# RESULTS OF A REGIONAL SOIL SURVEY OVER A GOLD AND BASE-METAL TERRAIN IN NORTHWEST LABRADOR

J.W. McConnell
Geochemistry, Geophysics and Terrain Sciences Section

## ABSTRACT

*During the summer of 1996, a reconnaissance soil survey was conducted in the Marion Lake area, northwest Labrador. The survey was designed to focus further exploration by identifying zones having anomalous gold or base-metal values. The area is located in the eastern portion of the Labrador Trough and is underlain mainly by Proterozoic gabbro, shale, siltstone, dolomite and basalt. Occurrences of copper and gold are reported within the region, notably near Montgomery Lake, and base metals are known from Martin and Marion–Moss lakes.*

*Regional lake-sediment geochemistry has revealed several sites having high gold and copper values. Three hundred and forty-four samples of BC-soil horizon were collected. Forty-three elements were determined using the <80 mesh fraction for analyses. Anomalous soil sites have been identified with maximum values of 38 ppb Au, 185 ppm Cu and 652 ppm Zn. These, plus other high values are encouraging for reconnaissance-level sampling and provide additional targets for detailed work.*

## INTRODUCTION

This report presents the results of a reconnaissance geochemical soil survey undertaken in 1996 in the Marion Lake area, northwest Labrador. The survey area includes parts of NTS map areas 23I/13 and 23J/16, and is located about 55 km east of Schefferville, Québec, the closest source of supplies and logistical support (Figure 1). The area is distinguished in the regional lake-sediment survey data (Hornbrook and Friske, 1989) by having high gold and copper values. Some base-metal mineralization is known in the general area and gold and copper mineralization occurs near Montgomery Lake, located abut 8 km southeast of the survey area. The soil survey was undertaken to determine if the soils and tills contain anomalous gold and base-metal concentrations. If so, the new data would be useful in focussing exploration attention. The area is underlain predominantly by weakly metamorphosed siltstone, shale, minor sandstone and gabbro. Glacial deposits consist mostly of thin till units of local derivation (Liverman *et al.*, 1993) and is suitable for geochemical exploration. Soil development has created a thin B-soil horizon that grades downward rapidly to BC- and C-soil horizons of slightly oxidized till. Topographic relief is low to moderate. Vegetation is predominantly black spruce whose park-like spacing affords easy traversing. Except for the western block in NTS map area 23J/16 that was accessed from fly camp, the area is accessible by canoe from Marion Lake using short portages.

## PREVIOUS WORK

Lake sediment and water sampling were undertaken over this area in 1978 as part of a larger regional survey by the Geological Survey of Canada (GSC) in conjunction with the Newfoundland Department of Mines and Energy. Samples were collected at an average density of 1 per 13 km² in the survey. Data and distribution maps of 16 elements in sediment and of uranium, floride and pH in water were first published in 1979 (Hornbrook *et al.*, 1979). The sediment samples were re-analyzed by instrumental neutron activation for gold and 25 other elements. These data, together with the original, were published by 1989 (Hornbrook and Friske, 1989); the report includes a data listing, analytical procedures, sample location and gold distribution maps. The Marion Lake area has 3 sediment samples in the 9 to 57 ppb Au range and 16 samples in the 5 to 7 ppb range; by way of comparison, the 98th percentile of Au in the entire Labrador survey was 6 ppb. Re-analysis of some of these failed to duplicate the original analyses but gold typically displays a "nugget effect" making individual analyses difficult to reproduce whereas clusters of high samples are more reliable. The distribution of copper in lake sediment shows the Marion Lake area to be strongly anomalous; the highest values are centred around Moss Lake and northern Marion Lake.

A regional till survey involving the collection of 355 samples unevenly distributed in the northeast quadrant of
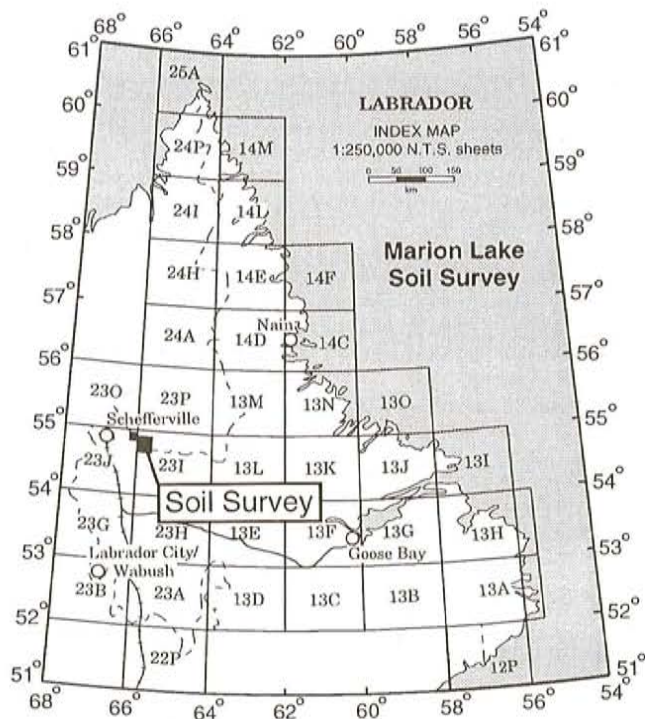
**Figure 1.** *Index map of survey area.*

NTS map area 23 was undertaken by the GSC and published in 1988 (Thompson *et al.*, 1988). The <0.002 mm clay fraction was analyzed for Cu, Cr, Fe, Mn, Mo, Ni, Pb, U and Zn, but not Au, and element-distribution maps at 1:500 000 scale were published. Five of the samples were within the current survey; one of these analyzed 451 ppm Cu. However, it should be noted that the clay fraction normally yields considerably higher Cu values than do the <0.180 mm or <0.063 fractions commonly used in mineral exploration.

A more tightly focussed till and surficial mapping survey (Liverman *et al.*, 1993) was conducted in NTS map areas 23J/9 and 23J/16, overlapping the extreme western part of the current Marion Lake survey. Liverman *et al.* (*op. cit.*) collected 270 samples at a density of about one per 6.6 km². The <0.063 mm fraction was analyzed for 29 elements by ICP-ES, and for 27 elements, including gold, by INAA. In the Rusty–Cunningham lakes corridor, an area partly overlapping the current detailed survey, 8 of 14 samples have >7.0 ppb Au, indicating a high background in the area. Liverman *et al.*'s (*op. cit.*) work indicated that generally, the till (diamicton) was widespread, mainly of local provenance and suitable for detailed geochemical exploration. A more inclusive report of the present survey including data listings, digital databases and colour figures of the distribution of elements in soil and gold and copper in lake sediment was released earlier (McConnell, 1997).

## GEOLOGY

Bedrock mapping of the Marion Lake area, NTS map area 23I/13, is by Donaldson (1966) who mapped at 1:63 360 scale. His work, as recompiled by Wardle (1982), is used as a geological base for the NTS map area 23I/13 portion of the accompanying geochemical figures and the description of the rock units is from Donaldson's (1966) memoir. The survey area is underlain by a package of Proterozoic sedimentary and volcanic rocks of the Labrador Trough that are intruded by gabbro. Donaldson (*op. cit.*) recognized two groups of gabbro rocks. The older Knob Lake Group comprises five sedimentary and volcanic formations – Sawyer Lake, Le Fer, Denault, Wishart and Menihek formations. It is in fault contact with the overlying Doublet Group, which is divided into the Murdoch, Thompson Lake and Willbob formations; both groups have been intruded extensively by gabbro sills. Lithologically, the sedimentary formations consist variously of shale, slate, phyllite, sandstone, siltstone, conglomerate, dolomite, quartzite and argillite; the volcanic units are metabasalt.

Regional greenschist-facies metamorphism is extensive. Most pelitic rocks have been recrystallized and show typical slate and phyllite mineral assemblages. The more competent sedimentary rocks, such as quartzites, siltstones and calcareous rocks, are only slightly recrystallized.

## MINERALIZATION

Exploration in the area for base and precious metals began in the 1940s. Labrador Mining and Exploration Limited, encouraged by the discovery of the nearby Frederickson deposit in 1942, decided to explore similar settings. The Frederickson deposit occurs as fracture fillings in gabbro, in contact with slates of the Menihek Formation; it grades 7% Zn, 1.3% Cu and 0.5% Pb and is with associated Au and Ag (Dugas, 1970). Several sulphide occurrences, some with associated Cu±Ag±Au values have been found within the current survey area. The latter are centred about 2.5 km south of the northeast end of Moss Lake and about 3 km northwest of Marion Lake (Frederickson–Connolly; F–C, and Gauthier–Martin; G–M, showings). The showings were mapped, and some were trenched and drilled in 1943 and 1944 (Moss, 1945). He reports the F–C showing to have a minimum 3400-ft strike length and widths varying from a few to a few tens of feet. It dips from 48° north to vertical. The deposit consists of disseminated to massive pyrrhotite and pyrite having minor chalcopyrite "replacing" a shaly greywacke (Menihek Formation) enclosed by two sills of "diorite". The deposit was tested with five DDHs, with maximum assays in each hole in the following ranges: Cu, 0.3 to 0.4% and Ag, 1.46 oz/ton. Three DDHs on the analogous G–M prospect had generally similar to lower results. However, one assay was 0.11 oz/ton Au. The reporting geologist discounted this as possible contamination as no gold values were known at that time in the area. The G–M prospect was redrilled in 1979. Two holes totalling 100 m in length

encountered "black and graphitic slate with syngenetic pyrite bands averaging 30 percent overall" having subordinate pyrrhotite and traces of chalcopyrite (Grant, 1979). Representative sections of the cores were assayed for U, Cu, Pb, Zn, Au and Ag. Typical results were: U, <0.005%, Cu, 0.03 to 0.04%; Pb, 0.01%; Zn, 0.10 to 0.40%; Au, <0.001 oz/ton; Ag, 0.06 oz/ton. Exploration for Ni was undertaken to the northeast and southwest of Moss Lake in 1992 (Butler and McLean, 1992). Running three, kilometre-long traverses from the lake, prospectors collected and analyzed 30 rock samples for Cu, Ni, Co, S and As; no gold values were reported. Their main objective was to evaluate the Wakuach gabbro for nickeliferous and ultramafic occurrences. Previously known sulphide occurrences were resampled; no significant new mineralized outcrops were discovered. The three best analyses were from sulphide mineralized gabbro (cpy, py, po) that gave Cu values ranging from 0.5 to 1.0% and Ni values <0.05%. No further work was recommended.

Mineralization at Montgomery Lake consists typically of disseminated pyrite, pyrrhotite, chalcopyrite and traces of chalcocite in carbonatized and silicified quartzites, dolomites and pelitic sediments of the Menihek Formation (Love, 1967). Maximum analyses reported are 2.04% Cu, 0.005 oz. Au and 0.02 oz Ag over two feet in drill core.

Several mineralized occurrences are located north of Martin Lake to Jimmick and Chicago lakes. Mineralization includes massive pyrite, minor chalcopyrite, sphalerite and galena. Analyses of up to 6% Zn and 0.5% Cu were reported at one prospect. Host rocks include limestone, shale and gabbro (Grant, 1971; Hoag, 1971).

