A PRELIMINARY REPORT ON DRIFT PROSPECTING STUDIES IN LABRADOR: PART II

R.A. Klassen

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Abstract

A study of glacial history and till geochemistry in east-central Labrador was continued during 1983. The last directions of regional ice flow were northeastward in the northern part of the area, and eastward to southeastward in the southern part. An earlier northward to north-northeastward phase of flow is recognized. Trace element geochemistry of clay-size and of pebble-size fractions of till is influenced by weathering (soil development). Trace metals are most abundant within the C soil horizon and decrease upward through the B and A horizons. Variations in the regional geochemistry of copper, nickel, and uranium in till generally match changes in regional bedrock type.

Résumé

L'étude de l'histoire glaciaire et de la géochimie des tills dans le centre-est du Labrador s'est poursuivie en 1983. L'écoulement régional le plus récent de la glace s'est fait en direction du nord-est dans la partie nord de la région et vers l'est et le sud-est dans la partie sud. Une phase d'écoulement plus ancienne vers le nord au nord-nord-est y est identifiée. La géochimie des oligo-éléments dans les fractions de till de la taille des argiles et des galets dépend du degré d'altération (évolution des sols). Les métaux à l'état de traces sont plus abondants dans l'horizon C et leur quantité diminue vers le haut dans les horizons B et A. Les variations dans la géochimie régionale du cuivre, du nickel et de l'uranium dans le till suivent généralement les changements dans le type de socle régional.

INTRODUCTION

The history of regional ice movement and the composition of drift in central and eastern Labrador have been studied by the Geological Survey to assist the development of drift prospecting techniques. Areas of fieldwork during 1982 and 1983 included the eastern part of Snegamook Lake (13K) and western part of Rigolet (13J) map areas (Melody Lake area), and during 1983, the eastern part of Ossokmanuan Lake (23H) and western part of Winokapau Lake (13E) map areas, (Churchill Falls area). This report refers only to results of field and laboratory work from the Melody Lake area; it expands on earlier comments by Klassen (1983) concerning ice flow directions and presents geochemical data based on analysis of samples collected during 1982.

Acknowledgments

Field assistance was capably and cheerfully provided by Mr. E. Ochs. Dr. C.F. Gower, Department of Mines and Energy, Newfoundland, provided camp logistical support and geological information concerning bedrock units and the origins of erratics, and he is thanked for his help. Mr. R. Bartlett, pilot, is thanked for his help and flying skills.

BEDROCK GEOLOGY

The study area occupies parts of the Nain and Grenville structural geological provinces and parts of the Makkovik Sub-Province. Bedrock includes a crystalline complex of gneiss, granite, and granitoid rocks of Archean to Helikian ages, and a sequence of sedimentary and volcanic supracrustal rocks of Aphebian and Helikian ages (Fig. 1). The supracrustal rocks include the Aphebian Moran Lake and Aillik groups, and the Paleohelikian Bruce River and Seal Lake groups. In the southern part, sedimentary rocks of the Hadrynian Double Mer Formation outcrop. The Proterozoic supracrustal rocks form part of the Central Mineral Belt of Labrador and are known to contain uranium and copper mineralization (Ryan, 1981, 1982a, b).

