British Columbia Geological Survey Geoscience Map 2025-01

Surficial geology of the Kinaskan Lake area, British Columbia (parts of NTS 104G/08, 09, 16, and 104H/12, 13)

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0 1 2 3 4 5 Kilometres

Scale 1:50,000

Geomatics by M. Sauvé. Cartography by P. Marczak.

Note: Where surficial geology map units consist of multiple materials, a compound map unit designator is used. These compound designators note areally more extensive and less extensive surficial materials joined with a '.' (e.g., Cv.R where Cv is more extensive than R). A stratigraphic relationship between two material types is noted with a '/' (e.g., GFv/Tu where GFv overlies Tu). We used the surficial geology data model of Deblonde et al. (2019) and definitions for surficial materials and surface expressions in Howes and Kenk (1997).

Descriptive Notes

The Kinaskan Lake map area, which includes the currently active Red Chris porphyry Cu-Au-Ag mine (see summary in Clarke et al., 2024), was covered by the Cordilleran ice sheet during the Late Wisconsinan (MIS 2) Fraser Glaciation (Clague and Ward, 2011). The map area is mainly in the Klastline Plateau, a subdivision of the Stikine Plateau (Holland, 1976), and in the ancestral territory of the Tahltan Nation. Generally lower in elevation than surrounding mountain ranges, the Stikine Plateau is an erosional surface that experienced differential uplift and dissection throughout the late Pliocene (Holland, 1976). The upland surfaces in the map area (Fig. 1) are generally above 1500 m; the main valley systems are incised to below 900 m. Ryder (1984) completed a terrain inventory report to accompany 1:250,000-scale mapping of the Stikine and Iskut River watersheds. Spooner (1994), Spooner and Osborn (2000), and Spooner at al. (1996, 2002) examined Quaternary environments in the Stikine Plateau region and stratigraphic units in the Stikine River valley, approximately 40 km northwest of the Kinaskan Lake area. Presented herein are the results of mapping (1:50,000 scale) and fieldwork completed using a combination of modern and traditional methods, adding to our current understanding. New data from this work serve to help interpret the glacial history of an area in northern British Columbia with active resource development that can be used to test models of glaciation and deglaciation largely developed for southern parts of the province (e.g. Fulton, 1991).

A lidar dataset that included most of the study area with a bare earth point density of 12 pts/m^2 and colour orthoimagery with a 0.2 m resolution were acquired in 2021 (McElhanney Ltd, 2021, unpublished data). These data were used to generate digital pseudo-stereo imagery, which are stereo images generated by shifting a single orthoimage over a digital elevation model. Digital black and white 1:60,000-scale air photo images, from flight lines flown in 1982, were used for mapping in the Kinaskan Lake valley where digital pseudo-stereo images were lacking (see 'source data boundary'). The Canadian Digital Elevation Model (CDEM), a 0.75 arcsecond (12 m) resolution surface (Natural Resources Canada, 2013) was used to support interpretation of air photo images. Map features and boundaries were drawn on the digital stereo images from both datasets using 3D visualization software (DAT/EM Summit Evolution) linked to a GIS (ESRI ArcGIS). Truck- and helicopter-supported ground truthing was completed during the summers of 2022 and 2023.

In the uplands of the map area, discontinuous veneers of till and colluvium overlie Stikine terrane bedrock (e.g., Nelson et al., 2013; Nelson, 2019); in the valley bottoms are thick sediment accumulations. Bedrock is exposed at surface on steep slopes and ridges. Valley bottom deposits include glacial and non-glacial sediments resulting from at least two regional glacial advances (Fig. 2). Organic material recovered in a sonic drill hole from between two till units near the base of the section produced radiocarbon ages of >54,000 ^{14}C years BP (Sauvé, 2024, Lab ID UCIAMS-271934), significantly older than the Late Wisconsinan till exposed at or near surface across much of the area.

Late Wisconsinan till on top of the plateaus is commonly a discontinuous veneer (<2 m) of poorly consolidated silt- and sand-rich diamicton. In the valley bottoms, tills are thick (>2 m) accumulations of silt- and clay-rich diamicton interpreted as subglacial deposits because of their high density and fissility. Well-developed streamlined tills (Ts) are at low and moderate elevations in the Little Iskut River, Iskut River, and Klappan River valleys. In the Little Iskut River valley are particularly well-developed streamlined landforms comprising till and bedrock with indicated ice-flow directions apparently aligning with orientations of structures in bedrock.

