GEOPROCESS FILE
SUMMARY REPORT

AISHIHIK LAKE MAP AREA
N.T.S. 115H

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 Introduction and User's 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's 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 and summaries followed by summaries of the bedrock geology, surficial geology and terrain hazards for this N.T.S. 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 attached to 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 N.T.S. 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 Introduction and User's 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 Aishihik map area encompasses portions of three morphogeological belts; from west to east they are the Coast, Omineca and Intermontane belts. The most notable geographic feature in the area is Aishihik Lake which is the largest alpine lake in North America.

The Coast Belt, in the southwestern portion of the map area, is underlain by two main units - Kluane Schist and Coast Plutonic Complex. The 55 million year old Kluane Schist (or Tempelman-Kluit's "Hornfelsed Schist", 1974) comprises dark purplish-brown, staurolite-cordierite-biotite schist and hornfels. The Coast Plutonic Complex is composed of 100-55 million year old Ruby Range granodiorite, hornblende diorite, and Coffee Creek granite and quartz monzonite.

The Omineca Belt is underlain by rocks of the Yukon-Tanana Terrane. In this map area the Yukon-Tanana Terrane is dominated by the pre-550 million year old Nisling Terrane biotite schist, micaceous quartzite, amphibolite and marble; and 400-320 million year old Nasina Assemblage graphitic quartzite, phyllite, marble and amphibolite with associated granodiorite orthogneiss.

The Intermontane Belt covers only the extreme eastern part of the map area. This is underlain by Stikine Terrane which includes 230-200 million year old Lewes River Group massive green basalt, tuff-breccia and associated sedimentary rocks; 200-160 million year old Laberge Group sandstone, conglomerate and shale; and 100-60 million year old Tantalus Formation chert-pebble conglomerate, sandstone and shale.

Yukon-Tanana and Stikine Terrane rocks are separated by vast exposures of approximately 185 million year old hornblende granodiorite, quartz diorite, pink quartz monzonite and porphyritic quartz monzonite of the Klotassin Suite. There are also several exposures of 70 million year old Carmacks Group basalt, flow breccia, intermediate tuff and tuff breccia (Mount Nansen Group in Tempelman-Kluit, 1974). The southwestern part of the map area also hosts several 55 million year old Nisling Range alaskite plutons, their associated north-trending feldspar porphyry dike swarms, and coeval Skukum Group felsic, vitric crystal tuff, lapilli tuff and welded tuff.

Mineral Deposits and Occurrences

Yukon Minfile lists 61 mineral occurrences in the Aishihik Lake map area of which 27 contain mineralization. Most of the mineral occurrences are copper-skarn, porphyry or veins. The most notable deposits are the copper skarns in the Hopkins Lake area, and the numerous gold-arsenopyrite veins in Kluane Schist in the southwest part of the map area. Coal occurs in Tantalus Formation clastic strata in the Vowel and Division Mountain area. The largest of these deposits is at Division Mountain where drill indicated undiluted mineable reserves total 31.7 million tonnes of high bolatile bituminous “B” coal.

SURFICIAL GEOLOGY

Information on the Quaternary geology of this area is provided by a 1990 report and a set of four maps at 1:100,000 scale by Hughes (1989a, b, c, d and 1990). Most of the Aishihik map sheet except for the northeast corner was included in the terrain hazards mapping by Thurber (1989).

The Aishihik map area can be subdivided into three main sections: 1) the Klondike Plateau (north of the Nisling River and west of the Nordenskiold River Valley); 2) the east third of the map (the Nordenskiold River Valley); and 3) the Kluane Plateau (south of the Nisling River and west of the Nordenskiold River Valley).

The Klondike Plateau was unglaciated during the Quaternary except for a few cirque glaciers located on some of the higher peaks. The plateau now consists of erosional surfaces incised by narrow valleys. At high elevations, exposed bedrock forms steep slopes. Lower slopes are mostly covered by colluviated or weathered bedrock. This mixture of material can range from coarse bouldery blockfields to a gravelly diamicton with fine-grained matrix. Permafrost which is common above treeline is indicated by sorted polygons, small solifluction lobes, and felsenmeer.

The Nordenskiold River valley was covered by the Cassiar lobe of the Cordilleran (McConnell) ice sheet. This ice was flowing northwesterly regionally. The ice margins locally resembled digits or tongues of ice controlled by the rugged topography. This area is now mainly covered by moraines ranging in thickness from 1 to 10 m. The Nordenskiold River floodplain consists of fine-grained silt and sandy sediments, and is commonly flanked by benches or terraces composed of gravelly glaciofluvial deposits capped by sand and silty sand.

