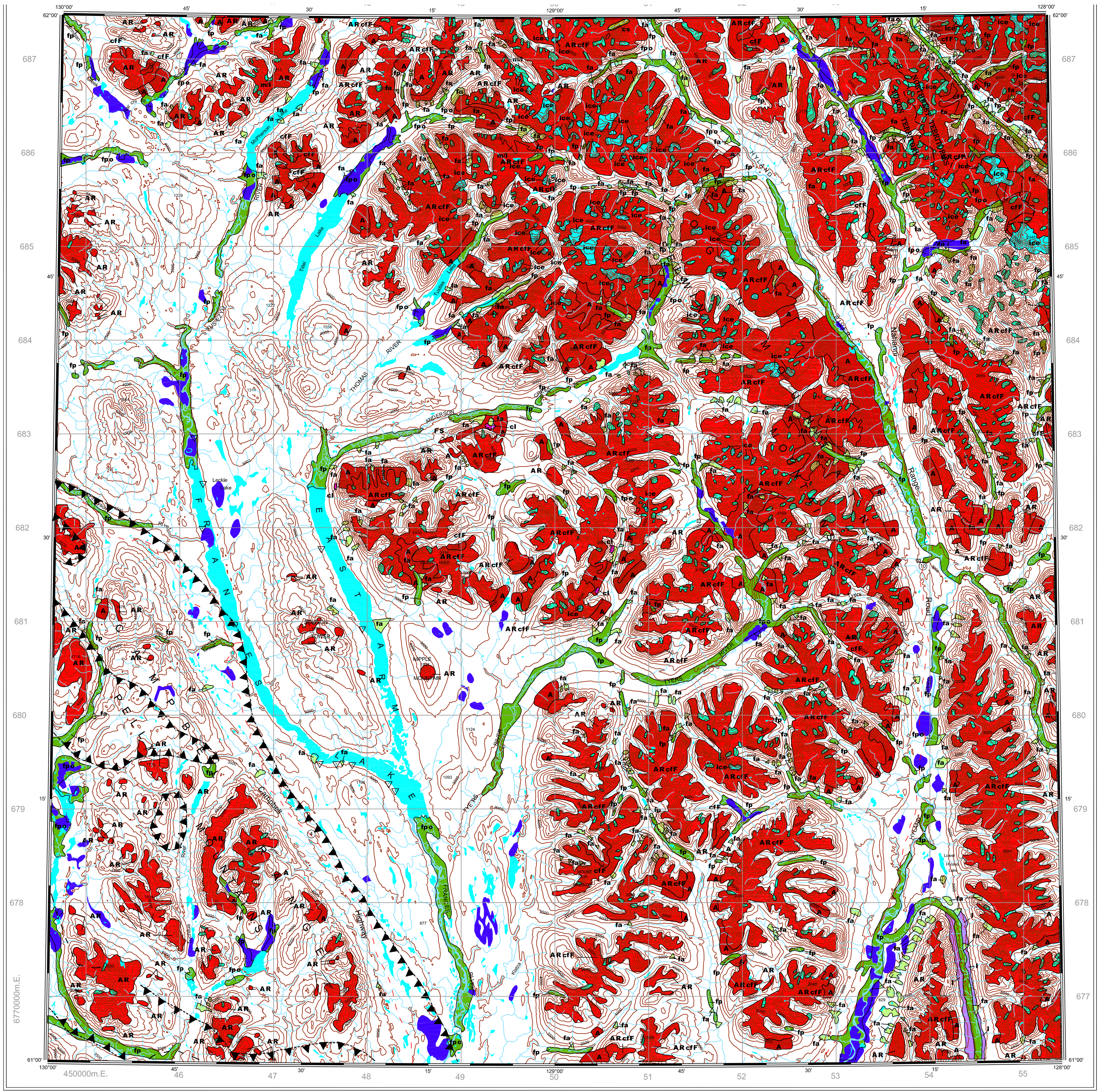


TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID NAD 83

ZONE 9

NOTE: THIS MAP HAS BEEN PRODUCED BY THE COMPILATION OF DATA FROM VARIOUS SOURCES. IT IS NOT TO BE USED TO DEFINE LEGAL BOUNDARIES.

THIS MAP IS ISSUED AS A PRELIMINARY GUIDE FOR WHICH THE DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT WILL ACCEPT NO RESPONSIBILITY FOR ANY ERRORS, INACCURACIES OR OMISSIONS WHATSOEVER.

EDITION: 2 PRINT DATE: MAY 11, 1999

FRANCES LAKE

YUKON TERRITORY

105H

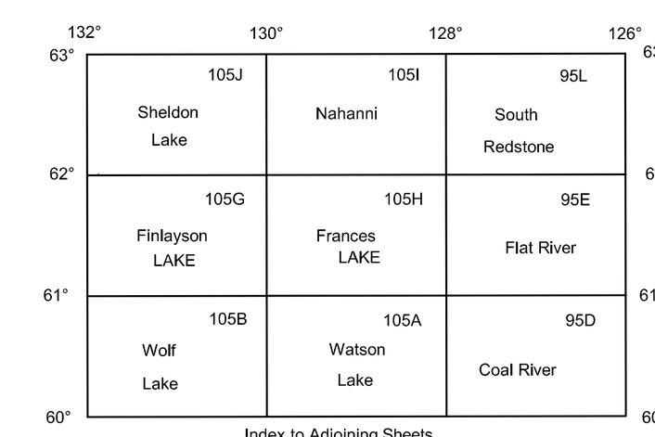
Scale

10 0 10 20 30 km

5 0 5 10 15 miles

N

CONTOUR INTERVAL 500 FEET Elevations in Feet above Mean Sea Level
North American Datum 1983 Transverse Mercator Projection
Universal Transvers Mercator Grid ZONE 9



Index to Adjoining Sheets.

