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NATMAP
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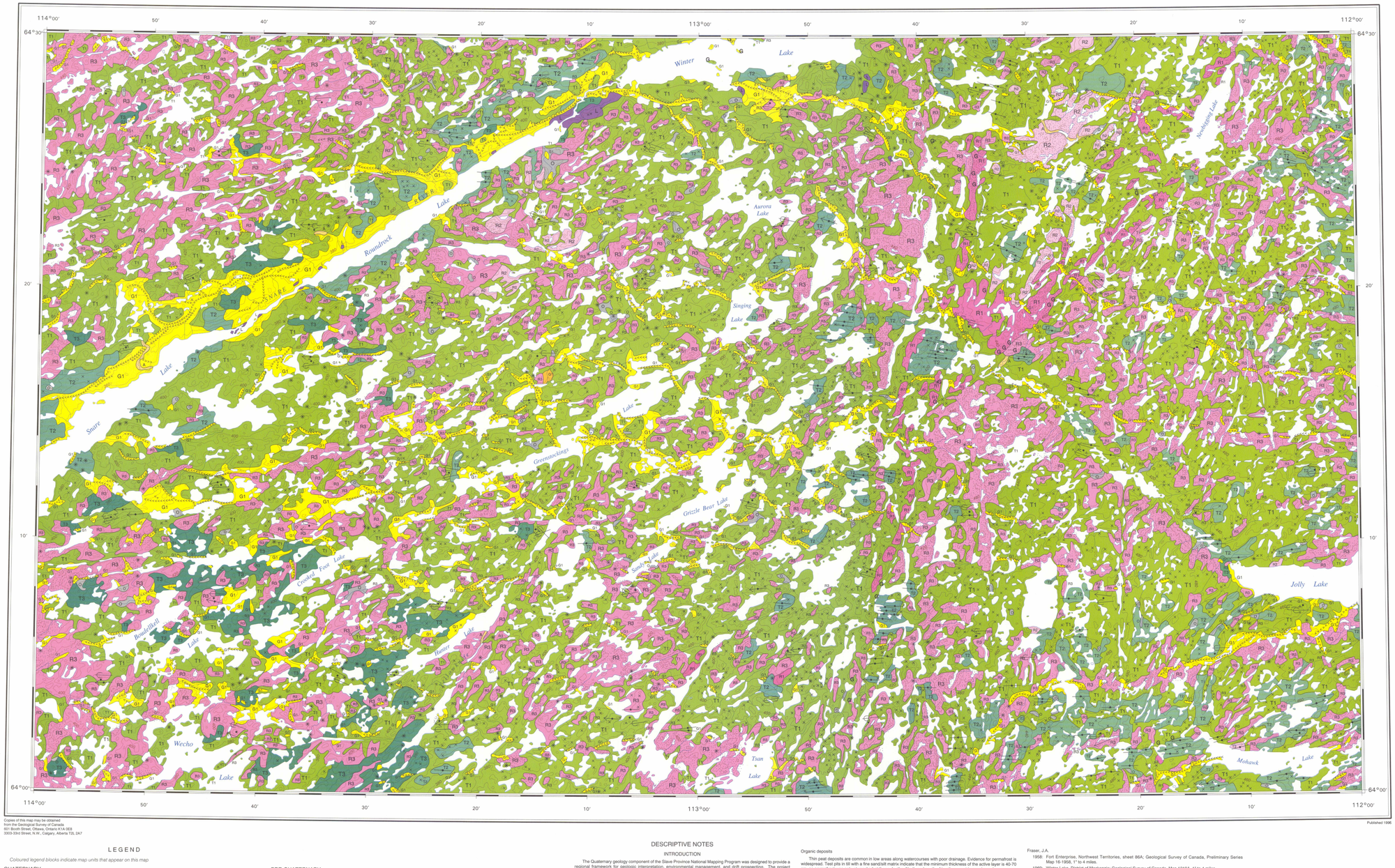
Le Programme national de cartographie géoscientifique du Canada



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Published 1996

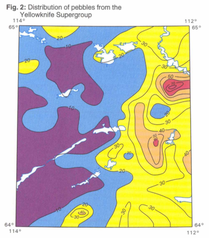
Fig. 1: Bedrock geology

LEGEND

YELLOWKNIFE SUPERGROUP

- *Metavolcanics*
- *Metasediments (greywacke, conglomerate) and metamorphic equivalents*
- *Undifferentiated granitoids and gneiss complexes*