## GEOPHYSICS

The area east and north of Marion Lake was surveyed in 1955 for Labrador Mining and Exploration Company Limited using airborne geophysics employing electromagnetic, magnetic and radiometric instrumentation (Grant, 1977). The Marion Lake area was part of a larger exploration concession (Block 135) that was flown at a height of 500 ft and line spacing of 1320 ft. Within the current geochemical survey area, two electromagnetic and magnetic anomalies in the Moss Lake and Rusty Lake area were investigated in 1977 by further ground geophysics (EM and fluxgate magnetometer) and prospecting (Grant, 1977). Lines were cut at 400 ft spacings and surveyed over the Moss Lake anomaly including about 11 km in the area of the Gauthier–Martin prospects.

## SURFICIAL ENVIRONMENT

A detailed study of the Labrador Trough area was done by Klassen and Thompson (1987) and later a comprehensive review and study of the surficial history of Labrador was presented by them. The authors recognized five phases of ice

flow in the Schefferville region. Of these, two were recognized in the Marion Lake survey area. The most significant one, in terms of erosional effects, was the earlier of the two. They concluded that Marion Lake was located on the spreading axis of an ice centre during this first phase – one lobe moving to the northwest and Martin Lake and the other toward the southeast. As a result, the erosion and dispersion of surficial soil during this event in the Marion Lake area was limited. The second and last phase to affect the Marion Lake area was a northeast flow, which only had a minor effect in the area (Klassen and Thompson, *op. cit.*).

Liverman *et al.* (1993) working immediately to the west of the survey area in NTS map areas 23J/9 and 23J/16 also recognized two ice-flow events. After examining 80 striation sites, they concurred with Klassen and Thompson's (1990) interpretation of a later northeast flow, but concluded that the earlier, and more significant, flow direction was not northwest but southeast except in the extreme northwest of NTS map area 23J/16 where stossed outcrops suggest a northwest flow. If Liverman *et al.* (1993) are correct, the ice-divide may have been farther to the northwest than Klassen and Thompson's (*op. cit.*) reconnaissance study suggested. Both reports agree that the later northeast ice-flow event had little erosional effect on the bedrock, but Liverman *et al.* (1993), citing evidence from clast fabrics and pebble lithology, consider it to have been the main agent of dispersal of glacial sediment thus complicating the task of tracing boulders to their point of origin. In NTS map area 23J/16, and by extrapolation, perhaps in NTS map area 23I/13, the surficial geology is variable and controlled in part by bedrock geology and topography. Areas underlain by the softer pelitic rocks tend to be low lying and have a more substantial cover of till than the areas underlain by more competent sedimentary or igneous rocks. Till (diamicton) is the most common surficial sediment. The matrix averages 60 percent and contains from 10 to 50 percent silt and clay. From their more detailed work at the northwest end of Martin Lake, they conclude that glacial dispersal distance is minor and up to 500 m. They also conclude that till geochemistry effectively reflects bedrock mineralization.

## SAMPLE COLLECTION

Three hundred and forty-four BC-soil horizon samples were collected from hand-dug pits. Sites were located at 200 m intervals along lines spaced 1 km apart. As a check on sampling variability, six pairs of duplicate samples were taken from sites located within 25 m of each other. Samples were stored in kraft paper bags and air dried in the field. Pertinent site information such as sample depth, vegetation, site drainage, nature of nearby bedrock or float, dominant clast lithology, soil texture and colour were recorded. Geographic coordinates were recorded by using a combination of pace-and-compass, topographic map reference and a Magellan

**Table 1.** Analytical methods for soil and rock samples

| ELEMENTS | METHOD | DIGESTION/ PREPARATION |
|---|---|---|
| (Ag), As, Au, Ba, Br, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Mo, Na, Ni, Rb, Sb, Sc, Sm, Ta, Tb, Th, U, W, Yb, (Zn), (Zr) | 1. Neutron Activation Analysis (INAA) | 5 to 10 g in shrink-wrapped vial (total analysis) |
| Ba, Be, Ce, Co, Cr, Cu, Dy, Ga, La, Li, Mn, Mo, Nb, Ni, Pb, Sc, Sr, Ti, V, Y, Zn, Zr* | 2. Inductively Coupled Plasma Emission Spectroscopy (ICP-ES) | $HF$-$HClO_4$-$HCl$ (total digestion) |
| Cd, Co, Cu, Fe, Mn, Ni, Pb, Zn* | 4. Atomic Absorption Spectroscopy (AA) | $HNO_3$-$HCl$ (3:1) (partial digestion) |
| Ag* | 6. Atomic Absorption Spectroscopy (AA) | $HNO_3$ |
| F | 9. Fluoride-ion selective electrode | Fusion with $Na_2CO_3$-$KNO_3$ flux |

NOTES: * Indicates preferred method of analysis. ( ) indicates less favoured method of analysis; use as alternative.

To enable the user to readily distinguish the method of analysis for a given element, a suffix is attached to the element symbol when used in statistical summaries and tables. The key to the suffixes is as follows:
1. Neutron activation analysis (INAA).
2. ICP-ES/after $HF$-$HClO_4$-$HCl$ digestion.
4. AA/after $HNO_3$-$HCl$ (3:1) digestion.
6. AA/after $HNO_3$ digestion.
9. Fluoride-ion selective electrode after fusion with flux of 2:1 $Na_2CO_3$:$KNO_3$.

Thus, for example, Zn4 is zinc analyzed by AA/$HNO_3$-HCL whereas Zn1 is zinc analyzed by INAA.

3000™ geographical positioning system. The instrument was found to be accurate to about ±50 m, although in areas of thick woods or rugged relief, accuracy could be much reduced. In addition, seven rock samples were collected from both typical and sulphide-bearing outcrops and from boulders encountered during traversing.

## SAMPLE PREPARATION AND ANALYSES

### Preparation

Soil samples were oven dried at 60°C at the Geological Survey's geochemical laboratory. One in 20 was selected as a laboratory duplicate and split in a riffle splitter. Each sample was then sifted in a stainless-steel sieve to <180 μm. Rock samples were pulverized to <100 μm in a tungsten carbide shatterbox in preparation for analysis. As a check on quality control, a laboratory standard of known composition and a split of a sample were included within each batch, and were added to every batch of 20 soil and rock samples for quality control.

### Analyses

Soil and rock samples were analyzed for 43 elements and loss-on-ignition. These elements and methods of analyses are listed in Table 1. Several elements (e.g., Cu, Fe, Pb, etc.) were analyzed by more than one method. The reader should note whether the method is "partial" or "total" and then select the element/method combination most suitable.

## DATA HANDLING

Statistical interpretation was done using SPSS™, a statistical package for the social sciences. All figures and most tables were developed using the software packages Corel Draw™, Lotus 1-2-3™, ArcView™ and Unistat™ (Nolan, 1990). The last is a software program developed at the Newfoundland and Labrador Geological Survey for plotting histograms and cumulative frequency curves from an ASCII database. ArcView™ (V. 1.0) is a viewer for the ArcInfo™ GIS program and runs under WINDOWS 3.x™ only. A similar product, Arc Explorer™, runs in the WINDOWS 95™

environment. Both may be downloaded from the ArcInfo web page. Text, table and figures were all output to a laser printer. The complete analytical database for this publication is available in digital format as ASCII or Lotus (*.wk1) files from the author or the Geoscience Publications and Information Section.

# DESCRIPTION AND DISCUSSION OF RESULTS

## STATISTICAL ANALYSIS

### Summary Statistics

To quantify the range and distribution characteristics of the element populations, summary statistics have been calculated for the soil data and tabulated in Table 2. Most element populations are more nearly log-normal than normal, hence the geometric mean as well as the arithmetic mean are given.

### Histograms of Analytical Data

Histograms for several elements analyzed in soil are found in Figure 2. These provide a quick graphical view of the shape of an element's population distribution and, in particular, show the relationship of extremely high values to the main population. The axis plotting the element value in each case is a log scale because most element populations more closely approximate a log distribution than an arithmetic distribution.

### Cumulative Frequency Plots

Cumulative frequency plots for nine elements are shown in Figure 3. These are very useful for recognizing subpopulations in the data, or population breaks. For example, arsenic shows a distinct break at 20 ppm and copper has one at about 100 ppm. When plotting data as symbol maps, more geologically meaningful distributions can be shown by selecting symbol ranges that correspond to these population breaks (inflection points) in the cumulative frequency plots.

### Correlation Analysis

Correlation coefficients show the strength of inter-element associations; i.e., the tendency for pairs of elements to vary sympathetically (positive correlations) or inversely (negative correlations) with each other in a given sample population. For example, if gold is associated with arsenic (arsenopyrite) in an area, this relationship may show as a positive correlation. Iron and manganese (hydr)oxides frequently act as significant scavenging agents for many metals in soils and sediments. (For some elements, this may be so extreme as to require normalizing, or even outright rejection, of the data involved.) Spearman-ranked correlation

coefficients have been calculated for several pairs of elements in the soil data. Spearman correlations make no assumptions about the nature or shape of the component populations. The correlation coefficients for all soil elements with iron (Fe2) and manganese (Mn2), as well as loss-on-ignition (also a possible element scavenger or dilutant), were calculated and are shown in graphical form in Figures 4, 5 and 6, respectively.

Table 3 presents the coefficients between most of the elements analyzed and a selection of base metals, precious metals and a few others. Statistically, correlations >|0.16| (i.e., absolute value of 0.16) are significant at the 99% confidence level. However, for practical purposes correlations of <|0.6| generally do not call for adjustment of values when dealing with scavenging agents like Fe and Mn. That is, enough of the element signal is present that satisfactory results may be obtained by treating only the raw values. For elements with coefficients >|0.6|, procedures such as regression analysis may be employed to minimize the component of the signal due to scavenging. Alternatively, scatter plots of the element pairs can be prepared to show whether a given sample is being strongly skewed by a scavenger. Figure 4 indicates that arsenic (As1) with a coefficient of 0.71, is the only element that exceeds the 0.6 threshold with iron. Figure 5 shows that three elements, Co, Ni and Dy exceed the 0.6 threshold with manganese. Cobalt in particular (r=0.83) appears to be strongly scavenged by manganese. In Figure 6, bromine shows its customary strong affiliation for organic matter (r=0.80) but several elements show evidence of a dilutant effect with LOI, particularly the rare-earth elements, and have strongly negative coefficients.

### Scatterplots

As an interpretive aid, scatterplots of the economic elements that exceed the 0.6 threshold for correlation coefficients in Figures 4 and 5 above, are presented in Figures 7, 8 and 9. These comprise As1 with Fe2, Co4 with Mn2, and Ni4 with Mn2, respectively.

## ELEMENT DISTRIBUTION IN SOIL

The locations of soil- and rock-sample sites in relation to geology are shown in Figure 10. An expanded geological legend for the figure is found in Table 4. The distribution of gold (Au1) and copper (Cu4) are shown as symbol maps in Figures 11 and 12. In each case, the intervals represented by the symbols correspond to intervals between inflection points on the corresponding cumulative frequency curve inset on the map. Thus, a given symbol represents samples from a distinctive subpopulation within the data.

