DESCRIPTIVE NOTES

INTRODUCTION Ongoing geological exploration and related infrastructure development in central and northern Slave Geological dammed by stagnant blocks of ice. Eskers at lower elevations exhibiting no evidence of wave reworking may be initiated regional surficial geology mapping through the Slave Province National Mapping Program (NATMAP) to lake level was relatively stable for an unknown period of time, but long enough in duration for the formation of beaches provide fundamental regional data on surficial materials and till geochemistry. In 1994, Terrain Sciences Divisio undertook mapping of the south half of the Contwoyto Lake map area (NTS 76 E). As an extension to Slave NATMAP, of 475 m and 470 m. A well defined drainage channel at 465 m occurs to the southwest of Fry Inlet. The channel has surficial geology mapping continued in 1996 in the north half of the Contwoyto Lake map area, east and north of been cut through hummocky till down to bedrock; material eroded during drainage of the glacial lake and formation of recently mapped 1:250 000 sheets (Kerr et al., 1995, 1997a). The project involved helicopter-assisted ground work the channel was redeposited as a bouldery glaciofluvial fan at the southwest end of the channel. Evidence of lake including terrain mapping, till sampling, pebble provenance studies, measurement of ice flow indicators, and recording outlets also exists in the Kathawachaga Lake (NTS 76 L) and Mara River (NTS 76 K) map areas to the north. permafrost features. Field traverses and airphoto interpretation provided information on the nature and distribution of surficial materials shown on the map. Till samples (1 kg) were collected from hand-dug pits at 219 sites for textural analysis and trace element geochemistry; 52 bulk till samples (10 kg) were collected for regional kimberlite indicator mineral analysis and gold grain analysis; pebbles (2 to 6 cm diameter) were collected from the till sample pits to

Lithological studies of pebble-sized clasts in till indicate that pebble dispersal trains are traceable for considerable assess glacial transport distances and ice flow patterns. Surficial geology was plotted on 1:60 000 scale airphotos and distances. In the northern half of the map area, Proterozoic sedimentary rock is the best indicator lithology because of recompiled at 1:125 000 on a topographic base. This map supersedes previous surficial geology maps of this area its clearly defined source area. Metaturbidites, metavolcanic, and granitoid rocks, however, form complex geological (Hart et al., 1989; Ward et al., 1995; Kerr et al., 1997b). Ward et al. (1996a, b), Kerr et al. (1998, 1999) present the structures where the different lithologies occur as small, disjointed bodies with convoluted contacts making them less The regional glacial geology was first presented by Blake (1963). Subsequent bedrock mapping projects included brief comments regarding glacial geology (Bostock, 1966, 1980; Tremblay, 1966, 1967, 1976), and associated reconnaissance till geochemistry in the Lupin area is summarized in Coker et al. (1992).

PHYSIOGRAPHY AND DRAINAGE

Nunavut. Elevations range from 414 m in the south half of the map area to 580 m in the Willingham Hills, and 640 m local down-ice direction), these concentrations generally decline to <10% over a distance of 40 km. In the Point Lake in the Peacock Hills. The terrain northwest and east of Contwoyto Lake is generally between 480 to 520 m, whereas map area (NTS 86 H) directly to the west, similar pebble transport distances have been recorded (Dredge et al., 1996). much of the area south of the lake is < 500 m. Local relief is variable, commonly from <10 m to 15 m in areas of outcrop and hummocky till, although relief >100 m occurs in rocky areas of the Peacock and Willingham Hills, and >50 m around Yamba Lake. Contwoyto Lake is on the divide between two drainage systems. Its southern outlet is Contwoyto River which flows into Back River and eastwards to Chantrey Inlet. The northern outlet drains into Kathawachaga Lake and Burnside

