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QUATERNARY MAPPING–GLACIAL-DISPERSAL STUDIES, SOPS ARM AREA, NEWFOUNDLAND

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ABSTRACT

Quaternary mapping is being conducted in the Sops Arm area of west-central Newfoundland. Regional mapping of a 25-by-50-km area and more detailed analyses of a 6.5-by-11.5-km area were undertaken to define glacial transport directions and the distribution of glacigenic sediments. In addition, till sampling along grids in the vicinity of two gold prospects (Browning Mine and Wizard) is being used to pattern glacial dispersal, both in the matrix (by geochemistry) and in the pebble fraction.

Two glacial-flow regimes have been identified, an earlier flow toward the east (080–110°) that affected the whole study area, and a later flow toward the north-northeast (020–050°) that affected mainly the area south of Sops Arm. The area south of Sops Arm where exploration is concentrated is typically covered by a substantial thickness of till.

Pebble-clast analysis was used to define the occurrence of clasts derived from the mineralized zones, and the road cut at the Wizard Prospect allows the definition of vertical glacial dispersal through 3 to 8 m of till. This dispersal is characterized by two trails, one sub-horizontal and parallel to the bedrock–till interface, and the other inclined toward the surface at an angle of 20 to 30 degrees.

Gold mineralization in the area is associated with numerous small alteration zones. This study shows that these zones may be identified by searching for the larger targets in till that were produced by glacial dispersal.

INTRODUCTION

The Sops Arm area has been the scene of gold exploration and some limited mining dating from the early 1900's (Snelgrove, 1935). Gold production from the Browning Mine amounted to 149 ounces. The recent interest in gold, and the discovery of the Hope Brook gold deposit on the south coast of Newfoundland, has brought about a revival of gold exploration across the island, including the Sops Arm area.

The objectives of this study are to determine the direction of glacial transport, to characterize glacial dispersal patterns (especially for gold), and to map the distribution of surficial landforms. McConnell *(this volume)* is carrying out a study to evaluate the effectiveness of standard geochemical prospecting techniques for gold, particularly in soil, stream sediment, stream water and lake sediment. The study of glacial dispersal patterns provides a framework to more fully evaluate the influences of glacial depositional environments on the geochemical distribution of gold.

Definition of Study Area and Program

The community of Sop's Arm is located on Sops Arm, White Bay, in west-central Newfoundland and can be accessed from the Trans-Canada Highway along Route 420. General field reconnaissance was carried out over a 25-by-50-km area (Figure 1), bounded by Jackson's Arm in the north, White Bay in the east, the Long Range Mountains in the west, and the Deer Lake basin and Turners Ridge in the south. A more detailed review of the surficial landforms was conducted over a 6.5-by-11.5-km area (Figure 1) that includes seven of the known gold prospects, west and south of Sops Arm. The Browning Mine (located about 1 km south of Corner Brook Pond) and the Wizard prospect (located about 1.5 km west of Corner Brook Pond) were selected for detailed grid sampling aimed at defining the glacial dispersal pattern of gold in each of these areas.

General Geology

The generalized geology of the Sops Arm area (Smyth and Schillereff, 1981; Erdmer, 1986) is shown in Figure 1. Silicic tuffs and shales of the Silurian Sops Arm Group host the Unknown Brook, Browning and Simms Ridge gold prospects. These rocks were subjected to carbonate–sericite–chlorite (pyrophyllite?) alteration associated with an epithermal–fumarolic hydrothermal system (Tuach, 1986). The volcanic rocks are bounded to the west by the Cambro-Ordovician Coney Arm Group, which overlies Precambrian Long Range granitoids of the Grenville Inlier, and to the south by the Devonian Gull Lake Intrusive Suite. Carboniferous sedimentary rocks of the Deer Lake and Anguille groups occur in the southern and eastern parts of the study area respectively.

