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OPTIMIZING GEOCHEMICAL SOIL SURVEYS FOR GOLD MINERALIZATION IN NEWFOUNDLAND

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ABSTRACT

B-horizon soil samples were collected from grids located over eight gold occurrences in four areas of Newfoundland to characterize the nature of geochemical dispersion around gold mineralization. The soil samples were sieved into three size fractions: <63 µm, <180 µm and a bulk sample of <300 µm. The first two fractions were analyzed by a variety of methods for several elements including gold, antimony, arsenic and base metals. The heavy minerals were separated from the <300 µm fraction, prior to analysis, using a spiral concentrator. The resulting data were analyzed statistically and plotted using a PC. Cumulative frequency plots were helpful in separating background populations from those associated with the mineralization, and for determining contour intervals or 'thresholds'. Gold is the most consistent element reflecting mineralization but correlation analysis indicates that antimony and arsenic are common gold associates and, in such cases, frequently have stronger and larger dispersion trains than does gold. Of the <63 µm and <180 µm fractions, the finer fraction is preferable, in that it usually gives more samples with detectable levels of gold (and other elements) and better analytical precision. However, in cases where gold is suspected to be coarse grained, the coarser fraction may be preferable. Similarily with the heavy-mineral concentrates, the <63 µm fraction produces better gold dispersion patterns except where the gold is thought to be coarse grained. Neutron activation analysis is the preferred analytical method as it provides data for 25 elements including gold, antimony, arsenic, molybdenum and sodium, all of which may be useful in gold exploration. Additionally, it uses a 10-g (or larger) aliquot, which reduces the 'nugget effect'.

INTRODUCTION

This article discusses the major findings of a survey (McConnell and Honarvar, 1989) into the nature of element distribution in soil, especially in areas close to gold mineralization in insular Newfoundland. The survey sought to identify the effects that such factors as the element content of mineralization, the Quaternary history and the size fraction analyzed, would have on the measurable geochemical dispersion from gold mineralization. Various statistical approaches were used to determine the best way to interpret and display the resulting data. The soil from eight mineral occurrences in four areas (Figure 1) were examined and sampled. In this article, the geological and surficial features, and the field-work and analytical procedures used, are first summarized and then the various aspects of the study are discussed with examples from specific areas.

GEOLOGY AND MINERALIZATION

Hickey's Pond–Monkstown Road Area

The following geological descriptions are from Huard and O'Driscoll (1985, 1986). The four mineral occurrences sampled in this area (the Strange, Bullwinkle, Monkstown Road 'D' and Hickey's Pond occurrences; Figure 2) are found within two alteration belts in volcanic rocks of the Upper Precambrian Love Cove Group. The rocks have been isoclinally folded, and flattening has destroyed any indicators of original facing directions. Metamorphic grade is low with the chloritization of some mafic minerals and alteration of

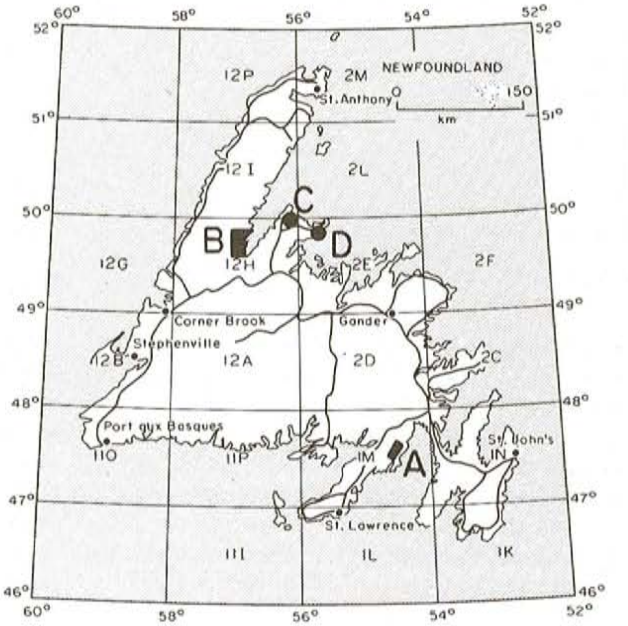


Figure 1. *Index map of study areas. (A: Monkstown Road/Hickey's Pond areas; B: White Bay area; C: Goldenville Mine; D: Betts Cove Mine).*