The authors would like to thank the following field assistants on the project: J. Adams (1994), M. Caddel (1994), and River, and northward to Bathurst Inlet. Streams in the southwestern part of the map area drain westward into Coppermine River. Numerous small lakes occupy glacially scoured bedrock basins, as well as isolated depressions in till helicopter and fixed wing logistical support. Field accommodations in 1996 were provided by V. Jackson, NWT Geolplains. Most drainage ways are shallow; few streams and rivers have cut deeply into bedrock or surficial sediments, with the exception of a few unnamed streams which have incised glaciofluvial sediments. The map area lies north of I. McMartin for critical review. the treeline, and supports sparse clumps of low birch, alder, and tundra heath vegetation; bedrock is commonly The Contwoyto Lake region lies within the zone of continuous permafrost (Brown, 1967). Permafrost is present from about 0.5 to 1 m below the surface, and was recorded to depths of approximately 500 m east of the map area (Judge et al., 1981; Taylor et al., 1982). Climatic data from an AES weather station operating at Lupin indicate a mean annual air temperature of -11.8°C (Atmospheric Environment Service, 1982).

BEDROCK GEOLOGY Archean rocks underlie most of the map area (King et al., 1992). They consist of supracrustal rocks of the Yellowknife Supergroup and younger granitoid rocks (Figure 1). The Yellowknife Supergroup contains metaturbidites (some with Armstrong, J.P. iron formation), and intermediate to felsic metavolcanic rocks, including rocks of the Central Volcanic Belt (Gebert and Jackson, 1994). These are intruded by granitoid rocks consisting of granite, granodiorite, diorite, tonalite, and gneiss. Proterozoic sedimentary rocks occur only in the north-central map area and include argillite, siltstone, greywacke, quartzite and minor dolomite. Gabbro sills are also restricted to the north-central map area. The region is crosscut by a variety of diabase dykes of which the northwest-trending Mackenzie swarm is most prominent. A number of important mineral deposits occur here, notably the iron formation hosted Lupin gold deposit, as well 1989: Glacial features around the Keewatin Ice Divide: Districts of Mackenzie and Keewatin; Geological Survey of as the smaller Butterfly gold occurrence (Figure 1), both associated with Yellowknife Supergroup metaturbidites. These rocks are also the host for many gold showings southwest of Contwoyto Lake. The Gondor volcanogenic Cu-Zr ± Pb deposit is associated with Yellowknife Supergroup metavolcanics, as are some Cu-Mo gossans (Figure 1). The Blake, W., Jr. central part of Slave Province is also currently the focus of diamond exploration. Numerous diamondiferous pipes, dating approximately 97 Ma to 52 Ma (Pell, 1995a), occur in the Winter Lake - Lac de Gras - Aylmer Lake area to the south. Those occurring in the Contwoyto Lake map area include Ranch Lake, Torrie, Sputnik, Eddie, Suzie (Pell, 1995b), Jericho (172 Ma; Cookenboo, 1997), Rush and Muskox (Armstrong, 1998), as well as the Contwoyto 1 pipe The exact number and locations of pipes in the Contwoyto Lake map area, however, have not yet been published Bostock, H.H. (GNWT, 1997). Other unreported or undiscovered pipes likely lie within the region. Differences in susceptibility to frost action were noted among rock types. Granitic outcrops show low to moderate

tered or heaved but may exhibit large talus slopes along the edges of escarpments.

SURFICIAL SEDIMENTS

TILL DEPOSITS

Till is the most extensive surficial sediment in the map area. It consists of a stony, matrix-supported diamicton, with the matrix ranging from sand to silt (Figure 2). Clasts range in size from small pebbles to large boulders, and are subangular to subrounded, and some are striated. Till is composed of up to 40 per cent clasts by volume, but most exposures have between 10 and 30 per cent. Based on thickness and surface morphology, till has been subdivided into veneer, blanket, and hummocky units.