### Gold

The distribution map of gold in soil is shown as Figure 11. The highest gold value (38 ppb) forms part of a three

**Table 2.** Summary statistics for soil data (N=338)

| ELEMENT | MEDIAN | ARITHMETIC MEAN | GEOMETRIC MEAN | STANDARD DEVIATION | MINIMUM | MAXIMUM |
|---|---|---|---|---|---|---|
| Ag6 | <0.1 | 0.10 | 0.07 | 0.19 | 0.05 | 2.4 |
| Al2 | 8.54 | 8.40 | 8.32 | 0.98 | 0.37 | 10.65 |
| As1 | 11.0 | 12.9 | 11.8 | 9.3 | 0.2 | 159 |
| Au1, ppb | 3 | 3.57 | 2.88 | 2.75 | 0.5 | 38 |
| Ba1 | 440 | 439 | 427 | 70.2 | 25 | 780 |
| Be2 | 1.2 | 1.28 | 1.26 | 0.22 | 0.2 | 1.9 |
| Br1 | 6.8 | 8.20 | 6.46 | 5.58 | 0.5 | 31 |
| Ca2, wt. % | 1.16 | 1.27 | 1.17 | 0.63 | 0.18 | 9.5 |
| Cd4 | 0.2 | 0.17 | 0.15 | 0.09 | 0.1 | 0.8 |
| Ce1 | 57 | 57.8 | 56.2 | 12.6 | 2 | 130 |
| Ce2 | 58 | 59.5 | 58.9 | 11 | 16 | 124 |
| Co1 | 21 | 20.5 | 19.1 | 7.4 | 1 | 56 |
| Co2 | 19 | 20.0 | 18.6 | 7.01 | 2 | 60 |
| Co4 | 12 | 12.9 | 11.8 | 5.3 | 1 | 41 |
| Cr1 | 140 | 148 | 144.5 | 34.4 | 22 | 430 |
| Cr2 | 122 | 124 | 120.2 | 30.0 | 16 | 422 |
| Cs1 | 2.3 | 2.34 | 2.24 | 0.61 | 0.7 | 4.5 |
| Cu2 | 55 | 59.9 | 53.7 | 28.2 | 11 | 250 |
| Cu4 | 47 | 52.0 | 46.8 | 24.8 | 9 | 209 |
| Dy2 | 2.4 | 2.54 | 2.51 | 0.61 | 0.5 | 11 |
| Eu1 | 1 | 0.89 | 1.05 | 0.44 | 0 | 2 |
| F9 | 434 | 444 | 432 | 118 | 50 | 1875 |
| Fe1, wt. % | 6.9 | 7.25 | 7.08 | 2.6 | 0.9 | 40.7 |
| Fe2, wt. % | 6.83 | 7.18 | 6.92 | 2.87 | 1.01 | 45.9 |
| Fe4, wt. % | 3.59 | 3.84 | 3.72 | 1.62 | 0.7 | 22.2 |
| Ga2 | 21 | 21.0 | 28.8 | 3.48 | 3 | 36 |
| Hf1 | 5 | 5.22 | 5.13 | 0.88 | 0.5 | 9 |
| K2, wt. % | 1.61 | 1.6 | 1.55 | 0.31 | 0.1 | 3.33 |
| La1 | 31 | 31.1 | 30.2 | 6.81 | 5 | 77 |
| La2 | 29 | 29.2 | 28.8 | 5.67 | 8 | 66 |
| Li2 | 34.2 | 33.9 | 32.4 | 7.89 | 2.4 | 65.9 |
| LOI, wt. % | 7.2 | 8.33 | 7.08 | 5.54 | 1.5 | 67.7 |
| Mg2, wt. % | 1.53 | 1.53 | 1.48 | 0.4 | 0.16 | 3.80 |
| Mn2 | 737 | 791 | 708 | 760 | 80 | 11790 |
| Mn4 | 264 | 336 | 263 | 700 | 17 | 11000 |
| Mo1 | 1.0 | 1.26 | 0.83 | 1.07 | 0.2 | 8 |
| Mo3 | 1.0 | 1.58 | 1.32 | 1.02 | 0.5 | 9 |
| Na2, wt. % | 1.24 | 1.24 | 1.20 | 0.26 | 0.06 | 2.12 |
| Nb2 | 10 | 10.2 | 10.0 | 2.37 | 1 | 28 |
| Ni1 | 51 | 52.5 | 49.0 | 18.4 | 5 | 130 |
| Ni2 | 42 | 42.2 | 39.8 | 14.4 | 1 | 155 |
| Ni4 | 35 | 35.0 | 32.36 | 13.5 | 1 | 127 |
| P2 | 472 | 521 | 490 | 284 | 229 | 4820 |
| Pb2 | 10 | 10.8 | 10.0 | 11.2 | 1 | 212 |
| Pb4 | 8 | 8.8 | 7.76 | 11.4 | 1 | 212 |
| Rb1 | 65 | 64.5 | 61.7 | 13.6 | 2 | 120 |
| Sb1 | 1.0 | 1.07 | 1.00 | 0.35 | 0.02 | 2.4 |
| Sc1 | 18.6 | 18.7 | 18.2 | 7.5 | 1.9 | 143 |
| Sc2 | 17.6 | 17.9 | 17.4 | 8.05 | 1.8 | 156 |
| Sm1 | 4.4 | 4.53 | 4.47 | 0.85 | 0.8 | 7.4 |
| Sr2 | 106 | 109 | 105 | 26.1 | 12 | 219 |
| Ta1 | 1.0 | 1.02 | 1.00 | 0.19 | 0.1 | 2 |
| Tb1 | 0.7 | 0.75 | 0.69 | 0.45 | 0.2 | 8.3 |
| Th1 | 7.5 | 7.47 | 7.24 | 1.33 | 0.7 | 11.2 |
| Ti2 | 5310 | 5290 | 5130 | 822 | 237 | 9090 |
| U1 | 2.8 | 2.82 | 2.75 | 0.72 | 0.6 | 9.1 |
| V2 | 176 | 178 | 174 | 28.7 | 11 | 272 |
| W1 | <1 | 0.41 | 0.30 | 0.35 | 0.2 | 1 |
| Y2 | 15 | 15.7 | 15.5 | 3.54 | 4 | 62 |
| Yb1 | 2.0 | 1.71 | 1.55 | 1.83 | 0.5 | 34 |
| Zn2 | 94 | 97 | 93.3 | 40.8 | 38 | 739 |
| Zn4 | 73 | 76.2 | 72.4 | 36.8 | 22 | 652 |
| Zr2 | 112 | 112 | 110 | 16.7 | 10 | 213 |

* NOTE: data in ppm unless otherwise indicated.

To enable the user to readily distinguish the method of analysis for a given element, a suffix is attached to the element symbol when used in statistical summaries and tables. The key to the suffixes is as follows:

1. Neutron activation analysis (INAA).
2. ICP-ES/after $HF-HClO_4-HCl$ digestion.
3. AA/after $HF-HClO_4-HCl$ digestion.
4. AA/after $HNO_3-HCl$ (3:1) digestion.
6. AA/after $HNO_3$ digestion.
9. Fluoride-ion selective electrode after fusion with flux of 2:1 $Na_2CO_3:KNO_3$.

Thus, for example, Zn4 is zinc analyzed by $AA/HNO_3-HCL$ whereas Zn1 is zinc analyzed by INAA.
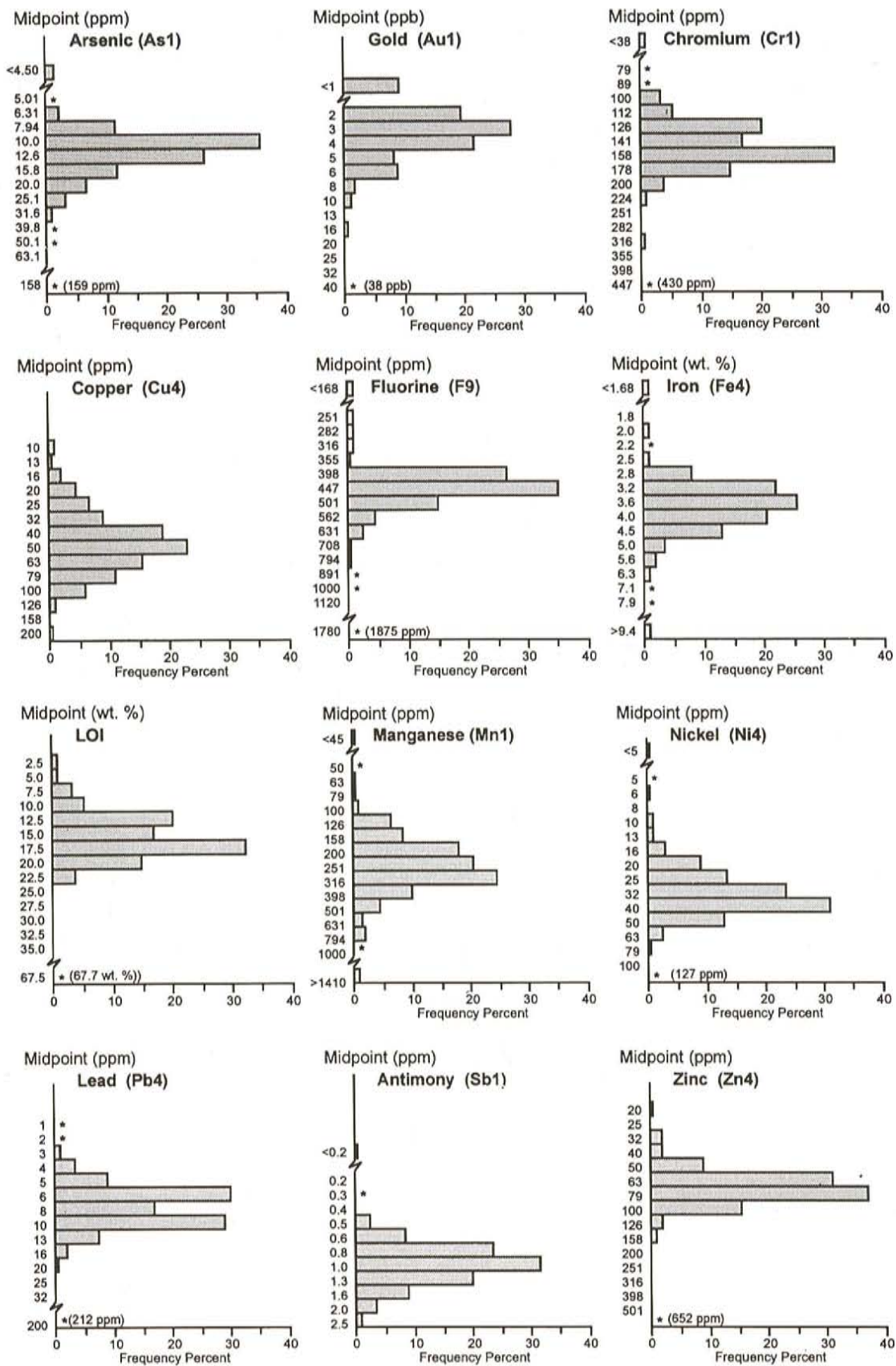
**Figure 2.** *Histograms of As1, Au1, Cr1, Cu4, F9, Fe4, LOI, Mn2, Ni4, Pb4, Sb1 and Zn4 in soil (N=338).*
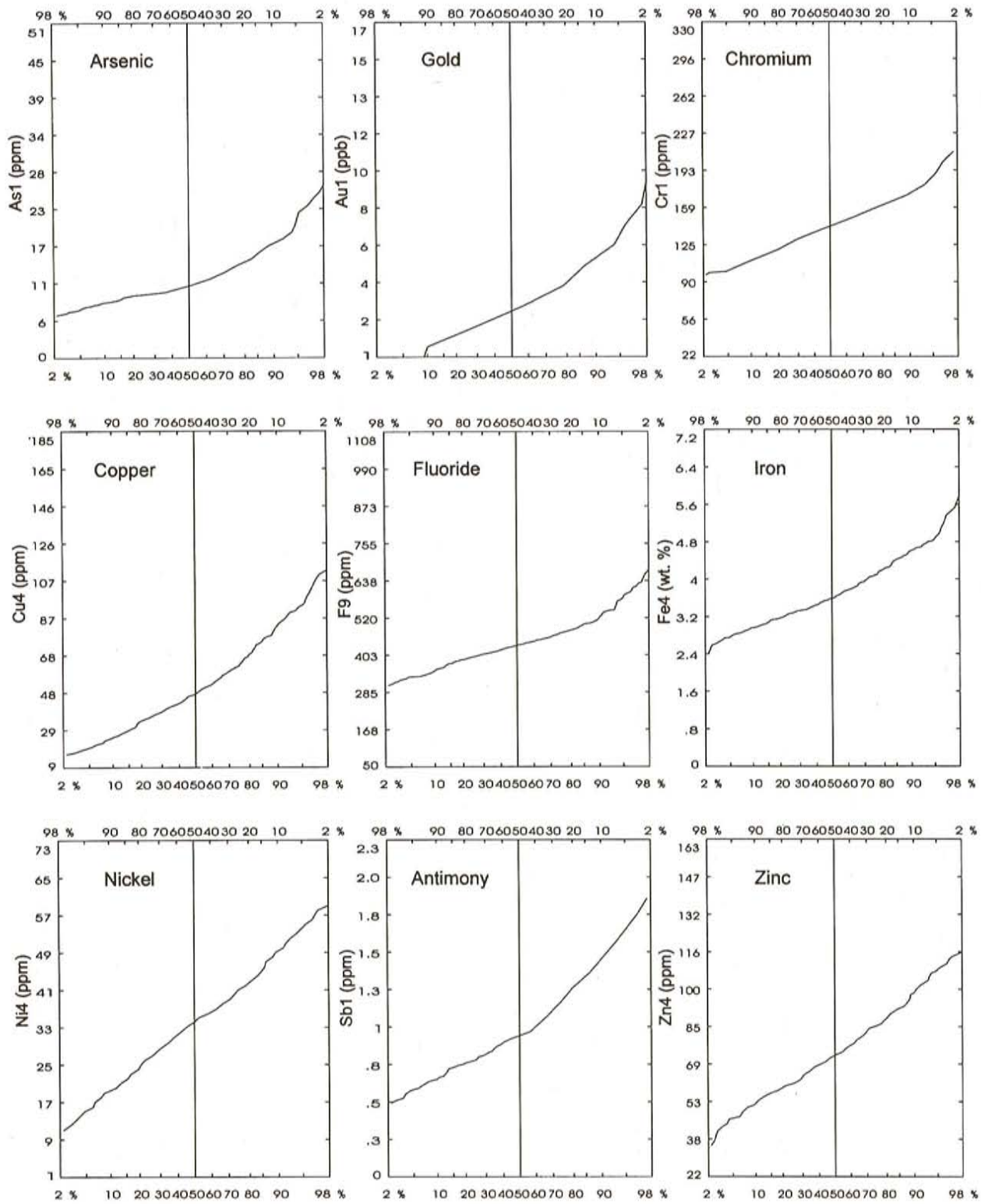
**Figure 3.** *Cumulative frequency plots of As1, Au1, Cr1, Cu4, F9, Fe4, Ni4, Sb1 and Zn4 in soil (N=338).*

