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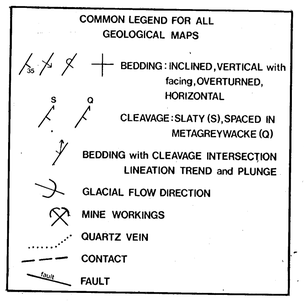
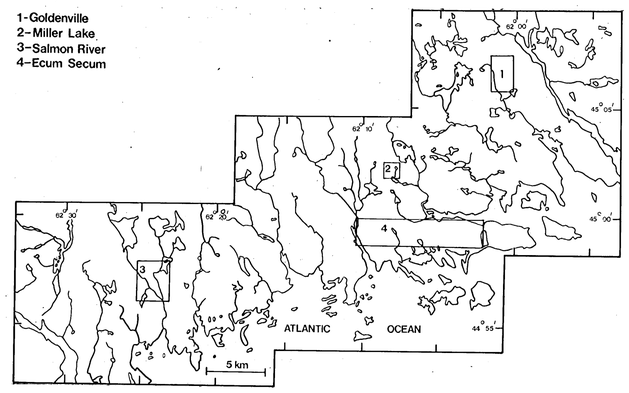
GEOCHEMICAL ANALYSIS OF GLACIAL DRIFT AND ITS APPLICATIONS IN BASE AND PRECIOUS METAL EXPLORATION, EASTERN SHORE REGION, NOVA SCOTIA





Geochemical analysis of glacial drift and its application in base and precious metal exploration in the Meguma Zone, Nova Scotia

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ABSTRACT

Four areas of the Eastern Shore Region, three former gold districts and an area of contact between the Halifax and Goldenville formations, were sampled in a till geochemistry study. The study was designed to aid gold and base metal exploration in Nova Scotia by providing examples of geochemical dispersal patterns in till down-ice from known mineralized zones in The Meguma zone.

Samples were obtained from the C-horizon of soils developed on the till, which was in turn derived from the local bedrock. The clay-sized (less than 2 µm) fraction of the till was geochemically analyzed by standard commercial techniques for most elements, it being the least affected by textural variations in the till matrix.

The sand-sized terminal grade for quartz and feldspars in the till indicates minor abrasive glacial transport. The silt-plus clay sized fraction (< 63 µm) was used for gold and arsenic analyses to minimize the likleyhood that some gold was missed, due to its presence as sand-sized flakes and nuggets in the till.

Computer-generated contour maps of element distributions provided further information on the dispersal of certain elements, down-ice from known gold occurrences. Gold and arsenic were found to be the best indicators of apparent gold occurrences. It is concluded that drift prospecting is a convenient and rapid method for determining the mineral potential for areas with poor bedrock exposure and locally derived till sheets.

INTRODUCTION

The major purpose of this study is to describe geochemical dispersal patterns in till derived from known metal occurrences in Meguma Group rocks. Typically, glacial dispersal trains exhibit element abundance peaks at or near the source, diminishing gradually in the down-ice direction. Dispersal trains originating from point sources exhibit abrupt lateral variation, and, in plan view, are characteristically flame or ribbon-shaped (Shilts, 1975; DiLabio, 1981). Areal variation in trace element abundances are closely tied to till lithology and bedrock characteristics. Because dispersal trains are much larger than their bedrock sources, they form large geochemical and lithologic targets that can be traced back to their origins, provided the till has not been transported far from its source.

Samples for this study were collcted from C-horizon soils developed in loose, sandy, grey till, derived from the underlying, sandy metagreywacke and silty slate of the Meguma Group. The permeable till forms a thin veneer, 1-4m thick, over much of the areas studied, and generally is weathered to depths greater than 2m (Stea and Fowler, 1979).

Within the till, labile minerals (mainly sulphides and carbonates) are destroyed to depths of several metres by weathering. Clay-sized particles fix a proportion of the metal cations released by weathering, and increase the concentration of these cations within the clay-sized (< 2 µm) fraction of the till (Shilts, 1975). In this study, elemental analysis utilizing the clay-sized fraction was chosen for most elements for several reasons.

(1) Textural variations in the till matrix have little effect on this fraction.
(2) The clay-sized fraction scavenges cations released by weathering.
(3) Smaller grain sizes incorporate more grains per sample analysed, and yield more reproducible results.
(4) Most gold grains in oxidized overburden are fine, being released from sulphides by weathering, in addition to being derived from fine-grained ore (DiLabio, 1985).