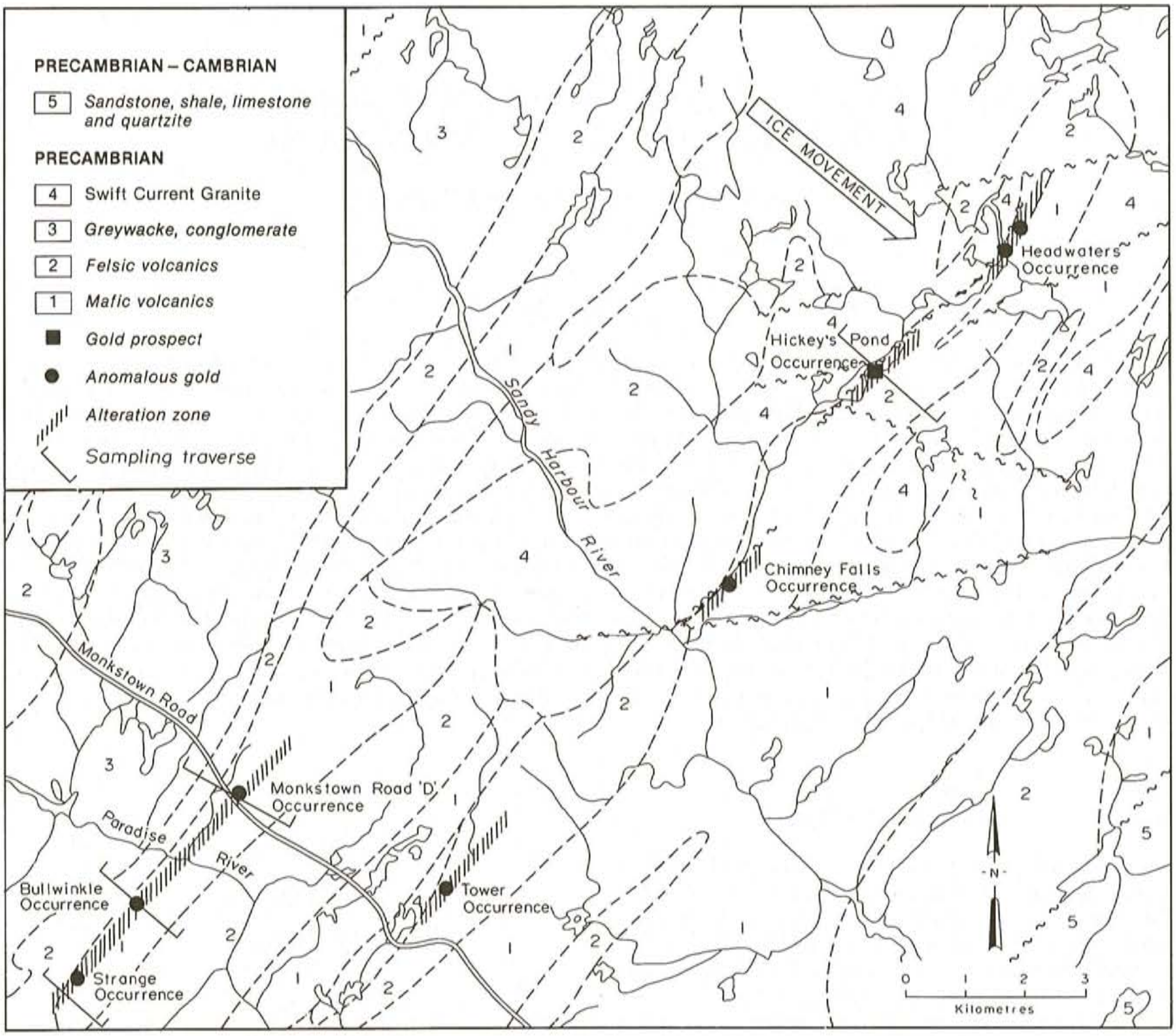


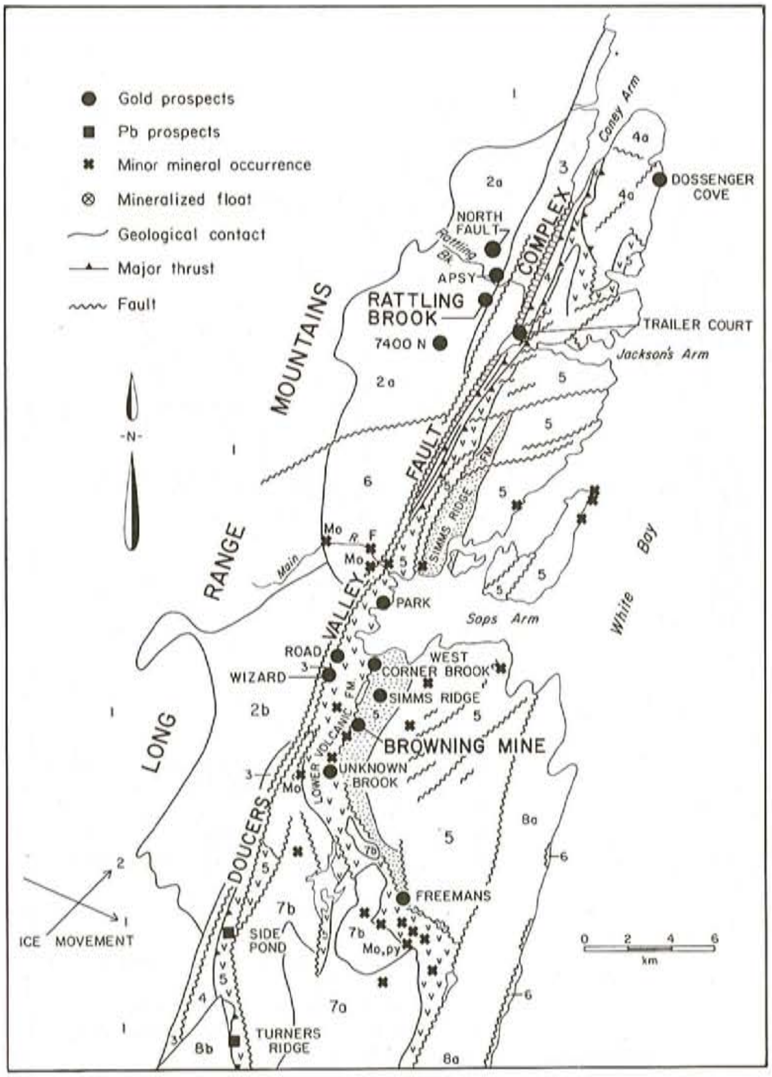
Figure 2. *Geology and sampling grids for Monkstown Road/Hickey's Pond areas (modified from Tuach* et al., *1988).*

some feldspars being the only apparent effects. The showings share many common features. All are located in highly siliceous rocks and have similar mineralogical associations (± alunite ± specularite ± pyrite ± chert). Huard and O'Driscoll (1985, 1986) concluded that these showings formed as hot-spring sinter deposits in a volcanic environment, and reported maximum gold values, in grab samples of bedrock at the four occurrences, ranging from 75 mg/t at the Bullwinkle occurrence to 5400 mg/t at Hickey's Pond.

The occurrence at Hickey's Pond has the highest gold values. It is located in the eastern alteration belt and consists of a 250-m by 50-m body of siliceous, resistant rock. It is typically banded, the layers variously being composed of combinations of alunite ± pyrophyllite ± specularite ± pyrite ± rutile. A breccia unit is also present; it consists of quartz-alunite clasts in a specularite-rich matrix. The showing is likely fault-bounded to the west by the Swift Current Granite. Rocks to the east are unaltered, felsic crystal tuffs.

White Bay Area (Rattling Brook and Browning Occurrences)

The following description of the regional geology of the White Bay area is from Tuach (1987), Smyth and Schillereff (1981, 1982) and Erdmer (1986a,b). The oldest rocks are Middle Proterozoic and earlier granitoids and gneiss, which form the Grenvillian basement (Figure 3). Of these, the Apsy pluton is the host rock of the Rattling Brook gold occurrence. The basement rocks are unconformably overlain by Lower Paleozoic platform sediments of the Coney Arm Group. These in turn are in fault contact with the southern White Bay Allochthon (Cambrian–Middle Ordovician)–a narrow belt of mafic volcanic schists and mélange and a region underlain



UPPER PALEOZOIC
(Basin-fill sequences and intrusions)

CARBONIFEROUS

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

DEVONIAN (ca. 398 Ma)

7 Gull Lake intrusive suite: **7a,** *intermediate and mafic intrusive rocks;* **7b,** *granite and trondhjemite*

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,** *Apsy pluton;* **2b,** *Main River pluton*

1 *Leucocratic gneiss, amphibolite and gabbro*

Figure 3. *Geology and sampling grids for White Bay area (modified from Tuach* et al., *1988).*

by granitoid rocks. Silurian volcanic and sedimentary rocks comprise the Sops Arm Group, which unconformably overlies the allochthon north of Jackson's Arm, and is elsewhere in fault contact with it or with the Coney Arm Group. The small Browning Mine deposit is found within a shale–carbonate sequence of the Sops Arm Group.

A major structural break, the Doucers Valley fault complex, separates platformal rocks of the Coney Arm Group from the Silurian rocks. More than a dozen gold occurrences are associated with the system, which Tuach (1987) regards as having served as a hydrothermal conduit for mineralizing fluids.

The gold mineralization at Rattling Brook is mainly confined to the Apsy pluton (Figure 3). Saunders and Tuach (1988) suggest that the deposit was formed as a result of a two-stage alteration and mineralization process. Initially, the precursor tonalite–granodiorite was converted to granite via potassium metasomatism, at which time plagioclase and mafic silicates were altered to K-feldspar and sericite. In the second stage (restricted to stockwork fractures, veins and selvages), deposition of albite, quartz, ankerite, sericite, pyrite, arsenopyrite and gold mineralization occurred. The significance of the area has been tested by several diamond-drill holes, and one hole has yielded 1.11 g/t of gold over 47 m (McKenzie, 1987).

