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# Morphology and geochemistry of soils formed on colluviated weathered bedrock: Case studies from unglaciated upland slopes in west-central Yukon

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Yukon Energy, Mines and Resources

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Cover photo: A soil profile from the Nugget zone on the Lone Star property that shows a distinct colluvial dispersion train of weathered mafic intrusive rock.

# EXECUTIVE SUMMARY

Soil morphology and geochemistry were studied at three mineral properties (gold; lead-zinc; copper-gold) in the unglaciated terrain of west-central Yukon. The purpose of this work was two-fold: to describe soil and parent material properties, and secondly, to assess the effects of soil development and slope processes on element distribution in soils derived primarily from colluvium and weathered bedrock. At each property, soils were examined on slopes with opposing aspects. Slopes with a north-facing aspect have poorly defined horizons due to cryoturbation. This process has also mixed most recent glacial loess into the upper soil horizons (0-50 cm depth), which can geochemically dilute the weathered bedrock parent material by as much as 600%. On south-facing slopes, the soils are permafrost-free and have more abrupt horizon boundaries. Geochemical variability within these soils is largely determined by colluvium composition rather than in-situ soil weathering. These results provide baseline pedological and soil-geomorphological descriptions for the Klondike Plateau, which will assist future biophysical mapping and contribute to our understanding of landscape evolution. Results pertaining to soil geochemistry provide landscape-related guidelines for mineral exploration. For example, the stratigraphic distribution of loess within soil profiles is described according to slope aspect. This allows the explorationist to design sampling procedures that are more likely to detect geochemical anomalies in the underlying bedrock. Soil geochemical variations in colluvium are shown to reflect upslope variations in bedrock lithology. Results of the soil particle size fraction geochemistry indicate that for base metal elements such as copper, lead and zinc, the -80 mesh component was generally the most responsive in either the B or C horizon. For gold, the -80 mesh fraction worked well in the B horizon, whereas the -230 mesh contained the highest concentration in the C horizon.

# ACKNOWLEDGEMENTS

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# 1.0) INTRODUCTION

Large regions of Yukon and Alaska have remained unglaciated throughout the current glacial period that began in the late Pliocene (Fig. 1). In west-central Yukon, the Klondike Plateau escaped glaciation by the Cordilleran ice sheet, but was exposed to climate oscillations throughout the Pleistocene. The soils and surficial geology of the Klondike Plateau are generally poorly understood despite this landscape's unique Plio-Pleistocene geologic history and mineral potential (Bradshaw and vanRanden, 2004).

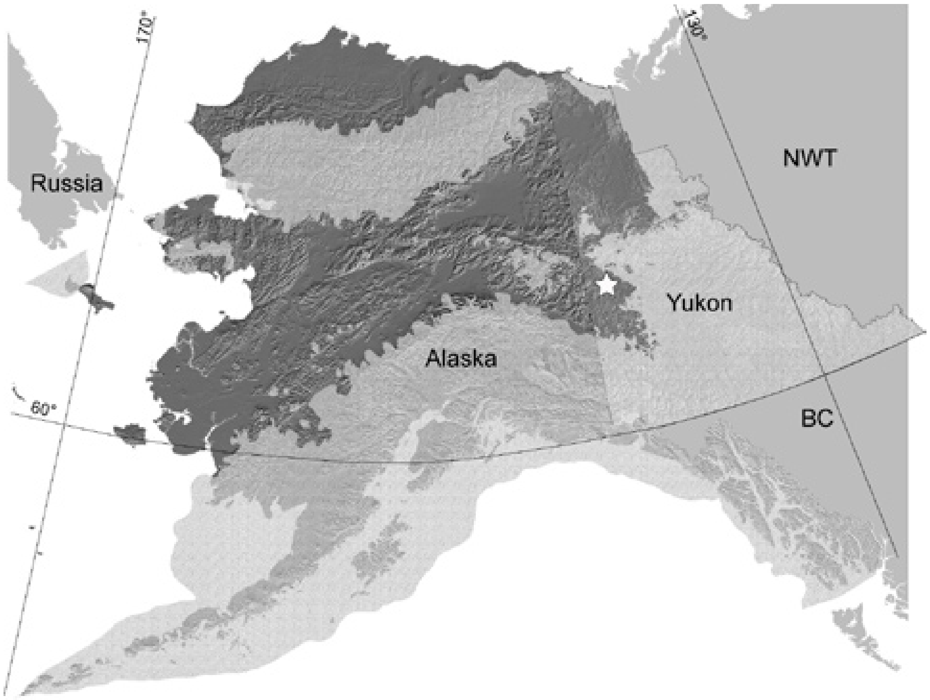

***Figure 1**. Map of northwestern North America showing the extent of unglaciated terrain in Yukon and Alaska. Areas of dark grey tone represent unglaciated regions. The maximum limit of Pleistocene glaciation is shown in the transparent light grey tone covering Alaska and Yukon. The study area is indicated by the star; (after Duk-Rodkin, 1999; Manley and Kaufman, 2002).*

Much effort in Canada and elsewhere in the northern hemisphere boreal region has been placed on refining mineral exploration methods that utilize soil geochemistry in glaciated environments Kauranne et al. (1992). These studies include describing the patterns of geochemical dispersal both laterally from mineralization and vertically through till deposits, and experimentation with size fraction geochemistry to enhance anomalies. With the exception of a soil geochemical study Hart and Jober (1997) in the unglaciated Dawson Range similar studies in unglaciated regions of northwestern North America are rare. Most studies of geochemical exploration in unglaciated terrain have occurred in lower latitudes where periglacial processes have not influenced soil formation (Butt and Zeegers (1992). Basic pedological studies in west-central Yukon have emphasized soil formation on older glacial deposits (Tarnocai and Smith, 1989) and on paleo-surfaces from soils uncovered in the loess deposits of the Klondike Plateau (Sanborn et al., 2006). However, little attention has been paid to the modern soils found in the unglaciated landscapes that are dominated by colluvial and residual parent materials.

This report presents results on the morphology, chemical and textural characteristics, and element distribution patterns of soils found on three mineral occurrences within unglaciated west-central Yukon. This research aims to characterize upland soils within these unglaciated environments and identify both the pedological and geomorphic processes that may influence the geochemical variability within these soils and their parent materials. With increased knowledge of these surficial environments it is hoped that mineral exploration methods and baseline biophysical characterizations can be improved.

# 2.0) SETTING

## *2.1) LOCATION*

The unglaciated regions of Yukon include the west-central and northern parts of the Territory (Fig. 1). The study sites lie near the eastern limit of the unglaciated terrain, marginal to the Cordilleran ice sheet limits. The unglaciated terrain continues westward into Alaska where large areas of the central and northern parts of the state have remained ice-free during the Plio-Pleistocene glaciations (Fig.1).

## *2.2) PHYSIOGRAPHY and DRAINAGE*

The unglaciated west-central Yukon is part of the Klondike Plateau topographic subdivision of the Yukon Plateaus (Bostock, 1948; Smith et al., 2004). The physiography evolved from a mature, subdued Miocene landscape that was undergoing intense chemical weathering (Tempelman-Kluit, 1980; Lowey, 2004). The initiation of uplift in the Late Miocene or Pliocene, possibly due to isostatic exhumation, caused stream rejuvenation and downcutting into the plateau surface (Tempelman-Kluit, 1980; Lowey, 2004). Continued erosion up to the present created the modern Klondike Plateau landscape of round-topped hills with long steep-sided ridges (Fig. 2.; Gleeson, 1970). Valleys and floodplains are narrow in their upper reaches and gradually widen downstream.

West-central Yukon is drained by the north-flowing Yukon River. Larger tributaries within the study area include the Sixty Mile, Indian and Klondike rivers (Fig. 3).

***Figure 2.*** *Oblique aerial photograph showing the confluence of Bonanza and Eldorado creeks in the Klondike goldfields. This physiography is typical of the dissected plateau landscape in west-central Yukon.*

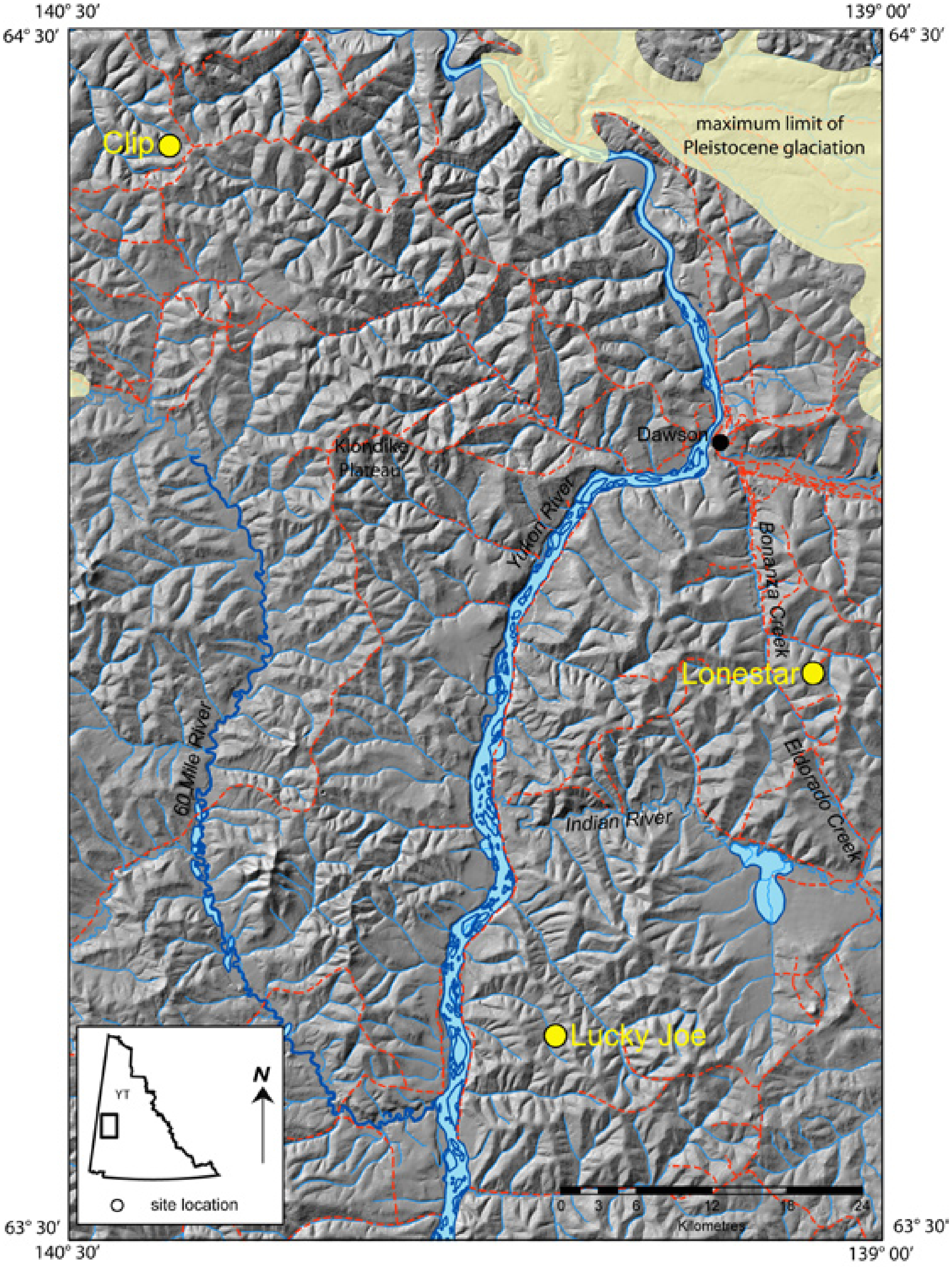

***Figure 3.*** *Hillshade model of west-central Yukon showing location of major rivers and the location of study sites. The maximum limit of Pleistocene glaciation (Duk-Rodkin, 1999) is also shown.*

## *2.3) GEOLOGY*

The unglaciated portions of west-central Yukon are underlain by Paleozoic accretionary rocks and Mesozoic post-accretionary rocks. The accretionary strata consist of medium- to high-grade, polydeformed metasedimentary (Klondike and Nasina assemblages) and meta-igneous rocks belonging to Yukon-Tanana Terrane (Fig. 4). These rocks consist of quartz-chlorite schist, quartz-muscovite schist, micaceous quartzite, graphitic quartzite, quartz feldspar-augen schist, amphibolite and orthogneiss (Templeman-Kluit, 1974; Debicki, 1985; Mortensen, 1990). A small amount of altered ultramafic rocks associated with Slide Mountain Terrane have also been mapped within the study area (Mortensen, 1990, 1996). The post-accretionary strata consist of sedimentary and volcanic rocks asigned to the Tantalus Formation and Carmacks Group, respectively. Northeast of Tintina Fault, a mid-Cretaceous to Tertiary right-lateral strike-slip fault, are ancestral North American sedimentary rocks of Selwyn Basin. These have been intruded by mid-Cretaceous Tombstone suite intrusives.

Previous work by Hart and Jober (1997) into the soil geochemistry of copper-gold porphyries in the Dawson Range (Yukon-Tanana Terrane) indicated that unglaciated plutonic suite rocks are locally oxidized to depths of 150 m. This oxidation and potential leaching of metals was the impetus for their study into metal distribution patterns within the upland soils.

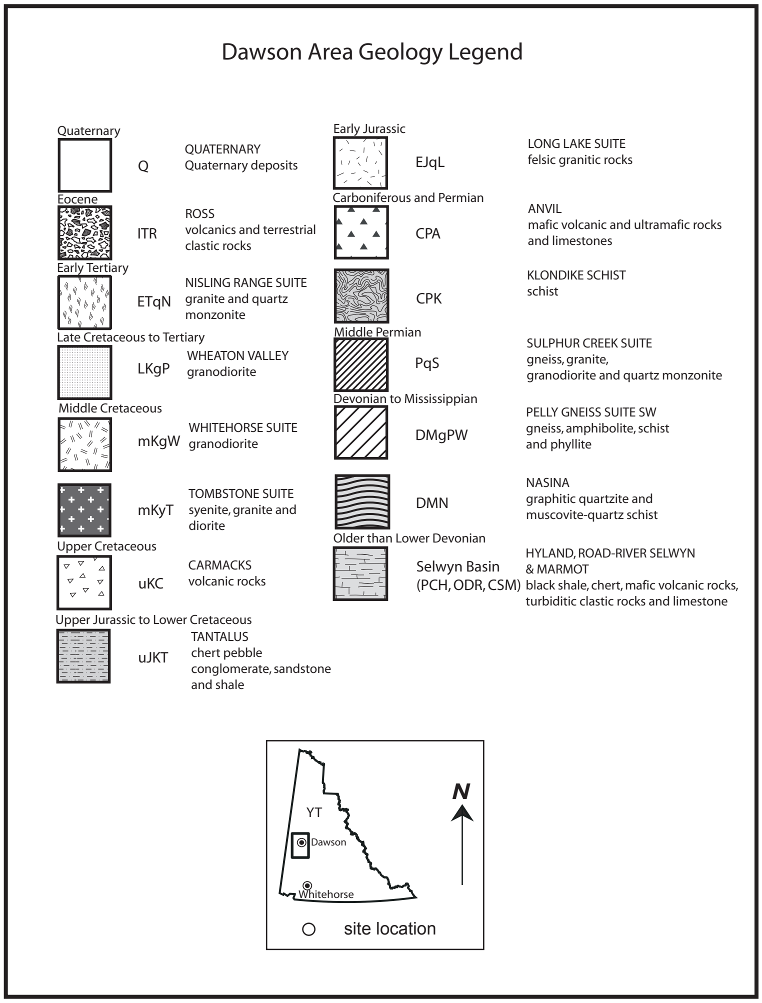

***Figure 4a.*** *Legend for Dawson area geology map at right, with study sites indicated, (Gordey and Makepeace, 2003).*

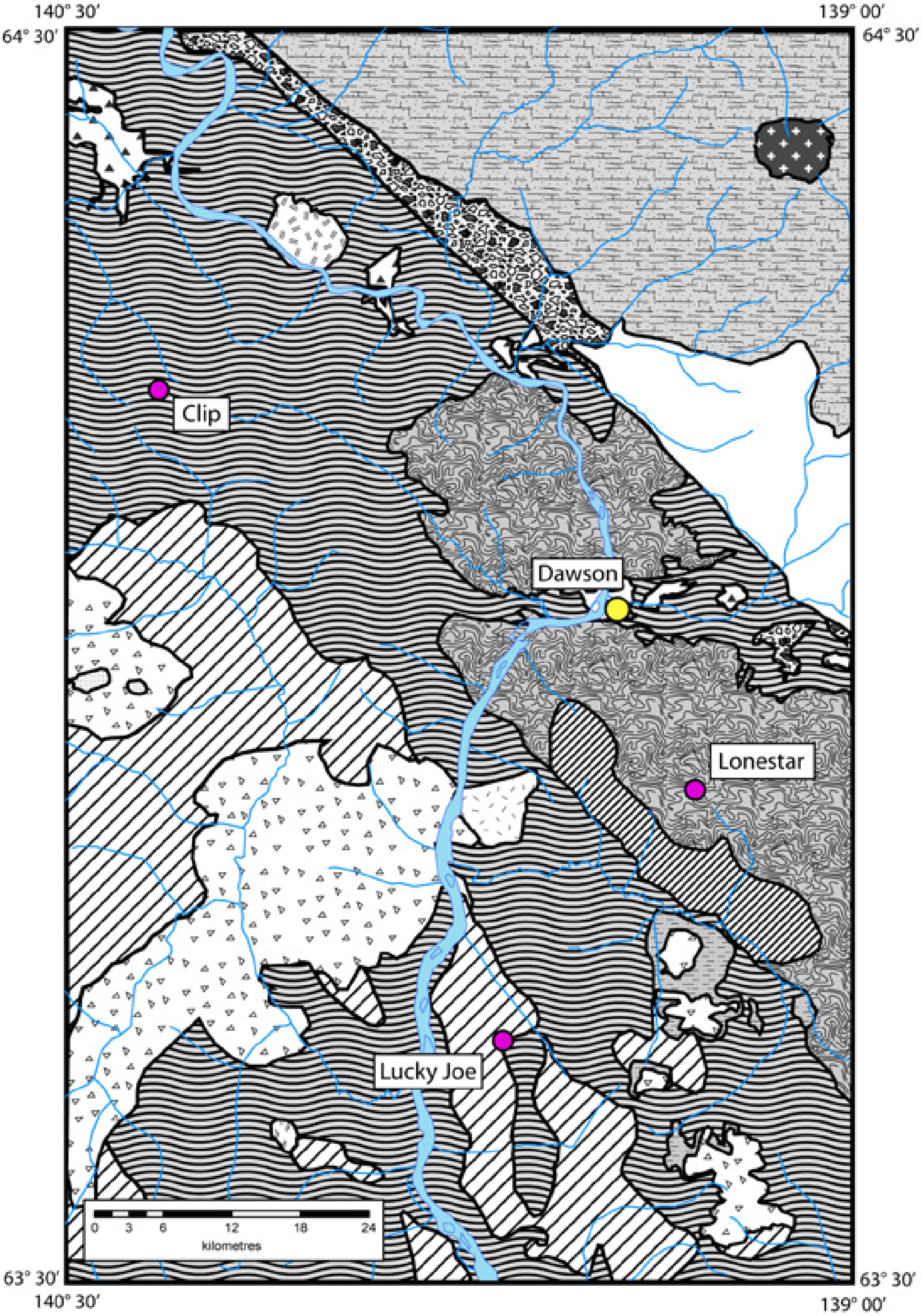

***Figure 4b.*** *Geology map of west-central Yukon (Gordey and Makepeace, 2003), with study sites indicated.*

### *2.4) SURFICIAL GEOLOGY*

The surficial geology of the study area is dominated by fluvial, colluvial and aeolian processes. Fluvial sediments are associated with active stream channels and bars. The Yukon River and its larger tributaries in the study area have wide, flat-bottomed floodplains whereas lower order tributaries are typically contained within steep V-shaped valleys that have narrow floodplains. Abandoned Pliocene and early Pleistocene fluvial terraces are preserved along the Yukon River and its tributaries (Fig. 5). These fluvial benches are as much as 150 m above modern floodplains. Colluvial deposits are widespread across the unglaciated region and are the most common surficial material (Duk-Rodkin, 1996; Jackson, 2005; Jackson et al., 2005). Colluvium is derived primarily from local weathered bedrock, intermixed with silty aeolian deposits (loess) and organic matter. Where fluvial benches are found, a gravel component to the colluvium may also exist. The texture of the colluvium across the upland surfaces varies according to the lithology of the underlying bedrock. Colluvial deposits may also retain sedimentary characteristics of mass wasting events. A recent study into forest fire-related active-layer-detachment slides in the west-central Yukon, has shown that this type of slope process is an effective transport mechanism that can impact large areas of the unglaciated landscape (Lipovsky et al., 2006).

**Figure 5.** *Aerial photograph of the Yukon River floodplain and adjacent uplands (view northward). At least two levels of fluvial terraces are visible next to the Yukon River (see arrows). The uppermost terrace appears cut into a pediment surface.*

Aeolian deposits, in the form of loess originating from nearby glacial outwash plains, were deposited across west-central Yukon during the Pleistocene glaciations. Older loess deposits have mostly been colluviated into the valley bottoms where they were fluvially eroded or accumulated as “muck” deposits. According to Fraser (1995), the distribution of muck deposits is limited to within 77 m elevation of the valley bottoms. Aspect is the primary control with most deposits being preserved at the base of north-facing slopes (Fraser, 1995). In smaller creeks where fluvial erosion is limited, muck is found on both sides of valleys. From this study it was recognized that a thin veneer (<25 cm) of loess is preserved on moderate upland slopes (10°; Fig. 6). On slopes with a south-facing aspect the loess forms a distinct unit at the top of the B horizon. A minor component of coarser locally-derived colluvium appears to have been incorporated in the loess by slope processes in many places. On north-facing slopes, permafrost is commonly present (or has been present), which enhances the colluviation of the surficial deposits. On these slopes, the loess has been incorporated in the underlying colluvium by cryoturbation. Its presence is suggested by increasing silt content towards the soil surface.

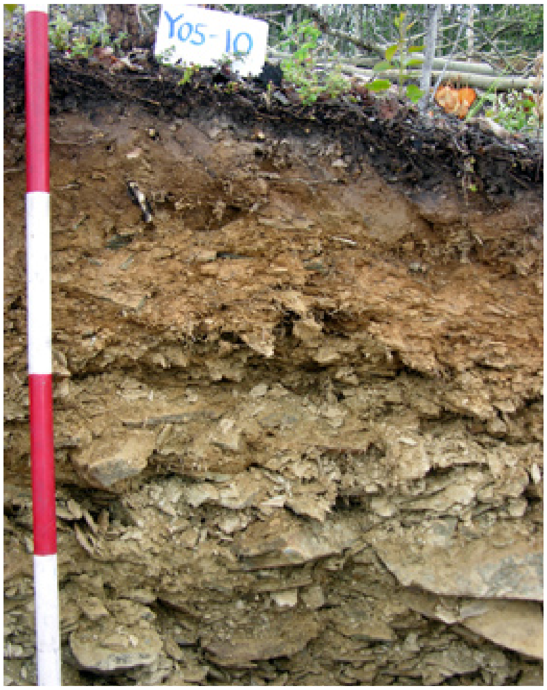

**Figure 6.** *Typical upland soil in the Klondike goldfields, with a veneer of loess at the top of the B horizon, indicated by an absence of coarse fragments. The staff is marked with 25-cm intervals.*

## *2.5) PERMAFROST*

The west-central Yukon is in the zone of widespread discontinuous permafrost. The thickest permafrost is found on the cooler north-facing slopes and it is generally absent on south-facing slopes (French et al., 1983; Smith et al., 2004; Fig 7). Massive ground ice bodies are commonly contained within the valley bottom muck deposits (Fraser and Burn, 1997). The main factors affecting permafrost distribution include slope aspect, angle and position, and thickness of moss mat cover. Active-layer thickness on upland sites can vary between 50 and 200 cm in the summer season (Smith et al., 2004). Most of the soil profiles examined in this study were permafrost-free despite morphological evidence of cryoturbation. This would suggest that the presence of permafrost is somewhat dynamic on the landscape and may be linked to longer term environmental factors attributed to Holocene climate variability.

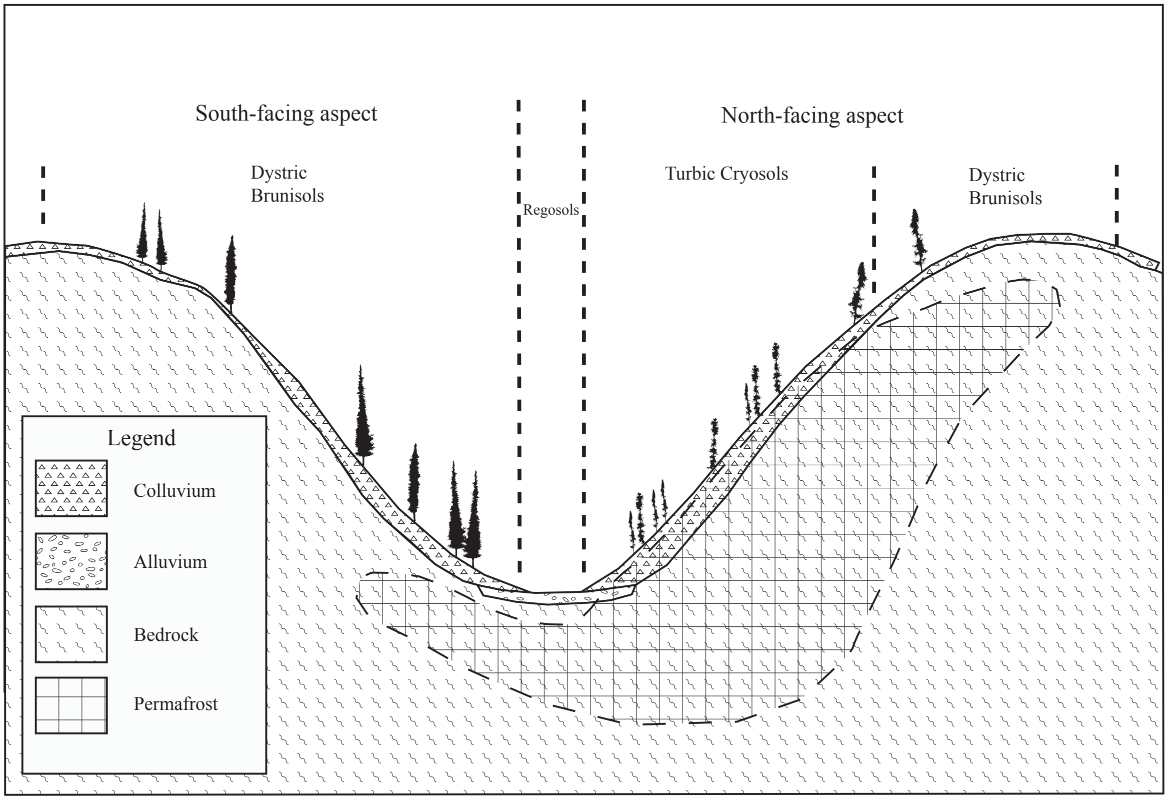

***Figure 7.*** *Idealized cross-section of a valley in the Klondike Plateau showing the distribution of permafrost and soil types (after Smith et al., 2004).*

## 3.0) METHODOLOGY

Three study sites were chosen over different mineral deposit types in order to evaluate the distribution of different elements in soils formed on colluvium derived from weathered bedrock in unglaciated landscapes. Slope aspect has an important influence on permafrost distribution and soil formation in the Klondike Plateau (Smith et al., 2004), so soil sampling sites was further stratified in order to capture the range of variation in soil morphology and parent materials on contrasting slope aspects. Exploration trenches were utilized where available, otherwise exposures were created using hand tools. In general, each site was located on a mid to upper slope position.

The three mineral properties identified to conduct the study were the Lone Star (orogenic gold), Clip (sedimentary exhalative) and Lucky Joe (metamorphosed porphyry copper). A full description of the properties is given in the Results section below.

At each property, a pit or a trench wall was excavated on opposing slope aspects. At each exposure, site descriptions were made, soil horizons were identified and their colour, texture, structure, thickness and associated contacts were described according to the Expert Committee on Soil Survey (1983). Soil horizon and classification nomenclature are according to the Soil Classification Working Group (1998) and Green et al. (1993), and relevant terms used in this study are summarized in Appendix D. Duplicate samples were taken from each mineral horizon for analyses of soil chemical properties and particle size distribution, and geochemistry, respectively. The former set of samples was air-dried and sieved (2 mm), and the < 2 mm fractions were used for soil chemical analyses (British Columbia Ministry of Forests analytical chemistry laboratory, Victoria, BC), and particle size analysis (Soilcon Laboratories, Richmond, BC). Surface organic horizons were air-dried, ground (< 2 mm) with a hammermill, and only the soil chemical analyses were performed on these samples.

Particle size analysis of mineral horizons used the pipette method (Gee and Bauder, 1986) after pretreatments to improve the dispersion of clays: removal of organic matter by hydrogen peroxide, and of sesquioxides by the citrate-bicarbonate-dithionite extraction. Total C and N were determined with a LECO CHN-600 Elemental Analyzer and total S (organic horizons only) with a LECO SC-32 Analyzer. For non-calcareous soils, total C can be taken as a reasonable approximation of organic C. Soil pH was measured with a Fisher Accumet pH Meter (model 915) with a Broadley-James E-9405-EC1-AO3BC soil probe pH electrode, using soil:water ratios of 1:1 for mineral soils and 1:2 for forest floors, and a soil:0.01 M $CaCl_2$ ratio of 1:2 for both mineral soils and forest floors. The pH measurements in $CaCl_2$ normally provide slightly lower values by ~ 0.5-1.0 units, and are considered to be closer to the "true" soil pH because 0.01 M $CaCl_2$ approximates the ionic strength of natural soil solutions. Cation exchange capacity (CEC) used the $BaCl_2$ method (Hendershot and Duquette, 1986), with exchangeable cations ($Ca^{2+}$, $Mg^{2+}$, $K^+$, $Na^+$, $Fe^{3+}$, $Al^{3+}$, $Mn^{2+}$) determined by inductively coupled argon plasma (ICP)-atomic emission spectroscopy (AES). CEC (and exchangeable cations) are measures of the ion exchange properties of soils, and indicate the capacity for retaining cations that results from negative charges present in soil organic components and clays.

Soil weathering products were extracted by three standard methods: sodium pyrophosphate (Fe and Al), acid ammonium oxalate (Fe, Al, Si), and citrate-dithionite-bicarbonate (Fe), with elemental concentrations in the extracts determined by ICP-AES (Carter, 1993). These extractions partition forms of Fe, Al, and Si into fractions that are diagnostic of soil-forming processes and indicate secondary weathering products that may scavenge or sequester other metals in soil profiles. Pyrophosphate-extractable Fe ($Fe_p$) and Al ($Al_p$) are usually interpreted as being in organically complexed form (McKeague, 1967). However, Fep concentrations can be inflated by the presence of finely divided colloidal Fe oxides, depending on how the extract is filtered or centrifuged (Schuppli et al. 1983), so $Al_p$ is more reliably interpreted as representing organically complexed forms than is $Fe_p$ (Parfitt and Childs 1988). Pyrophosphate extracts from our samples were treated with a flocculant and were centrifuged (Carter, 1993) prior to ICP-AES analysis, and this method yielded $Fe_p$ and $Al_p$ concentrations that were in good agreement with published values for standard reference samples. Organically complexed Fe and Al tend to be most abundant in B horizons of strongly acidic soils that have accumulated organic matter through translocation from overlying horizons. Oxalate-extractable Fe ($Fe_o$) consists primarily of amorphous or non-crystalline Fe oxyhydroxides, usually referred to as ferrihydrite (Parfitt and Childs, 1988). Oxalate extractable Si ($Si_o$) and the difference between oxalate- and pyrophosphate-extractable Al ($Al_o – Al_p$) indicate the amounts and composition of a group of non-crystalline weathering products known collectively as allophanic materials. These weathering products are common in many

acidic soils of temperate and boreal regions, as well as in soils formed in parent materials containing a substantial component of tephra (Parfitt and Kimble, 1989). Citrate-dithionite-bicarbonate-extractable Fe ($Fe_d$) comprises essentially all secondary forms of soil Fe released through weathering products, including ferrihydrite and defined Fe-oxide minerals such as hematite and goethite (Parfitt and Childs, 1988). Therefore, most Canadian soils tend to show relative values for extractable Fe and Al that increase in the following order:
$Fe_p < Fe_o < Fe_d$ and $Al_p < Al_o$.

For geochemical analyses (Acme Analytical, Vancouver, BC) a common and economical analytical methodology was followed in order to maintain relevance with the exploration industry. The sampling procedures followed were similar to those used by Hart and Jober (1997) with some change in the size fractions and analytical method. Samples were air dried and disaggregated using a mallet. Samples of 30 g derived from three size fractions were analysed for 37 elements by inductively coupled plasma mass spectrometry (ICP-MS) after an aqua regia digestion. Detection limits for ICP-MS analyses are shown in Table 1. The three size fractions analysed from each horizon were:

1. Crush: representative pebble fraction plus fines crushed in a ceramic pulverizer to -100 mesh (<149 microns);
2. -80 mesh (<177 microns) of matrix fraction;
3. -230 mesh (<63 microns) of matrix fraction.

It should be noted that the -80 mesh fraction includes all the material that makes up the -230 mesh fraction. Quality control measures were carried out to ensure data reliability. In every block of 25 samples, 1 analytical duplicate was inserted. This duplicate was obtained from the soil material following the sieve process. Analytical precision is judged as satisfactory based on the good correlation between the analytical duplicate pairs (Fig. 8).

| Element | Lower | Upper |
|---|---|---|
| Au | 0.2 ppb | 100 ppm |
| Ag | 2 ppb | 100 ppm |
| Al* | 0.01% | 10% |
| As | 0.1 ppm | 10000 ppm |
| B* | 1 ppm | 2000 ppm |
| Ba* | 0.5 ppm | 10000 ppm |
| Bi | 0.02 ppm | 2000 ppm |
| Ca* | 0.01% | 40% |
| Cd | 0.01 ppm | 2000 ppm |
| Co | 0.1 ppm | 2000 ppm |
| Cr* | 0.5 ppm | 10000 ppm |
| Cu | 0.01 ppm | 10000 ppm |
| Fe* | 0.01% | 40% |
| Ga* | 0.1 ppm | 1000 ppm |
| Hg | 5 ppb | 100 ppm |
| K* | 0.01% | 10% |
| La* | 0.5 ppm | 10000 ppm |
| Mg* | 0.01% | 30% |
| Mn* | 1 ppm | 10000 ppm |
| Mo | 0.01 ppm | 2000 ppm |
| Na* | 0.001% | 10% |
| Ni* | 0.1 ppm | 10000 ppm |
| P* | 0.001% | 5% |
| Pb | 0.01 ppm | 10000 ppm |
| S* | 0.02% | 10% |
| Sb | 0.02 ppm | 2000 ppm |
| Sc* | 0.1 ppm | 100 ppm |
| Se | 0.1 ppm | 100 ppm |
| Sr* | 0.5 ppm | 10000 ppm |
| Te | 0.02 ppm | 1000 ppm |
| Th* | 0.1 ppm | 2000 ppm |
| Ti* | 0.001% | 10% |
| Tl | 0.02 ppm | 1000 ppm |
| U* | 0.1 ppm | 2000 ppm |
| V* | 2 ppm | 10000 ppm |
| W* | 0.1 ppm | 100 ppm |
| Zn | 0.1 ppm | 10000 ppm |

*The digestion is only partial

***Table 1.*** *Detection limits for elements analysed by ICP-MS.*

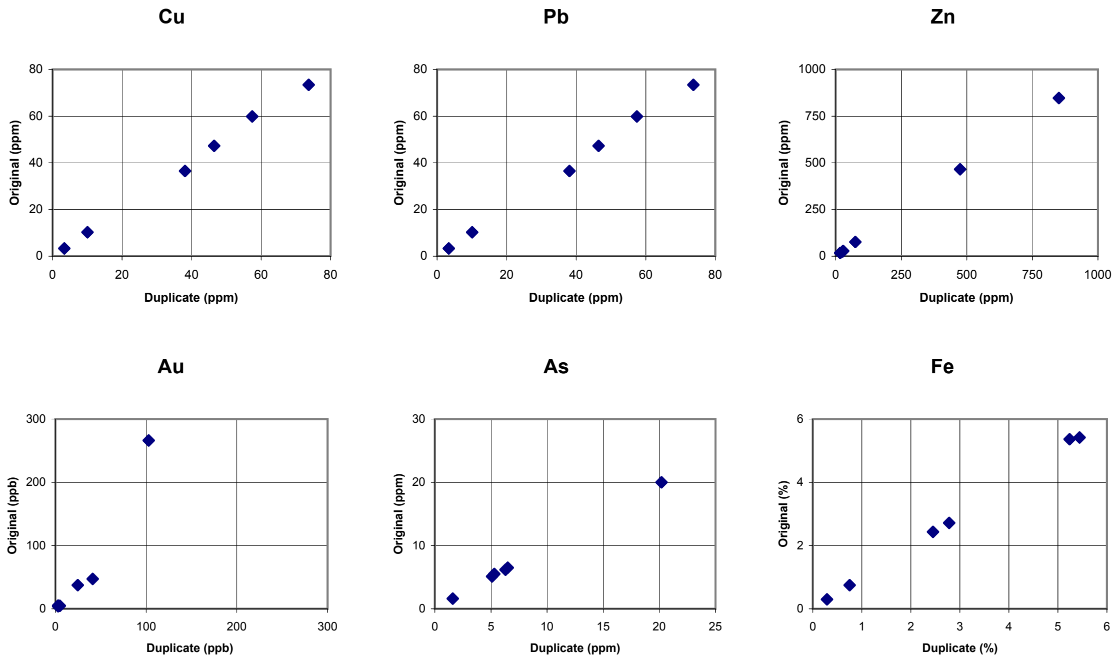

***Figure 8.*** *Correlation plots of laboratory geochemical duplicates. N = 6 in all diagrams.*

# 4.0) RESULTS

## *4.1) LONE STAR*

The Lone Star property is located in the Klondike goldfields of west-central Yukon, 20 km southeast of Dawson City (Fig. 2). Access to the property is provided by the Bonanza Creek road, and a variety of local exploration roads and trails. Two areas of the property were investigated in this study, the Boulder Lode (Bonanza Creek side) and Nugget zone (Eldorado Creek side).

