MARGINAL NOTES

INTRODUCTION

The Granite Creek map area includes the southwest section of the Gustavus Range. This area hosts summits approximately 2000 m in elevation such as Mt. Hinton and Mt. Albert. Granite and Albert creeks drain to the east into Roop Lakes, through the wide, ushaped lower Granite Creek valley. Keystone Creek flows to the west in a narrow, bedrock-controlled valley. Upper Granite Creek begins in a cirque on the southeast flank of Mt. Hinton (Fig. 1), and is joined by Albert Creek, which flows northward from Mt. Albert (Fig. 2). Lower Granite creek flows through the middle of the valley, depositing modern fluvial gravel and a blanket of organic material on the floodplain. Till from four alpine sources, as well as from the Cordilleran Ice Sheet (CIS), blanket the lower valley and intermix with glaciolacustrine sand and silt. Glaciolacustrine sediment can also be found capping moraines, and on valley walls above lateral moraines deposited when the CIS advanced up lower Granite Creek valley. Glaciofluvial gravel forms a proglacial fan where the former Granite Creek alpine glacier terminated and meltwater channels mark most former ice margins of the CIS. Till from the most recent glaciation is found in alpine glacier and Cordilleran Ice Sheet moraines (Fig. 3), as well as in cirque valleys as blankets and veneers where preserved. Loess forms blankets on most gentle slopes, which allows for its preservation (Fig. 4). Colluvium veneers, blankets, and fans form below steep slopes with active rockfall. Bedrock outcrops along steep cirque headwalls and in cirque valleys, as well as in Keystone Creek where fluvial downcutting processes are active. Stone stripes formed by frost heaving (Fig. 5) are found on gentle slopes. Flat upland surfaces host weathered bedrock (Fig. 6) and mud

Site: GRC-01W Location: 63°50'53.82" N, 135°3'25.66" W

Site: GRC-01S Location: 63°50'53.22" N, 135°3'22.16" W

GLACIAL HISTORY

The study area was glaciated by the Selwyn Lobe of the Cordilleran Ice Sheet (CIS), which flowed west-northwest (Hughes et al., 1969). As in the rest of the Yukon, glaciers were largely topographically controlled, with widespread nunataks (Jackson et al., 1991). Glaciers emanated out of upland areas such as the Selwyn Mountains and local cirques. Four alpine glaciers formed within the study area. The Granite Creek and 'east Granite' cirques produced ice that flowed south, whereas the Albert Creek and 'east Albert' cirques produced ice that flowed north into Granite Creek.

During the last glaciation in the study area, the CIS flowed west and advanced up lower Granite Creek to within 500 m of the Granite Creek alpine glacier limit. This blocked the drainage and caused water to overtop the divide and flow west through the Keystone Creek valley. Due to the blockage, local alpine glaciers flowed into a proglacial lake. Moraines representing the maximum extent of this alpine advance are subdued because of the floating margin, whereas well-defined alpine moraines represent a recessional phase. Evidence of earlier glaciations is preserved in the subsurface near the margins of the MIS 2 (29 -11.7 ka) limits. This includes till and glaciofluvial deposits from the MIS 4 glaciation (71 - 57 ka) and rare till from the MIS 6 glaciation (191 – 123 ka).

CHRONOLOGY

Optically stimulated luminescence (OSL) dates indicate that one glacial deposit dates to 68.0 ± 18.4 ka (Table 1). A sample taken from loess draped on a deglacial morainal landform dates to 51.3 ± 3.5 kg and the paleosol formed on this loess dates to 32.5 ± 2.4 ka. The MIS 2 limit of the Selwyn Lobe of the CIS was previously dated using terrestrial cosmogenic nuclides (TCN), and deglaciation is established at 15.9 ± 0.8 ka (Ward and Bond, unpublished data). Loess from the most recent glaciation dates alpine deglaciation prior to 12.1 ± 0.8 ka. Several units were sampled for radiocarbon dating but all samples were found to represent reworked material.

GEOMORPHIC PROCESSES

Gullying occurs on valley sides through till blankets likely deposited by the CIS and in bedrock of cirque headwalls. Rockfall is common along steep scarps of cirque walls deepened during the last glaciation. Solifluction is widespread on gentler slopes blanketed by fine-grained material. Cryoturbation is common and results in the formation of stone stripes (Fig. 5) in cirque valleys and widespread frost heaving of bedrock fragments. Many lateral moraines deposited by the ice sheet have been channeled by meltwater and exhibit irregular drainage networks.