Goldenville Mine Area

Hibbard (1983) describes the mineralization at the Goldenville Mine (Figure 4) as being located in, and adjacent to, a ferruginous chert and iron formation, which is intercalated with mafic volcanic and volcaniclastic rocks and greywacke of the Point Rousse ophiolite. Mineralization in the form of quartz-pyrite veins occurs sporadically along the 4-km strike length of the iron formation. The mine, which operated from 1904 to 1906 produced 4.6 kg of gold (Snelgrove, 1935).

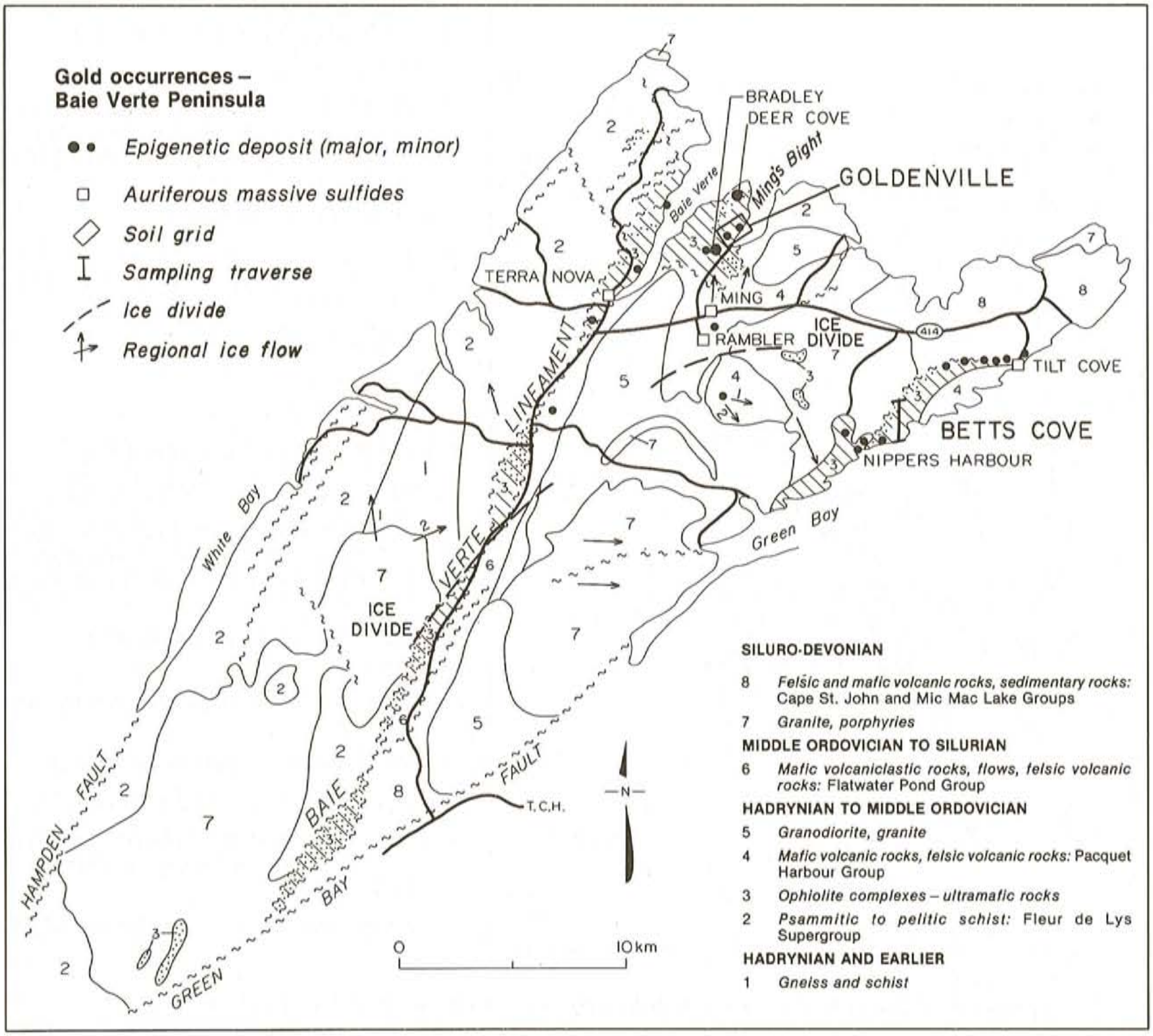


Figure 4. *Geology, Quaternary geology and locations of sampling grids for Baie Verte Peninsula (modified from Tuach* et al., *1988, and Liverman and St. Croix, 1989).*

Betts Cove Mine Area

The Betts Cove Mine (Figure 4) is an auriferous massive sulphide deposit, which was worked for its copper content from 1875 to 1883 (Hibbard, 1983). The orebody consists of massive pyrite and chalcopyrite, minor sphalerite and traces of galena (Upadhyay and Strong, 1973). Upadhyay and Strong (1973) regard the deposit, which is located at the contact of sheeted dykes and overlying pillow lavas, to be volcanic exhalative in origin.

SURFICIAL GEOLOGY

Hickey's Pond–Monkstown Road Area

The area is covered with extensive deposits of poorly drained till. Streamlined southeast-trending landforms indicate the direction of glacial transport (McConnell and Wells, 1987). In their regional study of the Quaternary features of the Burin Peninsula, Tucker and McCann (1980) describe the dominant landform in this area as northwest- to southeast-trending drumlins and flutings, which they interpret as resulting from outward radial flow from a Newfoundland-centred ice sheet. No attempts were made to determine the depth to bedrock at the four soil grids but the apparent conformity of surface morphology with underlying bedrock suggests that till depths are less than 3 to 4 m. Bedrock exposure is less than five percent.

White Bay Area

The Quaternary geology of the area was most recently described by Vanderveer and Taylor (1987). Their studies indicate that the entire area was affected by a 080 to 110° ice-flow regime from the Long Range Mountains. This was the only event to affect the Rattling Brook occurrence. A younger ice-flow regime, in the south of the area, was directed to the northeast and emptied into Sops Arm. This later ice-flow movement over-rode the Browning Mine area, resulting in more complex glacial dispersion than at the Rattling Brook occurrence. The terrain at the Rattling Brook occurrence is very rugged having slopes on the soil grid averaging 30°. Outcrop is scarce and depth to bedrock is probably less than 3 m at most sample sites.

Baie Verte Peninsula (Goldenville and Betts Cove Mines)

Liverman and St. Croix (1989) propose two episodes of glaciation for the peninsula. An earlier northeast flow radiating from a central Newfoundland ice cap which, in the northern part of the peninsula, was divided along the central axis of the peninsula into northerly and easterly components (Figure 4). Subsequently, a few kilometres south of the Rambler Mine area, a local ice centre may have developed from which, ice flowed to the north over the Goldenville Mine and to the southeast over the Betts Cove Mine. Till thicknesses are greater at the Goldenville Mine soil grid, where till depths of up to 5 m are estimated with little bedrock exposure. In contrast, till forms a veneer less than 1-m thick at Betts Cove and outcrop is abundant.