### Bedrock

The geology of the Klondike district was divided into three structural assemblages by Mortensen (1990). The Lone Star property includes lithostratigraphic units of assemblage 1, the uppermost thrust sheet in the series. Rocks consist of Permian felsic schist, chloritic schist, micaceous, chloritic and feldspathic quartzite, and quartz-augen schist (Mortensen, 1990). A bimodal suite of younger, post-accretion Eocene dykes cross-cut these rocks (Cranswick et al., 1995). Mineralization at Lone Star occurs within west-northwesterly striking fault zones. Gold occurs within cross-cutting quartz veins and also within mineralized schist (Cranswick et al., 1995).

### *4.1.1) BOULDER LODE*

The Boulder Lode zone lies on the north-facing (40°) side of the upland that separates Eldorado and Bonanza creeks (Fig. 9). Two soil profiles were documented in the wall of a northeast-trending exploration trench positioned approximately 60 m elevation below the summit of the ridge (Fig. 10).

***Figure 9.*** *Aerial view of the Boulder Lode zone on the Lone Star property. The arrow points to the location of the study trench.*

***Figure 10.*** *View of the exploration trench used to expose the soil profiles at the Boulder Lode zone.*

*4.1.1.1) Boulder Lode 1*

The soil exposed at Boulder Lode 1 was an Orthic Dystric Brunisol, based on its low pH (< 5.5) and low concentrations of $Fe_p + Al_p$ in B horizons, and absence of a continuous organic matter-enriched A (Ah) horizon thicker than 10 cm (Soil Classification Working Group 1998; Fig. 11; Appendices A and B). Three distinct parent material groupings were identified in the soil profile. The uppermost unit consisted of a mixture of colluviated weathered bedrock, organic material and loess (Fig.11). The broken pattern of A and B horizon boundaries evident in the profile was mirrored in the patchy distribution of C and irregular variation in texture with depth (Appendix B). Permafrost was not observed within the soil profile and was not intersected within 1 m of the surface in a hand-auger hole 4 m from the edge of the trench. This may reflect alteration of the soil temperature regime as a result of trenching more than 10 years earlier, as the northeasterly slope aspect and thick (20 cm) surface accumulation of organic matter are characteristic of sites elsewhere in the Klondike Plateau where permafrost is present. Therefore, the irregular pattern of horizon boundaries in the upper 40 cm may have resulted from cryoturbation within the active layer of a former Turbic Cryosol in which the permafrost table was marked by the maximum depth of incorporation of organic matter. (A and B horizon designations include the "y" suffix indicating modification by cryoturbation.) Therefore, the present soil classification could be modified by designating it as a cryoturbic phase.

Extractable Fe and Al concentrations were moderate in the A and B horizons, and approximately 2/3 of the extractable Fe was in non-crystalline form. More than half of the extractable Al was organically complexed and $Si_o$ concentrations are very low (< 0.05%), indicating that very little allophanic material was present. These patterns, combined with the subdued B horizon colours, suggested that only limited weathering has occurred in this soil.

Beneath the approximately 50-cm-thick solum (i.e., A and B horizons), the two underlying parent materials comprising the IIC and IIIC horizons had much sandier textures, with angular fragments of local bedrock comprising approximately 90% of the IIIC (Appendix B). Despite the predominance of sands in the fine fraction, some translocation of silts has occurred in the lower horizons of this profile, with 1- to 3-mm-thick silt coatings present on the upper surfaces of many coarse fragments in the uppermost 50 cm of the IIIC horizon.

**<u>Geochemistry</u>**

The distribution patterns of gold and potential pathfinder elements are illustrated in Figure 12 (also see appendix C). The gold concentration profile showed a general decrease in concentration with depth. Within the colluvial component of the soil (A and B horizons) the crush and -230 mesh fractions showed a similar gold concentration profile, with the A horizons having higher concentrations than the B horizons. In contrast, the -80 mesh fraction shows less consistency within the colluvium-based soil horizons. The highest gold concentrations were derived from

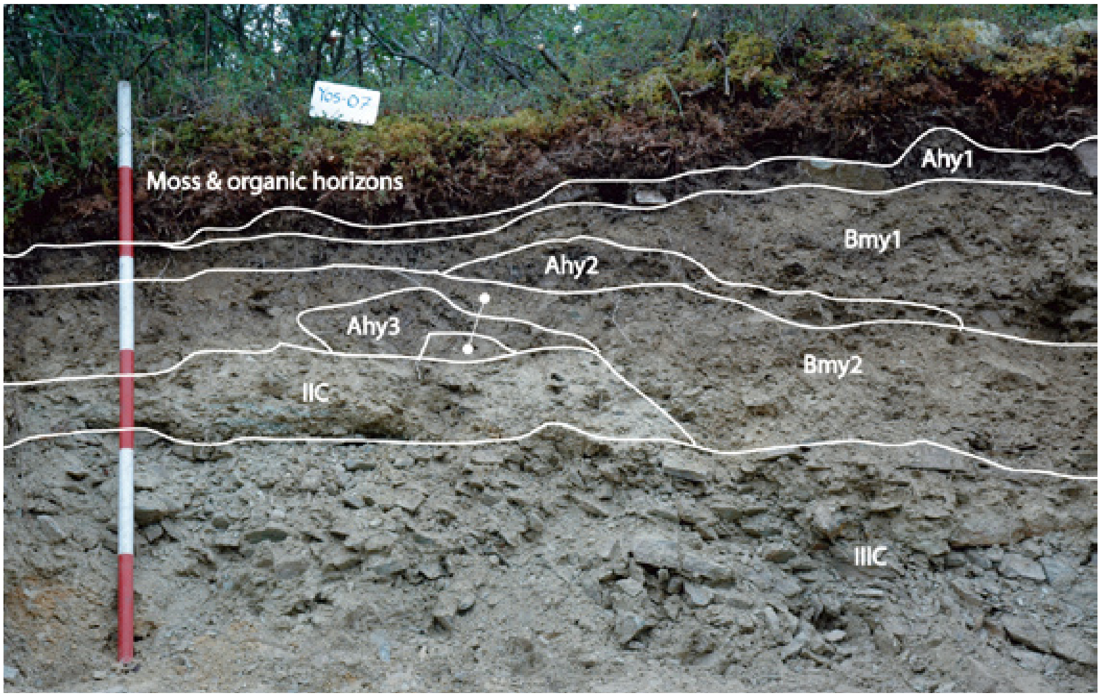

*__Figure 11.__ Soil profile at Boulder Lode 1, with horizon boundaries indicated.*

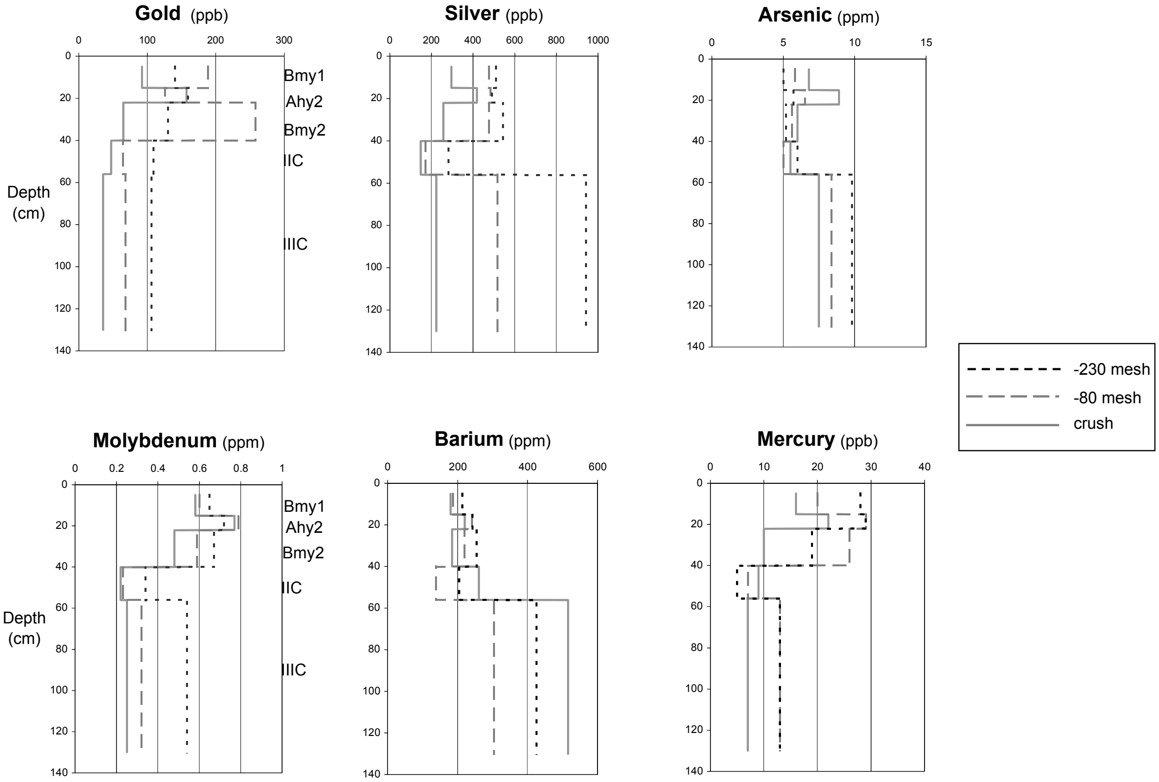

*__Figure 12.__ Selected element profiles from Boulder Lode 1, Lone Star property. Results from the Ahy3 horizon are not shown (see Appendix C).*

the -80 mesh fraction of the Bmy2 and Ahy3 horizons. (Data for the Ahy3 was not included in the concentration profile diagram because it lies adjacent to the Bmy2 horizon and could not be represented stratigraphically. See Appendix C for the geochemistry of the Ahy3 horizon.)

Potential pathfinder elements for gold on the Lone Star property include silver and arsenic. The concentration profiles for silver and arsenic were similar to that of gold in the crush and -230 mesh fractions. The only inconsistency occurred for the concentrations derived from the IIIC horizon (stratigraphically lowest). Here there was a dramatic increase in silver and arsenic content at depth, but little change in gold content. The relative geochemistry between size fractions showed little consistency for gold, silver and arsenic within the A and B horizons. However, within the C horizons, the -230 mesh fraction consistently returned higher concentrations, perhaps due to translocation of silts as evidenced by the silt caps. Separate analyses of the silt cap material in relation to the composition of silts in the overlying horizons would be needed to test this hypothesis.

Other pathfinder elements of potential interest include barium, molybdenum and mercury. The concentrations of molybdenum and mercury did not appear to be anomalous, however their concentration profiles are similar. When compared to gold the concentration profiles are somewhat similar with overall higher concentrations occurring in the A and B horizons relative to the C horizons (Fig.12). The barium concentration profile resembles closely that for silver and arsenic.

### *4.1.1.2) Boulder lode 2*

This soil, an Orthic Dystric Brunisol (cryoturbic phase), was 12 m laterally downslope from Boulder Lode 1 in the same exploration trench and has many similarities in its morphological, chemical and physical properties (Fig. 10 and 13; Appendices A and B). Soil parent materials are similar to those of Boulder Lode 1, consisting of a thicker (85 cm) mixed upper colluvial unit containing the solum, averaging 85 cm thick, that overlies in situ blocky-weathered quartz-muscovite schist and an oxidized, more finely weathered, schist (Fig. 13).

The upper colluvial unit has higher silt and clay concentrations than the IIC horizons, likely reflecting incorporation of aeolian materials through cryoturbation and solifluction, although permafrost was absent in the trench exposure (Appendix B). Flat schist clasts are oriented approximately parallel to the surface, in contrast to the fractures in the underlying bedrock that dip steeply into the hillslope. The surface organic horizon is similar in thickness to those at the upslope site, but the obvious incorporation of distinct pockets of subsurface organic matter-enriched Ah horizons is absent. Carbon concentrations decrease sharply below the thin Ahe horizon that lies immediately below the forest floor. As in the upslope soil, pH values are strongly acidic throughout the profile, with only a very slight increase with depth.

Concentrations and relative amounts of extractable Fe, Al and Si varied little within the B horizons and values were similar to those in the upper unit at Boulder Lode 1. More variability occurred at depth, with the IIC2 showing an $Fe_d$ concentration approximately twice that of the other IIC horizons, and a higher proportion of crystalline Fe-oxides than in any other horizon (Appendix B). This higher Fe content corresponded to noticeably redder hues (7.5YR, 10YR) than the other IIC horizons (2.5Y).

#### **Geochemistry**

The concentrations of selected elements from the soil at Boulder Lode 2 are displayed in Figure 14. Results from the IIC3 horizon are not displayed in the geochemical profiles because the horizon is situated stratigraphically adjacent to the IIC2. The geochemistry of the IIC3 horizon is displayed in Appendix C.

In general, the gold concentration progressively decreases with depth, whereas gold pathfinder elements have a more erratic distribution. Gold concentrations spike in the crush fraction from the Bmy2 horizon possibly reflecting a nugget that was liberated from a clast during processing. The geochemical profile for arsenic shows the highest concentrations obtained from the IIC2 horizon (Fig. 14). Silver has a concentration profile that reflects aspects of

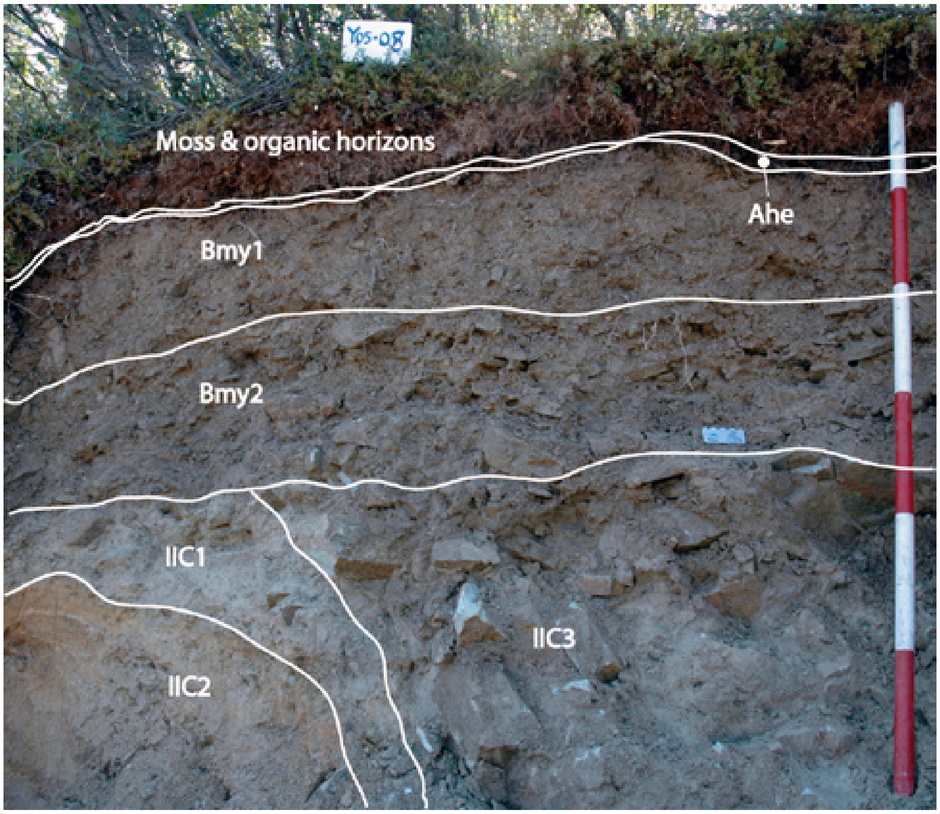

***Figure 13.*** *Soil at Boulder Lode 2, with horizon boundaries indicated.*

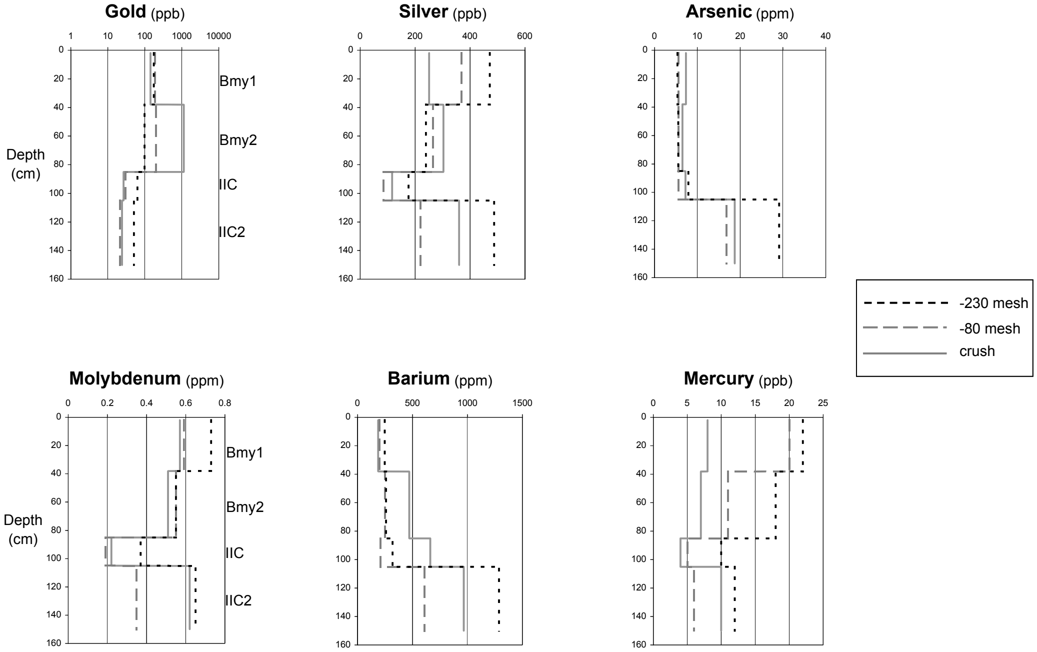

***Figure 14.*** *Selected element profiles from Bounder Lode 2, Lone Star property. Results from the IIC3 horizon are not shown (see Appendix C). (Note that the concentration scale for gold is logarithmic.)*

both the gold and arsenic profiles with relatively elevated upper and lower horizons. Likewise, there are similar distribution profiles between molybdenum and mercury concentrations and silver. The geochemical profile for barium is similar to arsenic with an elevated concentration in the IIC2 horizon.

Overall, none of the pathfinder element profiles illustrated in Figure 14 have a comparable profile to the gold distribution. Perhaps the only noticeable similarities in relative concentration patterns were observed between silver, molybdenum, barium and mercury, with lower concentrations present in the IIC horizon.

### *4.1.2) Nugget zone*

The Nugget zone lies in a mid-slope position above Eldorado Creek. The slope faces southwest (240°) and is adjacent to Oro Grande Gulch (Fig. 15). Eldorado Creek was the richest placer creek in the Klondike goldfields and placer mining has remained active to the present day (LeBarge, 2006). The Nugget zone lies within the Buckland shear zone and was discovered in 1994 by Kennecott Canada Inc. after anomalous gold values were recovered from a power auger soil sample (Cranswick et al., 1995). Subsequent trenching in 1994 along the soil sample line revealed a zone of gold-bearing discordant quartz veins (Fig.16). Gold values up to 26.5 g/t over 2 m were assayed from the mineralized bedrock (Cranswick et al., 1995). Two sections of the trench wall were investigated for their soil properties in this study. Nugget 1 lies about 140 m down slope of the mineralized bedrock whereas Nugget 2 is situated further upslope about 20 m down slope from the mineralization.

**Figure 15.** *Aerial view of the Nugget zone on the Lone Star property. The arrow points to the location of the study trench.*

#### *4.1.2.1) Nugget 1*

Nugget 1 is a 5-m-long exposure of Orthic Dystric Brunisols developed in silty loess overlying sandy phyllitic colluvium and blocky weathered mafic intrusive (dyke) bedrock. The site is in the middle portion of an 11˚ slope with a 240˚aspect. Three 1-m-wide soil profiles were described and characterized at equal intervals along this exposure (Fig. 17; Appendices A and B). The soil solum thickness ranges from 65 to 90 cm, although fine soil material occurs to greater depths in the interstices between fractured blocks of partially weathered mafic bedrock. In profile 1, the dyke is in contact with an oxidized quartz vein (Fig. 18). At the contact, the intrusive bedrock has been chemically weathered into sand and pebble-sized fragments. Where this material comes into contact with the overlying colluvium it becomes entrained, forming a distinct marker horizon downslope within the colluvium (Fig. 17, 18 and 19). The dispersion train gradually thins and rises within the soil profile over 4 m, and becomes indistinct within the uppermost B horizon of profile 3 (Fig. 17 and 20).

**Figure 16.** *Gold-bearing discordant quartz veins in schist exposed on the Nugget zone, Lone Star property.*

Permafrost and the cryoturbation features noted at Boulder

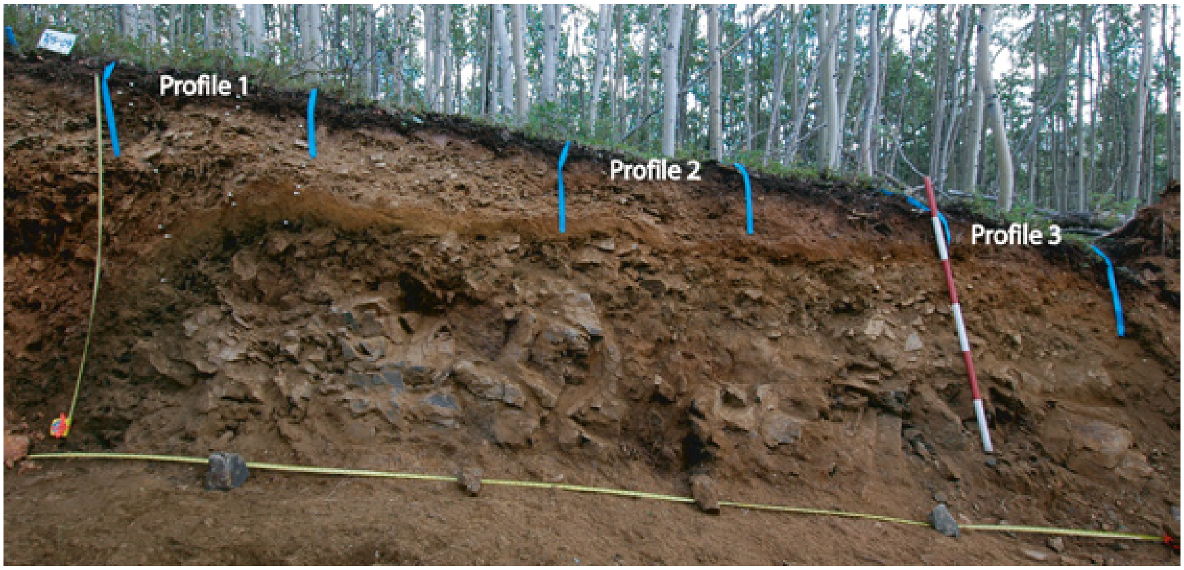

***Figure 17.*** *The trench wall exposure at Nugget 1, showing locations of the three soil profiles studied at this site, and the colluvial dispersal train of weathered mafic intrusive rock (see arrows).*

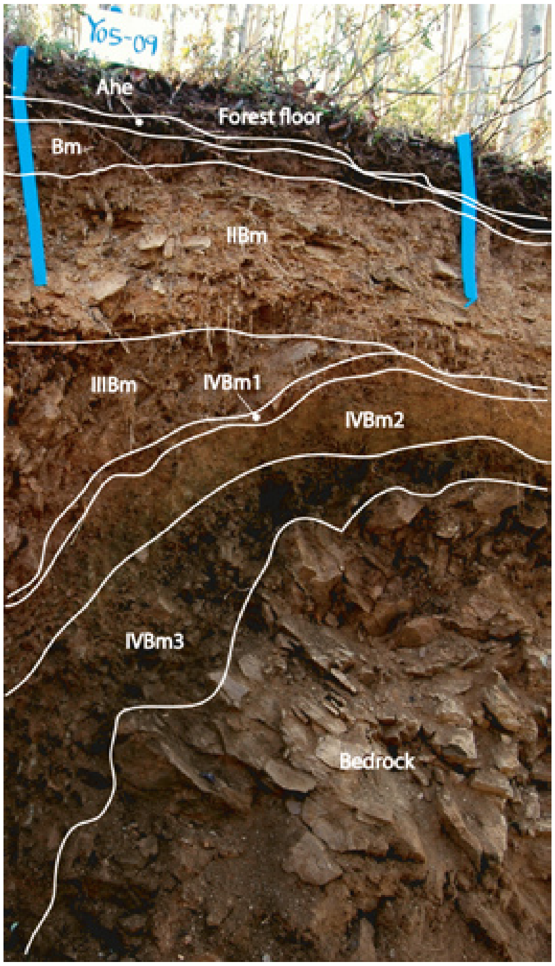

***Figure 18.*** *Soil profile 1 from the Nugget 1 site (Nugget 1-1) on the Lone Star property.*

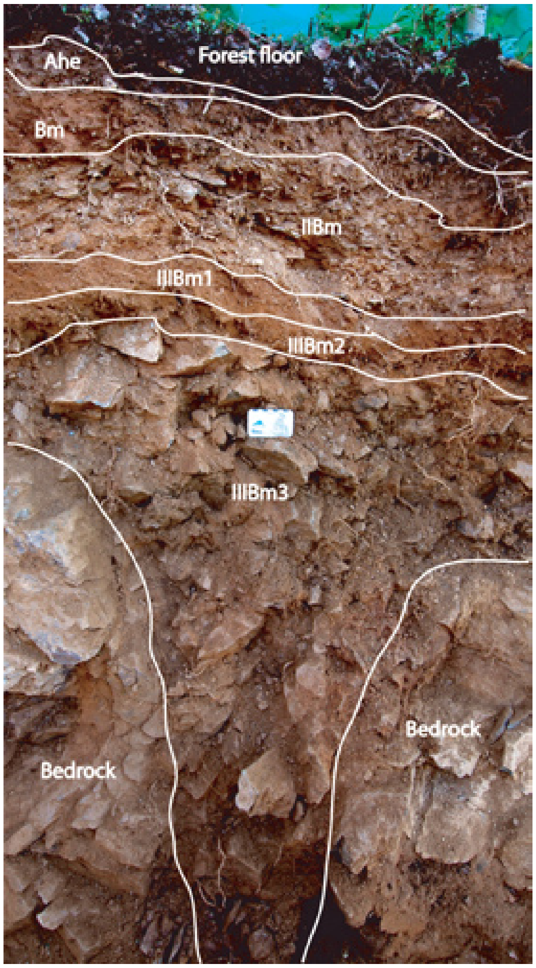

***Figure 19.*** *Soil profile 2 from the Nugget 1 site on the Lone Star property.*

Lode were absent. Other evidence for a warmer, well-drained soil environment included the thin (< 5 cm) forest floors, and well-oxidized 10YR and 7.5YR hues. This site, and Nugget 2 upslope from it, are dominated by aspen forest that contributes more base-rich litter, resulting in forest floor pH values and exchangeable $Ca^{2+}$ and $Mg^{2+}$ concentrations that were considerably higher than under the black spruce forest at Boulder Lode. Mineral soil pH($H_2O$) values tended to be highest (> 6) in the deepest B horizons, reflecting the abundance of Ca and Mg in underlying mafic bedrock.

The variety of parent materials and their downslope variation have strongly influenced the forms and amounts of secondary weathering products. Amorphous Fe forms (Feo) comprised 60-80% or more of the extractable Fe in the A and uppermost B horizons with a high proportion of silty aeolian materials, but this proportion decreased to 40-50% in the underlying horizons derived primarily from weathered mafic bedrock. The latter horizons also had the highest concentrations of total extractable Fe-oxides (Fed) in profiles 1 and 2. Those profiles also contained allophanic materials in the mafic-derived horizons, as suggested by the excess of Alo over Alp in relation to Sio.

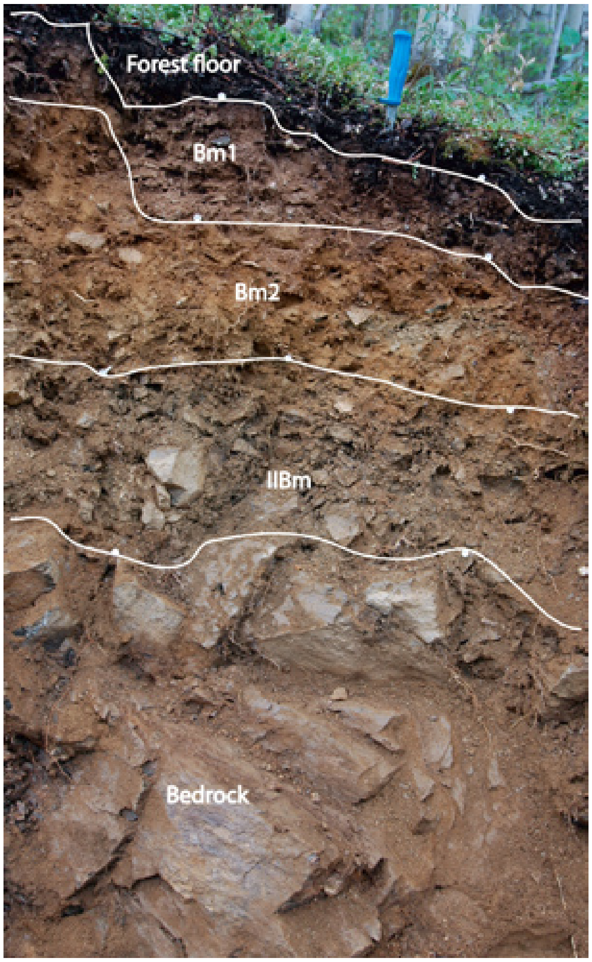

***Figure 20.*** *Soil profile 3 from the Nugget 1 site on the Lone Star property.*

## <u>Geochemistry</u>

The variable soil geochemistry at Nugget 1 reflected the diversity of parent materials at the site. The soil at profile 1 provides a good example of the parent material diversity. The lowermost horizons are derived from blocky weathered mafic intrusivebedrock. This is overlain by colluvial layers of finely weathered intrusive, vein quartz, phyllite and loess (Fig. 18; Appendix A).

The highest relative gold concentrations in profile 1 from Nugget 1 occurred in the IIIBm horizon containing weathered vein quartz regolith and colluvium in the mid to upper horizons of the exposure (Fig. 21). The stratigraphically lowest horizon in the blocky weathered mafic intrusive regolith (IVBm3) also contained relatively elevated gold concentrations. The soil horizons consisting of loess (Bm) or phyllitic colluvium (IIBm) consistently contained the lowest gold concentrations.

Arsenic and lead as gold-pathfinder elements had the most similar distribution to gold (Fig 21, 22 and 23). This correlation was most evident in vein-quartz-derived horizons and least expressed in the lower horizons formed in the weathered mafic intrusive rocks. The silver concentrations contrasted with arsenic and gold by displaying enrichment in the Ahe and Bm horizons (Fig. 21 and 22). This may reflect a scavenging process, which is addressed in the discussion below. Mercury concentrations varied in a pattern similar to that of silver at Nugget 1-1 but otherwise displayed no clear trends with depth.