SURFICIAL LANDFORMS

The distribution of the main surficial landforms within the detailed study area is shown in Figure 2. Unit 1 consists

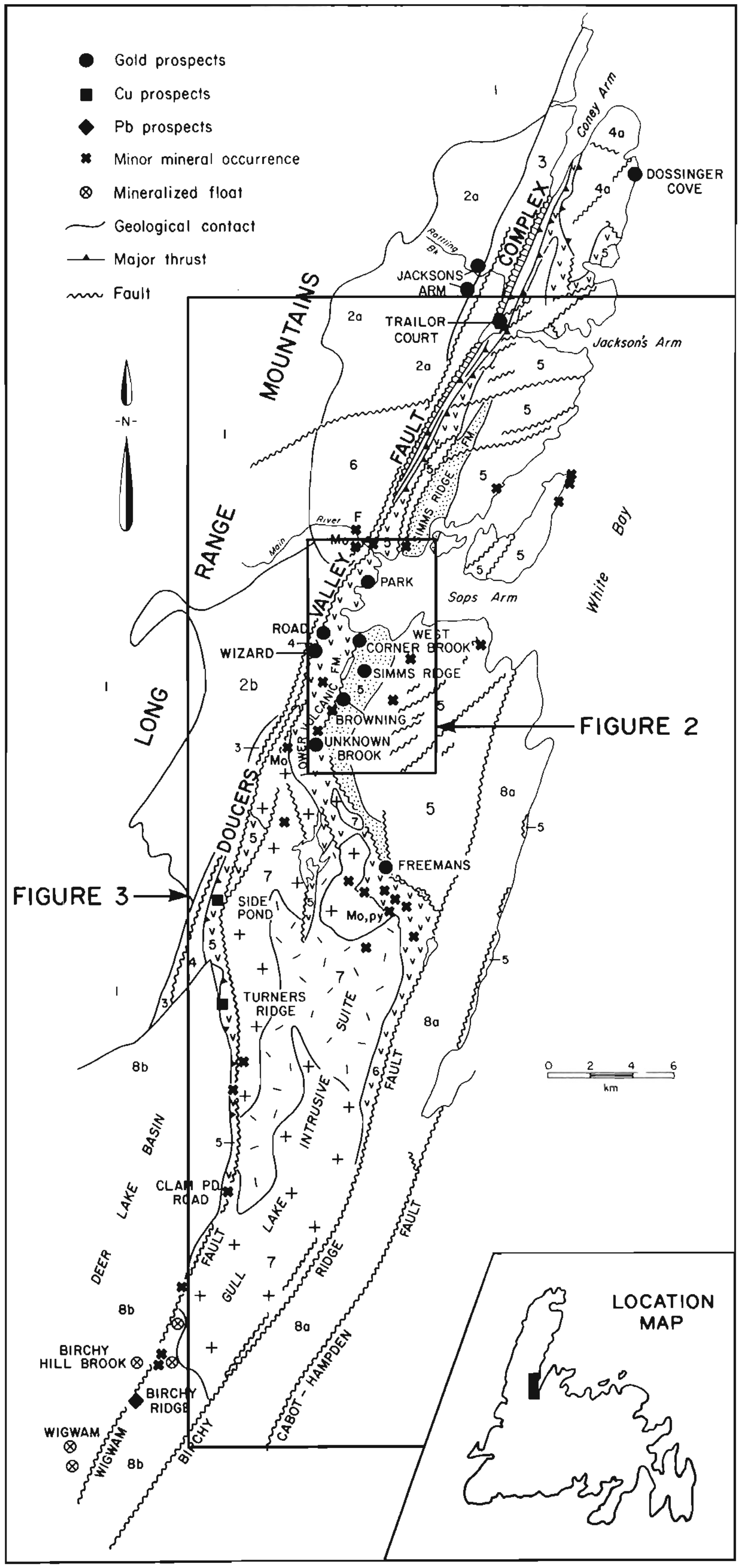

Figure 1. *General geology of study area (after Smyth and Schillereff, 1982; Erdmer, 1986).*

LEGEND

UPPER PALEOZOIC (Basin-fill sequences and intrusions)

CARBONIFEROUS

8 8b, Deer Lake Group (Visean): *conglomerate, sandstone, siltstone;* 8a, Anguille Group (Tournaisian): *graywacke, shale, minor sandstone and conglomerate*

DEVONIAN (approximately 398 Ma)

7 Gull Lake Intrusive Suite; 7a, *granites;* 7b, *intermediate and mafic intrusive rocks*

6 Devils Room Granite

SILURIAN

5 Sops Arm Group

LOWER PALEOZOIC ALLOCHTHON

CAMBRIAN–MIDDLE ORDOVICIAN

4 Southern White Bay Allochthon: *partially ophiolitic (mélange containing ultramafic blocks is cross-hatched);* 4a, Coney Head Complex