FIELD AND ANALYTICAL PROCEDURES

Sample Collection

Samples of B-horizon soil were collected along grid lines oriented both parallel and perpendicular to glacial-ice movement. Lines were laid out to transect mineralization with the expectation that the ends of the lines would be located over background or near-background material. Sample spacing varied from 25 to 100 m with the higher density sampling being done in proximity to mineralization. Most samples were of podzolic soil, developed on locally derived till, as judged by the nature and lithology of pebbles at the sample site. Three samples were taken at each site; a kraft-paper bag of soil was taken for each of the <180 μm (80 mesh) and <63 μm (230 mesh) series of samples and a bulk sample of about 2 kg was taken for heavy-mineral separation by Goldhound.

Sample Preparation

Samples were dried and sieved through stainless-steel sieves with the fine fraction being retained for analysis. Three mesh-sizes were used for the three sample-series. The <180 μm fraction was retained from one series of B-horizon samples and the <63 μm fraction was retained from the other. The coarsest sieve (300 μm or 50 mesh) was used to prepare the samples for processing by Goldhound.

A commercially available spiral concentrator (Goldhound) was used to obtain a panned heavy-mineral concentrate for analysis. The Goldhound relies on variations in settling velocities (hydraulic equivalence) to separate mineral grains. This procedure will not yield a true heavy-mineral concentrate such as is produced by heavy-liquid separations because the settling velocity is a function of both density and grain size. For example, a medium grain of feldspar could have the same hydraulic equivalence as a fine grain of gold, hence, in order to exclude much of the light material, fine grained gold must also be lost.

Analysis

Soil samples were analyzed by several different methods. To monitor analytical precision, five percent of the samples were randomly selected and split and included as blind duplicates in all analytical procedures.

Gold and 25 other elements were analyzed by direct neutron activation analysis at Becquerel Laboratories: As, Au, Ba, Br, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Na, Ni, Sb, Sc, Se, Sm, Ta, Tb, Th, U, W, Yb and Zr. The average weight of sample analyzed was 5.5 g in the <63 μm series, 6.4 g in the <180 μm series and 5.1 g in the Goldhound concentrates. The detection limit for gold is 1 mg/t in most samples.

The <63 μm and <180 μm series were also analyzed at the Geological Survey Branch laboratory in St. John's for additional elements. Analytical methods are more fully described by Wagenbauer *et al.* (1983). Atomic absorption spectrophotometry (AA) was used to determine Ag, Cd, Co, Cu, Fe, Mn, Mo, Ni, Pb, and Zn with background correction for Cd, Co, Ni and Pb. Fluorine contents of the <63 μm and <180 μm samples were determined by ion-specific electrode.

RESULTS AND DISCUSSION

Grid Design

A well designed soil-sampling grid should balance the cost of sampling and analysis against the risk of failing to detect an economic deposit. The length of a recognizable dispersion train is controlled by such factors as the nature of the topography, the glacial regime, the element association of the mineralization and the expected element-contrast with the local non-mineralized bedrock and the orientation of the expected mineralization in relation to the direction of glacial transport. Thus, any general recommendations must be constrained by consideration of conditions within the proposed survey area. Moreover, none of the eight occurrences examined is currently known to be an economic gold deposit, hence dispersion from larger or higher grade deposits would likely have somewhat broader or longer trains. With these constraints in mind, some guidelines are recommended for sample spacing for reconnaissance-scale surveying, as might be employed to follow-up lake sediment anomalies. Assuming the target offers an expected strike-length of at least 200 m, oriented at 90° to the direction of glacial transport, sampling lines should be run at 90° to the main glacial flow direction and be spaced at 500-m intervals.

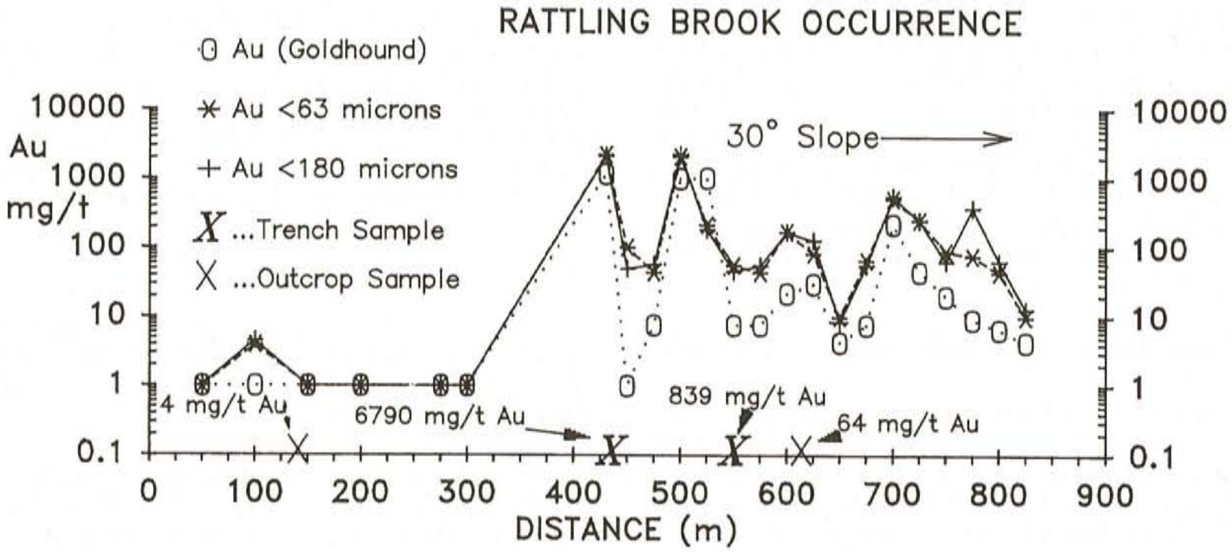


Figure 5. *Profiles of Au in <63 μm, <180 μm and Goldhound fractions of soils at Rattling Brook occurrence.*

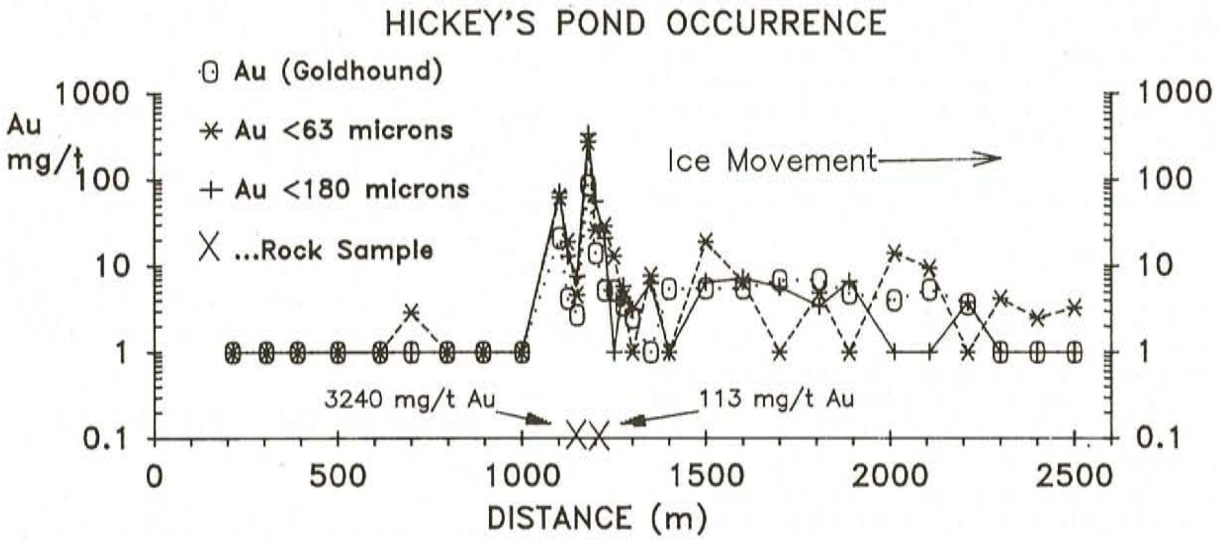


Figure 6. *Profiles of Au in <63 μm, <180 μm and Goldhound fractions of soils at Hickey's Pond occurrence.*

