Drift Prospecting Near Gold Occurrences at Onaman River, Ontario and Oldham, Nova Scotia

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ABSTRACT

In a continuing program of mapping glacial dispersal trains, near-surface till samples were collected down-ice from a copper-silver-gold prospect at Onaman River, Ontario, and down-ice from the past-producing gold district at Oldham, Nova Scotia. The program is designed to aid exploration by illustrating glacial dispersal from various types of known occurrences and by identifying postglacial processes that control drift composition at a detailed scale.

Native gold was mined at Oldham from arsenopyrite-bearing saddle reef quartz veins in a dome in Early Paleozoic slates of the Meguma Group. Gold abundances greater than 10 ppb in till form a dispersal train at least 1900 m long. Gold abundances between 40 and 100 ppb occur in clusters up to 600 m down-ice from gold-bearing bedrock. Anomalous arsenic abundances in till form a broad train 1100 m long that is significantly different in shape from the gold train.

At Onaman River, subeconomic amounts of Cu-Ag-Au occur in quartz lenses in Archean mafic volcanic rocks. A dispersal train defined by the distribution of mineralized boulders and increased abundances of Cu, Ag and Zn in till extends 600 m down-ice from mineralized bedrock. Gold abundances between 10 and 70 ppb do not define this dispersal train, but occur instead in clusters 300 to 600 m down-ice from mineralized bedrock. In vertical sections in the upper 2 m of copper-rich till, Au abundances vary sympathetically with Ag and Cu levels; however, there seems to be no preferential site of Au enrichment in the mineral portion of the soil profile.

Several of the mineralized boulders at Onaman River are richer in Au and Ag than the mineralized bedrock from which they were derived. Although some of the high Au and Ag assays were caused by biased sampling of sulphide-rich portions of the boulders, many were caused by leaching of sulphide minerals from the boulders, which left a limonitic boxwork that is enriched in Au and Ag. A few of the Au-rich boulders may have been derived from an unknown bedrock source.

Introduction

The purpose of this drift prospecting project is to study examples of glacial dispersal trains derived from known metal occurrences. A dispersal train (Fig. 1) has peaks of abundance of the distinctive component near its source and a gradual decline of abundance down-ice into a flat background plain. Laterally, the train usually has very abrupt edges with the background plain. The two sites discussed here were chosen because they are typical of the metal occurrences and glaciation in their districts, and because they could be sampled at the surface.

Some of the well-known problems in sampling for gold in surficial sediments arise from the low abundance of gold in rocks. Assuming that rock containing 7 ppm makes ore and that the areal extent of most mineralized subcrops is small,