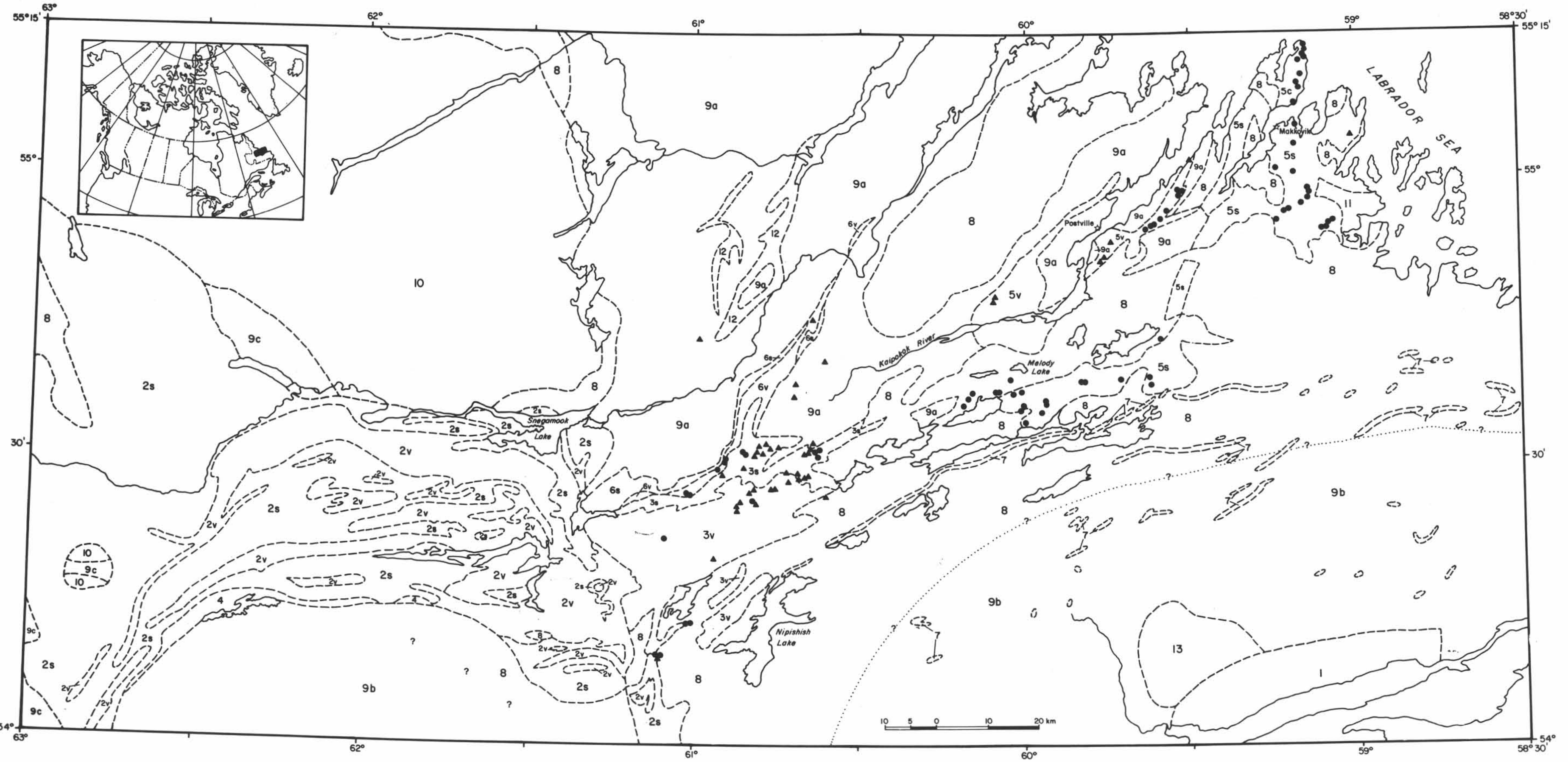
PREVIOUS WORK

Surficial materials of the study area have been mapped at 1:250 000 scale by Fulton et al. (1980a, b). Brief descriptions of ice flow directions in the Melody Lake area have been given by Vanderveer (1982) and Klassen (1983), who estimated that the last directions of regional ice flow were towards the east and southeast in the southern part of the study area and towards the northeast in the northern part. Both authors also found indications of ice flow oriented at about north to north-northeast. Klassen (1983) described erratics of sedimentary rock within the Melody Lake area derived from bedrock sources located more than 50 km to the west.

METHODS

The program of field sampling was conducted with helicopter (Bell 206) support. Sampling during 1983 was extended to the south and east of areas visited during 1982 to provide more complete coverage of the region. During reconnaissance mapping flights, landings were made to examine surficial deposits, landforms, and the evidence of ice flow directions, and till was sampled routinely for examination of clast lithology and for geochemical analysis. Throughout the study area till samples were collected at a density of about 1 per 10 000 ha for the purpose of characterizing regional variation in till composition. Samples were spaced more closely, at about 1 per 100 to 1 per 10 ha, near areas of known mineralization (eg. Michelin deposit) and areas of known mineralized erratics. Pits were dug to depths of 40-100 cm, depending on the depth to bedrock and the presence of coarse clasts, and samples were collected from the least oxidized soil horizon encountered near the base of the pit. To investigate the influence of weathering (e.g., soil development) on geochemistry, soil horizons were sampled sequentially in 15 test pits located throughout the area.

[1] Contribution to Canada-Newfoundland co-operative mineral program 1982-84. Project carried by Geological Survey of Canada



1 Double Mer Formation (Hadrynian)
conglomerate, arkose, sandstone

☼ 2 Seal Lake Group (Paleohelikian)
2s quartzite, conglomerate, arkose, sandstone, shale
2v mafic sills and flows

☼ 3 Bruce River Group (Paleohelikian)
3s conglomerate and sanastone
3v mafic and felsic volcanic rocks

Mineralization
▲ Copper
● Uranium

☼ 4 Letitia Lake Group (Paleohelikian)
felsic volcanic rocks, sedimentary rocks

☼ 5 Aillik Group (Aphebian)
5s rhyolite, acid volcanogenic sediments, conglomerate
5v metabasalts, metasiltstones and sandstones

☼ 6 Moran Lake Group (Aphebian)
6s mudstone, slate, quartzite, siltstone, sandstone, dolostone
6v mafic volcanic and metavolcanic rocks

☼ Supracrustal rocks of the Central Mineral Belt
★ no stratigraphic order implied