1997: Discovery and evaluation of the Jericho kimberlite pipe in the central Slave craton, northern Canada; in Fill veneer is generally <2 m thick, includes small bedrock outcrops, and conforms to underlying bedrock morphology. Where veneer is thin and discontinuous, structural bedrock features are commonly visible on airphotos. It is generally loosely compact with high concentrations of cobbles and boulders at the surface. Till veneer occurs throughout the

Dredge, L.A., Kerr, D.E., and Ward, B.C. till has been eroded and much of the fine grained portion of the matrix has been removed by meltwater, resulting in isolated lag deposits consisting of pebble to boulder-sized clasts <2 m in diameter. Till blankets are generally >2 m thick and either drape the underlying bedrock, forming undulating till plains, or form low to moderate-relief drumlinoid and crag-and-tail landforms. These tills are relatively compact, contain fewer boulders than till veneer, and may rep-Contwoyto Lake. Hummocky till is generally >5 m in thickness, is moderately compact, and forms hummocky, rolling topography with irregular till mounds a few metres high, and ridges ranging in length from tens of metres to more than 3 km. Many of these ridges are commonly transverse to ice flow direction, though some are parallel. Hummocky till occurs as a broad belt trending northwest-southeast across the central part of the map area south of Contwoyto Lake,

Dyke, A.S. and Dredge, L.A. of ablation till, with stagnant ice features such as kettle depressions.

1989: Quaternary geology of the northwestern Canadian Shield; in Chapter 3 of Quaternary geology of Canada and Greenland, (ed) R.J. Fulton; Geological Survey of Canada, no. 1, p. 189-214 Frost action within the active layer results in the widespread occurrence of mudboils in all till units. Solifluction lobes are also common and are most pronounced near the base of slopes. Ice wedge polygons may be present within tills, EBA Engineering Consultants Ltd. notably hummocky till, but are seldomly visible on the surface, possibly due to cryoturbation activity within the active layer. Several stabilized thaw flow slides occur in the hummocky till terrain in the northeastern regions of the map area.

GLACIOFLUVIAL DEPOSITS Glaciofluvial deposits consist of massive and stratified fine sand to cobbles in the form of eskers, kames, and proglacial outwash. Eskers have a linear to slightly sinuous form, and are generally parallel to the dominant glacial flow direction defined by striae and drumlinoid ridges: W in areas north and west of Pelonquin Lake, NW south of Contwoyto Lake, and NNW to NNE north of Contwoyto Lake (Figure 3). Differences in orientation correspond to divergent ice flow in late-glacial times. The crests of eskers are rounded to sharp. Cobble and boulder lags are common on the tops and sides of eskers. Eskers range from small ridges a few tens of metres long, to large complexes up to 32 km 1997: Mineral deposits and petroleum resources of the Northwest Territories; Department of Resources, Wildlife long and 20 to 30 m high. Outwash plains scarred by braided channels and kettle lakes are associated with the extremities of some eskers, and link longer esker segments together. Glaciofluvial deposits are potential resources for large volumes of granular materials and can serve as airstrips to facilitate development. Eskers cut into till blankets and veneers and are commonly flanked by meltwater corridors of boulder lags or 1989: Surficial geology, Contwoyto Lake (76 E/5-16), Northwest Territories; Geological Survey of Canada, Open washed and scoured bedrock zones up to 1 km wide. Meltwater channels carved in bedrock may link esker segments, forming part of the subglacial drainage network. In the northeast quadrant of the map area, eskers overlie hummocky till which exhibits little or no evidence of erosion. The presence of permafrost typically results in the formation of ice-wedge polygons in glaciofluvial sediments.

Judge, A.S., Taylor, A.E., Burgess, M.M., and Allen, V.S. Ice-wedge polygons are exceptionally well developed on most flat-topped outwash deposits. Polygons are on the order of 30 to 100 m in diameter with troughs up to 3 m deep. Smaller polygons, approximately 10 m in diameter, with troughs on the order of 0.3 m deep also occur on outwash sediments. Some eskers and outwash sediments are cored

GLACIOLACUSTRINE DEPOSITS A number of erosional and depositional shoreline landforms relate to a sequence of proglacial lakes that formed in the area surrounding Contwoyto Lake during deglaciation. Perched deltas, raised beaches and wave-cut terraces, from 1 to >10 m high, together with washed bouldery till surfaces, occur up to 50 m (485 to 490 m a.s.l.) above present lake level. Beaches consist of poorly to moderately sorted fine to coarse sand with variable amounts of pebbles, cobbles, Kerr, D.E., Wolfe, S.A., and Dredge, L.A. and boulders. They are best developed where glaciofluvial deposits have been reworked by wave action. Washed and wave-cut till surfaces are likely sources for poorly defined beaches which may occur in close proximity to erosional features. Fine-grained glaciolacustrine sediments are rare. Erosional drainage channels are cut into bedrock and till.

by massive ice in excess of 7 m thick (EBA Engineering Consultants Ltd., 1993).