Fig. 2: Distribution of pebbles from the Yellowknife Supergroup

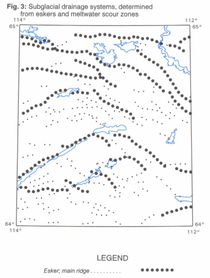


LEGEND

% Yellowknife Supergroup clasts in till

- < 10
- 10 - 20
- 20 - 40
- 40 - 60
- > 60

Fig. 3: Subglacial drainage systems, determined from eskers and meltwater scour zones



LEGEND

- Stagnant ice
- Glacial lake
- *Esker* . . . . . .
- *Ice lobe margin* . . . . . .
- *Ice flow* . . . . . .
- *Lake inflow (meltwater)* . . . . . .
- *Esker; main ridge* . . . . . .
- *Esker* . . . . . .

Fig. 4a: Glacial events

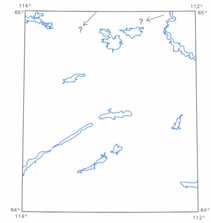


Fig. 4b

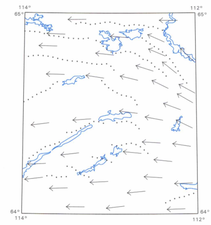
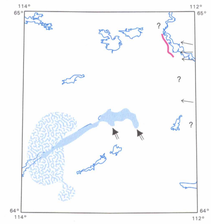


Fig. 4c



LEGEND

QUATERNARY
HOLOCENE

NONGLACIAL ENVIRONMENT

O — *ORGANIC DEPOSITS: peat and muck up to 2 m thick; formed predominantly by the accumulation of vegetative material in bogs; occurs in depressions and along valley bottoms; permafrost is commonly present; contains small palsas, ice-wedge polygons, and thermokarst collapse structures. Small unmapped organic deposits occur in most terrain units*

A — *ALLUVIAL DEPOSITS: gravel to silt size sediment deposited by modern streams and rivers; deposits generally are stratified and moderately sorted; 1 to 5 m thick; occurs as floodplains, in places covered by icings*

PLEISTOCENE (WISCONSIN GLACIATION)

GLACIAL ENVIRONMENT

L — *GLACIOLACUSTRINE DEPOSITS: silt and sand; cross-stratified to planar bedded; 1 to 8 m thick; deposited into temporary glacier-dammed lakes and ponds*

G2 — *GLACIOFLUVIAL DEPOSITS: sand, gravel, and minor silt more than 1 m thick; sorting ranges from good to poor, and stratification from massive or cross-stratified to planar bedded; deposited by water flowing from; or in contact with, glacier ice*

Outwash: rounded gravel and sand; massive to cross-stratified; probably less than 5 m thick; occurs as braided fans

G1 — *Esker sediments: sand, silt, and gravel; in planar, cross-stratified, and massive beds; 1 to 40 m thick; forms ridges with both sharp-crested and flat-topped segments, mounds, and flanking aprons; deposited at or behind the ice margin; formed subglacially or in subaerially exposed ice-walled channels. Zones of washed rock, small transverse gravel ridges associated with this unit, isolated kame deposits, and circular rim ridges are shown by symbols*

TILL DEPOSITS: unsorted glacial debris (diamicton), consisting of a silty sand matrix containing pebbles, cobbles, and boulders, with minor lenses of sorted sediments; deposited beneath, or along the margin of, glaciers as lodgement till, meltout till, and gravity flow deposits

T3 — *Hummocky till: from 5 to 30 m thick; forms irregular to rolling terrain with relief up to 15 m; some areas have abundant small meltwater channels and lag concentrations of boulders in depressions*

T2 — *Till blanket: from 2 to 10 m thick; occurs as till plains mimicking bedrock topography or as drumlinoids. Small rock outcrops in this unit are shown by symbols*

T1 — *Till veneer: less than 2 m thick; rock structure is generally visible on airphotos; unit includes patches of bedrock and till blanket*

PRE-QUATERNARY

BEDROCK: Precambrian granitic, gneissic, metasedimentary and metavolcanic rocks, mafic dykes and minor, younger (Tertiary?) kimberlite; may include patches of till veneer or glaciofluvial deposits; areas of shattered and frost-heaved rock, particularly on metasediments, are designated by symbols

R3 — *Granitoid rocks*

R2 — *Metasedimentary rocks*

R1 — *Volcanic rocks*

Geological boundary

Frost heaved and shattered rock

Raised beach

Lag concentration of glacially abraded boulders

Area of meltwater scour

Subglacial or proglacial meltwater channel

Esker (direction of flow known, unknown)

