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GEOLOGICAL SURVEY OF CANADA | COMMISSION GÉOLOGIQUE DU CANADA

NATMAP
CARTNAT
Canada's National Geoscience Mapping Program
Le Programme national de cartographie géoscientifique du Canada

DESCRIPTIVE NOTES

INTRODUCTION

Ongoing mineral exploration and development in the central and north Slave Geological Province have resulted in the need for a wide range of baseline information. In response, Terrain Sciences Division initiated regional surficial mapping through the Slave Province National Mapping (NATMAP) Program to provide data on surficial materials, ice flow history, and till geochemistry. As an extension to Slave NATMAP, surficial mapping continued during July 1997, focusing on the Hope Bay volcanic belt area in the north half of the Rideout Island and southwest quadrant of the Elu Inlet map sheets, excluding Kent Peninsula (NTS 76-O and 77 A).

The project involved helicopter-assisted ground work including terrain mapping, till sampling, pebble provenance studies, and measurement of ice flow indicators. Field traverses and airphoto interpretation provided information on the nature and distribution of surficial materials shown on the map. Till samples (2 kg) were collected from hand-dug pits at 95 sites for textural analysis and trace element geochemistry; pebbles (2 to 6 cm diameter) were collected from the till sample pits to assess glacial transport distances and ice flow patterns. Surficial geology was plotted on 1:60 000 scale airphotos, and recompiled at 1:125 000 on a topographic base. This map supersedes the previous surficial geology map and report of this area (Kerr and Knight, 1998a, b). Open File 3663 (Kerr et al., 2000) presents the results of regional till geochemistry. The regional glacial geology was first presented by Blake (1963), and Aylsworth and Shilts (1989), as part of a larger regional overview.

PHYSIOGRAPHY AND DRAINAGE

Koignuk River map area lies in the north-central District of Mackenzie. Elevations range from 0 m (present-day sea level) to 318 m in the Buchan and Naujaat Hills in the northwestern regions. The terrain in the western half of the map area rises abruptly inland from the coast southward and eastward, and is generally between 100-200 m elevation. Much of the area in the eastern region, including Koignuk River valley, is less than 100 m a.s.l., with the notable exception of the northeasternmost region where elevations reach 160 m. Local relief is variable, commonly less than 15 m in areas of outcrop and marine sediments, although relief more than100 m occurs in rocky areas of the Buchan and Naujaat Hills.

Regional drainage is northward, into Melville Sound, with a minor westward flow towards Bathurst Inlet. Koignuk River comprises the largest drainage system, forming a long, north-trending basin up to 40 km wide, that drains into Melville Sound. Its catchment area extends southward beyond the map area. Numerous small lakes occupy glacially scoured bedrock in the west, as well as isolated depressions in marine sediments and wave-washed till in the east. Most drainage ways are shallow; few streams and rivers have cut into bedrock or surficial sediments, with the exception of Koignuk River, which has incised marine and glaciofluvial sediments, and a few smaller unnamed rivers near the coast.

The map area lies north of treeline, and supports sparse clumps of tundra heath vegetation in rocky areas. In regions underlain by fine-grained marine sediments, low birch, alder, and peat predominate in areas of poor drainage. The Koignuk River map area lies within the zone of continuous permafrost (Brown, 1967). Climatic data from an Atmospheric Environment Service (AES) weather station operating at Cambridge Bay (120 km to the northeast) indicate an annual daily air temperature of -15/C (Atmospheric Environment Service, 1982).

BEDROCK GEOLOGY

The study area falls within the Bathurst Block of the northeastern Slave Province. Bedrock geology, generalized in Figure 1, consists primarily of Archean volcanic and granitic rocks, Proterozoic sedimentary rocks and gabbro sills and diabase dykes (Fraser, 1964; Roscoe, 1984). Economic interest is focused on the Hope Bay volcanic belt (Gebert, 1990, 1993) which is dominated by mafic volcanics with minor felsic volcanics, volcaniclastic rocks, metasedimentary rocks, and iron formation. These were metamorphosed from greenschist to amphibolite-facies and intruded by widespread granitic rocks consisting of granite, granodiorite, and gneiss. Proterozoic sedimentary rocks include quartzite, siltstone, and minor conglomerate of the Burnside River Formation. Gabbro sills intrude the volcanic, granitic, and sedimentary rocks, as do the northwest-trending Mackenzie and Franklin diabase dykes. Many outcrops have been glacially scoured and striated.