Samples should be collected at 200-m intervals along the lines. Such a grid system has a high probability of yielding at least one anomalous sample from a randomly located deposit. Under less than these ideal conditions or if the exploration philosophy demands the recognition of two or three anomalous samples, sampling density along the lines should be higher, although line spacing could remain the same. If a pathfinder element such as Sb or As is being used, one can have greater confidence that an anomaly will not be missed due to the 'nugget effect', to which gold-only surveys are prone.

B-Horizon Soils Versus Panned Concentrates

Of prime consideration in planning a survey is whether to analyze conventional B-horizon soil or to collect heavy-mineral concentrates. The additional cost of obtaining the latter is considerable and should be done only if warranted. In this study, both approaches were evaluated and the results suggest that the method of choice is largely dependent on the grain size of the expected gold mineralization. Conventional soil sampling, rather than pan concentrates, is more suitable for mineralization having an appreciable proportion of fine grained gold because the fine gold tends to be lost in the panning process; moreover, soils with fine gold are less prone to the 'nugget effect' and give reproducible analyses. Conversely, for mineralization where the gold is mostly coarse grained, panned concentrates are better. If possible, a small orientation survey using both methods should be done over one or more known occurrences, where the major effort is to be expended. The application of conventional gold panning may give superior results to those of the spiral concentrator discussed here. The technique, which involves the

Table 1. Geometric means and log standard deviations of <63 μm and <180 μm fractions and Goldhound (GH) concentrates. Means in g/t unless otherwise indicated

	Mean			Standard deviation (log)		
	<63μm	<180μm	GH	<63μm	<180μm	GH
Ag^1	0.11	0.11	-	.146	.162	-
As	8.0	6.7	6.8	.780	.845	.660
Au (mg/t)	4.2	4.0	4.	.751	.766	.904
Ba	280	262	181	.252	.294	.381
Co^2	6.8	7.1	15	.557	.551	.449
Cr	50	59	148	.525	.528	.746
Cu	12	12	-	.448	.479	-
Eu	.72	0.61	1.0	.357	.334	.332
F	188	176	-	.344	.341	-
Fe^2(%)	4.09	3.95	8.5	.289	.303	.304
La	20	18	26	.344	.334	.468
Mn	132	136	-	.433	.437	-
Mo^1	1.9	2.3	-	.290	.280	-
Na(%)	1.79	1.77	1.40	.189	.146	.193
Ni^2	16	15	18	.487	.479	.485
Pb	9.7	7.2	-	.493	.524	-
Sb	0.80	0.74	1.16	.306	.331	.405
Th	6.2	5.5	6.9	.369	.374	.615
U	1.96	1.77	3.2	.343	.372	.582
W	1.2	1.0	2.7	.435	.439	.458
Zn^1	34	33	-	.351	.323	-

\- Indicates no data. ^{1} denotes AA analysis, ^{2} denotes neutron activation analysis

examination and classification of gold-grain morphology, is also an important tool, but is outside the scope of this study.

In the occurrences studied here, little information is available on the grain size of gold, but visible gold was seen only in the concentrates from Hickey's Pond, although all were examined by binocular microscope. This suggests that the gold mineralization at most of these eight occurrences is fine grained. The Au distributions were more erratic for the concentrates than for the soils at five of the eight occurrences, but one occurrence gave similar results for both methods. However, the occurrences at Hickey's Pond and Goldenville yielded smoother down-ice patterns in the concentrates. Examples of the distribution of Au, at Rattling Brook (fine grained) and Hickey's Pond (coarse grained), in soils and in concentrates are shown in Figures 5 and 6. In Figure 5, the Goldhound data downslope (and down-ice) from the mineralization are more erratic and provide less contrast with background than do the two soil series. Conversely, in Figure 6, the Goldhound data provide a smoother down-ice decay pattern than can be seen in data from the two soil series.

Size Fractions

Two size fractions, <63 μm and <180 μm, were prepared, analyzed and compared. For most elements, including gold, the finer <63 μm fraction has somewhat higher concentration levels and smaller standard deviations than has the <180 μm fraction (Table 1). This result indicates that the <63 μm fraction is preferable because the higher values will give more analyses above detection limit for some critical elements including gold, and the smaller standard deviations suggest that the analyses are less 'noisy', hence the signal from mineralization will be more discernible. Exceptions to this generalization include the elements Co, Cr and Mo, which have relatively higher mean values in the <180 μm fraction. The cumulative frequency plots of Au, As, Pb and Sb (Figure 7) illustrate the differences in the two size fractions over the entire range of data. The last three elements are associated with the gold mineralization at some of the occurrences and are discussed below under the multi-element data section.

Data from the heavy-mineral concentrates are also included in Table 1; the mean Au value (4.0 mg/t) is actually lower than the mean Au value for the <63 μm fraction, presumably due to loss of fine gold, and the standard deviation of the concentrate fraction is considerably larger than those for the soil fractions.

Analytical Procedures

The most valuable analytical method is neutron activation (INAA) as it provided data for Au, Sb and As (the most useful

