GEOLOGICAL SURVEY OF CANADA

PAPER 66-46

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOCHEMICAL PROSPECTING RESEARCH IN 1966, COBALT AREA, ONTARIO

R. W. Boyle

Price, 50 cents

1966

GEOLOGICAL SURVEY

OF CANADA

PAPER 66-46

GEOCHEMICAL PROSPECTING RESEARCH IN 1966, COBALT AREA, ONTARIO

R. W. Boyle

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

Available by mail from the Queen's Printer, Ottawa,
from the Geological Survey of Canada,
601 Booth St., Ottawa
and at the following Canadian Government bookshops:

OTTAWA
Daly Building, Corner Mackenzie and Rideau

TORONTO
221 Yonge Street

MONTREAL
Æterna-Vie Building, 1182 St. Catherine St. West

WINNIPEG
Mall Center Bldg., 499 Portage Avenue

VANCOUVER
657 Granville Street

or through your bookseller

A deposit copy of this publication is also available
for reference in public libraries across Canada

Price 50 cents Cat. No. M44-66-46

Price subject to change without notice

ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1966

This paper is a résumé of a talk given by the writer to the Temiskaming Mine Operators Association, August 25, 1966.

In view of the immediate and potential interest in this work and to expedite publication, this paper has been prepared from the author's original notes and sketches.

GEOCHEMICAL PROSPECTING RESEARCH IN 1966, COBALT AREA, ONTARIO

INTRODUCTION

The statements made here and on the accompanying figures are tentative, since all of the analyses have not yet been plotted, and there has not been time to thoroughly assess all of the geological and chemical factors involved in the survey. A complete report will be published by the Geological Survey of Canada in due course.

The writer and his colleagues on the survey would like to thank Mr. J.E. Jerome for inviting us to conduct research in the Cobalt Area and all of the mine managers, geologists, and engineers who assisted in many ways. We would also like to thank Dr. Robert Thomson for assistance with the geological details and Mr. E.O. Walli, Principal of the Provincial Institute of Mining, Haileybury, for making available the chemical, rock preparation, and drafting laboratories of the Institute throughout the field season.

METHOD

The following surveys were carried out:

1. Analysis of soil and clay where thick glacial clay overlies silver-Ni-Co-As veins - Harrison Hibbert Vein (Fig. 1) Langis Silver and Cobalt Mining Co. Ltd., Casey Township (Fig. 2).

2. Analysis of soil and till where glacial till overlies silver-Ni-Co-As Veins - Silverfields Mining Corp. Ltd., Cobalt Area (Figs. 3 and 7), Hiho Silver Mines Ltd., Cobalt Area (Fig. 6), and Agnico Silver Mines Ltd., Cobalt Area, O'Brien Property (Fig. 8).

3. Analysis of drill core in Cobalt sediments - Silverfields Mining Corp., Ltd., Cobalt Area (Fig. 3).

4. Analysis of drill core in diabase - Langis Silver and Cobalt Mining Co. Ltd., Casey Township (Fig. 5).

5. Analysis of drill core in Keewatin greenstones - Silverfields Mining Corp. Ltd., Cobalt Area (Fig. 3) and Glen Lake Silver Mines Ltd.

6. Analysis of chip samples outward from known veins:
   (a) Cobalt sediments - Little Silver Vein, Cobalt Area (Fig. 4).
   (b) Diabase - Silverfields Mining Corp. Ltd.
   (c) Diabase - Agnico, O'Brien 6 vien.

7. Scintillation counter surveys of soil, till, glacial clay and rock over all traverses and veins mentioned in 1 to 6 above.

8. Water analyses and precipitate analyses
   (a) of springs and various drill holes on the surface and in underground workings in the Cobalt Area,
   (b) of springs, various drill holes in underground workings, and of domestic water wells in Casey Township adjacent to Langis Mine Area,
   (c) of various limonitic and manganiferous precipitates at the orifices of springs and drill holes in the Cobalt Area and in Casey Township.

9. Collection and analysis of soil, till, glacial clay, glacial sand, and all common rock types in the area for computation of normal background values in the area. These samples were collected from areas well removed from known mineral-bearing zones. Please refer to tables of background values.

The rocks, soils, tills, glacial clays and precipitates from springs and underground waters were analyzed for Cu, Pb, Zn, Ag, Ni, Co, Mo, Hg, As, Sb, Bi and Mn. The Cu, Pb, Zn, As, Sb, and Mo analyses were done by colorimetric methods; the Mn, Bi, Ag, Ni, and Co were done by spectrographic methods; and the Hg was done by the Lemaire Mercury "sniffer". The stream, spring, and underground waters were analyzed colorimetrically for total metals (mainly zinc), nickel, and cobalt in the field. The pH and Eh of the waters were determined with a portable pH meter.