The Kluane Plateau was glaciated by ice originating from the Coast and St. Elias Mountains. A complex network of ice tongues invaded the valleys, often coalescing with cirque and ice cap glaciers occupying the higher elevations, and to the east with Cassiar lobe ice. Landforms associated with the McConnell ice are well defined and consist of moraine ridges, ice contact deposits, and meltwater channels. Ice elevation averaged 1585 m. Maximum ice thickness was 1065 km and average ice thickness was approximately 710 m. Moraine deposits are common, and consist mainly of gravelly diamicton with a silty to sandy matrix with a low clay content, and a clast content of 20% to 40%. Solifluction lobes, frost shattered rocks, and sorted polygons are common on moraine and colluvium covered slopes. Glaciofluvial deposits are associated with the ice retreat in most valleys. These gravelly sands are well drained and provide stable surfaces, as they are usually free of ice-rich permafrost.

The intricate system of glaciers had a marked impact on the drainage in the area blocking and diverting the local streams. For example, the Aishihik lowland used to drain towards the north via the Nisling, White and Yukon Rivers, and now drains south and westwards via the Aishihik, Dezadeash and Alsek Rivers. The formation of glacially dammed lakes also resulted from drainage blockage. Lake Sekulmun-Aishihik, the largest glacial lake in the area, formed during the retreat of McConnell ice. The highest elevation of shoreline related to this lake is believed to be located at 1130 m which is 216 m above present lake-level. Well sorted silt and clay deposits of this lake are found at the north shore of present-day Aishihik lake and in the West Aishihik River valley. Drilling of the glaciolacustrine sediments at the north end of the Aishihik Lake confirmed the presence of thick ice-rich permafrost in such deposits.

The Reid advance is not well documented in this map area. It is believed that the northern limit of the Reid ice is located a few kilometres beyond to McConnell ice limits. The Reid ice was probably thicker and would have, in general, similar flow patterns than McConnell ice. Glacial lakes were likely associated with these glaciers as well, but they have not been documented. Signs of pre-Reid ice are not reported in this area. Hughes (1990) assumes that the limits of the older glaciations would be more extensive than that of the Reid, based on observations in adjoining map areas but to date there is no evidence of older glaciations in the area.

Cryoplanation terraces are common in the northwestern part of the map area on the high ridges developed on volcanic rocks (Carmacks Group) and on biotite schist and feldspar porphyry. In the southern part of the map area, they are found at high elevations on Skukum Group volcanic rocks and Ruby Range granodiorite.

TERRAIN HAZARDS

Terrain hazards information is derived from surficial geology report and maps (Hughes, 1990), and from terrain hazard maps (Thurber, 1989) which cover most of the map area.

Seismicity

There are eight recorded seismic events within the map area. All of the recorded events are 3.0 to 3.999 or less in magnitude.

Mass Movement Processes

Avalanches, gullying and rapid mass movements such as rockfalls are possible hazards on bedrock slopes slopes with a thin veneer of colluvium. Mudflows are associated with the lower slopes of colluvial fans, particularly after high rainfall.

Permafrost related mass movements such as detachment slides, creep and solifluction are possible, particularly on north facing slopes and at high elevations. Ice-rich deposits undercut by stream or wave erosion are actively slumping. The crests of such slopes show deep lobate cracks several metres behind the cliff face and should not be disturbed.

Permafrost

Permafrost is discontinuous but widespread in this area. Ice-rich permafrost is common in fine-grained alluvial deposits, fine-grained fan toe deposits and glaciolacustrine deposits. Permafrost with up to 40% volume of ice is common in well-sorted silt and clays along the West Aishihik River valley and along the north shore of Aishihik lake. The glaciolacustrine deposits north of Aishihik Lake contain up to 20 m of ice-rich permafrost. The areas located immediately above these slumping cliffs are often fractured and should not be disturbed.

The alluvial deposits between Sekulmun and Aishihik Lake consist of silty and fine sand, and contain 10 to 15 m of ice-bonded sediments, 2 to 3 m below the surface. Several of the thermokarst ponds in that landform are actively slumping.

Thick organic deposits commonly cover floodplain deposits which are in many cases underlain by permafrost. Large portions of lower terraces of the Nisling, west Aishihik and Jarvis Rivers are composed of such organic and ice rich sediments. Surface disturbances can accelerate or trigger permafrost thawing. Thermokarst subsidence, slumping, surface creep, mudslides and poor drainage may follow for several years.

Permafrost is also common at high elevations on north facing slopes and at high elevations in the morainal and colluvial deposits. Solifluction lobes, sorted polygons and frost heaving are often indicators of permafrost at shallow depth. Ice-content is expected to be low to nil in well drained coarse fluvial and glaciofluvial deposits. There is no permafrost under large water bodies, such as lakes and river.

