This map encompasses three physiographic regions: the De Pas batholith to the west, the glacially eroded composite terrane Core Zone rocks in the central portion, and Neoarchean intrusive suites along the eastern margin of the map (James et al., 2003). This map area experienced a complex ice-flow history during the last glaciation, driven by the development of the Laurentide Ice Sheet and migration of the Ancestral Labrador ice divide (Vincent, 1989; Rice et al. 2019a). Ice-flow indicators provide evidence for several ice-flow phases in the map area. The oldest ice-flow phase was to the northeast, associated with the buildup of the early Laurentide Ice Sheet in the Quebec highlands to the south (Veillette et al., 1999). The second flow phase was a radial flow to the east from an ice centre that occupied the western margin of the map area and was previously documented by Peterson (1965) and Clarhäll and Jansson (2003) in the Lac aux Goélands area (Fig. 1). During deglaciation, a large ice stream developed with the onset zone at the eastern edge of the De Pas Batholith that manifests as an abrupt change in surface geomorphology. This ice stream had a profound impact on the geomorphology of the southern part of the map area. Referred to as the Cabot Lake ice stream (Paulen et al., 2019: Rice et al., 2019b), it is an east-trending ice stream that provides evidence for rapid basal-flow acceleration in close proximity to an ice divide. The Cabot Lake ice stream occupies the lowland region near the headwaters of the George River and is bounded on its onset zone and terminus by large bedrock upland regions. Streamlined landforms dominate the geomorphology within the ice stream, many with elongation ratios of 12:1 or The Cabot Lake ice stream was relatively short-lived as a fourth phase of ice flow occurred following its shutdown,

characterized by sluggish and topographically controlled ice that flowed generally to the northeast. This fourth phase was also short-lived and of limited erosive power, as evidenced by the high degree of preservation of the ice stream landforms, with only minor, palimpsest forms north of Lac Résolution. During deglaciation, large east-trending eskers formed across the map in an orientation that differs from the late northeast trajectories of ice flow (Occhietti et al., 2004). As sluggish ice continued to ablate on the De Pas Batholith, ice-marginal north-south-trending meltwater channels formed, directing meltwaters either to glacial Lake Low to the south (Paulen et al., 2017) or glacial Lake Naskaupi to the north (Ives, 1960; Jansson, 2003).

# Acknowledgements

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# Suggested Readings

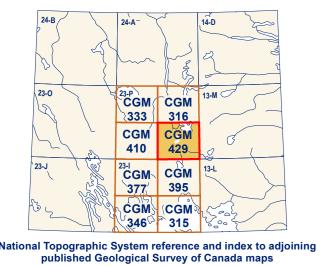
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The Lac aux Goélands area is of moderate relief La région cartographique de Lac aux Goélands characterized by till blankets in the lowlands and till veneers with large expanses of bedrock outcrops in the western and eastern margins. Bedrock was variably eroded by the Laurentide Ice Sheet, east of the Ancestral Labrador ice divide. Phases of ice flow imparted multiple sets of glacially streamlined landforms and erosional paleo-flow indicators on the landscape. However, the dominant eastward-trending, elongated streamlined landforms were formed by ice streaming during deglaciation. Multiple sets of discordant meltwater channels were formed from both an early phase of deglaciation, which fed into an eastward-trending esker network, and a subsequent late-phase ablation of the ice sheet, with north-south trending channels parallel to the retreating ice margin. Glaciolacustrine strandlines and littoral sediments within the upper George River basin mark the former northeastern extent of inundation of the earliest phase