RESULTS

Please refer to Figures 1 to 8 accompanying this report. These figures are schematic and not to any scale. In general the veins seldom exceed a width of 1 foot.

The following tentative results are evident from the surveys:

1. Analysis of glacial clay and soils developed on them are generally not effective in locating veins or vein clusters (Figs. 1 and 2). It is suggested, however, that overburden drilling may be effective if the tills

underlying the glacial clay or sand can be sampled (Fig. 9). Research in this method is, however, imperative before a conclusive statement can be made.

2. Radiometric surveys using a sensitive scintillometer are not effective in locating veins using soil, till, glacial clay, glacial sand, or rock. None of the traverses run over veins either at the surface or underground were positive.

3. Till analyses are effective in locating veins and vein clusters even where the till is relatively deep (up to 40 feet in one case) (Figs. 6, 7, and 8). The results and contrast in the anomalies are best where the till is relatively shallow (Fig. 8), a feature that suggests that the closer the sample is taken to the bedrock the better is the result. The A horizon appears to be the best accumulator of metals and in many cases gives anomalies with high contrast over or slightly downhill from known veins or vein clusters. The best indicator elements appear to be Ag, As, Sb, and Mn. Nickel and cobalt are also effective in some places. Mercury tends to be low in most places, but over the Silverfields vein clusters the content is relatively high (2 ppm). Anomalies in silver in the A horizon may exceed 20 ppm in places, those for arsenic 100 ppm, and those for antimony 7 ppm. In the B horizons the anomalies are several orders of magnitude lower (generally 2 or more). The dispersion of the metals in tills broadens with depth of till over the vein clusters, and in many cases there is a general broad anomaly with numerous high peaks.

4. The dispersion of Ag, As, Sb, Ni, Co, and Mn in rocks of the Cobalt sediments is broad and closely related to the silver veins and vein clusters. In general all of these elements rise considerably above the general background as the veins or vein clusters are approached. In some cases this rise can be seen as far as 100 feet from the veins, especially for As and Ag. Further details with respect to Cu, Pb, and Zn are given in Figure 3. Outward from the Little Silver Vein (Fig. 4) rock chips indicate the presence of the vein as far away as 140 feet when arsenic is considered and as far as 120 feet when silver is considered. Other elements generally begin to rise at about 20 feet from the vein.

5. The dispersion of Ag, As, Sb, Ni, and Co in rocks of the Keewatin at Silverfields and Glen Lake reveals a pattern somewhat similar to that in the Cobalt sediments. Manganese is erratic probably due to the presence in varying amounts of the element in the amphiboles of the greenstones. Where interflow bands, chert, etc. are present the dispersion of Cu, Pb, and Zn is highly erratic with values often exceeding 1 per cent for each of the elements. The silver veins are generally indicated by increasing contents of Ag, As, Sb, Ni, and Co as far as 20 feet or more from the veins.

6. The dispersion of nearly all the elements is narrow outward from veins in diabase. Drill core samples from Langis Mine show a rise in Ag, As, Ni, Co, etc. only some 7 feet from the vein (Fig. 5). This finding is also substantiated by chip samples from Agnico O'Brien 6 vein (Fig. 8).

7. The results from the water analyses have not been correlated at the time of writing. It can be said, however, that numerous springs and drill holes in the Cobalt Area and in Casey Township have waters containing higher than normal amounts of heavy metal, nickel, and cobalt. Some of these are clustered in certain areas. Cobalt is more mobile than nickel and appears in more of the samples than does nickel.

CONCLUSIONS

The following conclusions seem warranted:

1. Analyses of clay and derived soils are not effective for prospecting for silver veins in the Cobalt Area. Some thought should, however, be given to overburden drilling as outlined in Figure 9.

2. Analyses of till and derived soils should be effective for prospecting for silver veins in the Cobalt Area. The A horizon gives the best response but in some places the B horizon is likewise as good, especially where the till is relatively shallow. The best indicator elements in the till and derived soils are Ag, As, Sb, and Mn. Nickel and cobalt may also be effective in some areas and mercury may respond in a few places.

3. Both drill core samples and rock chips indicate the presence of veins and vein clusters. In the Cobalt sediments the dispersion is broad and veins may be indicated as far as 100 feet away. A somewhat similar pattern is present for silver veins in Keewatin greenstones, but the dispersion is generally more restricted. In the diabase the dispersion is narrow and veins are indicated only a few feet away by a rise in Ag, As, Ni, and Co.

4. Radiometric surveys proved negative for locating veins suggesting that this method is not applicable for soils, till, glacial clay, or rock.

5. Great care must be taken in the Cobalt Area in using geochemical methods because of the great amount of contamination present from old mine dumps, trenches, and domestic refuse.