LOWER PALEOZOIC AUTOCHTHON (Platform)

3 Coney Arm Group: *carbonate, shale, quartzite*

PRECAMBRIAN (Grenvillian basement)

MIDDLE PROTEROZOIC AND EARLIER

2 *Massive to foliated, feldspar-megacrystic, granitoid plutons;* 2a, French–Childs granodiorite; 2b, Main River granite

1 *Leucocratic gneiss, amphibolite, and gabbro*

mainly of barren outcrop although valleys may be covered by forest. Thin (less than 1 m) and discontinuous deposits of a till veneer occur locally. Unit 1 occurs in the higher terrain of the Long Range Mountains, to the west, and dominates the eastern part of this area. Unit 2 comprises colluvium that occurs as an apron at the base of some steeper slopes. Unit 3 is a continuous mantle of till, 1 to 3 m thick, that obscures most bedrock features and occurs in the central part of the area, generally along the flanks of intermediate slopes. Unit 4 comprises till accumulations that are generally greater than 3 m thick, locally reaching 5 to 10 m in thickness. The area southwest of Corner Brook Pond, which also includes the major gold prospects, is dominated by Unit 4. Unit 5 generally occurs in the lower elevations along the major river and stream valleys, and comprises glaciomarine (shell bearing in some areas) silt and clay that grade upward into glaciomarine–glaciofluvial sand, which is in turn overlain by gravel. This sequence (Unit 5) is typical of sediments deposited during postglacial marine inundation, which occurs while the land surface is still down-warped (due to the former ice loading). The inundation is accompanied by the deposition of silt and clay into proglacial marine embayments, followed by prograding sand overlain by gravel. During isostatic rebound, these deposits are raised above marine level and the streams incised to present levels.

Shells were discovered at the southwest edge of Corner Brook Pond and a subsequent carbon-14 date (Radiocarbon Laboratory, Geological Survey of Canada, Lab. No. GSC 4023), on *Mya Truncata,* yielded an age of 10,200 $\pm$ 100 years B.P. These shells occur at an elevation of 27 m above sea level (a.s.l.), near the upper contact between the marine silt–clay and the overlying sand and gravel terrace, which has a surface elevation of 30 m a.s.l. This date suggests that at least the coastal areas of the Sops Arm and White Bay areas, and possibly major parts of inland areas, were ice-free (deglaciated) by 10,200 years B.P.

GLACIAL TRANSPORT

Mapping of glacial features, particularly grooves and striae, and observation of the distribution of Long Range rock types were carried out. Miniature crag and tail features, outcrop stossing, crossing striae, and stoss and lee positioning