Magnetic Declination 1987 varies from 30° 36' easterly at the centre of the west edge to 30° 49' easterly at the centre of the east edge. Mean annual change 19.4' westerly.

GEOPROCESS FILE - SUMMARY REPORT

FRANCES LAKE MAP AREA - NTS 105H

INTRODUCTION

The GEOPROCESS File is a compilation of information and knowledge on geological processes and terrain hazards, including mass movement processes, permafrost, flooding risks, faults, seismic activity and recent volcanism, etc. Please refer to the GEOPROCESS File User Guide for more in-depth information on how the maps were developed, which other GEOPROCESS File maps are available, how to utilize this inventory and how to interpret the legend. Special interest should be taken in the detailed description of the terrain hazard map units. Appendices in the User Guide include summary papers on the geological framework, permafrost distribution, and Quaternary geology in Yukon and a list of comprehensive GEOPROCESS File references.

This report includes a brief discussion of the scope and limitations of the GEOPROCESS File compilation maps followed by summaries of the bedrock geology, surficial geology and terrain hazards for this NTS map area, and a list of references.

Geological Processes and Terrain Hazard Compilation Maps

The GEOPROCESS File map units were drafted on the 1:250 000 topographic base maps through interpretation from bedrock geology maps, surficial geology maps and in some cases terrain hazard maps at various scales. The compilation maps have a confidence level reflecting the original source material. All materials used to produce the maps are listed in the references on each map. A file containing the documentation used to construct these maps is available at the Indian and Northern Affairs library in Whitehorse, Yukon. Areas for which no surficial geology or terrain hazard information is published were left blank. Summary reports on surficial geology and terrain hazards for these map sheets were written by extrapolating the data from adjacent map sheets or smaller scale maps. Information from small scale (e.g., 1:1 000 000) maps was used for the summary reports, but not redrafted onto the 1:250 000 GEOPROCESS File maps.

The GEOPROCESS File compilation maps are intended as a first cut planning tool; the legend on the maps describes the general aspects of terrain hazards (also see below) and associated geological processes. **These maps should never replace individual site investigations for planning of site specific features, such as buildings, roads, pits, etc.**

Bedrock Geology Summaries

Each 1:250 000 NTS map area is described according to morphogeological belts and terranes defined by Gabrielse et al. (1991) and Wheeler et al. (1991). Bedrock geology (including structure) and mineral occurrences are briefly described and taken largely from the referenced, most recent 1:250 000 geological map with additional contributions from Wheeler and McFeely (1991), and Yukon MINFILE (1993). A summary paper ("A Geological Framework for Yukon") in Appendix A of the User Guide provides a framework and context for each of the bedrock summaries.

The level of knowledge and understanding of Yukon geology is constantly evolving with more detailed mapping and development of geological models. Names, ages and terrane affinities of rock units on the most recent 1:250 000 geological maps may, in some cases, now be considered incorrect. Thus information contained within some of the bedrock geology summaries may be out of date. Although much of the information reflects the knowledge at the time that the source map was published, additional information has been inserted whenever possible to assist the user in merging the information with current geological maps, concepts and understanding. The age ranges for similar packages of rocks may also vary between map areas since the actual rocks, or at least the constraints on their age, may vary between map areas.

BEDROCK GEOLOGY

The Frances Lake map area is entirely within the Omineca Belt and is crossed by northwest-southeast trending ranges of the Selwyn Mountains.

Most of the map area, except for the southwest portion, is underlain by the Hyland and Road River Groups which comprise the Selwyn Basin portion of ancient North America. The southwest portion is underlain by rocks of the Nisling allochthon. All these geological belts trend northwest-southeast. The Hyland Group consists of 800-530 million year old shale, slate, quartz-pebble conglomerate, grit, quartzite, maroon shale and slate, green argillite, limestone, dolomite, schist and gneiss. The Road River Group consists of 530-390 million year old Road River Group black slate, shale, argillite and phyllite.

The southwestern part of the map area is intruded by Devonian to Mississippian (320 to 410 million year old) Simpson Range megacrystic hornblende-biotite granodiorite and quartz diorite, and younger hornblende biotite quartz monzonite.

Mineral Deposits and Occurrences

Yukon MINFILE lists 101 mineral prospects, of which 76 host known mineralization. The majority of mineralized showings are skarn deposits, most of which are lead-zinc-silver +/- copper, or, less commonly, tungsten +/- molybdenum and copper. There are six known copper-lead-zinc-silver vein deposits, and one each of barite and molybdenum vein deposits. There are five lead-zinc-copper-silver sedimentary exhalative deposits, four tungsten-molybdenum porphyry deposits, and one copper- zinc volcanogenic massive sulphide deposit.

There are two jade occurrences. For the King Arctic, a total of 110 tonnes of jade were shipped in 1989 and 1990. Several tonnes of jade were shipped from the Tuchitua property between 1977 and 1979.

SURFICIAL GEOLOGY

The main source of information on the Quaternary geology for the Frances Lake area is a report and a set of four maps at the 100 000 scale by Dyke (1990). Included in the report (Dyke, 1990) are 200 till sample analyses such as texture, carbonate content, granule lithology and concentrations of base metals, silver and uranium.

The surface deposits of the Frances Lake map area are associated with the most recent Cordilleran ice sheet (late Wisconsinan), the McConnell glaciers, believed to have covered south and central Yukon between 26,500 and 10,000 years ago. This map area was covered by Cordilleran ice generally flowing from the north to the south. The ice originated from the Logan Dome, directly north of this area. The highest ridges of the Ragged Ranges and Logan Mountains acted as ice divides. As the ice retreated and thinned, the ice margin became a complex assemblage of ice lobes controlled by local topography.

Erosion by cirque glaciers and the overdeepening of stretches of large valley floors to form fjord-like lakes and troughs set into broader Tertiary valleys are significant topographic alterations directly caused by the glaciers. In addition, the mountain ranges have been dissected into numerous massifs by the formation of transection valleys. These valleys are the "result from breaching of alpine headwalls by vigorously moving ice streams during the Quaternary" (Dyke, 1990).