★ Intrusive and Metamorphic Rocks

7 Gabbro (Michael Gabbro)
8 Granitoid Intrusive Rocks
9 Gneiss
9a Hopedale Metamorphic Complex
9b Grenville Province
9c Churchill Province
10 Anorthosite Suite
11 Gabbro (Adlavik Intrusive Complex)
12 Metavolcanic rock and volcanogenic sediments
13 Mafic Intrusive (granulite facies)

Figure 1. *Generalized geological map of the Melody Lake study area and adjacent regions, east-central Labrador. Geology after Greene (1970), Gandhi (1978), Wardle and Bailey (1981), Gower et al. (1982), and Ryan (1981, 1982a, b).*

Figure 2

Bouldery ribbed moraine, shown forming a ridge oriented across the central part of the photograph between the lakes, is common within the study area. The boulders, which are large (>2 m) and form a nearly continuous cover, are most common in areas of granitoid bedrock south of Kaipokok River. Tree cover provides ground scale. (GSC 203803-I).

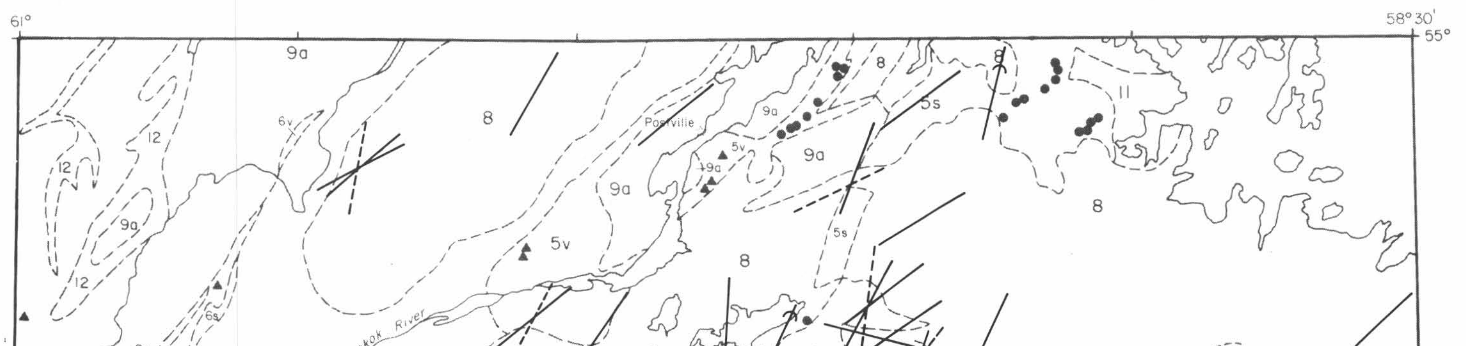


Figure 3. Ice flow trends, based chiefly on glacial striae. Regional ice movement was generally eastward, based on streamlined bedrock landforms. Striae trending nearly north, found at four locations, are considered to predate the last phase of regional ice flow. A magnetic declination of N32°W has been assumed for all measurements. Bedrock geology is explained in Figure 1.