We established the ice-flow history of the area by combining our landform- and outcrop-scale (Fig. 3) data with previous studies by Stumpf et al. (2000) and Spooner and Osborn (2000). At the onset of the Fraser Glaciation, ice-flow was directed to the northeast from glaciers sourced in the Coast Mountains to the west. As glaciation progressed and the Cordilleran ice sheet became established in northern British Columbia, ice-flow shifted towards the northwest indicating the existence of an ice divide southeast of the map area, likely in the Skeena or Omineca mountains. During deglaciation, glaciers generally flowed north within the confines of existing valley systems, in some instances moving upslope (e.g., in the Kinaskan Lake and Little Iskut River valleys).

At the end of the Fraser Glaciation, ice melted from the top down resulting in the plateau tops being ice-free before the lower elevation valleys, broadly following the deglacial model proposed by Fulton (1991). On the plateau surface in the northwest part of the map area, very well sorted horizontally bedded sands and silts (GLv) are locally developed, probably recording sedimentation in ice-dammed retreat-phase lakes. These deposits were recognized during fieldwork but were unidentifiable in the digital pseudo-stereo imagery. Thus, it is likely that additional retreat-phase lake sediments remain unmapped in similar topographic settings. On the plateau in the eastern part of the map area, meltwater sourced from stagnant ice in valleys to the south, cut across the plateau surface, as indicated by meltwater channels.

During deglaciation, active ice occupied the Kinaskan Lake valley. This ice retreated towards the south, down the slope gradient of the valley, and an extensive ice-dammed proglacial lake formed. We identified four distinct lake levels using subtle shoreline features and sporadic deltaic deposits (GLd) mapped in the Kinaskan Lake and Ealue Lake valleys (Fig. 4). Glaciolacustrine (GLv, GLb, GLn, GLp and GLh) sediments deposited during this retreat phase lake are generally limited to the Little Iskut River valley at the southern extent of the map area, but the mapped shorelines and outlet locations (red arrows, Fig. 4) indicate the lake was much more extensive. Undulating till (Tu) and till blankets (Tb), with lesser ice-contact glaciofluvial deposits (GFc) and glaciolacustrine sediments (GL), are common in lower elevation valleys, indicating a combination of active retreat and ice stagnation at the end of the Fraser Glaciation.

Holocene processes have modified the post-glacial landscape. Large landslides seated in bedrock developed at the southeastern edge of Todagin Mountain and at the southwestern edge of the plateau west of Kinaskan Lake. Smaller landslides, mostly seated in Quaternary sediments, are scattered across the modern landscape. Cirques containing active rock glaciers are in the northwest and southwest. On the plateau surfaces at higher elevations, patterned ground in the form of mud boils, solifluction lobes, boulder stripes, and discontinuous ground ice indicate active periglacial processes and likely permafrost. Beyond the limits of the map area, Ryder (1987) recognized Little Ice Age moraines.

Acknowledgements

We thank Steve Rombough and others at McElhanney Limited for providing lidar data and processing additional areas to support our mapping. Newcrest Red Chris Mining Limited, acquired by Newmont Corporation in 2023 after our work, provided logistical support during the field portion of the project and made orthoimagery available. Work was completed as part of the lead author's M.Sc. degree at Simon Fraser University. BGC Engineering Inc. is thanked for providing support for this research. Funding was provided by Mitacs, the Northern Scientific Training Program, a National Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant, and the Simon Fraser University Graduate Travel and Research Award (TARA). Thank you to Jack Carrigan and Katelyn Groeneveld for assisting in the field and capturing some of the images included herein.

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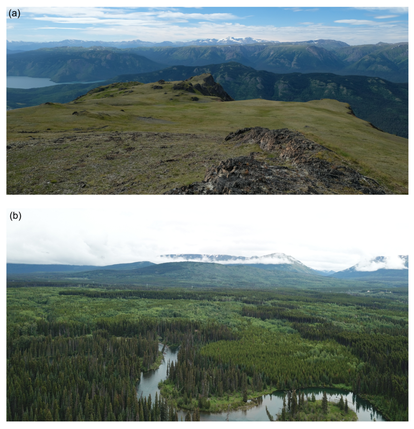


Fig. 1. Representative photos of map area. **a)** Upland surface dissected by valleys. View looking southwest toward Kinaskan Lake at the southern portion of the Klastline Plateau. Mount Edziza and the Spectrum Range are visible in the background. **b)** Low-relief terrain in a valley bottom with extensive glaciolacustrine and alluvial sediments. In the foreground is a meandering part of the Iskut River immediately north of its confluence with the Little Iskut River. Round Mountain and the plateaus surrounding Tsatia Mountain are visible in the background. View looking northeast.