Kames and gravelly transverse ridges

Drumlinoid till form

Rock crag-and-till tail form

Roche moutonne or whaleback

Striation (ice flow direction known, unknown; 1 = oldest)

Striation, poorly defined (ice flow direction known, unknown)

Gossan — G

Small rock outcrop

Sample site

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DESCRIPTIVE NOTES

INTRODUCTION

The Quaternary geology component of the Slave Province National Mapping Program was designed to provide a regional framework for geologic interpretation, environmental management, and drift prospecting. The project involved helicopter-assisted ground work including terrain mapping, till sampling, and measurement of ice flow indicators. Field traverses and airphoto interpretation provided information on the nature and distribution of surficial sediments shown on the map. About 118 till samples (2 kg) were collected in this map area for textural analysis and trace element geochemistry (Kerr et al., 1994); 49 additional 10 kg samples were collected for heavy mineral and kimberlite indicator analyses. A total of 118 pebble samples were also collected to assess ice flow styles and glacial transport distances. Maps were constructed using 1:60 000 scale airphotos, and recompiled onto a 1:125 000 base. This is the first surficial geology map produced for the area, and complements other Quaternary geology maps to the northwest (St-Onge, 1988), to the south (Kerr, 1990), and to the east (Ward et al., in press; Dredge et al., 1994, in press).

PHYSIOGRAPHY AND DRAINAGE

The Winter Lake map area lies in the central District of Mackenzie, on the watershed of three major drainage systems. The first flows northwest via the Coppermine River; the second flows southeast via Winter River to Winter Lake and northwest via River to Winter Lake, then southwest via Snare Lake. The third drainage system flows south via Yellowknife River. Numerous small lakes occupy glacially scoured bedrock basins, as well as isolated depressions in till plains. Most drainage ways are shallow; few streams and rivers have cut into bedrock or surficial sediments, with the exception of Snare River along which modest (2 to 4 m) river bank sections occur. Elevations range between 350 m and 500 m. Local relief is variable, commonly between <10 m and 30 m in areas of outcrop and till cover, although relief >40 m is prevalent in rugged rocky areas in the southwest. The southwestern quadrant of the map area lies south of treeline. Regions north of this limit support sparse clumps of stunted spruce, birch, low shrubs, alder, and tundra heath vegetation.

BEDROCK

The area lies within the central Slave Province of the Canadian Shield (McGlynn and Henderson, 1972; Padgham and Atkinson, 1991). Early attempts to describe bedrock, as well as to drumlins and eskers were made by Fry (1938) and Carrott (1939). Fraser (1958, 1969) mapped the bedrock and made general observations on striations, eskers and raised beaches. Hrabi et al., (1993, 1994) and Thompson et al. (1993, 1994) have mapped parts of the Winter Lake map area in more detail. The rocks consist primarily of Archean, subaquatically deposited (pillow) volcanics and related fine-grained sediments belonging to the Yellowknife Supergroup. Sedimentary rocks are also present and have been folded, faulted, and metamorphosed to various degrees into phyllite, schist, gneiss, and migmatite. The metasediments were later intruded by granites which are the dominant rock type in the area. Sulphide mineralization has occurred along faults near sediment/volcanic contacts. Dyke swarms trending northeast, north and northwest occur throughout the area.

Most rock outcrops show signs of glacial abrasion, faceting and streamlining, but surfaces tend to be weathered or lichen covered. Glacial polish and striations are best preserved on small granite pegmatite bodies which are prevalent across the map area. All rock types have been subjected to postglacial frost shattering. Scattered frost-heaved blocks occur above the level of surrounding bedrock surfaces.

SURFICIAL SEDIMENTS

Till deposits

Till is the most extensive sediment in the area. Only one stratigraphic unit of till has been recognized and is attributed to the Wisconsinan glaciation. This till consists of a matrix-supported diamicton, with the matrix ranging from silty sand to sand. The clast content varies from 5 to 40% of the total volume of material but is generally about 25%. Matrix size varies according to bedrock source, and the amount of meltwater associated with its deposition. Till derived from granitoid rocks has a sandy matrix, whereas that derived from the Yellowknife Supergroup is siltier. Where glacial meltwater was associated with ablation till deposition, the matrix is commonly medium to coarse sand.