sample cluster of high values in the Twin Pond area and also has a high copper value (Cu4 of 111 ppm). Gold is often associated with copper in this area (r=0.52) as can be seen in the table of correlation coefficients. The area is located about 3 km southeast from the closest known sulphide mineralization. Four other samples with >8 ppb Au are more widely distributed.

**Table 3.** Spearman correlation coefficients for selected elements in soil (N=338)

| | Ag6 | As1 | Au1 | Ca2 | Co4 | Cr1 | Cu4 | La1 | Mg2 | Mo2 | Ni4 | Pb4 | Sb1 | Ti2 | U1 | Zn4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag6 | **1.00** | 0.04 | -0.14 | -0.39 | -0.29 | -0.32 | -0.23 | -0.30 | -0.35 | 0.22 | -0.35 | 0.20 | 0.12 | -0.32 | 0.08 | -0.04 |
| Al2 | -0.19 | 0.14 | 0.21 | 0.07 | 0.43 | 0.51 | 0.52 | 0.10 | 0.49 | -0.02 | 0.56 | 0.02 | 0.00 | 0.08 | -0.01 | 0.42 |
| As1 | 0.04 | **1.00** | 0.43 | -0.09 | 0.23 | 0.18 | 0.46 | -0.22 | -0.05 | 0.69 | 0.18 | 0.64 | 0.74 | 0.06 | 0.44 | 0.46 |
| Au1 | -0.14 | 0.43 | **1.00** | 0.23 | 0.32 | 0.29 | 0.52 | 0.03 | 0.21 | 0.28 | 0.31 | 0.25 | 0.33 | 0.18 | 0.24 | 0.33 |
| Ba1 | -0.14 | -0.13 | -0.06 | 0.01 | 0.31 | 0.01 | 0.07 | 0.51 | 0.19 | -0.22 | 0.26 | -0.05 | 0.08 | -0.01 | 0.27 | 0.25 |
| Be2 | -0.15 | 0.14 | 0.17 | -0.04 | 0.57 | 0.11 | 0.44 | 0.46 | 0.28 | -0.05 | 0.55 | 0.16 | 0.18 | -0.20 | 0.42 | 0.62 |
| Br1 | 0.32 | 0.15 | -0.05 | -0.37 | -0.38 | -0.21 | -0.17 | -0.52 | -0.48 | 0.31 | -0.38 | 0.25 | 0.06 | -0.43 | -0.01 | -0.06 |
| Ca2 | -0.39 | -0.09 | 0.23 | **1.00** | 0.39 | 0.49 | 0.38 | 0.16 | 0.64 | -0.39 | 0.47 | -0.40 | -0.38 | 0.56 | -0.40 | 0.04 |
| Cd4 | 0.05 | 0.13 | 0.17 | 0.08 | 0.42 | 0.02 | 0.27 | 0.14 | 0.19 | -0.02 | 0.34 | 0.15 | 0.06 | -0.10 | 0.06 | 0.47 |
| Ce1 | -0.26 | -0.21 | 0.01 | 0.13 | 0.40 | 0.19 | 0.15 | 0.92 | 0.30 | -0.30 | 0.35 | -0.15 | -0.10 | 0.07 | 0.18 | 0.12 |
| Co2 | -0.34 | 0.19 | 0.32 | 0.51 | 0.97 | 0.51 | 0.68 | 0.31 | 0.75 | -0.23 | 0.88 | -0.03 | -0.12 | 0.25 | -0.11 | 0.48 |
| Co4 | -0.29 | 0.23 | 0.32 | 0.39 | **1.00** | 0.43 | 0.66 | 0.33 | 0.67 | -0.17 | 0.86 | 0.10 | -0.05 | 0.17 | -0.02 | 0.54 |
| Cr1 | -0.32 | 0.18 | 0.29 | 0.49 | 0.43 | **1.00** | 0.57 | 0.17 | 0.65 | -0.09 | 0.63 | -0.14 | -0.11 | 0.45 | -0.24 | 0.22 |
| Cs1 | 0.28 | 0.30 | -0.04 | -0.73 | -0.26 | -0.26 | -0.15 | -0.09 | -0.48 | 0.50 | -0.29 | 0.44 | 0.54 | -0.28 | 0.61 | 0.18 |
| Cu2 | -0.23 | 0.47 | 0.52 | 0.38 | 0.65 | 0.58 | 1.00 | 0.12 | 0.58 | 0.13 | 0.74 | 0.22 | 0.24 | 0.28 | 0.09 | 0.59 |
| Cu4 | -0.23 | 0.46 | 0.52 | 0.38 | 0.66 | 0.57 | **1.00** | 0.12 | 0.59 | 0.12 | 0.75 | 0.22 | 0.23 | 0.28 | 0.08 | 0.59 |
| Dy2 | -0.34 | -0.02 | 0.23 | 0.59 | 0.54 | 0.30 | 0.45 | 0.54 | 0.54 | -0.25 | 0.57 | -0.19 | -0.12 | 0.34 | 0.04 | 0.24 |
| F9 | 0.01 | 0.10 | -0.03 | -0.28 | 0.26 | 0.02 | 0.16 | 0.19 | 0.18 | 0.06 | 0.28 | 0.15 | 0.09 | -0.22 | 0.28 | 0.29 |
| Fe1 | -0.13 | 0.66 | 0.36 | 0.18 | 0.24 | 0.58 | 0.47 | -0.07 | 0.24 | 0.35 | 0.33 | 0.32 | 0.38 | 0.23 | 0.12 | 0.33 |
| Fe2 | -0.04 | 0.71 | 0.37 | 0.15 | 0.31 | 0.45 | 0.54 | -0.24 | 0.28 | 0.37 | 0.38 | 0.38 | 0.35 | 0.19 | 0.07 | 0.38 |
| Fe4 | -0.08 | 0.75 | 0.43 | 0.13 | 0.30 | 0.40 | 0.53 | -0.24 | 0.18 | 0.44 | 0.34 | 0.47 | 0.44 | 0.21 | 0.20 | 0.42 |
| K2 | -0.01 | -0.01 | 0.00 | -0.42 | 0.17 | -0.16 | 0.03 | 0.41 | -0.00 | 0.06 | 0.12 | 0.17 | 0.32 | -0.30 | 0.49 | 0.32 |
| La1 | -0.30 | -0.22 | 0.03 | 0.16 | 0.33 | 0.17 | 0.12 | **1.00** | 0.29 | -0.28 | 0.31 | -0.17 | -0.10 | 0.06 | 0.21 | 0.08 |
| Li2 | -0.07 | -0.00 | 0.03 | -0.27 | 0.41 | 0.08 | 0.23 | 0.33 | 0.23 | -0.09 | 0.43 | 0.16 | 0.04 | -0.32 | 0.20 | 0.55 |
| LOI | 0.40 | 0.16 | -0.13 | -0.45 | -0.47 | -0.25 | -0.30 | -0.61 | -0.53 | 0.37 | -0.48 | 0.28 | 0.04 | -0.39 | -0.03 | -0.16 |
| Mg2 | -0.35 | -0.05 | 0.21 | 0.64 | 0.67 | 0.65 | 0.59 | 0.29 | **1.00** | -0.41 | 0.82 | -0.27 | -0.36 | 0.37 | -0.35 | 0.25 |
| Mn2 | -0.26 | 0.19 | 0.28 | 0.48 | 0.83 | 0.28 | 0.47 | 0.32 | 0.54 | -0.17 | 0.65 | 0.00 | -0.01 | 0.20 | 0.06 | 0.43 |
| Mn4 | -0.21 | 0.17 | 0.22 | 0.28 | 0.80 | 0.14 | 0.38 | 0.37 | 0.41 | -0.15 | 0.59 | 0.10 | 0.04 | 0.01 | 0.19 | 0.48 |
| Mo3 | 0.22 | 0.69 | 0.28 | -0.39 | -0.17 | -0.09 | 0.12 | -0.28 | -0.41 | **1.00** | -0.23 | 0.60 | 0.75 | -0.04 | 0.55 | 0.26 |
| Na1 | -0.26 | -0.32 | -0.03 | 0.52 | 0.35 | 0.40 | 0.20 | 0.47 | 0.56 | -0.53 | 0.40 | -0.42 | -0.38 | 0.28 | -0.42 | -0.02 |
| Na2 | -0.24 | -0.39 | -0.09 | 0.54 | 0.36 | 0.23 | 0.16 | 0.31 | 0.57 | -0.61 | 0.39 | -0.48 | -0.48 | 0.29 | -0.51 | -0.07 |
| Nb2 | -0.11 | 0.02 | 0.03 | 0.05 | 0.00 | -0.09 | -0.05 | 0.27 | -0.10 | 0.14 | -0.05 | -0.01 | 0.22 | 0.48 | 0.28 | -0.04 |
| Ni2 | -0.39 | 0.13 | 0.30 | 0.56 | 0.83 | 0.69 | 0.74 | 0.29 | 0.86 | -0.27 | 0.97 | -0.12 | -0.17 | 0.35 | -0.17 | 0.46 |
| Ni4 | -0.35 | 0.18 | 0.31 | 0.47 | 0.86 | 0.63 | 0.75 | 0.31 | 0.82 | -0.23 | **1.00** | -0.01 | -0.12 | 0.26 | -0.10 | 0.54 |
| P2 | 0.21 | 0.23 | 0.10 | -0.03 | 0.13 | 0.11 | 0.20 | -0.27 | 0.05 | 0.14 | 0.13 | 0.11 | -0.02 | -0.22 | -0.05 | 0.19 |
| Pb2 | 0.29 | 0.53 | 0.11 | -0.40 | 0.10 | -0.18 | 0.18 | -0.15 | -0.22 | 0.44 | 0.02 | 0.76 | 0.51 | -0.35 | 0.38 | 0.41 |
| Pb4 | 0.20 | 0.64 | 0.25 | -0.40 | 0.10 | -0.14 | 0.22 | -0.17 | -0.27 | 0.60 | -0.01 | **1.00** | 0.66 | -0.19 | 0.49 | 0.44 |
| Rb1 | 0.11 | 0.18 | -0.02 | -0.54 | -0.04 | -0.14 | -0.05 | 0.24 | -0.22 | 0.32 | -0.08 | 0.33 | 0.47 | -0.20 | 0.60 | 0.27 |
| Sb1 | 0.12 | 0.74 | 0.33 | -0.38 | -0.05 | -0.11 | 0.23 | -0.10 | -0.36 | 0.75 | -0.12 | 0.66 | **1.00** | -0.05 | 0.72 | 0.40 |
| Sc1 | -0.38 | 0.12 | 0.34 | 0.69 | 0.42 | 0.78 | 0.51 | 0.33 | 0.63 | -0.14 | 0.52 | -0.19 | -0.08 | 0.55 | -0.15 | 0.19 |
| Sm1 | -0.38 | -0.15 | 0.15 | 0.43 | 0.48 | 0.21 | 0.26 | 0.85 | 0.46 | -0.36 | 0.45 | -0.21 | -0.13 | 0.20 | 0.17 | 0.14 |
| Sr2 | -0.33 | -0.29 | 0.05 | 0.82 | 0.32 | 0.34 | 0.21 | 0.28 | 0.50 | -0.51 | 0.37 | -0.49 | -0.42 | 0.45 | -0.40 | -0.02 |
| Ta1 | -0.23 | 0.10 | 0.10 | -0.04 | -0.04 | -0.03 | -0.06 | 0.37 | -0.15 | 0.15 | -0.07 | 0.05 | 0.33 | 0.31 | 0.39 | -0.08 |
| Tb1 | -0.22 | -0.09 | 0.16 | 0.41 | 0.42 | 0.19 | 0.25 | 0.60 | 0.42 | -0.24 | 0.39 | -0.14 | -0.08 | 0.22 | 0.11 | 0.14 |
| Th1 | -0.08 | 0.22 | 0.18 | -0.38 | 0.17 | -0.05 | 0.16 | 0.53 | -0.14 | 0.21 | 0.09 | 0.28 | 0.44 | -0.21 | 0.66 | 0.27 |
| Ti2 | -0.32 | 0.06 | 0.18 | 0.56 | 0.17 | 0.45 | 0.28 | 0.06 | 0.37 | -0.04 | 0.26 | -0.19 | -0.05 | **1.00** | -0.21 | -0.12 |
| U1 | 0.08 | 0.44 | 0.24 | -0.40 | -0.02 | -0.24 | 0.08 | 0.21 | -0.35 | 0.55 | -0.10 | 0.49 | 0.72 | -0.21 | **1.00** | 0.35 |
| V2 | -0.22 | 0.44 | 0.39 | 0.43 | 0.24 | 0.59 | 0.50 | -0.15 | 0.40 | 0.27 | 0.35 | 0.09 | 0.21 | 0.70 | -0.02 | 0.14 |
| W1 | 0.09 | 0.04 | 0.01 | -0.27 | -0.12 | -0.18 | -0.13 | 0.07 | -0.21 | 0.13 | -0.15 | 0.17 | 0.18 | -0.15 | 0.20 | 0.01 |
| Y2 | -0.30 | 0.02 | 0.23 | 0.56 | 0.47 | 0.22 | 0.39 | 0.53 | 0.44 | -0.19 | 0.47 | -0.13 | -0.02 | 0.38 | 0.16 | 0.24 |
| Zn2 | -0.05 | 0.42 | 0.31 | 0.11 | 0.56 | 0.27 | 0.61 | 0.07 | 0.33 | 0.19 | 0.58 | 0.34 | 0.33 | -0.07 | 0.26 | 0.97 |
| Zn4 | -0.04 | 0.46 | 0.33 | 0.04 | 0.54 | 0.22 | 0.59 | 0.08 | 0.25 | 0.26 | 0.54 | 0.44 | 0.40 | -0.12 | 0.35 | **1.00** |
| Zr2 | 0.15 | 0.07 | -0.10 | -0.61 | -0.21 | -0.39 | -0.25 | 0.24 | -0.46 | 0.31 | -0.28 | 0.24 | 0.38 | -0.15 | 0.57 | -0.03 |