Bedrock in this area comprises less than 20 % of the exposed surface. Ridge crest and steep walls were modified by large-scale glacial erosion and by periglacial and alpine processes. Other bedrock surfaces show little signs of erosion and are probably the remnant of pre-glacial surfaces.

McConnell moraine or till covers approximately 70 % of the map area. Drumlin fields, or glacially streamlined ridges, occupy most of the floor of the Frances River valley and indicate south to southwest ice-flow direction. The lithic composition of the till reflects the bedrock. Central crystalline terrane tills have mostly granitic clasts and a sandy loam to loamy sand matrix. In the Frances River valley, a black till results from the incorporation of black Devonian shale. High carbonate content (53 %) is found in the till matrix overlying limestone, otherwise, carbonate contents are lower than 10 %. This overall low carbonate content and coarse texture of most tills suggest that the moraines have a low buffering capacity to counteract acid precipitation. (Dyke, 1990).

Geochemically, most till units have distinctive signatures. The clay fraction from the shale-derived till shows high background levels of mercury (up to 100 ppb compared to 200 ppb in other till clay fractions). Tills associated with the Cretaceous monzonite and granodiorite or with the Precambrian gneiss show higher background concentrations of uranium than other till bodies (up to 20 ppb, compared to 4 ppb in most other tills). Cadmium, molybdenum and silver as well as arsenic are present at various levels in most area. Anomalies, usually expressed as high levels of uranium, zinc or lead, are identified in areas of known mineralization and in the Frances River valley along Robert Campbell highway and the shore of Frances Lake. According to Dyke (1990), the geochemical signatures and these anomalies (and others mentioned in his report) are associated with short travel distance from the source.

Glaciofluvial sand and gravel are found in several of the major valley floors. The Flat, Little Hyland, Hyland, Dolly Varden, Frances, Yusezyu valleys have significant gravelly deposits, in some cases as thick as 30 m. In addition to ice contact and proglacial outwash, several features associated with ice margins are present in this area. Ice crevasse fillings are associated with esker ridges in several areas, such as Dolly Varden Creek valley and along the east arm of Frances Lake. Subglacial meltwater channels occur in several places. One of them, located between the Yusezyu River and Thomas Creek cuts about 100 m into the bedrock.

As in most mountainous settings, glacial meltwater was dammed at some point during deglaciation and formed large lakes. In the Frances Lake map sheet, at least two such lakes were formed, associated with the northward-flowing tributaries of the Hyland River, in the southeast corner of the map area.

TERRAIN HAZARDS

Terrain hazards are derived from the surface geology maps. The Geological Survey of Canada's Pacific Geoscience Centre in Victoria provided the seismic information. Snow avalanches and slope failures in steep bedrock represent the highest risk hazard in the area.

Mass Movement Processes

Snow avalanching is common throughout the map area. Air photography interpretation (Dyke, 1990) has identified thousands of avalanche tracks in the general area. Development of any kind in proximity to steep escarpments, ridges, cirques and arr êtes prone to this hazard should be discouraged. Block fields (talus scree buildup with large blocks, but little matrix) are commonly associated with rock and snow avalanche paths. These block fields are not associated with any particular bedrock lithology.

Most colluvial and moraine-covered steep slopes are undergoing or have undergone slow mass movement processes such as creep, solifluction, cryoturbation or frost heaving. Although not a hazard per se, these processes will affect long term viability of roads or other structures and should be identified and located prior to construction.

Permafrost

The Frances Lake area lies within the discontinuous permafrost zone (Brown, 1967). According to Heginbottom's recent compilation (1995), the area is in the Extensive Discontinuous Permafrost Zone (50-90%), with low to medium ground ice content (<10 to 10-20%), increasing towards the west, and mean annual ground temperatures in the range of 0 to +2 degrees Celsius. Distribution of permafrost is predicted to be sporadic (Heginbottom and Radburn, 1992).

Ice content is expected to be nil to low in glaciofluvial and fluvial coarse-grained deposits in most landforms, such as terraces, fans, eskers, kames, as well as in recent slides. Ice content in morainal and colluvial deposits is expected to be low to moderate, and to be highest in high elevation deposits covered by thick organic deposits. Solifluction lobes and stripes, sorted stone polygons are an indication of permafrost. Dyke (1990) reports presence of permafrost at low elevation along the bluffs of Frances Lake, on steep slopes covered by peat and spruce.

High ice content is possible in fine-grained fluvial terraces located above stream level, in silty to clayey glaciolacustrine sediments. Ice lenses or veins are also common at the toe of colluviated (inactive) slopes covered by thick mosses.

Rock glaciers are numerous at high elevation on northeast- to northwest-facing slopes (slope orientation varies from 270 degrees to 90 degrees). At least 1000 rock glaciers have been mapped under the general class of rock glaciers. Some of these features are possibly debris-covered glaciers (ice-cored) or talus glaciers (ice-cemented) and are not linked to a specific rock unit. Dyke estimates that 90% of the rock glaciers are older than the White River ash (which is estimated to be 1200 years b.p. old) and based on lichenometric studies, could be 4000 years old. Younger rock glaciers are also found in the area. They can be as thick as 10 m. Surface movement rates of up to 51 m and snout advances of 2.5 m over 17 years have been recorded in the Nahanni National Park, east of this map sheet (Jackson and McDonald, 1980). Although these advance rates may not be typical of the rock glaciers of the Frances Lake map sheet they provide a possible rate of advance for such features.

Flooding and Other Risks

Floods related to ice-jams, snow melt and summer rainstorm are a possible hazard in lower reaches of most streams in the area. The steep portion of alluvial fans, in addition to the flooding risk, are also exposed to the additional possibility of mud and debris flows associated with rapid discharge increase.