PERMAFROST

Permafrost was encountered in only one placer mining excavation, but likely exists in many regions in the map area. Two rock

glaciers were identified during helicopter traverses, one on a north-facing and one on a west-northwest-facing cirque.

PLACER MINING AND GEOLOGY

Granite Creek has been mined since 2015, but exploration and mapping work in the Keno Hill mining camp began in the late 1880s (Boyle, 1965). Placer mining has focused on upper Granite and Albert creeks, and lower Keystone Creek to the south of the study area (Figure 2). Mineralization within the local Keno Hill Quartzite is the primary gold source. This includes oxidized and brecciated milky quartz veins. Multiple gold-bearing units are present in the Granite Creek valley, and were previously studied by LeBarge et al. (2002). These can be grouped into modern, interglacial/interstadial and glacial deposits (Steinke et al., 2022). Alpine basal till deposits have produced nuggety placer gold where the former alpine glacier reworked enriched stream deposits and mineralization bedrock near the mouth of the cirque. Glaciofluvial gravel deposited during the advance stages of alpine glaciation also contain economic concentrations of placer gold, however tend to be lower grade. Some of the highest concentrations of placer gold are found in buried interglacial/interstadial stream deposits. They are thin and somewhat discontinuous due to glacial erosion, but can be highly prospective. Modern (Holocene) placer deposits are found along Granite and Albert creeks, and are more enriched toward their bottom contact on a false bedrock of glacial sediment.

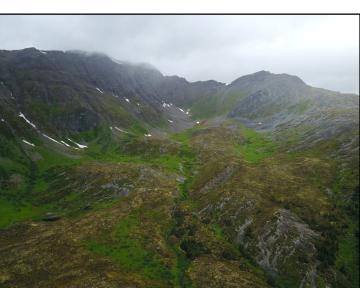


Figure 1: Aerial view of Granite Creek cirque and Mt. Hinton. The headwall is a zone of active erosion is visible by the

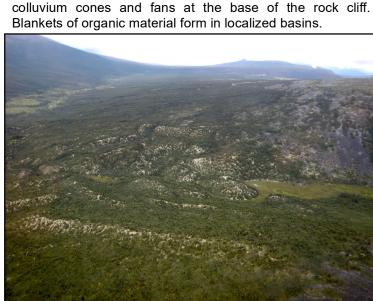


Figure 3: Lateral moraine deposited by the Cordilleran Ice Sheet along the Granite Creek valley side. Meltwater channels have cut through the till blanket, creating rolling



stripe (approximately 1.5 m to 2 m thick) in the Granite Creek cirque due to frost heaving. Stone stripes are

Figure 4: Loess blanket (brown silt) on lower slope of Granite Creek cirque overlying coarse alpine glacial outwash gravel and MIS 2 till. The top of the section is covered with anthropogenic material.

Figure 2: A view looking southeast down upper Granite

Creek toward the placer mine workings. Albert Creek is

visible in the background right.

gure 6: Weathered bedrock veneers are common on summits and upland slopes.

YUKON

widespread in the map area. Table 1: Geochronological results from the study area

	IR50		IR225		
Sample	Age <u>uncorr</u> (ka)	Age <u>corr</u> (ka)	Age <u>uncorr</u> (ka)	Age <u>corr</u> (ka)	
21JS-022	26.1 ± 1.4	32.5 ± 2.4	43.1 ± 2.6	51.1 ± 6.9	
21JS-023	29.8 ± 1.4	51.3 ± 3.5	54.2 ± 3.0	71.2 ± 6.9	
21JS-051	8.3 ± 0.6	12.1 ± 0.8	13.1 ± 0.8	15.2 ± 1.7	
21JS-061	46.7 ± 11.7	68.0 ± 18.4	20.7 ± 12.3*	21.3 ± 12.3*	

Radiocarbon Dates									
Sample	Lab ID	Material	¹⁴ C yr BP	Cal BP	Note	Calibration Data			
21JS-033	259690	wood	7030 ± 20	7840 - 7926		Reimer et al., 2022			
21JS-032	259691	wood/macrofossil	6945 ± 20	7730 - 7827		Reimer et al., 2022			
21JS-056	259692	bark	885 ± 20	739 - 788		Reimer et al., 2022			
21JS-034	259693	moss fragment	Modern	Modern	Excess 14C (bomb testing)	N/A			