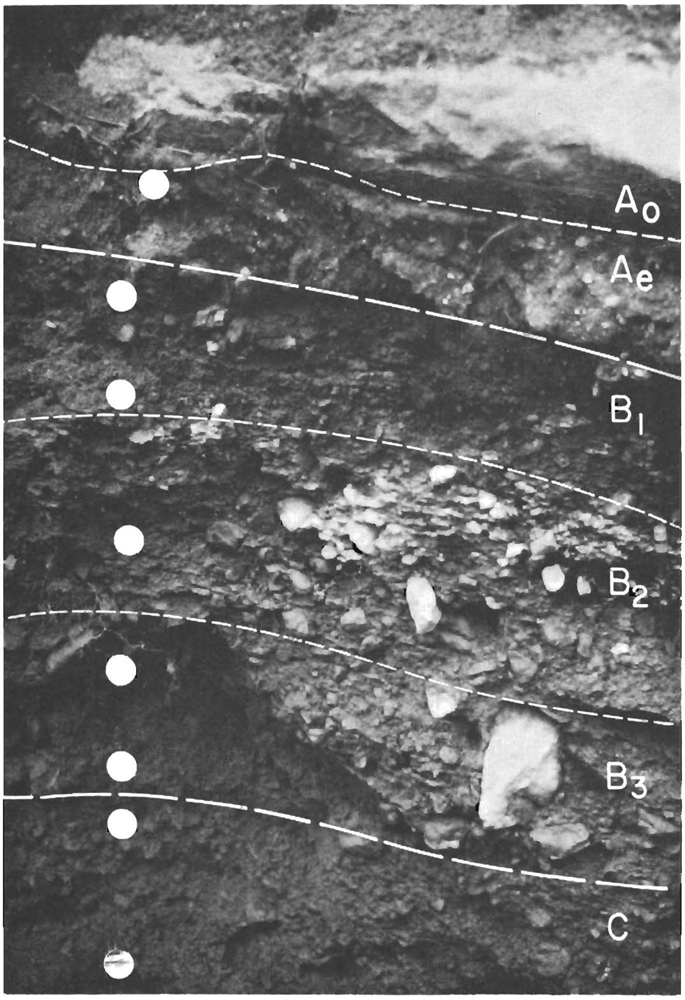


Figure 4. Podzol-like soil profile showing the different soil horizons commonly encountered during excavation of sample pits. Samples were collected at the points marked, and their trace metal contents are given in Figure 5. (GSC 203803-P).

The geochemical properties of till reported here are based on analysis of the clay-size (<0.002 mm) and of the pebble-size (2-4 mm) fractions. The two size fractions were chosen to compare the trace metal contents of two components of till that are considered likely to be distinct in their mineralogical and lithological makeup, and to further examine the influence of near-surface weathering. Clay is considered likely to retain elements released during weathering due to its higher content of phyllosilicate minerals and, consequently, its relatively high cation exchange capacity. Analysis for copper, lead, zinc, nickel, chromium, molybdenum, manganese, and iron was done, using atomic absorption methods, by Bondar-Clegg and Company Ltd. (Ottawa). Analysis for uranium was done using fluorimetric and delayed neutron activation methods.

RESULTS AND DISCUSSION

Surficial geology

Within the Melody Lake area till is extensive at the surface and is characteristically sandy and bouldery. In the northern part, till is thin (<2 m) to discontinuous over hilltops, and is much thicker across valley floors where it forms extensive areas of ribbed moraine (Rogen moraine) (Fig 2). In areas of granitoid rocks, south of Kaipokok River, till is dominated by large (>2 m) boulders that form a nearly continuous surface cover. Sampling of till in such areas can be extremely difficult due to the boulder cover.

In the southern part of the area, which is underlain by gneisses of the Grenville Province, till appears generally to be sandier and thicker, forming extensive areas of hummocky drift and streamlined landforms in the lee of bedrock hills. Some till deposits were found to be partially stratified, containing sand lenses and minor bedding, and are considered to have been deposited during deglaciation.

Directions of ice movement

Glacial striae vary in orientation from north-northeast to southeast within the Melody Lake study area (Fig. 3). Across the northern part of the area nearly all striae are oriented generally northeast, and across the southern part they are generally southeast to east. Because many were measured on hilltops and, in some cases, are oriented across topographic trends, the striae are thought to be the product of the last major phase of regional ice movement. Streamlined crag-and-tail landforms in the southern part (Fulton et al., 1980a) are similar in orientation to the striae reported here and indicate that ice flow was eastward towards the Labrador Sea; no evidence of flow having a westward component has been recognized.

At four separate locations striae and small grooves trending north to north-northeast, across the regional trends reported above, were observed (Fig. 3). At three of the sites the glacial markings were poorly defined and were not found within glacial polish. The fourth site was located near the coast, at the summit of Monkey Hill (elevation 700 m a.s.l.), overlooking the town of Makkovik, where all recorded striae in glacial polish trended N13°E; the streamlined form of bedrock at the summit indicated northward ice flow.

The nearly northward-oriented striae are interpreted to have been formed prior to the last regional phase of ice flow because they are not found generally within glacial polish and are poorly preserved. They indicate that a dispersal centre could have been located south to southwest of the study area during their formation. Alternatively, the ice moving eastward towards the Labrador Sea could have been turned northward within the Melody Lake area by flow from a separate dispersal centre located to the east or southeast.

With regard to the marked variations in directions of ice flow within the study area, reported above, the orientations of glacial dispersal trains could be expected to vary accordingly. Prospecting for the bedrock sources of dispersal trains requires that the regional history of ice flow be known to establish how local flow directions could have changed during the course of glaciation.

Distributions of indicator lithologies

Erratics of sedimentary rock, including red arkosic sandstone, conglomerate, and red quartzite derived from Proterozoic units west of Nipishish Lake (Fig. 1), were found as far east as the area of Postville and the western flanks of Mount Benedict. Their distribution is extended eastward of that reported by Klassen (1983) and demonstrates glacial transport distances of more than 100 km. Source areas are considered to most likely include the Seal River and Bruce River groups (Fig. 1).

Compositional evidence of early northward ice flow has not been recognized.

Till geochemistry

Soil profiles appear commonly to be Podzol-like, having a surface organic-rich Ao horizon, a bleached eluviated Ae horizon and iron-stained B_1 and B_2 horizons all of which overlie sediment without obvious weathering – the C horizon (Fig. 4). At wet, poorly drained sites, soils generally lack an eluviated horizon, the zone of iron stain is wider, and iron oxides can form a cemented (ortstein) layer.

