INFERRED HAZARDS

Rock fall and debris flows common

Landslides generally are recurrent

in susceptible areas and may be become active if disturbed.

Areas of fine textured materials

ice will be susceptible to high

elevations, where there is ground

solifluction rates and thermokarst

Subject to shifts in channel and

Subject to shift in channel and

Avalanches, ice and rock falls,

Avalanches, ice and rock falls.

Ice at depth make surface

susceptible to thermokarst,

Thick organic matter is often underlain by permafrost. Disturbance

of permafrost may cause poor drainage and thermokarsting.

unstable slopes.

Silt and clay, usually susceptible

to frost heaving and, if permafrost present, to thermokarsting when

bar positions, occasionally subject

bar positions, occasionally subject

and gentle slopes at high

if disturbed.

to flooding.

to flooding.

Crevasses.

disturbed.

Marsh

**Glacial Limits** 

**Unglaciated Terrain** 

Undifferentiated nonglacial deposits

McConnell glacial deposits

Hungry Creek or Buckland glacial deposits

Glacial ice flow direction

**Glaciated Terrain** 

Reid glacial deposits

Icefield glaciers

**Permafrost** 

**Geological Processes and Terrain Hazards** 

Doherty, R.A., Mougeot, C.M. and vanRanden, J.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: Doherty, R.A., Mougeot, C.M. and vanRanden, J.A., 1996.

Yukon GEOPROCESS File (2002), Geological Processes and Terrain Hazards of Mayo, 105M

Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, 1:250 000 scale.