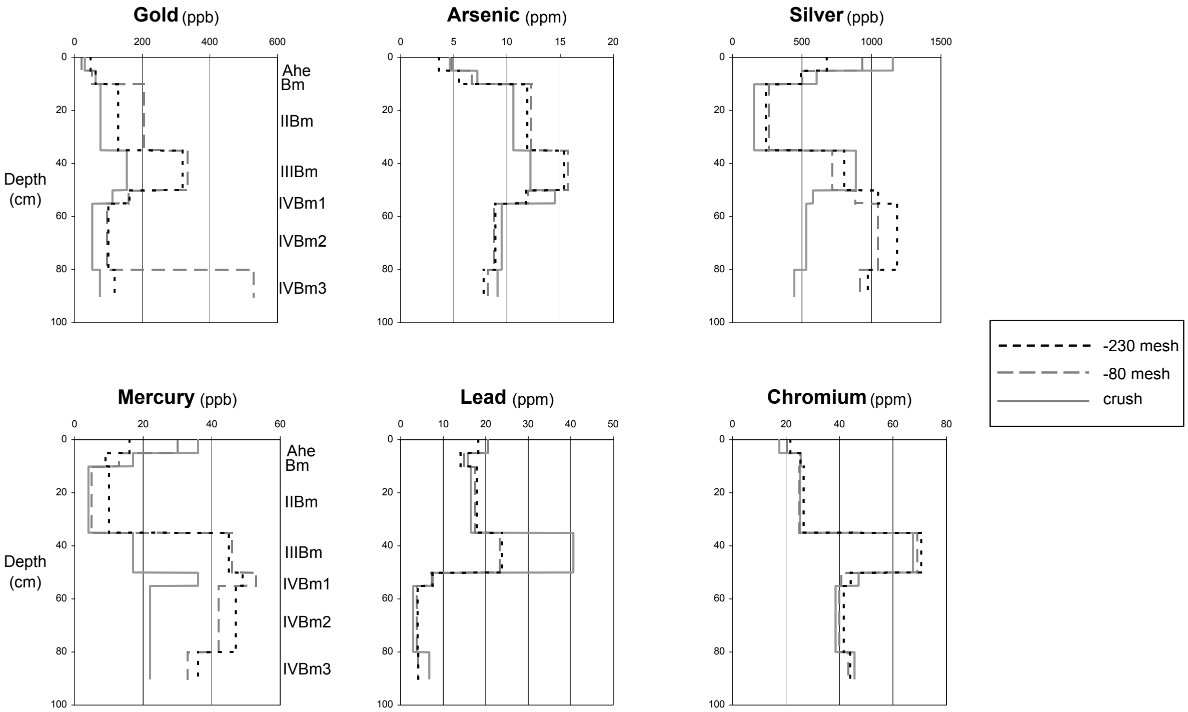

*Figure 21. Selected element profiles from Nugget 1-1, Lone Star property.*

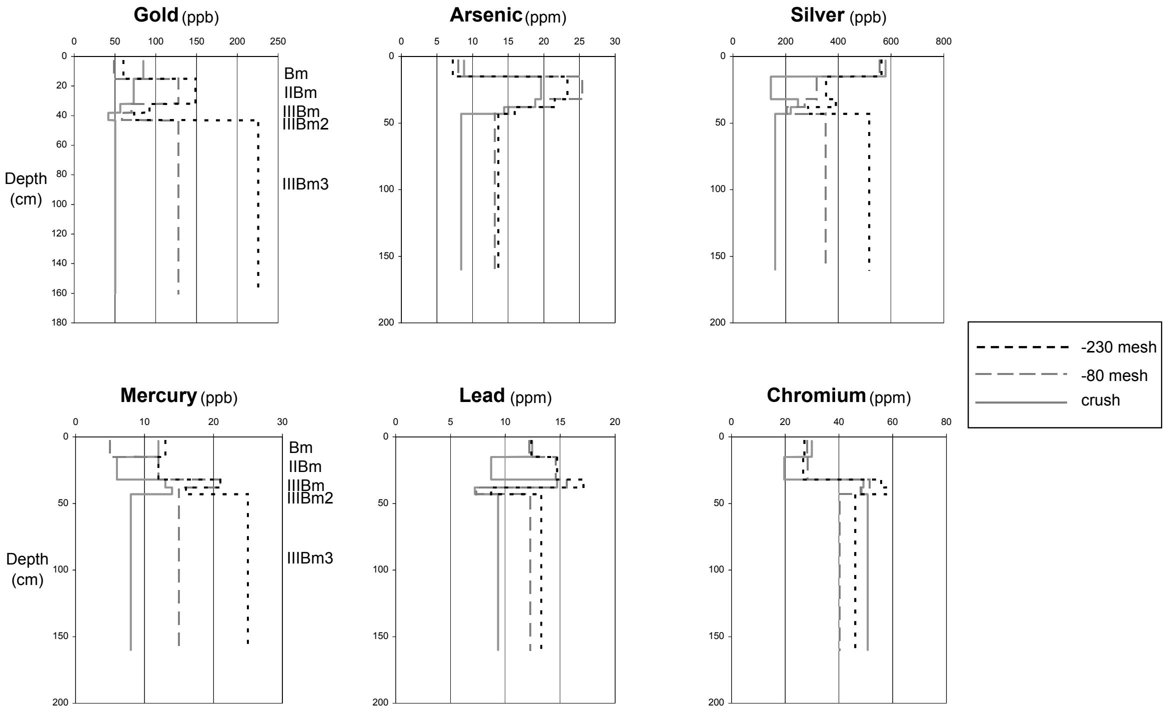

*Figure 22. Selected element profiles from Nugget 1-2, Lone Star property.*

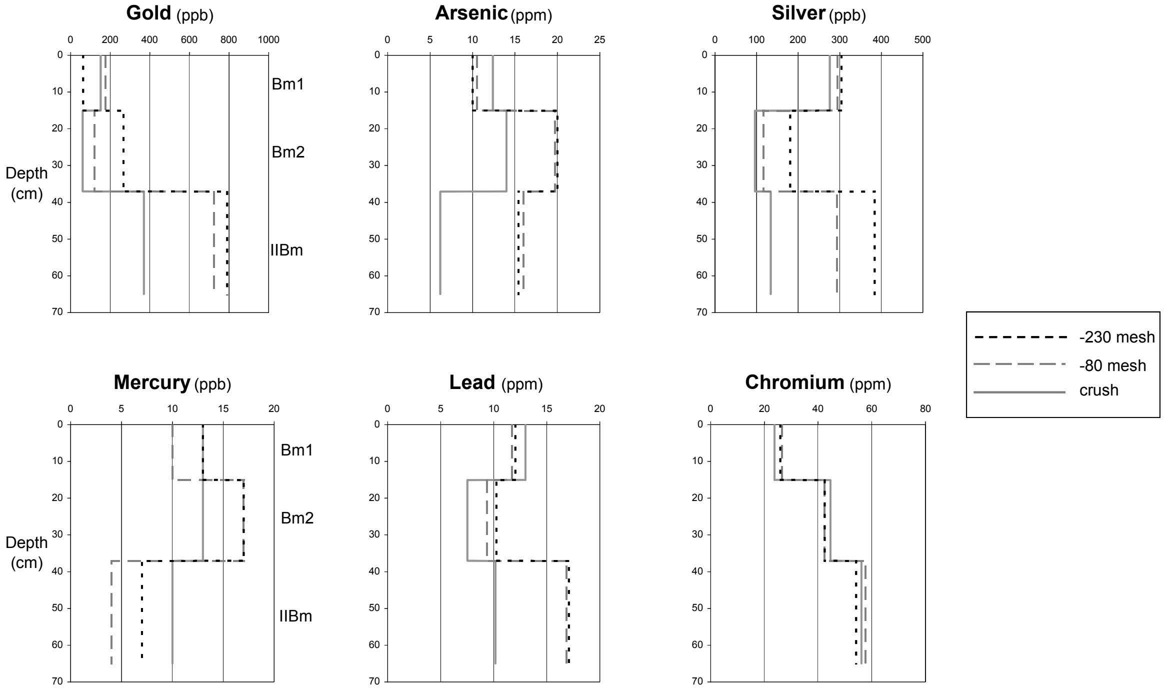

***Figure 23.*** *Selected element profiles from Nugget 1-3, Lone Star property.*

Amongst the elements charted in Figures 21, 22 and 23 there appears to be comparable concentrations between the different size fractions. The most erratic results occurred within the assays from the crush fraction. No particular size fraction consistently returned higher concentrations. The -80 mesh fraction returned the highest concentrations of gold and arsenic within the upper B horizons. Within the stratigraphically lowest B horizon, the highest gold values were consistently derived from the -230 mesh material.

#### *4.1.2.2) Nugget 2*

The second site investigated on the Nugget zone is located 110 m up-trench from the Nugget 1 exposure. Nugget 2 is situated on a 9° slope with a southwest aspect (240°). This exposure is located ~25 m downslope from known mineralization (Fig.16).

The soil at Nugget 2 was classified as an Orthic Dystric Brunisol, with the 50-cm-thick solum developed in loess and colluvium overlying weathered phyllitic bedrock (Fig. 24). The colluvium consisted predominantly of phyllite-derived materials, with minor amounts of quartz-vein fragments from outcrops upslope.

The degree of mixing of the different soil parent materials at Nugget 2 is minimal with only 5% colluvial clasts mixed into the loess. This is likely due to the absence of permafrost at this site and the relatively low slope angle. The relatively intact loess deposit also implies that permafrost has likely been absent from this site since the onset of loess deposition during the last glaciation. For a full description of the site and soil profile at Nugget 2 see Appendices A and B.

The simpler parent material composition at Nugget 2 has resulted in lower pH values, and lower exchangeable $Ca^{2+}$ and $Mg^{2+}$, and extractable Fe concentrations in the B horizons due to the absence of mafic bedrock. Unlike at Nugget 1, extractable Al and Si concentrations suggest that allophanic materials were largely absent in the B horizons.

### Geochemistry

Gold concentrations from the Nugget 2 soil horizons were generally high compared to concentrations found at Nugget 1(Fig. 25). The highest gold concentration (2317 ppb) was obtained from the crush fraction in the Bm

***Figure 24.*** *Soil profile at Nugget 2 on the Lone Star property, with horizons indicated.*

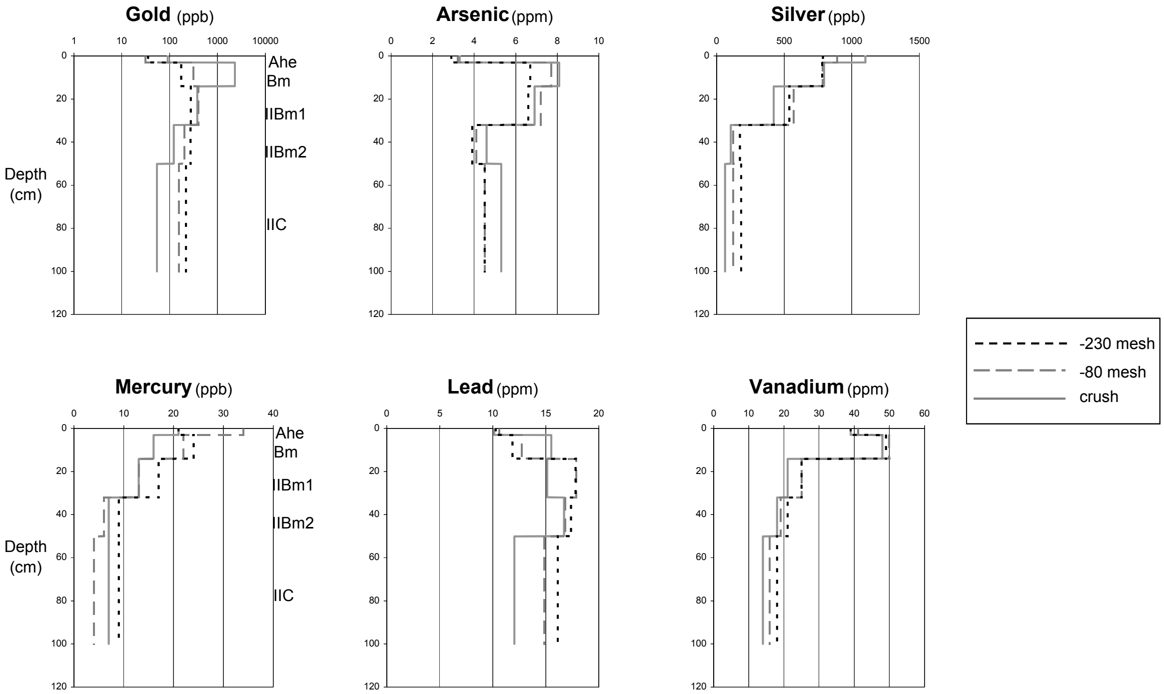

***Figure 25.*** *Selected element profiles from Nugget 2, Lone Star property. (Note that the concentration scale for gold is logarithmic.)*

horizon. Overall, the gold values were higher within the B horizons compared to the A or C horizons (Fig. 25). The arsenic concentrations, despite being relatively low, showed similar distribution patterns to those of gold (Fig. 25). The silver and mercury concentration profiles were similar in shape and showed a consistent decrease in concentration with depth (Fig. 25). The concentration profile for lead at Nugget 2 indicates the highest values are located in the lower B horizons. Vanadium concentrations were plotted because of the similar distribution patterns this element has with gold at the Bolder Lode exposures. While the actual vanadium concentrations may not be anomalous at Nugget 2, the relative concentrations within the soil horizons have a similar distribution to gold (Fig. 25).

A comparison of the size fractions analysed at Nugget 2 indicated a lack of consistency between fractions and horizons. The -230 mesh fraction returned higher values in the lower horizons whereas concentrations in the crush and -80 mesh fraction were generally higher in the A and upper B horizons (Fig. 25).

### *4.2) CLIP PROPERTY*

The Clip property is located 55 km northwest of Dawson City (Fig. 2). Access to the property is by foot 2 km north off the Top of the World highway. Two hand trenches were excavated on slopes with opposing aspects.

#### **Bedrock**

The Clip property lies within Yukon-Tanana Terrane and is underlain by rocks of the Devono-Mississippian Nasina Assemblage (Fig. 4; Green, 1972; Schmidt, 1996). The metamorphic rocks are of sedimentary origin and consist primarily of medium to dark grey, fine-grained carbonaceous, quartz-muscovite $^{+}$/- chlorite, biotite schists, muscovite-bearing quartzite, and minor marble (Schmidt, 1996). Mineralization was discovered in colluvial (talus) float trains by Cominco in 1979 (Olfert, 1979). The mineralized float consisted of thinly banded sphalerite, barite and minor pyrite in quartzite, in addition to, buff-weathered quartzite with thin laminations and stringers of galena, sphalerite and minor pyrite. Anomalous concentrations of Zn, Ba, Pb, Cu and Ag have been noted on the property. Zinc concentrations range between 2.0 and 9.2% and barite concentrations are between 1.15% and 11.41% (Olfert, 1979). A sedimentary-exhalative deposit model has been used to describe this prospect (Schmidt, 1996).

#### *4.2.1) Clip 1*

The first exposure documented on the Clip property was located on a north-facing (330°), 8° slope on the upper portion of the hillside. The soil exposed at Clip 1 was a Gleyed Sombric Brunisol (cryoturbic phase) developed in cryoturbated colluvium (Fig. 26). No permafrost was encountered at this site, however the broken lower boundary and discontinuous inclusions of tephra in the Ahy horizon, and complex colour streaking in the Bmgjy horizon suggested that

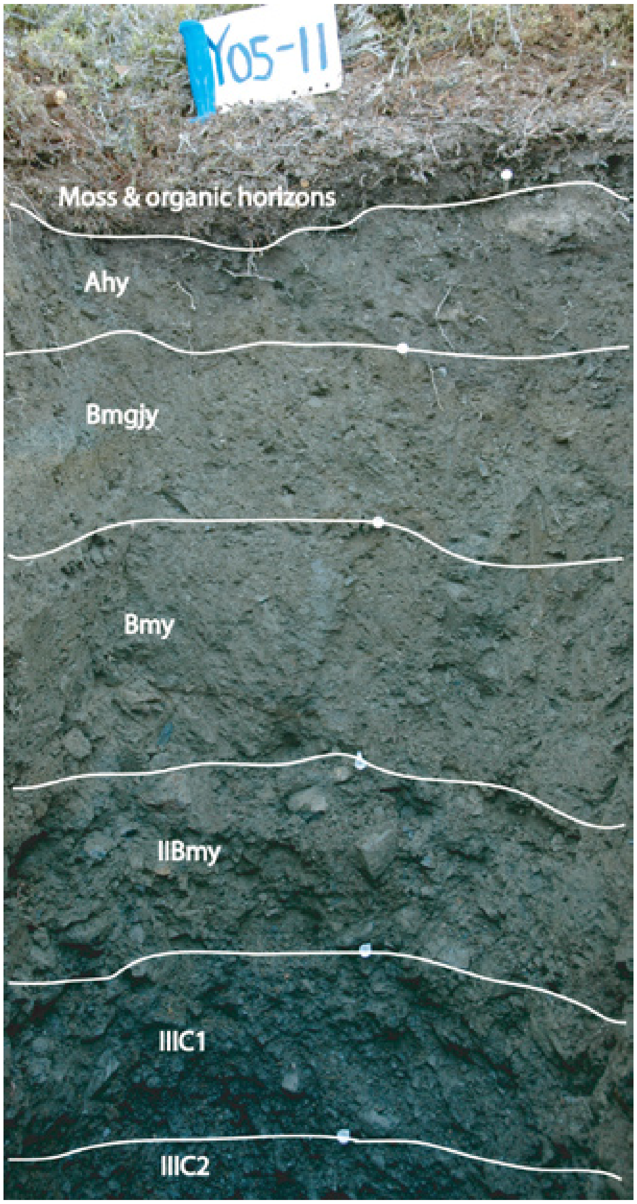

***Figure 26.*** *Soil profile at Clip 1 on the Clip property, with horizons indicated.*

cryoturbation was once active. A cold, moist soil environment is also inferred from the thick surface organic horizons, an organic matter-enriched A horizon and mottling in the upper B horizon.

The solum has formed in silty colluvium consisting of approximately 65 cm of variably mixed loess and bedrock-derived material, with the contribution of the former decreasing with depth as suggested by decreasing silt and clay, and increasing coarse fragment abundances. Although not evident from the particle-size analysis data, some downward translocation of silt has occurred, forming 1- to 3-mm-thick silt-rich coatings on upper surfaces of clasts in the IIIC1 horizons. The bedrock clasts consisted primarily of dark-grey schist (90%) and a brown schist (10%) that contains disseminated oxidized minerals as well as oxidation rinds on the clasts. Intact bedrock was not found within 100 cm of the soil surface. Soil reaction was acidic, with pH increasing slightly with depth, paralleled by an increasing ratio of exchangeable Ca:Al.

Almost the entire extractable Al was in organically complexed form (i.e., $Al_p \sim Al_o$), with negligible amounts of allophanic material ($Si_o \sim 0.05\%$) in all mineral horizons. Total extractable Fe ($Fe_d$) concentrations were relatively uniform (~ 1%) in all horizons, although the proportion of amorphous extractable Fe decreased by almost 2/3 from the A to the C horizon. These patterns suggest that Fe released by weathering of primary minerals has not been translocated vertically in the soil profile, but has tended to remain in less crystalline forms in the upper horizons with higher organic matter concentrations.

## Geochemistry

The geochemical profiles for the prospective elements at Clip 1 displayed a similar distribution character (Fig. 27). In general, concentrations increased with depth to the upper C horizon. The largest concentration increase for most elements occurred from the IIBmy to the IIIC1 horizon. Depending on the size fraction the increase was as much as 300-400% (Fig. 27).
Comparable geochemical profiles were observed between the different grain-size fractions analysed at Clip 1. Within

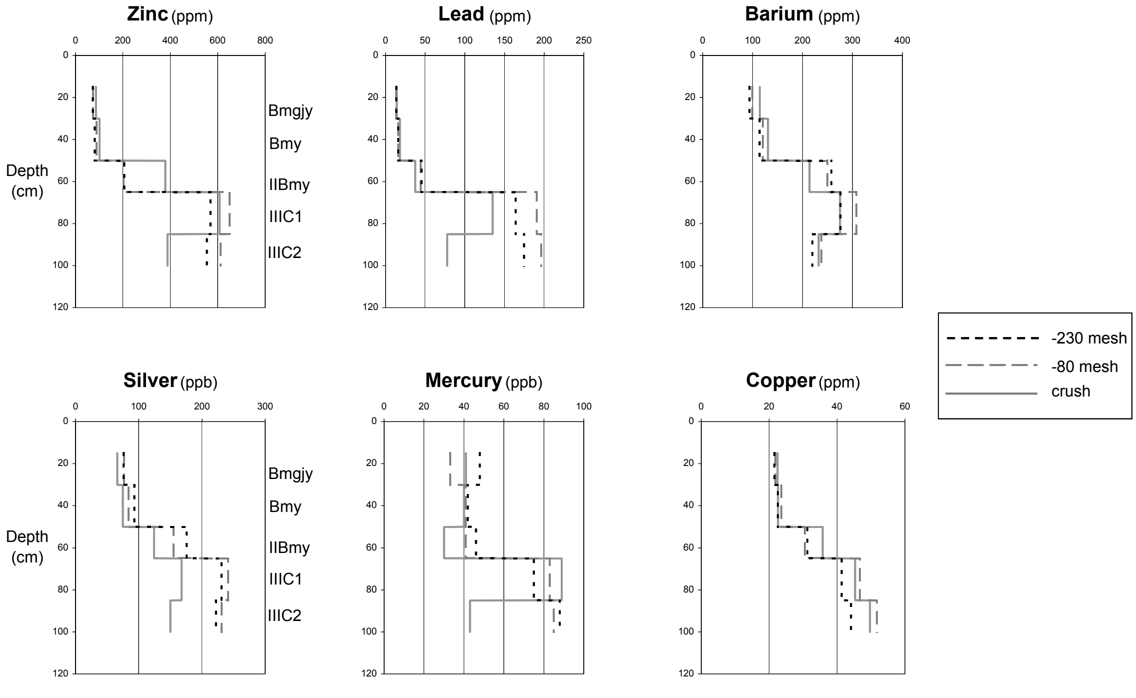

*Figure 27. Selected element profiles from Clip 1, Clip property.*

the C-horizon, where the highest zinc and lead concentrations were found, the -80 mesh fraction contained the highest values. The crush fraction contained the most geochemical variation amongst the fractions analysed.

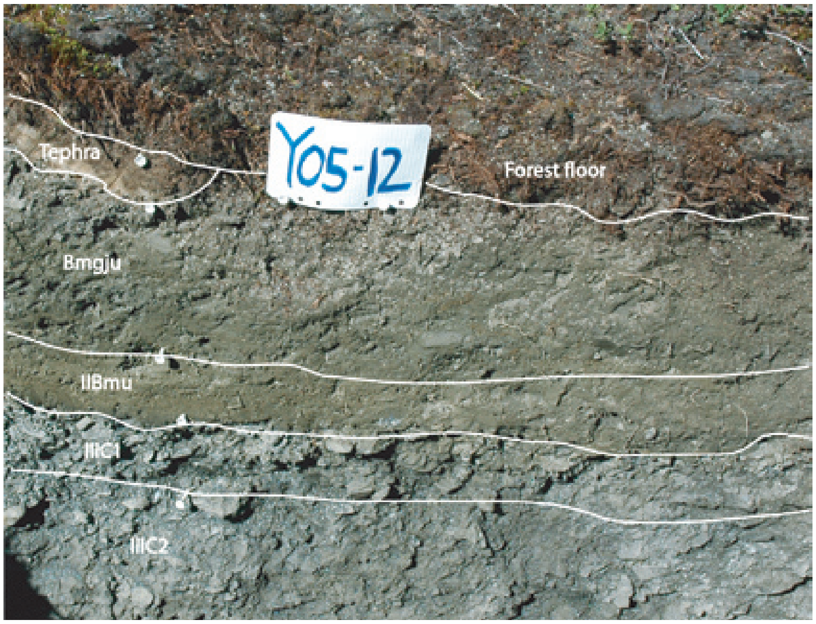

***Figure 28.*** *Soil profile at Clip 2 on the Clip property, with horizons indicated.*

### *4.2.2) Clip 2*

The second soil that was examined on the Clip property was a Gleyed Dystric Brunisol on the upper portion of an east-facing 6° slope. Permafrost was not found in the soil pit, and the morphology of the soil horizons suggests that cryoturbation has been less of an influence than at Clip 1. For example, a discontinuous but distinct tephra layer up to 5 cm thick occurred immediately beneath the surface organic horizon (Fig. 28), rather than intermixed with the upper mineral soil as at Clip 1. However, the strong contrasts in coarse fragment (~40% vs. < 5%) and sand (~ 35% vs. 15%) content between the upper and lower B horizons, may indicate that solifluction has locally buried surface aeolian veneers by mixed colluvial materials (Fig. 28). Given the high elevation of the Clip property (> 1000 m), periglacial conditions would have likely prevailed during much of the Pleistocene. The abrupt lower boundary of the solum at 31 cm separated the IIBmy from the C horizon, which consisted of > 80% coarse material (clasts) derived from dark gray schist. Two C horizons were recognized (IIIC1 and IIIC2) based on subtle differences in colour, but otherwise differed little in texture or chemical properties.

Although mottling, indicative of impaired drainage conditions, did occur in the upper B horizon, the lower mineral soil C concentrations and thinner surface organic horizons suggested a warmer, more aerated soil environment than at Clip 1. However, the presence of standing charred snags at this site suggested that observed forest floor thickness had been recently reduced by fire. Despite this, pH values in the surface horizons differed little from those observed at Clip 1, so the temporary increase in soil pH that usually occurs after fire has apparently dissipated (Fisher and Binkley, 2000).

The patterns of relative and absolute amounts of extractable Fe, Al, and Si were quite similar to those observed at Clip 1, although there was somewhat more pronounced decrease in Fed with depth, from 1.18 to 0.90%.

#### **Geochemistry**

The distributions of prospective elements at Clip 2 showed a general increase in concentration with depth (Fig. 29). Some variation occurred within the B and C horizons. For example, the element concentrations in the IIBmy horizon may be lower or higher compared to the overlying Bmgy horizon. For the main economic elements, zinc and lead, the relative concentrations within the soil were lowest in the lower B horizon. Within the C horizon there was less consistency between the results for zinc and lead. Zinc concentrations showed a progressive increase with depth whereas lead values decreased in the IIIC2 horizon (Fig. 29).

Comparison of the geochemistry from the three size fractions did not show any clear patterns amongst the elements

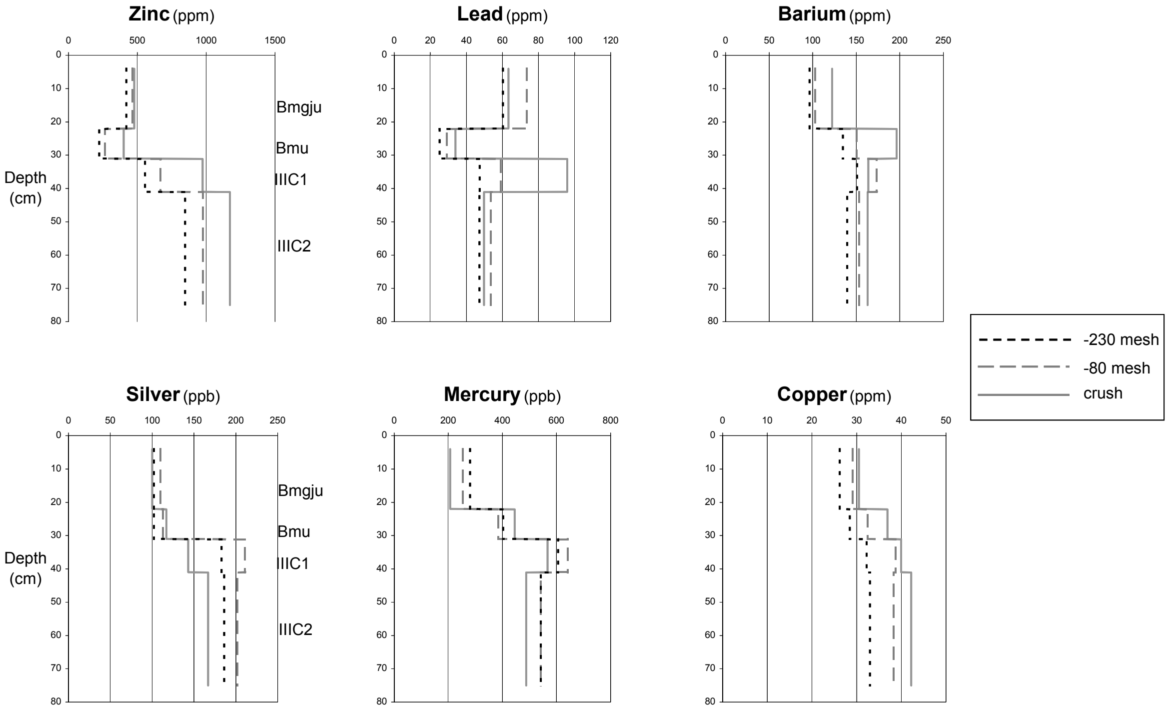

*Figure 29. Selected element profiles from Clip 2, Clip property.*

plotted. For zinc and lead, results from the crush fraction generally produced the highest concentration, however the crush fraction also exhibited the greatest variability (Fig. 29).

### *4.3) LUCKY JOE PROPERTY*

The Lucky Joe property lies 50 km south of Dawson City (Fig. 2). Access to the property is by helicopter. Two hand trenches, located on opposing slope aspects, were excavated on the Bear Cub anomaly (Fig. 30).

***Figure 30.*** *Aerial view of the Bear Cub zone on the Lucky Joe Property showing the location of the soil sites. Bear Cub 1 (right) and Bear Cub 2 (left).*

#### Bedrock

The Lucky Joe property is underlain by metamorphic rocks of Yukon-Tanana Terrane. These include mica schist, quartzite, amphibolite and orthogneiss. Paleozoic to Permian granitic Pelly Gneiss has intruded the rocks and younger intrusive bodies have also been documented on the property. Mineralization at the Lucky Joe deposit consists of disseminated copper and gold-bearing sulphides below a magnetite-rich unit . This was originally discovered after a follow-up on anomalous copper geochemistry in alluvial sediments from Lucky Joe Creek. More recently, the concept for a much larger mineralized copper system has developed following interpretation of low-level geophysical data. A metamorphosed porphyry copper/gold deposit model is being used to investigate this property. Of the three properties studied, the geology of this property most closely resembles the geology found in the Dawson Range gold-copper porphyries that were studied by Hart and Jober (1997). Comparisons with their results can be found in the Discussion section to follow.

*4.3.1) Bear Cub 1*

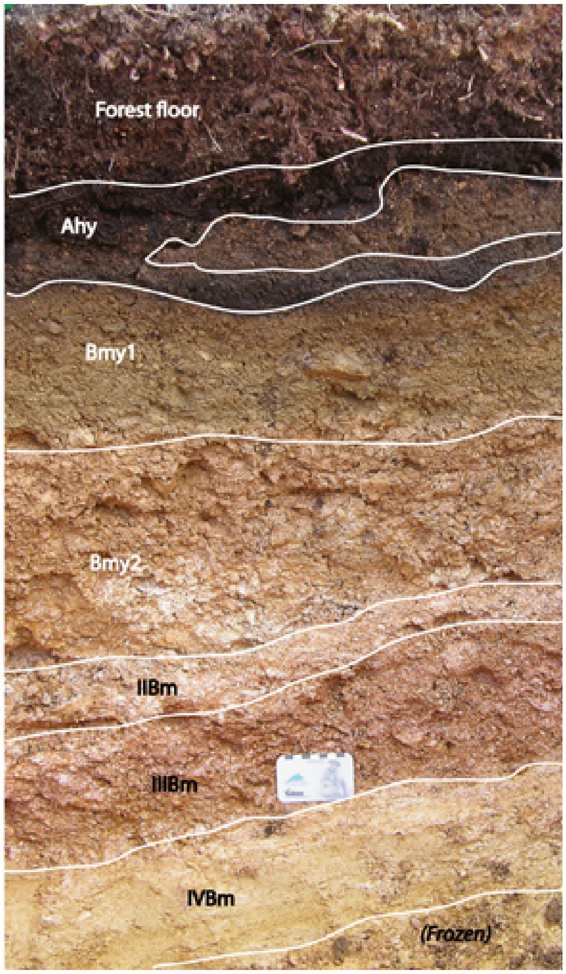

***Figure 31.*** *Soil profile at Bear Cub 1 on the Lucky Joe property, with horizons indicated.*

The two soil pits excavated on the Lucky Joe property were located within the Bear Cub zone, where known anomalous copper and gold had been identified within the soil (Fig. 30). The first soil pit was situated approximately 60 m downslope from the ridge crest on a north-facing (340˚) 14˚ slope. The soil was classified as an Orthic Dystric Turbic Cryosol and its parent material consisted of cryoturbated colluvium and loess (Fig. 31). There was no coherent bedrock found above the permafrost table at 80 cm.

The thick (18-cm) forest floor at this site is consistent with observations of surface organic horizon thicknesses on similar aspects in the Klondike Plateau. The 2004 forest fire caused only minor charring of the moss and litter. Soil reaction was strongly acidic throughout the active layer, with pH increasing slightly with depth.

Cryoturbation was evident in the form of involutions of the dark-coloured Ahy horizon into the Bmy horizon (Fig. 31). In contrast, the underlying horizons had smooth or wavy boundaries, with much less disruption or mixing evident, perhaps indicating that active layers have been thinner in the past. However, the considerable uniformity in soil textures, and absence of a distinct silty surface horizon, did suggest that a greater degree of mixing of parent materials has occurred than at Bear Cub 2.

The predominantly 7.5YR and 5YR hues in the lower Bm horizons paralleled the high (>2.5%) Fed concentrations. Almost all of the extractable Fe was in crystalline form, as indicated by the negligible $Fe_p$ concentrations and low $Fe_o$ / $Fe_d$ ratios (< 0.10) below 35 cm depth. Extractable Al and Si concentrations were low, suggesting that little organically complexed Al and allophanic material were present.

**Geochemistry**

The geochemical profiles for the prospective metals and potential pathfinder elements at Bear Cub 1 are displayed in Figure 32. The distributions of copper, gold and silver were similar, showing a progressive increase with depth from the Bmy horizon to the IIIBm horizon. Concentrations were subsequently reduced in the IVBm horizon with copper exhibiting the largest decrease. The iron concentration also had a similar distribution to that of copper except in the IVBm horizon (Fig. 32). Other elements that had a similar distribution to copper, gold and silver within the data set included cobalt, strontium and calcium (Appendix C).

The concentration profile for molybdenum was plotted in Figure 32 to illustrate its contrasting distribution to copper. Molybdenum concentrations were relatively uniform in the upper horizons and increased by 400% in the IVBm horizon. The distribution of zinc also contrasted with copper, showing a gradual decrease in concentration with depth (Fig. 32).

A comparison of the grain-size fraction geochemistry at Bear Cub 1 indicated that the -80 mesh typically returned the highest concentrations.

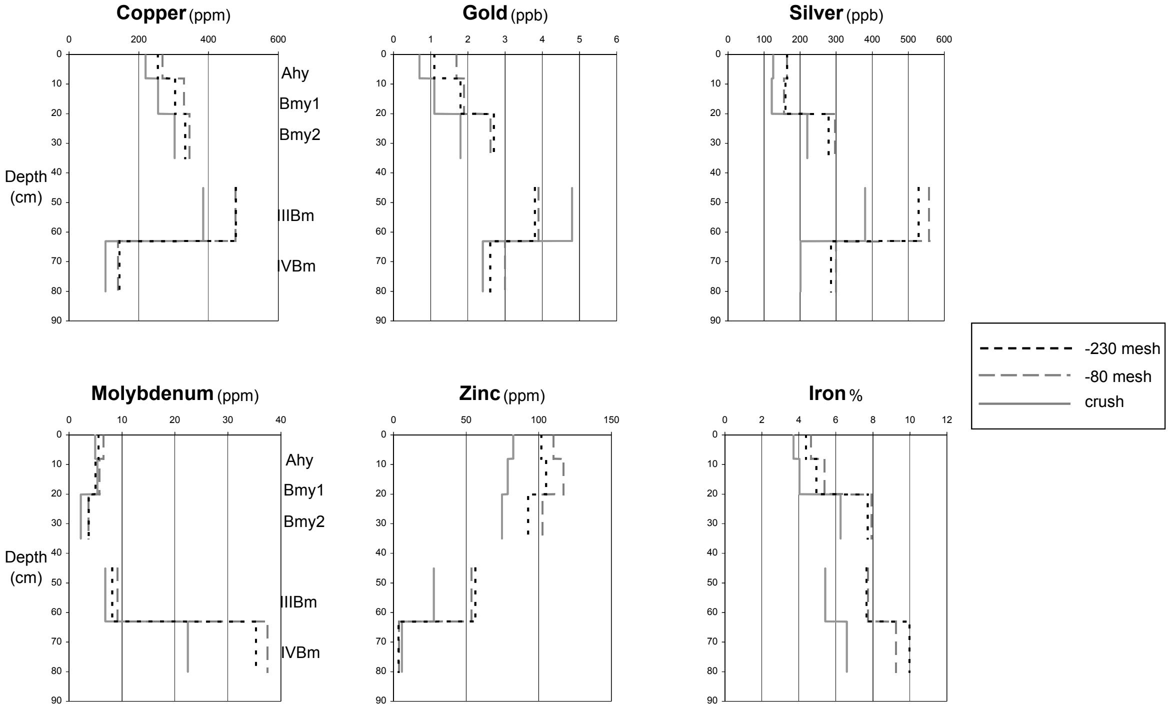

*Figure 32. Selected element profiles from Bear Cub 1, Lucky Joe property. (Gap in profiles indicates missing sample.)*

### 4.3.2) Bear Cub 2

The second soil pit was situated on an 18° slope that has a south-southeast-facing aspect (130°). The site is well-drained and no permafrost was found to at least 230 cm depth. The soil at this site is an Orthic Dystric Brunisol (Fig. 33), with strong brown and dark red colours in the upper 75 cm of the profile. The parent material consists of a veneer of silt loam loess overlying sandy loam colluvium and loamy sand schist-derived saprolite. Below the B horizon, there is a gradual transition to weathered bedrock, accompanied by decreasing clay content. The soil pit was excavated to 140 cm depth and a soil auger sample obtained incoherent weathered bedrock at 230 cm. No outcrops were observed on the upper slope portions of the hill containing the Bear Cub 1 and 2 sites, so it is likely that depth to consolidated bedrock could be considerably greater. The unconsolidated portion is assumed to represent an oxidized surface cap.