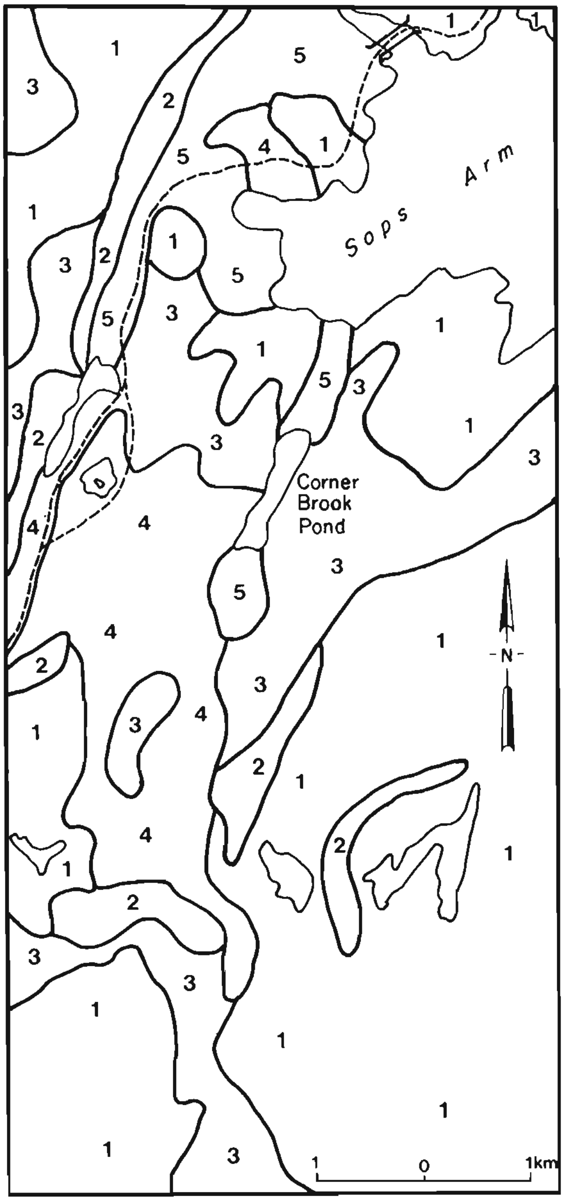

Figure 2: *Distribution of Quaternary sediments, Corner Brook Pond area, Sops Arm. Unit 1: bedrock—minor till cover may be present; Unit 2: Colluvium and talus; Unit 3: till, 1 to 3 m thick, as a continuous mantle—bedrock may be present; Unit 4: till, commonly 3 to 10 m thick; Unit 5: glaciofluvial sediments, underlain by shell-bearing marine silt and clay in some areas.*