présente un relief modéré et est caractérisée par la présence de nappes de till dans les basses terres et de placages de till avec de grandes étendues d'affleurements rocheux le long de ses marges ouest et est. Le substratum rocheux a été érodé à des degrés divers par l'Inlandsis laurentidien, à l'est de la protoligne de partage glaciaire du Labrador. Les phases d'écoulement glaciaire ont donné lieu à de multiples ensembles de formes de relief glaciaires et d'indicateurs de paléo-écoulements de nature érosive dans le paysage. Toutefois, les formes de relief profilées et allongées dominantes, dirigées vers l'est. ont été formées par des courants glaciaires lors de la déglaciation. De multiples ensembles de chenaux d'eau de fonte discordants ont été formés à la fois lors d'une phase précoce de déglaciation, avec des chenaux intégrés à un réseau d'eskers de direction est, et lors d'une phase tardive ultérieure d'ablation de la nappe glaciaire, avec des chenaux d'orientation nord-sud parallèles à la marge glaciaire en retrait. Les lignes de

la phase initiale du Lac glaciaire Naskaupi.



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Natural Resources Ressources naturelles
Canada Canada **CANADIAN GEOSCIENCE MAP 429** 

SURFICIAL GEOLOGY LAC AUX GOÉLANDS

NTS 23-P southeast

# rivage glaciolacustres et les sédiments littoraux dans le bassin supérieur de la rivière George marquent l'ancienne étendue nord-est de l'inondation associée à

40' 30' 20' 10' 86 88 90 92 94 96 98 400 02 04 06 08 10 12 14 16 18 20 22 24 26 28 30 32 434000 m E. A U X $G O \not E L A N D S$ geochronology, regional correlations, and the enigmatic orma domain; Current Research (2003), Newfoundland (preliminary), scale 1:100 000. https://doi.org/10.4095/300685 review, with new evidence from northern Quebec; Quaternary Science Reviews, v. 18, p. 993–1019. **CANADIAN GEOSCIENCE MAP 429 SURFICIAL GEOLOGY** Authors: R.C. Paulen, J.M. Rice, and M. Ross Base map at the scale of 1:50 000 from Natural Resources Canada, Scientific editing by A. Weatherston The Geological Survey of Canada welcomes corrections or additional with modifications information from users LAC AUX GOÉLANDS Elevations in metres above mean sea level Geology based on air-photo interpretation and fieldwork by R.C. Paulen Initiative of the Geological Survey of Canada, conducted under the (gscpublications-cgcpublications@nrcan-rncan.gc.ca).

# POST LAST GLACIATION

NON-GLACIAL ENVIRONMENT ORGANIC DEPOSITS: peat and muck, 1 to 2 m thick on average; formed by the accumulation of plant material in various stage of decomposition; occurs as

low-relief, wet terrain (swamps, bogs, and fens). Organic deposits: fen; derived from sedges and partially decayed shrubs in a eutrophic environment; commonly forms a ribbed pattern of small shrubs

transverse to drainage with ponds of open water. Organic deposits, undifferentiated: undifferentiated bog and fen deposits, the area may be locally mixed or underlain with alluvial sediments; often

associated with minor alluvial channels established for surface drainage. COLLUVIAL DEPOSITS: landslide deposits; silt, sand, diamicton, and rock fragments ranging from pebbles to large boulders; usually occur at the base of steep bedrock-controlled slopes; unspecified gravity deposits derived mainly from till and bedrock.

Colluvial veneer: gravity sediments, sand and reworked till with boulders (derived from till) or large rock fragments (derived from bedrock); <2 m thick, often draping the underlying till or bedrock morphology.

ALLUVIAL SEDIMENTS: undifferentiated deposits of sorted gravel, sand, silt, and organic detritus; commonly stratified, variable thickness; deposited by

Alluvial sediments, undifferentiated: gravel to silt and organic detritus, variable thickness.

> LACUSTRINE SEDIMENTS: cobble to pebble gravel, sand, silt, and minor organic detritus; >1 m thick, consisting of beach and storm deposits, ice-rafted debris, or formed during recent fluctuations in lake levels, deposited along the shorelines of larger lakes. Lacustrine beach sediments: fine sand to coarse cobble gravel and organic detritus; forming beach ridges up to 1 m high, sediments deposited adjacent

Lacustrine littoral and nearshore sediments: fine silty sand to sand and gravel, moderately sorted, not more than 1 m thick, exposed from regression of larger lakes during the Holocene; commonly produced by lacustrine winnowing of till deposits.