The forest floor was largely destroyed by

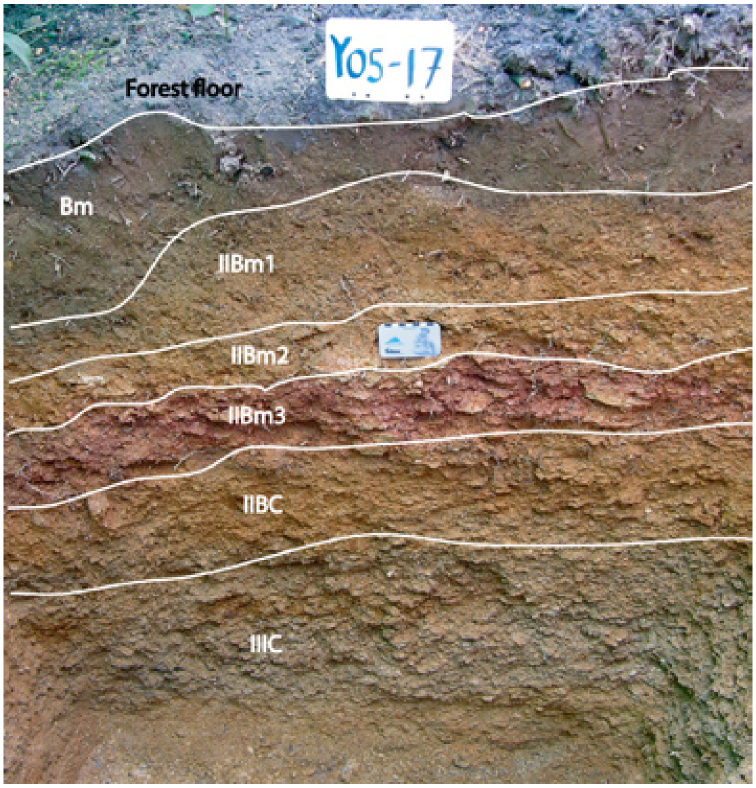

***Figure 33.** Soil profile at Bear Cub 2 on the Lucky Joe property, with horizons indicated.*

a 2004 wildfire, although it is likely that its pre-fire thickness was considerably less than at Bear Cub 1. The low C concentration (< 17%) of the charred remnant of FH horizon likely resulted from some intermixing of mineral material by post-fire erosion. The near-neutral pH in this horizon is typical of the temporarily reduced acidity in surface soils usually observed after fires, an effect that usually dissipates within a few years. Otherwise, the acidic pH values in the mineral horizons were similar to those at Bear Cub 1, increasing slightly with depth.

Below the abrupt textural change at the base of the Bm horizon, clay and silt content decreased gradually with depth in the colluvium and bedrock-derived horizons. This contrasts with the much greater uniformity of textures in the cryoturbated active layer at Bear Cub 1.

The reddening of the lower Bm horizons was even more pronounced than at Bear Cub 1, and corresponded to extractable Fe concentrations that were the highest of any soil examined in this study (> 3% $Fe_d$ ). As at Bear Cub 1, almost all of the extractable Fe was in crystalline form, particularly in the lower Bm horizons, and the 2.5YR hue of the IIBm2 horizon may indicate that hematite is present (Schwertmann, 1993). Little Fe and Al were present in organically complexed forms, and the low concentrations of Alo and Sio suggested that only small amounts of allophanic material (<1%) were present. Fed concentrations decreased from > 3% to < 1% from the IIBm3 to the IIIC horizon, while the aqua regia-soluble Fe concentrations in all size fractions showed much less change with depth in these horizons. If the latter values are an approximation of total Fe content, then these trends likely reflect a weakening in the intensity of weathering with depth. Given the very low Fep concentrations in all horizons, it appears that pedogenic oxides have accumulated primarily through in-situ weathering of primary minerals, rather than by downward translocation of organic complexes, as in Podzolic soils (Lundström et al., 2000).

## Geochemistry

With the exception of zinc, the metal concentrations at Bear Cub 2 were relatively low in the loess-derived Bm horizon (Fig. 34). Concentrations increased by 200 – 700% from the Bm to the IIBm horizon, which consisted mostly of locally derived colluviated weathered bedrock. Copper concentrations remained relatively constant at depth with the exception of the IIBm3 horizon (Fig. 34). Gold concentrations also increased below the Bm horizon but unlike copper, gold concentrations were elevated in the IIBm3 horizon (Fig. 34). The concentration profile for

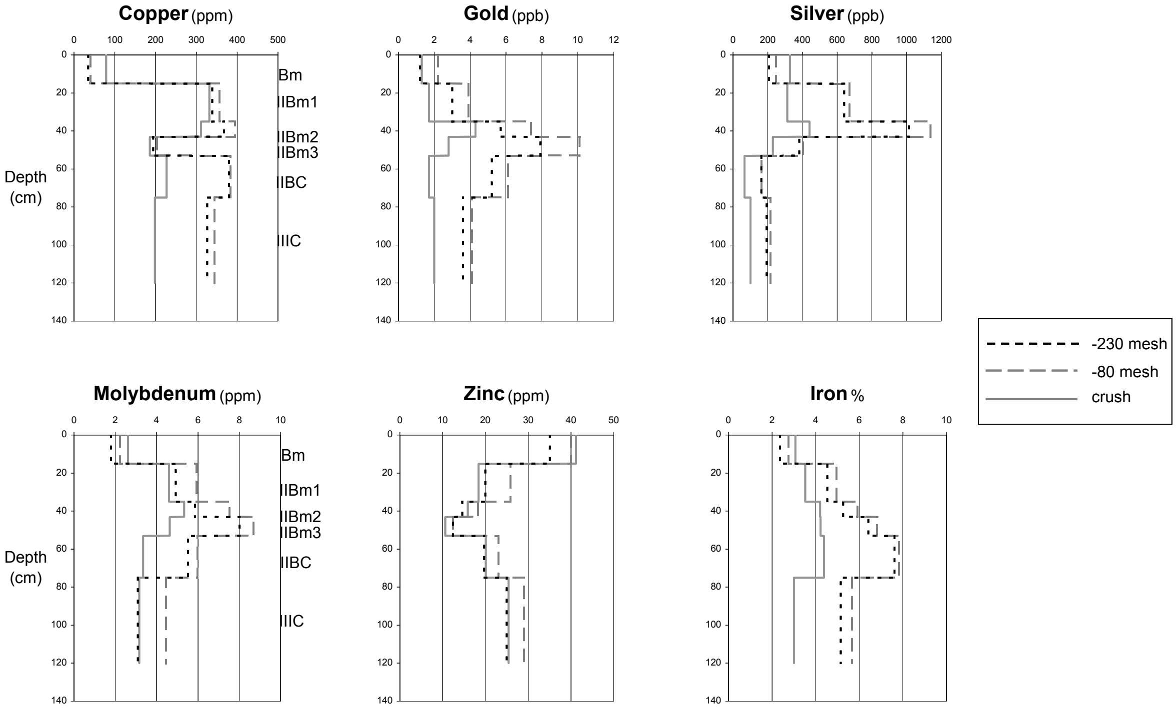

*__Figure 34.__ Selected element profiles from Bear Cub 2, Lucky Joe property.*

molybdenum was similar to that for gold, however the molybdenum values were not as high as those observed from the IVBm horizon at Bear Cub 1. Zinc concentrations were highest in the loess-rich Bm horizon whereas zinc depletion is apparent in the IIBm3 horizon and the lower two horizons.

For the elements assessed in Figure 34 at Bear Cub 2, the -80 mesh fraction consistently returned the highest concentrations within the regolith-based horizons. Within the loess-derived Bm horizon, analyses of the crush fraction typically returned the highest concentrations. In contrast, the crush fraction returned the lowest concentrations in the colluvium-derived horizons.

## 5.0) DISCUSSION

The upland soils of west-central Yukon have developed on slopes that have been strongly influenced by colluviation. Clear microclimatic contrasts, related to changes in slope aspect, result in a pattern of soil-landscape variation that is recognizable across the study area. Due to the important role of slope processes in this landscape, in situ soil weathering appears to have had a largely secondary influence on soil characteristics, despite the age of the unglaciated surface. The main factors affecting soil characteristics include bedrock lithology, slope aspect, geomorphic processes and aeolian contributions.

### *5.1) NORTH-FACING ASPECTS*

The Brunisols and Cryosols found on north-facing aspects are developed in a layer of colluvium and in-situ weathered bedrock. Permafrost or former permafrost processes have played an important role in modifying soil morphology by forming cryoturbate horizons within the seasonally thawed active layer. This process mixes the various parent materials and disrupts soil horizon development. This was apparent at the Lonestar and Clip properties where the A and B horizons were only weakly differentiated. Soil horizon development on these aspects was generally indistinct, showing weak oxidation, limited extractable aluminum, and a lack of vertical translocation of clay and weathering products. Horizons within the present or former active layers have higher silt content and a brownish colour, reflecting incorporation of loess. Placement of the boundary between the B and C horizon is often based on the apparent lower limit of cryoturbation. Colluviation is also most pronounced within the active layer.

The geochemistry of soils developed on slopes with colder microclimates can be influenced by the effects of cryoturbation. This is accomplished by mixing loess and organic material to depth within the soil profile. Organic material can act as an adsorption site for certain metals like iron, mercury and lead, which increases the geochemical variability within a soil and can provide misleading results (Evans, 1989). At the Lone Star property (Boulder Lode 1), cryoturbated inclusions of A-horizon material were assayed and compared to the geochemistry of surrounding B horizons. Results showed slight increases in the extractable iron content within these inclusions, however no observable patterns were present for gold or potential pathfinder elements. It is proposed that the main cause of gold variability in these colluvial–based soils is most likely attributed to lithologic changes in upslope bedrock.

The diluting effects of loess incorporation on soil geochemistry is perhaps more significant than scavenging or complexing of metals by organic matter. Loess incorporation may obscure any geochemical anomalies derived from the underlying weathered bedrock. Intact loess deposits were not observed on the north-facing slopes, which suggest that cryoturbation has effectively mixed the loess into the colluviated weathered bedrock. Evidence of loess incorporation in the soil is suggested by the elevated silt content of surface mineral horizons, for example, at the Clip property where silt accounted for 54% of the two upper B horizons. This contrasted with 30% silt in the lower B horizon and 8% in the upper C horizon. In contrast, the percentage sand content increases with depth, which corresponded to a significant increase in zinc concentration from the B to the C horizon (Fig. 27). By comparing the geochemistry of the upper B horizons (15-50 cm depth) with the C-horizons ($65^{+}$ cm depth) the amount of loess dilution at Clip 1 is estimated to be upwards of 600%.

Dilution effects were also present on the Lone Star property. Within the loess-rich B horizon, gold concentrations were commonly highest in the -80 mesh versus the -230 mesh component. This is reasonable since the -80 mesh component includes fine sand, which is less likely to be an aeolian addition, and therefore decreases the overall percentage of loess in the sample. The opposite is true for the weathered bedrock-rich C horizon on the Lone Star property where the -230 mesh component consistently returned the highest concentrations. In this horizon the -230 mesh component may contain a relatively high percentage of locally produced clay, which not only has a geochemical signature similar to the local bedrock but also has the ability to scavenge and accumulate free metals.

### Recommendations for exploration geochemistry on north-facing slopes

Devising soil exploration strategies for north-facing slope conditions can benefit from an awareness of permafrost distribution and colluvial processes. In these environments the colluvium consists of a combined layer of weathered bedrock, loess and organic material that is creeping downslope. Typically, the base of the colluvium will consist of material that is derived from a proximal bedrock source (within ~0-10 m) compared to the more distally derived near surface component (~5-50 m). Likewise, the more distally derived material will represent a blend of a relatively large area of upslope bedrock, whereas the proximally derived material will represent a smaller point source. Recognizing these surficial characteristics allows the explorationist to target levels within the colluvium that suit the type of program they are conducting, whether it be regional- or target-scale exploration.

Consideration must also be given to the effects fire has on the mass transport of debris in these environments. Numerous active-layer detachment slides have been identified in the Dawson area since the forest fires of 2004 (Lipovsky et al., 2006). These slides are typically located on north- and east-facing aspects and can transport colluvial deposits more than 200 m to the valley floor (Lipovsky et al., 2006). Modern examples of these slides are obvious, however older slides may retain little surface expression and will undoubtedly affect the interpretation of soil geochemistry.

As mentioned earlier, samples derived from the upper B horizons (typically the upper 30-50 cm of a soil) can contain a significant loess component and should be avoided in order to limit geochemical dilution. However, the practicalities of predicting loess content from a small soil pit or auger sample may be difficult. It is recommended that a large exposure of the soil be excavated in order to observe the textural properties within a given exploration target. A ratio of at least 40% clasts (pebbles) to 60% matrix (sand, silt, clay) should be present within a horizon to ensure significant weathered bedrock content in the matrix fraction. At the sites investigated in this study, the transition from dominantly loess to dominantly weathered bedrock fractions in the soil matrix typically occurred in the lower part of the B horizon (>50 cm depth). The lower B horizon may still contain some loess, however the overall percentage will be lower compared to overlying horizons.

C-horizon material will provide the most accurate indication of bedrock geochemistry. This is mainly because it has endured limited colluvial transport and contains the least amount of foreign material incorporated by cryoturbation. Using hand tools to extract C-horizon samples can be difficult due to factors such as high coarse fragment content, permafrost, or thickness of the overlying surficial materials.

## *5.2) SOUTH-FACING ASPECTS*

The morphology and geochemistry of soils at the south-facing sites were strongly influenced by the variability of bedrock and colluvium properties. The absence of cryoturbation gives the colluvium a layered appearance that can be related to lithological units upslope. The surficial deposits on these slopes are generally thin (< 2 m) and a typical soil has formed within a relatively intact layer of loess that overlies colluviated weathered bedrock and in-situ weathered bedrock. Evidence of solifluction at Clip 2 suggests that permafrost may have been a factor on southerly aspects in alpine and subalpine environments.

Compared to the Brunisolic and Cryosolic soils on north-facing aspects, the Orthic Dystric Brunisols developed on the south-facing aspects generally displayed more abrupt horizon boundaries, more limited accumulation of organic matter in both the forest floor and mineral horizons, stronger brown or reddish brown oxidized colours, and higher extractable Fe concentrations. Although lacking the clay films characteristic of B horizons in Luvisolic soils formed

on Pliocene or early Pleistocene glacial deposits in west-central Yukon (Tarnocai and Smith, 1989), these soils have similarly reddish colours and concentrations of extractable Fe and Al in many of their B horizons.
Soil geochemical variability on the south-facing slopes appears to have been more influenced by the complexities of parent material than the in-situ effects of soil weathering. Some translocation of elements between horizons has likely occurred, however distinguishing and quantifying this effect from the effects of compositional variability is difficult and will require further study. This is highlighted at Nugget 1-1 on the Lone Star property where the IIBm (10-35 cm depth), IIIBm (35-50 cm depth) and IVBm1 (50-55 cm depth) consist of colluviated phyllite, vein quartz and mafic intrusive material, respectively. The geochemistry reflects the compositional changes between the horizons, with the highest gold content occurring in the vein-quartz-rich colluvium (Appendix C) as would be expected.

Soil weathering and its effects on metal distributions were also assessed in a soil having little compositional variability in the colluvium. At Bear Cub 2 all of the horizons below the loess consisted of weathered mica schist. The copper concentrations were surprisingly uniform beneath the loess (Fig. 34), other than a 10-cm-thick iron-rich horizon, which was depleted in copper and enriched in gold relative to the other B horizons. The anomalous geochemistry of this iron-rich horizon (IIBm3) is likely due to lithological changes in the colluvium. The elevated B and C horizons at Lucky Joe are similar to Hart and Jober's (1997) results from the Dawson Range. They suggested that the metal concentrations observed in the lower B and C horizons were enriched by downward metal precipitation. This was suggested because of the relatively depleted concentrations observed in the upper B horizon, which they hypothesized was the result of downward percolation by acidified waters. While this may be true, the depletion in the upper B horizon at Lucky Joe appears to be controlled by loess dilution. Processes of secondary enrichment in the lower horizons at Lucky Joe were not apparent. Differences arising between the Dawson Range study and this study may result from the terrain in which the soil profiles were described. The Dawson Range study focused on soils that were free of permafrost and on level ground as opposed to this study that targeted soils on slopes.

Beneath the A horizon, the loess veneer was easily recognized on all the southerly aspect sites. Limited colluviation of the loess has meant that few clasts have been incorporated from underlying colluviated weathered bedrock. In general, clast abundance was estimated at less than 10% in the surface loess veneer. As a result, the loess-influenced A and B horizons showed little expression of geochemical anomalies compared to the underlying colluviated weathered bedrock. This was particularly evident at Bear Cub 2 (Fig. 33 and 34). An exception occurred at Nugget 2 where vein-quartz fragments were observed in the loess as a result of its proximity (<20 m) to known gold-bearing veins. Geochemical analyses of the crush fraction at this site returned a gold value of 2317 ppb and relatively high gold concentrations in the -80 and -230 mesh fractions.

## **Recommendations for exploration geochemistry on south-facing slopes**

Soil geochemical variability on south-facing slope aspects reflects the contributions of both loess and locally derived colluvium. The usefulness of loess geochemistry using weak extractions or mobile metal ion analyses was not addressed in this study. For conventional soil geochemical surveys, samplers should be trained to identify and avoid the loess veneer. Suitable samples of weathered bedrock material are readily obtainable under the loess (base of loess = ~15 cm depth). This contrasts with north-facing aspects where cryoturbation effects makes it necessary to sample within the lower B or C horizon (~50 cm depth) in order to maximize metal concentrations.

On the Lone Star property, the bedrock sources of colluvium were expressed in a predictable sequence of parent materials. It was apparent from the colluvium that the upper portions consisted of further-traveled debris derived from a broader area of upslope bedrock, whereas the lower portions of the colluvium represented more locally derived weathered bedrock. As on north-facing slopes, this observation should be considered when designing soil sampling strategies. For example, where low-density sampling is being conducted (>200-m line spacing), the top of the colluviated weathered bedrock will represent a greater area of upslope bedrock and therefore increase the chances of locating mineralized rock on that slope segment. Selective sampling within the colluvium also depends on an understanding of the lateral distance required for a bedrock fragment to travel vertically within the colluvial column. Observations on the Lone Star property indicate that this lateral distance can be fairly short. At Nugget 1, a zone of weathered intrusive rock was easily traced downslope within the colluvium (Fig. 17). The intrusive material became entrained within the colluvium at 50 cm depth and rose to 15 cm depth over the course of 4 m on a 14° slope. At Nugget 2, the maximum transport distance for the gold-bearing vein quartz to reach the top of the colluvial layer, near the base of the loess, was 25 m on a 9° slope. In order to adequately assess the entrainment process, the total lateral dispersal distance needs to be mapped in future studies.

The pattern of complex but distinct stratification of parent materials observed at mid-slope elevations on the Lone Star (779 m a.s.l.) and Lucky Joe (741 m a.s.l.) properties is not necessarily transferable into higher elevation sites. On the Clip property (1044 m a.s.l.), a soil pit on an east-facing subalpine slope exposed a layer of material displaying solifluction, consisting of mixed loess and weathered bedrock, that had overridden and buried a relatively undisturbed loess deposit (Fig. 28). As a result, the solifluction sediment, which contained 40% clasts and 60% matrix, had twice the lead concentrations of the underlying loess (Fig. 29). This highlights the importance of recognizing how complexities in soil characteristics reflect the interplay of parent materials, elevation, and moderate slope aspect changes. For exploration, this means that it is insufficient simply to advise samplers to collect soil material from a constant depth.

### *5.3) SIZE FRACTION GEOCHEMISTRY*

Comparison of the geochemistry derived from -80 and -230 mesh fractions illustrated that while actual concentrations may differ between the two fractions the concentration profiles were commonly similar. In fact, stronger geochemical contrasts were observed between horizons as opposed to between grain-size fractions. As a result, more emphasis should be placed on determining appropriate soil horizon as opposed to size fraction. Results from the crush fraction, on the other hand, had a tendency to produce more erratic concentrations. In certain circumstances, however, assaying the crush fraction may be useful. On the Lone Star property it was observed that by incorporating the clast fraction into the assay you are essentially testing whether the coarse component contains gold. The presence of gold would confirm that colluviation has been insufficient to liberate the gold into the matrix and therefore the bedrock source must lie nearby. Analyses of this kind may be useful as a follow up on a sample split.

Determining the appropriate soil grain-size fraction to assay may depend upon the commodity of interest and the target soil horizon. Results from this study indicate that for base metals such as copper, lead and zinc, the -80 mesh component was generally the most responsive in either the B or C horizon. For gold, the -80 mesh fraction worked well in the B horizon whereas the -230 mesh contained the highest concentration in the C horizon. This conclusion was also made by Hart and Jober (1997) in the Dawson Range. They suggest this might be a reflection of mature soils in which gold has been chemically transferred to the clay fraction from sand-size rock grains. Above all for mineral exploration, it is recommended that consistency be maintained in both the target sample horizon and mesh size of interest.

## 6.0) FUTURE WORK

This study generally focused on single soil profiles at each of the mineral occurrences. The majority of these sites were located on upper slope positions, near to known mineralized rock. It is recommended that future studies explore soil profiles associated with mid- and lower slope positions to further understand the unglaciated soil landscape. This would also benefit from more continuous soil profile transects to observe local variability. This would rely upon suitable trench exposures.

A second important focus for future studies should look more closely at colluvial content and mineral dispersion within colluvium. The strong geochemical variability associated with lithological changes in the colluvium complicates interpretation of soil geochemical data. Colluvial parent materials in a single soil profile could be derived from several bedrock lithologies. Soil samples derived from the upper portions of the colluvium could have a source as much as 100 m from the sampling site, whereas samples derived from the lower portions of the colluvium may originate only 5-10 m upslope. Future research should describe more thoroughly colluvial dispersion on these slopes. Such a study should try to trace mineral transport distances both laterally from mineralization and vertically within the colluvium.

## 7.0) CONCLUSIONS

The morphology and geochemistry of upland soils in the unglaciated areas of west-central Yukon are strongly influenced by variability in bedrock lithology, aeolian additions, permafrost, and colluviation. Soil horizon development is limited by the active colluvial processes, which displace soil material and disrupt weathering. This is most evident on slopes with north-facing aspects where permafrost is most common. Colluvial dispersion is mainly focused within the active layer and is enhanced by cryoturbation. In contrast, south-facing aspects are free of permafrost and consequently show stronger B-horizon development and more abrupt horizon boundaries.

The main factor affecting the geochemistry of these soils, aside from the bedrock, was the addition of loess during the last glacial period. Loess acts as a geochemical dilutant within the surficial environment, and so its distribution within the soil profile is important to recognize when conducting mineral exploration soil surveys. On north-facing slopes samples should target the lower B horizon (~50 cm depth) in order to minimize loess content. On south-facing slopes the loess veneer is typically more intact at the surface and samples only need to penetrate to ~25 cm depth to obtain weathered bedrock material. Geochemical analyses of different size fractions within a horizon showed relative consistency between the -80 and -230 mesh fractions. Results from the crush fraction, which included pebbles, showed more erratic concentrations compared to the other fractions. In general, geochemical variability was stronger between horizons as opposed to between grain-size fractions.

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# APPENDIX 1: SOIL MORPHOLOGICAL DESCRIPTIONS

Site Name: **Boulder Lode 1**
Site No. **Y05-07**

Site Description
Location: Lone Star – Boulder Lode zone: upper trench site

Latitude: 63º53’36.5”N Longitude: 139º13’49.2”W

UTM: 586861 E, 7086339N Elevation: 991 m

Aspect: 40º Slope: 15% Slope position: Upper slope

Parent material: Colluvium over weathered metamorphic bedrock

Comments: No permafrost detected to 80 cm depth at 4 m away from trench.

*Soil classification:* Orthic Dystric Brunisol (cryoturbic phase)

| **Horizon** (Sample No.) | **Depth** (cm) | **Description** |
|---|---|---|
| S/Lv | 20-18 | Living feathermoss and lichens intermingled with dwarf birch leaf litter; 2-4 cm thick. |
| Fm | 18-3 | Dark brown (7.5YR 3/2 d); partially decomposed moss; moderate, non-compact matted; abundant very fine, fine, medium and coarse, horizontal and oblique roots; abundant mycelia; clear, wavy boundary; 10-20 cm thick; extremely acid. |
| Hh | 3-0 | Very dark greyish brown (10YR 3/2 d); humified organic matter; friable; plentiful very fine, fine, medium and coarse, horizontal and oblique roots; abrupt, wavy boundary; 1-4 cm thick; extremely acid. |
| Ahy1 | 0-5 | Very dark greyish brown (10YR 3/2 m) and very dark brown (10YR 2/2 m); silt loam; moderate, fine and medium subangular blocky; friable; plentiful very fine and fine oblique roots; 50% angular gravel and cobbles; clear, broken boundary; 0-10 cm thick; extremely acid. |
| Bmy1 | 5-15 | Brown (10YR 4/3 m) and dark yellowish brown (10YR 4/4 m); loam; moderate, fine and medium subangular blocky; friable; few very fine and fine oblique roots; 50% angular gravel and cobbles; clear, wavy boundary; 8-20 cm thick; extremely acid. |
| Ahy2 | 15-22 | Dark brown (10YR 3/2 m); loam; moderate, fine subangular blocky; friable; few very fine and fine oblique roots; 40% angular gravel and cobbles; clear, wavy boundary; 0-8 cm thick; extremely acid. |
| Bmy2 | 22-45 | Brown (10YR 5/3 m); loam; weak, medium subangular blocky; friable; few very fine and fine oblique roots; many, 1-3 mm thick silt films on void walls and upper clast surfaces; 50% angular gravel and cobbles; clear, wavy boundary; 15-25 cm thick; extremely acid. |
| Ahy3 | 25-40 | Dark brown (10YR 3/2 m); loam; weak, fine subangular blocky; friable; few very fine and fine oblique roots; 10-20% angular gravel; clear, broken boundary; 0-15 cm thick; extremely acid. |
| IIC | 40-56 | Light yellowish brown (2.5Y 6/4 m) and light grey (2.5Y 7/2 m); sandy loam; massive; friable; 20% angular gravel; clear, wavy boundary; 0-20 cm thick; extremely acid. |
| IIIC | 56-130$^+$ | Pale yellow (2.5Y 7/4 m); sandy loam; massive and single grain; very friable; many, 1-3 mm thick silt coatings on upper clast surfaces in uppermost 50 cm of horizon; 90% angular gravel and cobbles; very strongly acid. |

Site Name: **Boulder Lode 2**
Site No. **Y05-08**

Site Description
Location: Lone Star – Boulder Lode zone: lower trench site

Latitude: 63º53’36.9”N Longitude: 139º13’48.1”W

UTM: 586861 E, 7086339N Elevation: 994 m

Aspect: 40º Slope: 15% Slope position: Upper slope

Parent material: Colluvium over weathered metamorphic bedrock

*Soil classification:* Orthic Dystric Brunisol (cryoturbic phase)

| **Horizon** (Sample No.) | **Depth** (cm) | **Description** |
|---|---|---|
| S/Lv | 20-18 | Living feathermoss, intermingled with dwarf birch and Labrador tea leaf litter; 1-3 cm thick. |
| Fm | 18-0 | Dark brown (7.5YR 3/2 d); partially decomposed moss; plentiful, very fine, fine, medium and coarse, horizontal and oblique roots; abundant mycelia; abrupt, wavy boundary; 15-20 cm thick; extremely acid. |
| Ahe | 0-2 | Black (10YR 2/1 m) and greyish brown (10YR 5/2 m); silt loam; moderate, fine and medium granular; friable; plentiful very fine, fine and medium, horizontal roots; 30% angular gravel and cobbles; abrupt, wavy boundary; 1-3 cm thick; extremely acid. |
| Bmy1 | 2-38 | Brown (10YR 5/3 m); loam; moderate, medium subangular blocky; friable; few very fine and fine, oblique roots; 30% angular gravel and cobbles; gradual, wavy boundary; 35-40 cm thick; extremely acid. |
| Bmy2 | 38-85 | Pale brown (10YR 6/3 m); sandy loam; moderate, medium subangular blocky; friable; few, very fine, oblique roots; many, 1-3 mm thick silt coatings; 70% angular gravel and cobbles; clear, wavy boundary; 40-50 cm thick; extremely acid. |
| IIC1 | 85-105 | Pale yellow (2.5Y 7/3 m); sandy loam; single grain; loose; 40% angular cobbles; abrupt, wavy boundary; 0-35 cm thick; extremely acid. |
| IIC2 | 105-150$^+$ | Reddish yellow (7.5YR 6/6 m) and very pale brown (10YR 8/2 m); sand; single grain; loose; 20% angular gravel; extremely acid. |
| IIC3 | 85-150$^+$ | Light grey (2.5Y 7/2 m); sandy loam; single grain; loose; 80% angular gravel and cobbles; extremely acid. |

Site Name: **Nugget 1**
Site No. **Y05-09**

Site Description
Location: Lone Star – Nugget zone: lower trench site

Latitude: 63º53'15.1"N Longitude: 139º16'18.5"W

UTM: 584859 E, 7085582N Elevation: 779 m

Aspect: 240º Slope: 25% Slope position: Midslope

Parent material: Aeolian veneer over colluvium derived from weathered metamorphic (phyllite) bedrock with mafic intrusions.
Comments: Three profiles (1 m wide) were described and sampled over 5 m of cleaned exposure in an exploration trench oriented approximately perpendicular to the contour. The sequence of profiles 1-3 is arranged upslope to downslope.

**Profile 1**
*Soil classification:* Orthic Dystric Brunisol

| Horizon (Sample No.) | Depth (cm) | Description |
|---|---|---|
| Lv | 5-4 | Leaf litter from aspen, Labrador tea, and crowberry; 1 cm thick; strongly acid. |
| Fm | 4-0 | Very dark brown (10YR 2/2 m); partially decomposed organic matter; moderate, non-compact matted; abundant, very fine, fine, and medium, oblique and horizontal, and plentiful, coarse, horizontal roots; abrupt, wavy boundary; 3-5 cm thick; medium acid. |
| Ahe | 0-5 | Very dark greyish brown (10YR 3/2 m) and brown (10YR 5/3 m); silt loam; weak, medium granular; friable; abundant, very fine, fine, and medium, horizontal and oblique roots; 5% angular gravel; abrupt, broken boundary; 0-6 cm thick; extremely acid. |
| Bm | 5-10 | Strong brown (7.5YR 4/6 m); silt loam; weak, medium subangular blocky, and moderate, fine platy; friable; plentiful very fine, fine, and medium and few coarse, horizontal and oblique roots; 20% angular gravel; clear, wavy boundary; 3-6 cm thick; extremely acid. |
| IIBm | 10-35 | Brown (7.5YR 5/4 m); sandy loam; weak, fine platy; friable; plentiful, very fine and fine, oblique roots; 80% angular (phyllite) gravel and cobbles; clear, wavy boundary; 15-30 cm thick; extremely acid. |
| IIIBm | 35-50 | Strong brown (7.5YR 4/6 m) and dark brown (7.5YR 3/4 m); sandy loam; massive; friable; plentiful, very fine and fine, oblique roots; 90% angular (quartz) gravel and cobbles; abrupt, wavy boundary; 0-45 cm thick; very strongly acid. |
| IVBm1 | 50-55 | Dark brown (7.5YR 3/4 m); loam; massive; friable; few, very fine and fine oblique roots; 5% angular (weathered mafic) gravel; clear, wavy boundary; 5-8 cm thick; strongly acid. |
| IVBm2 | 55-80 | Olive brown (2.5Y 4/4 m) and dark brown (7.5YR 3/4 m); sandy loam; massive; friable; few, very fine and fine oblique roots; 20% angular (weathered mafic) gravel; clear, wavy boundary; 15-30 cm thick; strongly acid. |
| IVBm3 | 80-90 | Dark olive brown (2.5Y 3/3 m); sandy loam; single grain; very friable; few, very fine and fine oblique roots; 90% angular (mafic) gravel and cobbles; clear, wavy boundary; 5-20 cm thick; strongly acid. |
| R | $90\text{-}150^{+}$ | Fractured mafic bedrock. |

**Profile 2:**

*Soil classification:* Orthic Dystric Brunisol

| **Horizon**<br>**(Sample No.)** | **Depth**<br>**(cm)** | **Description** |
|---|---|---|
| Lv | 4-3 | Leaf litter from aspen and kinnickinick; 1 cm thick; very strongly acid. |
| Fm | 3-0 | Very dark brown (10YR 2/2 m); partially decomposed organic matter; moderate, non-compact matted; abundant, very fine, fine, and medium, oblique and horizontal, and plentiful, coarse, horizontal roots; abrupt, wavy boundary; 2-4 cm thick; slightly acid. |
| Ahe | 0-3 | Very dark greyish brown (10YR 3/2 m) and brown (10YR 5/3 m); silt loam; weak, medium granular; friable; abundant, very fine, fine, and medium, horizontal and oblique roots; 5-10% angular gravel; abrupt, broken boundary; 0-4 cm thick; very strongly acid. |
| Bm | 3-15 | Strong brown (7.5YR 4/6 m); silt loam; weak, fine platy; friable; plentiful very fine, fine, and medium and few coarse, horizontal and oblique roots; 5-10% angular gravel; abrupt, wavy boundary; 8-18 cm thick; extremely acid. |
| IIBm | 15-32 | Strong brown (7.5YR 4/6 m); loam; weak, fine platy; friable; plentiful, very fine, fine, and medium, horizontal and oblique roots; 80% angular (phyllite) gravel and cobbles; abrupt, wavy boundary; 14-18 cm thick; extremely acid. |
| IIIBm1<br>*(= IVBm1 in profile 1)* | 32-38 | Brown (7.5YR 4/4 m); loam; weak, fine and medium subangular blocky; friable; plentiful, very fine, fine, and medium, horizontal and oblique roots; 5-10% angular fine gravel; clear, wavy boundary; 4-6 cm thick; extremely acid. |
| IIIBm2<br>*(= IVBm2 in profile 1)* | 38-43 | Strong brown (7.5YR 4/6 m); loam; weak, fine and medium subangular blocky; friable; plentiful, very fine, fine, and medium, horizontal and oblique roots; 10-20% angular gravel; abrupt, wavy boundary; 5-8 cm thick; very strongly acid. |
| IIIBm3<br>*(= IVBm3 in profile 1)* | 43-160$^{+}$ | Dark yellowish brown (10YR 4/4 m); sandy loam; massive; very friable; few, very fine and fine oblique roots; 90% angular (mafic) cobbles; gradual, irregular boundary; strongly acid. |
| R | 65$^{+}$ | Fractured mafic bedrock. |

**Profile 3:**

*Soil classification:* Orthic Dystric Brunisol

| Horizon (Sample No.) | Depth (cm) | Description |
|---|---|---|
| Lv | 4-3 | Leaf litter from aspen and kinnickinick; 1 cm thick; strongly acid. |
| Fm | 3-0 | Black (10YR 2/1 m); partially decomposed organic matter; moderate, non-compact matted; abundant, very fine and fine, oblique and horizontal roots; abrupt, wavy boundary; 2-4 cm thick; medium acid. |
| Bm1 | 0-15 | Brown (7.5YR 4/4 m) and dark brown (7.5YR 3/4 m); silt loam; weak, fine platy, and weak, fine and medium, subangular blocky; friable; plentiful very fine and fine, few medium, oblique roots; 40% angular (mixed lithology) gravel; clear, irregular boundary; 11-20 cm thick; extremely acid. |
| Bm2 | 15-37 | Strong brown (7.5YR 4/6 m) and (7.5YR 5/6 m), with 3 cm thick band of yellowish brown (10YR 5/6 m) disintegrated phyllite; sandy loam; weak, fine subangular blocky; friable; plentiful very fine and fine, few medium, oblique roots; 50% angular (mixed lithology) gravel; clear, wavy boundary; 20-25 cm thick; extremely acid. |
| IIBm | 37-65 | Dark yellowish brown (10YR 4/4 m); sandy loam; single grain; loose; plentiful very fine and fine, few medium, oblique roots; 80% angular (mafic) gravel; clear, irregular boundary; 22-35 cm thick; very strongly acid. |
| R | 65-120$^+$ | Fractured mafic bedrock. |

Site Name: **Nugget 2**
Site No. **Y05-10**

Site Description
Location: Lone Star – Nugget zone: upper trench site

Latitude: 63º53'16.3"N Longitude: 139º16'14.3"W

UTM: 584915E, 7085671N Elevation: 784 m

Aspect: 240º Slope: 16% Slope position: Mid-slope

Parent material: Aeolian veneer over colluvium derived from weathered metamorphic (phyllite) bedrock.