Seismicity

There are two recorded seismic events within the map area. These events are 2.0 to 2.999 in magnitude, or less.

REFERENCES

Frances Lake Map Area - NTS 105H

To be thorough, check the references for adjacent N.T.S. map sheets and the General Reference List (See User Guide).

Most of the following references should be available for viewing in the DIAND library on the third floor of the Elijah Smith building in Whitehorse. The library and call number of some internal government reports are listed.

*Blusson, S.L., 1966. Frances Lake map-area. Geological Survey of Canada, Preliminary map 6-1966.

Brown, R.J.E., 1967. Permafrost in Canada. Geological Survey of Canada, Map 1246, (scale 1:7 603 200).

*Canadian Earthquake Epicentre File; Maintained by the Geological Survey of Canada, Geophysics Division.

*Dyke, A.S., 1983. Surficial geology of Frances Lake, Yukon Territory and District of Mackenzie (105H). Geological Survey of Canada, Open File 895, (1:125 000-scale map).

*Dyke, A.S., 1990a. A lichenometric study of holocene rock glaciers and neoglacial moraines, Frances Lake map area, southeastern Yukon Territory and Northwest Territories. Geological Survey of Canada, Bulletin 394, 33 p.

*Dyke, A.S., 1990b. Quaternary geology of the Frances Lake map area, Yukon and Northwest Territories. Geological Survey of Canada, Memoir 426, 39 p.

*Dyke, A.S., 1990c. Surficial materials and landforms, Dolly Varden Creek, Yukon Territory. Geological Survey of Canada, Map 1674A, (scale 1:100 000).

*Dyke, A.S., 1990d. Surficial materials and landforms, Frances River, Yukon Territory and Northwest Territories. Geological Survey of Canada, Map 1675A, (scale 1:100 000).

*Dyke, A.S., 1990e. Surficial materials and landforms, Little Hyland River, Yukon Territory and Northwest Territories. Geological Survey of Canada, Map 1677A, (scale 1:100 000).

Dyke, A.S., 1990e. Surficial materials and landforms, Yusezyu River, Yukon Territory. Geological Survey of Canada, Map 1676, (scale 1:100 000)

Gabrielse, H., Tempelman-Kluit, D.J., Blusson, S.L. and Campbell, R.B. (comps.), 1980. MacMillan River, Yukon - District of MacKenzie-Alaska (Sheet 105, 115). Geological Survey of Canada, Map 1398A.

Gabrielse, H. and Yorath, C.J. (eds.), 1991. Geology of the Cordilleran Orogen in Canada. Geological Survey of Canada, Geology of Canada, No. 4, 844 p.

Geological Survey of Canada, 1990. Regional stream sediment and water geochemical reconnaissance data (105H). Geological Survey of Canada, Open File 1649.

Hamilton, S.M., Michel, F.A. and Jefferson, C.W., 1988. Groundwater geochemistry, South Nahanni Resource Management Area, District of Mackenzie. Geological Survey of Canada, Paper 88-01E, p. 127-136. (NTS 95E, 105H, 105I)

Heginbottom, J.A. and Radburn, L.K. (comps.), 1992. Permafrost and ground ice conditions of northwestern Canada. Geological Survey of Canada, Map 1691A, scale 1:1,000 000.

Heginbottom, J.A., 1995. Canada Permafrost, The National Atlas of Canada 5th Edition, Natural Resources Canada, Geological Survey of Canada, Map MCR 4177F, 1:7 500 000 scale.

Jackson, L.E. Jr. and McDonald, G.M., 1980. Movement of an ice-core rock glacier, Tungsten, N.W.T. Canada, 1963- 1980. Arctic, v.33, no.4, p. 842-847.

*Wheeler, J.O., Brookfield, A.J., Gabrielse, H., Monger, J.W.H., Tipper, H.W. and Woodsworth, G.J., 1991. Terrane map of the Canadian Cordillera. Geological Survey of Canada, Map 1713.

*Wheeler, J.O. and McFeely, P., 1991. Tectonic Assemblage map of the Canadian Cordillera and adjacent parts of the United States of America. Geological Survey of Canada, Map 1712A.

Yukon MINFILE, 1994. 105H - Frances Lake, Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada.

* References used in compiling this map

NOTE: A new digital compilation of Yukon Geology is now available by Steve Gordey and Andrew Makepeace (GSC Open File D3826 and/or DIAND Open File 1999-1(D)), and more recent MINFILE updates should also be verified (Yukon MINFILE, 2001).

LEGEND

LEGEND TERRAIN HAZARDS

MAP SYMBOL	TERRAIN HAZARDS	ASSOCIATED RISK LEVELS, COMMENTS
	Mass Movement Processes	
A	Snow Avalanched.	high
F	Extremely slow to moderate rates of failure in soil and bedrock, including soil creep, rock creep, earthflow, soil or rock slump, debris or rock slide.	low to intermediate
R	Moderate to extremely rapid rates of failure in soil and bedrock (1.5 m/d to >3 m/s), including rock slump, debris slide, rock slide, debris flow, debris torrent, debris avalanche, rockfall, rock avalanche.	high
	Arctic, Alpine and Periglacial Processes	
X	Permafrost present.	low
K	Thermokarst present.	low
S	Soliflucted.	low to intermediate
Z	Grouped, cryoturbated, solifluted, nivated.	low to intermediate
	Fluvial Processes	
B	Braided, unstable channels, risk of flooding.	intermediate to high
E	Fluvial erosion, deposition and low risk of flooding.	low to intermediate
J	Anastomosing.	intermediate to high
U	Flooded regularly.	intermediate to high
	Miscellaneous Erosion Processes	
T	Karst.	intermediate
P	Piping.	intermediate to high
V	Gullied.	low to intermediate

