; 20% angular gravel (lapilli); clear, wavy boundary; 9-17 cm thick; pH 5.88.
Bm2	15-22	Dark yellowish brown (10YR 4/4 m); sandy loam; single grain; very friable; plentiful very fine and fine roots; 80% angular gravel (lapilli); abrupt, smooth boundary; 5-10 cm thick; pH 6.24.
Bm3	22-26	Dark brown (10YR 3/3 m); sandy loam; weak, fine subangular blocky; very friable; few very fine and fine roots; abrupt, wavy boundary; 3-7 cm thick; pH 6.06.
C	26-32	Black (2.5 Y 2.5/1 m); sand; single grain; very friable; few very fine roots; abrupt, smooth boundary; 2-7 cm thick; pH 6.37.
IIC	32-72	Black (10YR 2/1 m); sand; single grain; loose; >95% angular gravel (lapilli); abrupt, wavy boundary; 35-45 cm thick; pH 6.54.
R	72+	Basalt bedrock.

DISCUSSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

Although the basaltic lava flows in the Fort Selkirk volcanic field span a large age range, geological events – glacial advances, loess deposition – have prevented the soils on these surfaces from comprising a true chronosequence, *i.e.,* differing only in age, but otherwise subjected to the same ecological, climatic and topographic influences. Nevertheless, this fascinating area provides conditions that may facilitate a number of follow-up studies of both pedological and ecological processes.

The observations of the Early and Middle Pleistocene lava flows are restricted to limited areas near their southern edges, so any general interpretations must be made cautiously. Diamicton of uncertain origin is encountered (site Y09-05) on the Early Pleistocene flow, but there is no evidence of previous soil formation in this material below the loess veneer. This is unexpected, because Early

Pleistocene glacial deposits elsewhere in central Yukon, including within the Carmacks (115I) map sheet, display strong soil development characterized by thick reddish-brown B horizons with significant clay accumulations (Tarnocai and Smith, 1989; Jackson, 2000). Similarly, on the Middle Pleistocene lava flow, the loess-basalt contacts are abrupt and the bedrock appears fresh and unweathered. In both situations, the loess is strongly calcareous and has been decalcified to depths of about 40-50 cm, suggesting that it is of the same age on both surfaces, and presumably deposited during the McConnell glaciation. The lack of soil development on the underlying materials is striking and unexpected, particularly given the subdued topography which should favour preservation of older soils. Perhaps loess accumulations of equal or greater thickness, with similarly high carbonate content, have persisted on these surfaces throughout much of the Pleistocene, serving to isolate the underlying materials from pedogenesis. Additional observations should be made farther north, away from the Yukon River, to determine if this pattern of limited soil formation is indeed typical on these landforms.

The most interesting area for potential follow-up work is around Volcano Mountain. The virtual absence of soils and vascular plant cover on the Holocene flow immediately west of Leech Lake is a graphic demonstration of the slow rate of primary succession in this climate. However, climate may not be the paramount factor, as shown by similarly slow rates of soil formation on Holocene basalts in the Craters of the Moon lava field in southern Idaho (Vaughan and McDaniel, 2009). Lava morphological types are shown to exert a strong influence on soil formation, with much slower accumulation of organic detritus and soil mineral material on the highly fractured, blocky surfaces of a’a-type flows. Although the lapilli at site Y09-18 may be older than the adjacent lava flow at Y09-19, the more strongly coloured solum formed on this material may also reflect the influence of its finer particle size in promoting weathering and plant colonization. Since basalts are generally devoid of quartz, it may be possible to quantify the aeolian contribution to soils formed on these volcanic surfaces.

Observations made on this trip were restricted by time, but it would be worth examining the Holocene flows at Volcano Mountain more carefully to assess the gradients of primary succession and soil formation at their margins. Detrital organic matter fluxes (*e.g.,* wind-blown leaf litter) should diminish rapidly with distance from the flow margin, and these conditions may enable field studies of successional pathways. Since the Holocene flows occur across a considerable elevation range, the assemblage of surfaces at Volcano Mountain may provide a matrix of age and elevation combinations that would be useful in ecological research. With additional dating control, the sequence of flows around Volcano Mountain could be a valuable addition to comparative studies of succession and soil formation on basaltic materials at other sites in the Cordillera, such as the Nass River flows, Nazko Cone in the Anahim volcanic belt, and the Wells Gray area of east-central British Columbia.

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