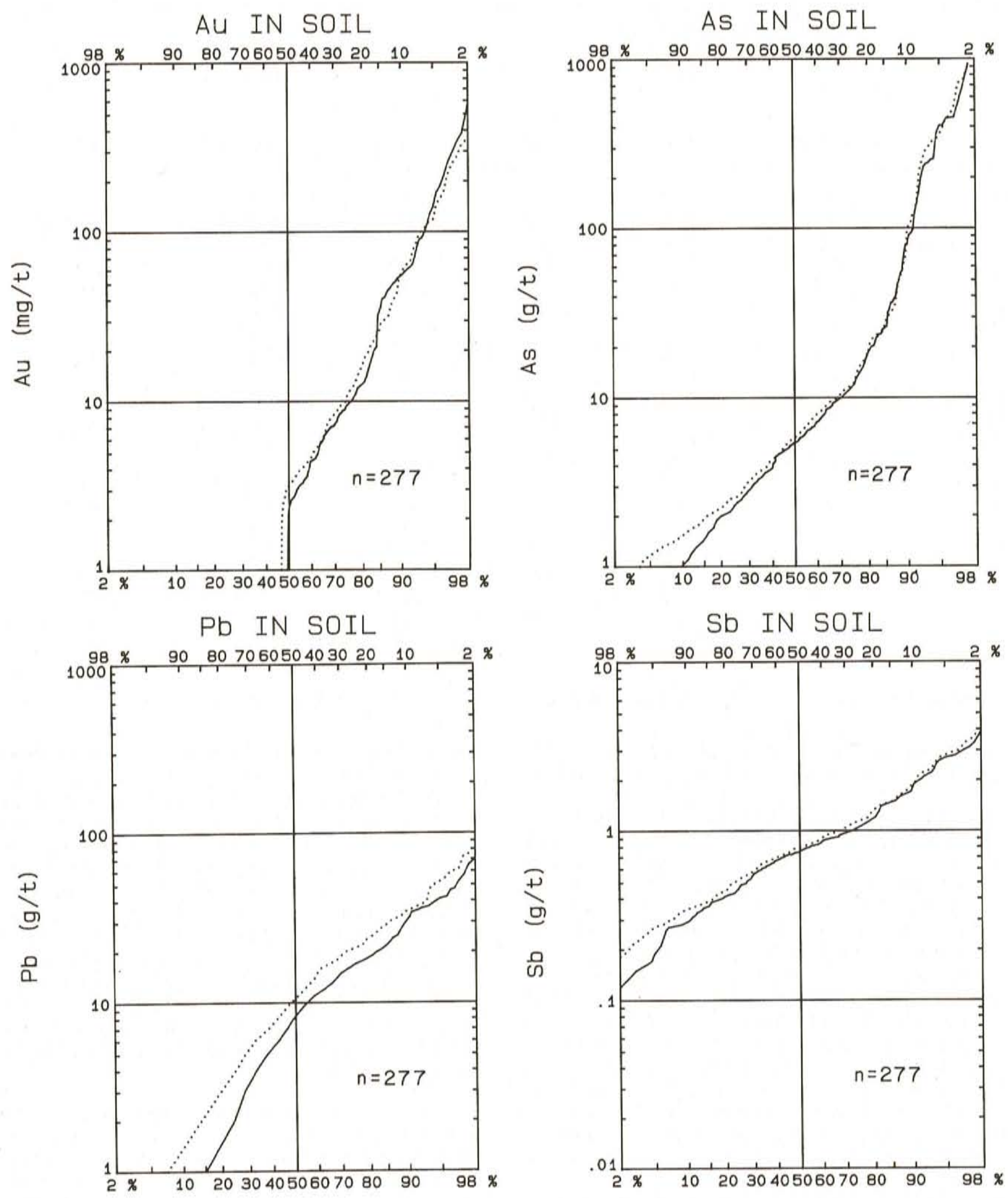


Figure 7. *Cumulative frequency plots of Au, As, Pb and Sb in <63 μm and <180 μm soil fractions. (<63 μm: dotted line; <180 μm: solid line).*

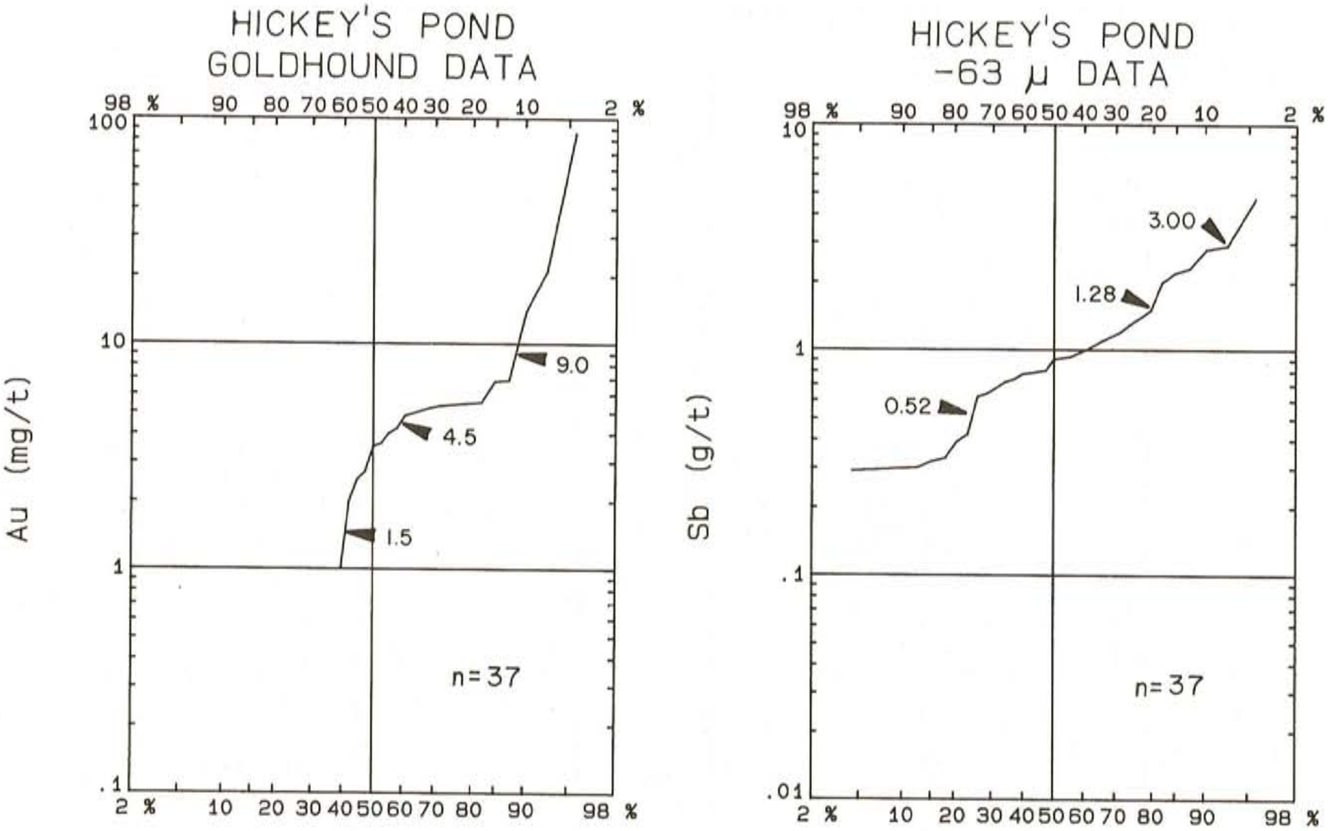


Figure 8. *Cumulative frequency plots of Au (Goldhound) and Sb (<63 µm) in soil at Hickey's Pond occurrence.*

pathfinder elements), as well as for 23 other elements. The method can easily handle large sample aliquots (10 or 35 g) thus reducing the 'nugget' effect, which may result from using the smaller aliquots commonly used for atomic absorption methods. If only gold data are required, it is less expensive to use other methods than INAA but large aliquots should be employed. A detection limit of 1 mg/t for Au is recommended at the reconnaissance stage, where most samples are likely to have less than detection-limit concentrations and subtle anomalies may be significant. At later stages, a higher (and less expensive) detection limit may be adequate, although the savings in analytical costs may be largely offset by the necessity for closer sample spacing.

INTERPRETIVE METHODS

Much knowledge of the nature of the geochemical landscape of an area can be gained by the application of some rudimentary statistical procedures. Too often, this step is bypassed and nothing more is done with the data than the plotting of contour maps, often on the basis of some arbitrary threshold value or percentile.