SELECTED REFERENCES

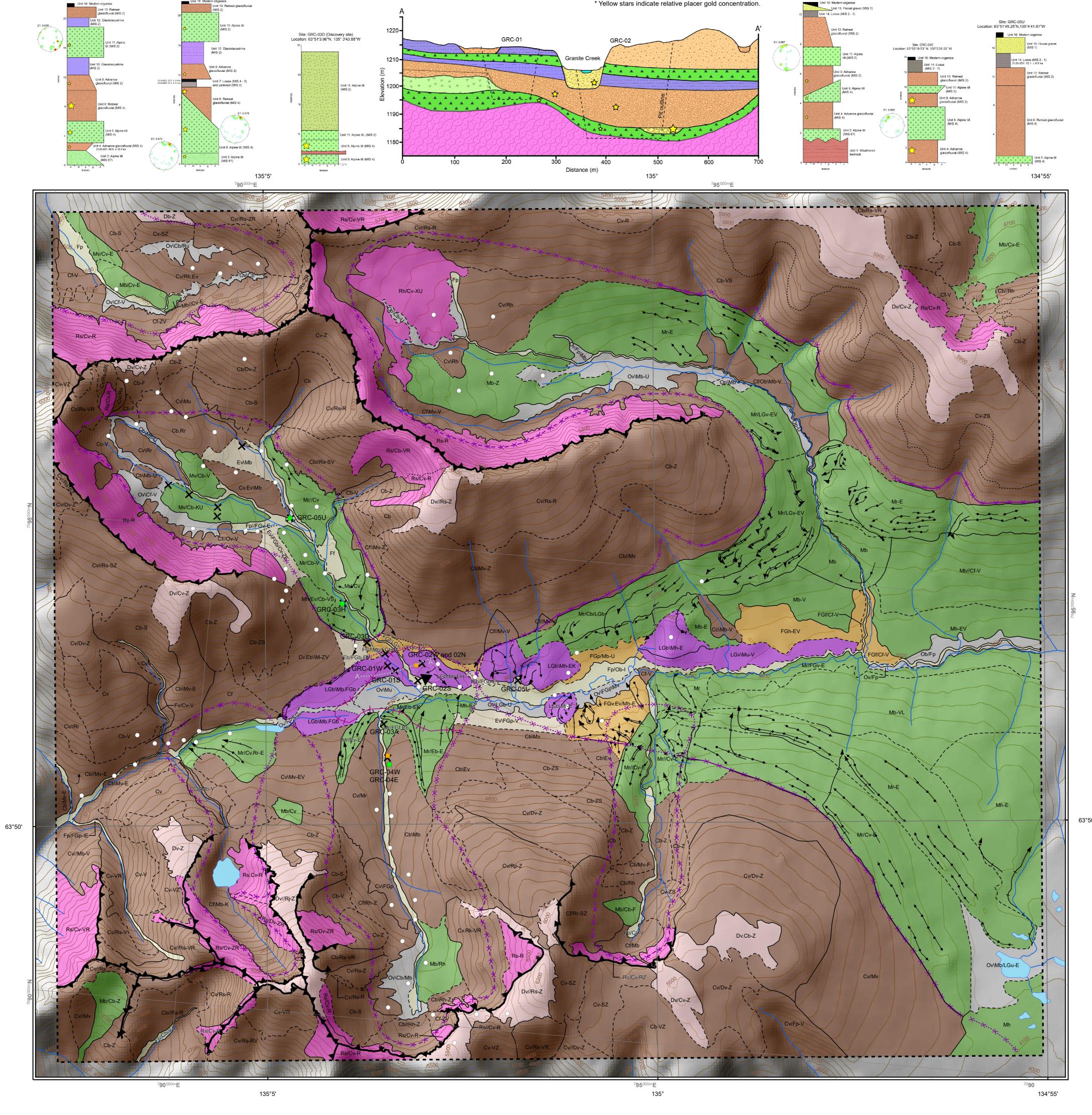
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SURFICIAL GEOLOGY