ALLUVIAL DEPOSITS Alluvial deposits consisting of gravel to silt size sediment deposited by modern streams and rivers are present in the Kerr, D.E., Knight, R.D., and Dredge, L.A. map area, but rarely form units large enough to appear on the map. They range from massive to well stratified and vary in thickness from 1 to 5 m. Alluvial sediments are associated with meandering, braided, and floodplain environments, and also with alluvial fans, and undergo annual erosion and deposition. They typically occur in areas where

glaciofluvial sediments have been reworked. ORGANIC DEPOSITS Organic deposits consist of peat formed by the accumulation of fibrous, woody, and mossy vegetative matter up to 1

m or more in thickness, locally overlain by a dense grass or shrub cover. These sediments are present predominantly

glacial lakes, where they may overlie fine-grained glaciolacustrine and lacustrine sediments. Ice-wedge polygons 1992: Late Archean tectono-magmatic evolution of the central Slave Province, Northwest Territories; Canadian occur locally in organic sediments but are not common. Figure 4 is a summary diagram of ice flow direction based on airphoto interpretation and approximately 200 striae points, as well as on regional observations made by Blake (1963), Bostock (1980), and Tremblay (1976) in the Contwoyto Lake map area. At a few locations in the eastern half of the study area, striae record an early SW flow (Figure 1995b: Kimberlites and diamond exploration in the Central Slave Province, NWT (75 M, N; 76 C, D, E, F; 85 P; 86 A,

4A), although the westerly extent of this event is not presently known. It may relate to an early SW flow reported in the Lac de Gras and Aylmer Lake areas to the south (Ward et al., 1994). Crosscutting striae and streamlined rock forms indicate a later, dominant W ice flow in the southern regions (Figure Prest, V.K. 4B), which gradually shifts clockwise to a N flow in the northeastern map area. The youngest flow is defined by large-scale ice flow indicators (drumlins and crag-and-tails), eskers and striae (Figure 4C), which suggest a SW flow in the southernmost part of the map area, a WNW flow in the central and northwest regions of Contwoyto Lake, and a N flow northeast of Contwoyto Lake. The general ice flow pattern represented in Figure 4B parallels the glacial drainage system (Figure 3) defined by eskers and outwash established during deglaciation.

GLACIAL HISTORY The Contwovto Lake area lies within the central part of the Keewatin Sector of the Laurentide Ice Sheet (Dyke and Prest, 1987; Dyke and Dredge, 1989), west of the M'Clintock Ice Divide, which was prominent during the Late Wisconsin maximum (18 000 to 13 000 BP). From 13 000 BP, the ice divide shifted eastwards into the District of Keewatin. striae represent a SW ice advance prior to the establishment of the dominant regional patterns, possibly during ice tions, as striae in the north-central map area appear to be unaffected by local topography which could be expected to cause local deviations in flow around the Peacock and Willingham Hills at the north end of Contwoyto Lake. The youngest SW, WNW, and N ice flow indicators likely relate to the last phases during deglaciation, as evidenced by the Stagnant ice relating to divergent ice flow is responsible for large areas of hummocky till, particularly in the south- Ward, B.C., Dredge, L.A., and Kerr, D.E. central and northeast regions, where ridges, some parallel to ice flow, occur. These may represent small recessional 1994: Ice flow indicators, Winter Lake-Lac de Gras- Aylmer Lake, District of Mackenzie, Northwest Territories; or interlobate moraines, crevasse fillings or kettle topography features. Nonoriented rim ridges (Prest, 1968, p. 10) composed of till are also present in the northeast quadrant and may reflect the position of former cavities in the ice.