Flooding and Other Risks

Most of the central and southwest portions of the map area are part of the Aishihik Basin. The eastern portion of the St. Elias Mountains and the northwestern part of the Coast Mountains are drained to the south by the Alsek River which crosses the extreme northwest corner of British Columbia and a portion of Alaska to enter the Gulf of Alaska. The streams draining through the Alsek River are characterized by peak flow in spring due to snow melt and glacial melting, and again in late summer due to snow melt at high elevations.

The Nordenskiold and Nisling rivers are part of the Yukon River watershed and drain to the northwest. Ice jams and peak flow usually take place during late spring to early summer.

References

Aishihik Lake Map Area
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To be thorough, check the references for adjacent N.T.S. map sheets and the General Reference List (See Introduction and User's 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.

Ballantyne, S.B. and Harris, D.C., 1991, An investigation of platinum-bearing alluvium from Florence Creek, Yukon. ***In:*** Current Research, Part A, Paper 91-1A, Geological Survey of Canada, p. 119-129.

Beaton, A.P., Cameron, A.R., and Goodarzi, F., 1992, Petrography, geochemistry and utilization potential of the Division Mountain coal occurrence, Yukon Territory. ***In:*** Current Research, Part E, Paper 92-1E, Geological Survey of Canada, p. 23-32.

Cockfield, W.E., 1927, Aishihik Lake District, Yukon. Geological Survey of Canada, Summary Report, 1926, p. 1-13. Reprinted in Bostock, H.S., 1957, Selected field reports of the Geological Survey of Canada, 1898-1933. Geological Survey of Canada, Memoir 284, p. 558-569.

Gabrielse, H., Tempelman-Kluit, D.J., Blusson, S.L. and Campbell, R.B. (comp.), 1980, MacMillan river, Yukon - District of MacKenzie - Alaska (Sheet 105, 115). Geological Survey of Canada, Map 1398A (one 1:1,000,000 map)
NTS 105, 115

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

Geological Survey of Canada, 1985, Regional stream sediment and water geochemical reconnaissance data, Yukon (NTS 115H). Geological Survey of Canada, Open File 1219.

Gordey, S.L., 1973, Petrology and structural relations of volcanic and basement rocks on the west side of Aishihik Lake Yukon Territory. Unpublished B.Sc. thesis, University of British Columbia, 69 p.

Hughes, O.L., 1967, Surficial geology studies, Aishihik lake map-area. Geological Survey of Canada, Paper 67-1A, p. 48-49.

Hughes, O.L., 1989a, Surficial geology, Little Buffalo Lake, Yukon Territory. Geological Survey of Canada, Map 23-1987, scale 1:100,000.

Hughes, O.L., 1989b, Surficial geology, Long Lake, Yukon Territory. Geological Survey of Canada, Map 20-1987, scale 1:100,000.

Hughes, O.L., 1989c, Surficial geology, Stevens Lake, Yukon Territory. Geological Survey of Canada, Map 22-1987, scale 1:100,000.

Hughes, O.L., 1989d, Surficial geology, West Aishihik River, Yukon Territory. Geological Survey of Canada, Map 21-1987, scale 100,000.

Hughes, O.L., 1990, Surficial geology and geomorphology, Aishihik Lake, Yukon Territory. Geological Survey of Canada, Paper 87-29, 23 p.

Horner, R., 1988, Seismicity in the Glacier Bay Region of Southeast Alaska and adjacent areas of British Columbia. In: Milner, A.M. and Wood, J.D., Jr., (eds.), Proceedings of the Second Glacier Bay Science Symposium;; United States Department of the Interior, National Park Service, Anchorage, Alaska, p. 6-11.

Indian and Northern Affairs Canada, 1993, Yukon Minfile 115H. Exploration and Geological Services Division, Indian and Northern Affairs Canada.

Jackson, L.E., Jr. and MacKay, T.D., 1990, Glacial limits and ice-flow directions of the last Cordilleran ice sheet in Yukon Territory between 60 and 63 degrees north. Geological Survey of Canada, Open File 2329. ***NTS 95D, 105A, 105B, 105C, 105D, 115A, 115E, 115F, 115G, 115H, 115I, 115J, 106K, 106L, 115G, 115H***

Johnston, S.T., 1988, The tectonic setting of the Aishihik Batholith, SW Yukon. ***In:*** Yukon Geology, Vol. 2; Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 37-41.

Johnston, S.T., 1993, Geologic evolution of Nisling assemblage and Stikine terrane in the Aishihik Lake area, southwest Yukon. Unpublished Ph.D. thesis, University of Alberta, Edmonton, Alberta, 336 p.

Johnston, S.T., Hart, C.J.R., Mihalynuk, J.G., Brew, D.A. and Ford, A.B., 1993, The Northern Intermontane Superterrane; Field guide to accompany the 1993 Geological Association of Canada, NUNA conference, Canada-Yukon Geoscience Office, 68 p.