GRANITE CREEK

YUKON parts of 105M/14 and 105M/15

SCALE 1:20 000

1:50 000 scale topographic base data produced

CENTRE FOR TOPOGRAPHIC INFORMATION,

NATURAL RESOURCES CANADA Copyright His Majesty the King

FIVE THOUSAND METRE GRID

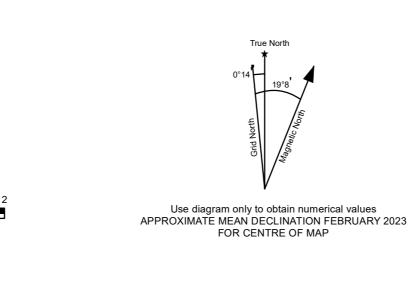
Universal Transverse Mercator Projection

North American Datum 1983

Zone 8

CONTOUR INTERVAL 100 FEET

Elevations in feet above Mean Sea Level

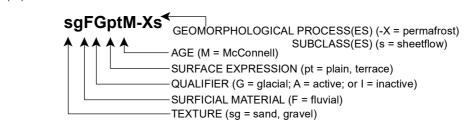


Site: GRC-03A Location: 63°50'33.32" N, 135°3'28.92" W

TERRAIN CLASSIFICATION SYSTEM

This surficial geology map was classified using the Terrain Classification System for British Columbia (Howes and Kenk, 1997), with minor modification to meet standards set by the Yukon Geological Survey. For example, we have added some permafrost process subclasses to accomodate the wider variety of permafrost features found in Yukon. We have also added an age classification to distinguish materials deposited during different Pleistocene glaciations.

A sample map unit label is shown below to illustrate the terrain classification system. Surficial materials form the core of the polygon map unit labels and are symbolized with a single upper case letter. Lower case textures are written to the left of the surficial material, and lower case surface expressions are written to the right. An upper case activity qualifier (A = active; I = inactive) may be shown immediately following the surficial material designator. The glacial qualifier "G" may alternatively be written immediately following the surficial material to indicate glacially modified materials. Age is indicated by a capital letter that follows the surface expression but precedes the process modifiers. Geomorphological processes (capital letters) and subclasses (lower case letters) always follow a



COMPOSITE SYMBOL DELIMITERS: Due to scale limitations, up to 4 terrain units may be included in a single map unit label (e.g. sgFGptM.dsmMbM/xsCv\zcLGpM-XsV). Each component is separated by a delimiter that indicates relative proportions between the components (".", "/", "/") or a stratigraphic relationship "\").

"." - terrain units on either side of the symbol are of approximately equal proportion "/" - terrain unit(s) before the symbol is more extensive than the one(s) following "//" - terrain unit(s) before the symbol is considerably more extensive than the one(s) following

form blankets and veneers.

"\" - terrain unit(s) before the "\" symbol stratigraphically overlies the one(s) following 1st terrain unit / 2nd terrain unit // 3rd terrain unit \ Underlying terrain unit

>50% of map unit / 30-49% of map unit // 10-29% of map unit

SURFICIAL MATERIALS

Surficial materials are non-lithified, unconsolidated sediments. They are produced by weathering, sediment deposition, biological accumulation, human and volcanic activity. In general, surficial materials are of relatively young geological age and they constitute the parent material of most (pedological) soils. Note that a single polygon will be coloured only by the dominant surficial material, but other materials may exist in that unit.

Organic: Organic material resulting from the accumulation of vegetative matter. Contains at least 30% organic matter by weight (17% or more organic carbon). Saturated organic sediments include bog, fen and swamp deposits. Rarely saturated organics include forest floor accumulations overlying bedrock. Landforms include plains, and deposits also form blankets and veneers. Eolian: Materials transported and deposited by wind action. Grain sizes are medium to fine sand and silt, well

Colluvium: Materials that have reached their present position due to gravity-induced movement (mass wasting processes) with no agent of transportation such as water or ice. Mass wasting processes include creep, solifluction, landslides and rock falls. Typical grain sizes depend on the processes involved with deposition, for example solifluction results in fine-grained materials, and rock falls result in large, angular blocky deposits. Landforms are veneers, blankets, cones and fans. Colluvium can be difficult to distinguish from alpine till due to the unconsolidated and poorly sorted characteristics of both deposits.

sorted, non-compacted, and massive. Thickness of eolian deposits is highly variable and range from a few

centimetres to over 2 m in thickness. Preservation is most common in flat-lying areas and lower slopes. Deposits

Fluvial: Materials transported and deposited by streams; synonymous with alluvial. Consist of gravel, sand, and/or silt. Gravel contains subrounded clasts and has a sandy matrix. In cirque valleys, deposits tend to be coarser grained and do not exhibit stratification. Distal from the cirques, the deposits are finer grained and exhibit some stratification. Low energy channels and floodplain surfaces contain fine-grained sediments. Landforms include plain, terraces and veneers.