Several mineral deposits associated with the Hope Bay belt occur in the study area, notably the Boston and Windy gold deposits, as well as smaller gold showings associated with quartz veins in greenstone, and copper prospects. The north end of the belt also hosts an abandoned silver mine where native silver ore was mined in veins.

SURFICIAL SEDIMENTS

TILL DEPOSITS

Till is a widespread Quaternary sediment in the map area but it is not easily recognized on aerial photographs or in the field – the till is overlain by marine sediments and/or reworked by marine processes, because the study area was submerged by a postglacial sea following deglaciation. Till in the area consists of a silty to fine sandy matrix-supported diamicton (Fig. 2), and exhibits low to high compaction. Till is composed of up to 50 per cent clasts, but most exposures have between 10 and 30 per cent, with some being striated. Clasts range in size from small pebbles to large boulders, although medium to large pebbles predominate. Subangular to subrounded clasts are most common.

Till veneers, generally less than 2 m thick, are common in rocky, more elevated areas containing extensive bedrock outcrops such as the Buchan and Naujaat Hills. Till veneer is generally loosely compact with high concentrations of cobbles and boulders at the surface; where veneer is discontinuous, structural bedrock features are visible. In some areas, much of the fine grained sediment in the matrix was removed by meltwater and wave action, resulting in isolated lag deposits of pebble to boulder-sized clasts < 2 m in diameter. Till veneers are the main surficial sediment above the limit of marine submergence (approximately 200-220 m a.s.l.). Till blankets generally 2 to 10 m thick form low to moderate-relief drumlinoid and crag-and-tail features in the west-central and southeast regions. These thick tills are generally relatively compact.

GLACIOFLUVIAL SEDIMENTS

Glaciofluvial deposits consist of eskers, kames, and proglacial outwash. Eskers range from small, sinuous ridges a few tens of metres long to large, more linear features up to 15 km long. They generally trend northwest in the western region and north northwest to north in the eastern part of the map area (Fig. 3). They are rare to absent in the northern half of the map area. Cobble and boulder lags, resulting from wave action during postglacial marine regression, cover eskers in places as well as bedrock surfaces between esker segments. Texture ranges from fine sand to cobbles and may change rapidly over short distances. In the southern half of the map area, small outwash terraces are associated with the esker complexes. As with eskers, their grain size is variable. Esker-outwash complexes generally parallel the dominant glacial flow direction, and those within Koignuk River valley may be characterized by raised beaches in their flanks. Such glaciofluvial deposits are potential resources for large volumes of granular materials. The presence of permafrost typically results in the formation of ice-wedge polygons in glaciofluvial sediments. Some eskers and outwash sediments are likely cored by massive ice, and geotechnical investigations should be conducted prior to any development.

MARINE SEDIMENTS

Marine sediments are the dominant surficial sediment in the map area. They are extensive along the coastal lowlands of Melville Sound, extending up to 75 km inland in Koignuk River valley, and commonly occupy low areas in the bedrock topography along the coast of Bathurst Inlet. They provide evidence for postglacial marine inundation and subsequent emergence of approximately 220 m (Fig. 3). Marine sediments consist primarily of three types: 1) a veneer ranging in composition from clay to sand and gravel, less than 2 m thick, covering extensive regions below marine limit; (2) undifferentiated, massive to well stratified clay and silt, which may be overlain by a thin sand layer, forming a blanket 2 to 20 m; and (3) coarse sand, pebbles, and cobbles of littoral origin (raised beaches) found at various elevations from near marine limit to present sea level.