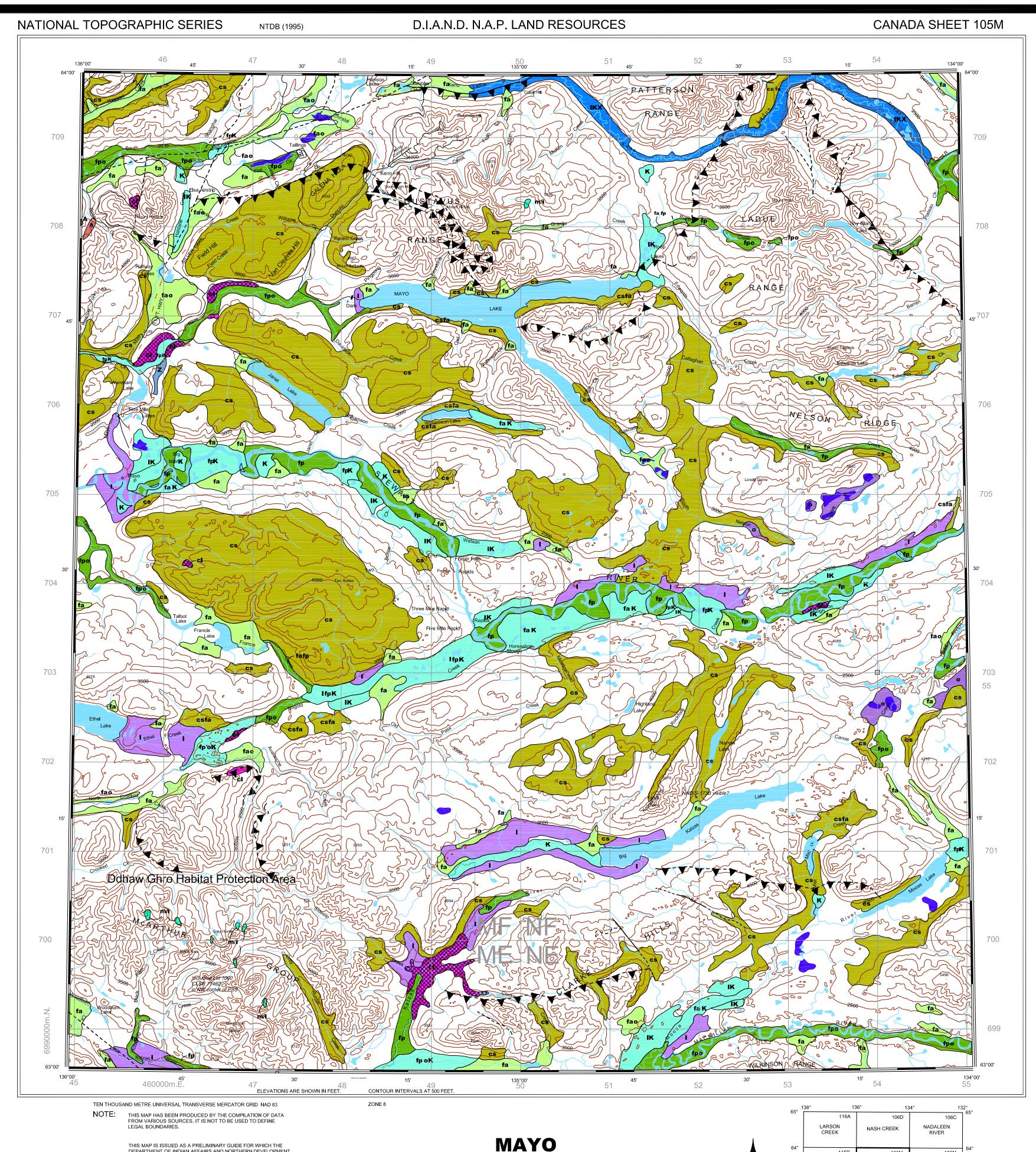
pre-Reid glacial deposits

and crevasses.

on active fans, steep slopes

generally unstable to traffic.





### **GEOPROCESS FILE - SUMMARY REPORT** MAYO MAP AREA - NTS 105M

# 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.

his 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

## 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 (Roots and Murphy, 1992)

EDITION: 2 PRINT DATE: 99/07/19

The Mayo map area encompasses a landscape of high rounded hills and wide swampy valleys. Higher mountains occur to the southwest in the McArthur Range, and north of Mayo Lake as the Gustavus Mountains. Holocene glaciers filled the valleys but uplands above 1370 metres remained exposed. Bedrock is located in north-facing cirques, as erosional remnants on hill tops, and in stream canyons. Uplands are typically mantled with frost-fractured rock

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT WILL ACCEPT NO RESPONSIBILITY FOR ANY ERRORS, INACCURACIES

The map area is within the Omineca Belt and is dominated by sedimentary rocks of the Selwyn Basin. The rocks are divisible into three main packages which are progressively more deformed from south to north. The sedimentary sequence in the southernmost quarter of the map area includes 800-530 million year old Hyland Group quartz metasandstone, conglomerate, maroon shale, siltstone and phyllite which are overlain by 530-450 million year old siltstone and sandstone of the Kechika Formation, 450-390 million year old Road River Group siltstone and chert, and the 380-325 million year old Earn Group sandstone, chert-pebble conglomerate, siltstone, mudstone, dark limestone and chert. The broad folds and widely spaced thrust faults that cause these rocks to repeat are offset by northwest-trending faults that are spaced 3-8 km apart. The Tintina

Across the centre of the map area is a 45 km wide belt of quartz-mica schist and chlorite schist of the Hyland Group. These rocks are tightly folded and strongly foliated and form the hanging wall of the south-dipping Robert Service Thrust. These and the overlying stratigraphy described in the paragraph above have been called the Robert Service Thrust Sheet.

Fault is located in the southwestern corner of the map area.

The northern quarter of the map area contains flattened, moderately south-dipping metasedimentary and meta-igneous rocks that occur as thrust panels beneath the Robert Service Thrust Fault and the Tombstone Thrust. This is known as the Tombstone Thrust Sheet. Earn Group sericite schist and chloritic phyllite and Keno Hill guartzite (360-320 million years old) are intruded by dykes and sills of 220 million year old metadiorite. Phyllite is generally incompetent, whereas adjacent quartzite and metadiorite are more resistant and brittle. Farther north in the McQuesten River valley is less strained chert and

Several small 100-90 million year old biotite-hornblende granite and quartz monzonite plutons of the Selwyn Suite occur along a northwesterly trend across the map area. Two larger plutons are both 94 million years old. The low-lying Roop Lakes pluton (130 sq km) northeast of Mayo Lake is thought to be responsible for mineralization in the Keno Hill area, and the craggy, irregular shaped McArthur Pluton (160 sq km) has one active, and several fossil,

## Mineral Deposits and Occurrences

hotsprings along its margin.

meta-siltstone of the Earn Group.