Comments: Profile was described over a lateral interval of 250 cm.

*Soil classification:* Orthic Dystric Brunisol

| **Horizon** (Sample No.) | **Depth** (cm) | **Description** |
|---|---|---|
| Lv | 4-3 | Leaf litter from aspen and crowberry; 1-2 cm thick; very strongly acid. |
| Fm | 3-0 | Very dark brown (10YR 2/2 m); partially decomposed organic matter; moderate, non-compact matted; abundant, very fine, fine, and medium, oblique and horizontal roots; abrupt, wavy boundary; 2-4 cm thick; medium acid. |
| Ahe | 0-3 | Brown (10YR 5/3 m) and very dark brown (10YR 3/2 m); silt loam; weak, medium granular; friable; abundant, very fine and fine, and few, medium and coarse, horizontal and oblique roots; 5% angular gravel; abrupt, broken boundary; 0-4 cm thick; extremely acid. |
| Bm | 3-14 | Brown (7.5YR 4/4 m); silt loam; moderate, fine and medium subangular blocky, and weak, fine platy; friable; abundant, very fine and fine, and few, medium and coarse, horizontal and oblique roots; 5% angular gravel; clear, wavy boundary; 9-15 cm thick; extremely acid. |
| IIBm1 | 14-32 | Strong brown (7.5YR 5/6 m) and (7.5YR 4/6 m); sandy loam; moderate, fine and medium platy; friable; abundant, very fine and fine, horizontal and oblique roots; 40% angular (phyllite) gravel; clear, wavy boundary; 17-20 cm thick; extremely acid. |
| IIBm2 | 32-50 | Yellowish brown (10YR 5/6 m); sandy loam; massive; very friable; few, very fine and fine, oblique roots; 80% angular gravel and cobbles; gradual, wavy boundary; 0-25 cm thick; extremely acid. |
| IIC | 50-100$^{+}$ | Yellowish brown (10YR 5/4 m); sandy loam; single grain; loose; 90% angular gravel and cobbles; extremely acid. |

Site Name: **Clip 1**
Site No. **Y05-11**

<u>Site Description</u>
Location: Clip property: NW aspect

Latitude: 64º13’1.0”N Longitude: 140º23’24.1”W

UTM: 529603E, 7121324N Elevation: 1033 m

Aspect: 330º Slope: 14% Slope position: Upper slope

Parent material: Cryoturbated colluvium, with tephra included in surface mineral horizon

*Soil classification:* Gleyed Sombric Brunisol (cryoturbic phase)

| **Horizon** (Sample No.) | **Depth** (cm) | **Description** |
|---|---|---|
| S | 17-15 | Feathermoss. |
| Fm | 15-3 | Dark brown (7.5YR 3/3 m); partially decomposed organic matter; moderate, non-compact matted; abundant, very fine, fine, and medium, oblique and horizontal roots; abundant mycelia; abrupt, wavy boundary; 10-15 cm thick; extremely acid. |
| Hh | 0-3 | Very dark brown (10YR 2/2 m); decomposed organic matter; plentiful, very fine, fine, medium horizontal and oblique roots; abrupt, wavy boundary; 3-4 cm thick; extremely acid. |
| Ahy | 0-15 | Very dark grey (10YR 3/1 m); [tephra inclusions: pale brown (10YR 6/3 m)]; silt loam; weak to moderate, fine and medium subangular blocky; friable; plentiful, very fine, fine, and medium, oblique roots; 10% angular fine gravel; clear, broken boundary; 0-25 cm thick; extremely acid. |
| Bmgjy | 15-30 | Dark greyish brown (10YR 4/2 m) with streaks up to 5 cm thick of dark brown (10YR 3/3 m) and dark greyish brown (2.5Y 4/2 m); silt loam; few, medium distinct dark brown (7.5YR 3/4 m) mottles; weak, fine subangular blocky; friable; few, very fine and fine, oblique roots; 10% angular and subangular fine gravel; clear, wavy boundary; 10-25 cm thick; extremely acid. |
| Bmy | 30-50 | Dark greyish brown (10YR 4/2 m); silt loam; weak, fine subangular blocky; friable; few, very fine and fine, oblique roots; 10% angular fine gravel; clear, wavy boundary; 15-30 cm thick; extremely acid. |
| IIBmy | 50-65 | Dark greyish brown (2.5Y 4/2 m); silt loam; weak, medium subangular blocky; friable; 40% angular gravel; clear, wavy boundary; 15-20 cm thick; extremely acid. |
| IIIC1 | 65-85 | Black (5Y 2.5/1 m); sandy loam; massive; friable; common, 1-3 mm thick silt coatings; 80% angular gravel; clear, wavy boundary; extremely acid. |
| IIIC2 | 85-100$^+$ | Black (2.5Y 2.5/1 m); sandy loam; massive; friable; 90% angular gravel; very strongly acid. |

Site Name: **Clip 2**
Site No. **Y05-12**

Site Description
Location: Clip property: E aspect

Latitude: 64º12’59.2”N Longitude: 140º22’44.8”W

UTM: 530135E, 7121279N Elevation: 1044 m

Aspect: 90º Slope: 10% Slope position: Upper slope

Parent material: Colluvium, with tephra immediately beneath surface organic horizons

*Soil classification:* Gleyed Dystric Brunisol (cryoturbic phase)

| **Horizon** **(Sample No.)** | **Depth** **(cm)** | **Description** |
|---|---|---|
| FH (burned) | 3-0 | Black (10YR 2/1) and very dark brown (10YR 2/2 m); charred partially decomposed and humified organic matter; moderate, non-compact matted; plentiful, very fine, fine, and medium, horizontal roots; abrupt, wavy boundary; 2-4 cm thick; extremely acid. |
| Tephra | 0-4 | Pale brown (10YR 6/3 m); silt loam; massive; very friable; few, very fine and fine oblique roots; abrupt, broken boundary; 0-5 cm thick. |
| Bmgju | 4-22 | Very dark grey (2.5Y 3/1 m) and dark yellowish brown (10YR 3/4 m); silt loam; few, medium prominent strong brown (7.5YR 5/6 m) mottles; moderate, fine subangular blocky; very friable; plentiful, very fine and fine, oblique roots; 40% angular gravel; clear, wavy boundary; 15-26 cm thick; extremely acid. |
| IIBmu | 22-31 | Very dark greyish brown (2.5Y 3/2 m); silt loam; moderate, medium subangular blocky; friable; plentiful, very fine and fine, oblique roots; <5% angular gravel; abrupt, smooth boundary; 8-10 cm thick; extremely acid. |
| IIIC1 | 31-41 | Dark grey (2.5Y 4/1 m); sandy loam; massive and single grain; loose; 80-90% angular gravel; gradual, smooth boundary; 10 cm thick; extremely acid. |
| IIIC2 | 41-75$^{+}$ | Very dark grey (5Y 3/1 m); sandy loam; massive and single grain; loose; 80-90% angular gravel; very strongly acid. |

Site Name: **Bear Cub 1**
Site No. **Y05-16**

<u>Site Description</u>
Location: Lucky Joe property – Bear Cub 1

Latitude: 63º37’17.8”N Longitude: 139º34’54.7”W

UTM: 570298E, 7055623N Elevation: 729 m

Aspect: 340º Slope: 25% Slope position: Upper slope

Parent material: Cryoturbated colluvium derived from deeply weathered bedrock.

*Soil classification:* Orthic Dystric Turbic Cryosol

| **Horizon** (Sample No.) | **Depth** (cm) | **Description** |
|---|---|---|
| S | 20-18 | Feathermoss and partially burned forest floor organic materials. |
| Fm | 18-4 | Very dark brown (7.5YR 2.5/2 m); partially decomposed moss; plentiful, very fine, fine, and medium, horizontal and oblique, and few, coarse horizontal roots; abrupt, wavy boundary; 10-20 cm thick; extremely acid. |
| Hh | 4-0 | Black (10YR 2/1 m); humified organic matter; plentiful, very fine, fine, and medium, horizontal and oblique, and few, coarse horizontal roots; abrupt, wavy boundary; 3-9 cm thick; extremely acid. |
| Ahy | 0-8 | Black (7.5YR 2.5/1 m) and dark brown (7.5YR 3/2 m); sandy loam; weak, fine and medium subangular blocky; friable; few, very fine and fine oblique roots; 30% angular fine gravel; abrupt, broken boundary; 0-10 cm thick; extremely acid. |
| Bmy1 | 8-18 | Brown (7.5YR 4/4 m); sandy loam; weak, medium subangular blocky; friable; few, very fine and fine, oblique roots; 30-40% angular gravel; abrupt, wavy boundary; 8-18 cm thick; extremely acid. |
| Bmy2 | 18-35 | Strong brown (7.5YR 5/6 m); sandy loam; massive; friable; 30-40% angular gravel; abrupt, smooth boundary; 12-17 cm thick; extremely acid. |
| IIBm | 35-45 | Reddish yellow (7.5YR 6/6 m) and strong brown (7.5YR 5/8 m); sandy loam; massive; friable; 20% angular gravel; abrupt, smooth boundary; 6-13 cm thick; extremely acid. |
| IIIBm | 45-63 | Yellowish red (5YR 5/8 m and 5YR 4/6 m); sandy loam; massive; friable; 30-40% angular gravel; 14-20 cm thick; very strongly acid. |
| IVBm | 63-80$^+$ | Brownish yellow (10YR 6/8 m); sandy loam; massive; friable; 10-20% angular gravel; permafrost at 80 cm; extremely acid. |

Site Name: **Bear Cub 2**
Site No. **Y05-17**

Site Description
Location: Lucky Joe property – Bear Cub 2

Latitude: 63º37’14.6”N Longitude: 139º34’52.0”W

UTM: 570342E, 7055530N Elevation: 741 m

Aspect: 130º Slope: 32% Slope position: Upper slope

Parent material: Aeolian veneer over colluvium derived from deeply weathered bedrock. Augering indicated weathered bedrock present to at least 230 cm depth.

*Soil classification:* Orthic Dystric Brunisol

| **Horizon** (Sample No.) | **Depth** (cm) | **Description** |
|---|---|---|
| FH (burned) | 4-0 | Black (10YR 2/1 m); charred remnant of forest floor; plentiful, very fine, fine, medium, and coarse, horizontal and oblique roots; abrupt, wavy boundary; 2-5 cm thick; slightly acid. |
| Bm | 0-15 | Brown (10YR 4/3 m); silt loam; moderate, fine and medium subangular blocky; very friable; abundant, very fine, fine, and medium, oblique and horizontal, and few coarse horizontal roots; 2% angular gravel; abrupt, wavy boundary; 12-25 cm thick; extremely acid. |
| IIBm1 | 15-35 | Strong brown (7.5YR 4/6 m); sandy loam; weak, medium subangular blocky; very friable; abundant, very fine and fine, and few medium oblique roots; 40% angular fine gravel (< 1 cm diameter); clear, wavy boundary; 7-28 cm thick; extremely acid. |
| IIBm2 | 35-43 | Strong brown (7.5YR 5/6 m); sandy loam; weak, medium subangular blocky; very friable; abundant, very fine and fine oblique roots; 60% angular gravel; abrupt, wavy boundary; 6-10 cm thick; extremely acid. |
| IIBm3 | 43-53 | Dark red (2.5YR 4/6 m); sandy loam; massive; friable; plentiful, very fine and fine oblique roots; 70% angular gravel; abrupt, wavy boundary; 0-12 cm thick; extremely acid. |
| IIIBC | 53-75 | Strong brown (7.5YR 5/8 m); loamy sand; single grain; friable; few, very fine and fine, oblique roots; 50% angular gravel; gradual, wavy boundary; 17-25 cm thick; extremely acid. |
| IIIC | 75-120$^+$ | Dark yellowish brown (10YR 4/6 m) and olive brown (2.5Y 4/3 m) in bands 4-8 cm thick; loamy sand; single grain; loose; 50% angular gravel; very strongly acid. |

# APPENDIX 2: SELECTED SOIL CHEMICAL AND PHYSICAL PROPERTIES

Site Name: **Boulder Lode 1**
Site No. **Y05-07**

| | Depth | % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Sand** | **Silt** | **Clay** | **Total C** | **Total N** | **Total S** | **pH($H_2O$)** | **pH($CaCl_2$)** |
| Fm | 18-3 | | | | 43.4 | 1.22 | 0.0914 | 3.92 | 3.29 |
| Hh | 3-0 | | | | 39.6 | 1.40 | 0.1086 | 4.06 | 3.32 |
| Ahy1 | 0-5 | 13.2 | 67.3 | 19.6 | 10.3 | 0.37 | | 4.54 | 3.80 |
| Bmy1 | 5-15 | 48.3 | 43.6 | 8.1 | 0.7 | 0.05 | | 5.07 | 4.19 |
| Ahy2 | 15-22 | 38.6 | 46.5 | 14.8 | 1.8 | 0.08 | | 5.03 | 4.01 |
| Bmy2 | 22-45 | 42.7 | 49.3 | 8.0 | 0.5 | 0.03 | | 5.30 | 4.09 |
| Ahy3 | 25-40 | 44.1 | 46.6 | 9.3 | 1.1 | 0.05 | | 5.05 | 4.06 |
| IIC | 40-56 | 64.9 | 29.2 | 5.8 | 0.1 | 0.01 | | 5.48 | 4.23 |
| IIIC | 56-130+ | 59.5 | 35.2 | 5.2 | 0.1 | 0.03 | | 5.59 | 4.59 |

| | Depth | cmol (+) / kg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Ca^{2+}$** | **$Mg^{2+}$** | **$K^+$** | **$Na^+$** | **$Al^{3+}$** | **$Fe^{3+}$** | **$Mn^{2+}$** | **CEC (sum)** |
| Fm | 18-3 | 6.50 | 3.84 | 4.30 | 0.134 | 1.49 | 0.573 | 1.471 | 18.31 |
| Hh | 3-0 | 9.76 | 2.16 | 0.99 | 0.133 | 10.58 | 1.793 | 0.315 | 25.73 |
| Ahy1 | 0-5 | 4.16 | 1.47 | 0.33 | 0.033 | 6.58 | 0.417 | 0.012 | 13.00 |
| Bmy1 | 5-15 | 1.33 | 0.59 | 0.09 | < 0.001 | 2.14 | 0.005 | 0.002 | 4.14 |
| Ahy2 | 15-22 | 1.51 | 0.61 | 0.09 | 0.018 | 2.96 | 0.014 | 0.006 | 5.20 |
| Bmy2 | 22-45 | 1.21 | 0.61 | 0.07 | 0.015 | 2.06 | < 0.001 | 0.006 | 3.96 |
| Ahy3 | 25-40 | 1.16 | 0.53 | 0.07 | 0.004 | 2.51 | 0.006 | 0.007 | 4.28 |
| IIC | 40-56 | 1.35 | 0.88 | 0.07 | < 0.001 | 0.95 | < 0.001 | 0.009 | 3.25 |
| IIIC | 56-130+ | 1.85 | 1.18 | 0.11 | 0.015 | 0.41 | 0.003 | 0.005 | 3.57 |

| | Depth | % | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Al_p$** | **$Al_o$** | **$Fe_p$** | **$Fe_o$** | **$Fe_d$** | **$Si_o$** | **$Fe_o$ / $Fe_d$** |
| Ahy1 | 0-5 | 0.223 | 0.315 | 0.419 | 0.596 | 0.832 | 0.041 | 0.715 |
| Bmy1 | 5-15 | 0.090 | 0.159 | 0.177 | 0.473 | 0.727 | 0.031 | 0.651 |
| Ahy2 | 15-22 | 0.169 | 0.260 | 0.325 | 0.652 | 0.898 | 0.044 | 0.727 |
| Bmy2 | 22-45 | 0.085 | 0.156 | 0.146 | 0.448 | 0.698 | 0.032 | 0.642 |
| Ahy3 | 25-40 | 0.109 | 0.176 | 0.208 | 0.476 | 0.717 | 0.031 | 0.664 |
| IIC | 40-56 | 0.033 | 0.062 | 0.043 | 0.110 | 0.261 | 0.021 | 0.420 |
| IIIC | 56-130+ | 0.026 | 0.047 | 0.037 | 0.115 | 0.275 | 0.017 | 0.418 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

Site Name: **Boulder Lode 2**
Site No. **Y05-08**

| | **Depth** | % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Sand** | **Silt** | **Clay** | **Total C** | **Total N** | **Total S** | **pH($H_2O$)** | **pH($CaCl_2$)** |
| Fm | 18-0 | | | | 46.9 | 1.15 | 0.1138 | 3.87 | 3.17 |
| Ahe | 0-2 | 17.5 | 58.8 | 23.7 | 16.2 | 0.69 | | 4.15 | 3.47 |
| Bmy1 | 2-38 | 46.3 | 44.5 | 9.2 | 0.8 | 0.04 | | 5.03 | 4.08 |
| Bmy2 | 38-85 | 59.7 | 33.9 | 6.4 | 0.4 | 0.03 | | 5.16 | 4.11 |
| IIC1 | 85-105 | 70.9 | 25.5 | 3.6 | 0.1 | 0.01 | | 5.48 | 4.22 |
| IIC2 | 105-150+ | 87.4 | 8.7 | 3.9 | 0.1 | 0.01 | | 5.52 | 4.39 |
| IIC3 | 85-150+ | 71.6 | 24.6 | 3.8 | 0.2 | 0.02 | | 5.38 | 4.37 |

| | **Depth** | cmol (+) / kg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Ca^{2+}$** | **$Mg^{2+}$** | **$K^{+}$** | **$Na^{+}$** | **$Al^{3+}$** | **$Fe^{3+}$** | **$Mn^{2+}$** | **CEC (sum)** |
| Fm | 18-0 | 6.34 | 2.91 | 3.91 | 0.183 | 4.34 | 1.111 | 0.412 | 19.22 |
| Ahe | 0-2 | 7.29 | 2.00 | 0.41 | 0.033 | 5.61 | 0.482 | 0.210 | 16.04 |
| Bmy1 | 2-38 | 1.29 | 0.62 | 0.05 | 0.001 | 2.18 | 0.006 | 0.005 | 4.16 |
| Bmy2 | 38-85 | 1.18 | 0.63 | 0.05 | 0.002 | 1.74 | < 0.001 | 0.005 | 3.60 |
| IIC1 | 85-105 | 0.67 | 0.40 | 0.02 | < 0.001 | 0.51 | < 0.001 | < 0.001 | 1.60 |
| IIC2 | 105-150+ | 2.30 | 1.45 | 0.06 | 0.009 | 0.33 | < 0.001 | 0.013 | 4.16 |
| IIC3 | 85-150+ | 1.02 | 0.56 | 0.04 | < 0.001 | 0.59 | < 0.001 | 0.002 | 2.21 |

| | **Depth** | % | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Al_p$** | **$Al_o$** | **$Fe_p$** | **$Fe_o$** | **$Fe_d$** | **$Si_o$** | **$Fe_o$ / $Fe_d$** |
| Ahe | 0-2 | 0.253 | 0.329 | 0.518 | 0.652 | 0.835 | 0.048 | 0.781 |
| Bmy1 | 2-38 | 0.103 | 0.190 | 0.188 | 0.537 | 0.811 | 0.041 | 0.662 |
| Bmy2 | 38-85 | 0.085 | 0.164 | 0.150 | 0.453 | 0.687 | 0.048 | 0.659 |
| IIC1 | 85-105 | 0.030 | 0.063 | 0.039 | 0.116 | 0.293 | 0.030 | 0.394 |
| IIC2 | 105-150+ | 0.028 | 0.075 | 0.039 | 0.208 | 0.616 | 0.036 | 0.339 |
| IIC3 | 85-150+ | 0.039 | 0.087 | 0.058 | 0.184 | 0.367 | 0.044 | 0.503 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

Site Name: **Nugget 1**
Site No. **Y05-09**

**Profile 1:**

| | **Depth** | % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Sand** | **Silt** | **Clay** | **Total C** | **Total N** | **Total S** | **pH($H_2O$)** | **pH($CaCl_2$)** |
| Lv | 5-4 | | | | 53.3 | 1.14 | 0.0979 | 5.48 | 5.08 |
| Fm | 4-0 | | | | 40.8 | 1.52 | 0.1195 | 6.08 | 5.62 |
| Ahe | 0-5 | 19.9 | 62.0 | 18.1 | 6.3 | 0.25 | | 5.19 | 4.47 |
| Bm | 5-10 | 22.4 | 63.8 | 13.8 | 1.4 | 0.07 | | 5.17 | 4.16 |
| IIBm | 10-35 | 59.9 | 31.4 | 8.7 | 0.3 | 0.03 | | 5.29 | 4.23 |
| IIIBm | 35-50 | 64.7 | 25.9 | 9.4 | 0.2 | 0.02 | | 5.76 | 4.69 |
| IVBm1 | 50-55 | 42.6 | 44.6 | 12.8 | 0.3 | 0.02 | | 6.10 | 5.07 |
| IVBm2 | 55-80 | 62.0 | 30.0 | 8.0 | 0.3 | 0.02 | | 6.33 | 5.38 |
| IVBm3 | 80-90 | 72.0 | 20.3 | 7.7 | 0.3 | 0.02 | | 6.72 | 5.52 |

| | **Depth** | cmol (+) / kg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Ca^{2+}$** | **$Mg^{2+}$** | **$K^{+}$** | **$Na^{+}$** | **$Al^{3+}$** | **$Fe^{3+}$** | **$Mn^{2+}$** | **CEC (sum)** |
| Lv | 5-4 | 66.99 | 10.90 | 2.47 | 0.093 | 0.01 | 0.003 | 0.880 | 81.34 |
| Fm | 4-0 | 77.72 | 7.83 | 3.77 | 0.129 | 0.06 | 0.010 | 1.966 | 91.48 |
| Ahe | 0-5 | 12.58 | 2.48 | 0.46 | 0.023 | 1.37 | < 0.001 | 0.846 | 17.76 |
| Bm | 5-10 | 3.64 | 1.10 | 0.26 | 0.016 | 3.96 | < 0.001 | 0.125 | 9.10 |
| IIBm | 10-35 | 3.74 | 1.37 | 0.13 | 0.005 | 3.37 | < 0.001 | 0.006 | 8.61 |
| IIIBm | 35-50 | 10.96 | 1.72 | 0.10 | 0.019 | 0.32 | < 0.001 | 0.008 | 13.12 |
| IVBm1 | 50-55 | 23.89 | 3.10 | 0.11 | 0.042 | 0.09 | < 0.001 | 0.007 | 27.24 |
| IVBm2 | 55-80 | 23.72 | 2.35 | 0.12 | 0.057 | 0.01 | < 0.001 | 0.003 | 26.24 |
| IVBm3 | 80-90 | 22.11 | 1.86 | 0.19 | 0.088 | 0.03 | 0.015 | 0.001 | 24.30 |

| | **Depth** | % | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Al_p$** | **$Al_o$** | **$Fe_p$** | **$Fe_o$** | **$Fe_d$** | **$Si_o$** | **$Fe_o$ / $Fe_d$** |
| Ahe | 0-5 | 0.183 | 0.328 | 0.413 | 1.184 | 1.448 | 0.060 | 0.817 |
| Bm | 5-10 | 0.153 | 0.299 | 0.276 | 0.939 | 1.395 | 0.061 | 0.673 |
| IIBm | 10-35 | 0.090 | 0.231 | 0.080 | 0.387 | 0.908 | 0.068 | 0.426 |
| IIIBm | 35-50 | 0.046 | 0.255 | 0.077 | 0.550 | 1.219 | 0.153 | 0.451 |
| IVBm1 | 50-55 | 0.041 | 0.352 | 0.075 | 0.917 | 1.713 | 0.190 | 0.535 |
| IVBm2 | 55-80 | 0.036 | 0.327 | 0.062 | 0.750 | 1.466 | 0.189 | 0.511 |
| IVBm3 | 80-90 | 0.029 | 0.253 | 0.054 | 0.590 | 1.157 | 0.132 | 0.510 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

**Profile 2:**

| Horizon | Depth (cm) | % Sand | Silt | Clay | Total C | Total N | Total S | $pH(H_2O)$ | $pH(CaCl_2)$ |
|---|---|---|---|---|---|---|---|---|---|
| Lv | 4-3 | | | | 53.2 | 1.08 | 0.0776 | 5.41 | 4.84 |
| Fm | 3-0 | | | | 47.7 | 1.85 | 0.1341 | 6.67 | 6.07 |
| Ahe | 0-3 | 18.2 | 63.1 | 18.7 | 11.6 | 0.51 | | 5.43 | 4.78 |
| Bm | 3-15 | 24.2 | 61.1 | 14.7 | 0.8 | 0.05 | | 5.23 | 4.32 |
| IIBm | 15-32 | 47.6 | 41.6 | 10.8 | 0.5 | 0.04 | | 5.30 | 4.23 |
| IIIBm1 | 32-38 | 46.7 | 37.7 | 15.6 | 0.6 | 0.04 | | 5.53 | 4.48 |
| IIIBm2 | 38-43 | 45.9 | 37.6 | 16.4 | 0.5 | 0.04 | | 5.67 | 4.72 |
| IIIBm3 | 43-160+ | 59.0 | 28.1 | 13.0 | 0.3 | 0.03 | | 6.17 | 5.18 |

| Horizon | Depth (cm) | cmol (+) / kg $Ca^{2+}$ | $Mg^{2+}$ | $K^{+}$ | $Na^{+}$ | $Al^{3+}$ | $Fe^{3+}$ | $Mn^{2+}$ | CEC (sum) |
|---|---|---|---|---|---|---|---|---|---|
| Lv | 4-3 | 61.09 | 11.44 | 2.53 | 0.09 | 0.02 | 0.006 | 0.570 | 75.75 |
| Fm | 3-0 | 123.12 | 11.38 | 1.95 | 0.08 | 0.02 | < 0.001 | 0.165 | 136.70 |
| Ahe | 0-3 | 23.81 | 3.17 | 0.53 | 0.017 | 0.40 | < 0.001 | 0.838 | 28.75 |
| Bm | 3-15 | 3.28 | 1.07 | 0.23 | 0.018 | 4.28 | < 0.001 | 0.030 | 8.91 |
| IIBm | 15-32 | 3.69 | 1.46 | 0.21 | 0.019 | 3.05 | 0.002 | 0.009 | 8.44 |
| IIIBm1 | 32-38 | 6.06 | 1.87 | 0.14 | 0.082 | 1.56 | 0.003 | 0.002 | 9.72 |
| IIIBm2 | 38-43 | 8.23 | 2.38 | 0.12 | 0.095 | 1.07 | 0.002 | 0.001 | 11.91 |
| IIIBm3 | 43-160+ | 20.49 | 3.83 | 0.13 | 0.132 | 0.03 | < 0.001 | 0.010 | 24.63 |

| Horizon | Depth (cm) | % $Al_p$ | $Al_o$ | $Fe_p$ | $Fe_o$ | $Fe_d$ | $Si_o$ | $Fe_o$ / $Fe_d$ |
|---|---|---|---|---|---|---|---|---|
| Ahe | 0-3 | 0.224 | 0.365 | 0.391 | 0.966 | 1.096 | 0.050 | 0.882 |
| Bm | 3-15 | 0.107 | 0.348 | 0.068 | 0.890 | 1.378 | 0.081 | 0.646 |
| IIBm | 15-32 | 0.133 | 0.315 | 0.112 | 0.558 | 1.321 | 0.085 | 0.422 |
| IIIBm1 | 32-38 | 0.325 | 0.897 | 0.120 | 0.867 | 1.967 | 0.212 | 0.441 |
| IIIBm2 | 38-43 | 0.307 | 0.885 | 0.107 | 0.868 | 1.972 | 0.213 | 0.440 |
| IIIBm3 | 43-160+ | 0.042 | 0.307 | 0.060 | 0.654 | 1.558 | 0.153 | 0.420 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

**Profile 3:**

| | **Depth** | % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Sand** | **Silt** | **Clay** | **Total C** | **Total N** | **Total S** | **pH($H_2O$)** | **pH($CaCl_2$)** |
| Lv | 4-3 | | | | 51.8 | 1.24 | 0.0940 | 5.74 | 5.20 |
| Fm | 3-0 | | | | 46.3 | 1.67 | 0.1287 | 6.22 | 5.70 |
| Bm1 | 0-15 | 28.9 | 55.1 | 16.1 | 1.6 | 0.09 | | 5.57 | 4.53 |
| Bm2 | 15-37 | 60.7 | 28.3 | 11.0 | 0.5 | 0.03 | | 5.51 | 4.51 |
| IIBm2 | 37-65 | 72.2 | 20.4 | 7.4 | 0.3 | 0.02 | | 5.48 | 4.75 |

| | **Depth** | cmol (+) / kg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Ca^{2+}$** | **$Mg^{2+}$** | **$K^{+}$** | **$Na^{+}$** | **$Al^{3+}$** | **$Fe^{3+}$** | **$Mn^{2+}$** | **CEC (sum)** |
| Lv | 4-3 | 64.50 | 13.22 | 3.83 | 0.127 | 0.01 | 0.002 | 0.696 | 82.38 |
| Fm | 3-0 | 96.60 | 10.79 | 2.75 | 0.081 | 0.01 | 0.002 | 0.473 | 110.72 |
| Bm1 | 0-15 | 7.04 | 2.73 | 0.74 | 0.017 | 1.29 | < 0.001 | 0.139 | 11.95 |
| Bm2 | 15-37 | 5.40 | 1.95 | 0.59 | 0.041 | 1.70 | 0.002 | 0.006 | 9.69 |
| IIBm2 | 37-65 | 10.27 | 2.85 | 0.35 | 0.055 | 0.38 | < 0.001 | 0.011 | 13.92 |

| | **Depth** | % | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Al_p$** | **$Al_o$** | **$Fe_p$** | **$Fe_o$** | **$Fe_d$** | **$Si_o$** | **$Fe_o$ / $Fe_d$** |
| Bm1 | 0-15 | 0.131 | 0.336 | 0.228 | 1.041 | 1.799 | 0.096 | 0.579 |
| Bm2 | 15-37 | 0.204 | 0.610 | 0.067 | 0.576 | 1.336 | 0.137 | 0.431 |
| IIBm2 | 37-65 | 0.082 | 0.286 | 0.052 | 0.393 | 0.977 | 0.079 | 0.402 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

Site Name: **Nugget 2**
Site No. **Y05-10**

| | **Depth** | % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Sand** | **Silt** | **Clay** | **Total C** | **Total N** | **Total S** | **pH($H_2O$)** | **pH($CaCl_2$)** |
| Lv | 4-3 | | | | 52.0 | 1.10 | 0.0873 | 5.49 | 4.92 |
| Fm | 3-0 | | | | 45.6 | 1.89 | 0.1480 | 6.17 | 5.74 |
| Ahe | 0-3 | 16.9 | 68.3 | 14.8 | 6.3 | 0.28 | | 4.76 | 4.09 |
| Bm | 3-14 | 24.2 | 63.0 | 12.8 | 0.7 | 0.05 | | 4.93 | 4.06 |
| IIBm1 | 14-32 | 57.0 | 35.1 | 7.9 | 0.3 | 0.03 | | 5.19 | 4.03 |
| IIBm2 | 32-50 | 59.2 | 36.3 | 4.5 | 0.2 | 0.02 | | 5.31 | 4.16 |
| IIC | 50-100+ | 65.9 | 30.4 | 3.7 | 0.1 | 0.01 | | 5.50 | 4.29 |

| | **Depth** | cmol (+) / kg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Ca$^{2+}$** | **Mg$^{2+}$** | **K$^{+}$** | **Na$^{+}$** | **Al$^{3+}$** | **Fe$^{3+}$** | **Mn$^{2+}$** | **CEC (sum)** |
| Lv | 4-3 | 55.67 | 18.81 | 2.86 | 0.144 | 0.01 | 0.001 | 0.746 | 78.24 |
| Fm | 3-0 | 85.62 | 18.08 | 2.96 | 0.080 | 0.02 | 0.004 | 0.766 | 107.53 |
| Ahe | 0-3 | 6.71 | 1.90 | 0.24 | 0.043 | 2.76 | 0.017 | 1.159 | 12.83 |
| Bm | 3-14 | 1.36 | 0.93 | 0.29 | 0.021 | 2.75 | 0.007 | 0.010 | 5.37 |
| IIBm1 | 14-32 | 1.06 | 0.70 | 0.23 | 0.018 | 3.96 | 0.002 | < 0.001 | 5.97 |
| IIBm2 | 32-50 | 1.37 | 0.98 | 0.10 | 0.022 | 2.45 | < 0.001 | < 0.001 | 4.92 |
| IIC | 50-100+ | 1.73 | 1.22 | 0.05 | 0.020 | 0.95 | < 0.001 | < 0.001 | 3.97 |

| | **Depth** | % | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Al$_p$** | **Al$_o$** | **Fe$_p$** | **Fe$_o$** | **Fe$_d$** | **Si$_o$** | **Fe$_o$ / Fe$_d$** |
| Ahe | 0-3 | 0.113 | 0.193 | 0.221 | 0.472 | 0.820 | 0.038 | 0.576 |
| Bm | 3-14 | 0.127 | 0.267 | 0.127 | 0.668 | 1.216 | 0.060 | 0.550 |
| IIBm1 | 14-32 | 0.104 | 0.221 | 0.066 | 0.330 | 0.803 | 0.056 | 0.411 |
| IIBm2 | 32-50 | 0.062 | 0.140 | 0.043 | 0.222 | 0.527 | 0.048 | 0.422 |
| IIC | 50-100+ | 0.034 | 0.092 | 0.044 | 0.174 | 0.334 | 0.046 | 0.521 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