Average Elemental Composition of Rocks, Cobalt area, Ontario

Rock Type	Locality and Age	Pb	Zn	Cu	As	Sb	Mo	W	Ag	Ni	Co	Bi	Mn	Hg	Gamma radiation Counts/sec.
Basic to intermediate lavas (greenstones)	Cobalt area Keewatin	5	135	100	10	< 2	~1	< 4	0.25	122	56	< 0.05	2500	0.03	60
Lamprophyre	Cobalt area Pre-Algoman	< 2.5	83	6	3	< 2	< 1	< 4	< 0.5	50	30	< 0.05	3000	0.03	72
Lamprophyre	Cobalt area Post-Algoman	< 2.5	35	125	< 1	< 2	< 1	< 4	< 0.5	1500	100	< 0.05	2000	0.03	80
Granite	Cobalt area Algoman (Lorrain granite)	10	25	6	< 1	< 2	1	< 4	< 0.5	2	< 10	< 0.05	70	0.03	250
Syenite	Casey Township Algoman	5	10	2	< 1	< 2	< 1	< 4	< 0.5	70	10	< 0.05	700	0.02	200
Nippissing Quartz diabase (sill)	Cobalt area Keweenawan	< 2.5	65	90	< 2	< 2	1	< 4	0.11	128	40	< 0.05	2000	0.03	50
Olivine diabase (dykes)	Cobalt area Keweenawan	< 2.5	40	64	< 1	< 2	< 1	< 4	< 0.5	100	50	< 0.05	2000	0.03	80
Interflow sediments: graphitic schist, slate, chert	Cobalt area Keewatin	500	500	400	80	5	3	< 4	3.0	130	80	0.83	500	0.05	125
Conglomerate	New Liskeard area Timiskaming	12	105	57	4	< 2	< 1	< 4	< 0.5	150	30	< 0.05	1500	0.02	130
Greywacke and slate	Haileybury-New Liskeard area Timiskaming	12	75	45	5	< 2	< 1	< 4	< 0.5	125	25	< 0.05	1000	0.02	115
Conglomerate	Cobalt area Huronian Coleman Formation	5	25	22	< 5	< 2	< 1	< 4	< 0.1	60	30	< 0.05	500	0.10	100
Greywacke, quartzite, and arkose	Cobalt area Huronian Coleman Formation	< 5	20	20	< 5	< 2	< 1	< 4	< 0.1	60	25	< 0.05	500	0.10	95
Greywacke, slate, and quartzite	Cobalt area Huronian Firstbrook Formation	< 2.5	43	8	3	< 2	2	< 4	< 0.5	88	25	< 0.05	515	0.03	200
Quartzite and arkose	Cobalt area Huronian Lorrain Formation	< 2.5	5	2	< 1	< 2	< 1	< 4	< 0.5	20	< 10	< 0.05	20	0.03	172
Limestone, dolomite	Haileybury area Ordovician	< 2.5	6	2	< 1	< 2	~1	< 4	< 0.5	< 2	< 5	< 0.05	365	0.03	60
Limestone, dolomite	New Liskeard area Silurian	< 5	10	8	< 2	< 5	< 1	< 4	< 0.5	5	< 5	< 0.05	250	0.03	55

Note: 1. All values are given in parts per million
2. Average values have been computed from composite and single analyses of rocks well removed from sites of known mineralization.

Average elemental composition of soils, till, and clay, Cobalt area, Ontario

Soil Type	Locality	Pb	Zn	Cu	As	Sb	Mo	W	Ag	Ni	Co	Bi	Mn	Hg	Gamma rad. Counts/sec.
Soil on till A_1 horizon	Cobalt area	10	33	16	2	3	< 1	< 4	0.5	30	11	< 0.05	572	0.20	80
Soil on till B horizon	Cobalt area	12	30	15	< 2	< 2	< 1	< 4	< 0.5	35	13	< 0.05	505	0.11	70
Till C horizon	Cobalt area	10	30	16	2	< 2	< 1	< 4	< 0.5	35	10	< 0.05	500	0.20	70
Soil on sand & gravel A_1 horizon	Cobalt area	25	60	7	< 5	2	1	< 4	< 0.5	25	10	< 0.05	500	0.50	80
Soil on sand & gravel A_2 horizon	Cobalt area	5	7	4	< 2	< 2	< 1	< 4	< 0.5	11	3	< 0.05	400	0.20	80
Soil on sand & gravel B horizon	Cobalt area	5	27	5	< 2	< 2	< 1	< 4	< 0.5	20	10	< 0.05	600	0.30	100
Sand and gravel C horizon	Cobalt area	5	18	9	< 2	< 2	< 1	< 4	< 0.5	27	15	< 0.05	500	0.10	110
Soil on clay A_1 horizon	Cobalt area and Casey township	14	131	41	5	2	< 1	< 4	< 0.5	46	15	< 0.05	490	0.20	80
Soil on clay B or G (gley) horizon	Cobalt area and Casey township	12	106	33	2	1	< 1	< 4	< 0.5	46	17	< 0.05	590	0.14	85
Clay C horizon	Cobalt area and Casey township	13	90	34	2	1	< 1	< 4	< 0.5	54	19	< 0.05	880	0.11	85

Note: 1. All values are given in parts per million
2. Average values have been computed from composite and single analyses of soils, etc. well removed from sites of known mineralization.