Yukon MINFILE lists 80 mineral occurrences for the Mayo area. Most are associated with the Keno Hill silver camp or are in the McArthur Game Sanctuary. Approximately 50 occurrences are silver-lead-zinc veins, with or without copper, tungsten, tin or gold. A number of tungsten-gold and copper skarns are found at the margins of the granitic intrusions. Two barite occurrences are located in the northeast corner of the map area in Earn Group

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).

sedimentary rocks near Tiny Island Lake. The Keno Hill-Galena Hill mining area has Flooding Hazards produced 6.7 billion g of silver, 274 million kg of lead and 153 million kg of zinc from 4.8 billion tonnes of ore between 1921 and 1988. Current reserves are approximately 400 000 tonnes of 1000 grams per tonne silver and 5% lead. Placer deposits in the Mayo map area are located on creeks draining into Mayo Lake and on Duncan Creek and its tributaries. Total recorded production from approximately eight creeks is 317 180 gms of gold between 1978 to 1990.

YUKON TERRITORY

CONTOUR INTERVAL 500 FEET Elevations in Feet above Mean Sea Level

North American Datum 1983 Transverse Mercator Projection

**Universal Transvers Mercator Grid ZONE 8** 

#### The Mayo map area lies within the limits of the McConnell Glaciation. A complex assemblage of moraines, glaciofluvial and glaciolacustrine deposits is found in valley bottoms. Fine-grained deposits from glacial lakes are present in No-gold Creek, Upper Kalzas River and the Keno-Ladue River valleys as well as in the Stewart River valley. These deposits have a tendency to fail when undercut by streams and to develop thermokarst collapse features when the permafrost is disturbed.

The main source of information for this map sheet is the set of surficial geology maps surveyed by O. Hughes (1982) and the soil survey maps produced by Rostad, et al. TERRAIN HAZARDS

#### Most terrain hazards in the Mayo map area are related to permafrost. Areas underlain by greenstones that are more resistant than the enclosing metasedimentary rocks could be susceptible to rock slides, however, distribution of this lithology is confined to areas around Mayo Lake, and there are no documented

One magnitude 3.8 seismic event has been recorded with a focal point apparently unrelated to any surface fault trace.

The surficial geology maps in this area do not contain information relevant to rockslides, avalanches or other rapidly occurring landslides; however, as permafrost is widespread in this area, movement of soil and debris on slopes can easily be triggered if the permafrost is disturbed. Solifluction and soil creep are common especially on steeper slopes covered with a blanket of colluvium or moraine. The glaciolacustrine silt and clay deposits are susceptible to failure when undercut, and recessive slides are common where the vegetation cover has been disturbed.

Mass Movement Processes

SURFICIAL GEOLOGY

Permafrost in the Mayo area is extensive and discontinuous, with a low to moderate ice content. Frozen surficial sediments contain ice veins, ice lenses and ice wedges (Heginbottom and Radburn, 1992). Larger ice bodies are present at depth, especially in thick fine-grained glaciolacustrine and alluvial sediments. River valley floors usually contain discontinuous permafrost with visible ice which may be present as massive ice wedges or in thermokarst collapse features.

Note: To be thorough, check the references for adjacent NTS map sheets and Lynch, J.V.G., 1986. Mineral Zoning in the Keno Hill silver-lead-zinc mining district, the General Reference List.