1995: Surficial geology, Contwoyto Lake, District of Mackenzie, Northwest Territories (76 E south half); Geological Immediately east of the map area, Blake (1963) reported the existence of a large end morainic ridge (Twin Jugs Moraine; Aylsworth and Shilts, 1989) oriented north-south, associated with an extensive area of hummocky till. This

moraine was interpreted to represent the terminal position of ice moving SW across the area south of Bathurst Inlet During deglaciation, a sequence of proglacial lakes developed in the basin of Contwoyto Lake. The size and configuration of lakes evolved as a function of ice-front position and configuration, relative to the outlet locations and their

Ward, B.C., Kjarsgaard, I.M., Dredge, L.A., Kerr, D.E., and Stirling, JAR elevations. Evidence of meltwater impounded by stagnant or eastward retreating ice occurs as wave-washed zones 1996b: Distribution and chemistry of kimberlite indicator minerals, southern Contwoyto Lake map area (76 E), and beaches up to 490 m a.s.l., approximately 45 m above present lake level in the north half of the map area, and 470 m a.s.l. (35 m above present lake level) in the south half (Figure 5). The precise extent of glacial lakes defined on the basis of isolated shoreline features at similar elevations, and the effects of differential uplift on shoreline

elevations, have yet to be determined. It is likely that the initial ice marginal lakes at 490 m were small isolated lakes. e of the higher shoreline elevations associated with inlets of Contwoyto Lake may have formed in proglacial lakes Province have resulted in the need for a wide range of baseline information. In response, Terrain Sciences Division further evidence of stagnant blocks of ice that persisted longer in some areas. Preliminary studies suggests that the

useful for dispersal studies. The highest concentrations (up to 96%) of Proterozoic clasts occur in the Peacock Hills area underlain by Proterozoic bedrock. Concentrations of 20 to 25% occur as much as 18 to 35 km down-ice (west) of the source, and generally decrease to <10% approximately 25 to 42 km down-ice (west and southwest). The distribution of sedimentary pebbles illustrates that the early SW flow transported clasts across the north end of Contwoyto Lake, northwest of Lupin. Subsequent NW ice flows are responsible for the dispersal train west of Peacock The Contwoyto Lake map area lies in north-central District of Mackenzie, bordering Northwest Territories and pendicular to ice flow. Overlying these rocks, metaturbidite clasts constitute <40% of the pebbles in till. Westward (the

ACKNOWLEDGMENTS

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evidence of frost shattering or heaving, depending on the joint pattern. Sedimentary, metasedimentary, and volcanic 1980: Geology of the Itchen Lake area, District of Mackenzie; Geological Survey of Canada, Memoir 391, 101 p. rocks may be extensively frost shattered and heaved up to 1 m as an individual block or as frost blisters, especially

near bases of slopes, in small depressions and other areas of poor drainage. Gabbro sills are not extensively shat-1967: Permafrost in Canada; Geological Survey of Canada, Map 1246A, scale 1:7 603 200

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N 1/2); Geological Survey of Canada, Open File 3768. in topographic depressions, poorly defined water courses with imperfect drainage, and in areas once submerged by King, J.E., Davis, W.J., and Relf, C.

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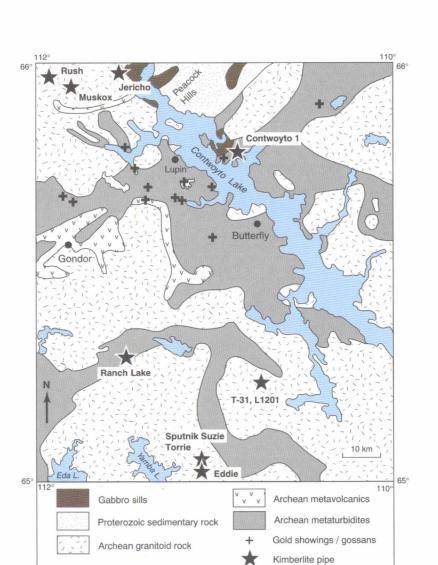
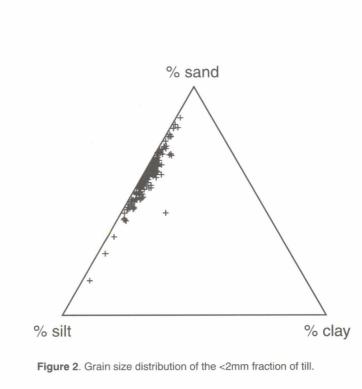