There are some drawbacks to this technique. Coarse gold particles, such as those common in Meguma gold ores, will be under-represented in the < 2 µm fraction, as will gold remaining bound in unoxidized pyrite and arsenopyrite, and particulate gold attached to quartz grains. DiLabio (1985) fully discussed the effect of sample grain size on gold abundances in weathered and unweathered tills.

Clay-sized fractions of each sample were analysed by standard commercial** atomic absorption techniques for Cu, Zn, Ag, Ni, Co, Mn, Fe, Mo and Pb. Au and As were determined in the silt plus clay (< 63 µm) fraction to overcome drawbacks associated with using the clay-sized fraction alone (DiLabio, 1985). Au was determined by fire assay preconcentration and atomic absorption spectrophotometry after digestion in aqua regia. As was determined by colorimetry. Analytical results were plotted on maps and contoured by computer utilising a standard plotting routine.

Stea and Fowler (1979) published results of a regional study of minor and trace element variations in tills from the Meguma Terrane, east of Halifax. Table 1 gives their summary statistics for tills derived from the Goldenville Formation sandy metagreywacke (Quartzite Till) and the Halifax Formation slate and silty slate (Slate Till).

Mean values may be considered as background values for the purposes of comparison with our results. Anomalous values my be assumed to be greater than the mean values plus twice the standard deviation (Hawkes and Webb, 1962). Crocket, et al. (in press) estimated an average gold value for "unmineralized" Meguma Group rocks to be 1-2 ppb. An average gold value for Meguma-derived till may be similar. Crocket, et al. (in press) further suggested that a threshold value of 10 ppb serves to differentiate background and anomalous gold in Meguma Group rocks. Arsenic and gold were shown to be strongly correlated in their study (Crocket, et al., in press).

+ Contribution to Canada-Nova Scotia Mineral Development Program 1981-1984

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** Analyses by Bondar-Clegg and Co. Ltd., Ottawa

MacEachern and Stea (1985) studied three-dimensional dispersal patterns of gold and other elements in till at Forest Hill, Guysborough County, Nova Scotia, and concluded that gold and arsenic are the best elements to analyse for detailed geochemical exploration programs for gold in Meguma Group rocks. Based on their results, three or more anomalous points lying in line in the direction of ice flow are considered to constitute a glacial dispersal train in this study.

STUDY AREAS

Four areas were chosen for study (see index map). Goldenville, Miller Lake and Salmon River (Figs. 1, 2 and 3) are areas of former gold production (see Faribault, 1899; Malcolm and Faribault 1929; and Henderson, 1986). Visible gold occurs in stratabound quartz-carbonate-chlorite veins within the Goldenville Formation sandy metagreywacke and interbedded slate (Zentilli and Graves, 1982; Henderson, 1983, Henderson and Henderson, in press). Arsenopyrite commonly occurs in the veins and surrounding host rocks. The Ecum Secum area (Fig. 4) was chosen in order to study the chemistry of tills derived from the uppermost Goldenville Formation and lowermost Halifax Formation, where, at Eastville, Nova Scotia, stratabound zinc-lead mineralization occurs along 10 km of this stratigraphic interval (Zentilli et al., 1986).

GOLDENVILLE (Figure 1)

The Goldenville Gold District lies 3.2 km west of Sherbrooke, Guysborough County. Visible gold was taken from numerous bedding-parallel and other stratabound veins, situated on the crest and limbs of a truncated, west-plunging anticline (Faribault, 1898). Till samples, 39 in all, were collected about 0.5 km apart in an area of approximately 8.5 km^2 and extending 3 km south of the region mined. Gold, lead and copper exhibit anomalously high values for one sample collected within the area disturbed by mining, suggesting that the sample may have been contaminated. The map for arsenic shows a ribbon-like dispersal pattern of anomalous values parallel to the ice-flow direction. The anomalous values cover an area of about 500 m by at least 3500 m, which is interpreted as a dispersal train.

MILLER LAKE (Figure 2)

Miller Lake Gold District is situated about 8 km north of Ecum Secum bridge in Guysborough county. Gold was mined from several quartz veins exposed on the truncated crest of a doubly-plunging, upright anticline. The area sampled covers the eastern part of the gold-bearing structure. It encompasses about 2 km^2, from which 133 till samples were collected, 100m apart. Interestingly, the map of gold values shows 89 and 50 ppb sites, up-ice from any recorded gold occurrences. The map of arsenic values shows an east-west striking anomalous pattern along the crest of the dome, suggesting that arsenic is distributed along-strike in the source rocks. None of the element distribution maps reflect down-ice dispersal from the dome, and only gold and arsenic exhibit anomalous values in the area sampled.