Permafrost has extensively affected marine sediments and evidence for this is widespread. In many areas along the coast, particularly within Koignuk River valley, the fine grained marine blanket deposits are gullied and bare of vegetation cover. Retrogressive thaw flowslides are common along streams in this area, with active slides typically more than 10 m in diameter and headwalls 1 to 2 m high. Solifluction lobes are particularly active in fine-grained marine sediments. They show considerable sediment translocation, with lobes tens of metres long. Locally, significant downslope movement has occurred in recent times as evidenced by solifluction lobes encroaching on raised beaches near present sea level. Ice-wedge polygons are common on most raised beach and sandy littoral sediments. Where littoral sediments form laterally extensive veneers over marine silts or clays, tundra ponds and low-centre polygons are common.

ALLUVIAL SEDIMENTS

Alluvial sediments comprise silt to gravel size sediment deposited by postglacial streams and rivers. They range from massive to well stratified, and vary in thickness from 1 to 5 m. Alluvial sediments are associated with meandering and braided stream environments, as well as floodplains and alluvial fans.

ORGANIC SEDIMENTS

Organic sediments 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 cover. They occur predominantly in topographic depressions and valley bottoms with poor drainage and are most noticeable where they overlie fine grained marine sediments. Ice-wedge polygons are common in organic sediments and are noted in the underlying glaciofluvial or marine deposits. Frozen ground was encountered at depths as shallow as 0.10 m below the surface in peat in late summer.

GLACIAL HISTORY

Figure 4 is a summary diagram of ice flow direction based on airphoto identification of ice-streamlined landforms and 167 striae measurements, as well as on regional observations made by Blake (1963) in the Koignuk River map area. At a few locations in the northeast, cross-cutting striae were noted, and their relationships record an early west-northwestward to north-northwestward flow (1 in Fig. 4), although the extent of this event is not presently known.

Throughout the southern and central study area, a strong pattern of Late Wisconsin ice flow radiating from the southeast (2 in Fig. 4) is apparent. Flow shifts clockwise from west-southwestward in the southwest region to westward, northwestward, and eventually north-northwestward in the northeastern map area. This flow is responsible for the creation of all streamlined glacial landforms (drumlins and crag-and-tails) in the study area. Where Melville Sound meets Bathurst Inlet, the northwestward flow rotates anticlockwise to a westward flow. Westward flows were also recorded in the coastal zones of the northeastern region. Local variations in ice flow directions were encountered along the eastern edge of the Buchan Hills and are attributed to local topography, deflecting ice northward along major escarpments. Ice appears to have preferentially flowed down the NNW-trending axis of the broad shallow Koignuk River valley. A late focus of flow was also directed into Bathurst Inlet. The general radiating pattern for ice is reflected in the orientation of fluted landforms.

This region became ice-free by about 9000 BP (Dyke and Prest, 1987). During deglaciation, the study area experienced rapid ice retreat which was simultaneous with the marine incursion across isostatically depressed terrain. Little evidence exists in this region that can be used to define marine limit elevation precisely, but regional data suggest an elevation of approximately 220 m, and an age of about 9000 BP (Kerr, 1994). The size and configuration of postglacial precursors of Bathurst Inlet and Melville Sound evolved as a function of glacioisostatic uplift over the last 9000 years. As sea level dropped to successively lower elevations, numerous beaches were formed where suitable sediments for strandlines were present. The region is still experiencing uplift at present (Kerr, 1996).

PEBBLE LITHOLOGY PROVENANCE STUDIES

To illustrate patterns of glacial dispersal and to estimate transport distances as an aid to mineral exploration, volcanic rocks were chosen as an indicator lithology because of a clearly defined source area, economic importance, and ease of distinction from sedimentary and granitic rocks. Figure 5a shows the percentage (by count) and distribution of volcanic pebbles in till over the area. Volcanic pebbles occur at about 25% of the 95 sites, and the majority of these sites are underlain by volcanic rocks. In contrast, Figure 5b shows the percentage of granitic pebbles which are found at all sample sites.

The expected distribution pattern of volcanic pebbles is a sharp decline in clast concentration down-ice from the source rock and bedrock contact, as illustrated by Shilts (1975) and other workers. The pebble distribution map (Fig. 5a) illustrates that the dominant north- northwestward flow over the Hope Bay volcanic belt transported clasts northwestward onto granitic terrain. The highest concentrations (up to 90%) of volcanic clasts are found in areas underlain by volcanic bedrock. Their numbers, however, remain generally low (20-40%), even over the volcanic belt itself. Concentrations decrease rapidly to < 20% to 0% approximately 10 km down-ice from the nearest source outcrops. Only 5% of the sites record concentrations up to 6% volcanics 45 km down-ice.