Figure 1. Generalized bedrock geology modified from Gebert and Jackson (1994), with location of important mineral occurrences.



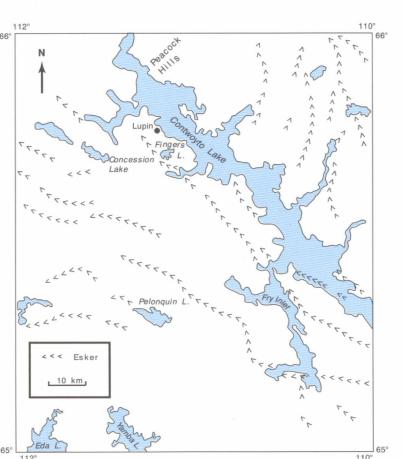
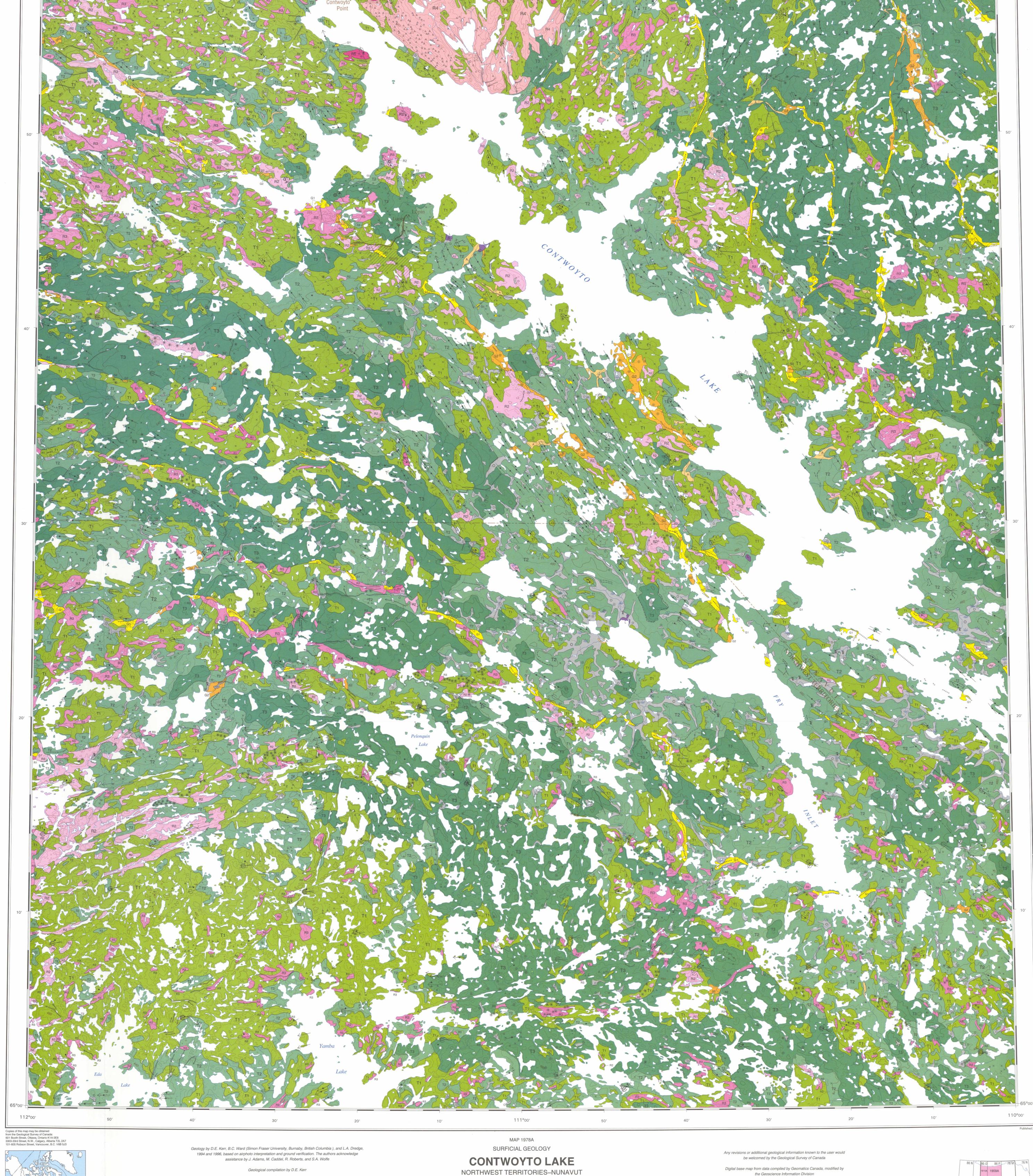