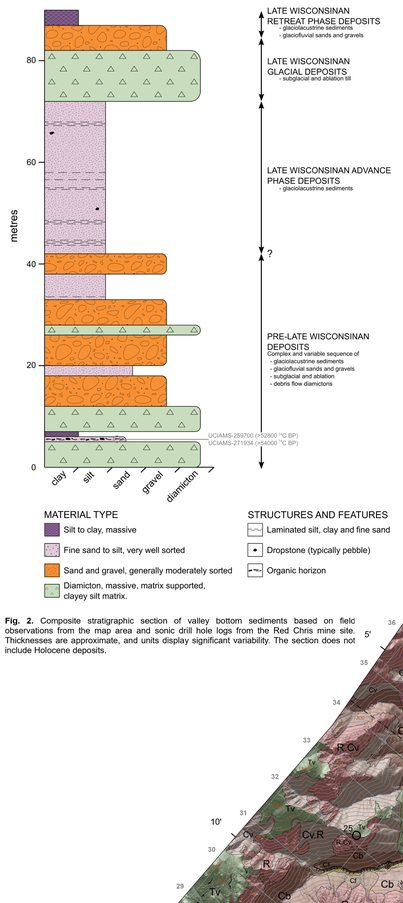
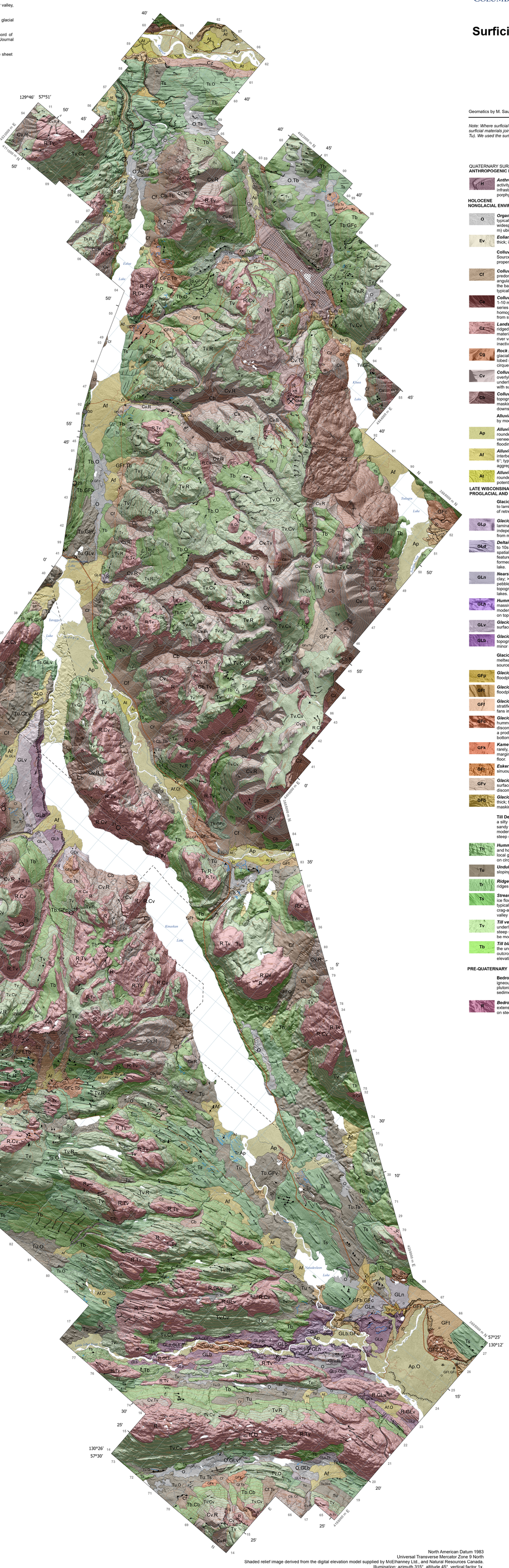


Fig. 2. Composite stratigraphic section of valley bottom sediments based on field observations from the map area and sonic drill hole logs from the Red Chris mine site. Thicknesses are approximate, and units display significant variability. The section does not include Holocene deposits.