NOTE: Correlations >|0.16| are significant at the 99% confidence level.

To enable the user to readily distinguish the method of analysis for a given element, a suffix is attached to the element symbol when used in statistical summaries and tables. The key to the suffixes is as follows:

1. Neutron activation analysis (INAA).
2. ICP-ES/after HF-HClO$_4$-HCl digestion.
3. AA/after HF-HClO$_4$-HCl digestion.
4. AA/after HNO$_3$-HCl (3:1) digestion.
6. AA/after HNO$_3$ digestion.
9. Fluoride-ion selective electrode after fusion with flux of 2:1 Na$_2$CO$_3$:KNO$_3$.

Thus, for example, Zn4 is zinc analyzed by AA/HNO$_3$-HCL whereas Zn1 is zinc analyzed by INAA.
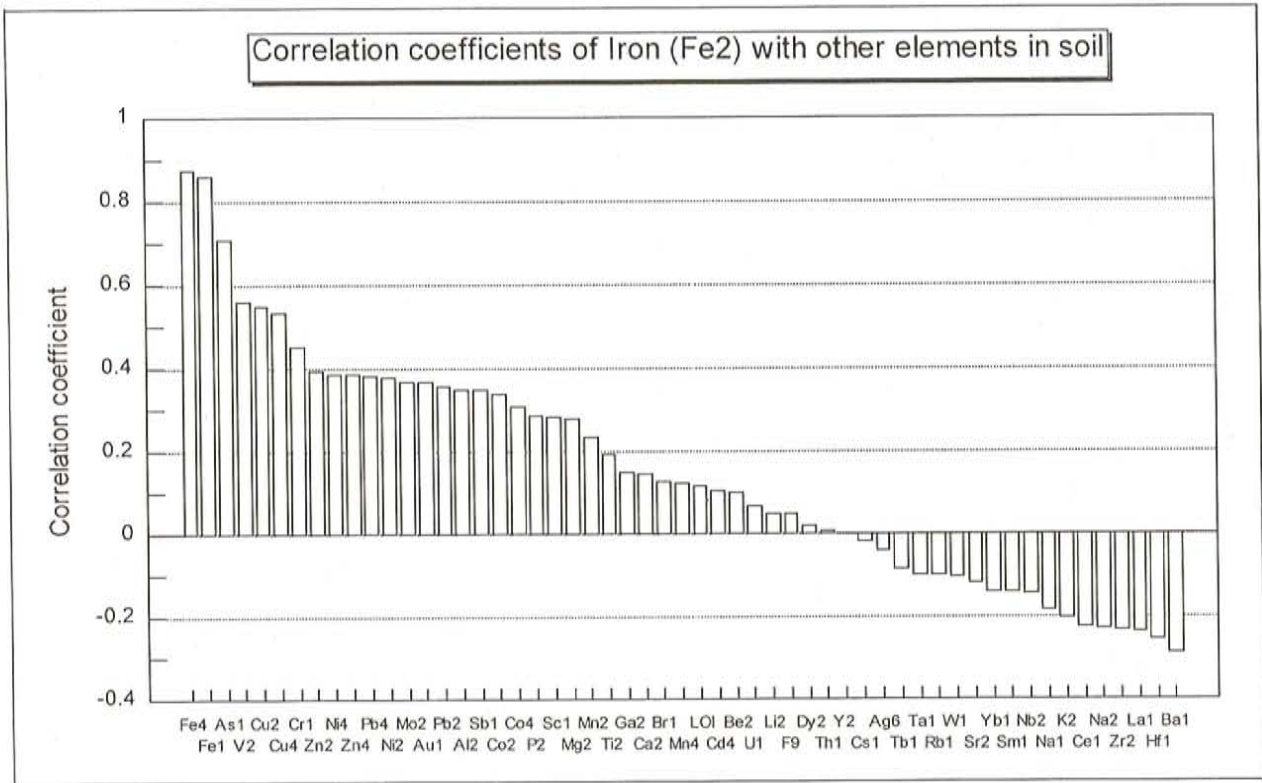
**Figure 4.** *Spearman correlation coefficients of Fe2 with other elements in soil (N=338).*
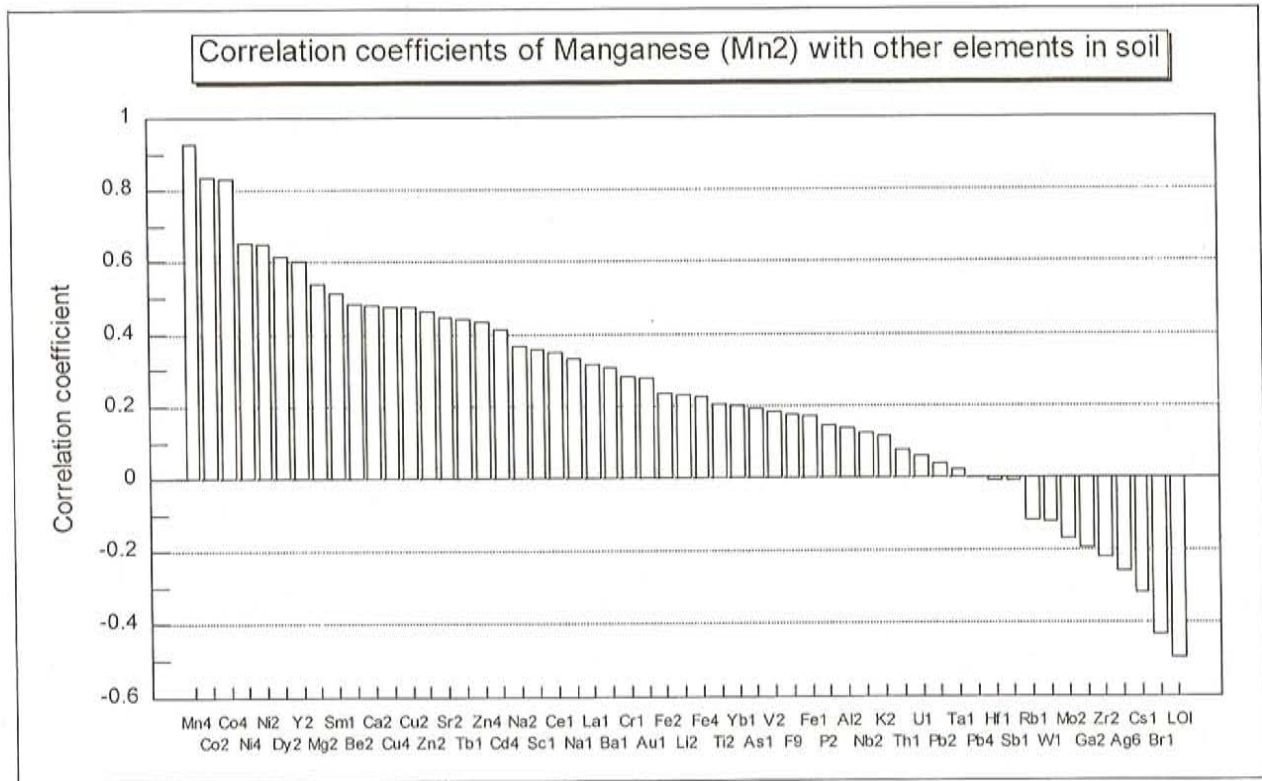