Figure 3. Glacial drainage systems as defined by eskers and glaciofluvial



Scale 1:125 000/Échelle 1/125 000

Her Majesty the Queen in Right of Canada, 2000
 Sa Majesté la Reine du chef du Canada, 2000

Universal Transverse Mercator Projection

North American Datum 1983

Projection transverse universelle de Mercator

Système de référence géodésique nord-américain, 1983

Co-ordinated through the auspices of the NATMAP Slave Province Project

Digital cartography by R.L. Allard, Geoscience Information Division

Logistic support provided by the Polar Continental Shelf Project as part of its mandate to promote

scientific research in the Canadian North. PCSP 1-94 and 003-96

QUATERNARY NONGLACIAL ENVIRONMENT ORGANIC DEPOSITS: peat and muck up to 1 m thick; formed predominantly by the accumulation of vegetative material; occurs in depressions, along valley bottoms and in areas once submerged by glacial lakes where they may overlie fine-grained lacustrine sediments; may contain ice-wedge polygons. Small unmapped organic deposits occur in most terrain units ALLUVIAL DEPOSITS: gravel to silt size sediment, 1 to 5 m thick, deposited by modern streams and rivers; deposits range from massive to well stratified; associated with meandering, braided, and floodplain environments PLEISTOCENE (WISCONSIN GLACIATION)

GLACIAL ENVIRONMENT GLACIOLACUSTRINE DEPOSITS: silt, sand, and gravel; 1 to 10 m thick; cross-stratified to planar bedded sands; deposited in temporary glacier-dammed lakes; associated with deltas and raised beaches indicated by symbols; may contain GLACIOFLUVIAL DEPOSITS: sand, gravel, and minor silt; 1 to 20 m thick; sorting ranges from good to poor, and stratification from massive or cross-stratified to planar

LEGEND

bedded; deposited by water flowing from, or in contact with, glacier ice; may contain Outwash: rounded gravel and sand; massive to cross-stratified; probably less than 20 m thick; occurs as braided fans and outwash plains, commonly containing ice-wedge

Esker sediments: sand, silt, and gravel; in planar, cross-stratified, and massive beds; 1 to 20 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 bedrock (meltwater scours) between esker segments, isolated kame deposits, and boulder lags are shown by symbols between esker segments 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 lodgment till, meltout till, and

Hummocky till: greater than 2 m thick; forms irregular to rolling terrain with relief up to 15 m, locally forming hills and ridges up to 3 km long; some areas have abundant small meltwater channels and lag concentrations of boulders in depressions. Stabilized retrogressive thaw flow slides may be indicative of ice-rich till Till blanket: greater than 2 m thick; occurs as till plains or as drumlinoids. Small rock outcrops in this unit are shown by symbols

gravity flow deposits; may contain massive ground ice

includes patches of bedrock and till blanket PRE-QUATERNARY BEDROCK: Archean metasedimentary, metavolcanic, granitic, and gneissic rocks; Proterozoic sedimentary rocks, mafic dykes and sills; may include patches of till veneer or glaciofluvial deposits; areas of shattered and frost-heaved rock are