Granitic clasts are the dominant pebble lithology throughout most of the study area (Fig. 5b), with the majority of sites containing almost 90-100% granite. They mask much of the volcanic belt and dilute the volcanic clast count. Only in the area underlain by sedimentary rocks do the granite clasts show any significant decrease, even though they are present as erratic boulders. The highest concentrations (up to 95-100%) of granitic clasts occur east of the volcanic belt and in the south-central regions. A slight decrease in concentration (to 80%) east of Bathurst Inlet is the result of dilution by sedimentary clasts. These clasts may be associated with pre-existing outcrops which were completely eroded during the last glaciation, or alternatively to unmapped bedrock covered by surficial sediments.

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REFERENCES

Atmospheric Environment Service
1982: Canadian climate normals, temperature and precipitation 1951-1980. The North: Yukon and Northwest Territories; Environment Canada, Downsview.

Aylsworth, J.M. and Shilts, W.W.
1989: Glacial features around the Keewatin Ice Divide: Districts of Mackenzie and Franklin; Geological Survey of Canada, Paper 88-24, 21 p.

Blake, W. Jr.
1963: Notes on glacial geology, northeastern District of Mackenzie; Geological Survey of Canada, Paper 63-28, 12 p.

Brown, R.J.E.
1967: Permafrost in Canada; Geological Survey of Canada, Map 1246A, scale 1:7 603 200.

Dyke, A.S., and Prest, V.K.
1987: Paleogeography of northern North America 11 000 - 8 400 years ago; Geological Survey of Canada, Map 1703A, 3 sheets, scale 1:12 500 000.

Fraser, J.A.
1964: Geological notes on Northeastern District of Mackenzie, Northwest Territories; Geological Survey of Canada, Paper 63-40.

Gebert, J.
1990: Geology of the Hope Bay and Elu Inlet metavolcanic belts, Bathurst Block, northeastern Slave province, Northwest Territories; in Exploration Overview 1990, Indian and Northern Affairs Canada, p. 26-27.
1993: Geology and mineral potential of the Archean Hope Bay and Elu Inlet volcanic belts, northeastern Slave structural province, District of Mackenzie, Northwest Territories; part of NTS areas 76-O/9, 10, 15, 16 and 77A/2, 3, 6, 7, 10; Indian and Northern Affairs Canada, EGS 1993-01.

Kerr, D.E.
1994: Late Quaternary stratigraphy and depositional history of the Parry Peninsula-Perry River area, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Bulletin 465, 34 p.
1996: Late Quaternary sea level history in the Paulatuk to Bathurst Inlet area, Northwest Territories; Canadian Journal of Earth Sciences, v. 33, p. 389-403.

Kerr, D.E. and Knight, R.
1998a: Surficial geology, Rideout island and Elu Inlet, District of Mackenzie, Northwest Territories (76-O, N/2; 77A, SW/4); Geological Survey of Canada, Open File 3597, scale 1:125 000.
1998b: Surficial geology and implications for drift prospecting, Hope Bay volcanic belt area, Northwest Territories; in Current Research 1998-A, Geological Survey of Canada, p. 21-28.

Kerr, D.E., Knight, R., and Kyer, T.
2000: Till geochemistry, Rideout Island and Elu Inlet map areas, Nunavut (NTS 76-O, N/2; 77A, SW/4); Geological Survey of Canada, Open File 3663, 92 p.

Roscoe, S.M.
1984: Assessment of mineral resource potential in the Bathurst Inlet area, NTS 76J, K, N, O including the proposed Bathurst Inlet National Park; Geological Survey of Canada, Open File 788, 75 p.

Shilts, W.W.
1975: Principles of geochemical exploration for sulphide deposits using shallow samples of glacial drift; Canadian Institute of Mining and Metallurgy Bulletin, v. 68, p. 73-80.