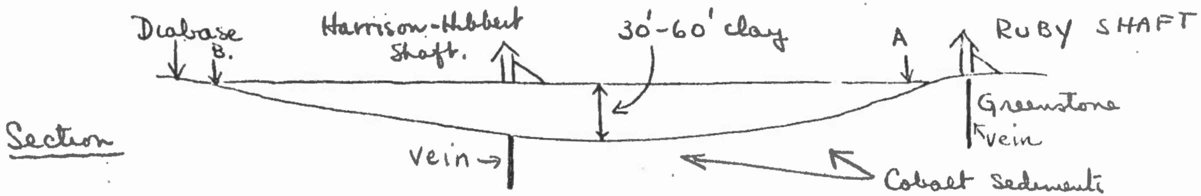

Figure 1. Schematic Sketch Harrison - Hibbert Vein, North Cobalt.

Notes:

Soil traverse from A - B (east-west). Generally negative for locating Harrison - Hibbert vein. Arsenic and silver relatively high in A horizon of soils near Ruby Shaft. This may indicate that surface waters have carried the arsenic and silver, as well as other elements, down slope from Ruby and other veins.

For geological details see R. Thomson., Cobalt Silver Area, Map 2050, Ontario Department of Mines.

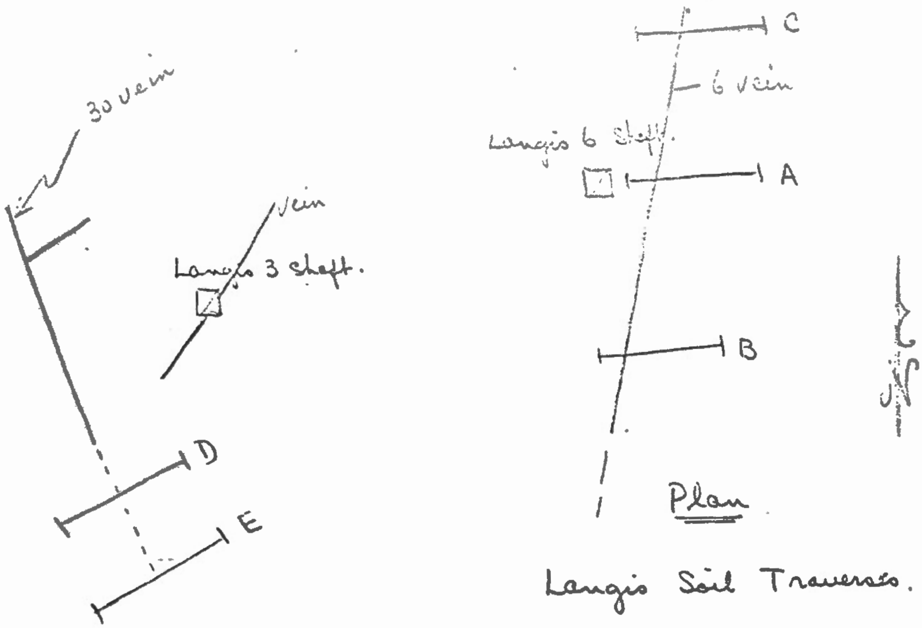

Figure 2. Schematic Sketch Langis Soil Traverses, Casey Twp., Ontario.

Notes:

Traverses A, B, and C are in clay that is about 110 feet deep above vein 6.

Traverses D and E are partly clay and partly till that are generally only a few feet deep over bedrock.

Traverses A, B, and C were generally negative. The vein is not indicated in either A or C horizons*.

Some anomalies occur on traverses D and E. It is not positive that these indicate the extension of 30 vein.

For geological details see Thomson, R., Casey and Harris Townships, Ont. Dept. Mines Geological Report No. 36.

---

* There is no well developed B horizon in this area.