Fig. 3. Rat tails on pebble conglomerate outcrop surface southeast of the Red Chris mine site. Flow towards 255°, indicated by white arrow. Scale card is 8 cm long.

Map ID	MINFILE No.	Name	Status	Commodity	Deposit type
1	104H 036	B31	Showing	Cu	L03: Alkalic porphyry Cu-Au
2	104G 034	GJ	Prospect	Cu, Au, Ag, Pb, Zn	L04: Porphyry Cu ± Mo ± Au
3	104G 243	GJ EAST	Showing	Cu, Au, Ag	L04: Porphyry Cu ± Mo ± Au
4	104G 086	DONNELLY	Developed Prospect	Cu, Au, Pb, Zn, Ag, Mo	L04: Porphyry Cu ± Mo ± Au
5	104G 189	NORTH DONNELLY	Developed Prospect	Cu, Au, Pb, Zn, Ag	L04: Porphyry Cu ± Mo ± Au
6	104G 180	NORTH	Prospect	Cu, Au, Ag	
7	104G 087	SUN	Showing	Cu, Ag	I06: Cu±Ag quartz veins
8	104G 188	YT	Showing	Cu	L04: Porphyry Cu ± Mo ± Au
9	104G 035	HORN	Prospect	Ag, Au, Pb, Zn, Cu, Barite	I05: Polymetallic veins Ag-Pb-Zn±Au
10	104G 177	HORN EAST	Showing	Au, Ag, Zn, Pb, Cu	I02: Intrusion-related Au pyrrhotite veins
11	104G 176	HORN NORTH	Showing	Zn, Pb, Ag, Cu	I05: Polymetallic veins Ag-Pb-Zn±Au
12	104G 044	AL	Prospect	Cu, Au	L04: Porphyry Cu ± Mo ± Au
13	104G 245	QC WEST SE	Showing	Au, Cu, Ag, Pb, Zn	I05: Polymetallic veins Ag-Pb-Zn±Au
14	104G 033	QC	Prospect	Cu, Au	L04: Porphyry Cu ± Mo ± Au
15	104G 244	PLATEAU	Showing	Au, Cu	Unknown
16	104G 160	QC - VEIN ZONE	Prospect	Au, Zn, Cu, Ag, Pb	I05: Polymetallic veins Ag-Pb-Zn±Au
17	104G 251	COOLRIDGE MOUNTAIN SW2	Showing	Pb, Zn, Ag, Au	I05: Polymetallic veins Ag-Pb-Zn±Au
18	104G 175	BOND	Showing	Cu, Au	I06: Cu±Ag quartz veins
19	104G 174	BEAUCHAMPS	Showing	Au, Ag, Cu, Pb, Zn	I05: Polymetallic veins Ag-Pb-Zn±Au
20	104G 173	TREVOR PEAK	Prospect	Au, Cu, Pb	I01: Au-quartz veins
21	104G 172	WOLF WEST	Showing	Au, Cu, Zn	L02: Porphyry-related Au
22	104G 171	BLOWDOWN	Showing	Au, Cu, Zn, Pb	I06: Cu±Ag quartz veins
23	104G 045	WOLF	Prospect	Cu, Au	L04: Porphyry Cu ± Mo ± Au
24	104G 071	ART	Showing	Cu	Unknown
25	104G 170	SOUTH SEESTOR	Showing	Cu, Au	
26	104H 031	GIN	Showing	Cu, Au, Ag, Pb, Zn	L03: Alkalic porphyry Cu-Au
27	104H 005	RED CHRIS	Producer	Cu, Au, Ag, Pb, Zn, Mo	L04: Porphyry Cu ± Mo ± Au
28	104H 026	ELDORADO	Prospect	Cu, Au, Pb, Zn, Mo	L03: Alkalic porphyry Cu-Au
29	104H 037	D1	Showing	Cu, Au, Ag	L03: Alkalic porphyry Cu-Au
30	104H 012	COYOTE	Prospect	Mo, Cu, Au	I05: Polymetallic veins Ag-Pb-Zn±Au
31	104G 481	TODAGIN	Showing	Ag, Zn	I05: Polymetallic veins Ag-Pb-Zn±Au
32	104H 011	RAM	Showing	Mo	L05: Porphyry Mo (Low F- type)

Table 1. Mineral occurrences from MINFILE database (MINFILE, 2024). Abbreviated deposit type designations (e.g., L03) follow deposit descriptions detailed in Lefebure and Jones (2022).