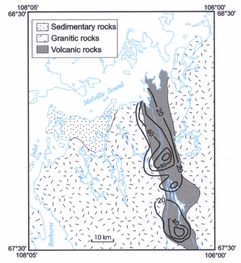


Figure 5a. Clast lithology map showing contoured percentages of volcanic pebbles in till, with bedrock geology underlay (n = 95)

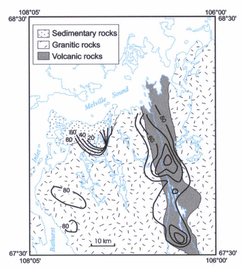
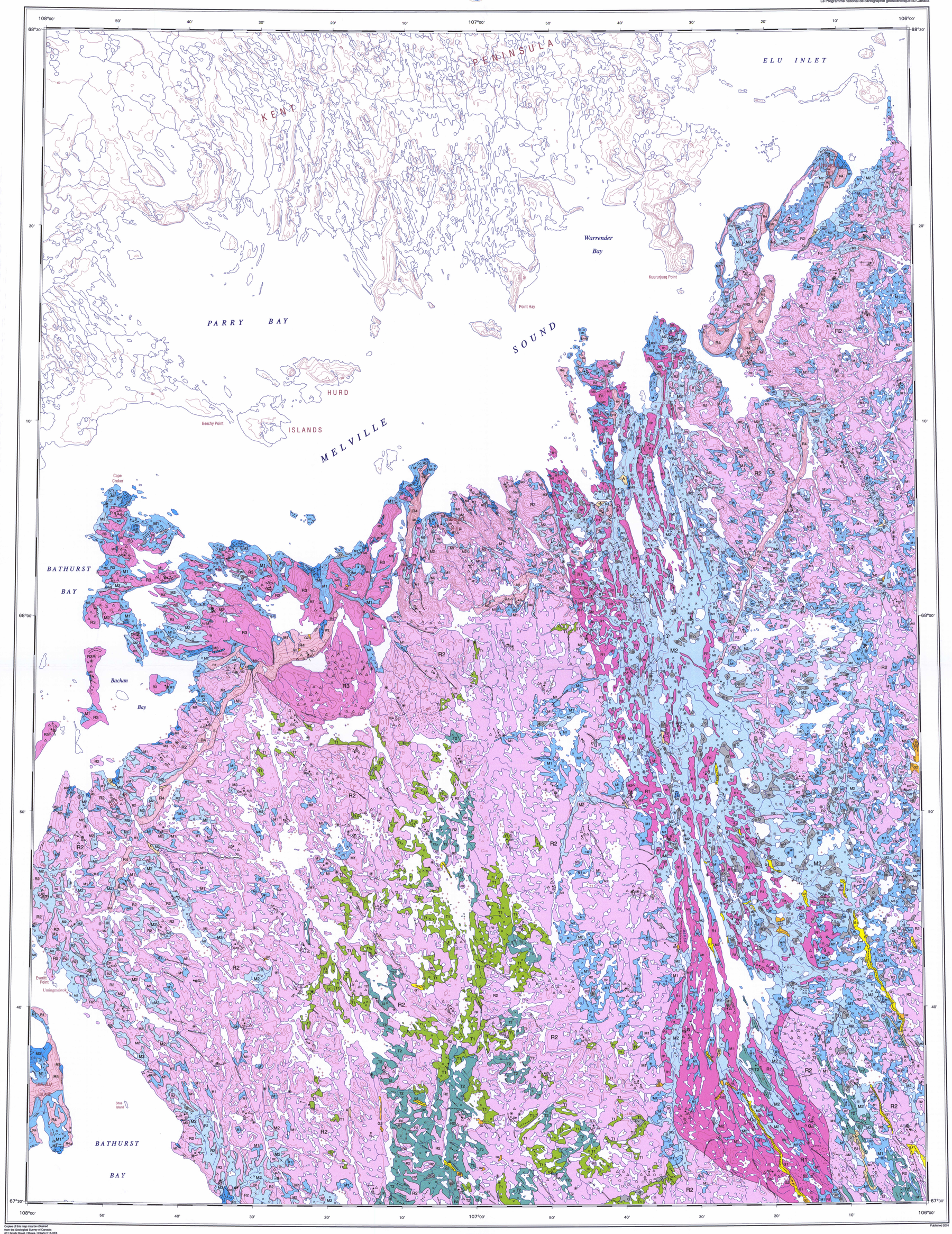


Figure 5b. Clast lithology map showing contoured percentages of granitic pebbles in till with bedrock geology underlay (n = 95).