Glaciofluvial: Materials deposited by glacial meltwater either proglacially or in contact with glacier ice. Typically poorly to moderately sorted, poorly bedded, and composed of a wide range of particle sizes. A silty sand matrix is common. Features that indicate collapse of material during melting of supporting ice include slump structures and hummocky or irregular terrain. Landforms include plains, terraces, fans, blankets and veneers.

Outwash gravel deposited during advance and retreat of alpine glaciers. Glacier advance outwash is typically overlain by more recent deposits whereas retreat outwash is present near surface as plains, terraces and fans. EARLY WISCONSIN - GLADSTONE (G) Gladstone glaciofluvial deposits were only documented in section underlying Late Wisconsinan deposits on Granite

transported beneath, beside, on, within and in front of a glacier. Characteristics are highly variable and depend on the material source. Alpine till contains dominantly subangular local quartzite, phyllite and gabbro. Ice sheet till is distinguished by the presence of rounded granite cobbles from the nearby Roop Lakes pluton. Deposits range from being well compacted (basal till) to non-compacted (melt-out and ablation till), non-stratified, and containing a heterogeneous mixture of particle sizes. Landforms include blankets, veneers, hummocks, ridges, terraces and

Morainal (till): Material deposited directly by glacier ice without modification of other agent of transport. Can be

LATE WISCONSIN - McCONNELL (M) Sources of McConnell till originate from local alpine glaciers that formed in the Gustavus Range and the Selwyn

EARLY WISCONSIN - GLADSTONE (G) Till from the Gladstone glaciation underlies McConnell deposits, particularly near the limit of McConnell alpine glaciation in Granite Creek.

The Reid glaciation was more extensive than the Gladstone and McConnell glaciations. Reid-age erratics were previously noted above the McConnell glacial limit on stable surfaces at elevations of 1615 m and 1645 m (Bond, 1999 and 1998). Preservation potential of Reid till is low and only found outside the McConnell glaciation limits and

Glaciolacustrine: Lacustrine sediment deposited in or along margin of glacial ice-dammed lakes. Lakebed sediments consist of stratified fine sand, silt and/or clav. Landforms include plains, blankets and veneers. Deposits are contorted where former alpine glaciers advanced into the glacial lake and overrode the lake bottom sediment.

Bedrock: Bedrock outcrops and rock covered by a thin mantle (up to 10 cm thick) of unconsolidated or organic

materials and include scarps. Bedrock is composed of weathered grey to black phyllite and grey to beige quartzite of

Mechanical weathering through frost shattering (periglacial weathering) is the dominant process and results in the

creation of angular fragments. Includes blockfields or 'felsenmeer' that do not indicate downslope movement. Other indicators include patterned ground formed by frost churning. Landforms are veneers and blankets and are found on

An ice-marginal lake formed when the drainage of Granite and Albert creeks was blocked by the Selwyn Lobe of the cordilleran Ice Sheet during the McConnell (MIS 2) glaciation. This lake inundated a portion of the Granite Creek valley bottom, but preservation is variable due to deglacial erosional processes. Shorelines associated with this lake at glacial maximum are mapped.

LATE WISCONSIN - McCONNELL (M)

flat, upland surfaces.

the Mississippian Keno Hill Formation. The bedrock is fractured, folded and foliated, and hosts mineralized quartz veins. Veins contain fine to coarse-grained quartz, milky white quartz, or quartz breccia. Mineralized zones are highly oxidized. Landforms include ridges and steep slopes. Weathered bedrock: Bedrock decomposed or disintegrated in-situ by mechanical and/or chemical weathering and does not apply to deposits subject to movement by gravity. The character depends on processes acting on the rock.