Site Name: **Clip 1**
Site No. **Y05-11**

| | **Depth** | % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Sand** | **Silt** | **Clay** | **Total C** | **Total N** | **Total S** | **pH**$(H_2O)$ | **pH**$(CaCl_2)$ |
| Fm | 15-3 | | | | 50.5 | 1.42 | 0.1186 | 4.20 | 3.39 |
| Hh | 3-0 | | | | 31.1 | 1.21 | 0.1281 | 4.11 | 3.29 |
| Ahy | 0-15 | 23.1 | 61.9 | 15.0 | 4.7 | 0.19 | | 4.81 | 3.88 |
| Bmgjy | 15-30 | 29.5 | 59.3 | 11.2 | 1.6 | 0.08 | | 5.00 | 4.02 |
| Bmy | 30-50 | 28.3 | 60.1 | 11.6 | 1.2 | 0.06 | | 5.23 | 4.06 |
| IIBmy | 50-65 | 43.6 | 49.6 | 6.8 | 0.5 | 0.04 | | 5.29 | 4.08 |
| IIIC1 | 65-85 | 57.8 | 38.4 | 3.7 | 0.7 | 0.05 | | 4.53 | 4.20 |
| IIIC2 | 85-100+ | 59.3 | 36.2 | 4.5 | 1.0 | 0.06 | | 5.22 | 4.57 |

| | **Depth** | cmol (+) / kg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | $Ca^{2+}$ | $Mg^{2+}$ | $K^+$ | $Na^+$ | $Al^{3+}$ | $Fe^{3+}$ | $Mn^{2+}$ | **CEC (sum)** |
| Fm | 15-3 | 7.00 | 5.20 | 4.66 | 0.206 | 4.11 | 1.099 | 0.579 | 22.85 |
| Hh | 3-0 | 4.49 | 1.37 | 0.68 | 0.130 | 8.78 | 1.656 | 0.106 | 17.22 |
| Ahy | 0-15 | 1.43 | 0.29 | 0.06 | 0.045 | 4.28 | 0.058 | < 0.001 | 6.16 |
| Bmgjy | 15-30 | 0.45 | 0.08 | 0.02 | 0.033 | 2.28 | 0.019 | < 0.001 | 2.88 |
| Bmy | 30-50 | 0.59 | 0.13 | 0.04 | 0.028 | 2.01 | 0.002 | < 0.001 | 2.80 |
| IIBmy | 50-65 | 1.64 | 0.42 | 0.05 | 0.040 | 1.58 | < 0.001 | 0.011 | 3.74 |
| IIIC1 | 65-85 | 2.96 | 0.75 | 0.07 | 0.031 | 0.75 | < 0.001 | 0.006 | 4.57 |
| IIIC2 | 85-100+ | 4.02 | 0.99 | 0.09 | 0.032 | 0.59 | < 0.001 | 0.005 | 5.73 |

| | **Depth** | % | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | $Al_p$ | $Al_o$ | $Fe_p$ | $Fe_o$ | $Fe_d$ | $Si_o$ | $Fe_o / Fe_d$ |
| Ahy | 0-15 | 0.299 | 0.336 | 0.442 | 0.636 | 0.962 | 0.061 | 0.661 |
| Bmgjy | 15-30 | 0.312 | 0.313 | 0.448 | 0.736 | 1.092 | 0.051 | 0.675 |
| Bmy | 30-50 | 0.266 | 0.276 | 0.408 | 0.747 | 1.135 | 0.055 | 0.658 |
| IIBmy | 50-65 | 0.063 | 0.160 | 0.095 | 0.473 | 1.056 | 0.054 | 0.449 |
| IIIC1 | 65-85 | 0.033 | 0.099 | 0.034 | 0.270 | 1.042 | 0.037 | 0.259 |
| IIIC2 | 85-100+ | 0.032 | 0.106 | 0.033 | 0.283 | 1.218 | 0.040 | 0.232 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

Site Name: **Clip 2**
Site No. **Y05-12**

| | **Depth** | % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Sand** | **Silt** | **Clay** | **Total C** | **Total N** | **Total S** | **pH($H_2O$)** | **pH($CaCl_2$)** |
| FH | 3-0 | | | | 43.8 | 1.41 | 0.1216 | 4.23 | 3.49 |
| Bmgju | 4-22 | 35.6 | 54.2 | 10.2 | 1.2 | 0.06 | | 5.08 | 4.26 |
| IIBmu | 22-31 | 14.5 | 71.3 | 14.1 | 0.7 | 0.05 | | 5.62 | 4.51 |
| IIIC1 | 31-41 | 61.6 | 32.9 | 5.5 | 0.7 | 0.05 | | 5.90 | 4.32 |
| IIIC2 | 41-75+ | 65.2 | 31.0 | 3.8 | 0.7 | 0.04 | | 6.18 | 4.69 |

| | **Depth** | cmol (+) / kg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Ca^{2+}$** | **$Mg^{2+}$** | **$K^+$** | **$Na^+$** | **$Al^{3+}$** | **$Fe^{3+}$** | **$Mn^{2+}$** | **CEC (sum)** |
| FH | 3-0 | 18.42 | 4.01 | 0.76 | 0.095 | 2.68 | 0.204 | 1.022 | 27.19 |
| Bmgju | 4-22 | 0.42 | 0.14 | 0.08 | 0.015 | 1.38 | 0.003 | 0.003 | 2.03 |
| IIBmu | 22-31 | 1.01 | 0.36 | 0.06 | 0.019 | 1.01 | < 0.001 | 0.002 | 2.46 |
| IIIC1 | 31-41 | 1.11 | 0.39 | 0.06 | 0.013 | 0.35 | < 0.001 | < 0.001 | 1.93 |
| IIIC2 | 41-75+ | 1.59 | 0.52 | 0.07 | 0.014 | 0.18 | < 0.001 | < 0.001 | 2.37 |

| | **Depth** | % | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Al_p$** | **$Al_o$** | **$Fe_p$** | **$Fe_o$** | **$Fe_d$** | **$Si_o$** | **$Fe_o$ / $Fe_d$** |
| Bmgju | 4-22 | 0.246 | 0.321 | 0.353 | 0.686 | 1.179 | 0.073 | 0.58 |
| IIBmu | 22-31 | 0.261 | 0.407 | 0.292 | 0.704 | 1.078 | 0.114 | 0.65 |
| IIIC1 | 31-41 | 0.071 | 0.151 | 0.097 | 0.369 | 0.997 | 0.051 | 0.37 |
| IIIC2 | 41-75+ | 0.035 | 0.094 | 0.049 | 0.276 | 0.896 | 0.038 | 0.31 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

Site Name: **Bear Cub 1**
Site No. **Y05-16**

| | **Depth** | % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Sand** | **Silt** | **Clay** | **Total C** | **Total N** | **Total S** | **pH($H_2O$)** | **pH($CaCl_2$)** |
| Fm | 18-4 | | | | 52.9 | 0.67 | 0.1012 | 3.90 | 3.08 |
| Hh | 4-0 | | | | 39.9 | 1.13 | 0.2024 | 4.42 | 3.69 |
| Ahy | 0-8 | 62.6 | 28.0 | 9.4 | 4.4 | 0.16 | | 5.16 | 3.93 |
| Bmy1 | 8-20 | 67.7 | 26.9 | 5.4 | 0.4 | 0.02 | | 5.68 | 4.05 |
| Bmy2 | 20-35 | 68.6 | 20.1 | 11.4 | 0.3 | 0.01 | | 5.72 | 4.26 |
| IIBm | 35-45 | 65.0 | 22.8 | 12.2 | 0.1 | 0.01 | | 5.78 | 4.49 |
| IIIBm | 45-63 | 67.1 | 24.2 | 8.7 | 0.2 | 0.01 | | 5.93 | 4.56 |
| IVBm | 63-80+ | 65.2 | 26.4 | 8.3 | 0.1 | 0.01 | | 5.81 | 4.31 |

| | **Depth** | cmol (+) / kg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Ca^{2+}$** | **$Mg^{2+}$** | **$K^{+}$** | **$Na^{+}$** | **$Al^{3+}$** | **$Fe^{3+}$** | **$Mn^{2+}$** | **CEC (sum)** |
| Fm | 18-4 | 15.29 | 4.28 | 2.70 | 0.391 | 1.76 | 0.270 | 0.645 | 25.34 |
| Hh | 4-0 | 21.50 | 2.82 | 0.48 | 0.171 | 8.22 | 0.760 | 0.027 | 33.98 |
| Ahy | 0-8 | 4.25 | 0.87 | 0.07 | 0.047 | 4.17 | 0.038 | < 0.001 | 9.46 |
| Bmy1 | 8-20 | 3.99 | 0.92 | 0.06 | 0.051 | 2.11 | 0.007 | < 0.001 | 7.14 |
| Bmy2 | 20-35 | 7.04 | 1.67 | 0.10 | 0.084 | 1.17 | 0.005 | < 0.001 | 10.07 |
| IIBm | 35-45 | 4.14 | 0.99 | 0.08 | 0.032 | 0.17 | 0.004 | < 0.001 | 5.40 |
| IIIBm | 45-63 | 5.79 | 1.21 | 0.10 | 0.066 | 0.15 | 0.002 | < 0.001 | 7.31 |
| IVBm | 63-80+ | 8.53 | 1.83 | 0.10 | 0.036 | 0.40 | 0.010 | < 0.001 | 10.90 |

| | **Depth** | % | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Al_p$** | **$Al_o$** | **$Fe_p$** | **$Fe_o$** | **$Fe_d$** | **$Si_o$** | **$Fe_o$ / $Fe_d$** |
| Ahy | 0-8 | 0.211 | 0.316 | 0.194 | 0.441 | 1.424 | 0.053 | 0.31 |
| Bmy1 | 8-20 | 0.088 | 0.230 | 0.063 | 0.507 | 1.407 | 0.061 | 0.36 |
| Bmy2 | 20-35 | 0.060 | 0.165 | 0.061 | 0.498 | 1.975 | 0.046 | 0.25 |
| IIBm | 35-45 | 0.025 | 0.068 | 0.045 | 0.234 | 2.964 | 0.037 | 0.08 |
| IIIBm | 45-63 | 0.030 | 0.092 | 0.048 | 0.242 | 2.814 | 0.046 | 0.09 |
| IVBm | 63-80+ | 0.018 | 0.037 | 0.048 | 0.214 | 2.693 | 0.020 | 0.08 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

Site Name: **Bear Cub 2**
Site No. **Y05-17**

| | **Depth** | % | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **Sand** | **Silt** | **Clay** | **Total C** | **Total N** | **Total S** | **pH($H_2O$)** | **pH($CaCl_2$)** |
| FH | 4-0 | | | | 16.4 | 0.55 | 0.0448 | 6.84 | 6.28 |
| Bm | 0-15 | 22.0 | 63.8 | 14.2 | 0.9 | 0.05 | | 5.06 | 4.01 |
| IIBm1 | 15-35 | 65.5 | 25.0 | 9.5 | 0.5 | 0.03 | | 5.17 | 3.98 |
| IIBm2 | 35-43 | 64.1 | 27.2 | 8.7 | 0.5 | 0.03 | | 4.99 | 3.95 |
| IIBm3 | 43-53 | 67.9 | 25.5 | 6.6 | 0.4 | 0.02 | | 4.97 | 3.89 |
| IIBC | 53-75 | 83.8 | 11.6 | 4.6 | 0.1 | 0.01 | | 5.67 | 4.25 |
| IIIC | 75-120+ | 85.4 | 11.5 | 3.1 | 0.1 | 0.01 | | 5.80 | 4.71 |

| | **Depth** | cmol (+) / kg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Ca^{2+}$** | **$Mg^{2+}$** | **$K^+$** | **$Na^+$** | **$Al^{3+}$** | **$Fe^{3+}$** | **$Mn^{2+}$** | **CEC (sum)** |
| FH | 4-0 | 24.01 | 2.94 | 1.18 | 0.090 | 0.01 | < 0.001 | 0.180 | 28.41 |
| Bm | 0-15 | 2.39 | 1.42 | 0.18 | 0.049 | 2.11 | 0.019 | 0.004 | 6.17 |
| IIBm1 | 15-35 | 2.90 | 1.86 | 0.16 | 0.072 | 2.14 | 0.015 | < 0.001 | 7.14 |
| IIBm2 | 35-43 | 2.32 | 1.37 | 0.14 | 0.048 | 1.77 | 0.016 | < 0.001 | 5.67 |
| IIBm3 | 43-53 | 0.82 | 0.50 | 0.09 | 0.036 | 1.39 | 0.011 | < 0.001 | 2.85 |
| IIBC | 53-75 | 4.68 | 2.00 | 0.20 | 0.104 | 1.29 | 0.001 | < 0.001 | 8.28 |
| IIIC | 75-120+ | 7.09 | 2.45 | 0.25 | 0.112 | 0.11 | < 0.001 | < 0.001 | 10.02 |

| | **Depth** | % | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Horizon** | (cm) | **$Al_p$** | **$Al_o$** | **$Fe_p$** | **$Fe_o$** | **$Fe_d$** | **$Si_o$** | **$Fe_o$ / $Fe_d$** |
| Bm | 0-15 | 0.098 | 0.265 | 0.085 | 0.450 | 1.313 | 0.066 | 0.34 |
| IIBm1 | 15-35 | 0.071 | 0.270 | 0.070 | 0.347 | 1.989 | 0.138 | 0.17 |
| IIBm2 | 35-43 | 0.062 | 0.214 | 0.103 | 0.689 | 2.707 | 0.096 | 0.25 |
| IIBm3 | 43-53 | 0.044 | 0.122 | 0.077 | 0.526 | 3.333 | 0.054 | 0.16 |
| IIBC | 53-75 | 0.044 | 0.187 | 0.054 | 0.307 | 1.981 | 0.179 | 0.15 |
| IIIC | 75-120+ | 0.037 | 0.120 | 0.022 | 0.123 | 0.859 | 0.083 | 0.14 |

Subscripts: p = pyrophosphate; o = oxalate; d = dithionite-citrate-bicarbonate.

# APPENDIX 3: SOIL GEOCHEMISTRY

### Boulder Lode 1 geochemistry

| Fraction/Horizon | Number | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmy1 | Y05-07-04 | 0.58 | 11.58 | 26.61 | 41.5 | 296 | 6.5 | 3.8 | 215 | 1.35 | 6.8 | 0.9 | 92.3 | 5.6 | 10 | 0.1 | 0.48 | 0.18 | 17 | 0.07 | 0.022 | 18.6 | 13.3 | 0.43 | 180.2 | 0.015 | 1 | 0.88 | 0.006 | 0.12 | <.1 | 1.2 | 0.06 | <.01 | 16 | 0.3 | 0.05 | 2.7 | 30 |
| Ahy2 | Y05-07-05 | 0.77 | 17.68 | 33.63 | 47.9 | 418 | 7.7 | 4.2 | 255 | 1.64 | 8.9 | 1.4 | 157.2 | 3.5 | 11.6 | 0.15 | 0.5 | 0.15 | 21 | 0.08 | 0.031 | 19.4 | 22 | 0.5 | 220.3 | 0.016 | 1 | 1.12 | 0.009 | 0.14 | 0.1 | 1.4 | 0.09 | <.01 | 22 | 0.4 | 0.06 | 3.6 | 30 |
| Bmy2 | Y05-07-06 | 0.48 | 9.73 | 29.35 | 40.4 | 257 | 6.7 | 4.8 | 255 | 1.25 | 6 | 1 | 65.1 | 6.4 | 8.3 | 0.08 | 0.38 | 0.11 | 15 | 0.06 | 0.02 | 18.1 | 12.7 | 0.47 | 184.5 | 0.015 | 1 | 0.86 | 0.006 | 0.12 | <.1 | 1.4 | 0.06 | <.01 | 10 | 0.2 | 0.13 | 2.5 | 30 |
| Ahy3* | Y05-07-07 | 0.51 | 10.1 | 27.81 | 32.6 | 334 | 4.9 | 3.4 | 206 | 1.13 | 5.4 | 0.9 | 118 | 5.2 | 8.4 | 0.1 | 0.38 | 0.13 | 14 | 0.07 | 0.027 | 20.8 | 10.3 | 0.33 | 191.1 | 0.012 | 1 | 0.79 | 0.007 | 0.14 | 0.1 | 1.1 | 0.06 | <.01 | 11 | 0.2 | 0.25 | 2.2 | 30 |
| II C | Y05-07-08 | 0.22 | 5.06 | 59.81 | 17.3 | 148 | 1.4 | 1.2 | 166 | 0.3 | 5.5 | 1.4 | 47.3 | 12.8 | 6.2 | 0.05 | 0.4 | 0.44 | 2 | 0.03 | 0.009 | 34.5 | 2.1 | 0.08 | 260.4 | 0.002 | 1 | 0.36 | 0.007 | 0.15 | <.1 | 0.6 | 0.05 | <.01 | 9 | 0.1 | 0.05 | 0.8 | 30 |
| III C | Y05-07-09 | 0.25 | 4.65 | 37.83 | 13 | 223 | 1.1 | 0.6 | 78 | 0.28 | 7.5 | 1.8 | 35.5 | 13.5 | 6.4 | 0.06 | 0.7 | 0.14 | 2 | 0.03 | 0.006 | 32.9 | 1.8 | 0.07 | 515.9 | 0.001 | 1 | 0.33 | 0.011 | 0.16 | <.1 | 0.6 | 0.05 | <.01 | 7 | 0.1 | 0.04 | 0.7 | 30 |
| **-80 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmy1 -80 | Y05-07-04 | 0.6 | 13.52 | 26.44 | 46.1 | 475 | 8.5 | 3.4 | 157 | 1.38 | 5.8 | 1.1 | 188.7 | 5.6 | 10.9 | 0.13 | 0.41 | 0.14 | 21 | 0.09 | 0.024 | 21.9 | 16.7 | 0.47 | 186.6 | 0.02 | <1 | 1 | 0.003 | 0.06 | 0.1 | 1.6 | 0.07 | <.01 | 20 | 0.2 | 0.04 | 3.1 | 30 |
| Ahy2 -80 | Y05-07-05 | 0.79 | 15.85 | 29.68 | 49.1 | 483 | 9.4 | 4.1 | 196 | 1.52 | 6.5 | 1.2 | 125.7 | 2.7 | 12.6 | 0.15 | 0.49 | 0.17 | 24 | 0.09 | 0.03 | 19.7 | 19.1 | 0.47 | 240.9 | 0.016 | <1 | 1.16 | 0.005 | 0.06 | 0.1 | 1.6 | 0.09 | 0.02 | 29 | 0.3 | 0.05 | 3.7 | 30 |
| Bmy2 -80 | Y05-07-06 | 0.59 | 12.1 | 26.36 | 44.4 | 476 | 7.7 | 3.7 | 184 | 1.25 | 5.6 | 1.1 | 257.8 | 5.9 | 10.4 | 0.12 | 0.39 | 0.14 | 19 | 0.08 | 0.021 | 22.7 | 15 | 0.41 | 218.9 | 0.02 | <1 | 0.91 | 0.003 | 0.05 | 0.1 | 1.5 | 0.07 | <.01 | 26 | 0.2 | 0.05 | 2.8 | 30 |
| Ahy3 -80* | Y05-07-07 | 0.59 | 12.75 | 29.21 | 42.5 | 516 | 7.8 | 3.5 | 174 | 1.3 | 5.8 | 1.1 | 296.7 | 4.2 | 10.9 | 0.13 | 0.42 | 0.14 | 19 | 0.08 | 0.025 | 22.6 | 16.1 | 0.41 | 246.5 | 0.017 | <1 | 0.96 | 0.004 | 0.06 | 0.1 | 1.4 | 0.07 | 0.02 | 22 | 0.3 | 0.05 | 2.8 | 30 |
| II C -80 | Y05-07-08 | 0.23 | 5.96 | 38.31 | 20.2 | 170 | 1.7 | 0.7 | 68 | 0.32 | 5 | 1.3 | 64.5 | 14.6 | 5.7 | 0.05 | 0.43 | 0.21 | 2 | 0.04 | 0.01 | 36.8 | 3 | 0.1 | 137.6 | 0.003 | <1 | 0.29 | 0.001 | 0.06 | <.1 | 0.6 | 0.03 | <.01 | 7 | 0.1 | 0.06 | 0.6 | 30 |
| III C -80 | Y05-07-09 | 0.32 | 7.08 | 38.78 | 23.6 | 516 | 2.7 | 1 | 72 | 0.44 | 8.4 | 1.8 | 68.2 | 15.8 | 9.4 | 0.07 | 0.61 | 0.19 | 5 | 0.06 | 0.011 | 41.3 | 4.8 | 0.11 | 304.2 | 0.004 | <1 | 0.36 | 0.002 | 0.07 | <.1 | 0.7 | 0.04 | <.01 | 13 | 0.2 | 0.06 | 0.9 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmy1 -230 | Y05-07-04 | 0.65 | | 26.76 | 51.3 | 510 | 10.2 | 4 | 161 | 1.52 | 5 | 1.2 | 140.6 | 6.4 | 12.6 | 0.14 | 0.39 | 0.15 | 25 | 0.11 | 0.023 | 27.6 | 19.7 | 0.51 | 213.7 | 0.025 | 1 | 1.14 | 0.005 | 0.06 | <.1 | 1.9 | 0.09 | <.01 | 28 | 0.2 | 0.06 | 3.3 | 30 |
| Ahy2 -230 | Y05-07-05 | 0.72 | 13.85 | 28.77 | 56.6 | 489 | 9.5 | 4.2 | 195 | 1.53 | 5.7 | 1 | 159.8 | 2.9 | 13.2 | 0.19 | 0.43 | 0.17 | 26 | 0.1 | 0.026 | 20.4 | 18.2 | 0.47 | 242.5 | 0.018 | 1 | 1.18 | 0.007 | 0.06 | 0.1 | 1.5 | 0.1 | 0.01 | 29 | 0.2 | 0.04 | 3.4 | 15 |
| Bmy2 -230 | Y05-07-06 | 0.67 | 13.51 | 28.37 | 47.7 | 544 | 9.7 | 4.3 | 203 | 1.48 | 5.2 | 1.2 | 130.2 | 6.9 | 12.9 | 0.13 | 0.39 | 0.16 | 24 | 0.1 | 0.021 | 27.9 | 18.7 | 0.49 | 254.8 | 0.026 | 1 | 1.1 | 0.005 | 0.06 | <.1 | 1.8 | 0.08 | 0.01 | 19 | 0.2 | 0.04 | 3.1 | 30 |
| Ahy3 -230* | Y05-07-07 | 0.67 | 13.52 | 29.01 | 46 | 524 | 9.6 | 3.9 | 183 | 1.43 | 5 | 1.2 | 158 | 5.2 | 12.6 | 0.16 | 0.43 | 0.16 | 24 | 0.1 | 0.023 | 28.2 | 18.7 | 0.46 | 266 | 0.022 | 1 | 1.07 | 0.005 | 0.06 | <.1 | 1.8 | 0.09 | <.01 | 25 | 0.2 | 0.06 | 3.1 | 15 |
| II C -230 | Y05-07-08 | 0.34 | 9.25 | 53.45 | 32.9 | 282 | 3 | 1.1 | 100 | 0.52 | 6 | 2 | 109.4 | 20.6 | 8 | 0.07 | 0.56 | 0.27 | 5 | 0.06 | 0.014 | 59 | 5.6 | 0.14 | 204.4 | 0.003 | 1 | 0.5 | 0.002 | 0.07 | <.1 | 0.9 | 0.05 | <.01 | 5 | 0.1 | 0.07 | 1 | 30 |
| III C -230 | Y05-07-09 | 0.54 | 10.67 | 50.18 | 38.4 | 943 | 5.5 | 1.6 | 106 | 0.76 | 9.8 | 2.5 | 106.2 | 22.2 | 13 | 0.11 | 0.74 | 0.25 | 8 | 0.1 | 0.016 | 61.8 | 9.6 | 0.23 | 425.2 | 0.006 | <1 | 0.63 | 0.003 | 0.09 | <.1 | 1.3 | 0.06 | 0.01 | 13 | 0.1 | 0.06 | 1.5 | 30 |

*not included in figure 12

# Boulder Lode 2 geochemistry

| | | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraction/Horizon | Number | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmy1 | Y05-08-03 | 0.57 | 10.67 | 27.74 | 35 | 251 | 5.9 | 4.6 | 217 | 1.3 | 7.3 | 1.1 | 143.2 | 7.5 | 10.3 | 0.1 | 0.38 | 0.15 | 16 | 0.07 | 0.023 | 21.8 | 12 | 0.38 | 187.8 | 0.014 | 1 | 0.87 | 0.006 | 0.13 | <.1 | 1.3 | 0.06 | <.01 | 8 | 0.3 | 0.05 | 2.4 | 30 |
| Bmy2 | Y05-08-04 | 0.51 | 14.13 | 21.38 | 30.9 | 303 | 5.8 | 3.5 | 170 | 1.14 | 6.5 | 1.2 | 1127 | 8.2 | 19 | 0.07 | 0.37 | 0.11 | 16 | 0.07 | 0.019 | 22.2 | 10.8 | 0.31 | 470 | 0.016 | <1 | 0.83 | 0.011 | 0.15 | <.1 | 1.5 | 0.06 | 0.01 | 7 | 0.3 | 0.04 | 2.1 | 30 |
| II C1 | Y05-08-05 | 0.22 | 5.45 | 43.78 | 22.1 | 116 | 2.3 | 1.3 | 137 | 0.49 | 7.2 | 1.3 | 26.8 | 13.5 | 8.3 | 0.08 | 0.67 | 0.14 | 5 | 0.03 | 0.009 | 30.9 | 3.5 | 0.11 | 662.3 | 0.005 | 1 | 0.37 | 0.011 | 0.15 | <.1 | 0.9 | 0.05 | <.01 | <5 | 0.2 | 0.04 | 1 | 30 |
| II C2 | Y05-08-06 | 0.62 | 5.84 | 26.46 | 43.8 | 360 | 3.8 | 0.7 | 1067 | 0.83 | 18.7 | 2.8 | 24.2 | 22.8 | 11.1 | 0.54 | 0.45 | 0.03 | 2 | 0.05 | 0.012 | 45.8 | 2 | 0.12 | 966.7 | 0.001 | <1 | 0.43 | 0.014 | 0.11 | <.1 | 2 | 0.05 | 0.01 | 10 | 0.2 | 0.05 | 0.9 | 30 |
| II C3* | Y05-08-07 | 0.28 | 6.34 | 45.53 | 22.9 | 221 | 3.4 | 1.6 | 125 | 0.65 | 6.8 | 1.3 | 16 | 12.2 | 10.5 | 0.1 | 0.64 | 0.14 | 8 | 0.05 | 0.011 | 30.1 | 5.6 | 0.13 | 623.2 | 0.009 | 1 | 0.42 | 0.014 | 0.14 | <.1 | 0.9 | 0.05 | <.01 | 6 | 0.2 | 0.03 | 1.1 | 30 |
| **-80 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmy1 -80 | Y05-08-03 | 0.59 | 12.78 | 22.69 | 40.4 | 368 | 7.8 | 3.4 | 152 | 1.26 | 5.6 | 1.2 | 188 | 7.7 | 10.5 | 0.09 | 0.4 | 0.13 | 20 | 0.08 | 0.021 | 25.2 | 15.1 | 0.4 | 196.4 | 0.021 | <1 | 0.94 | 0.004 | 0.06 | <.1 | 1.6 | 0.06 | <.01 | 20 | 0.2 | 0.06 | 2.8 | 30 |
| Bmy2 -80 | Y05-08-04 | 0.55 | 13.97 | 22.22 | 39.7 | 265 | 9 | 3.9 | 171 | 1.31 | 5.5 | 1.2 | 199.6 | 7.1 | 10.9 | 0.09 | 0.38 | 0.11 | 21 | 0.08 | 0.021 | 20.6 | 15.2 | 0.39 | 251 | 0.022 | <1 | 0.9 | 0.004 | 0.04 | <.1 | 1.7 | 0.05 | 0.01 | 11 | 0.2 | 0.03 | 2.3 | 30 |
| II C1 -80 | Y05-08-05 | 0.19 | 4.88 | 25.4 | 19.4 | 85 | 2.5 | 0.9 | 54 | 0.42 | 5.6 | 1.1 | 30 | 12.6 | 5.2 | 0.06 | 0.59 | 0.12 | 4 | 0.03 | 0.01 | 27.6 | 3.8 | 0.12 | 206.5 | 0.007 | <1 | 0.26 | 0.002 | 0.05 | <.1 | 0.7 | 0.02 | <.01 | 5 | 0.1 | 0.02 | 0.6 | 30 |
| II C2 -80 | Y05-08-06 | 0.35 | 4.13 | 19.34 | 39.8 | 220 | 2.1 | 0.3 | 427 | 0.68 | 16.8 | 2.1 | 21.4 | 21.5 | 9.5 | 0.22 | 0.4 | 0.03 | <2 | 0.05 | 0.011 | 42.3 | 1.7 | 0.12 | 607.8 | 0.001 | <1 | 0.28 | 0.001 | 0.03 | <.1 | 1.8 | 0.02 | 0.01 | 6 | 0.2 | 0.04 | 0.5 | 30 |
| II C3 -80* | Y05-08-07 | 0.32 | 8.03 | 36.45 | 25.7 | 206 | 5.3 | 2 | 102 | 0.75 | 6.5 | 1.3 | 37.3 | 11.4 | 9 | 0.11 | 0.59 | 0.13 | 12 | 0.07 | 0.016 | 28 | 8.4 | 0.18 | 273.5 | 0.017 | <1 | 0.43 | 0.003 | 0.05 | <.1 | 1.2 | 0.03 | <.01 | 9 | 0.2 | 0.03 | 1.2 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmy1 -230 | Y05-08-03 | 0.73 | 14.8 | 25.82 | 46.6 | 472 | 10.6 | 4.3 | 190 | 1.59 | 5.3 | 1.4 | 175.4 | 8.4 | 13.5 | 0.11 | 0.39 | 0.17 | 27 | 0.12 | 0.023 | 30.9 | 20.4 | 0.5 | 246.5 | 0.031 | 1 | 1.21 | 0.005 | 0.08 | <.1 | 2.2 | 0.1 | 0.01 | 22 | 0.2 | 0.04 | 3.4 | 30 |
| Bmy2 -230 | Y05-08-04 | 0.55 | 13.77 | 21.38 | 38 | 239 | 9.4 | 4 | 190 | 1.33 | 5.5 | 1.2 | 99.1 | 7 | 11.2 | 0.09 | 0.34 | 0.12 | 22 | 0.08 | 0.02 | 21.9 | 15.8 | 0.4 | 258.1 | 0.024 | <1 | 0.95 | 0.004 | 0.05 | <.1 | 1.7 | 0.05 | <.01 | 18 | 0.2 | 0.04 | 2.4 | 30 |
| II C1 -230 | Y05-08-05 | 0.37 | 9.03 | 37.05 | 34.6 | 176 | 5.6 | 1.8 | 92 | 0.84 | 7.9 | 1.7 | 62.5 | 18.2 | 10 | 0.11 | 0.83 | 0.19 | 13 | 0.07 | 0.018 | 48.9 | 8.9 | 0.21 | 319.6 | 0.016 | 1 | 0.54 | 0.003 | 0.06 | <.1 | 1.4 | 0.04 | 0.02 | 10 | 0.1 | 0.03 | 1.3 | 30 |
| II C2 -230 | Y05-08-06 | 0.65 | 9.13 | 38.43 | 92.4 | 488 | 5 | 0.5 | 776 | 1.45 | 29.1 | 4.3 | 50.6 | 45.1 | 20.6 | 0.36 | 0.67 | 0.07 | 3 | 0.11 | 0.024 | 93.9 | 4 | 0.26 | 1287.8 | 0.001 | 1 | 0.69 | 0.002 | 0.05 | <.1 | 4.1 | 0.05 | 0.01 | 12 | 0.4 | 0.07 | 1.1 | 15 |
| II C3 -230* | Y05-08-07 | 0.53 | 12.65 | 50.15 | 43.4 | 363 | 9.7 | 3.6 | 163 | 1.31 | 7.9 | 1.8 | 46.9 | 14.2 | 15.4 | 0.17 | 0.76 | 0.18 | 25 | 0.15 | 0.027 | 41.2 | 15.9 | 0.34 | 382.5 | 0.035 | 1 | 0.76 | 0.006 | 0.06 | <.1 | 1.9 | 0.05 | <.01 | 14 | 0.1 | 0.04 | 2.1 | 30 |