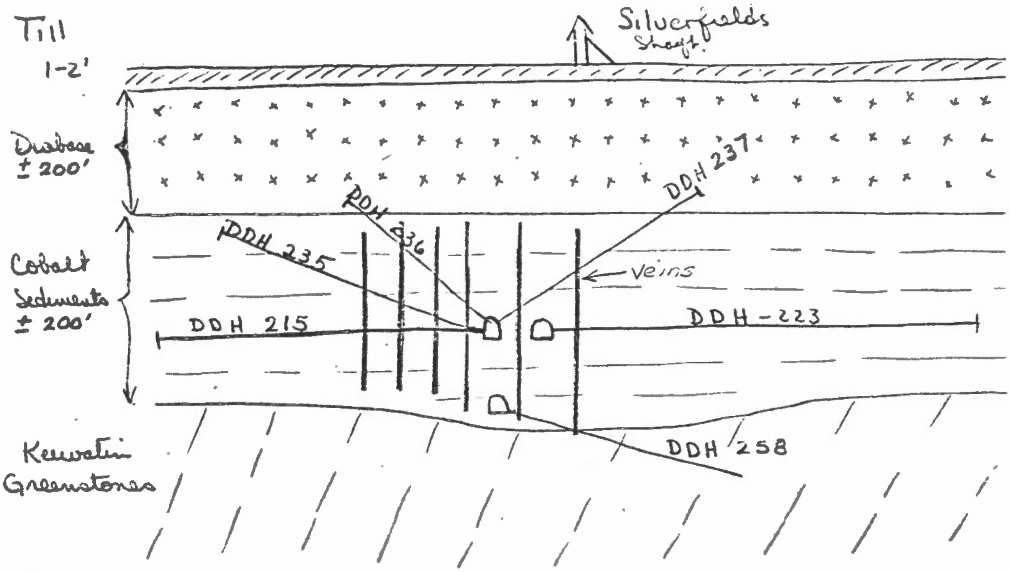

Figure 3. Silverfields Section, Drill Core Analysis.

Notes:

Two foot sections along the total lengths of 6 diamond drill holes were analyzed for Cu, Pb, Zn, As, Sb, Ag, Ni, Co, Mo, Bi, Mn, and Hg.

Results:

1. The dispersion halo of the principal elements associated with the silver veins is broad and generally outlines the vein clusters. The best elements as indicators are Ag, Ni, Co, As, Sb, and Mn. Mercury contents are generally low but do show higher than normal values in the ore zones.

2. The dispersion of Cu, Pb, and Zn is broad but erratic. These elements seem to belong to an early phase of mineralization. Their overall dispersion pattern is, however, coincident with the vein clusters. The disseminated galena, sphalerite, and chalcopyrite in the quartzites and conglomerates does not seem to bear any relationship to single veins but seems to be related to the more porous parts of the sedimentary beds.

3. The dispersion of Ag, As, and Sb is marked. In some places these elements appear in some abundance (many times the normal background) as far as 40 feet from individual veins and vein clusters.

For geological details see Thomson R., Cobalt Silver Area, Ont. Dept. Mines Map 2051.

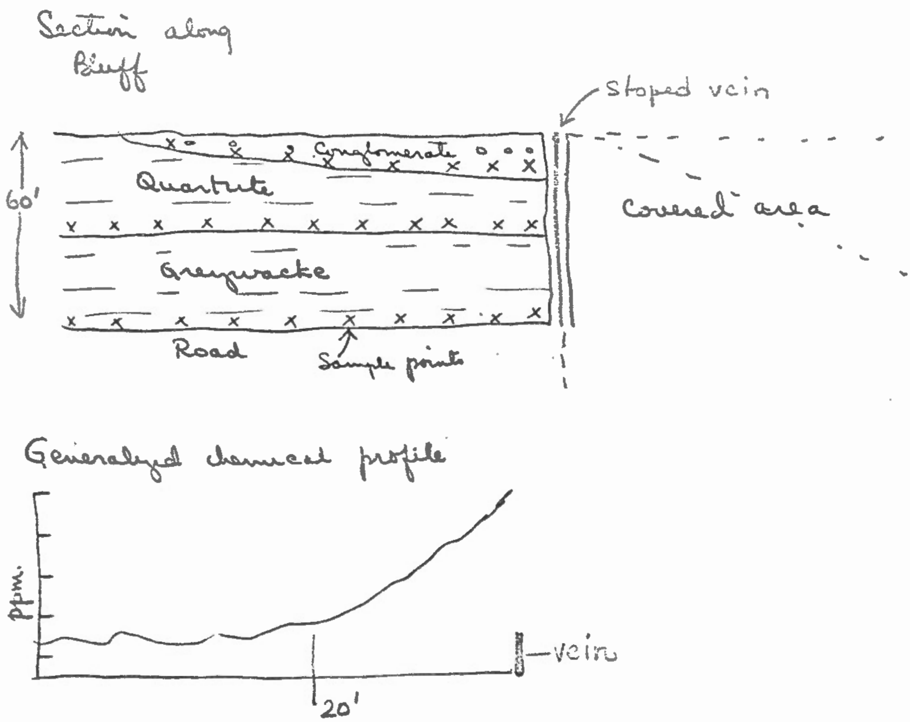

Figure 4. Little Silver Vein, Rock Chip Analysis.