GROUND OBSERVATION SITES: GEOLOGICAL BOUNDARIES: (labelled with site number, e.g. GRC-06) / approximate field station x stratigraphic station AGE OF GLACIAL FEATURES: radiocarbon sample McConnell (M) - late Wisconsin till sample Gladstone (G) - early Wisconsin Reid (R) - Illinoian heavy mineral sample Pre-Reid (>R) - early to middle Pleistocene frozen ground age unspecified OTHER SURFACE FEATURES: GLACIAL FEATURES: moraine ridge open system pingo; uncollapsed, collapsed meltwater channel + tor cirque arête עללללללך esker cryoplanation terrace GLACIAL LIMITS:

7 drumlin (coloured by glacial age) ★ landslide, active layer detachment # palsa

Yukon mineral occurrence

escarpment — — cross-section thermokarst pond _____ strandline placer mine TOPOGRAPHIC FEATURES:

streams wetlands

defined approximate

OTHER LINEAR FEATURES:

... X assumed

106D/02

WILLIAMSON SOUTH NELSON

SCOUGALE CREEK

TINY ISLAND

MCQUESTEN

Texture refers to the size, shape and sorting of particles in clastic sediments, and the proportion and degree of decomposition of plant fibre in organic sediments. Texture is indicated by up to three lower case letters, placed immediately before the surficial material designator, listed in order of decreasing abundance. Specific clastic textures a - blocks: angular particles >256 mm in size

b - boulders: rounded particles >256 mm in size k - cobbles: rounded particles 64 - 256 mm in size p - pebbles: rounded particles 2 - 64 mm in size s - sand: particles between 0.0625 - 2 mm in size z - silt: particles 2 µm - 0.0625 mm in size c - clay: particles ≤2 μm in size

Common clastic textural groupings

o - organic: general organic materials

d - mixed fragments: a mixture of rounded and angular particles >2 mm in size x - angular fragments: a mixture of angular fragments >2 mm in size (i.e., a mixture of blocks and rubble) g - gravel: a mixture of two or more size ranges of rounded particles >2 mm in size (e.g., a mixture of boulders, cobbles and pebbles); may include interstitial sand m - mud: a mixture of silt and clay; may also contain a minor fraction of fine sand Organic terms

SURFACE EXPRESSION

land surface. This three-dimensional shape of the material is equivalent to 'landform' used in a non-genetic sense (e.g., ridges, plain). Surface expression symbols also describe the manner in which unconsolidated surficial materials relate to the underlying substrate (e.g., veneer). Surface expression is indicated by up to three lower case letters, placed immediately following the surficial material designator, listed in order of decreasing extent. b - blanket: a layer of unconsolidated material thick enough (>1 m) to mask minor irregularities of the surface of the underlying material, but still conforms to the general underlying topography; outcrops of the underlying unit are rare f - fan: sector of a cone with a slope gradient less than 15° (26%) from apex to toe; longtitudinal profile is smooth and straight, or slightly concave/convex h - hummock: steep sided hillock(s) and hollow(s) with multidirectional slopes dominantly between 15-35° (26-70%) if

composed of unconsolidated materials, whereas bedrock slopes may be steeper; local relief >1 m; in plan, an assemblage

of non-linear, generally chaotic forms that are rounded or irregular in cross-profile; commonly applied to knob-and-kettle

Surface expression refers to the form (assemblage of slopes) and pattern of forms expressed by a surficial material at the

p - plain: a level or very gently sloping, unidirectional (planar) surface with slopes 0-3° (0-5%); relief of local surface irregularities generally <1 m; applied to (glacio)fluvial floodplains, organic deposits, lacustrine deposits and till plains ridge: elongate hillock(s) with slopes dominantly 15-35° (26-70%) if composed of unconsolidated materials; bedrock slopes may be steeper; local relief is >1 m; in plan, an assemblage of parallel or sub-parallel linear forms; commonly applied to drumlinized till plains, eskers, morainal ridges, crevasse fillings and ridged bedrock t - terrace: a single or assemblage of step-like forms where each step-like form consists of a scarp face and a horizontal or

gently inclined surface above it; applied to fluvial and lacustrine terraces and stepped bedrock topography v - veneer: a layer of unconsolidated materials too thin to mask the minor irregularities of the surface of the underlying material; 10 cm - 1 m thick; commonly applied to eolian/loess veneers and colluvial veneers

GEOMORPHOLOGICAL PROCESSES Geomorphological processes are natural mechanisms of weathering, erosion and deposition that result in the modification of

the surficial materials and landforms at the Earth's surface. Unless a qualifier (A (active) or I (inactive)) is used, all

processes are assumed to be active, except for deglacial processes. Up to three upper case letters may be used to indicate processes. These are listed in order of decreasing importance and placed after the surface expression symbol, following a Subclasses are used to provide more specific information about a general geomorophological process, and are represented by lower case letter(s) placed after the related process designator. Up to two subclasses can be associated with each process. Process subclasses used on this map are defined with the related process below. The symbol " is used after -R and -F to specify the polygon that contains the initiation zones of mass movements.