Copies of this map may be obtained from the Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8 3303-33rd Street, N.W., Calgary, Alberta T2L 2A7 101-605 Robson Street, Vancouver, B.C. V6B 5J3

Geology by D.E. Kerr and R.D. Knight, 1997, based on airphoto interpretation and ground verification; logistical support from the Polar Continental Shelf Project

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

Digital cartography by P. St-Amour, Earth Sciences Sector Information Division (ESS Info)

This map was produced from processes in conformance with the Cartographic Services Section Quality Management System, Ottawa, registered to the Quality System ISO 9001: 1994 standards

MAP 1998A

SURFICIAL GEOLOGY

KOIGNUK RIVER

NUNAVUT

Scale 1:125 000/Échelle 1/125 000

kilometres 2 0 2 4 6 8 10 kilometres

Universal Transverse Mercator Projection
North American Datum 1983
© Her Majesty the Queen in Right of Canada, 2001

Projection transverse universelle de Mercator
Système de référence géodésique nord-américain, 1983
© Sa Majesté la Reine du chef du Canada, 2001

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

Digital base map from data compiled by Geomatics Canada, modified by the ESS Info

Proximity to the North Magnetic Pole causes the magnetic compass to be erratic in this area Magnetic declination 2001, 21°23' W, decreasing 26.6' annually

Elevations in metres above mean sea level

Contour interval above 68° is 20 metres, below 68° is 50 metres

Published 2001

LEGEND

QUATERNARY
HOLOCENE

NONGLACIAL ENVIRONMENT

O — ***ORGANIC DEPOSITS:*** *peat and muck up 2 m thick but commonly less than 1 m thick; formed predominantly by the accumulation of vegetative material in bogs; occurs in depressions, along valley bottoms, and on marine silt and clay; may contain ice-wedge polygons. Small unmapped organic deposits occur in most terrain units*

A — ***ALLUVIAL DEPOSITS:*** *silt, sand, and gravel deposited by modern streams and rivers; deposits generally are stratified and moderately sorted; 1 to 5 m thick; occurs as floodplains and terraces*

MARINE DEPOSITS: *clay, silt, sand, and gravel; massive to well laminated silt and clay, and massive to cross-stratified and planar stratified sand; 1 to 20 m thick; deposited during marine regressions, resulting in a coarsening-upward sequence; may include fine-grained glaciomarine sediments exposed at the base of stratigraphic sections; may contain segregated and disseminated ground ice; rounded pebbles and cobble gravel form raised beaches indicated by symbols; commonly fossiliferous*

M3 — ***Littoral sediments:*** *medium to coarse sand with pebbles, may also consist of small cobbles and shingles; 1 to 3 m thick; blanket deposits, with flat to gently undulating surfaces, in places overlies fine-grained sediments; may contain beach ridges and ice-wedge polygons indicated by symbols*

M2 — ***Marine blanket:*** *undifferentiated clay and silt with minor sand and rare cobbles, from 2 to to 20 m thick; commonly occurs as a coarsening-upward sequence with flat to gently undulating surface; contains segregated ice; may be gullied and exhibits retrogressive thaw flow slides and ice-wedge polygons indicated by symbols*

M1 — ***Marine veneer:*** *undifferentiated sediment, consisting of a clay to sand matrix containing pebbles, cobbles, and boulders but predominantly silt and sand, less than 2 m thick; occurs as sediments infilling depressions between bedrock outcrops and as a lag on washed bedrock and till surfaces below marine limit*

PLEISTOCENE (WISCONSIN GLACIATION)

GLACIAL ENVIRONMENT

D — ***GLACIOMARINE AND MARINE DELTAS:*** *sand, gravel, and cobbles, massive to cross-stratified; up to 15 m thick; exhibits channelled surfaces, ice-wedge polygons, and beach ridges*