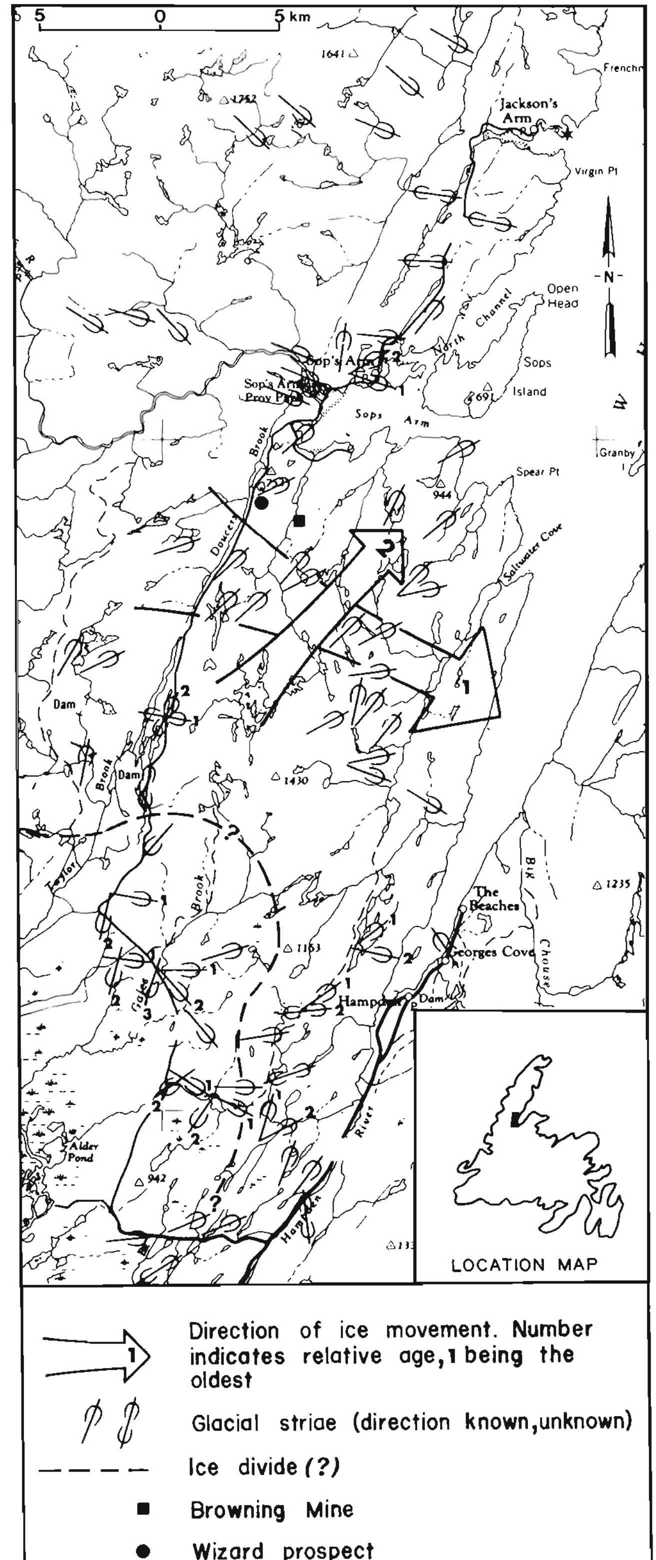

Figure 3: *Glacial flow, Sops Arm area.*

of striae were used to establish the direction of glacial movement and to determine the relative ages of glacial movement on outcrops that retained more than one set of striae. There were at least two regimes of glacial flow in the study area. The earlier ice flow (Flow 1 on Figure 3) was toward the east (080 to 110) from an ice mass that presumably was centred in the Long Range Mountains. This flow transported Grenville granite clasts and boulders across the study area, which have been identified as far east as Saltwater Cove. Subsequently, ice moved (Flow 2 on Figure 3) toward the north—northeast (020 to 050), from a centre presumed to be south of Gull Pond, crossing the central part of the study area and exiting through Sops Arm into White Bay.

The following tentative correlations of ice-flow directions in the Sops Arm area and the Upper Humber River area to the immediate south (Vanderveer and Sparkes, 1982) are suggested:

1) Flow 1, off the Long Range Mountains and toward the east in the Sops Arm area, correlates with ice flow off the Long Range Mountains (phase two) in the Upper Humber River area.

2) Flow 2 toward the northeast in the Sops Arm area correlates with the latest recorded (third phase) flow to the southwest in the Upper Humber River area. This implies that the last remnants of active ice in both areas originated from the same centre. This centre was probably located along the height of land between White Bay in the north and the Humber Valley in the south, i.e., southwest of Gull Pond.

GLACIAL-DISPERSAL STUDIES

The variable nature of the two glacial flows in the study area raises questions concerning the pattern of the resultant glacial dispersal. Two sampling programs were undertaken along grids to define dispersal from known sources of gold mineralization: one over the Browning Mine, which is exposed along Corner Brook (3 km south of Sops Arm), and the other over the Wizard prospect, which is exposed along a road cut on Route 420, about 3 km southwest of Sops Arm (Figure 3).

In both areas, a till-sampling program was carried out along established exploration-industry grid lines. The grid lines over both prospects are approximately transverse (east–northeast) to the regional bedrock structures (e.g., Doucers Valley fault complex, Figure 1). They are sub-parallel to the earlier eastward glacial flow and intersect the later northeastward glacial flow at an acute angle. Sampling was at 50-m spacings along grid lines spaced 100 m apart, within 100 m of each prospect. A spacing of 100 m, along grid lines spaced 200 m apart, was used for areas farther down-ice of the prospect.

Clast (pebble) samples were taken in conjunction with the till-sampling program for lithological analysis. The alteration zones, which host the gold-bearing quartz veins in a pyrophyllite(?)–sericite(?) matrix, are distinct from other local rock types, and therefore are being evaluated as a useful tracer in the glacial dispersal studies.

Local rock types (unaltered and altered volcanic rocks and shale) are generally the predominant clast type in most samples. However, granitic clasts, derived either from the Long Range Mountains granitoid rocks to the west, or from the Gull Lake Intrusive Suite to the south, form a significant component of the pebble fraction of some samples. The amount of altered volcanic clasts is variable, ranging from zero to less than 10 percent in some samples to being the dominant or only rock type present. A preliminary review of clast content at each grid area is as follows:

1) At the Browning Mine, local shale, which underlies the eastern part of the grid area (Figure 4-A), was present in 32 of 39 pebble samples and was the dominant clast type in all but 15 samples; unaltered volcanic rocks (Figure 4-B) were present in 17 samples and constituted the largest percentage in 8 samples, particularly in the southwestern part of the grid area (possibly reflecting the underlying bedrock geology); altered, pyrophyllite(?)–sericite(?) volcanic clasts (Figure 4-C) occurred in 6 samples. A group of 3 samples west of Corner Brook had more than 11 percent pyrophyllite(?) clasts. Granite clasts (Figure 4-D) were present in 22 of the 39 samples, and the highest granite-clast concentration is in the western part of the grid.

2) In the Wizard prospect area, clasts of locally-derived unaltered volcanic rocks (Figure 5-A) were dominant in 10 of 24 samples, particularly north of the road. The dominance of locally derived volcanic rocks in till over the central part of the grid can be related to the shallowness of the till cover. Bedrock (unaltered volcanic rocks) is exposed in the road cut and along the woods road at the western limit of the grid. Five of the 9 samples, containing clasts of altered volcanic rocks, (Figure 5-B), form a weak dispersal pattern to the northeast of the prospect, down-ice of Flow 2 (Figure 3). Granites (Figure 5-C) are present in 19 of the 24 samples and constitute the dominant clast type in 9 samples.