SALMON RIVER (Figure 3)

Also know as Darrs Hill (Malcolm and Faribault, 1929) and Dufferin Mine, this gold district lies east of Salmon River, and 6.5 km north of Port Dufferin, Halifax County. Gold was extracted principally from a large saddle-reef quartz vein on the crest of an anticline (Faribault, 1897). A belt of Halifax formation lies across the area, south of the gold district. The area sampled is about 9 km^2, and 57 samples were collected, between 200 and 500 m apart. The 280 ppb gold anomaly and the 2000 ppm arsenic anomaly are close to the Dufferin Mine stamp mill and represent contamination. No clear down-ice dispersal train is indicated on any of the element distribution maps although several sites of anomalous Au and As lie on the down-ice edge of the mineralized structure. The 15 000 ppm manganese anomaly may be related to a regional geochemical pattern of Mn enrichment associated with the Goldenville-Halifax stratigraphic transition, as suggested by Zentilli et al. (1986).

ECUM SECUM (Figure 4)

This area was selected in order to sample the Goldenville-Halifax contact zone for stratiform base metal anomalies (see Zentilli et al., 1986). From an area of about 8.4 km^2, 28 till samples were collected. None of the element distribution maps indicate clear glacial dispersal trains or stratigraphically related patterns. However, anomalous points are notable south of Bear Brook: two for gold, three for arsenic, and three for molybdenum.

CONCLUSIONS

These maps provide additional examples of element dispersal trains in till, down-ice from known gold occurrences in Meguma Group rocks (see DiLabio, 1982; MacEachern and Stea, 1985). Gold and arsenic appear to be the best indicator elements for the location of gold occurrences in areas sampled. In the Miller Lake survey (Figure 2), arsenic anomalies are distributed parallel to strike in the area of known gold occurrence, and may be closely tied to their bedrock source.

Although the areas sampled across the Goldenville-Halifax contact zone do not exhibit striking base metal anomalies, it would seem that drift prospecting is a convenient, rapid method to test the base metal potential of this poorly exposed interval on a regional scale.

ACKNOWLEDGEMENTS

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REFERENCES

Crocket, J.H.; Fueten, F.; Clifford, P.M.; Kabir, A. and Henderson, J.R., in press, Distribution of Gold and Arsenic in Turbidites at Harrigan Cove, Nova Scotia: Implications on Gold Mineralization; in Turbidite-hosted Gold Deposits, Special Paper, Geological Association of Canada.

DiLabio, R.N.W., 1981; Glacial Dispersal of Rocks and Minerals at the South End of Lac Mistassini, Quebec, with Special Reference to the Icon Dispersal Train; Geological Survey of Canada, Bulletin 323, 46 pp.

DiLabio, R.N.W., 1982; Drift Prospecting Near Gold Occurrences at Onaman River, Ontario and Oldham, Nova Scotia; Geology of Canadian Gold Deposits; Canadian Institute of Minning and Metallurgy, Special Volume No. 24, pp. 261-266.

DiLabio, R.N.W., 1985; Gold Abundance vs. Grain Size in Weathered and Unweathered Till; in Current Research, Part A, Geological Survey of Canada, Paper 85-1A, pp. 117-122.

Faribault, E.R., 1897; Plan and Section, Salmon River Gold District; Geological Survey of Canada, Map 647.

Faribault, E.R.; 1898; Plan and Section, Goldenville Gold District; Geological Survey of Canada, Map 645.

Faribault, E.R., 1899; The Gold Measures of Nova Scotia and Deep Mining; Journal of the Mining Society of Canada, Vol. II pp. 119-128.

Graves, M.C. and Zentilli, M., 1982; A Review of the Geology of Gold in Nova Scotia; Geology of Canadian Gold Deposits; C.I.M. Special Volume No. 24, pp. 233-242.

Hawkes, H.E. and Webb, J.G., 1962; Geochemistry in Mineral Exploration; Harper and Row, 415 pp.

Henderson, J.R., 1983; Analysis of Structure as a Factor Controlling Gold Mineralization in Nova Scotia; in Current Research, Part B, Geological Survey of Canada, Paper 83-1B, Report 2.

Henderson, J.R., 1986; Geology, Ecum Secum Area, Nova Scotia; Geological Survey of Canada, Map 1648A.

Henderson, M.N. and Henderson, J.R.; Constraints on the Origin of Gold in the Meguma Zone, in the Region Between Sheet Harbour and Goldenville, Nova Scotia; Maritime Sediments and Atlantic Geology, in press.

McEachern, L.J. and Stea, R.R., 1985; The Dispersal of Gold and Related Elements in the Tills and Soils at the Forest Hill Gold District, Guysborough County, Nova Scotia; Geological Survey of Canada, Paper 85-1B, 31 pp.