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 bedded; deposited by water flowing from, or in contact with, glacier ice; may contain massive ground ice. Zones of washed bedrock (meltwater scours), isolated kame deposits, and boulder lags shown by symbols*

G2 — ***Outwash:*** *sand to rounded gravel; massive to cross-stratified; 2 to 20 m thick; deposited at or beyond the ice margin; occurs as braided fans and outwash plains with ice-wedge polygons; may exhibit raised beaches indicated by symbols*

G1 — ***Esker sediments:*** *silt, sand, 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; forms anastomosing or subparallel segments of subaerially exposed ice-walled channels; may exhibit raised beaches and ice-wedge polygons indicated by symbols*

TILL DEPOSITS: *unsorted glacial debris (diamicton), consisting of a silt to sand matrix with pebbles, cobbles, and boulders; deposited beneath, or along the margin of, glaciers as lodgment till, ablation till, and gravity flow deposits; commonly fossiliferous below marine limit*

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; occurs as a discontinuous layer where rock structure is generally visible on airphotos, and as a lag on washed bedrock below marine limit; unit may include bedrock outcrop, till blanket, and marine sediments below marine limit*

PRE-QUATERNARY

BEDROCK: *Archean metavolcanic, granitic, and gneissic rocks. Proterozoic sedimentary rocks, mafic dykes, and sills; may include patches of till and marine veneer; areas of scoured, shattered and frost-heaved rock are shown by symbols*

R4 — *Gabbro sills and dykes*

R3 — *Sedimentary rocks*

R2 — *Granitic and gneissic rocks*

R1 — *Metavolcanic rocks*

Geological boundary
Retrogressive thaw flow slide
Large solifluction lobes
Frost heaved and shattered rock
Ice-wedge polygons
Raised beach
Area of meltwater scour
Lag concentration of glacially abraded boulders
Subglacial or proglacial meltwater channel
Esker (direction of flow known, unknown)
Kames
Drumlinoid till form
Crag and tail
Roche moutonnée or whaleback
Striation (ice flow direction known, ↕ = older)
Gossan G
Small rock outcrop
Sample site

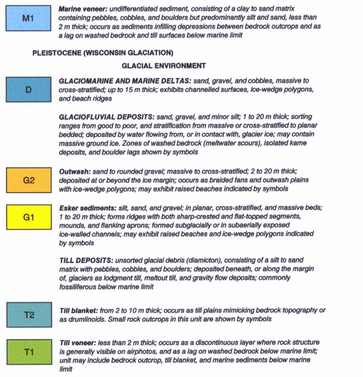


Figure 1. Generalized bedrock geology, showing selected mineral deposits, gossans (G), and Au, Ag or Cu showing (x); modified from Roscoe (1984) and Gebert (1993).

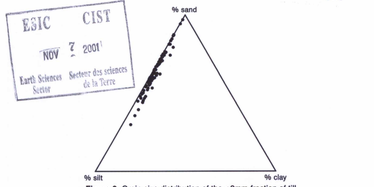


Figure 2. Grain size distribution of the < 2mm fraction of till

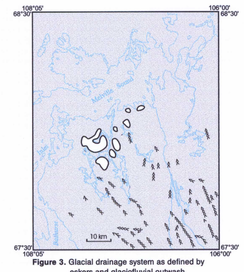


Figure 3. Glacial drainage system as defined by eskers and glaciofluvial outwash. Area submerged by postglacial sea below ~ 220 m a.s.l. is shaded.

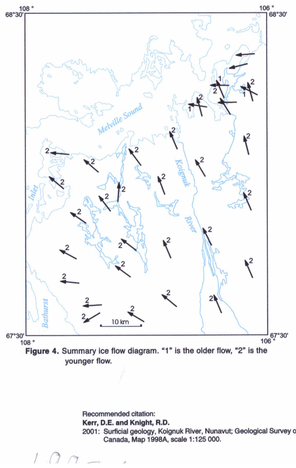


Figure 4. Summary ice flow diagram. "1" is the older flow, "2" is the younger flow.

Recommended citation:
Kerr, D.E. and Knight, R.D.
2001: Surficial geology, Koignuk River, Nunavut; Geological Survey of Canada, Map 1998A, scale 1:125 000.

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