Till veneer: less than 2 m thick; rock structure is generally visible on airphotos; unit

Geological boundary Retrogressive thaw flow slide Solifluction lobe Frost heaved and shattered rock Ice-wedge polygon Raised beach Area of meltwater scour Lag concentration of glacially abraded boulders Subglacial or proglacial meltwater channel Esker (direction of flow known, unknown) . Crag-and-tail landform

Striation (ice flow direction known, 1 = oldest) Small rock outcrop Mine waste and settling ponds (symbol overlies pre-development geology indicated on map)

Roche moutonnée or whaleback

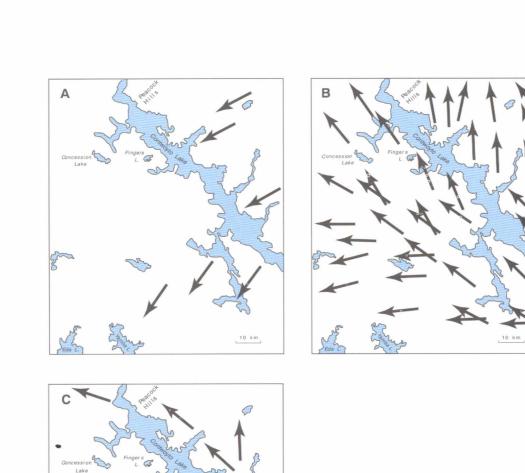
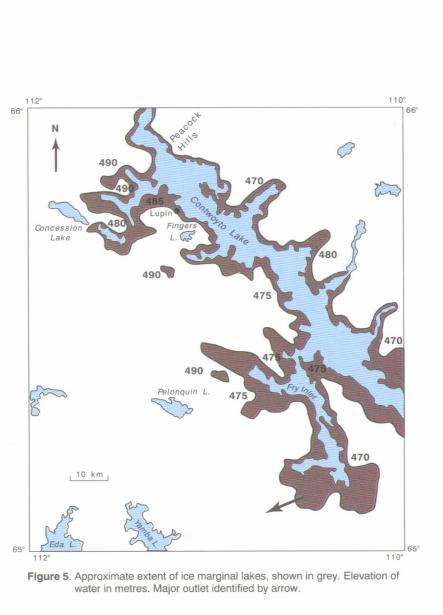
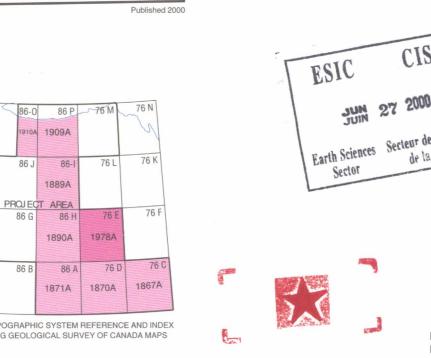
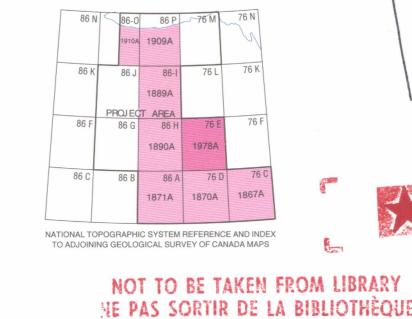


Figure 4. Sequence of ice flows in Contwoyto Lake map area: A is the oldest, C is the youngest.







Mean magnetic declination 2000, 24°58'E, decreasing 21.6' annually. Readings vary from 23°38'E in the SE corner to 26°15'E in

the NW corner of the map

Elevations in metres above mean sea level

Recommended citation: Kerr, D.E, Ward, B.C, and Dredge, L.A. 2000: Surficial geology, Contwoyto Lake, Northwest Territories-Nunavut; Geological Survey of Canada, Map 1978A, scale 1:125 000.