EROSIONAL PROCESSES V - Gully erosion: Running water, mass movement and/or snow avalanching, resulting in the formation of parallel and subparallel, long, narrow ravines.

FLUVIAL PROCESSES I - Irregularly sinuous channel: A clearly defined main channel displaying irregular turns and bends without repetition of similar features; backchannels may be common, and minor side channels and a few bars and islands may be present, but regular and irregular meanders are absent.

MASS MOVEMENT PROCESSES F - Slow mass movements: Slow downslope movement of masses of cohesive or non-cohesive surficial material and/or R - Rapid mass movements: Rapid downslope movement by falling, rolling, sliding or flowing of dry, moist or saturated debris

PERIGLACIAL PROCESSES C - Cryoturbation: Movement of surficial materials by heaving and/or churning due to frost action (repeated freezing and S - Solifluction: Slow gravitational downslope movement of saturated non-frozen overburden across a frozen or otherwise impermeable substrate.

Z - General periglacial processes: Solifluction, cryoturbation and nivation, possibly occuring in a single polygon. DEGLACIAL PROCESSES E - Channeled by meltwater: Erosion and channel formation by meltwater alongside, beneath, or in front of a glacier.

T - Ice contact: Landforms that developed in contact with glacier ice such as kames. HYDROLOGICAL PROCESSES Processes controlled by the presence of water:

H - Kettled: Depressions in surficial materials resulting from the melting of buried glacier ice.

U - Inundation: Areas affected seasonally by standing water resulting from a high water table.

APPROXIMATE GLACIAL MAXIMUM MARINE ISOTOPE STAGE GLACIATION TIME PERIOD 20 000 years ago M - McConnell late Wisconsin G - Gladstone early Wisconsin 60 000 years ago 120 000 years ago early to Middle Pleistocene 2.6 million to 200 000 years ago

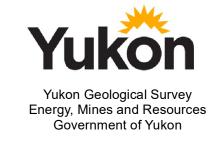
SURFICIAL MATERIAL AGE

ACKNOWLEDGEMENTS This project took place in the Traditional Territory of the Na-Cho Nyäk Dun First Nation. The authors would like to thank

Granite Creek Resources, Dulac Mining, Earth and Iron Mines Ltd., Gem Steel Edmonton Ltd., and Archer, Cathro & Associates (1981) Limited for access to mining exposures, hospitality and knowledge. We thank Kenya Franz for providing field assistance. Leyla Weston kindly completed a thorough edit of the map. Chad Cote and Bailey Staffen assisted with the geodatabase and cartography. This study was supported by the Yukon Geological Survey, the Natural Sciences and ngineering Research Council of Canada and Polar Canada's Northern Scientific Training Program.

RECOMMENDED CITATION Steinke, J.L., Ward, B.C. and Bond, J.D., 2023. Surficial geology of Granite Creek (part of NTS 105M/14 and 105M/15),

Yukon (scale 1: 20 000). Yukon Geological Survey, Open File 2023-02. Any revisions or additional geological information known to the user would be welcomed by the Yukon Geological Survey. Paper copies of this map may be obtained from the Yukon Geological Survey, Energy, Mines and Resources, Government of Yukon, Room 102 - 300 Main St., Whitehorse, Yukon, Y1A 2B5. Email: geology@yukon.ca. A digital PDF (Portable Document Format) file of this map may be downloaded free of charge from the Yukon Geological Survey website: https://yukon.ca/en/science-and-natural-resources/geology



Open File 2023-02

Surficial Geology of Granite Creek (NTS 105M/15 and part of 105M/14) Yukon (scale 1:20 000)

Steinke, J.L., Ward, B.C. and Bond, J.D.