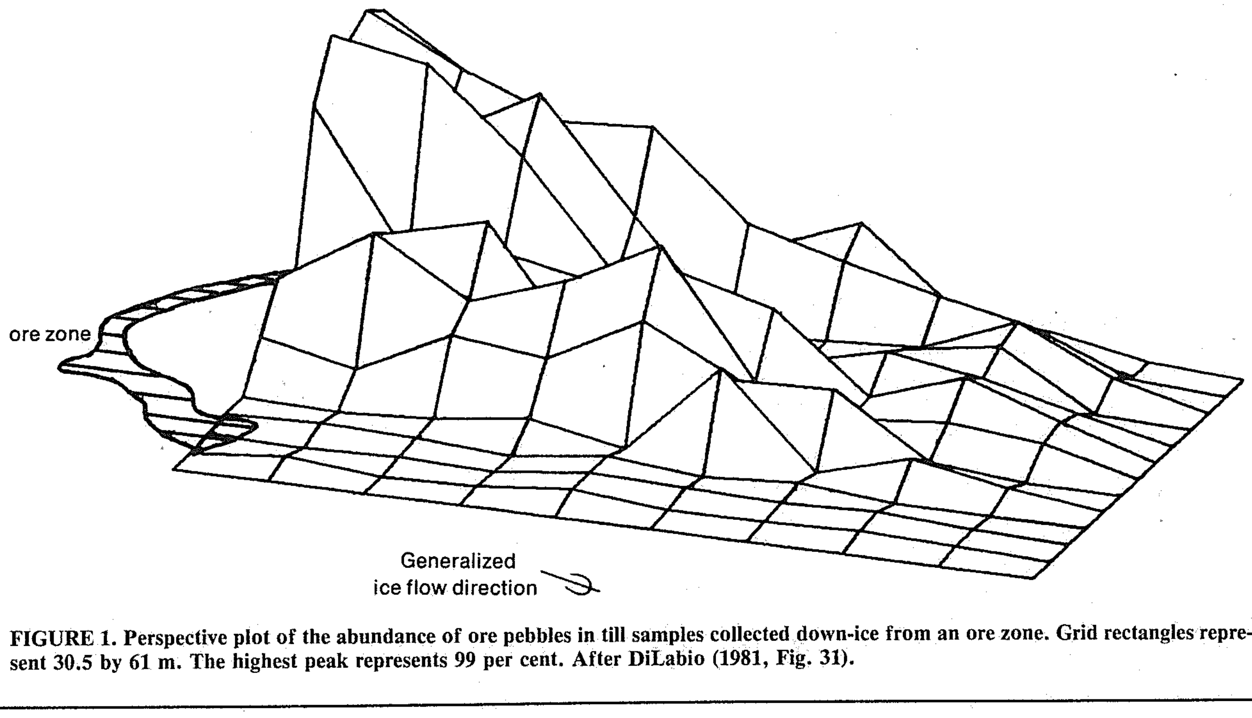

FIGURE 1. Perspective plot of the abundance of ore pebbles in till samples collected down-ice from an ore zone. Grid rectangles represent 30.5 by 61 m. The highest peak represents 99 per cent. After DiLabio (1981, Fig. 31).

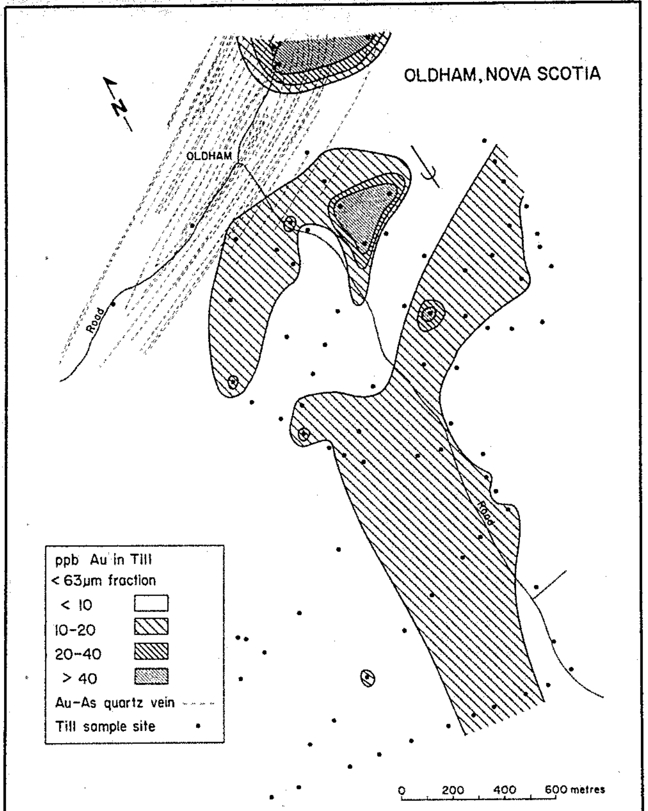

FIGURE 2. Gold abundances in the <63 μm fraction of till at Oldham.