Trace element geochemistry of till varies with the position of the sample within the near-surface zone of weathering. Among samples collected from individual soil profiles, the content of trace metals within clay is consistently greatest within the least weathered part of the profile exposed at the base of sample pits and decreases upwards to the eluviated horizon (Fig. 5). Metal concentrations within the clay-size fraction can change by an order of magnitude between the bottom and top of metre-deep pits for some of the elements analyzed. Although relative change in metal content is much greater within clay, profiles of the trace metal variation in the pebble-size fraction appear similar to those based on analysis of clay and metal concentrations decrease upward within test pits.

The geochemical differences observed within the sample pits are associated here with weathering processes and are not the result of compositional change associated with a bipartite sequence of 'basal' till and overlying 'ablation' till. Neither lithological nor gross textural change was noted within the test pits to indicate the presence of two compositionally distinct sediment types. In addition, the patterns of change in trace elements match closely those of iron and manganese which are easily mobilized and are associated with soil development.

The abundance of trace metals is not greatest within the iron-stained B horizon, contrary to the generalized profile shown by Levinson (1974, p. 98). The profiles (Fig. 5) indicate that in both size fractions, trace elements are depleted in the A and B horizons relative to their levels within sediment of the underlying C horizon. Similar trends

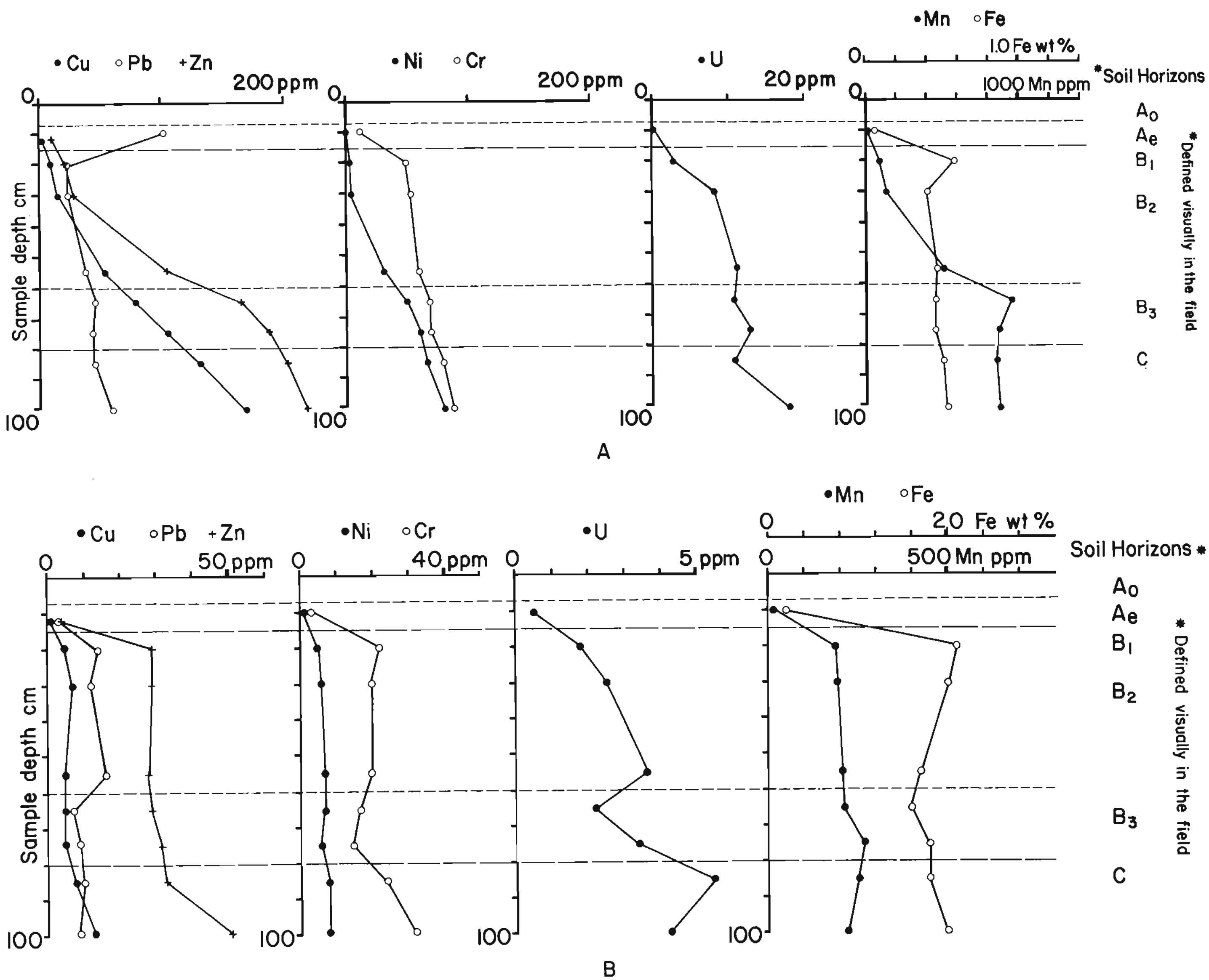


Figure 5. Trace element variation in (A) clay-size (<0.002 mm) and (B) pebble-size (2-4 mm) fractions within the soil profile shown in Figure 4. The pit was dug within a dispersal train of uraniferous erratics, and metal contents are generally greater than found elsewhere in the study area. The shapes of the trace element profiles are, however, typical.