Johnston, S.T. and Timmerman, J., 1994, Geological Map of the Aishihik Lake map area, southwest Yukon (115H/6). Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Canada/Yukon Economic Development Agreement, Geoscience Open File 1994-1 (G), (scale 1:50,000).

Johnston, S.T. and Timmerman, J., 1994, Geological map of Hopkins Lake area (115H/7). Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Canada/Yukon Economic Development Agreement, Geoscience Open File 1994-2 (G), (scale 1:50,000).

Johnston, S.T. and Timmerman, J.R, 1994, Geological map of the Aishihik Lake and Hopkins Lake areas (115 H6/7), southwest Yukon. ***In:*** Yukon Exploration and Geology, 1993. Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 93-110.

Morin, J.A., 1981, Geology and Mineralization of the Hopkins lake area, 115 H 2,3,6,7. ***In:*** Geology and Exploration 1979-80, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 98-104.

Price, L.W., 1973, Rates of mass wasting in the Ruby Range, Yukon Territory. National Academy of Science Conference on Permafrost, Yakutsk, Siberia, Printing and Publishing Office, Washington, D.C.

Rampton, V.N., 1981, Surficial materials and landforms of Kluane National Park, Yukon Territory. Geological Survey of Canada, Paper 79-24.
NTS 115F/G, 115H, 115A

Rostad, H.P.W., Kozak, L.M., and Acton, D.F. 1977, Soil survey and Land Evaluation of the Yukon Territory. Department of Indian Affairs and Northern Development, Northern Environmental and Renewable Resources Branch, Land Management Division, Whitehorse, Yukon.

The mylars for these maps are stored at the Exploration and Geological Services drafting department. Blue line copies are located in the G.P.I. files.

Subsoil texture, Carmacks area, Sheet 4, Yukon Territory. Soil and Soil Suitability Information Series, Agriculture Canada, Yukon, Indian and Northern Affairs, Canada, 1:125,000 map.
NTS 115I, 115H, 105E, 105L

Soil drainage and permafrost, Carmacks area, Sheet 4, Yukon Territory. Soil and Soil Suitability Information Series, Agriculture Canada, Yukon, Indian and Northern Affairs, Canada, 1:125,000 map.
NTS 115I, 115H, 105E, 105L

Surface texture, Carmacks area, Sheet 4, Yukon Territory. Soil and Soil Suitability Information Series, Agriculture Canada, Yukon, Indian and Northern Affairs, Canada, 1:125,000 map.
NTS 115I, 115H, 105E, 105L

Topography and genetic material, Carmacks area, Sheet 4, Yukon Territory. Soil and Soil Suitability Information Series, Agriculture Canada, Yukon, Indian and Northern Affairs, Canada, 1:125,000 map.
NTS 115I, 115H, 105E, 105L

Subsoil texture, Takhini-Dezadeash area, Sheet 7, Yukon Territory. Soil and Soil Suitability Information Series, Agriculture Canada, Yukon, Indian and Northern Affairs, Canada, scale 1:125,000).
NTS 115A, 105D, 115H

Soil drainage and permafrost, Takhini-Dezadeash area, Sheet 7, Yukon Territory. Soil and Soil Suitability Information Series, Agriculture Canada, Yukon, Indian and Northern Affairs, Canada, (scale 1:125,000).
NTS 115A, 105D, 115H

Subsoil texture, Takhini-Dezadeash area, Sheet 7, Yukon Territory. Soil and Soil Suitability Information Series, Agriculture Canada, Yukon, Indian and Northern Affairs, Canada, (scale 1:125,000).
NTS 115A, 105D, 115H

Topography and genetic material, Takhini-Dezadeash area, Sheet 7, Yukon Territory. Soil and Soil Suitability Information Series, Agriculture Canada, Yukon, Indian and Northern Affairs, Canada, (scale 1:125,000).
NTS 115A, 105D, 115H

Tempelman-Kluit, D.J., 1974, Reconnaissance geology of Aishihik Lake, Snag and part of Stewart River map-areas, west-central Yukon. Geological Survey of Canada, Paper 73-14, 93 p.

Tempelman-Kluit, D.J., 1974, Geology of Aishihik Lake. Geological Survey of Canada, Map 17-1973, scale 1:250,000.

Tempelman-Kluit, D.J., 1980, Evolution of physiography and drainage in southern Yukon. Canadian Journal of Earth Sciences, Vol. 17, p. 1189-1203.

Tempelman-Kluit, D.J. and Currie, R., 1978, Reconnaissance rock geochemistry of Aishihik Lake, Snag and Stewart River map-areas in the Yukon Crystalline Terrane. Geological Survey of Canada, Paper 77-8, 72 p.
NTS 115H, 115I, 115N/O

Thurber Consultants Ltd., 1989, Kluane Terrain Hazard mapping study. Yukon Land Use Planning, Whitehorse, Indian and Northern Affairs Canada.

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.