On Site Symbols	Risk Level
Unit boundary (defined, approximate).	
Erosional escarpment.	high
Landslide escarpment.	high
Landslide (includes source and runout areas).	high
Pingo.	high
Rock glacier.	high
Spring or saline seep.	low
Observation of frozen soil or ground ice.	low
Rapid mass movements (debris torrent) with known point source. Limits of runout not implied by symbol.	high
Slow mass movement (earth flow) with landslide, escarpment source. Limits of landslide runout not implied by symbol.	intermediate to high

LEGEND SEISMIC EVENTS

SYMBOL	MAGNITUDE REPRESENTED	SYMBOL	MAGNITUDE REPRESENTED
▫	<2.0	▫	4.0 to 4.999
▫	2.0 to 2.999	▫	5.0 to 5.999
▫	3.0 to 3.999	▫	>6.0

LEGEND GEOLOGICAL PROCESSES

MAP SYMBOL	DESCRIPTION	INFERRED HAZARDS
cf	Talus fan or apron, moderate to steep slope, coarse angular bedrock fragments, sources are often areas of rapidly disintegrating bedrock.	Rock fall and debris flows common on active fans, steep slopes generally unstable to traffic.
cl	Landslide, moderate slope, varies from large blocks of bedrock to finer material.	Landslides generally are recurrent in susceptible areas and may be become active if disturbed.
cs	Colluvium covered slope, gentle to moderate slope, underlain by unsorted rubble, solifluction and other periglacial features common.	Areas of fine textured materials and gentle slopes at high elevations, where there is ground ice will be susceptible to high solifluction rates and thermokarst if disturbed.
fa	Alluvial fan, active.	Subject to shifts in channel and bar positions, occasionally subject to flooding.
fp	Floodplain.	Subject to shift in channel and bar positions, occasionally subject to flooding.
ice	Glacier ice.	Crevasses.
im	Mountain ice caps.	Avalanches, ice and rock falls, and crevasses.
is	Cliff glacier.	Avalanches, ice and rock falls.
l	Lacustrine or glaciolacustrine sediments.	Silt and clay, usually susceptible to frost heaving and, if permafrost present, to thermokarsting when disturbed.
m/i	Rock glacier, debris covered glacier.	Ice at depth make surface susceptible to thermokarst, unstable slopes.
o	Organic.	Thick organic matter is often underlain by permafrost. Disturbance of permafrost may cause poor drainage and thermokarsting.

LEGEND FAULTS

Fault
defined, approximate, assumed, extrapolated beneath overburden

Fault
Solid circle indicates downthrown side
Arrows indicate relative movement

Thrust Fault (teeth indicate upthrust side)