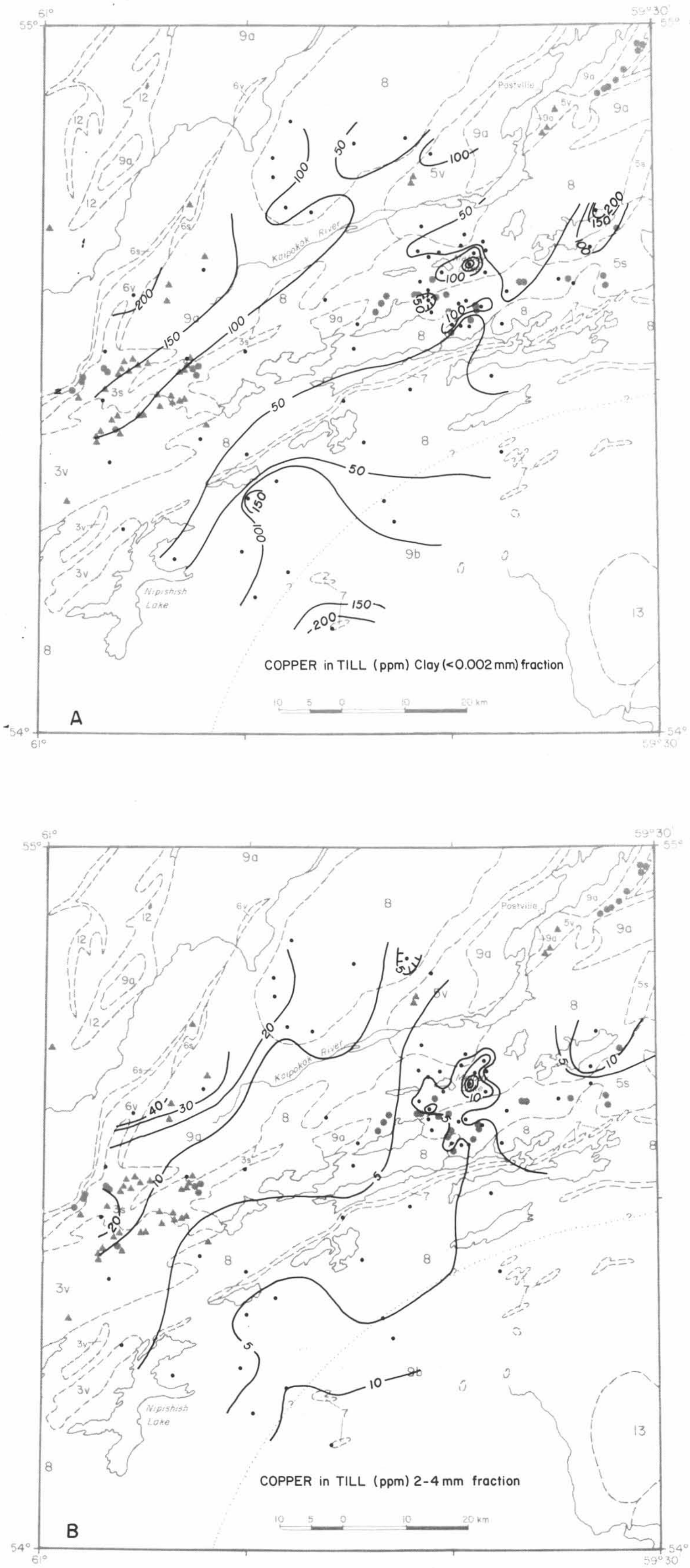


Figure **6.** *Regional variation in the copper content in the (A) clay-size (<0.002 mm) and (B) pebble-size (2-4 mm) fractions of till. Bedrock geology is explained in Figure 1.*