*not included in figure 14

## Nugget 1-1 geochemistry

| Fraction/Horizon | Number | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ahe | Y05-09-03 | 1.06 | 13.34 | 20.57 | 66.3 | 1152 | 10.8 | 24.6 | 4139 | 1.95 | 4.6 | 0.5 | 29.9 | 0.5 | 24.3 | 0.84 | 0.57 | 0.19 | 43 | 0.35 | 0.07 | 11.7 | 17.5 | 0.29 | 646.9 | 0.026 | 1 | 1.16 | 0.013 | 0.15 | 0.1 | 1.6 | 0.12 | <.01 | 36 | 0.2 | 0.03 | 6 | 30 |
| Bm | Y05-09-04 | 1.03 | 11.23 | 15.77 | 55.2 | 605 | 13.9 | 13.4 | 992 | 2.65 | 7.2 | 0.6 | 61.5 | 3.7 | 19.9 | 0.17 | 0.77 | 0.15 | 48 | 0.28 | 0.041 | 14.5 | 25.5 | 0.64 | 335 | 0.05 | <1 | 1.64 | 0.023 | 0.18 | 0.2 | 2.7 | 0.15 | <.01 | 17 | 0.2 | 0.03 | 6.8 | 30 |
| II Bm | Y05-09-05 | 1.04 | 21.48 | 16.52 | 65.6 | 154 | 17.4 | 9.3 | 250 | 2.54 | 10.6 | 1.2 | 75.8 | 10.2 | 10.5 | 0.12 | 0.98 | 0.12 | 21 | 0.19 | 0.031 | 20.4 | 25.2 | 0.85 | 244.8 | 0.054 | 1 | 1.47 | 0.005 | 0.18 | 0.3 | 3.6 | 0.1 | <.01 | <5 | 0.4 | 0.02 | 5.5 | 30 |
| III Bm | Y05-09-06 | 4.52 | 31.68 | 40.62 | 86.8 | 886 | 34.4 | 17.3 | 692 | 3.51 | 12.2 | 1.2 | 154.2 | 8.4 | 24.4 | 0.21 | 1.02 | 2.07 | 60 | 0.5 | 0.073 | 23.3 | 67.4 | 1.7 | 221.8 | 0.122 | 1 | 2.13 | 0.027 | 0.16 | 0.6 | 7.5 | 0.12 | <.01 | 17 | 0.4 | 0.15 | 9.2 | 30 |
| IV Bm1 | Y05-09-07 | 0.64 | 28.74 | 7.59 | 85.8 | 578 | 47.7 | 37.2 | 770 | 5.72 | 14.5 | 1.1 | 111.7 | 4.2 | 92.1 | 0.11 | 2.13 | 0.06 | 95 | 1.57 | 0.116 | 39.9 | 47.1 | 2.38 | 257.6 | 0.296 | <1 | 3.95 | 0.203 | 0.49 | 0.2 | 6 | 0.65 | <.01 | 36 | 0.4 | <.02 | 11.7 | 30 |
| IV Bm2 | Y05-09-08 | 0.44 | 25.88 | 2.92 | 78.1 | 530 | 44.5 | 33 | 759 | 5.54 | 9.5 | 0.6 | 51.6 | 2 | 106.3 | 0.1 | 1.07 | 0.04 | 87 | 1.58 | 0.116 | 20.7 | 38.5 | 2.47 | 101.4 | 0.244 | <1 | 3.83 | 0.211 | 0.58 | <.1 | 3.4 | 0.52 | <.01 | 22 | 0.3 | <.02 | 10.6 | 30 |
| IV Bm3 | Y05-09-09 | 0.41 | 26.23 | 6.72 | 73.9 | 444 | 37.5 | 30.2 | 768 | 5.08 | 9.1 | 0.5 | 74.7 | 2.6 | 90.2 | 0.15 | 0.84 | 0.05 | 86 | 1.38 | 0.11 | 16.3 | 45.6 | 2.27 | 143.1 | 0.226 | <1 | 3.39 | 0.182 | 0.62 | <.1 | 3.9 | 0.4 | <.01 | 22 | 0.3 | <.02 | 10 | 30 |
| **-80 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ahe -80 | Y05-09-03 | 1.14 | 12.06 | 20.63 | 69.2 | 933 | 10.6 | 20.4 | 3219 | 2 | 4.8 | 0.5 | 19.7 | 0.8 | 22.1 | 0.65 | 0.66 | 0.19 | 47 | 0.31 | 0.072 | 13.5 | 20.2 | 0.28 | 651 | 0.042 | 1 | 1.26 | 0.009 | 0.14 | 0.3 | 2 | 0.14 | <.01 | 30 | 0.4 | 0.02 | 6.6 | 15 |
| Bm -80 | Y05-09-04 | 1.05 | 8.54 | 14.95 | 54.5 | 501 | 10.6 | 8.3 | 578 | 2.41 | 6.7 | 0.6 | 51.7 | 4 | 13.1 | 0.14 | 0.75 | 0.14 | 45 | 0.19 | 0.027 | 15.1 | 25.3 | 0.48 | 329.4 | 0.039 | <1 | 1.56 | 0.006 | 0.12 | 0.2 | 3 | 0.13 | <.01 | 13 | 0.1 | 0.02 | 6.6 | 30 |
| II Bm -80 | Y05-09-05 | 1.09 | 22.65 | 17.54 | 64.5 | 259 | 17.2 | 8.3 | 207 | 2.57 | 12.3 | 1.3 | 205.2 | 10.7 | 10.9 | 0.14 | 1.39 | 0.14 | 21 | 0.17 | 0.023 | 22.6 | 25 | 0.78 | 238.4 | 0.049 | <1 | 1.47 | 0.002 | 0.11 | 0.3 | 3.7 | 0.1 | <.01 | 5 | 0.5 | 0.02 | 5.3 | 30 |
| III Bm -80 | Y05-09-06 | 1.67 | 36.31 | 23.25 | 97.1 | 718 | 36.8 | 16.3 | 569 | 3.99 | 15.7 | 1.8 | 334.5 | 13.4 | 27.5 | 0.23 | 1.36 | 0.22 | 56 | 0.57 | 0.085 | 30.8 | 69.1 | 1.8 | 219.4 | 0.109 | <1 | 2.36 | 0.02 | 0.12 | 0.5 | 8.7 | 0.13 | <.01 | 46 | 0.5 | 0.02 | 9.3 | 30 |
| IV Bm1 -80 | Y05-09-07 | 0.58 | 26.63 | 7.23 | 73.2 | 885 | 40.8 | 26.4 | 576 | 4.95 | 12 | 1.1 | 159.3 | 4.3 | 79 | 0.09 | 1.93 | 0.05 | 82 | 1.37 | 0.099 | 35 | 40.7 | 2.11 | 236.5 | 0.233 | <1 | 3.45 | 0.172 | 0.39 | 0.2 | 5.6 | 0.53 | <.01 | 53 | 0.3 | <.02 | 9.8 | 30 |
| IV Bm2 -80 | Y05-09-08 | 0.42 | 27.62 | 3.71 | 76.6 | 1047 | 44.4 | 30.3 | 627 | 5.18 | 8.8 | 0.9 | 95.6 | 2.8 | 97.4 | 0.08 | 1.14 | 0.03 | 82 | 1.47 | 0.114 | 22.4 | 40 | 2.33 | 98.2 | 0.216 | <1 | 3.6 | 0.18 | 0.49 | <.1 | 3.5 | 0.49 | <.01 | 42 | 0.2 | <.02 | 10.1 | 30 |
| IV Bm3 -80 | Y05-09-09 | 0.39 | 24.08 | 4.14 | 73.2 | 914 | 39 | 31.1 | 713 | 5.03 | 8.2 | 0.6 | 529.5 | 2.5 | 86.8 | 0.11 | 0.94 | 0.03 | 80 | 1.37 | 0.115 | 18 | 43.4 | 2.26 | 81.1 | 0.186 | <1 | 3.24 | 0.17 | 0.57 | <.1 | 3 | 0.4 | <.01 | 33 | 0.2 | <.02 | 9.7 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ahe -230 | Y05-09-03 | 1.03 | 10 | 18.24 | 58 | 678 | 9.5 | 14.4 | 1963 | 1.9 | 3.6 | 0.5 | 46.6 | 1.4 | 19.7 | 0.38 | 0.49 | 0.18 | 46 | 0.28 | 0.055 | 14.6 | 21.6 | 0.31 | 575.8 | 0.034 | 1 | 1.25 | 0.01 | 0.12 | 0.1 | 2.3 | 0.12 | 0.02 | 16 | 0.1 | <.02 | 6 | 15 |
| Bm -230 | Y05-09-04 | 0.96 | 7.44 | 14.05 | 49.6 | 493 | 9.8 | 6.9 | 385 | 2.33 | 5.5 | 0.6 | 62.1 | 4.2 | 13.2 | 0.12 | 0.7 | 0.14 | 46 | 0.19 | 0.022 | 16.3 | 25.4 | 0.48 | 331.2 | 0.038 | <1 | 1.52 | 0.006 | 0.11 | 0.2 | 2.8 | 0.13 | 0.01 | 9 | 0.1 | 0.02 | 6 | 30 |
| II Bm -230 | Y05-09-05 | 1.15 | 23.6 | 17.93 | 66 | 240 | 18 | 9.3 | 232 | 2.8 | 11.9 | 1.4 | 128.6 | 10.7 | 11.2 | 0.15 | 1.34 | 0.15 | 23 | 0.19 | 0.024 | 23.2 | 26.6 | 0.86 | 242.6 | 0.048 | <1 | 1.57 | 0.002 | 0.11 | 0.2 | 3.8 | 0.11 | <.01 | 10 | 0.5 | <.02 | 5.4 | 30 |
| III Bm -230 | Y05-09-06 | 1.78 | 37.66 | 23.83 | 100 | 804 | 39.1 | 17.4 | 613 | 4.32 | 15.4 | 1.8 | 318.7 | 12.8 | 29.8 | 0.24 | 1.35 | 0.24 | 61 | 0.61 | 0.087 | 31.6 | 70.6 | 1.85 | 237.6 | 0.113 | 1 | 2.59 | 0.028 | 0.13 | 0.5 | 8.9 | 0.15 | <.01 | 45 | 0.5 | <.02 | 9.5 | 30 |
| IV Bm1 -230 | Y05-09-07 | 0.62 | 27.73 | 7.45 | 77.8 | 1047 | 42.9 | 27.8 | 609 | 5.31 | 11.8 | 1.2 | 161.6 | 4.4 | 83.1 | 0.11 | 1.76 | 0.06 | 89 | 1.5 | 0.106 | 34.9 | 44.2 | 2.18 | 236.3 | 0.271 | <1 | 3.7 | 0.181 | 0.39 | 0.2 | 5.7 | 0.55 | <.01 | 49 | 0.4 | <.02 | 9.9 | 30 |
| IV Bm2 -230 | Y05-09-08 | 0.44 | 28.24 | 3.96 | 78.6 | 1184 | 44.7 | 31.5 | 674 | 5.45 | 8.9 | 0.9 | 99.3 | 2.7 | 102.4 | 0.1 | 1.07 | 0.04 | 88 | 1.56 | 0.12 | 22.3 | 41.6 | 2.34 | 100.1 | 0.238 | 1 | 3.83 | 0.2 | 0.5 | <.1 | 3.6 | 0.51 | <.01 | 47 | 0.4 | <.02 | 10.2 | 30 |
| IV Bm3 -230 | Y05-09-09 | 0.39 | 24.01 | 4.15 | 72.2 | 973 | 39 | 32 | 732 | 5.22 | 7.8 | 0.6 | 118.1 | 2.5 | 91.3 | 0.12 | 0.83 | 0.03 | 85 | 1.44 | 0.12 | 17 | 44 | 2.23 | 79.8 | 0.203 | <1 | 3.49 | 0.184 | 0.55 | <.1 | 3 | 0.41 | <.01 | 36 | 0.2 | <.02 | 9.2 | 30 |

# Nugget 1-2 geochemistry

| | | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraction/Horizon | Number | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bm | Y05-09-14 | 1.25 | 10.18 | 12.43 | 61.8 | 579 | 14.7 | 8.5 | 360 | 2.65 | 8.8 | 0.7 | 84.7 | 5.4 | 14.6 | 0.12 | 1.08 | 0.12 | 47 | 0.22 | 0.032 | 15.4 | 29.9 | 0.61 | 322 | 0.062 | 1 | 1.86 | 0.012 | 0.21 | 0.3 | 3.2 | 0.15 | <.01 | 12 | 0.2 | 0.02 | 7.4 | 30 |
| II Bm | Y05-09-15 | 0.94 | 11.69 | 8.71 | 40.9 | 144 | 12.3 | 7.5 | 220 | 2.06 | 19.6 | 0.8 | 72.8 | 6.9 | 11.1 | 0.11 | 1.01 | 0.07 | 23 | 0.21 | 0.036 | 14.2 | 19.6 | 0.67 | 189.4 | 0.052 | 1 | 1.21 | 0.01 | 0.18 | 0.4 | 2.4 | 0.08 | <.01 | 6 | 0.3 | 0.02 | 4.3 | 30 |
| III Bm1 | Y05-09-16 | 0.92 | 29.92 | 14.72 | 86.7 | 247 | 54.9 | 36.8 | 654 | 5.81 | 18.8 | 0.6 | 56.4 | 4.9 | 38 | 0.14 | 1.7 | 0.08 | 93 | 0.76 | 0.083 | 11.7 | 49.1 | 2.3 | 487.8 | 0.259 | 1 | 4.83 | 0.079 | 0.46 | 0.3 | 3.8 | 0.46 | <.01 | 13 | 0.3 | 0.02 | 13 | 30 |
| III Bm2 | Y05-09-17 | 0.66 | 25.42 | 7.21 | 72.3 | 219 | 48.2 | 31.8 | 631 | 5.3 | 14.4 | 0.5 | 41.7 | 4.4 | 48.4 | 0.09 | 1.07 | 0.06 | 90 | 0.89 | 0.078 | 13.8 | 48.4 | 2.17 | 565.9 | 0.275 | <1 | 4.59 | 0.096 | 0.37 | 0.2 | 3.9 | 0.33 | <.01 | 14 | 0.3 | <.02 | 12.2 | 30 |
| III Bm3 | Y05-09-18 | 0.71 | 26.74 | 9.33 | 80.8 | 160 | 37.7 | 31.4 | 785 | 5.38 | 8.4 | 0.6 | 50.3 | 4.2 | 54.8 | 0.11 | 1.21 | 0.05 | 104 | 0.93 | 0.103 | 14.3 | 50.7 | 2.27 | 254.7 | 0.225 | <1 | 3.26 | 0.083 | 0.25 | 0.1 | 6.4 | 0.15 | <.01 | 8 | 0.3 | <.02 | 11.6 | 30 |
| **-80 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bm -80 | Y05-09-14 | 1.12 | 8.62 | 12.16 | 62.3 | 556 | 12.1 | 6.7 | 323 | 2.5 | 8 | 0.6 | 48.5 | 4.8 | 13.8 | 0.13 | 0.82 | 0.13 | 47 | 0.2 | 0.023 | 15 | 28.2 | 0.51 | 308.5 | 0.048 | <1 | 1.75 | 0.005 | 0.12 | 0.2 | 3.4 | 0.14 | <.01 | 5 | 0.1 | 0.03 | 7.2 | 30 |
| II Bm -80 | Y05-09-15 | 1.5 | 16.24 | 14.58 | 64.3 | 317 | 15.9 | 8.1 | 243 | 2.9 | 25.4 | 1.2 | 127.7 | 9.7 | 12.6 | 0.14 | 1.41 | 0.13 | 32 | 0.2 | 0.028 | 19.7 | 28.3 | 0.89 | 278.1 | 0.064 | 1 | 1.76 | 0.004 | 0.15 | 0.5 | 3.9 | 0.12 | <.01 | 12 | 0.4 | 0.04 | 6.2 | 30 |
| III Bm1 -80 | Y05-09-16 | 1.15 | 32.59 | 15.58 | 87.4 | 271 | 55.9 | 34.5 | 515 | 5.67 | 20.9 | 0.6 | 70.2 | 5.7 | 34.1 | 0.14 | 1.57 | 0.1 | 93 | 0.74 | 0.067 | 9.3 | 51.4 | 2.17 | 604.2 | 0.281 | <1 | 5.19 | 0.08 | 0.39 | 0.3 | 4.3 | 0.39 | <.01 | 21 | 0.3 | <.02 | 13.4 | 30 |
| III Bm2 -80 | Y05-09-17 | 0.73 | 28.14 | 7.34 | 70.5 | 203 | 52.8 | 32.6 | 521 | 5.38 | 15 | 0.5 | 58.5 | 4.2 | 46.2 | 0.09 | 1.05 | 0.06 | 92 | 0.92 | 0.07 | 12.7 | 48.1 | 2.19 | 648 | 0.282 | <1 | 4.9 | 0.092 | 0.33 | 0.2 | 3.7 | 0.32 | <.01 | 15 | 0.3 | <.02 | 12.2 | 30 |
| III Bm3 -80 | Y05-09-18 | 0.85 | 26.21 | 12.27 | 75.6 | 352 | 33.1 | 22.5 | 545 | 4.65 | 13.1 | 1 | 127.8 | 6.8 | 52.5 | 0.09 | 1.52 | 0.08 | 79 | 0.86 | 0.075 | 14.1 | 40.3 | 1.89 | 207 | 0.178 | <1 | 3.1 | 0.06 | 0.21 | 0.2 | 6.1 | 0.17 | <.01 | 15 | 0.3 | <.02 | 10 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bm -230 | Y05-09-14 | 1.07 | 8.63 | 12.38 | 61.2 | 563 | 12.3 | 6.8 | 323 | 2.59 | 7.2 | 0.6 | 60.3 | 4.6 | 14.8 | 0.13 | 0.75 | 0.13 | 48 | 0.21 | 0.024 | 14.4 | 27.1 | 0.55 | 288.1 | 0.047 | 1 | 1.8 | 0.007 | 0.13 | 0.2 | 3.2 | 0.14 | 0.02 | 13 | 0.1 | 0.03 | 6.8 | 30 |
| II Bm -230 | Y05-09-15 | 1.48 | 15.87 | 14.72 | 64.9 | 353 | 15.1 | 7.6 | 245 | 2.98 | 23.3 | 1.2 | 148.6 | 9 | 13.3 | 0.14 | 1.33 | 0.13 | 34 | 0.2 | 0.028 | 19 | 26.7 | 0.89 | 264.2 | 0.063 | 1 | 1.83 | 0.005 | 0.15 | 0.5 | 3.7 | 0.13 | 0.01 | 12 | 0.3 | 0.06 | 6 | 30 |
| III Bm1 -230 | Y05-09-16 | 1.38 | 34.62 | 17.12 | 92.3 | 390 | 57.6 | 37.3 | 534 | 6.07 | 21.5 | 0.7 | 92.4 | 6.3 | 32.9 | 0.16 | 1.46 | 0.13 | 100 | 0.69 | 0.066 | 9.4 | 55.7 | 2.05 | 669.7 | 0.324 | 1 | 5.56 | 0.072 | 0.38 | 0.3 | 4.4 | 0.4 | <.01 | 21 | 0.4 | 0.03 | 13.8 | 30 |
| III Bm2 -230 | Y05-09-17 | 0.91 | 31.14 | 8.71 | 81.2 | 285 | 58.1 | 37.9 | 585 | 6.26 | 15.9 | 0.6 | 73.5 | 4.7 | 47.7 | 0.12 | 1.03 | 0.08 | 109 | 0.98 | 0.074 | 13 | 57.5 | 2.33 | 782.4 | 0.365 | 1 | 5.64 | 0.095 | 0.35 | 0.2 | 3.7 | 0.37 | <.01 | 16 | 0.3 | <.02 | 13.1 | 30 |
| III Bm3 -230 | Y05-09-18 | 0.99 | 30.13 | 13.27 | 83.7 | 517 | 36.5 | 25.2 | 598 | 5.25 | 13.6 | 1.3 | 225.7 | 8.1 | 58.6 | 0.11 | 1.56 | 0.1 | 91 | 0.98 | 0.079 | 17.1 | 46.1 | 2.01 | 231.1 | 0.274 | 1 | 3.73 | 0.073 | 0.24 | 0.3 | 7.1 | 0.22 | <.01 | 25 | 0.3 | 0.02 | 10.8 | 15 |

# Nugget 1-3 geochemistry

| Fraction/Horizon | Number | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bm1 | Y05-09-22 | 1.15 | 10.78 | 12.99 | 58.2 | 276 | 12.1 | 16.1 | 1422 | 2.46 | 12.4 | 0.7 | 151.6 | 5.5 | 13.6 | 0.18 | 0.84 | 0.13 | 39 | 0.25 | 0.04 | 12.7 | 23.8 | 0.64 | 336.4 | 0.068 | 1 | 1.4 | 0.013 | 0.21 | 0.3 | 2.5 | 0.1 | <.01 | 13 | 0.3 | 0.03 | 6.3 | 30 |
| Bm2 | Y05-09-23 | 0.7 | 22.49 | 7.52 | 74 | 96 | 43.3 | 30.4 | 610 | 5.29 | 14 | 0.4 | 61.2 | 3.4 | 27.9 | 0.08 | 1.22 | 0.05 | 95 | 0.67 | 0.071 | 8.8 | 44.6 | 2.07 | 475 | 0.28 | <1 | 4.18 | 0.056 | 0.22 | 0.2 | 2.9 | 0.13 | <.01 | 13 | 0.3 | 0.02 | 12.4 | 30 |
| II Bm | Y05-09-24 | 0.46 | 21.7 | 10.15 | 76.4 | 134 | 37.2 | 27.7 | 767 | 4.56 | 6.2 | 0.4 | 369.4 | 3.5 | 34.9 | 0.1 | 0.68 | 0.06 | 94 | 0.75 | 0.085 | 10.3 | 56.1 | 2.25 | 416.8 | 0.207 | <1 | 2.89 | 0.059 | 0.24 | 0.2 | 5.6 | 0.11 | <.01 | 10 | 0.1 | 0.02 | 11.5 | 30 |
| **-80 Mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bm1 -80 | Y05-09-22 | 1.25 | 9.49 | 11.75 | 71.7 | 295 | 13.9 | 11.9 | 880 | 2.72 | 10.5 | 0.6 | 175.6 | 4.7 | 15.4 | 0.19 | 0.92 | 0.13 | 50 | 0.28 | 0.036 | 14.2 | 26.5 | 0.63 | 462.8 | 0.09 | <1 | 1.62 | 0.01 | 0.21 | 0.3 | 3 | 0.14 | <.01 | 10 | 0.2 | <.02 | 7.1 | 30 |
| Bm2 -80 | Y05-09-23 | 1.05 | 25.17 | 9.37 | 71.5 | 116 | 43.7 | 26.7 | 459 | 5.03 | 19.7 | 0.6 | 120.6 | 4.9 | 21.5 | 0.09 | 1.3 | 0.07 | 87 | 0.52 | 0.039 | 6.2 | 42.4 | 1.84 | 573.1 | 0.238 | <1 | 4.81 | 0.036 | 0.2 | 0.3 | 3.3 | 0.16 | <.01 | 17 | 0.2 | <.02 | 12.5 | 30 |
| II Bm -80 | Y05-09-24 | 0.96 | 30.2 | 16.85 | 87.8 | 294 | 37.2 | 22.5 | 668 | 4.88 | 16 | 0.8 | 723.5 | 6.8 | 32.4 | 0.1 | 1.07 | 0.12 | 88 | 0.61 | 0.069 | 9.3 | 57.6 | 2.3 | 450.5 | 0.167 | <1 | 3.31 | 0.028 | 0.21 | 0.4 | 7.1 | 0.15 | <.01 | <5 | 0.2 | <.02 | 12.7 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bm1 -230 | Y05-09-22 | 1.2 | 9.75 | 12.04 | 74.1 | 304 | 14 | 12.3 | 903 | 2.85 | 10 | 0.6 | 62.7 | 4.7 | 16.7 | 0.21 | 0.91 | 0.14 | 53 | 0.29 | 0.036 | 14.9 | 25.9 | 0.65 | 468.2 | 0.089 | 1 | 1.73 | 0.01 | 0.21 | 0.3 | 3.1 | 0.16 | 0.01 | 13 | 0.1 | 0.03 | 7.1 | 30 |
| Bm2 -230 | Y05-09-23 | 1.03 | 26.6 | 10.26 | 76.6 | 181 | 46.4 | 28.1 | 472 | 5.36 | 20 | 0.6 | 266.2 | 5.1 | 24.2 | 0.11 | 1.35 | 0.08 | 90 | 0.56 | 0.041 | 6.4 | 42.5 | 1.84 | 592.3 | 0.276 | 1 | 5.12 | 0.046 | 0.22 | 0.3 | 3.4 | 0.19 | <.01 | 17 | 0.3 | 0.02 | 12.9 | 30 |
| II Bm -230 | Y05-09-24 | 0.91 | 29.96 | 17.09 | 88.9 | 384 | 36.5 | 22.3 | 655 | 4.92 | 15.4 | 0.8 | 789.7 | 6.6 | 33.4 | 0.12 | 1.06 | 0.13 | 86 | 0.62 | 0.07 | 9.3 | 54.2 | 2.19 | 418.7 | 0.179 | 1 | 3.33 | 0.034 | 0.21 | 0.4 | 6.6 | 0.15 | <.01 | 7 | 0.2 | <.02 | 12 | 30 |

## Nugget 2 geochemistry

| | | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraction/Horizon | Number | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ahe | Y05-10-03 | 0.74 | 15.77 | 10.13 | 48.3 | 1101 | 11.7 | 12.5 | 1840 | 1.57 | 3.3 | 0.3 | 91.3 | 0.8 | 23.1 | 0.56 | 0.51 | 0.16 | 39 | 0.27 | 0.049 | 9.8 | 16.5 | 0.33 | 479.4 | 0.034 | <1 | 0.95 | 0.013 | 0.08 | 0.2 | 1.5 | 0.08 | <.01 | 21 | 0.2 | 0.04 | 4.8 | 30 |
| Bm | Y05-10-04 | 0.87 | 14.92 | 15.51 | 60.5 | 796 | 13.4 | 9.4 | 378 | 2.54 | 8.1 | 0.6 | 2317.1 | 5.4 | 12.7 | 0.18 | 0.6 | 0.19 | 48 | 0.16 | 0.027 | 14.7 | 27.2 | 0.58 | 228.5 | 0.058 | <1 | 1.72 | 0.01 | 0.15 | 0.2 | 2.7 | 0.1 | <.01 | 16 | 0.3 | 0.03 | 6 | 30 |
| II Bm1 | Y05-10-05 | 0.61 | 14.09 | 15.14 | 51.4 | 422 | 9.4 | 6.2 | 191 | 1.91 | 6.9 | 0.9 | 378.2 | 9.4 | 11.5 | 0.19 | 0.78 | 0.13 | 21 | 0.14 | 0.019 | 19.9 | 18.4 | 0.58 | 195.5 | 0.055 | <1 | 1.26 | 0.006 | 0.21 | 0.5 | 2.2 | 0.1 | <.01 | 13 | 0.4 | 0.03 | 4.8 | 30 |
| II Bm2 | Y05-10-06 | 0.33 | 15.75 | 16.73 | 57.5 | 105 | 10.6 | 6.6 | 182 | 1.84 | 4.6 | 1 | 121.7 | 9 | 20.5 | 0.18 | 0.59 | 0.11 | 18 | 0.35 | 0.046 | 20 | 24 | 0.76 | 165.4 | 0.09 | <1 | 1.17 | 0.006 | 0.25 | 0.7 | 2.4 | 0.12 | <.01 | 7 | 0.3 | 0.02 | 5 | 30 |
| II C | Y05-10-07 | 0.28 | 13.93 | 12.03 | 60.5 | 62 | 10.5 | 6.3 | 224 | 1.73 | 5.3 | 0.6 | 54 | 5 | 17.8 | 0.15 | 0.38 | 0.09 | 14 | 0.35 | 0.056 | 14.7 | 19.4 | 0.75 | 173.4 | 0.074 | <1 | 1.1 | 0.009 | 0.18 | 0.3 | 2.1 | 0.09 | <.01 | 7 | 0.2 | <.02 | 4.2 | 30 |
| **-80 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ahe -80 | Y05-10-03 | 0.77 | 14.89 | 10.58 | 50 | 891 | 12.7 | 11.9 | 1848 | 1.49 | 3.2 | 0.3 | 31 | 0.5 | 23.3 | 0.66 | 0.41 | 0.15 | 41 | 0.27 | 0.052 | 11.1 | 16.9 | 0.26 | 548.8 | 0.037 | 1 | 0.98 | 0.011 | 0.07 | 0.1 | 1.6 | 0.09 | <.01 | 34 | 0.1 | 0.02 | 5.1 | 30 |
| Bm -80 | Y05-10-04 | 0.92 | 11.65 | 12.71 | 57.2 | 783 | 12.7 | 6.4 | 239 | 2.36 | 7.7 | 0.5 | 311.7 | 4.7 | 11.6 | 0.13 | 0.61 | 0.15 | 50 | 0.12 | 0.019 | 14.4 | 26.7 | 0.48 | 223 | 0.052 | <1 | 1.68 | 0.005 | 0.09 | 0.2 | 2.7 | 0.1 | <.01 | 22 | 0.1 | <.02 | 5.6 | 30 |
| II Bm -80 | Y05-10-05 | 0.77 | 14.33 | 17.87 | 61.3 | 569 | 9.8 | 5.4 | 185 | 2.1 | 7.2 | 0.9 | 397.7 | 10 | 10.5 | 0.17 | 0.87 | 0.16 | 25 | 0.12 | 0.015 | 21.4 | 22.1 | 0.63 | 151.1 | 0.065 | <1 | 1.43 | 0.002 | 0.11 | 0.5 | 2.8 | 0.1 | <.01 | 13 | 0.2 | 0.03 | 5.3 | 30 |
| II Bm2 -80 | Y05-10-06 | 0.36 | 14.94 | 16.83 | 61.5 | 122 | 10.4 | 5.7 | 187 | 1.9 | 4.1 | 1 | 205.5 | 10.7 | 17.9 | 0.14 | 0.61 | 0.13 | 19 | 0.29 | 0.042 | 21.1 | 25.9 | 0.8 | 115.3 | 0.096 | <1 | 1.19 | 0.002 | 0.1 | 0.7 | 2.4 | 0.1 | <.01 | 6 | 0.2 | <.02 | 5 | 30 |
| II C -80 | Y05-10-07 | 0.34 | 13.56 | 14.85 | 66.8 | 120 | 11 | 6.1 | 234 | 1.85 | 4.5 | 0.9 | 157 | 7.9 | 19.7 | 0.16 | 0.49 | 0.11 | 16 | 0.35 | 0.06 | 21.4 | 22.4 | 0.81 | 121.4 | 0.075 | <1 | 1.14 | 0.002 | 0.09 | 0.4 | 2.6 | 0.1 | <.01 | <5 | 0.2 | 0.02 | 4.5 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ahe -230 | Y05-10-03 | 0.69 | 12.74 | 10.28 | 46 | 787 | 10.4 | 10.2 | 1539 | 1.46 | 2.9 | 0.3 | 35.4 | 0.6 | 20.4 | 0.55 | 0.36 | 0.16 | 39 | 0.23 | 0.047 | 9.8 | 16 | 0.25 | 476.6 | 0.033 | 1 | 0.95 | 0.01 | 0.06 | 0.1 | 1.4 | 0.09 | 0.03 | 21 | 0.1 | <.02 | 4.5 | 30 |
| Bm -230 | Y05-10-04 | 0.82 | 10.2 | 11.86 | 53.2 | 781 | 11 | 5.8 | 223 | 2.34 | 6.7 | 0.4 | 174.7 | 4.1 | 10.7 | 0.12 | 0.54 | 0.14 | 49 | 0.11 | 0.02 | 12.5 | 23.3 | 0.46 | 187.8 | 0.043 | <1 | 1.6 | 0.005 | 0.08 | 0.2 | 2.3 | 0.09 | 0.03 | 24 | 0.2 | 0.02 | 4.9 | 30 |
| II Bm -230 | Y05-10-05 | 0.73 | 13.74 | 17.8 | 60.9 | 538 | 9.6 | 5.1 | 179 | 2.15 | 6.6 | 0.9 | 275.4 | 9.1 | 10.7 | 0.16 | 0.82 | 0.16 | 25 | 0.12 | 0.015 | 20.4 | 20.9 | 0.64 | 144.1 | 0.062 | <1 | 1.45 | 0.002 | 0.11 | 0.5 | 2.6 | 0.1 | <.01 | 17 | 0.3 | 0.02 | 5.2 | 30 |
| II Bm2 -230 | Y05-10-06 | 0.36 | 15.29 | 17.38 | 63.3 | 172 | 10.7 | 5.8 | 193 | 2.02 | 3.9 | 1.1 | 271.4 | 9.8 | 19 | 0.16 | 0.6 | 0.12 | 21 | 0.3 | 0.042 | 20.9 | 26.5 | 0.85 | 117.8 | 0.094 | <1 | 1.27 | 0.002 | 0.1 | 0.7 | 2.5 | 0.09 | 0.02 | 9 | 0.2 | 0.02 | 5 | 30 |
| II C -230 | Y05-10-07 | 0.36 | 14.31 | 16.13 | 69.6 | 181 | 11.5 | 6.6 | 248 | 2.02 | 4.5 | 0.9 | 219.6 | 7.7 | 19.9 | 0.17 | 0.48 | 0.12 | 18 | 0.36 | 0.059 | 21.5 | 22.8 | 0.89 | 124.5 | 0.073 | <1 | 1.22 | 0.002 | 0.09 | 0.4 | 2.7 | 0.11 | 0.02 | 9 | 0.1 | <.02 | 4.6 | 30 |

## Clip 1 geochemistry

| | | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraction/Horizon | Site number | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmgjy | Y05-11-04 | 0.9 | 22.5 | 14.19 | 86.3 | 66 | 19.5 | 6.9 | 223 | 2.46 | 7.8 | 1.1 | 4.2 | 3.3 | 12.4 | 0.1 | 0.63 | 0.17 | 46 | 0.13 | 0.049 | 21.5 | 26.6 | 0.4 | 114.5 | 0.047 | <1 | 1.52 | 0.01 | 0.17 | <.1 | 2.3 | 0.17 | <.01 | 41 | 0.5 | 0.03 | 4.6 | 30 |
| Bmy | Y05-11-05 | 0.88 | 22.61 | 18.08 | 101 | 75 | 19.5 | 7.6 | 284 | 2.36 | 7.6 | 1.2 | 7.8 | 3.6 | 12.8 | 0.13 | 0.68 | 0.17 | 44 | 0.13 | 0.051 | 21.3 | 26.4 | 0.38 | 130.8 | 0.046 | 1 | 1.45 | 0.011 | 0.16 | <.1 | 2.6 | 0.17 | <.01 | 40 | 0.4 | 0.05 | 4.4 | 30 |
| II Bmy | Y05-11-06 | 0.86 | 35.76 | 37.38 | 378.5 | 124 | 30 | 11.9 | 796 | 2.46 | 8 | 1.4 | 3.3 | 6.7 | 15.4 | 0.73 | 1.39 | 0.1 | 32 | 0.14 | 0.061 | 30.7 | 18.3 | 0.31 | 214 | 0.035 | 1 | 1.08 | 0.008 | 0.18 | <.1 | 2.6 | 0.17 | <.01 | 30 | 0.4 | 0.04 | 3 | 30 |
| III C1 | Y05-11-07 | 1.02 | 45.33 | 135.01 | 607.8 | 168 | 33.1 | 10.3 | 794 | 2.75 | 7.9 | 1.7 | 3.9 | 10.5 | 17.9 | 0.87 | 0.9 | 0.15 | 37 | 0.17 | 0.072 | 37.6 | 22.7 | 0.45 | 275.1 | 0.038 | 1 | 1.36 | 0.007 | 0.28 | <.1 | 2.8 | 0.23 | 0.01 | 89 | 0.3 | 0.04 | 4 | 30 |
| III C2 | Y05-11-08 | 1.34 | 49.65 | 77.76 | 387.6 | 150 | 33.4 | 8 | 496 | 3.12 | 8.3 | 2 | 3 | 10.8 | 22.7 | 0.9 | 0.76 | 0.24 | 47 | 0.26 | 0.119 | 38.9 | 26.6 | 0.49 | 232.3 | 0.033 | 1 | 1.47 | 0.006 | 0.31 | <.1 | 3.3 | 0.22 | 0.03 | 43 | 0.5 | 0.1 | 4.6 | 30 |
| **-80 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmgjy -80 | Y05-11-04 | 0.78 | 21.79 | 13.24 | 73.6 | 77 | 19 | 6.2 | 174 | 2.26 | 6.2 | 1.1 | 0.9 | 2.8 | 12.5 | 0.1 | 0.51 | 0.15 | 42 | 0.14 | 0.05 | 20 | 28.4 | 0.43 | 99.5 | 0.054 | 1 | 1.55 | 0.007 | 0.11 | <.1 | 2.4 | 0.17 | <.01 | 33 | 0.3 | <.02 | 4.6 | 30 |
| Bmy -80 | Y05-11-05 | 0.76 | 23.6 | 15.75 | 88.8 | 84 | 20.7 | 7.1 | 226 | 2.28 | 6.7 | 1.2 | 4.4 | 3 | 14.3 | 0.13 | 0.54 | 0.16 | 44 | 0.16 | 0.053 | 21.5 | 29.8 | 0.44 | 120.5 | 0.058 | 1 | 1.57 | 0.007 | 0.11 | <.1 | 2.7 | 0.17 | <.01 | 41 | 0.3 | 0.03 | 4.8 | 30 |
| II Bmy -80 | Y05-11-06 | 0.78 | 30.46 | 44.46 | 203.6 | 155 | 24.9 | 9.6 | 515 | 2.35 | 7 | 1.4 | 1.9 | 6.4 | 18.4 | 0.51 | 0.82 | 0.15 | 41 | 0.18 | 0.052 | 26.2 | 25.4 | 0.43 | 249.5 | 0.065 | 1 | 1.31 | 0.007 | 0.11 | <.1 | 3.7 | 0.15 | <.01 | 41 | 0.2 | 0.03 | 4 | 30 |
| III C1 -80 | Y05-11-07 | 1.14 | 46.72 | 190.81 | 650.4 | 241 | 39.9 | 16.3 | 1031 | 2.83 | 10 | 1.8 | 3 | 11.1 | 22.4 | 1.2 | 1.27 | 0.22 | 37 | 0.21 | 0.078 | 36.3 | 23.6 | 0.45 | 307.6 | 0.056 | 1 | 1.27 | 0.004 | 0.16 | <.1 | 3.1 | 0.25 | <.01 | 83 | 0.5 | 0.05 | 3.8 | 30 |
| III C2 -80 | Y05-11-08 | 1.2 | 51.67 | 196.2 | 611.8 | 231 | 39.2 | 13.4 | 838 | 2.95 | 9.7 | 1.9 | 3.7 | 12.5 | 24.7 | 1.25 | 1.2 | 0.27 | 39 | 0.23 | 0.082 | 39.7 | 25.5 | 0.47 | 237.4 | 0.054 | <1 | 1.33 | 0.004 | 0.18 | <.1 | 3.2 | 0.25 | <.01 | 85 | 0.6 | 0.07 | 4 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmgjy -230 | Y05-11-04 | 0.75 | 21.58 | 13.63 | 72.6 | 76 | 19.3 | 6.3 | 174 | 2.31 | 6.1 | 1.1 | 3.6 | 2.7 | 12.2 | 0.1 | 0.49 | 0.17 | 44 | 0.15 | 0.05 | 19 | 26.9 | 0.45 | 93.7 | 0.052 | <1 | 1.57 | 0.006 | 0.11 | <.1 | 2.3 | 0.17 | 0.02 | 48 | 0.4 | 0.03 | 4.6 | 30 |
| Bmy -230 | Y05-11-05 | 0.74 | 22.55 | 16.01 | 81.1 | 93 | 19.5 | 7.3 | 230 | 2.34 | 6.4 | 1.2 | 7.4 | 2.8 | 13.5 | 0.15 | 0.52 | 0.17 | 46 | 0.15 | 0.051 | 20.1 | 27.6 | 0.45 | 114.1 | 0.054 | 1 | 1.58 | 0.007 | 0.11 | 0.1 | 2.7 | 0.17 | 0.01 | 42 | 0.4 | 0.03 | 4.5 | 30 |
| II Bmy -230 | Y05-11-06 | 0.82 | 31.25 | 45.27 | 206 | 176 | 26.2 | 9.7 | 517 | 2.52 | 6.9 | 1.4 | 2.9 | 6.3 | 18.8 | 0.52 | 0.76 | 0.17 | 46 | 0.19 | 0.054 | 26.3 | 25.2 | 0.46 | 257.9 | 0.067 | <1 | 1.39 | 0.008 | 0.11 | <.1 | 3.8 | 0.16 | 0.01 | 46 | 0.2 | 0.02 | 4 | 30 |
| III C1 -230 | Y05-11-07 | 1.01 | 41.33 | 164.1 | 569.2 | 231 | 34.6 | 14.3 | 888 | 2.54 | 9 | 1.6 | 2 | 9.9 | 21.8 | 1.02 | 1.06 | 0.19 | 35 | 0.19 | 0.074 | 33.2 | 20.6 | 0.41 | 275.8 | 0.053 | <1 | 1.16 | 0.004 | 0.16 | <.1 | 2.9 | 0.23 | <.01 | 75 | 0.3 | 0.07 | 3.4 | 30 |
| III C2 -230 | Y05-11-08 | 0.99 | 44.09 | 174.7 | 554.1 | 222 | 33.2 | 11.5 | 743 | 2.65 | 9 | 1.7 | 2.7 | 11 | 24 | 1.09 | 1.05 | 0.22 | 38 | 0.21 | 0.077 | 37.3 | 22.3 | 0.42 | 219.7 | 0.054 | 1 | 1.22 | 0.004 | 0.18 | <.1 | 3.1 | 0.23 | <.01 | 88 | 0.4 | 0.05 | 3.7 | 30 |