Notes:

1. Chip samples of conglomerate, quartzite and greywacke were taken about every 5 feet and analyzed for Cu, Pb, Zn, As, Sb, Ag, Ni, Co, Mo, Bi, Mn, and Hg.

2. In general as one approaches the vein Ag, As, Ni, Co, Sb, and Mn begin to show a rise in content between 20 and 15 feet outward from the vein.

3. The Cu, Pb and to a less extent the Zn contents also show a rise as one approaches the vein.

4. The general silver and arsenic contents of the country rocks well removed from the vein (up to 50 feet) are high and anomalous. Silver is of the order of 5 ppm and As about 30 ppm.

For further geological details see Thomson R., Cobalt Silver Area, Ont. Dept. Mines Map 2050.

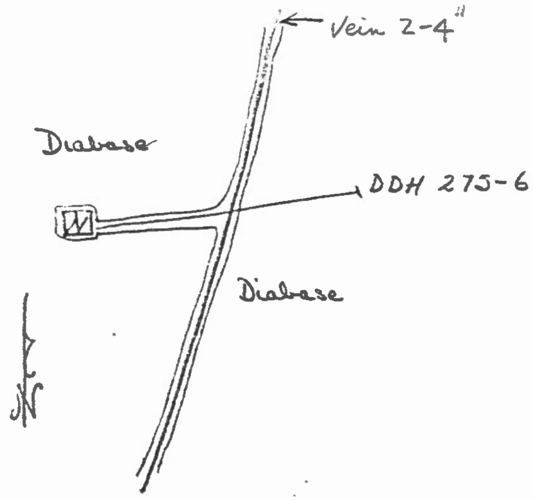

Figure 5. Langis Shaft 6, Diamond Drill Core Analysis of Diabase.

Notes:

1. Diamond drill core was analyzed every 4 feet for Cu, Pb, Zn, As, Sb, Ag, Ni, Co, Mo, Bi, Mn, and Hg.

2. Adjacent to the vein As, Mo, Co, Ni, Ag, Cu, Pb, Zn, and Hg show a rise. Silver and arsenic show the best rise and contrast. The maximum distance over which this rise is observable is 7 feet. The remainder of the diabase is very low in all metals.

3. The results from this experiment and from others in diabase show that the dispersion halo about the veins is restricted and not like the broad dispersion noted in the Cobalt sediments.

4. In general the average content of metals in the diabase is very low (see the Table of Averages for the elements in the area). Only near the veins or where the diabase is fractured is there any rise over the normal background.

For further geological details see Thomson R., Casey and Harris Townships, Ontario Dept. Mines, Geological Report No. 36.

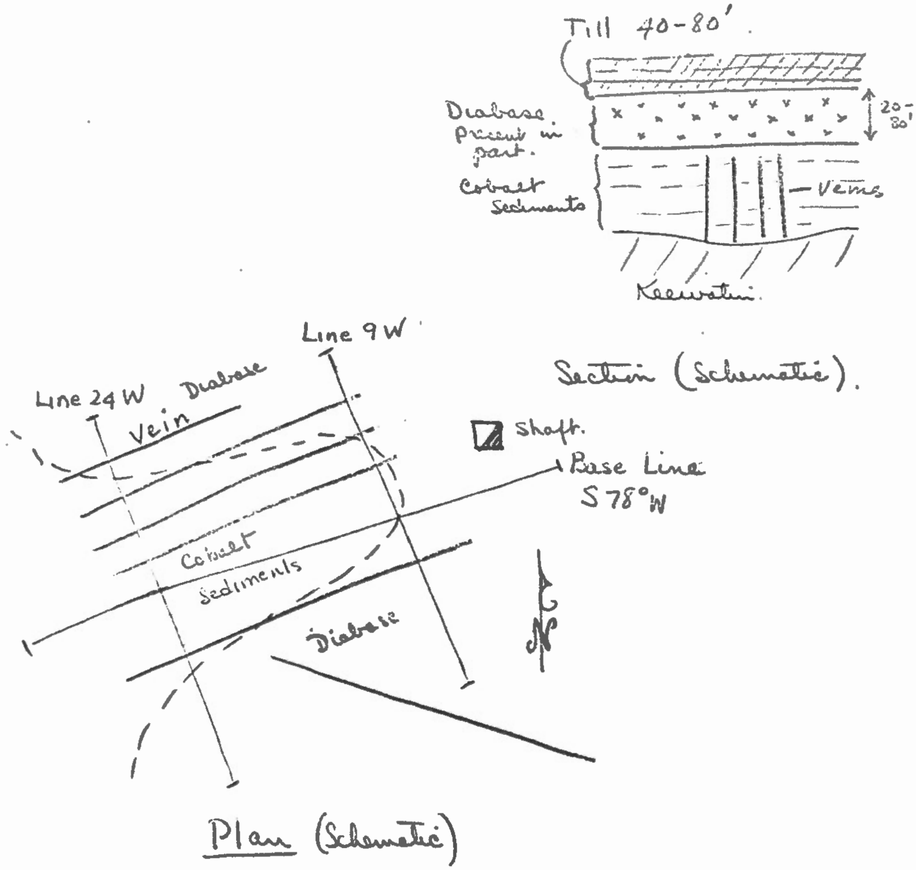

Figure 6. Hiho Silver Mines, Soil Traverses on Till.