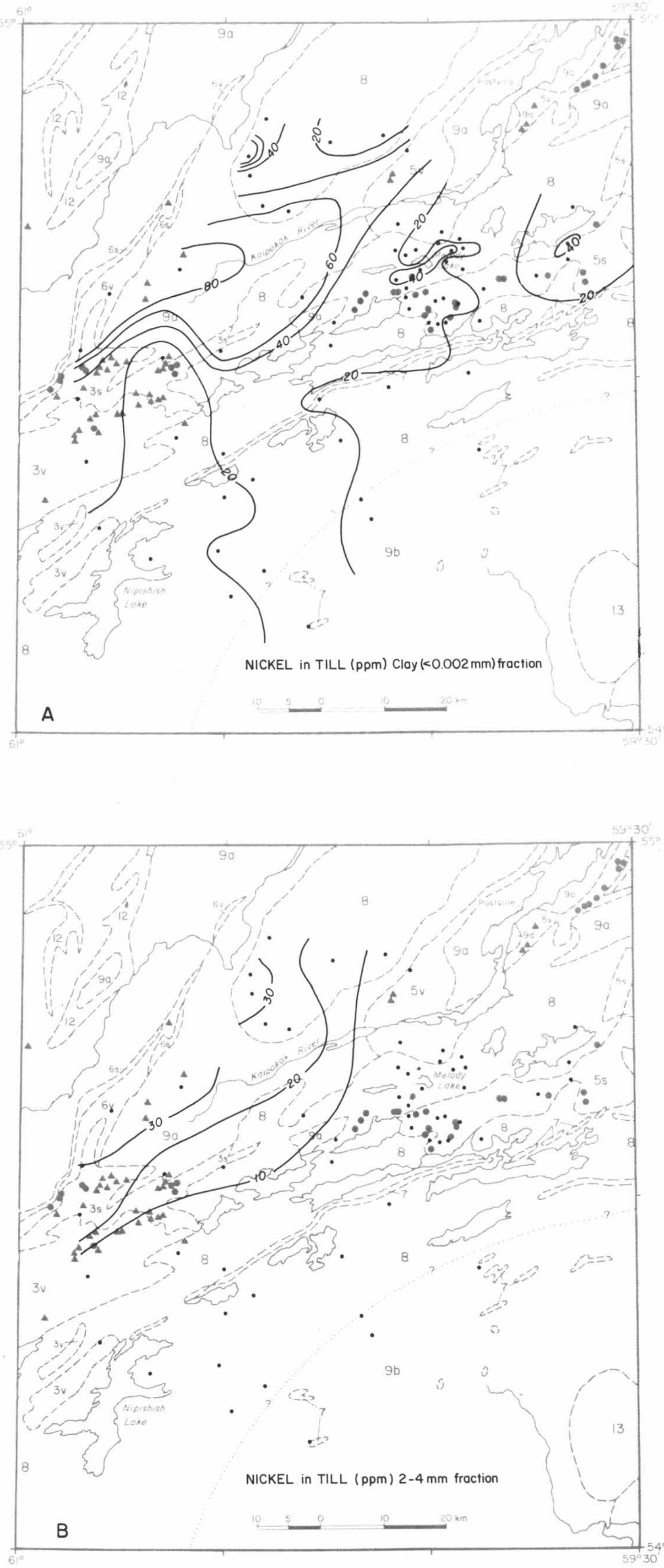


Figure **7.** *Regional variation in the nickel content in the (A) clay-size (<0.002 mm) and (B) pebble-size (2-4 mm) fractions of till. Bedrock geology is explained in Figure 1.*