The till sheet has been divided into 3 units based on thickness and surface morphology: veneer, blanket, and hummocky. Till veneers are generally loose in texture and their surfaces are characterized by high concentrations of cobbles and boulders of local provenance. Bedrock structure is usually visible on airphotos. Till blankets either drape the underlying bedrock, forming gently undulating till plains, or contain low-relief drumlinoid features, as are found between Winter Lake and Lake Providence. Till in blankets is relatively compact and contains fewer boulders than veneers. Hummocky till is associated with surface ablation and ice stagnation, is 5-30 m thick and forms irregular topography with relief up to 15 m. It has a loose, bouldery texture and a washed appearance and is commonly associated with kames. Till veneers and blankets are pervasive throughout the area. Hummocky deposits are more restricted in nature and occur only in isolated localities south of Snare and Roundrock lakes and west of Lake Providence. Meltwater has variably affected all three map units. Lag concentrations of abraded boulders are common in low areas of commodoy terrain, and are present as ablation features on other till surfaces as well.

Glaciofluvial deposits

Glaciofluvial sediments are widespread but limited in extent. They are dominantly in the form of eskers and related kames, and to a lesser degree, of outwash fans. An extensive dendritic network of small eskers feeds into three large eskers that trend west-northwest across the northern half of the map area. In the southern half, eskers consist of relatively short, more isolated segments, although a major glaciofluvial system is found along the Snare Lake-Roundrock Lake valley. Eskers range from small sinuous ridges to the large, more linear features up to 25-35 m high and 45 km in length. Ridges vary from sandy and flat-topped, to bouldery and sharp-crested. Sediments exposed in the rare sections are dominantly poorly sorted. Abrupt changes in surface sediment from fine sand to bouldery gravel are common. Exposures of washed, bare rock up to 1 km wide commonly flank large eskers and connect ridge segments. Associated with the esker systems, either adjacent to or on the washed zones, are small kame features whose surfaces are strewn with abundant boulders. Their morphology ranges from streamlined forms parallel to meltwater flow, through slightly elongated forms perpendicular to flow, to irregular shapes.

Glaciolacustrine deposits

Evidence for short-lived, isolated proglacial lakes occurs throughout the map area in the form of raised beaches. The latter are well developed on the flanks of eskers which are associated today with small, unnamed kettle lakes. Along the Snare Lake-Roundrock Lake-Winter Lake valley, isolated deposits of rhythmically bedded silt and clay sediments, up to 5 m thick, attest to a relatively long lived, ice-dammed glacial lake. Glaciolacustrine rhythmites were seen to overlie fine-grained subaqueous outwash in one locality. The elevations of these sediments and raised beaches north and south of Winter Lake suggest the ancestral Winter Lake was up to 35 m higher than its present level.

Organic deposits

Thin peat deposits are common in low areas along watercourses with poor drainage. Evidence for permafrost is widespread. Test pits in till with a fine sand/silt matrix indicate that the minimum thickness of the active layer is 40-70 cm, as permafrost was not yet reached at these depths. North and south of treeline, most ice wedge polygons occur within the organic and glaciofluvial units. Nonsorted circles (mud boils) and sorted circles are best developed in till.

GLACIAL HISTORY

The area lies within the central part of the Keewatin sector of the Laurentide Ice Sheet (Dyke and Prest, 1987; Dyke and Dredge, 1989). The Winter Lake map area lies west of the M'Clintock Ice Divide, which was prominent during the Late Wisconsinan maximum (18 000 - 13 000 years BP). After 13 000 BP, the ice divide shifted eastward into the District of Keewatin, and Laurentide ice disappeared from there about 7000 years ago. At its maximum, the northern margin of the Keewatin ice sheet extended north of the Arctic coast and as far west as the Mackenzie Valley. Radiocarbon dates on marine shells, beyond the boundaries of this map area to the north, suggest that ice still covered the area about 10 000 BP but that the ice margin lay 150-200 km east of Winter Lake by 9000 BP.

Ice flow indicators

Some aspects of the glacial history and assessment of glacial transport of material can be determined from the relative age and strength of striations. Although many rock outcrops are lichen-covered or have rough, weathered surfaces, most granitic outcrops, prevalent throughout the map area, have maintained their glacial polish and striations on bare outcrop or under a thin veneer of till. Striations on other rock types were found on larger, individual mineral crystal faces, and on fresh bedrock surfaces exposed by removing the protective till veneer. The majority of outcrops show only one distinct set of striae. However, at a few sites, more than one ice flow direction was observed. In some cases, age relationships could be determined directly by examining sets of cross-cutting striae. Unfortunately, in most cases, the cross-cutting relationship was ambiguous. The striation data indicate a dominant westward to northwestward flow. Striae that trend southwest to the north of Big Lake may represent an earlier flow, which is widespread in the adjacent map area to the east (Ward et al., 1994, in press; Dredge et al., 1994, in press). However, this older southwest flow was not detected in most of the Winter Lake map area. Similarly, a final westward flow cross-cuts a major northwest flow to the west and south of Lake Providence. All these striations likely represent the same glaciation because the surfaces they were found on are all relatively unweathered.