<u>Notes:</u>

1. Soils on lines 9W and 24W were collected from the A and B horizons at 25 foot intervals and analyzed for Cu, Pb, Zn, As, Sb, Mo, Ag, Ni, Co, Bi, Mn, and Hg.

2. The A horizon gives the best response. The values in the B horizon are one or two magnitudes less than those in the A horizon.

3. The soils in both the A and B horizon are enriched in a number of the elements especially in Ag and As. Some of the peaks in the A horizon appear to correspond to the vein-clusters below.

For further geological details see Thomson R., Cobalt Silver Area Southwestern Sheet, Ont. Dept. Mines Map 2051.

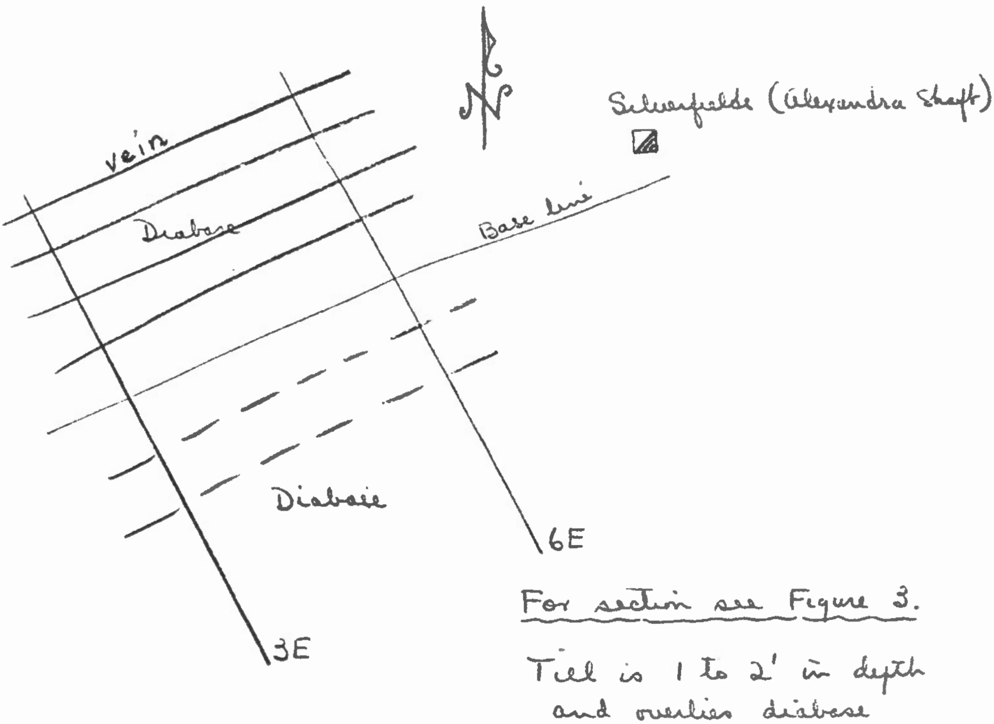

Figure 7. Silverfields, Soil Analyses on Till.

Notes:

1. Soils on lines 3E and 6E were collected from the A and B horizons at 25 foot intervals and analyzed for Cu, Pb, Zn, As, Sb, Mo, Ag, Ni, Co, Bi, Mn, and Hg.

2. The A horizons give the best response although the values in the B horizons are also relatively high.

3. The soils in both the A and B horizon are enriched in a number of the elements especially in Ag, As, Sb, Mn, and Hg. Some of the peaks in the A and B horizons appear to correspond to the vein clusters below.

For further geological details see Thomson, R., Cobalt Silver Area Southwestern Sheet, Ont. Dept. Mines Map 2051.