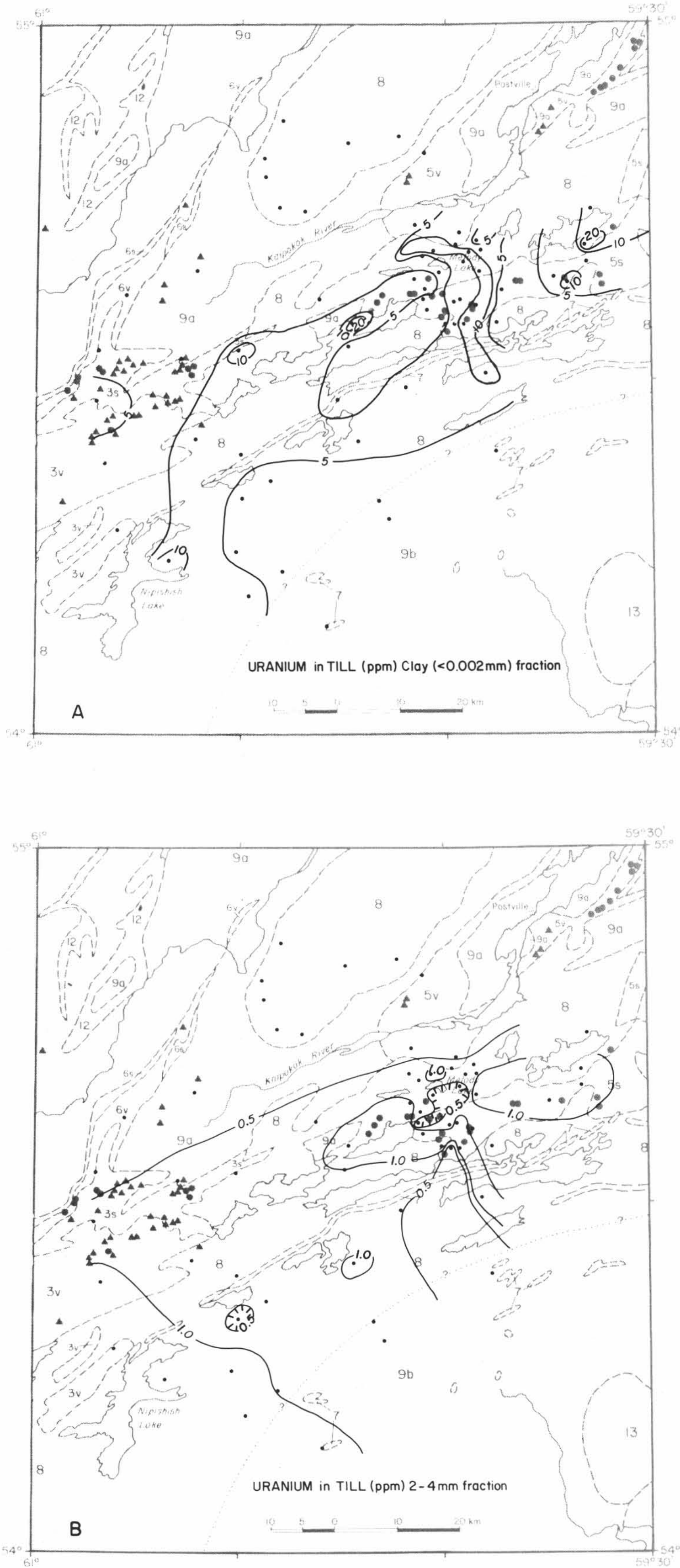


Figure 8. Regional variation in the uranium content in the (A) clay-size (<0.002 mm) and (B) pebble-size (2-4 mm) fractions of till. Bedrock geology is explained in Figure 1.

were found in pits dug in areas of 'background' and 'anomalous' metal levels. Because there is less relative change in metal concentration among samples collected near the base of the B or upper C soil horizons, the least oxidized sediment provides a better basis for geochemical comparison among samples from different sites.

Despite the geochemical variation related to weathering, broad trends in the geochemistry of till appear to reflect differences in regional bedrock geology (Fig. 6 to 8). The general distribution of trace elements in till is similar for the clay and pebble fractions, although contour patterns are slightly more complex for the clay fraction. Contoured patterns follow the regional northeast to east strike of the principal bedrock units, and trace element levels can vary significantly across the study area.

Copper and nickel levels are greatest in the northwest part of the study area, in areas of gneiss of the Nain Province, and are least in the southeastern part in areas of gneiss and granitoid rocks of the Grenville Province. Areas of Bruce River volcanic rock in the west-central part, which are characterized by numerous reported sites of copper mineralization (Ryan, 1982a, b), are not associated with regionally higher levels of copper in till (Fig. 1).

High copper and nickel concentrations at the western edge of the granite complex north of Kaipokok River could be due either to the composition of local bedrock or to northeastward glacial transport of metal-enriched till. Although the correct interpretation is not known, it is noted that elsewhere over the granite, metal concentrations are low. Till to the southwest (up ice) of the granite, however, is characterized by regionally elevated metal levels.

Regional geochemical patterns associated with uranium differ from those of copper and nickel and outline a central zone of enrichment that is more or less coincident with supracrustal rocks of the Central Mineral Belt and, in particular, the Aillik Group. Within the central zone, single samples characterized by anomalously high uranium levels occur. The significance of the anomalous samples is unclear, although they would appear to be related to local bedrock sources. Sites of known uranium mineralization (Fig. 1) are reported by Ryan (1982a, b).

CONCLUSIONS

The principal directions of ice flow within the study area during the last regional phase of glaciation are northeastward in the northern part of the area and eastward to southeastward in the southern part. There is indication of an earlier, nearly northward to north-northeastward phase of flow. Erratics of sedimentary rock derived from supracrustal bedrock suites have been found to the eastern limits of the area, demonstrating glacial transport distances of more than 100 km.

The geochemistry of till is influenced by weathering (soil formation), and trace metal levels are greatest within sediment of the least weathered (C horizon) zone for the clay-size (<0.002 mm) and pebble-size (2-4 mm) fractions. Consequently, analysis of the till collected from the C horizon is considered to provide the best basis for geochemical comparison of samples collected from different sites.

Patterns of regional geochemical variation in till generally outline the major geological units, although elevated metal levels do not necessarily indicate areas of greatest mineral potential, as indicated by the distribution of mineralized showings in bedrock. The trace element levels in till reported here provide a background for the recognition of anomalous samples encountered at a more detailed scale of sampling within the Melody Lake area.

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