**Figure 5.** *Spearman correlation coefficients of Mn2 with other elements in soil (N=338).*
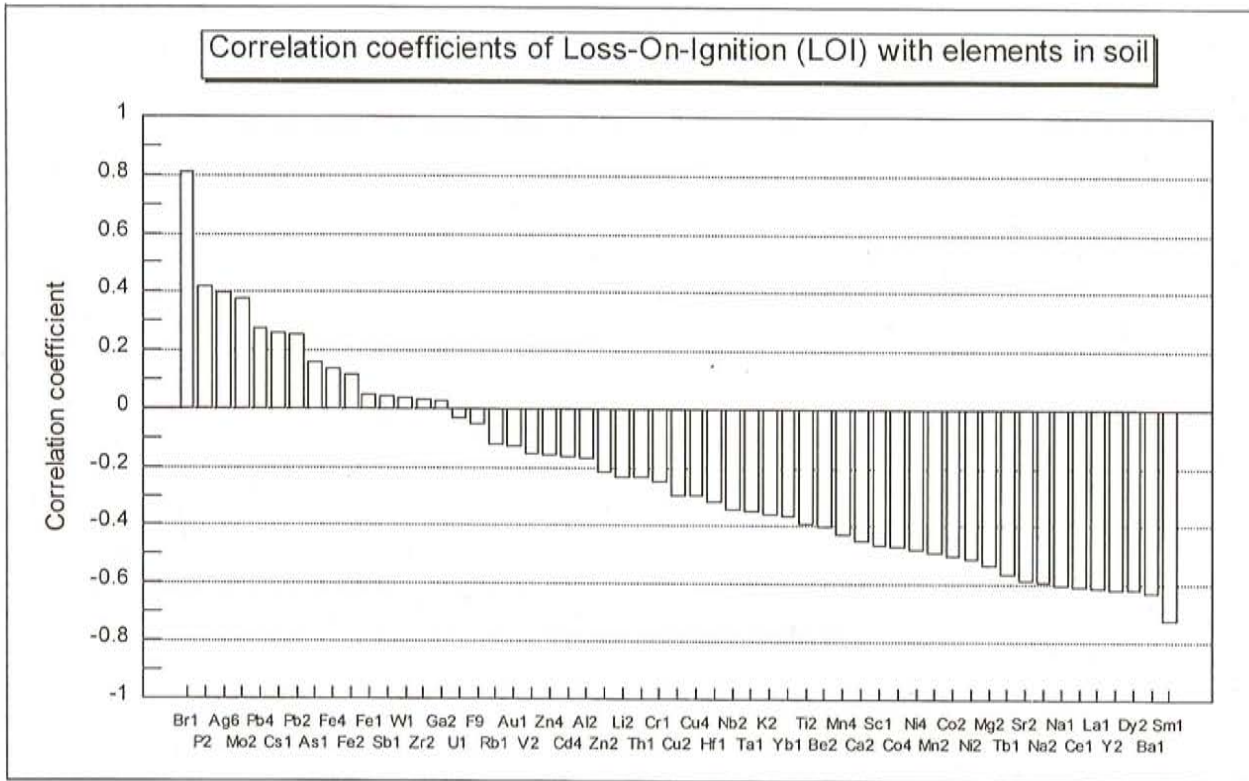
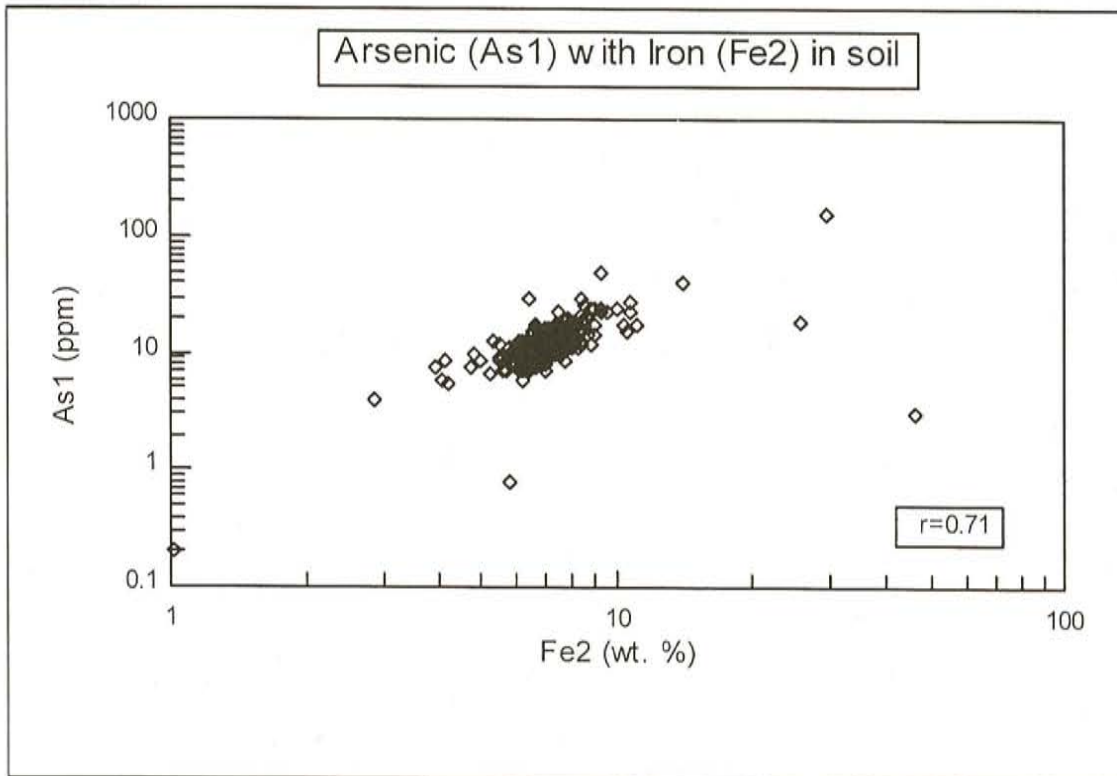Figure 6. *Spearman correlation coefficients of LOI with selected elements in soil (N=338).*



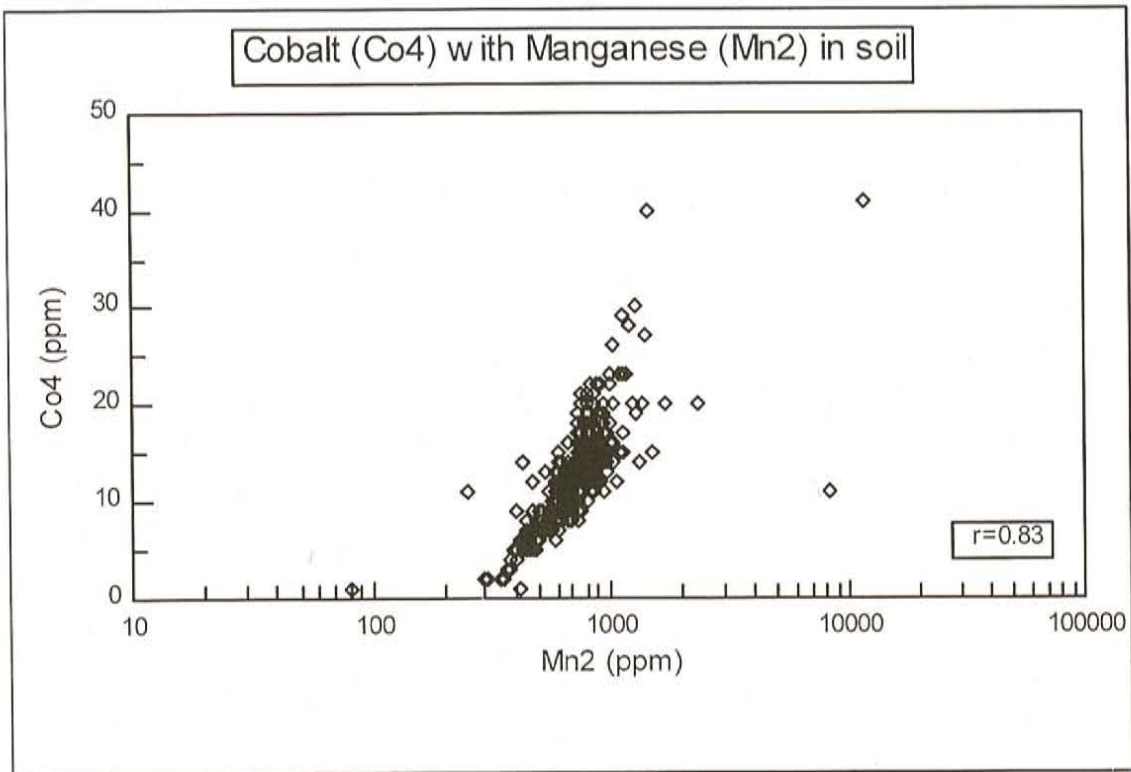Figure 7. *Scatterplot of arsenic with iron in soil (N=338).*