VERTICAL DISPERSAL PATTERN IN TILL

The road cut above the Wizard prospect allowed an opportunity to detail the vertical dispersal pattern from the alteration zone, through 3 to 8 m of glacial material. Pebble and till-matrix samples were collected at 1-m intervals from a series of trenches spaced at 10-m intervals along the face of the road cut. A continuous series of trenches were made, consisting of four trenches on the north side of the road and six on the south side road.

For presentation purposes, the results of clast analysis from only four of the ten trenches (Figure 6-A, -B, -C) are discussed here. (The diagrams in Figure 6 contain a vertical to horizontal exaggeration of 2:1, and the reader's attention is drawn to the unexaggerated schematic on each diagram.) Unaltered volcanic clasts (Figure 6-A) are present in the upper part of the section and along the base of the till cover to the northeast. Granite clasts in till (Figure 6-B) are prevalent within the middle to lower parts of the section, and commonly form the dominant clast type. Altered volcanic clasts eroded from the gold-bearing zone have been dispersed from the outcrop through the overlying till (Figure 6-C). The till plume of altered volcanic clasts forms two dispersal trails, one subparallel to the outcrop surface and another inclined toward the surface. This composite dispersal pattern is similar to the 'idealized geochemical dispersion model' described by Miller (1984). The clast-dispersal trail at the Wizard prospect slopes upward (20 to 30 degrees from the horizontal) toward the