North American Datum 1983
Universal Transverse Mercator Zone 9 North
Shaded relief image derived from the digital elevation model supplied by McElhanney Ltd., and Natural Resources Canada.
Illumination: azimuth 315°, altitude 45°, vertical factor 1x.
Base map at the scale of 1:50 000 from GeoBC, with modifications.
Contour interval 50 metres. Elevations in metres above mean sea level.

QUATERNARY SURFICIAL DEPOSITS

ANTHROPOGENIC DEPOSITS

H — ***Anthropogenic deposits:*** geologic materials modified by human activity; typically <10 m thick (locally >50 m); predominantly mine site infrastructure including mine tailings and waste rock at the Red Chris porphyry Cu-Au mine.

HOLOCENE

NONGLACIAL ENVIRONMENTS

O — ***Organic deposits:*** accumulations of plant material >0.3 m thick; typically in relatively flat, poorly drained areas with standing water; widespread in valley bottoms, sporadic on alpine plateaus; thin (<0.3 m) ubiquitous organic layers are omitted from the map.

Ev — ***Eolian veneer:*** very well sorted fine sand and silt; generally <1 m thick; infill depressions; rare isolated dunes.

Colluvial and mass wasting deposits
Sourced from bedrock and/or sediment; appearance and geotechnical properties dependent on source materials.

Cf — ***Colluvial fan:*** poorly sorted sand and gravel and diamicton; predominantly subangular clasts but range from subrounded to angular, oxidized; typically 1-10 m thick, but may be >10 m thick at the base of large slopes; slope gradients between 5° and 20°; typically where steep creeks enter valleys.

Ca — ***Colluvial apron and talus slope:*** diamicton and rubble; typically 1-10 m thick (locally >10 m near the base of tall slopes); typically a series of colluvial cones that have merged into a relatively homogeneous slope with gradients between 20° and 40°; sourced from steep upslope bedrock exposures.

Cz — ***Landslide deposits:*** diamicton, rubble, and blocks; hummocky and ridged topography; large deposits may be >100 m thick; includes material from slope failure at the edge of plateaus and the flanks of river valleys; slide scarps, tension cracks, and drop blocks; includes inactive and active landslides.

Cg — ***Rock glacier:*** rubble and blocks with an ice matrix or that blanket glacial ice; hummocky and ridged topography; variable thickness; lobed surface expression indicates flow; common in higher elevation cirques.

Cv — ***Colluvial veneer:*** sand and rubble, rare diamicton discontinuously overlying till or bedrock; <2 m thick; surface expression mimics underlying topography; common bedrock outcrops; on steep slopes with subsequent bedrock.

Cb — ***Colluvial blanket:*** sand and rubble, rare diamicton; >2 m thick; topography predominantly controlled by the underlying material but masking minor irregularities; typically overlies till or bedrock; downslope of colluvial veneers.

Alluvial deposits: generally well sorted, typically stratified; deposited by modern streams and rivers.

Ap — ***Alluvial floodplain:*** sand and gravel with minor silt; common rounded cobbles; >2 m thick; local and discontinuous organic veneers; form low-relief planar surfaces near modern rivers; prone to flooding.

Af — ***Alluvial fan:*** gravel and sand to gravel; >2 m thick; stratified with rare interbeds containing organic materials; slope gradient between 1° and 6°; typically include colluvial material near the apex; potential aggregate source.

At — ***Alluvial terrace:*** well-sorted sand and gravel, minor silt; common rounded cobbles; >2 m thick; terraces above modern floodplains; potential aggregate source.

LATE WISCONSINAN
PROGLACIAL AND GLACIAL ENVIRONMENTS

Glaciolacustrine deposits: generally well sorted; commonly bedded to laminated, rarely massive; in ice-dammed lakes along the margins of retreating glaciers; distribution affected by outlet elevations.

GLp — ***Glaciolacustrine plain:*** silt and clay; >2 m thick; massive to laminated; rare isolated pebbles; smooth horizontal surface independent of underlying topography; formed in deep water away from margins of glacial lakes.

GLd — ***Deltaic glaciolacustrine:*** sand and gravel, minor silt; >2 m thick (up to 10s of m); bedded; smooth low-angle surface with steeper margins; spatially associated with shoreline deposits and local ice contact features; commonly dissected by modern stream channels and fans; formed at the point where sediment-laden inflow entered a glacial lake.