Airphoto Lineament

LEGEND QUATERNARY VOLCANISM

No known recent volcanism in map area 105H

OTHER FEATURES

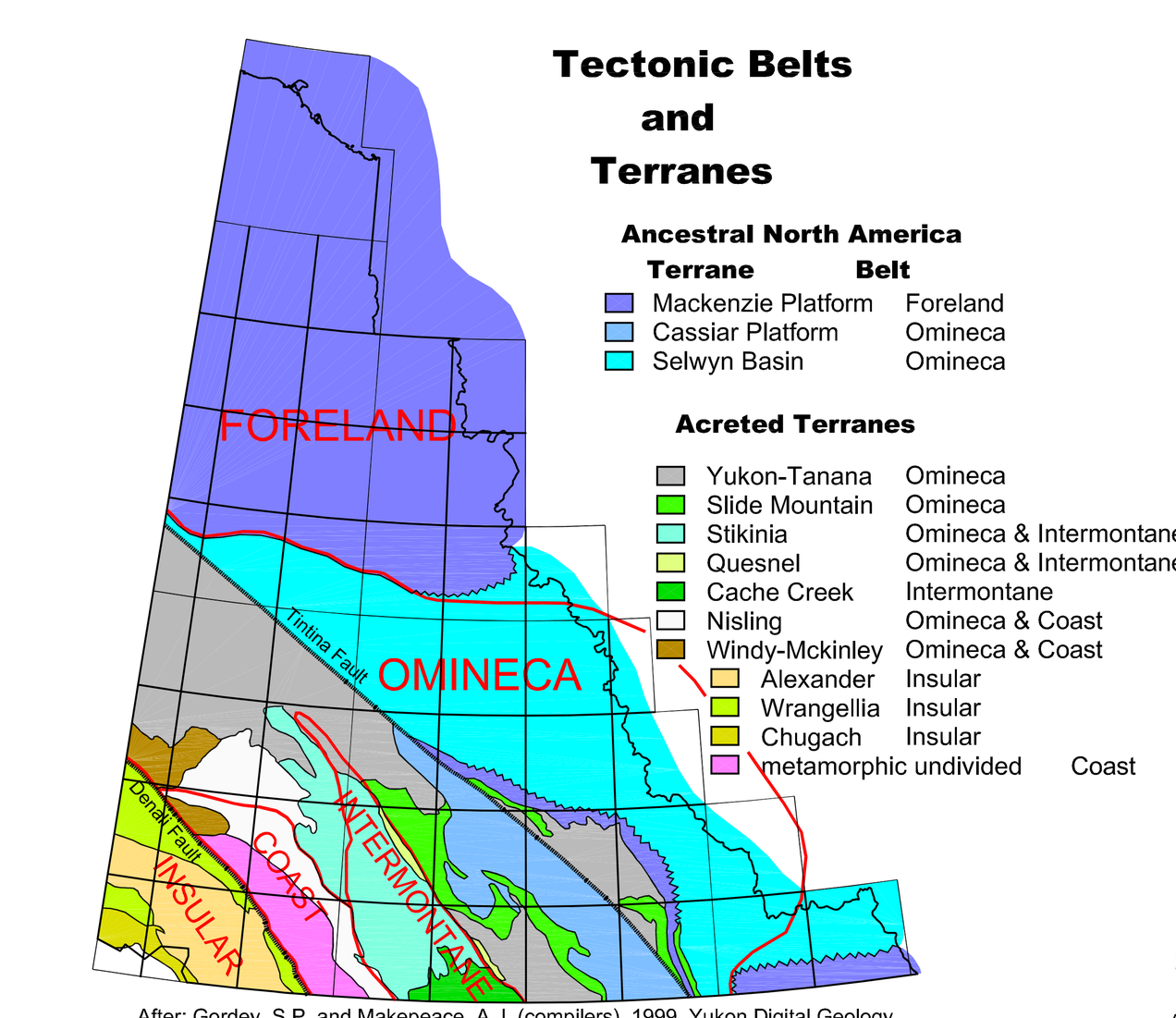
Roads

Streams

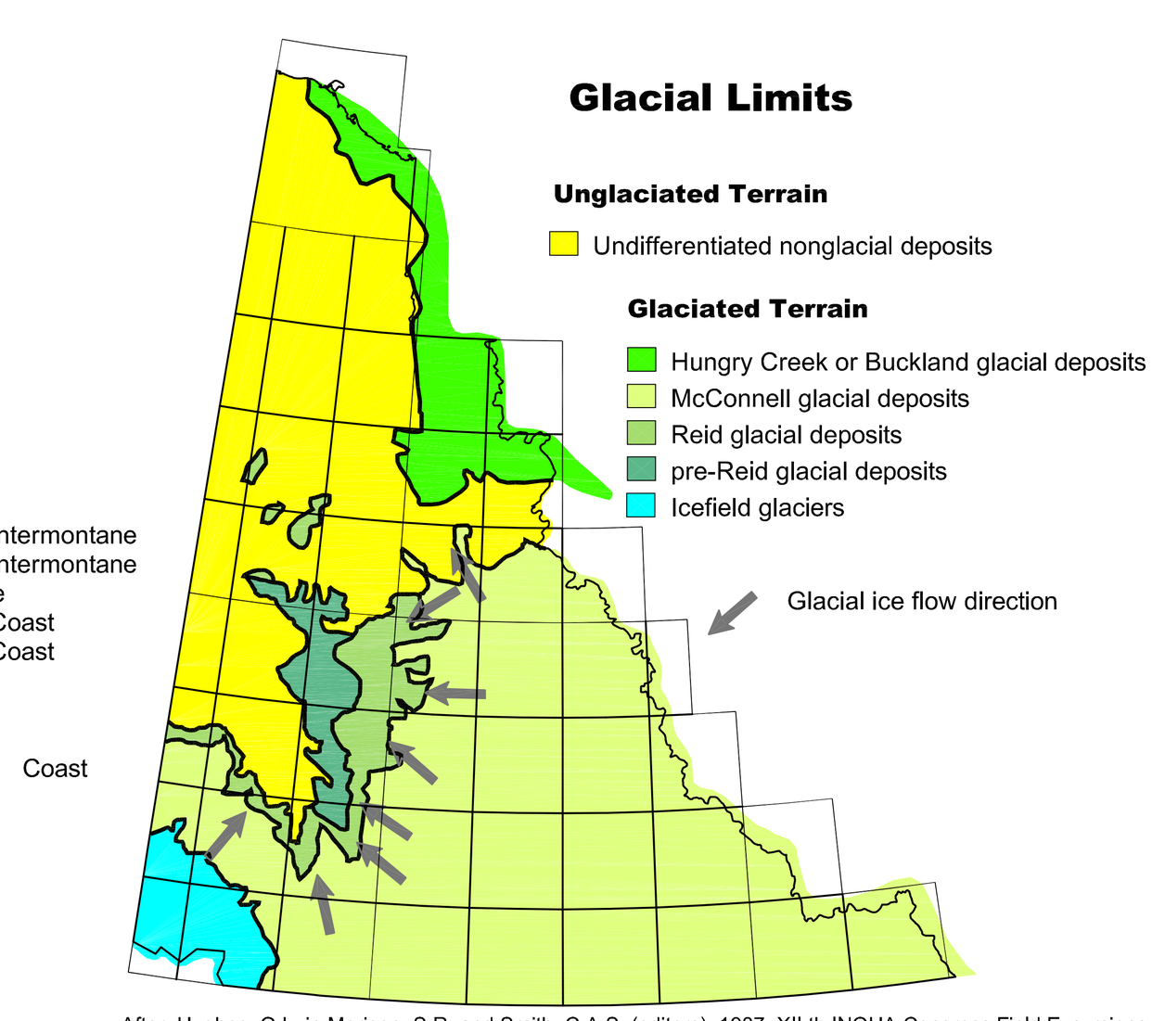
Lakes

Marsh

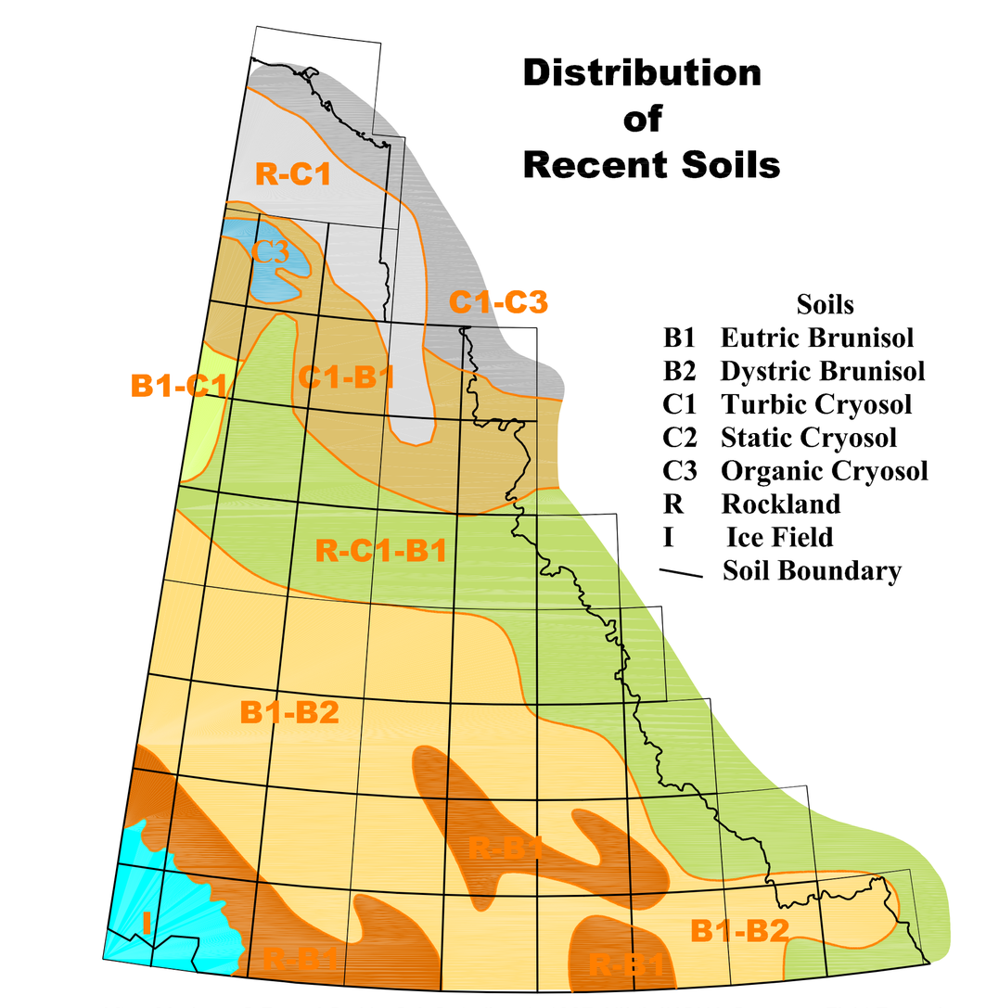
NOTE: Where areas have more than one identified process or hazard, the colour of the encompassing polygon is assigned based on a hierarchical scheme relating to the severity of the hazard. The