Lacustrine sediments, undifferentiated: gravel, sand, silt, and organic detritus; variable thickness.

## POSTGLACIAL OR LATE WISCONSIN PROGLACIAL AND GLACIAL ENVIRONMENTS

winnowing of till deposits.

subaerial environment.

GLACIOLACUSTRINE SEDIMENTS: coarse gravel, sand, silt, and minor clay; commonly massive to portly stratified: >1 m; derived from winnowing of till in relatively shallow water; formed during the earliest stages of glacial Lake

Ridged beach sediments: pebbly to coarse granular sand; moderate to well sorted, with stratification generally less than 2 m thick and open framework of clasts: deposited during glacial lake inundation limited to elevations of approximately 485 m and lower for glacial Lake Naskaupi. Littoral and nearshore sediments: sand and gravel, moderately sorted, not

GLACIOFLUVIAL SEDIMENTS: sand and gravel with minor silt and diamicton; well to poorly sorted, massive to stratified; deposited by glacial meltwater streams from, or in contact with, glacial ice in a subglacial, subaqueous or proglacial subaerial environment Outwash plain sediments: moderately to poorly sorted sand and gravel with isolated boulders, massive to crudely stratified; >2 m thick; forms a

more than 1 m thick, commonly produced by nearshore glaciolacustrine

bedrock topography and structure. Glaciofluvial terrace: well sorted, subrounded to rounded cobbly-pebbly gravel to fine sand; terraced sediments that were formed along former floodplain of glaciofluvial channels.

continuous cover, sometimes with braided bedforms, that masks underlying

Outwash fan sediments: fine sand to well rounded pebbly gravel, minor silt, moderately sorted; cross-stratified, with foreset bedding; sediments fine toward distal edge of fan; deposited at the terminus of subglacial and Hummocky sediments: cobble gravel and fine sand, with minor silt and

isolated boulders; massive to crudely stratified, moderate to poor sorting; commonly deposited in ice-contact environments, local relief of hummocks is 2 to 4 m, often associated with minor kame deposits. **Ice-contact sediments:** moderately to poorly sorted sand and gravel, massive to crudely stratified often occurring as small hummocks and ridges

ice, often associated with subglacial meltwater corridors and esker networks. Kame sediments: small conical or lobate hills (<5 m high) of very coarse, poorly sorted boulder glaciofluvial sediments; often will mark the beginning of a subglacial meltwater corridor (i.e., esker); deposited from meltwater flowing within the former ice sheet down to the substrate, as moulin kames. Esker sediments: linear to sinuous ridges of moderate to well sorted sand

and gravel, cross-stratified to massive; characterized by pronounced ridges with crested peaks, or flat topped and winnowed by proglacial lakes; associated deposits often flank each side; deposited as ice-contact sediments in larger subglacial meltwater corridors; can be associated with kame deposits, other ice-contact sediments, and outwash fan deposits with kettle depressions and lakes.

Glaciofluvial veneer: glacial meltwater sediments, gravels to fine sand with minor silt; cross-stratified to massive; <1 m thick, often draping the underlying till or bedrock morphology. Glaciofluvial sediments, undifferentiated: sand, gravel with minor silt; well

to poorly sorted, massive to stratified; deposited by glacial meltwater streams from, or in contact with, glacial ice in a subglacial, subaqueous, or proglacial

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GLACIAL SEDIMENTS: silty-sand to sandy diamicton; with striated and faceted clasts of various lithologies; clast content ranges from 15 to 25%;

thickness ranges from 1 to >4 m thick; till at lower elevations has been

exposed to varying degrees of washing and winnowing from meltwater channel

systems and glacial Lake Naskaupi; generally thicker in the lowland regions

and also as lee-side tails of streamlined glacial landforms; deposited directly by