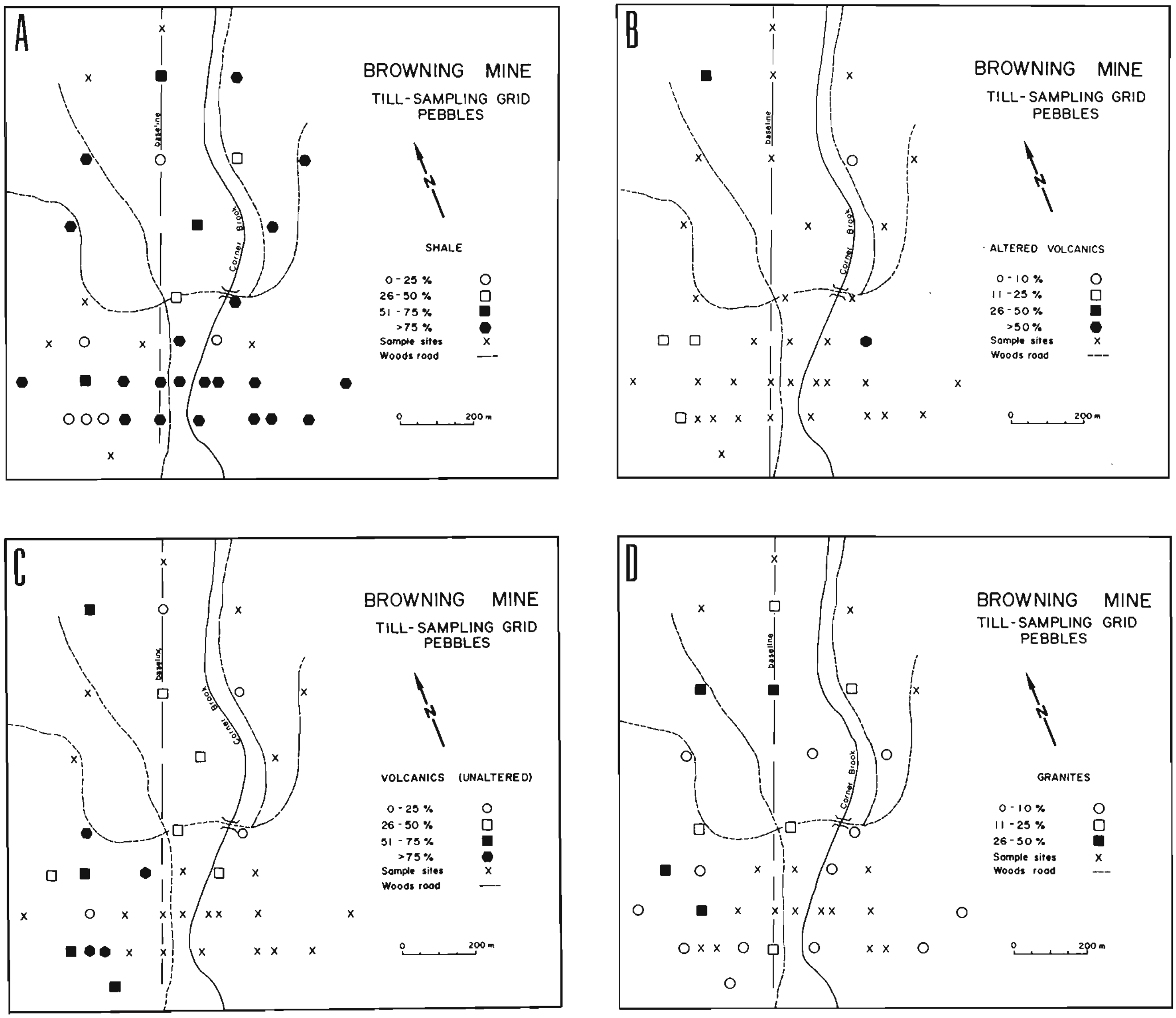

Figure 4: *Clast dispersal, Browning Mine grid, Sops Arm area, by rock type: A) shale, B) unaltered volcanic rock, C) altered (mineralized) volcanic rock, D) granite derived from sources outside the grid area.*

northeast, parallel to the last glacial movement (Flow 2, Figure 3). This clastic diapiric form reaches almost to the surface within 20 to 30 m of the up-ice contact of the mineralized zone.

Matrix samples were collected for study of textural (grain size) and geochemical variations to assist in the definition of these glacial dispersal patterns. Analyses are not yet available, but are anticipated to mirror these preliminary observations.

DISCUSSION

Much of the exploration effort in the area south of Sops Arm comprises till of varying thickness (Unit 3 and Unit 4, Figure 2). The area has also been affected by two glacial flows, an earlier flow to the east and a later flow to the northeast.

Gold mineralization in the Silurian rocks is associated with pre and posttectonic quartz veins that occur in numerous small alteration zones.

This study shows that as a result of glacial dispersal, individual mineralized zones may be located by searching for the larger target areas in glacial till. These target zones can be identified by the application of drift-prospecting techniques similar to those discussed in this study.