relative order of severity is: Terrain Hazards (Mass Movement Processes then Fluvial Processes then Arctic, Alpine and Periglacial Processes) followed by Geological Processes.



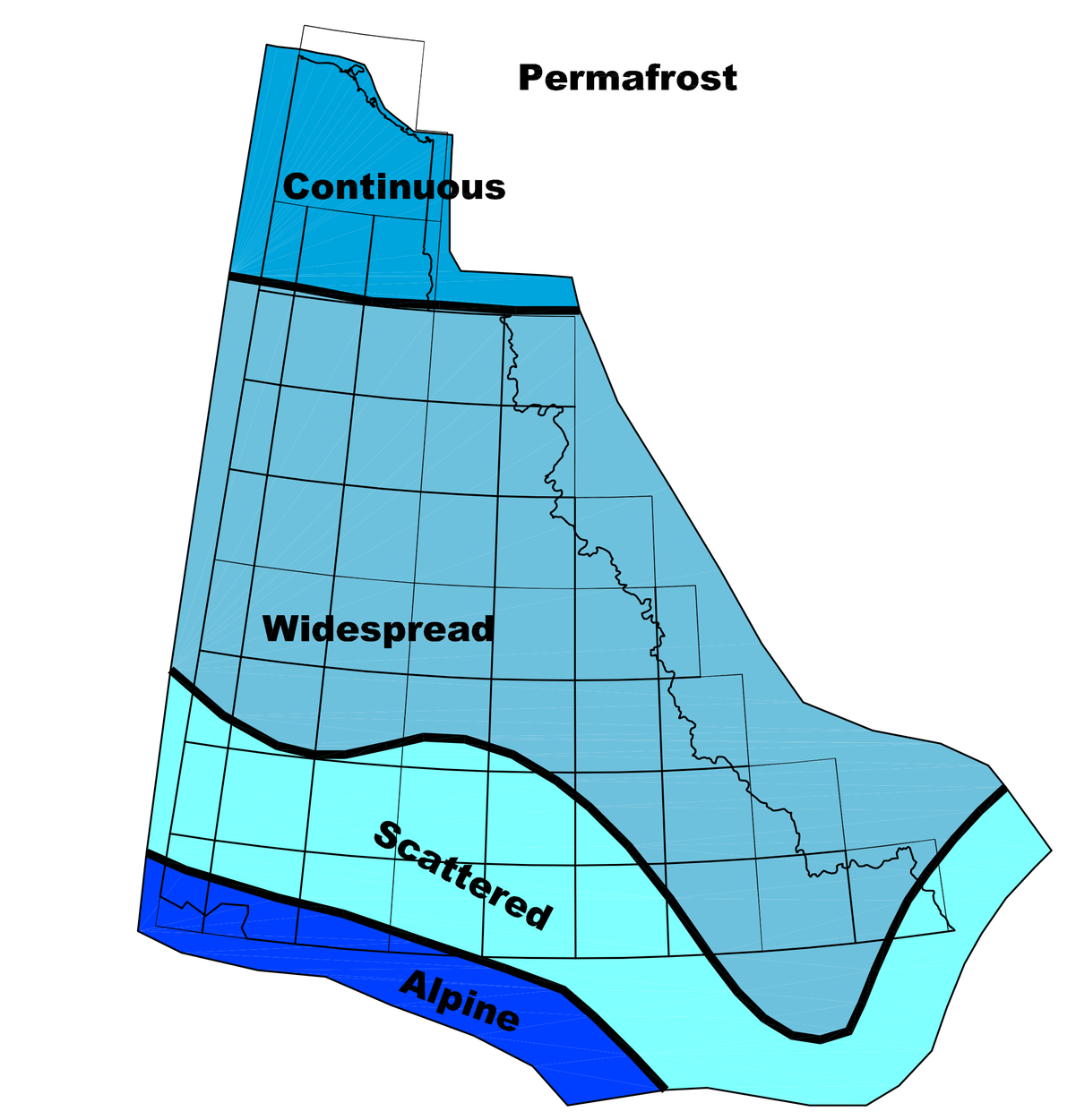
After: Gordey, S.P. and Makepeace, A.J. (compilers), 1999. Yukon Digital Geology Geological Survey of Canada Open File D3826, Exploration and Geological Services Division Yukon, Indian and Northern Affairs, Open File 1999-1 (D)