GLn — ***Nearshore glaciolacustrine:*** medium- to fine-sand and silt, trace clay; >2 m thick; massive to laminated; well sorted; rare isolated pebbles; planar to undulating surface independent of underlying topography; formed in shallow water near the margins of glacial lakes.

GLh — ***Hummocky glaciolacustrine:*** silt and clay; variable thickness; massive to laminated; rare isolated pebbles; hillocks and hollows with moderate to steep slopes; kettles, local ridges and channels; formed on top of melting ice.

GLv — ***Glaciolacustrine veneer:*** well sorted sand, silt, and clay; <2 m thick; surface expression mimics underlying topography.

GLb — ***Glaciolacustrine blanket:*** well-sorted sand, silt, and clay; >2 m thick; topography mainly controlled by the underlying material but masking minor irregularities.

Glaciofluvial deposits: generally moderately sorted; deposited by meltwater sourced from glacial ice; represent a potential aggregate source.

GFp — ***Glaciofluvial terrace:*** gravel and sand; >2 m thick; above modern floodplains or alluvial deposits.

GFt — ***Glaciofluvial terrace:*** gravel and sand; >2 m thick; above modern floodplains or alluvial deposits.

GFf — ***Glaciofluvial outwash fan:*** moderately sorted gravel; weakly stratified; generally <5 m thick; formed on valley walls as paraglacial fans immediately following deglaciation.

GFc — ***Glaciofluvial ice-contact:*** poorly sorted sand and gravel; >2 m thick; hummocky ridged and kettled surface expressions; locally with discontinuous glaciolacustrine sediments in areas that were ponded; a product of ice stagnation, typically in low-relief areas of valley bottoms.

GFk — ***Kame terrace:*** poorly sorted gravel interstratified with diamicton and, rarely, glaciolacustrine sediments; >2 m thick; formed at the lateral margins of a retreating glacier; on valley walls above modern valley floor.

GFr — ***Esker:*** poorly sorted gravel; 5-20 m thick; massive to weekly bedded; sinuous ridges with peaked or flat tops; in valley bottoms.

GFv — ***Glaciofluvial veneer:*** moderately sorted sand and gravel; <2 m thick; surface expression mimics underlying topography; occurs discontinuously overlying till.

GFb — ***Glaciofluvial blanket:*** moderately sorted sand and gravel; >2 m thick; topography mainly controlled by the underlying material but masking minor irregularities.

Till Deposits: generally diamicton; range from very dense, unsorted with a silty clay matrix to poorly sorted, oxidized, gravel rich diamicton with a sandy silty matrix; in alpine and subalpine environments, modified by modern periglacial processes as evidenced by patterned ground; on steep slopes primary features may be modified by creep.

Th — ***Hummocky till:*** sand and gravel rich diamicton; >2 m thick; hillocks and hollows with moderate to steep slopes and local relief of 1-2 m; local glaciolacustrine and glaciofluvial sediments between hummocks; on cirque floors, saddles, and valleys; a product of ice stagnation.

Tu — ***Undulating till:*** diamicton; >2 m thick; irregular surface with gently sloping mounds and depressions; in areas of low elevation and relief.

Tr — ***Ridged till:*** diamicton; >2 m thick; includes discontinuous elongate ridges interpreted as moraines or crevasse fills; local relief of 1-2 m.

Ts — ***Streamlined till:*** diamicton; >2 m thick; landforms oriented parallel to ice flow direction; local relief is 1-10 m; individual landforms are typically ~0.5 km long (up to ~1 km); includes drumlins, flutes, and crag-and-tails; typically in valley bottoms or on gentle slopes between valley bottoms and plateau surfaces.

Tv — ***Till veneer:*** diamicton; <2 m thick; surface expression mimics underlying topography; abundant bedrock outcrops; on moderately steep slopes and at high elevations; commonly with colluvium; may be modified by creep processes.

Tb — ***Till blanket:*** diamicton; >2 m thick; topography mainly controlled by the underlying material but masking minor irregularities; rare bedrock outcrops; typically on moderate slopes and at low- to moderate-elevations.