Streamlined bedrock forms are common throughout the map area and coincide with the main striations. A prominent swarm of roches moutonnées and drumlins cuts the granitic rocks northeast of Tsan Lake and east of Whitewolf Lake, indicating a strong westward ice flow. A major drumlin field, indicating a northwestward ice flow between Winter Lake and Lake Providence, gradually shifts westward south of Big Lake, paralleling the striation trend.

Ice flow directions can also be determined from the orientation of eskers, which commonly occur perpendicular to ice margins. The largest eskers have major ridge segments generally trending northwestward in the central map area. North of Stanvation and Big lakes, they have west trending segments, which may reflect the last major ice flow direction in this region.

Pebble transport and distribution reflect the dominant ice flow patterns recorded by striae. Metavolcanic and metasediment clasts in till generally attain their highest concentration (up to 80%) where they overlie these bedrock types. Abundance decreases to 10-20% over a distance of up to 40 km in the down-ice direction. In two locations, poorly developed, west trending linear dispersal trains originate from the larger outcrops of the eastern map area. They range from 10 km to 20 km in width and 30 km to 40 km in length.

Glacial events

Striations to the east of the map area record an early ice flow towards the southwest. This ice flow was interpreted by Dredge et al. (in press) as relating to the build-up phase of the last glaciation. It is unclear if an equivalent flow crossed the Winter Lake area, as only one site, in the north-central map area, indicates a similar cross-cutting relationship. Cross-cutting striations, streamlined rock forms and drumlins indicate a later flow toward the northwest in the central regions, progressively shifting to the west in the northern areas. This flow is tentatively placed during the period from the Late Wisconsinan glacial maximum through to the recession.

In the southern regions, striations and fluted landforms record a flow to the west with minor deviations to the west-southwest. In many areas, glaciofluvial deposits appear to follow valleys and ridges, suggesting that flow was in part topographically controlled. Major eskers and related tributary segments are associated with this period. The washed rock zones extending as much as 1 km beyond the flanks of the eskers probably resulted from meltwater scour during periods when high water volumes or high hydraulic pressure caused sheetflow of meltwater beyond the confines of subglacial tunnels. Some of these zones were subsequently modified by proglacial meltwaters during the final stages of ice retreat, as evidenced by rare outwash fans. The presence of silty clay rhythmites overlying fine-grained subaqueous outwash suggests that rhythmites must have been deposited in glacial lakes fed by meltwater. Isolated pockets of hummocky till along Snare River indicate that the natural southwest drainage was initially impeded by stagnant ice related to downwasting of part of the ice sheet, leading to the creation of these ice-dammed lakes. A restricted, late glacial flow towards the west and west-northwest is inferred from striation sequences west and south of Lake Providence. This shift in flow may be a response to ice recession and related to ice lobing reported farther east (Dredge et al., in press

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86 H	76 E	76 F
1890A (in press)		
86 A	76 D	76 C
North Half 1871A	1870A	1867A
South Half		
85 P	75 M	75 N

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Geology by D.E. Kerr, B.C. Ward, and L.A. Dredge, 1993 with assistance from M. Gingras, R. Paulen, and B. Pierna

Digital cartography by the Geological Survey of Canada

Contribution to the Slave Province NATMAP Project

Logistical support was provided by the Polar Continental Shelf Project

Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

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Mean magnetic declination 1995, 27°10′ E, decreasing 19.7′ annually. Readings vary from 26°10′ E in the SE corner to 28°05′ E in the NW corner of the map

Elevations in meters above mean sea level

LOCATION MAP

GEOLOGICAL SURVEY OF CANADA — COMMISSION GÉOLOGIQUE DU CANADA

MAP 1871A

SURFICIAL GEOLOGY

WINTER LAKE

(SOUTH HALF)

DISTRICT OF MACKENZIE

NORTHWEST TERRITORIES

Scale 1:125 000 · Échelle 1/125 000

Kilometres 2 0 2 4 6 8 10 Kilomètres

Universal Transverse Mercator Projection — Projection transverse universelle de Mercator

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1871A (S½)

Recommended citation:
Kerr, D.E., Ward, B.C., and Dredge, L.A.
1996: Surficial geology, Winter Lake, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Map 1871A, (South Half), scale 1:125 000

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