Single-Element Data

An overview of the character of the distribution of a given element can be provided by calculating the mean, median, standard deviation, coefficient of variation and range. Such statistics are most easily calculated using specialized software on a PC, although a calculator will suffice if relatively few data are involved. Most trace-element populations are positively skewed and more meaningful means and standard deviations result from using log-transformed rather than arithmetic data. As a rule of thumb, if the coefficient of variation (the ratio of the standard deviation to the arithmetic mean) is greater than 0.5, then the data should be log-transformed. Many software packages are available for statistical calculations. One designed specifically for handling geochemical data is UNISTAT (Nolan, *this volume*), which enables the user to determine easily the above statistics, as well as plot histograms and cumulative frequency plots (CFP). Histograms graphically depict the distribution of a population and may enable one to see multiple populations not apparent from the summary statistics. However, separate populations can be recognized more readily from cumulative frequency plots. Examples of CFP's produced by UNISTAT are shown in Figures 7 and 8. The latter is included to illustrate how a CFP can be used to recognize component populations, and to optimize the choice of contour intervals so as to distinguish, rather than blend, significant geochemical groupings. The CFP of the gold data from the Goldhound concentrate at the Hickey's Pond occurrence reveals the presence of four subpopulations, with separations defined by inflection points on CFP, (see Sinclair, 1976) at about 9, 4.5 and 1.5 mg/t. These are used to define the symbol ranges in the accompanying Au map (Figure 9), which gives a clear picture of the relationship between mineralization and dispersion of gold in soil. Mineralized bedrock is located on the peninsula,

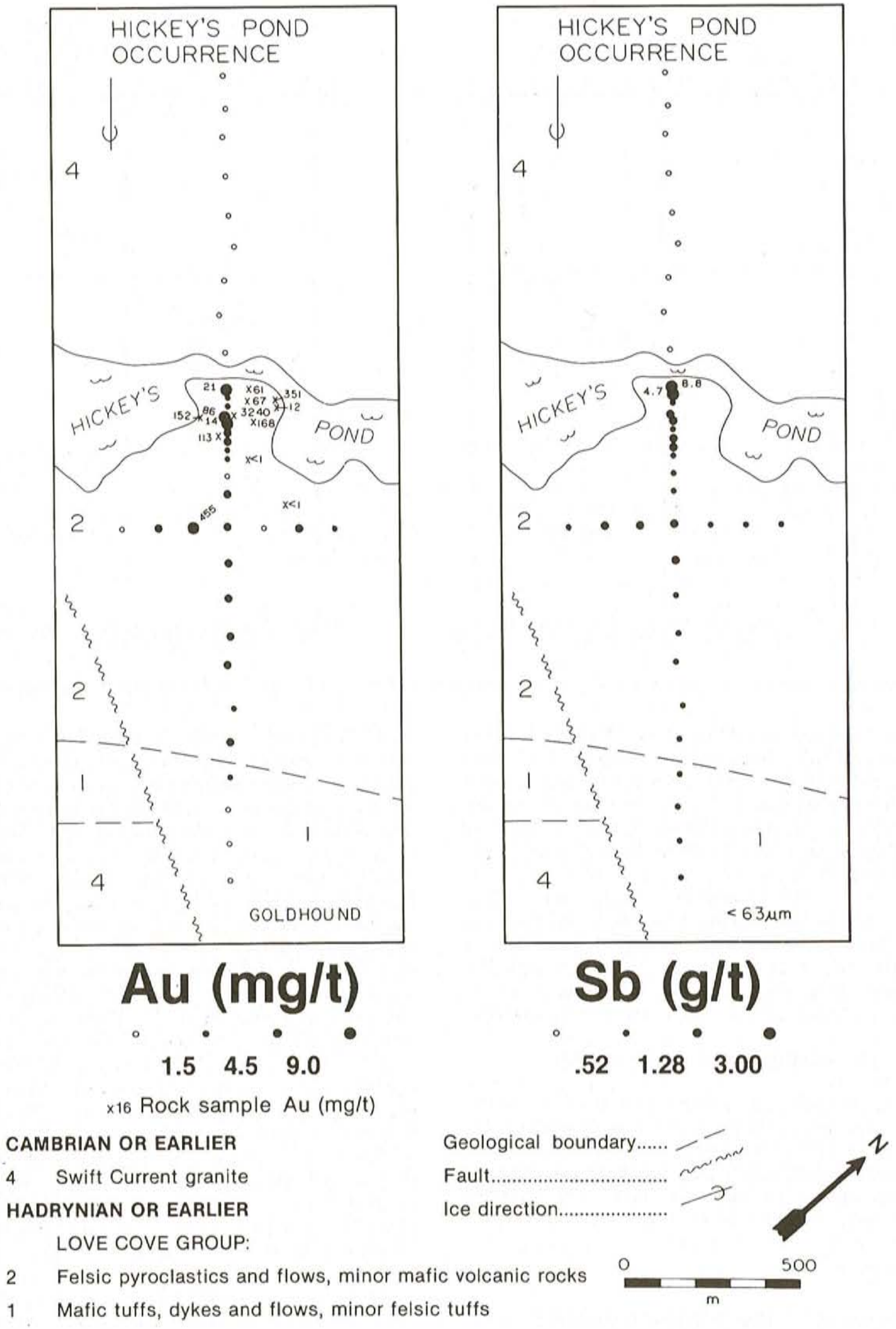


Figure 9. *Distribution of Au (Goldhound) and Sb (<63 µm) in soil at Hickey's Pond occurrence.*

Table 2. Spearman rank correlation coefficients of Au with selected elements in <63 μm soils by mineral occurrence (logged data)

Area	Ag	As	Ce	Cu	Fe	La	Mo	Na	Pb	Sb	Sc	Th	U
Monkstown 'D' (N=33):	*	*	.39	*	-.30	.49	.48	-.45	.39	.23	-.34	.53	.51
Bullwinkle (N=27):	*	*	.52	*	*	.54	*	-.40	.45	.36	*	*	*
Hickey's Pond (N=37):	.40	.54	*	.34	*	*	*	-.29	*	.74	*	-.29	*
Rattling Bk (N=31):	.54	.88	.68	*	.48	.74	*	*	*	.75	-.57	.59	.55
Browning (N=44):	*	*	*	*	*	*	*	*	*	*	*	*	*
Goldenville (N=70):	*	*	*	*	.31	*	.27	*	*	*	*	*	*
Betts Cove (N=11):	*	*	*	*	*	*	*	*	*	*	*	*	*

* indicates variables are not significantly correlated at the 95% confidence level

which protrudes into Hickey's Pond and is distinguished by rocks with high gold analyses ('X's') in Figure 9. The CFP of Sb in <63 μm soil (Figure 8) also indicates four subpopulations, each of which is assigned a separate symbol in Figure 9. In this instance, these symbols can be considered to represent soil samples from background (open circle), distal (small dot), proximal (medium dot) and overlying (large dot) populations. In other examples, the samples with the highest metal values may be from sites down-ice or downslope from mineralization.

Multi-Element Data

Element associations may provide information on the nature of the mineralization and on the presence of 'pathfinder elements'. A correlation coefficient measures the strength of an association or relationship between pairs of variables and has a value between ± 1. A value of zero indicates no relationship, a value of + 1 indicates a perfect one-to-one relationship, and a value of − 1 indicates an inverse one-to-one relationship.