## Clip 2 geochemistry

| | | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraction/Horizon | Number | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmgju | Y05-12-03 | 1.13 | 30.49 | 63.32 | 476.9 | 100 | 22.3 | 6.8 | 255 | 2.77 | 7.3 | 1.3 | 3.2 | 7 | 14.3 | 0.68 | 0.65 | 0.24 | 47 | 0.11 | 0.052 | 29.5 | 26.6 | 0.43 | 122.2 | 0.044 | 1 | 1.56 | 0.01 | 0.26 | <.1 | 2.5 | 0.28 | 0.02 | 207 | 0.5 | 0.05 | 4.6 | 30 |
| II Bmu | Y05-12-04 | 0.96 | 36.92 | 33.95 | 401.5 | 117 | 29.3 | 10.8 | 471 | 3.03 | 9.8 | 1.8 | 3.7 | 7 | 20.4 | 1.16 | 0.65 | 0.2 | 57 | 0.21 | 0.072 | 25.3 | 33 | 0.57 | 196.4 | 0.06 | 2 | 1.95 | 0.014 | 0.21 | 0.1 | 5.1 | 0.22 | 0.01 | 445 | 0.4 | 0.03 | 5 | 30 |
| III C1 | Y05-12-05 | 2.09 | 39.97 | 95.91 | 974 | 143 | 25.2 | 8 | 361 | 2.73 | 6.4 | 1.7 | 2.7 | 8.7 | 16.4 | 1.7 | 0.71 | 0.17 | 43 | 0.13 | 0.064 | 26 | 24.8 | 0.45 | 163.8 | 0.053 | 1 | 1.44 | 0.01 | 0.31 | <.1 | 3.2 | 0.3 | 0.02 | 567 | 0.8 | 0.07 | 4 | 30 |
| III C2 | Y05-12-06 | 1.15 | 42.23 | 49.69 | 1172.7 | 167 | 25.8 | 7.2 | 387 | 2.78 | 6 | 1.9 | 2.4 | 9.9 | 19.5 | 1.96 | 0.61 | 0.18 | 44 | 0.16 | 0.075 | 30.7 | 25.4 | 0.45 | 162.9 | 0.052 | 1 | 1.38 | 0.009 | 0.32 | <.1 | 3.1 | 0.27 | 0.01 | 488 | 0.8 | 0.05 | 4.1 | 30 |
| **-80 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmgju -80 | Y05-12-03 | 1.13 | 29.05 | 73.39 | 465.6 | 110 | 23.7 | 7.1 | 238 | 2.72 | 6.2 | 1.3 | 5 | 6.1 | 14.7 | 0.8 | 0.62 | 0.2 | 48 | 0.11 | 0.045 | 30 | 28 | 0.47 | 103.1 | 0.048 | <1 | 1.65 | 0.005 | 0.17 | <.1 | 2.5 | 0.3 | 0.02 | 254 | 0.5 | 0.04 | 4.6 | 30 |
| II Bmu -80 | Y05-12-04 | 0.84 | 32.48 | 29.08 | 264.6 | 113 | 27.2 | 9.3 | 359 | 2.69 | 8.1 | 1.4 | 3.7 | 5.5 | 17.5 | 0.96 | 0.65 | 0.15 | 50 | 0.19 | 0.064 | 20.7 | 29.2 | 0.55 | 150.5 | 0.056 | 1 | 1.66 | 0.007 | 0.11 | <.1 | 4.2 | 0.15 | 0.01 | 384 | 0.4 | 0.03 | 4.2 | 30 |
| III C1 -80 | Y05-12-05 | 1.13 | 38.65 | 59.08 | 669.7 | 211 | 30.6 | 9.3 | 372 | 3.02 | 7.7 | 1.7 | 4.1 | 7.8 | 21.5 | 1.51 | 0.73 | 0.2 | 52 | 0.19 | 0.064 | 31.6 | 32.3 | 0.57 | 173.4 | 0.062 | <1 | 1.73 | 0.007 | 0.18 | <.1 | 4.3 | 0.24 | 0.02 | 641 | 0.5 | 0.04 | 4.6 | 30 |
| III C2 -80 | Y05-12-06 | 1.01 | 38.29 | 53.6 | 975.1 | 202 | 26.7 | 7.2 | 255 | 2.7 | 5.3 | 1.5 | 4 | 7.8 | 23.4 | 1.72 | 0.69 | 0.16 | 44 | 0.18 | 0.055 | 28.8 | 26.5 | 0.52 | 153.3 | 0.066 | 1 | 1.31 | 0.006 | 0.17 | <.1 | 3.2 | 0.25 | 0.03 | 542 | 0.6 | 0.05 | 3.8 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bmgju -230 | Y05-12-03 | 1 | 26.23 | 60.24 | 420.4 | 102 | 21.2 | 6.6 | 223 | 2.55 | 5.8 | 1.1 | 3.7 | 5.2 | 14.1 | 0.67 | 0.53 | 0.17 | 47 | 0.1 | 0.039 | 28 | 25.2 | 0.44 | 96.3 | 0.046 | <1 | 1.59 | 0.005 | 0.17 | <.1 | 2.3 | 0.25 | <.01 | 280 | 0.2 | 0.03 | 4.3 | 30 |
| II Bmu -230 | Y05-12-04 | 0.78 | 28.44 | 25.14 | 222.6 | 102 | 24.5 | 8.7 | 319 | 2.36 | 7.8 | 1.3 | 4.5 | 4.8 | 16 | 0.82 | 0.54 | 0.13 | 45 | 0.16 | 0.059 | 18.1 | 25.7 | 0.48 | 134.5 | 0.051 | 1 | 1.46 | 0.007 | 0.1 | <.1 | 3.9 | 0.13 | <.01 | 403 | 0.3 | <.02 | 3.9 | 30 |
| III C1 -230 | Y05-12-05 | 0.94 | 32.22 | 47.34 | 555 | 183 | 24.7 | 8.3 | 338 | 2.65 | 6.9 | 1.5 | 3.8 | 6.5 | 20.2 | 1.2 | 0.6 | 0.16 | 48 | 0.16 | 0.058 | 26.9 | 27.2 | 0.5 | 151 | 0.056 | 1 | 1.56 | 0.007 | 0.16 | <.1 | 3.8 | 0.2 | <.01 | 606 | 0.4 | 0.03 | 4.2 | 30 |
| III C2 -230 | Y05-12-06 | 0.86 | 32.99 | 47.29 | 846.7 | 186 | 23.3 | 6.7 | 242 | 2.43 | 5.1 | 1.3 | 3.8 | 7 | 22.2 | 1.5 | 0.59 | 0.15 | 41 | 0.16 | 0.048 | 26.1 | 23 | 0.47 | 139.7 | 0.061 | <1 | 1.18 | 0.006 | 0.16 | <.1 | 3 | 0.22 | <.01 | 542 | 0.5 | 0.04 | 3.4 | 30 |

## Bear Cub 1 geochemistry

| | | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraction/Horizon | Number | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ahy | Y05-16-03 | 4.95 | 219.49 | 4.76 | 82.4 | 125 | 4.6 | 15.7 | 184 | 3.71 | 1.5 | 1.7 | 0.7 | 5.1 | 92.7 | 0.07 | 0.12 | 0.32 | 68 | 0.15 | 0.036 | 17.6 | 7.7 | 0.61 | 343.7 | 0.058 | 1 | 2.42 | 0.114 | 0.38 | <.1 | 6 | 0.13 | 0.54 | 13 | 1.9 | 0.12 | 7.1 | 30 |
| Bmy1 | Y05-16-04 | 5.33 | 255.33 | 4.56 | 78.7 | 121 | 4.3 | 14.6 | 188 | 4.04 | 1.2 | 1.9 | 1.1 | 7.5 | 102.6 | 0.06 | 0.11 | 0.36 | 74 | 0.16 | 0.034 | 18.8 | 7.3 | 0.64 | 409.4 | 0.071 | 1 | 2.68 | 0.136 | 0.45 | <.1 | 6.9 | 0.14 | 0.62 | 5 | 2.3 | 0.16 | 7.4 | 30 |
| Bmy2 | Y05-16-05 | 2.21 | 303.01 | 7.25 | 74.7 | 220 | 4.5 | 18.9 | 88 | 6.25 | 0.3 | 1.2 | 1.8 | 10 | 180.5 | 0.07 | 0.08 | 0.82 | 62 | 0.16 | 0.048 | 25.1 | 6.7 | 0.41 | 154.9 | 0.027 | 1 | 3.16 | 0.495 | 0.45 | <.1 | 5 | 0.2 | 1.88 | 10 | 7.4 | 0.4 | 6.8 | 30 |
| III Bm | Y05-16-07 | 6.82 | 384.33 | 3.3 | 27.8 | 380 | 2.1 | 13.9 | 114 | 5.42 | 1.6 | 2 | 4.8 | 9.6 | 307.2 | 0.06 | 0.08 | 0.6 | 39 | 0.18 | 0.036 | 11 | 10.2 | 0.19 | 222.9 | 0.03 | 1 | 1.65 | 0.184 | 0.45 | <.1 | 3.3 | 0.27 | 1.06 | 7 | 7.5 | 0.22 | 5.9 | 30 |
| IVBm | Y05-16-08 | 22.43 | 104.83 | 1.62 | 5.7 | 201 | 0.4 | 0.6 | <1 | 6.59 | 0.1 | 0.5 | 2.4 | 8.6 | 135.7 | <.01 | 0.04 | 0.56 | 23 | 0.14 | 0.057 | 48.9 | 4.4 | 0.04 | 134.1 | 0.01 | <1 | 0.55 | 0.249 | 0.85 | <.1 | 1.2 | 0.32 | 2.09 | <5 | 6.8 | 0.22 | 2.5 | 30 |
| **-80 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ahy -80 | Y05-16-03 | 6.49 | 267.74 | 5.56 | 110.2 | 163 | 7.5 | 20.1 | 240 | 4.64 | 2.3 | 2.1 | 1.7 | 5.6 | 113.5 | 0.1 | 0.17 | 0.32 | 93 | 0.18 | 0.048 | 20.8 | 12.7 | 0.87 | 412.8 | 0.087 | 1 | 3.3 | 0.118 | 0.48 | <.1 | 8 | 0.15 | 0.63 | 18 | 2.1 | 0.09 | 9.7 | 30 |
| Bmy1 -80 | Y05-16-04 | 5.75 | 328.81 | 5.21 | 117.2 | 156 | 7.7 | 21.8 | 273 | 5.38 | 2.1 | 2.3 | 1.9 | 8 | 127.9 | 0.09 | 0.15 | 0.35 | 103 | 0.18 | 0.045 | 21.7 | 12.9 | 1.04 | 342.9 | 0.103 | <1 | 3.68 | 0.137 | 0.59 | <.1 | 9.5 | 0.2 | 0.73 | 7 | 2.4 | 0.1 | 10 | 30 |
| Bmy2 -80 | Y05-16-05 | 3.66 | 344.82 | 7.48 | 102.4 | 297 | 4.9 | 24.1 | 136 | 7.92 | 0.8 | 1.3 | 2.6 | 10.9 | 177.3 | 0.08 | 0.08 | 0.79 | 81 | 0.25 | 0.048 | 22.8 | 10.4 | 0.68 | 162.9 | 0.034 | <1 | 3.53 | 0.484 | 0.51 | <.1 | 6.1 | 0.22 | 2.06 | <5 | 7.4 | 0.44 | 7.9 | 30 |
| III Bm -80 | Y05-16-07 | 9.14 | 477.3 | 3.87 | 53.6 | 558 | 4.5 | 29.2 | 156 | 7.73 | 1.9 | 2 | 3.9 | 12.6 | 206.5 | 0.05 | 0.08 | 0.66 | 54 | 0.24 | 0.047 | 16.7 | 13.9 | 0.33 | 151.5 | 0.031 | <1 | 1.94 | 0.268 | 0.51 | <.1 | 4.2 | 0.31 | 1.55 | <5 | 9.9 | 0.26 | 7.3 | 30 |
| IV Bm -80 | Y05-16-08 | 37.41 | 140.21 | 1.8 | 3.8 | 299 | 0.3 | 0.6 | <1 | 9.24 | 0.8 | 0.6 | 3 | 13.5 | 174.8 | <.01 | 0.06 | 0.96 | 26 | 0.18 | 0.079 | 72.8 | 5.7 | 0.03 | 106.6 | 0.015 | <1 | 0.48 | 0.309 | 1.14 | <.1 | 1 | 0.48 | 3.02 | <5 | 10.5 | 0.35 | 2.8 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ahy -230 | Y05-16-03 | 5.58 | 254.84 | 5.47 | 101.8 | 164 | 7.4 | 18.6 | 226 | 4.39 | 2.5 | 2 | 1.1 | 5.1 | 111.6 | 0.1 | 0.17 | 0.3 | 88 | 0.17 | 0.045 | 18.8 | 12.9 | 0.79 | 303.4 | 0.078 | <1 | 3.21 | 0.11 | 0.45 | <.1 | 7.1 | 0.13 | 0.58 | 26 | 2 | 0.08 | 8.8 | 30 |
| Bmy1 -230 | Y05-16-04 | 4.99 | 304.47 | 4.81 | 105 | 159 | 7.4 | 19.6 | 256 | 4.94 | 2.7 | 2.2 | 1.8 | 7.9 | 122.3 | 0.07 | 0.13 | 0.33 | 95 | 0.17 | 0.045 | 20.7 | 12.8 | 0.95 | 239.9 | 0.101 | 1 | 3.5 | 0.137 | 0.59 | <.1 | 9.1 | 0.18 | 0.71 | 11 | 2 | 0.11 | 9.5 | 30 |
| Bmy2 -230 | Y05-16-05 | 3.7 | 333.29 | 7.26 | 92.7 | 279 | 4.9 | 22.8 | 130 | 7.72 | 1.3 | 1.3 | 2.7 | 10.8 | 168.3 | 0.08 | 0.09 | 0.79 | 74 | 0.23 | 0.048 | 22.6 | 9.9 | 0.59 | 114.9 | 0.029 | <1 | 3.5 | 0.503 | 0.53 | <.1 | 5.8 | 0.22 | 2.03 | 10 | 7.4 | 0.43 | 7.9 | 30 |
| III Bm -230 | Y05-16-07 | 8.14 | 478.4 | 3.51 | 56.3 | 529 | 4.7 | 29.7 | 163 | 7.65 | 2 | 1.9 | 3.8 | 12.6 | 202 | 0.05 | 0.09 | 0.62 | 53 | 0.22 | 0.046 | 16 | 13.4 | 0.3 | 123.1 | 0.027 | <1 | 1.84 | 0.259 | 0.53 | <.1 | 4.2 | 0.32 | 1.49 | 8 | 9.4 | 0.26 | 7 | 30 |
| IV Bm -230 | Y05-16-08 | 35.31 | 144.25 | 1.7 | 3.4 | 286 | 0.4 | 0.6 | <1 | 9.98 | 0.9 | 0.6 | 2.6 | 14.1 | 174.9 | <.01 | 0.06 | 0.98 | 26 | 0.16 | 0.083 | 75.4 | 6.2 | 0.03 | 73.4 | 0.014 | <1 | 0.44 | 0.328 | 1.28 | <.1 | 1 | 0.48 | 3.12 | <5 | 10.8 | 0.39 | 2.8 | 30 |

## Bear Cub 2 geochemistry

| | | Mo | Cu | Pb | Zn | Ag | Ni | Co | Mn | Fe | As | U | Au | Th | Sr | Cd | Sb | Bi | V | Ca | P | La | Cr | Mg | Ba | Ti | B | Al | Na | K | W | Sc | Tl | S | Hg | Se | Te | Ga | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraction/Horizon | Number | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | % | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | % | % | ppm | ppm | % | ppm | % | ppm | % | % | % | ppm | ppm | ppm | % | ppb | ppm | ppm | ppm | gm |
| **Crush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bm | Y05-17-02 | 2.61 | 78.6 | 9.06 | 41.2 | 328 | 15 | 7.1 | 170 | 3.07 | 6.3 | 0.6 | 1.3 | 4 | 67.4 | 0.05 | 0.41 | 0.23 | 67 | 0.17 | 0.017 | 13 | 29.9 | 0.58 | 185.4 | 0.07 | 1 | 2.5 | 0.043 | 0.16 | <.1 | 3.9 | 0.12 | 0.19 | 12 | 1.3 | 0.04 | 6.3 | 30 |
| II Bm1 | Y05-17-03 | 4.6 | 332.05 | 5.4 | 18.4 | 313 | 3.4 | 2.8 | 63 | 3.52 | 0.9 | 1.2 | 1.7 | 9.4 | 275.9 | 0.02 | 0.08 | 0.42 | 30 | 0.17 | 0.032 | 28.5 | 7.6 | 0.73 | 154.4 | 0.029 | <1 | 3.62 | 0.127 | 0.29 | <.1 | 6 | 0.14 | 0.63 | 13 | 7 | 0.11 | 6.3 | 30 |
| II Bm2 | Y05-17-04 | 5.33 | 311.17 | 4.21 | 15.9 | 441 | 2.6 | 1.6 | 43 | 4.2 | 1 | 1.1 | 4.3 | 8.8 | 196.4 | 0.02 | 0.08 | 0.58 | 23 | 0.11 | 0.03 | 26.7 | 6.9 | 0.66 | 137 | 0.029 | <1 | 2.67 | 0.227 | 0.3 | <.1 | 4.6 | 0.14 | 0.88 | 16 | 9 | 0.13 | 5.2 | 30 |
| II Bm3 | Y05-17-05 | 4.63 | 185.84 | 3.99 | 10.6 | 230 | 2.1 | 1 | 37 | 4.22 | 0.9 | 0.7 | 2.8 | 8.8 | 177.4 | 0.01 | 0.08 | 0.5 | 22 | 0.09 | 0.027 | 17.7 | 5.1 | 0.42 | 106.6 | 0.021 | <1 | 2.04 | 0.261 | 0.26 | <.1 | 3.6 | 0.12 | 0.9 | 11 | 6.9 | 0.12 | 4.4 | 30 |
| II BC | Y05-17-06 | 3.34 | 226.93 | 4.67 | 20.1 | 67 | 1.8 | 1.1 | 83 | 4.38 | <.1 | 1 | 1.7 | 9 | 209.3 | 0.01 | 0.03 | 0.29 | 46 | 0.22 | 0.034 | 30.2 | 5.9 | 0.96 | 109.7 | 0.049 | <1 | 3.38 | 0.223 | 0.47 | <.1 | 8 | 0.2 | 0.88 | <5 | 5.4 | 0.07 | 6.7 | 30 |
| III C | Y05-17-07 | 3.16 | 198.03 | 3.9 | 25.4 | 101 | 2.2 | 1.5 | 115 | 3 | 0.4 | 1 | 2 | 8.5 | 184.7 | 0.02 | 0.02 | 0.25 | 51 | 0.28 | 0.026 | 23.3 | 6.1 | 1.16 | 119.2 | 0.057 | <1 | 3.82 | 0.117 | 0.46 | <.1 | 7.7 | 0.19 | 0.46 | 5 | 3.6 | 0.07 | 6.8 | 30 |
| **-80 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bm -80 | Y05-17-02 | 2.22 | 39.73 | 7.51 | 40 | 248 | 15.3 | 7 | 161 | 2.75 | 5.6 | 0.4 | 2.2 | 3.1 | 40.2 | 0.04 | 0.47 | 0.17 | 61 | 0.14 | 0.014 | 10 | 28 | 0.47 | 136.5 | 0.063 | <1 | 1.89 | 0.022 | 0.09 | <.1 | 2.7 | 0.09 | 0.12 | 15 | 0.7 | <.02 | 5 | 30 |
| II Bm -80 | Y05-17-03 | 5.92 | 356.18 | 6.77 | 25.8 | 670 | 6.3 | 4.9 | 86 | 4.96 | 2.6 | 1.7 | 3.9 | 12.3 | 328.5 | 0.03 | 0.16 | 0.42 | 48 | 0.2 | 0.042 | 33.3 | 14 | 0.82 | 199.7 | 0.048 | <1 | 4.74 | 0.136 | 0.3 | <.1 | 7.2 | 0.19 | 0.72 | 18 | 7.9 | 0.08 | 7.8 | 30 |
| II Bm2 -80 | Y05-17-04 | 7.52 | 394.22 | 4.79 | 18.3 | 1137 | 4.2 | 2.3 | 61 | 5.91 | 2.3 | 1.5 | 7.4 | 12.2 | 257.9 | 0.02 | 0.14 | 0.53 | 34 | 0.13 | 0.041 | 31.1 | 10.6 | 0.72 | 132.3 | 0.042 | <1 | 3.99 | 0.226 | 0.27 | <.1 | 5.6 | 0.18 | 0.97 | 21 | 10.6 | 0.12 | 6.5 | 30 |
| II Bm3 -80 | Y05-17-05 | 8.69 | 202.76 | 3.76 | 12.4 | 402 | 3.5 | 1.6 | 44 | 6.82 | 3 | 0.8 | 10.1 | 10.9 | 197.2 | 0.01 | 0.18 | 0.67 | 25 | 0.07 | 0.037 | 17.8 | 8 | 0.33 | 83.2 | 0.03 | <1 | 1.82 | 0.364 | 0.19 | <.1 | 3.8 | 0.1 | 1.31 | 11 | 9.7 | 0.14 | 4.6 | 30 |
| II BC -80 | Y05-17-06 | 5.98 | 383.48 | 5.85 | 23 | 165 | 3 | 1.8 | 101 | 7.81 | 0.9 | 1.7 | 6.1 | 14.3 | 316.9 | 0.03 | 0.06 | 0.43 | 73 | 0.26 | 0.054 | 42.8 | 10.4 | 1.15 | 151.6 | 0.067 | <1 | 4.98 | 0.358 | 0.65 | <.1 | 12.4 | 0.28 | 1.61 | <5 | 10.8 | 0.13 | 9.1 | 30 |
| III C -80 | Y05-17-07 | 4.46 | 344.58 | 5.2 | 29 | 215 | 3.8 | 3.1 | 121 | 5.66 | 1 | 2.1 | 4.1 | 14.3 | 293.2 | 0.03 | 0.07 | 0.4 | 78 | 0.27 | 0.048 | 35.1 | 10 | 1.23 | 180.6 | 0.087 | <1 | 5.39 | 0.179 | 0.64 | <.1 | 11.2 | 0.28 | 0.94 | 5 | 8.7 | 0.1 | 8.3 | 30 |
| **-230 mesh** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bm -230 | Y05-17-02 | 1.79 | 34.51 | 5.81 | 35.1 | 208 | 13.5 | 6.5 | 150 | 2.37 | 5 | 0.3 | 1.2 | 2.6 | 34.7 | 0.05 | 0.39 | 0.14 | 56 | 0.12 | 0.012 | 8.7 | 25.6 | 0.4 | 122.6 | 0.058 | <1 | 1.71 | 0.017 | 0.08 | <.1 | 2.5 | 0.08 | 0.09 | 9 | 0.7 | <.02 | 4.6 | 30 |
| II Bm -230 | Y05-17-03 | 4.92 | 338.68 | 5.36 | 20 | 640 | 5.2 | 4.8 | 70 | 4.53 | 2.7 | 1.5 | 3 | 11.6 | 314.8 | 0.02 | 0.13 | 0.37 | 41 | 0.17 | 0.041 | 29.7 | 12.3 | 0.65 | 178.1 | 0.042 | <1 | 4.53 | 0.127 | 0.29 | <.1 | 6.8 | 0.16 | 0.68 | 31 | 7.2 | 0.1 | 7.1 | 30 |
| II Bm2 -230 | Y05-17-04 | 5.85 | 367.84 | 3.9 | 14.6 | 1013 | 3.6 | 2.4 | 54 | 5.26 | 2.1 | 1.2 | 5.7 | 10.5 | 241.6 | 0.02 | 0.14 | 0.46 | 30 | 0.11 | 0.037 | 26.8 | 10.1 | 0.58 | 120.5 | 0.037 | <1 | 3.69 | 0.195 | 0.25 | <.1 | 5.1 | 0.15 | 0.85 | 28 | 9 | 0.11 | 5.6 | 30 |
| II Bm3 -230 | Y05-17-05 | 8.01 | 194.17 | 3.39 | 12.4 | 381 | 4 | 1.9 | 44 | 6.41 | 3.1 | 0.8 | 7.9 | 10.1 | 183.2 | 0.01 | 0.21 | 0.66 | 24 | 0.07 | 0.035 | 16.2 | 9 | 0.28 | 76.2 | 0.029 | <1 | 1.68 | 0.347 | 0.18 | <.1 | 3.6 | 0.1 | 1.17 | 16 | 9.5 | 0.21 | 4.4 | 30 |
| II BC -230 | Y05-17-06 | 5.52 | 380.07 | 5.43 | 19.7 | 163 | 2.7 | 1.8 | 89 | 7.61 | 1.1 | 1.7 | 5.2 | 13.5 | 305.8 | 0.03 | 0.07 | 0.44 | 65 | 0.21 | 0.053 | 41.2 | 9.7 | 0.98 | 142.2 | 0.071 | <1 | 5.15 | 0.344 | 0.63 | <.1 | 10.9 | 0.27 | 1.61 | 11 | 10.2 | 0.14 | 8.5 | 30 |
| III C -230 | Y05-17-07 | 3.09 | 326.48 | 4.23 | 25 | 194 | 3.8 | 3.2 | 108 | 5.15 | 0.9 | 1.6 | 3.6 | 13 | 258.1 | 0.02 | 0.05 | 0.35 | 68 | 0.23 | 0.046 | 30.5 | 9.6 | 1.09 | 161.3 | 0.072 | <1 | 4.93 | 0.162 | 0.57 | <.1 | 9.4 | 0.25 | 0.81 | 5 | 8 | 0.08 | 7 | 30 |

# APPENDIX 4: SOIL CLASSIFICATION AND GEOLOGICAL TERMINOLOGY

This Appendix provides a brief introduction to the terminology used to designate the geology, soil horizons and to classify the soils and surficial geology documented in this report. Terminology for the soils portion of the report is based primarily on the 3rd edition of the Canadian System of Soil Classification (Soil Classification Working Group, 1998), as well as B.C. Ministry of Environment, Lands, and Parks / B.C. Ministry of Forests (1998), with terminology for organic horizons according to Green et al. (1993). Terminology for the geology portion of the report is largely derived from the Oxford Dictionary of Earth Sciences (1991) and the Glossary of Geology 5th edition (2005). These sources should be consulted for fuller definitions of the terms discussed here, as well as for a more complete account of the structure of soil and humus form classification systems in Canada.

## Soil horizon nomenclature

Soil horizons are layers of mineral or organic materials that are approximately parallel to the land surface, and that have been modified by processes of soil formation.

Organic horizons contain more than 17% organic carbon, and are usually found at the surface of soil profiles, unless disrupted by slope processes or cryoturbation. (Lowland peat or O horizons will not be discussed here.) Three major organic horizons are recognized in upland settings, and represent successive stages in the decomposition of leaves, twigs, and woody materials, perhaps with a component of bryophytes:

**L** - original structures are largely intact (e.g. recently fallen leaf litter);

**F** - partially decomposed organic matter, with some of the original structures no longer recognizable as a result of decomposition processes involving soil fauna and/or microbes, especially fungi;

**H** - highly decomposed organic matter in which the original structures are unrecognizable.

In addition, a surface layer of living bryophytes can often be recognized, and is designated with "**S**". Living bryophytes may be intermingled with suspended litter materials.

Specific subordinate types of organic horizons are designated by adding suffixes, and those recognized in this study consisted of:

**Lv** - residues display initial decay and are strongly discoloured;

**Fm** - partially decomposed residues are matted together with abundant fungal mycelia;

**Hh** - consists of strongly decomposed organic matter with a black colour and greasy appearance.

Mineral horizons contain 17% or less organic carbon. The major mineral horizons are designated:

**A** - formed at or near the soil surface in the zone of leaching or eluviation of organic materials in solution or suspension, or of maximum in situ accumulation of organic matter, or both;

**B** - enriched in organic matter, iron and aluminum oxides, or clay; or by the development of soil structure; or by a change of colour resulting from hydrolysis, reduction, or oxidation;

**C** - relatively unaffected by the soil-forming processes, and similar to the original parent material, except for some modification by reduction and oxidation, and/or accumulation of carbonates and soluble salts.

Where more than one mineral parent material is present, recognized on the basis of texture, mineralogy, or geological origin, these are indicated by Roman numerals are included in the horizon designation, as in IIBm, IIIC, and so on. Subdivisions within a horizon, based on some observable or measurable property, are indicated by appending numerical suffixes, as in Bm1, Bm2, and Bm3.

These major mineral horizons are given additional suffixes to indicate specific characteristics. Some suffixes can be used with more than one major horizon, although the combinations occurring in these soils represent only a subset of the possible combinations. Note that suffixes such as “m” and “h” have different meanings when applied to mineral and organic soils.

Two types of A and three types of B horizons were recognized in the soils studied:

**Ahy** - where h indicates enrichment in organic matter, giving a dark colour, and y indicates disruption by cryoturbation;

**Ahe** - indicates that both enrichment in organic matter, and leaching or eluviation have occurred, often resulting in a splotchy or streaked appearance with grayer and darker brown or black colours intermingled;

**Bm** and **Bmy** - both exhibit some type of modification (m) of appearance or other properties in comparison with the underlying parent material (e.g. reddening or change in structure), but not to a degree sufficient to qualify as one of the other B horizon types; y indicates cryoturbation;

**Bmgju and Bmu** - indicates that this B horizon has undergone modification (m) that includes features typical of gleying (g), such as iron-rich mottles created by alternating reducing and oxidizing conditions, but those features are weakly developed or juvenile (j); u indicates horizons that have been disrupted by processes other than cryoturbation, such as mass movement or tree uprooting.

## Soil classification

The soils examined in this study belong to two of the ten orders in the Canadian System of Soil Classification: Brunisolic and Cryosolic. The classification system is hierarchical, with five levels of progressively greater generality, culminating in the orders. Classifications of individual soils are reported in this study at the subgroup level, which is the third or intermediate level in the hierarchy, immediately below the great groups.

Brunisolic soils display a moderate degree of development, but lack the characteristics required for other soil orders. These soils are generally characterized by brownish Bm horizons and have usually formed under forest vegetation. In Yukon landscapes, Brunisols are the most common soil encountered where permafrost is absent. The most common soil subgroup found in this study was Orthic Dystric Brunisol, which indicates that these soils conformed to the central concept (Orthic) of the Dystric great group of the Brunisolic order. “Dystric” indicates that these soil lack an A horizon in which organic matter has accumulated (Ah), and pH values in the B horizon are clearly acidic (below 5.5 in the upper 25 cm of the B horizon). In one case, the soil belonged to the Sombric great group, which indicates a similarly acidic B horizon, but with the presence of an Ah horizon at least 10 cm thick. Gleyed subgroups were recognized in two cases, based on the presence of some mottling in B horizons, indicative a wetter moisture regime and periodic alternation between oxidizing and reducing conditions.

Cryosolic soils have permafrost within 1 or 2 m of the surface, depending on the degree of disruption of horizons by cryoturbation. One of the soils examined in this study was an Orthic Dystric Turbic Cryosol, indicating that permafrost was present within 2 m of the surface, horizons within the active layer had been markedly disrupted by cryoturbation, and pH was below 5.5 in the B horizons.

## Geological Terms

**Accretion** – in terms of structural geology it is addition of material (such as an oceanic plate, volcanic island or continent) to the edge of a continent, thereby enlarging the continent. Much of southwest Yukon consists of accreted terranes that were added to the ancient North American margin.

**Active-layer** - Seasonally frozen ground that overlies permafrost.

**Active-layer detachment slides** - a landslide of active-layer material. Typically occurs following a forest fire.

**Aeolian** - the erosion, transport, and deposition of material by wind action. See Loess.

**Clast** - fragment of rock. Generally refers to coarser fragments such as pebbles and cobbles.

**Colluvium, colluvial** - unconsolidated sediment that has moved down slope by creep and/or surface wash. May also include sediment transported by landslide processes. The process of colluviation is enhanced in active-layers environments.

**Crush fraction** - a sample preparation technique that crushes a representative portion of a soil sample (including pebbles if present) in a ceramic pulverizer until the sample is able to completely pass through a 100 mesh screen (0.149 mm).

**Cryoturbation** - general term for all frost action-based movements, such as churning, of a soil. Cryoturbation is most pronounced in permafrost active-layers.

**Discordant quartz veins** - quartz veins that cross-cut the bedding planes or foliation.

**Dispersion train** - a string of clastic materials that has moved from its source by processes of glacial or colluvial transport.

**Float** - a fragment of rock that has been displaced from its source.

**Fluvial benches** - a level of bedrock, sand and gravel marking the former floodplain elevation of a river or stream.

**Geomorphology** - scientific study concerned with the evolution of landforms.

**Holocene** - epoch of the earth's history that covers the last 10,000 years.

**Isostatic exhumation** - rebound/uplift of the earth's surface due to crustal lightening causing further erosion of the earth's surface.

**Loess** - wind deposited sediment often consisting of largley homogenous silt and fine sand-sized particles. Loess is most often associated with glacial periods or areas of active glaciation.

**Muck** - a term applied to accumulations of organic material, loess and permafrost in the unglaciated valley bottoms of Yukon and Alaska.

**Pleistocene** - epoch of earth's history from about 2.7 million years ago to 10,000 years ago. The end of the Pliocene and beginning of the Pleistocene is currently the subject of some debate.

**Periglacial** - a climate, process or area where the dominant surface process involves freezing and thawing. Typically it pertains to the areas adjacent to an ice sheet which would be exposed to cold conditions associated with the ice.

**Permafrost** - areas of the ground that have remained below 0 °C for at least 2 consecutive years.
**Permian** - period of the Earth's history from 286-248 million years ago.

**Plio-Pleistocene** - a term that is used to refer to the time spanning the Pliocene and Pleistocene epochs.

**Pliocene** - epoch of the Earth's history from 5.1-2.7 million years ago. The end of the Pliocene and beginning of the Pleistocene is currently the subject of some debate.

**Porphyry** - a medium to coarse-grained felsic igneous rock containing more than 25% phenocrysts by volume.

**Sedimentary exhalative deposit (SEDEX)** - typically a base-metals sulphide deposit that formed when mineralizing fluids upwelled into a submarine sedimentary environment. The term used to describe an active process of this kind is 'black smoker'.

**Shear zone** - a zone within a body of rock that has undergone intense deformation causing a body to slide parallel to the plane of contact. Brittle shear zones are marked by a surface rupture such as a fault.

**Solifluction** - the slow downslope flow of water-logged surficial sediment and organic material. Often has a lobate surface expression and is most common in alpine environments.

**Tephra** - a general term for all pyroclastic sediments from a volcano. Often it refers to air-fall material (includes volcanic ash).

**-80 mesh fraction** - a common sieve mesh size used to separate soil particles. Equal to <0.177 mm.

**-230 mesh** - a common sieve mesh size used to separate soil particles. Equal to <0.062 mm.