B.Sc. thesis, University of British Columbia. Although very few hydrological studies were available when this map was compiled, it Bostock, H.S., 1947. Mayo, Yukon Territory. Geological Survey of Canada, Map is locally known that alluvial flat areas within the lower reaches of the Liard, Stewart, Mayo and other small rivers are flooded seasonally. Some years, low level terraces up to 3 m above the stream channel are flooded as a result of the snow melt or ice jam during break-up. The Town of Mayo has been flooded in the past due to ice jams in the Mayo River (Underwood and McLelland, 1983). This situation has been prevented in the recent past by controlling stage levels at the hydroelectric plant on Hill District, Yukon Territory. Geological Survey of Canada, Open file 612. Geothermal gradients around the McArthur River Game Sanctuary are high and a

McQUESTEN

CARMACKS

Agnetic Declination 1970 varies from 33 ° 15' easterly at the entre of the west edge to 34° 03' easterly at the centre of the east edge. Mean annual change 4.2' westerly.

number of hot springs are active in the area.

MAYO

GLENLYON

Index to Adjoining Sheets.

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1:1 000 000

File 1962.

Canada, Open file 1650.

**LEGEND** TERRAIN HAZARDS ASSOCIATED RISK LEVELS, COMMENT MAP SYMBOL DESCRIPTION Mass Movement Processes Talus fan or apron, moderate to steep slope, coarse angular bedrock fragments, Snow Avalanched. sources are often areas of rapidly disintegrating bedrock. Extremely slow to moderate rates of failure in soil and low to intermediate bedrock, including soil creep, rock creep, earthflow, soil Landslide, moderate slope, varies from large or rock slump, debris or rock slide. blocks of bedrock to finer material. Moderate to extremely rapid rates of failure in soil and high bedrock (1.5 m/d to >3 m/s), including rock slump, Colluvium covered slope, gentle to debris slide, rock slide, debris flow, debris torrent, debris moderate slope, underlain by unsorted avalanche, rockfall, rock avalanche. rubble, solifluction and other periglacial Arctic, Alpine and Periglacial Processes features common. Permafrost present. Alluvial fan, active. Thermokarst present. Soliflucted. low to intermediate Grouped, cryoturbated, soliflucted, nivated. low to intermediate Floodplain. Fluvial Processes Braided, unstable channels, risk of flooding. intermediate to high Fluvial erosion, deposition and low risk of flooding. low to intermediate Mountain ice caps. intermediate to high Cliff glacier. Flooded regularly. intermediate to high Lacustrine or glaciolacustrine sediments Miscellaneous Erosion Processes intermediate intermediate to high Rock glacier, debris covered glacier. low to intermediate On Site Symbols Unit boundary (defined, approximate). Erosional escarpment. Landslide escarpment. defined, approximate, assumed, Landslide (includes source and runout areas). extrapolated beneath overburden Rock glacier. Solid circle indicates downthrown side Arrows indicate relative movement Spring or saline seep. Observation of frozen soil or ground ice. Thrust Fault (teeth indicate upthrust side) source. Limits of runout not implied by symbol. Slow mass movement (earth flow) with landslide, intermediate to high escarpment source. Limits of landslide runout not No known recent volcanism in map area 105M implied by symbol. 4.0 to 4.999 <2.0 5.0 to 5.999 2.0 to 2.999 Streams 3.0 to 3.999 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. Tectonic Belts **Ancestral North America** Terrane Belt Mackenzie Platform Foreland Cassiar Platform Omineca Selwyn Basin **Acreted Terranes** Yukon-Tanana Omineca Slide Mountain Omineca ] Stikinia Omineca & Intermontane Quesnel Omineca & Intermontane Cache Creek Intermontane ] Nisling Omineca & Coast l Windy-Mckinley Omineca & Coast Alexander Insular ■ Wrangellia Insular Chugach Insular metamorphic undivided Coas After: Gordey, S.P. and Makepeace, A.J. (compilers), 1999. Yukon Digital Geology 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 Geological Survey of Canada Open File D3826, Exploration and Geological Services Division Yukon, Indian and Northern Affairs, Open File 1999-1 (D) Recent Soils **B1** Eutric Brunisol **B2** Dystric Brunisol C1 Turbic Cryosol C2 Static Cryosol C3 Organic Cryosol R Rockland I Ice Field Soil Boundary 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 Exploration and Geological Services Division Indian and Northern Affairs Canada **Yukon GEOPROCESS File** 

North American Datum 1927, Universal Transverse Mercator Projection ZONE 7