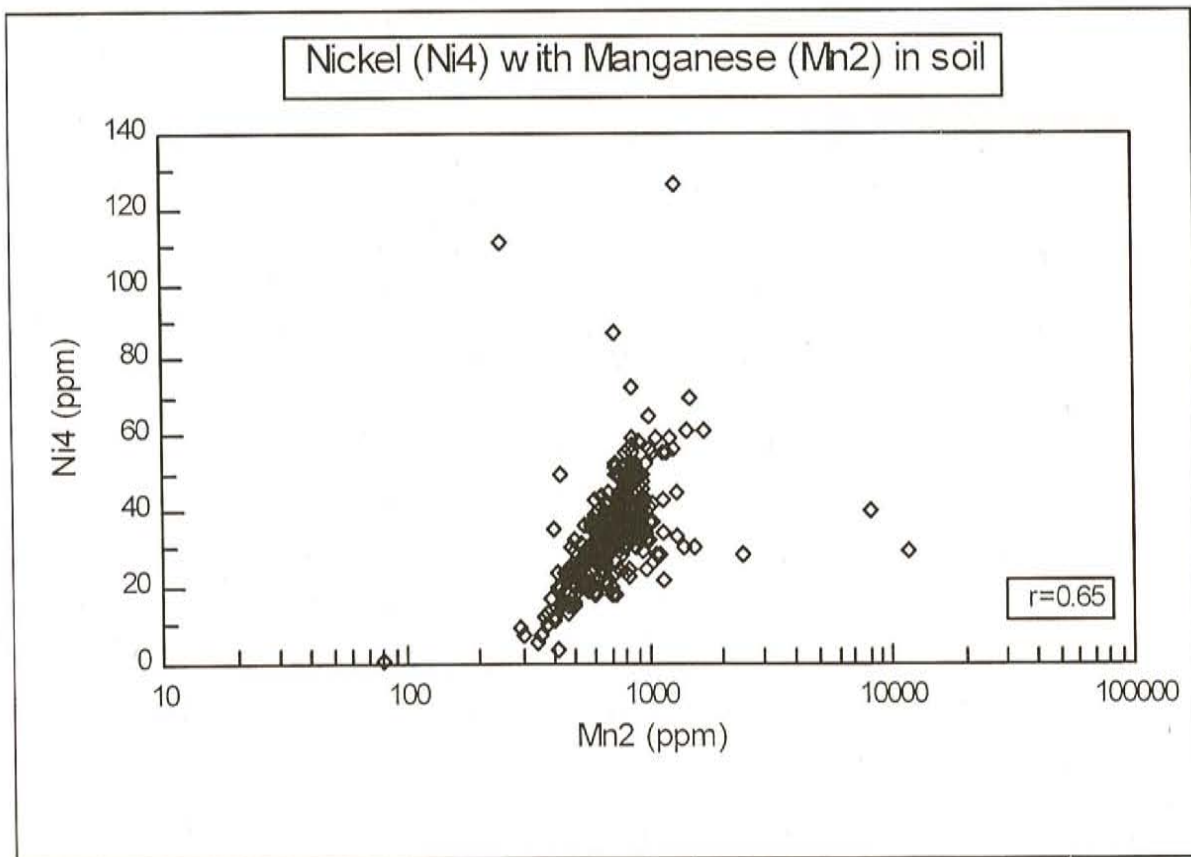**Figure 8.** *Scatterplot of cobalt with manganese in soil (N=338).*
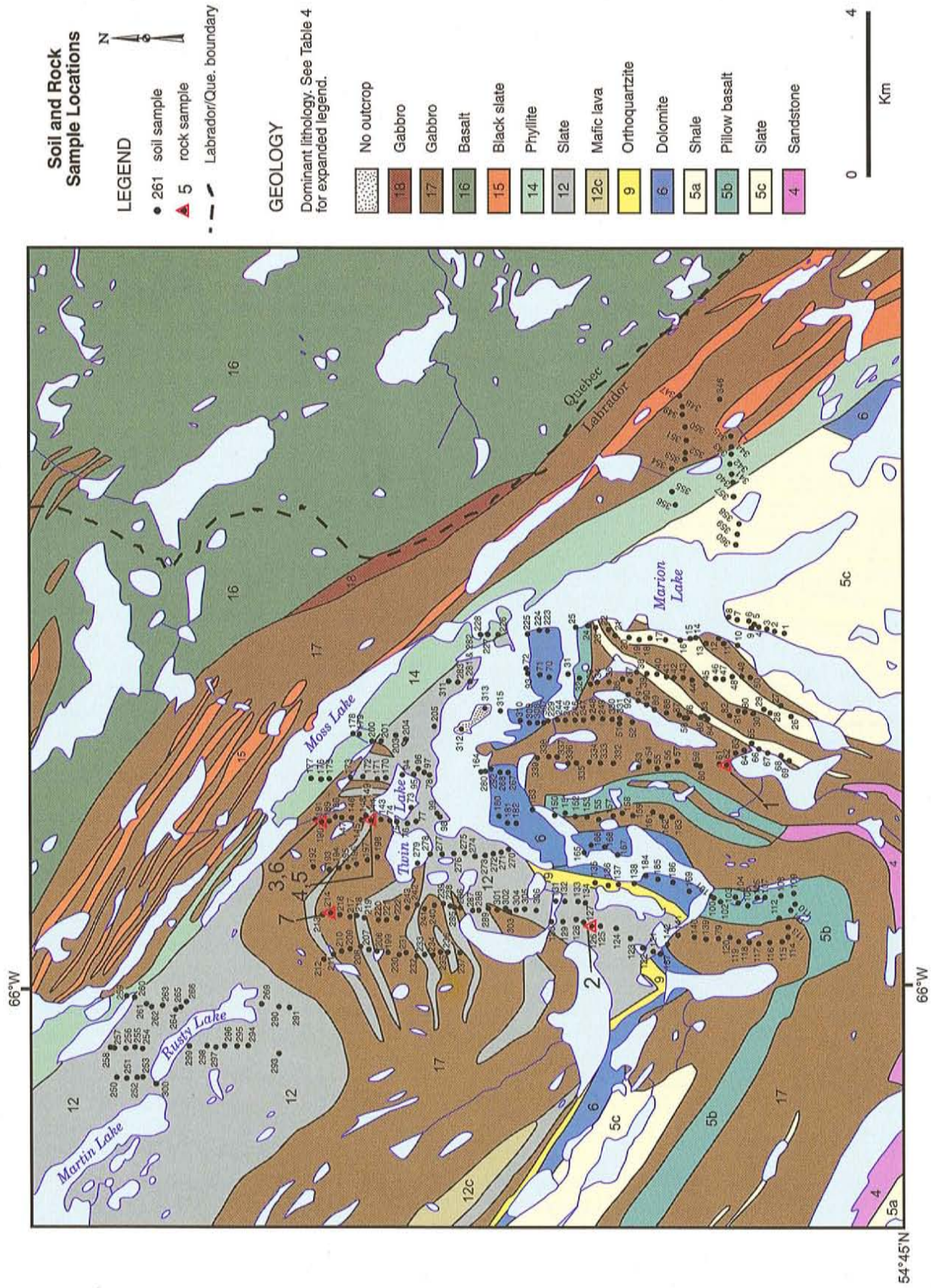


**Figure 9.** *Scatterplot of nickel with manganese in soil (N=338).*

**Figure 10.** *Location of soil and rock sample sites in relation to the regional geology and drainage.*

**Table 4.** Geology legend for Figure 10. Descriptions after Donaldson (1966), formation names after Wardle (1982)

| UNIT No. | FORMATION NAME | DESCRIPTION |
|---|---|---|
| PALEOPROTEROZOIC | | |
| Montagnais Intrusive Series | | |
| 18 | Wakuach Gabbro | Glomeroporphyritic gabbro |
| 17 | Wakuach Gabbro | Gabbro |
| Doublet Group | | |
| 16 | Willbob Formation | Pillow basalt, minor tuff and pillow breccia |
| 15 | Thompson Lake Formation | Black slate, banded siltstone and quartzite |
| 14 | Murdoch Formation | Chlorite phyllite, mafic lava; chlorite siltstone |
| Knob Lake Group | | |
| 12 | Menihek Formation | Slate, shale; minor quartzite, argillite |
| 12c | Menihek Formation | Mafic lava and tuff |
| 9 | Wishart Formation | Orthoquartzite, conglomerate, siltstone |
| 6 | Denault Formation | Stromatolitic dolomite |
| 5a | Le Fer Formation | Grey shale, siltstone and greywacke |
| 5b | Le Fer Formation | Pillow basalt; minor gabbro |
| 5c | Le Fer Formation | Slate, phyllite and siltstone |
| 4 | Sawyer Lake Formation | Purple sandstone and/or orthoquartzite |

## Copper

The distribution of copper in soil is shown in Figure 12. Most of the highest value samples form a northwest-trending belt centred on Twin Pond; the belt is at least 8 km in length. Its southeast terminus is not defined because samples were not collected in the area east of Marion Lake. The two occurrences of previously known copper mineralization are located at the northeast end of the belt (Figure 12); they were not observed in the field. However, they are reflected by two samples with high copper contents (110 and 90 ppm). The second highest Cu analysis (185 ppm) is from a sample near the south end of Marion Lake. Its low associated Fe and Mn contents do not suggest a problem with oxide scavenging.

## Nickel

The distribution of nickel in soil (not illustrated) presents a weaker reflection of the "copper belt" that runs through Twin Pond. However, most of the highest value samples are found in the Keco Lake–Marion Lake area. Two adjacent high nickel samples (#340 and #357 with 87 and 127 ppm respectively) are found to the east of Marion Lake. One of these also has high copper (108 ppm) although the iron content is also high (Fe4 = 5.9%).

## Zinc

The distribution of zinc in soil (not illustrated) reveals a pattern of high values that is quite similar to that of copper in the Marion Lake–Twin Pond area and in the Keco Lake area. The highest value (Zn4 = 652 ppm) is from sample #223 located near the west shore of Marion Lake (Figure 10) having high nickel (Ni4 = 61 ppm) and iron (Fe4 = 4.97%).

## ELEMENT DISTRIBUTION IN ROCK SAMPLES

None of the rock samples were found to have very high values of base metals or precious metals. The sample locations are shown in Figure 10. Most of the highest values were from a deposit of bog iron (sample 3); these included 1.1 ppm Ag6, 157 ppb Au1, 498 ppb As1, and 461 ppm Pb2. A gossanous siltstone boulder (sample 2) analyzed 571 ppm Cu2 and a pyritiferrous outcrop of black slate (sample 7) analyzed 1520 ppm Zn2. A selection of rock analyses are included in Table 5.