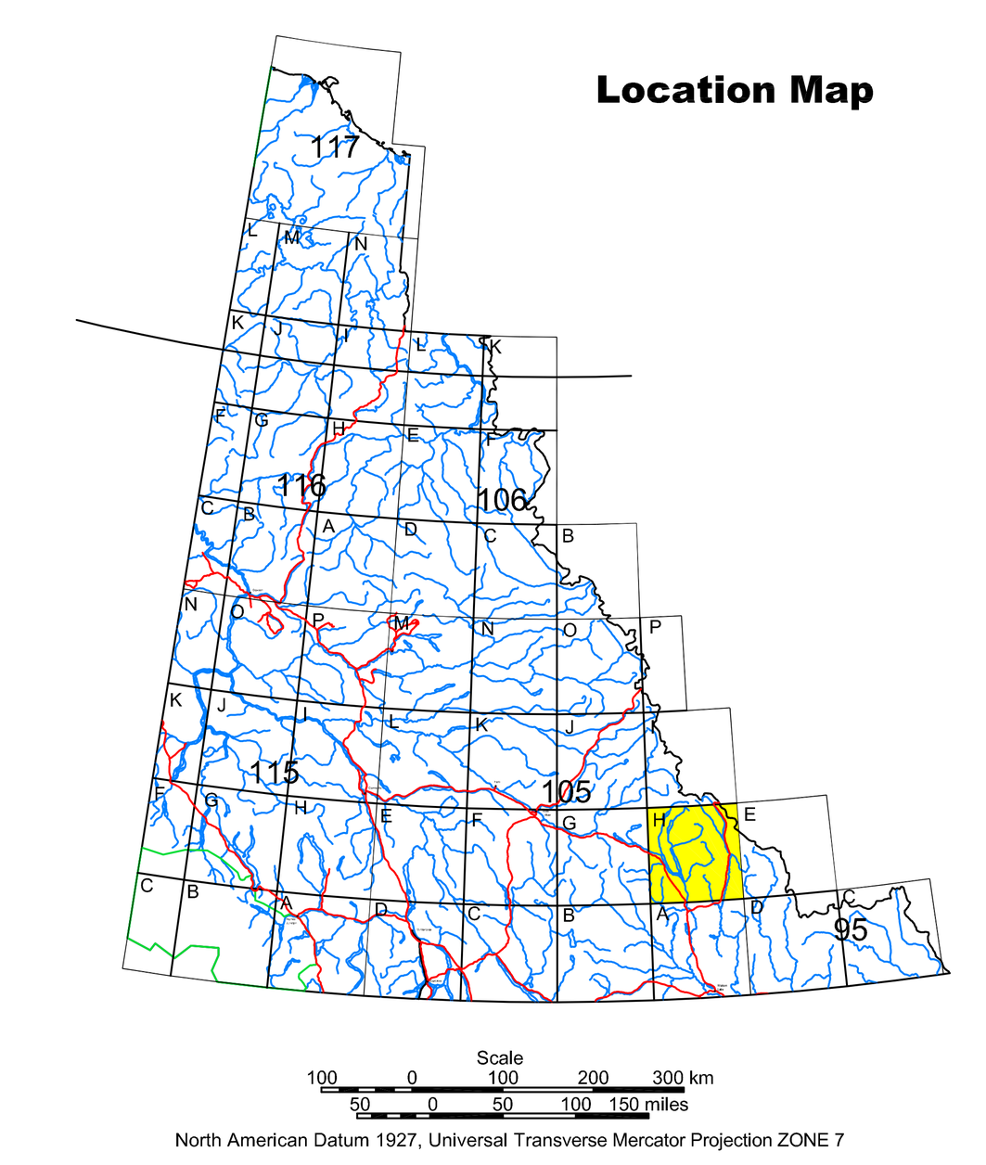
After: Hughes, O.L. in Morison, S.R. and Smith, C.A.S. (editors), 1987, XII th INQUA Congress Field Excursions A20, p12 to 16 - Research in Yukon, National Research Council of Canada, Ottawa, Canada, 110p



After: Morison, S.R. and Smith, C.A.S. (editors), 1987, XII th INQUA Congress Field Excursions A20a and A20b - Research in Yukon, National Research Council of Canada, Ottawa, Canada, 110p



After: Brown, R.J.E., 1978, Permafrost: Plate 32, Hydrological Atlas of Canada, Fisheries and Environment, Canada. 34 plates



North American Datum 1927, Universal Transverse Mercator Projection ZONE 7

Exploration and Geological Services Division
Yukon Region
Indian and Northern Affairs Canada

Yukon GEOPROCESS File

Geological Processes and Terrain Hazards of Frances Lake 105H

by

Mougeot, C.M. and Walton, L.A.

Copies of this map may be obtained from Geoscience and Information Sales c/o Whitehorse Mining Recorder, Indian and Northern Affairs Canada, Room 102, 300 Main Street, Whitehorse, Yukon Y1A 2B5 (867) 667-3266; FAX; (867) 667-3267

Recommended citation: Mougeot, C.M. and Walton, L.A., 1996. Yukon GEOPROCESS File (2002), Geological Processes and Terrain Hazards of Frances Lake, 105H Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, 1:250 000 scale.