Malcolm, W. and Faribault, E.R., 1929; Gold Fields of Nova Scotia; Geological Survey of Canada, Memoir 156, 253 pp. (reprinted in 1976 as memoir 385).

Shilts, W.W., 1975; Principles of Geochemical Exploration for Sulphide Deposits, Using Shallow Samples of Glacial Drift; Canadian Mining and Metallurgy Bulletin, Vol. 68, No. 757, pp. 73-80.

Stea, R.R. and Fowler, J.H., 1979; Minor and Trace Element Variations in Wisconsinan Tills, Eastern Shore Region, Nova Scotia; Nova Scotia Department of Mines and Energy, Paper 79-4, 3- pp.

Zentilli, M.; Graves, M.C.; Mullja, T. and MacInnes, I., 1986; Geochemical Characterization of the Goldenville-Halifax Transition of the Meguma Group of Nova Scotia: a Preliminary Report; in Current Research, Part A, Geological Survey of Canada, Paper 86-1A, pp. 423-428.

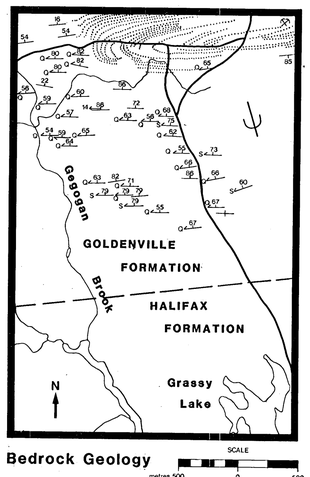
TABLE I. Summary Statistics for Quartzite Till and Slate Till From the Meguma Zone, Nova Scotia (after Stea and Fowler, 1979)

	QUARTZITE TILL (n = 122)			SLATE TILL (n = 22)		
ELEMENT	MEAN	S.D.	ANOMALOUS	MEAN	S.D.	ANOMALOUS
Cu	134.8	83.9	> 302.6	109.4	76.5	> 262.4
Zn	198.7	93.7	> 386.1	149.6	60.4	> 270.4
Ag	0.2	0.0	> 0.2	0.0	0.0	> 0
Ni	69.7	38.3	> 137.3	39.3	34.4	> 108.1
Co	34.8	20.9	> 76.6	24.3	20.6	> 65.5
Mn	3176.2	3156.8	> 9489.8	2514.3	3720.1	> 9954.5
Fe	6.7%	1.6%	> 9.9%	11.5%	6.6%	> 24.7%
Mo	1.3	1.0	> 3.3	4.2	3.0	> 10.2
Pb	98.7	102.3	> 303.3	172.0	135.0	> 442.0
Au	N/A			N/A		
As	31.7	22.7	> 77.1	42.8	46.6	> 136.0

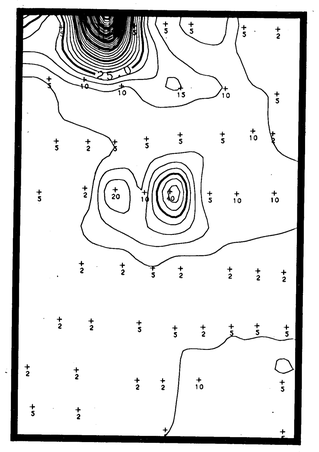
values in p.p.m., except Fe (%)

N/A - no assay

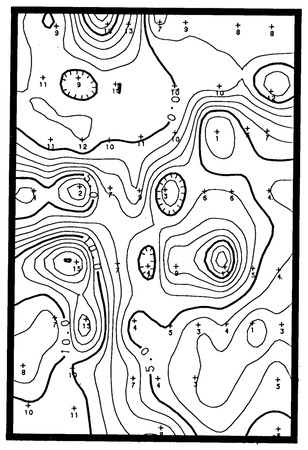
FIG. 1 – GOLDENVILLE



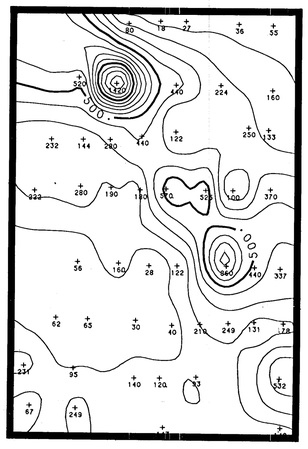
Bedrock Geology — SCALE metres 500 0 500