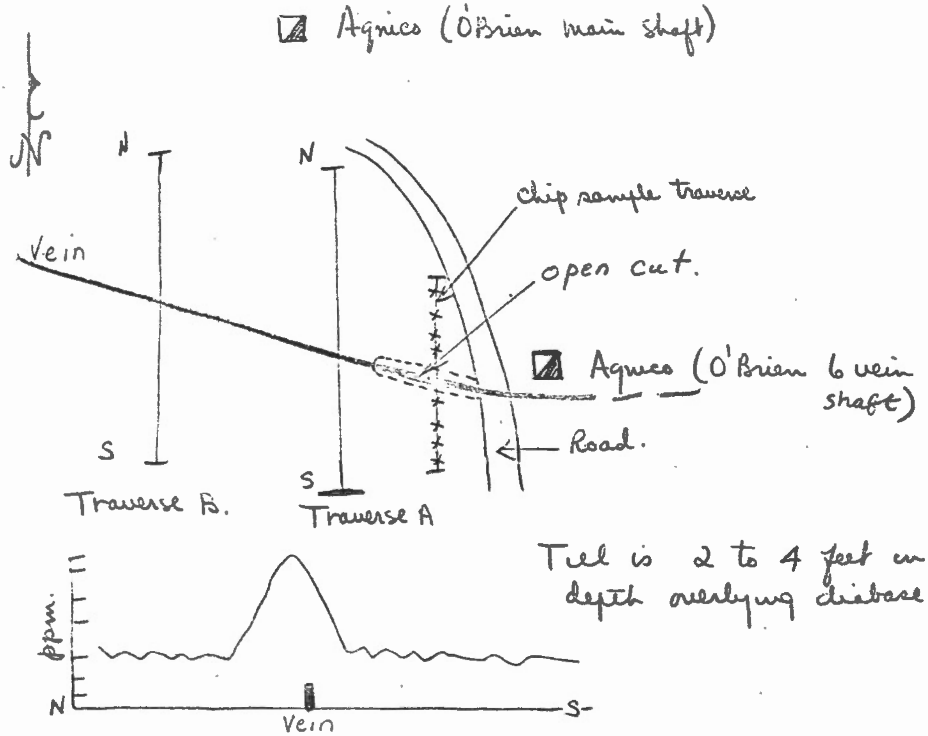

Figure 8. Agnico - O'Brien Soil Traverses on Till overlying Diabase.

Notes:

1. Soils on traverse lines A and B were collected from the A and B horizons at 25 foot intervals and analyzed for Cu, Pb, Zn, As, Sb, Mo, Ag, Ni, Co, Bi, Mn, and Hg.

2. The A horizon gives the best response but B also gives good results.

3. The soils in both A and B horizon are enriched in a number of the elements especially in Ag, Ni, Co, As, Mn, Cu, Pb, and Zn. The peak in the two profiles is correlative with the position of the vein. Ag, Co, and As mark the vein best.

For further details see Thomson R., Cobalt Silver Area, Ont. Dept. Mines Map 2050.

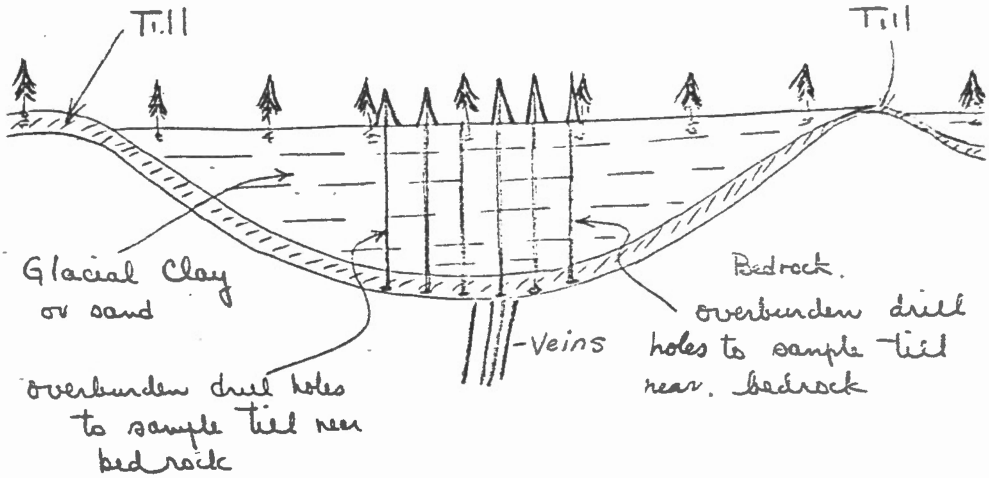

Figure 9. Overburden drilling to sample till below glacial clay or sand.

Notes:

1. The results obtained to date on the surface tills suggest that a close grid of overburden drill holes through glacial clay or sand to sample the underlying till near the bedrock may be effective in locating vein clusters. The spacing of the holes should probably not be less than 50 feet. On a reconnaissance basis 100 foot centres might be effective followed by further fill-in holes where necessary.

2. Good geological assessments and projection from known vein clusters or patterns will be required if success is to be achieved.

3. Areas covered by great thicknesses of till should also respond to the above treatment.

For previous work employing deep drilling in the area the reader is referred to Koehler et al, Geochemical prospecting at Cobalt,Ontario; Econ. Geology, vol. 49, pp. 378-388.