Ridged till: bouldery, silty-sand diamicton of varying thickness, characterized

generally by subparallel low-relief ridges, often transverse to other regional

Streamlined till: silty-sand diamicton, deposited by active flowing ice,

drumlinoid features, and larger crag-and-tail forms, including mega-scale

**Till veneer:** bouldery, sandy diamicton; less than 1 m but up to 2 m thick

many small outcrops of bedrock; geomorphology commonly resembles the

underlying bedrock structure; local regions of frost-heaved bedrock and

Till blanket: silty-sand diamicton; >2 m thick; forms continuous cover that

masks underlying bedrock topography and structure; frost boils and

**Bedrock:** Core Zone bedrock, consisting of a composite Precambrian

lithotectonic terrane of undifferentiated Archean rocks and Paleoproterozoic

supracrustal rocks. The middle Paleoproterozoic De Pas Batholith outcrops

in the western margin of the map area; Neoarchean metatonalites, and

tonalitic and granitic gneisses of the Core Zone are located in the central

Winnowed sediments and localized thin (<1 m) sorted sediments of sand,

gravel, and cobble lag deposits; surface may exhibit meltwater channels or

portion of the area; Mesoarchean intrusive suites of granitic pegmatite, syenite, porphyritic granite, diatexite, and orthogneiss occur along the

locally; forms a discontinuous cover over bedrock and interspersed with

associated with larger oriented landforms; geomorphology includes

ice-flow indicators, as ribbed moraine.

glacial lineations created by ice streams.

boulders are frequent at higher elevations.

solifluction stripes are frequent.

eastern edge of the map sheet.

Geological boundary (confidence defined)

minor littoral features.

Meltwater channel: Minor, paleocurrent direction unknown

Minor, paleocurrent direction known

Minor moraine ridge

<><><>< > Direction unknown or unspecified

Esker ridge:

>>>>>>> Direction known or inferred

Direction known

Small outcrop

Till sample location

Drumlinoid ridge or fluting

Major, paleocurrent direction unknown

Major, paleocurrent direction known

Crossed, relative ages given (1 = oldest)

Station location (ground observation or stratigraphic section)

Beach crest

PRE-QUATERNARY

111

**Geological Survey of Canada Canadian Geoscience Maps** 

and J.M. Rice, 2014 to 2016. Geological compilation by R.C. Paulen, 2016 to 2018 Geology conforms to Surficial Data Model v. 2.3.14 (Deblonde et al., 2018). Geomatics by L. Robertson Cartography by M.J. Baldock

auspices of the GEM-2 Hudson-Ungava Core Zone Surficial activity as part of Natural Resources Canada's Geo-mapping for Energy and Minerals (GEM) program. ogistical support provided by the Polar Continental Shelf Program.

(PCSP) as part of its mandate to promote scientific research in the

Canadian north. PCSP 060-16

Map projection Universal Transverse Mercator, zone 20

North American Datum 1983

NTS 23-P southeast

1:100 000

Mean magnetic declination 2022, 20°33'W, decreasing 15.1' annually Readings vary from 20°21'W in the SW corner to 20°45'W in the NE

corner of the map. This map is not to be used for navigational purposes. Title photograph: On the bedrock uplands looking northeast to Lac aux Goélands, Quebec. Photograph by R.C. Paulen. NRCan photo 2019-254

Data may include additional observations not portrayed on this map. See map info document accompanying the downloaded data for more information about this publication. This publication is available for free download through

GEOSCAN (https://geoscan.nrcan.gc.ca/).

Figure 1. Detailed inset of the region between Lac aux Goélands and

Lac Raude, in the northeastern part of the surficial map, showing mapped glacial striae by both Clarhäll and Jansson (2003) and this

study (PTA stations in red), documenting an older northeast flow phase

figure are North American Datum 1927

followed by an easterly flow phase. Note that the UTM gridlines on this

Canada

**SURFICIAL GEOLOGY** LAC AUX GOÉLANDS

NTS 23-P southeast