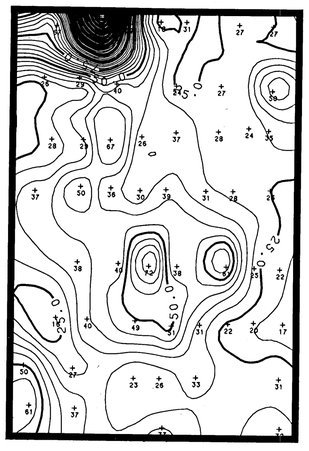
Au C.I.-5ppb Max. Value-205ppb



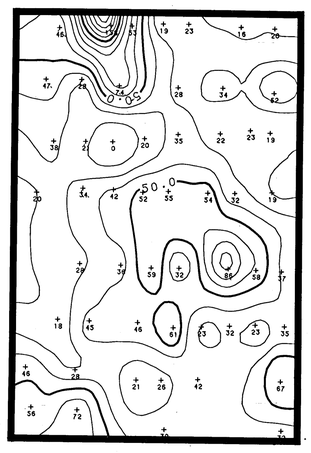
Ag C.I.-1ppm Max. Value-15ppm



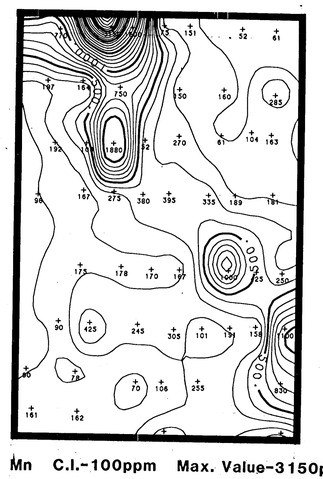
As C.I.-100ppm Max. Value-1420ppm



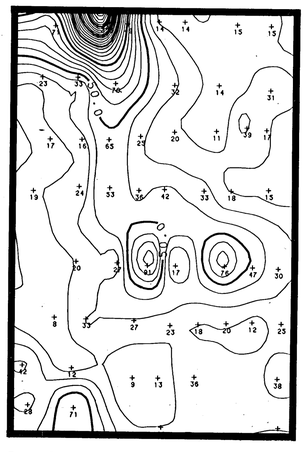
Pb C.I.-5ppm Max. Value-383ppm



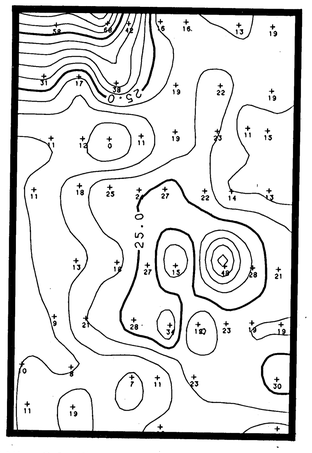
Zn C.I.-10ppm Max. Value-159ppm



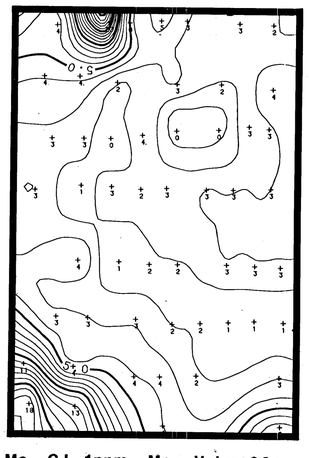
Mn C.I.-100ppm Max. Value-3150ppm



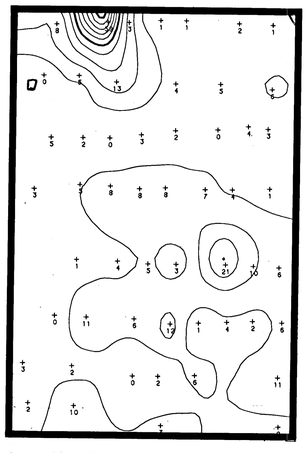
Cu C.I.-10ppm Max. Value-325ppm



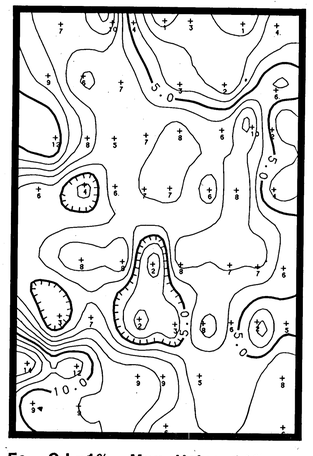
Ni C.I.-5ppm Max. Value-68ppm



Mo C.I.-1ppm Max. Value-23ppm



Co C.I.-5ppm Max. Value-59ppm



Fe C.I.-1% Max. Value-14%

Sheet 1 of 3

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