Spearman rank correlation coefficients are useful for data distributions that are irregular or strongly skewed, such as Au distributions consisting of many values below detection limit. Table 2 summarizes the Spearman coefficients of Au with several elements for seven of the occurrences studied. The three occurrences in the Monkstown Road area share some common element associations. All have a Au−Sb association and all suggest the presence of Na depletion over mineralized bedrock. The Hickey's Pond occurrence shows a very strong Au−Sb correlation (0.74), and the distribution map of Sb in soil (Figure 9) shows a smoother and clearer dispersion pattern than does that of gold from the heavy-mineral concentrate. The dispersions of Sb and Au in <63 μm soil can also be seen in profile in Figure 10. Here again, Sb acts as a pathfinder element yielding a longer dispersion train than Au.

Several elements correlate with Au at the Rattling Brook occurrence with the Au−As correlation being strongest (0.88). A profile of these two elements is shown in Figure 11. It is not clear whether the dispersion of the pathfinder element is more extensive than that of Au as the downslope and down-ice extent of the anomaly was not determined. It appears, however, that the As anomaly is diminishing more gradually than that of Au. Other elements that correlate with Au include U, Ce and La. These may provide a clue to host-rock composition and/or alteration features and thus provide additional geological information for prospecting in the immediate area.

None of the elements examined correlates significantly with Au at the Browning or Betts Cove deposits and element-distribution maps (McConnell and Honarvar, 1989) indicate Au is the best guide at these occurrences. Interestingly, Au is a better indicator of the Betts Cove orebody than is Cu despite its having been mined primarily for Cu.

CONCLUSION

Clearly, soil surveys for Au mineralization are effective. To optimize their benefits, the design and choice of sampling grids, sample preparation and analytical procedures should all be considered in light of the expected nature and grain size of the target mineralization, and of the glacial cover and Quaternary history. Ideally, a small orientation study should be done first, to help determine the parameters of the survey.

In general, Au in the <63 μm fraction of B-horizon soil gives the best results of the three fractions examined here. Antimony and As are the most common pathfinder elements noted and should be considered in any survey. The <63 μm size-fraction, for most elements, gives the best results as it yields more homogeneous samples for analysis and higher absolute concentrations (which commonly improves analytical precision). The neutron activation method of analysis (INAA) is recommended despite its higher cost because it gives a broad spectrum of analyses including Au, As and Sb, and because it uses large sample aliquots, which reduce the 'nugget effect'.

Interpretation of the survey data should attempt to:

- quantify the distribution characteristics of the various elements,

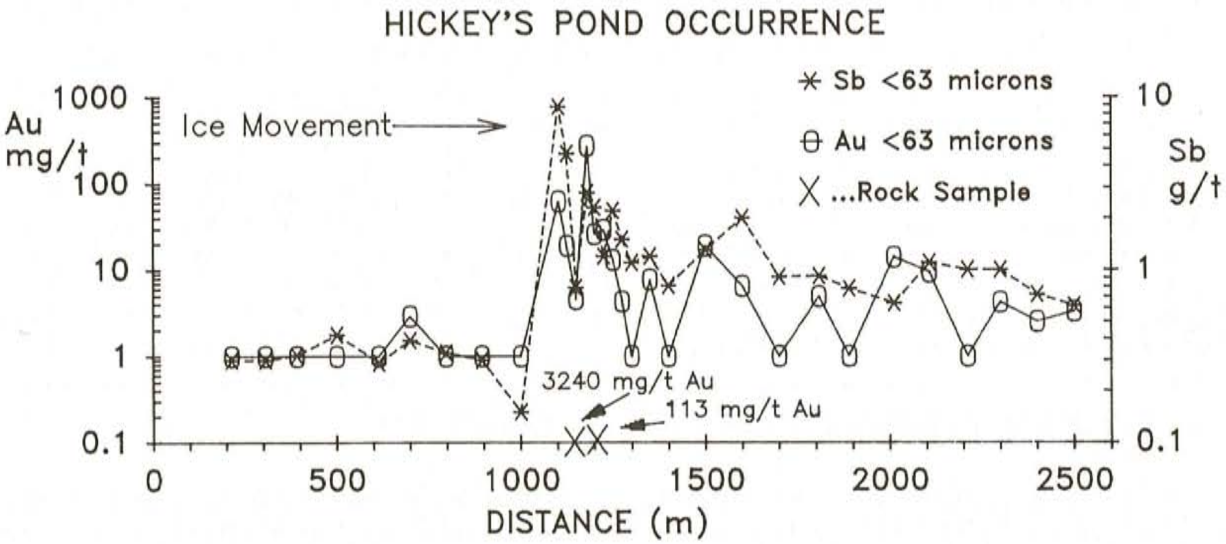


Figure 10. *Profiles of Au and Sb in < 63 µm soil at Hickey's Pond occurrence.*

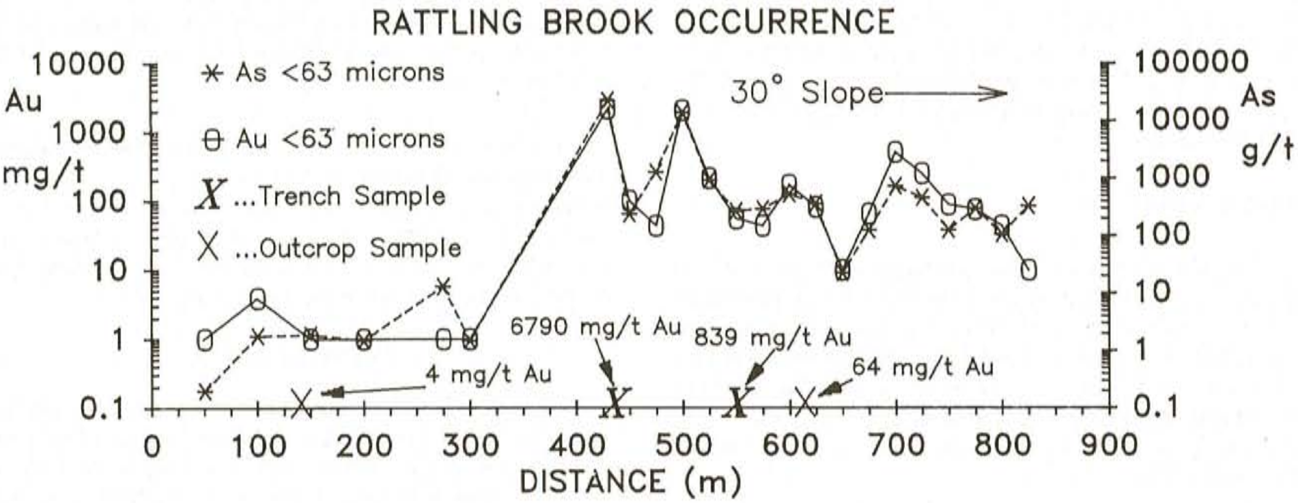


Figure 11. *Profiles of Au and As in < 63 µm soil at Rattling Brook occurrence.*

- identify and separate component populations before plotting the data, and
- recognize element associations for use as possible pathfinders and to provide a better understanding of the geological parameters of the area.

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