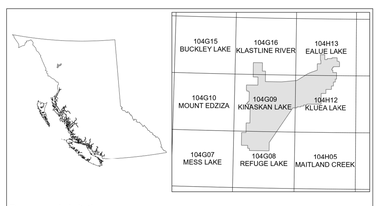
PRE-QUATERNARY

Bedrock: Stikine terrane (Nelson et al., 2013); in the north includes igneous and volcanosedimentary rocks (Triassic and Jurassic) and allied plutonic complexes (Triassic), in the south, Bowser basin (Cretaceous) sedimentary rocks (Evenchick et al., 2009; Nelson, 2019).

R — ***Bedrock:*** bedrock outcrop; locally includes areas of colluvium and till; extensively frost shattered at higher elevations; commonly exposed on steep slopes and at elevation in alpine environments.

Source data boundary[1]
Mine tailings
Open pit mine
Gravel pit
Quarry
Landslide:
Landslide toe
Small scar
Landslide escarpment
Tension crack
Rock glacier
Ground ice
Terrace scarp
Sediments partly reworked by meltwater channels
Kettle
Beach crest
Lake outlet central axis
Glaciofluvial delta
Meltwater Channel:
Minor (flow direction unknown)
Minor (flow direction known)
Minor lateral (tick indicates uphill side)
Major
Moraine ridge
Kame
Esker ridge
Crevasse fill ridge
Fluted bedrock or drift:
Paleo ice-flow direction unknown
Paleo ice-flow direction known
Crag-and-tail ridge; paleo ice-flow direction indicated
Erratic
Glacial striations:
Paleo ice-flow direction unknown
Paleo ice-flow direction known
Cirque headwall
Small bedrock outcrop in thick drift
Station (ground observation)
Geological contact (defined)
Mineral occurrence (see Table 1; numbers indicate Map ID)
Producer
Developed Prospect
Prospect
Showing

[1]*Boundary indicates the area where mapping was completed using digital stereo air photo images. The remainder of the mapping was completed using digital pseudo-stereo imagery derived from lidar data and orthoimagery.*



Recommended citation
Sauvé, M., Ward, B. C., and Ferbey, T., 2025. Surficial geology of the Kinaskan Lake area, British Columbia (parts of NTS 104G/08, 09, 16, and 104H/12, 13). British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Geoscience Map 2025-01, 1:50,000 scale.

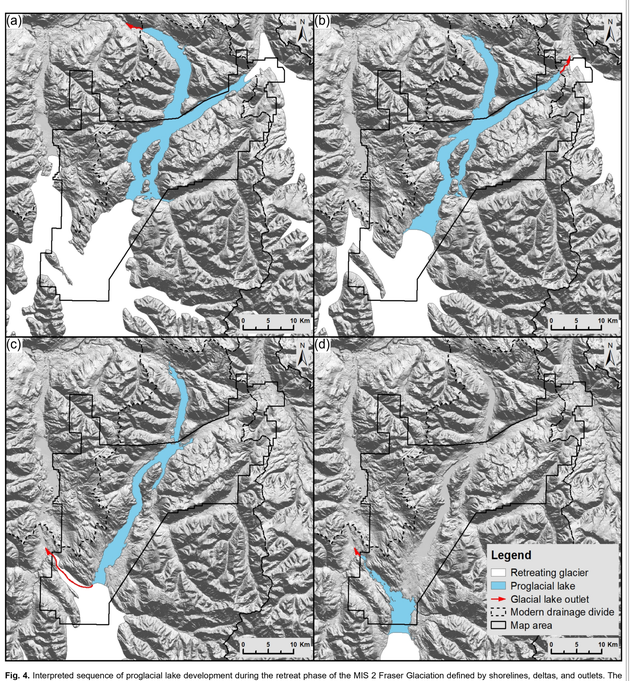


Fig. 4. Interpreted sequence of proglacial lake development during the retreat phase of the MIS 2 Fraser Glaciation defined by shorelines, deltas, and outlets. The lake level dropped sequentially from a) 930 m, b) 900 m, c) 850 m to d) 810 m as ice retreating in the valley bottom exposed lower elevation outlets. Lake outlets in a) and b) are evidenced by outsized gullies cut into the valley fill sequences. Lake outlet in c) is interpreted to be supraglacial or subglacial, with ice in the valley bottom having partially blocked drainage. Lake outlet in d) is interpreted to have been controlled by topography but modern depositional processes have obscured the channel location. Differential isostatic depression at time of lake formation is not accounted for here. Digital elevation model is a hillshade render of the 0.75 arcsecond resolution CDEM (Natural Resources Canada, 2013).