## SUMMARY AND CONCLUSIONS

In the area surrounding Twin Pond where three samples are located that have 10 to 38 ppb Au, further exploration is warranted. This area is 2 to 3 km southeast of the closest known sulphide mineralization. Here, the gold correlates positively with Cu, particularly in the area where the 38 ppb Au sample also has 111 ppm Cu4 content.

The Cu and Ni soil data reflect the known sulphide mineralization northeast of Twin Pond. High Cu values form a belt extending from the known mineralization for 8 km to the southeast. The highest value is found about 1 km southeast of the closest known sulphide occurrence. The zone of high Cu values is the most prospective area identified for discovering new copper mineralization. Nickel values are more subdued in this belt and more prominent in the Keco Pond–Marion Lake area. Some high Zn values are found around the northern part of Marion Lake with a high value of 652 ppm. The sulphide mineralization 2 km northwest of Twin Pond appears reflected in a soil sample in the area (121 ppm Zn), which itself is near a gossanous outcrop of slate with 1520 ppm Zn (sample 7).
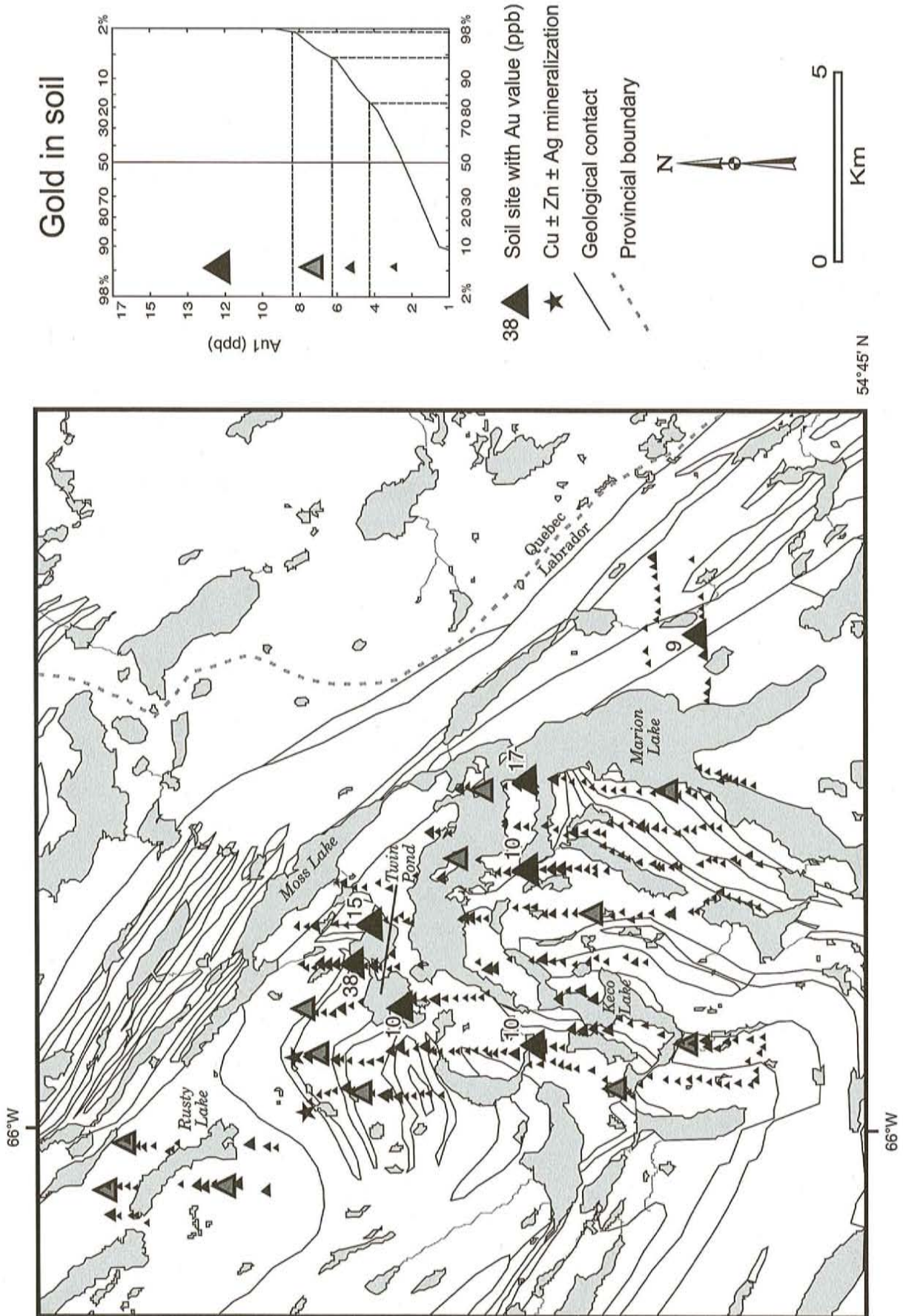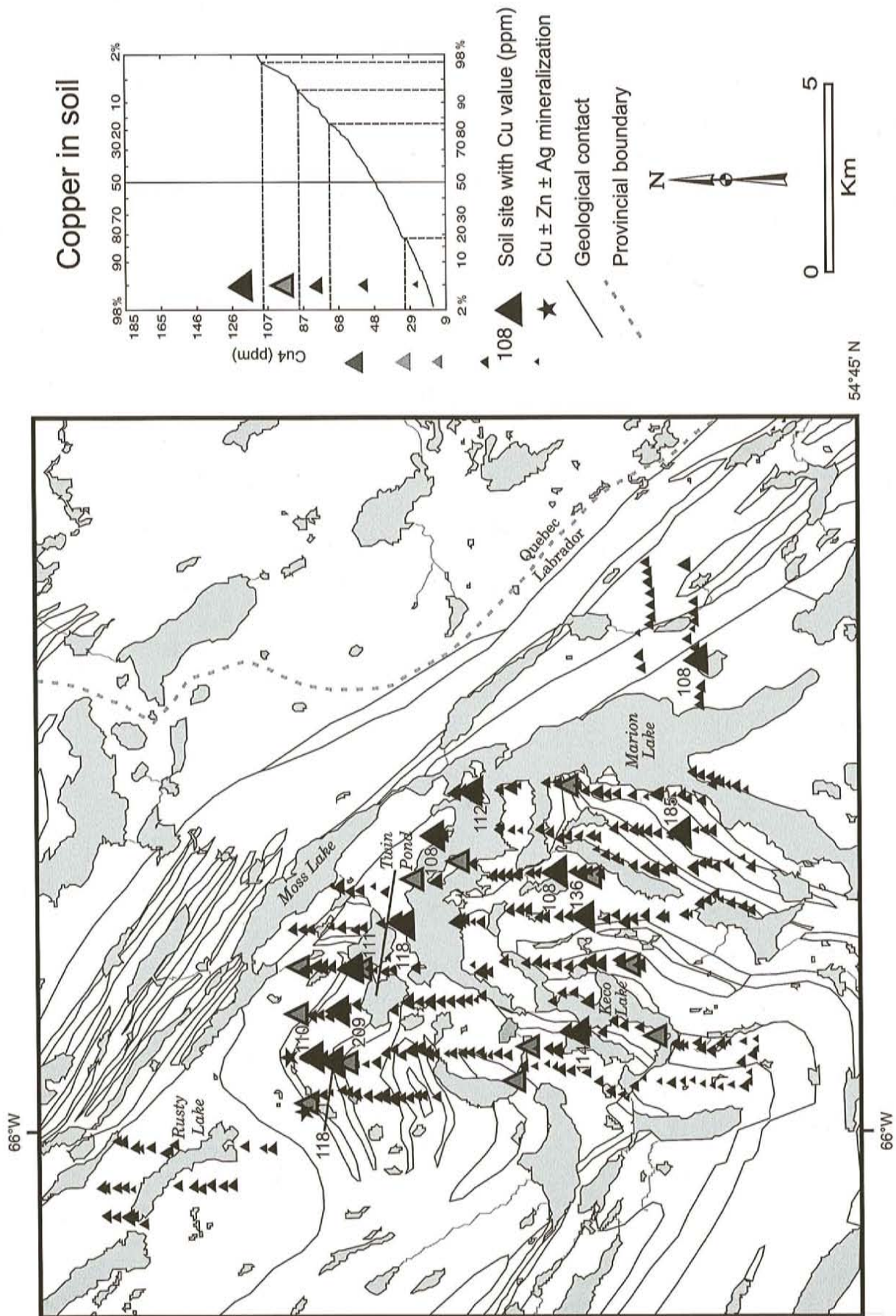
Figure 11. *Distribution of gold in soil.*

Figure 12. *Distribution of copper in soil.*

**Table 5.** Locations and selected analyses of rock samples; values in ppm unless otherwise indicated

| Field Number | Laboratory Number | NTS | UTM ZONE | UTM EASTING | UTM NORTHING | Ag6 | As1 | Au1 ppb | Cr2 | Cu2 | Fe1 % | Ni2 | Pb2 | Zn2 | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6247001 | 6240114 | 23I13 | 20 | 312019 | 6074450 | .05 | 2.1 | .5 | 184 | 17 | 3.3 | 17 | 1 | 22 | pyritiferrous black slate |
| 6247002 | 6240115 | 23I13 | 20 | 308603 | 6077530 | .05 | 6.1 | 4.0 | 47 | 571 | 14.9 | 121 | 6 | 51 | gossanous siltstone? boulder |
| 6247003 | 6240116 | 23I13 | 20 | 310975 | 6083175 | 1.10 | 498.0 | 157.0 | 57 | 58 | 22.2 | 13 | 461 | 60 | bog iron |
| 6247004 | 6240117 | 23I13 | 20 | 311050 | 6082175 | .05 | 35.6 | 1.0 | 37 | 17 | 3.5 | 8 | 1 | 11 | weathered,gossaned,qtz-vnd rock |
| 6247005 | 6240118 | 23I13 | 20 | 311050 | 6082175 | .05 | 47.7 | 13.0 | 66 | 263 | 4.7 | 14 | 1 | 12 | silicified mafic intrusive |
| 6247006 | 6240119 | 23I13 | 20 | 311000 | 6083175 | .50 | 92.2 | 1.0 | 103 | 173 | 16.8 | 50 | 58 | 42 | pyritiferrous black slate |
| 6247007 | 6240121 | 23I13 | 20 | 309052 | 6083105 | .50 | 111.0 | 27.0 | 20 | 176 | 29.3 | 142 | 30 | 1520 | 10-15% pyrite in weathered slate |

NOTE: To enable the user to readily distinguish the method of analysis for a given element, a suffix is attached to the element symbol when used in statistical summaries and tables. The key to the suffixes is as follows:
1. Neutron activation analysis (INAA).
2. ICP-ES/after $HF-HClO_4-HCl$ digestion.
3. AA/after $HF-HClO_4-HCl$ digestion.
4. AA/after $HNO_3-HCl$ (3:1) digestion.
6. AA/after $HNO_3$ digestion.
9. Fluoride-ion selective electrode after fusion with flux of 2:1 $Na_2CO_3:KNO_3$.

Thus, for example, Zn4 is zinc analyzed by AA/$HNO_3$-HCL whereas Zn1 is zinc analyzed by INAA.

As well as suggesting new areas for exploration attention, the study verifies the effectiveness of soil geochemistry in this area in reflecting known mineralization even at the reconnaissance scale.

## ACKNOWLEDGMENTS

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