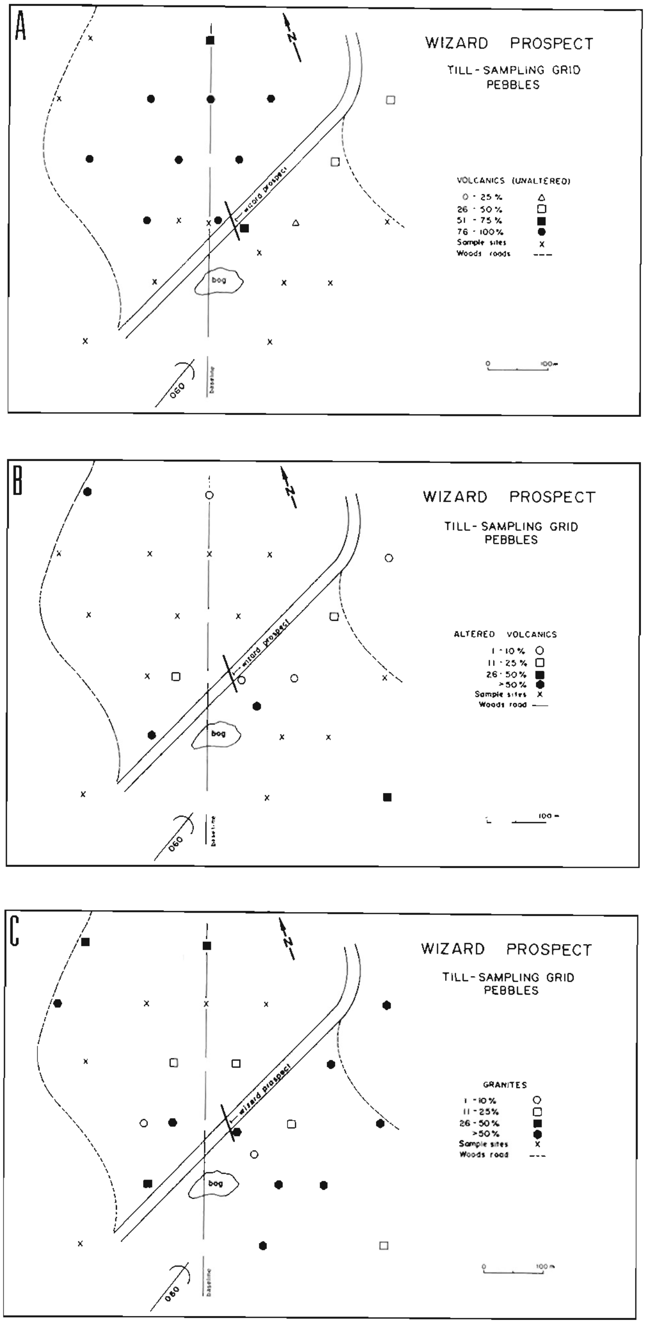

Figure 5: *Clast dispersal, Wizard prospect grid, Sops Arm area, by rock type: A) unaltered volcanic rock, B) altered (mineralized) volcanic rock, pyrophyllite(?), C) granite derived from sources outside the grid area.*

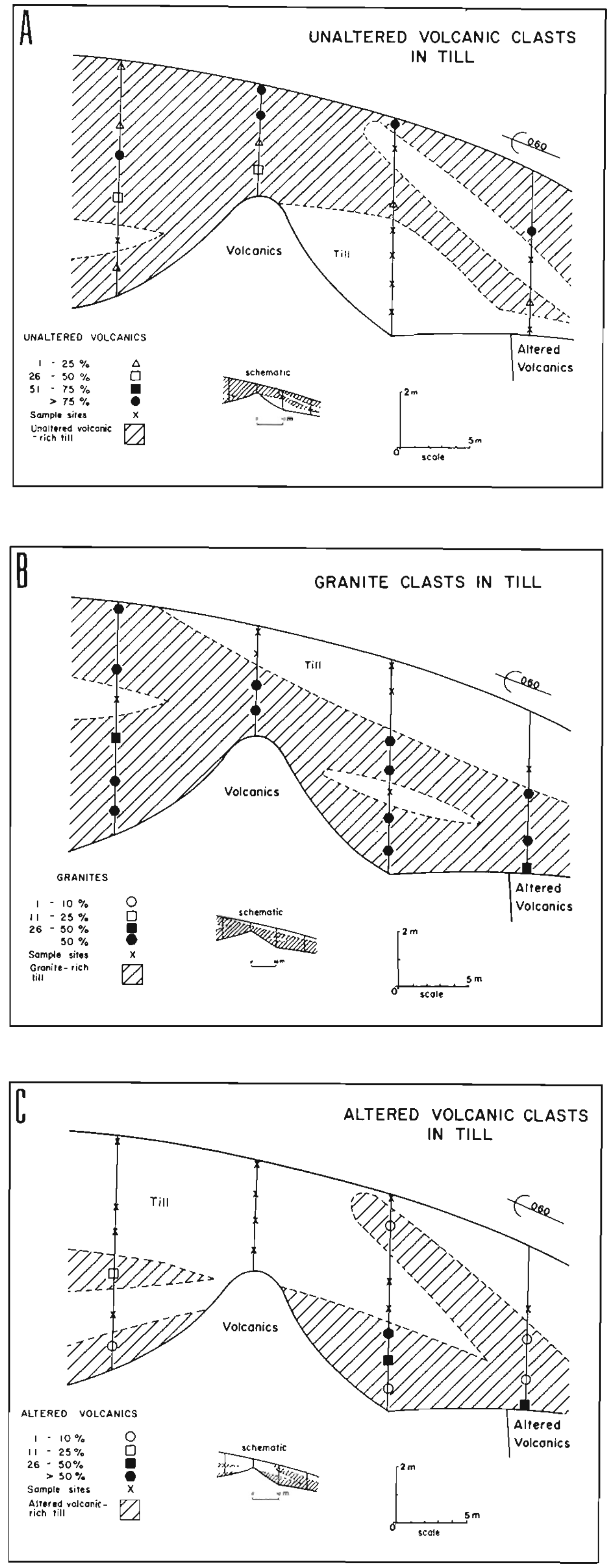

Figure 6: *Clast dispersal vertically through till, Wizard prospect, Sops Arm area, by rock type: A) unaltered volcanic rock, B) granite, C) altered (mineralized) volcanic rock–pyrophyllite(?)*

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