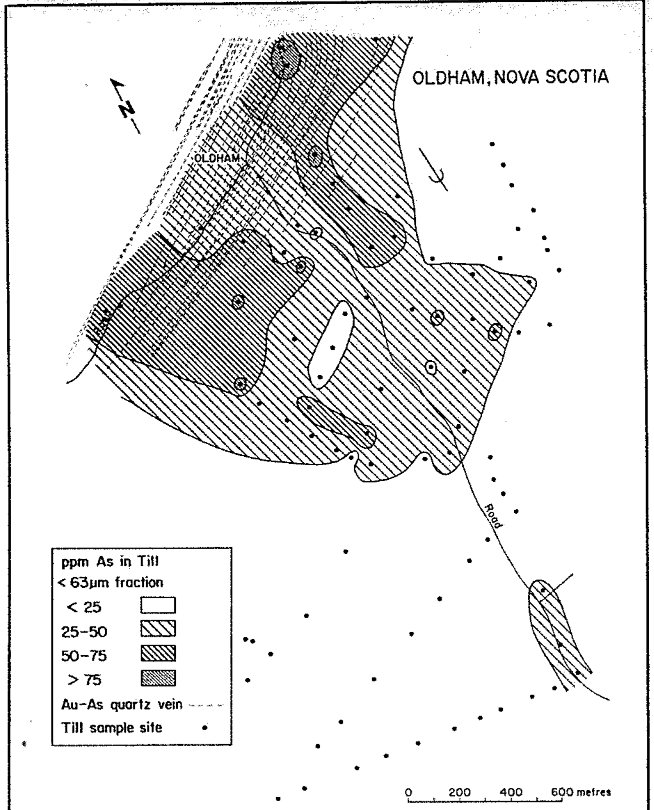

FIGURE 3. Arsenic abundances in the <63 μm fraction of till at Oldham.

then the abundances of gold in surficial sediments will be very low. This leads to the common assumption that gold abundances greater than about 10 ppb in soils are significant.

In order to produce precise results in the 10-ppb range, a large sample (>10 grams) is analyzed (Brown and Hilchey, 1974). If 10 grams of minus 80-mesh sediment is analyzed, about 33 million grains are used. A finer fraction, such as minus 250 mesh (<63 μm), contains about 260 million grains, and 10 grams of fine sand-sized heavy minerals contain about 4 million grains. Assuming that some gold is present in particulate form, the larger the number of grains in the analyzed fraction, the more reproducible the results will be. For example, the presence or absence of 1 grain of gold in 33 million <80 mesh grains could influence that sample by about ±30 ppb, whereas 1 grain in 260 million could influence a sample by ±4 ppb. Ten grams of sand-sized heavy minerals are influenced by the presence or absence of 1 gold grain to the extent of ±250 ppb. Therefore, in terms of reproducibility, the finest fraction that is economically obtainable would seem to be the best analytical fraction in soils and oxidized till. This is particularly true if it is assumed that most gold grains in oxidized overburden are fine because they were derived from fine-grained ore and they were released from sulphide minerals during weathering. Gold in the form of complexes or ions or associated with organic matter also will be well represented in the fine fraction. Of course, there are many places where coarse particulate gold will be underrepresented by a fine-grained fraction, such as in unoxidized tills where gold is found dissolved in intact coarse sulphide grains and anywhere gold is present as free sand-sized grains or attached to silicate sand grains.

Till samples, essentially C-horizon soils, were collected 30 m apart on lines 50 m apart at Onaman River and 100 to 200 m apart on zig-zag lines at Oldham. Where possible, samples were collected at 10- to 40-cm vertical intervals in sections up to 2.5 m deep in oxidized till. Clay (<2 μm) fractions of Onaman River samples were analyzed for Cu, Zn, Ag, Bi, Ni, Co, Mn, Fe and As. Arsenic was determined in the silt plus clay (<63 μm) fraction of Oldham samples. The <63 μm fraction was selected for all gold analyses for the reasons stated above. Analyses for gold were done commercially* by the fire assay-A.A. method, and analyses of the other metals were done commercially by standard techniques. A Leco carbon analyzer was used to estimate the carbonate content of the <63 μm fraction of selected Onaman River samples.

Seclected samples were examined with a scanning electron microscope (SEM) using CRT displays of secondary and backscatter images. Qualitative analyses of grains were obtained by energy-dispersive X-ray techniques.

Oldham, Nova Scotia

At Oldham, Nova Scotia, about 2 km north of Halifax airport, gold was mined from narrow aresenopyrite-bearing saddle-reef quartz-carbonate veins in a dome in slates of the Meguma Group. The structural control on these deposits is strong (Faribault, 1899; Malcolm, 1929; Keppie, 1976; Graves and Zentilli, in press). The topography of the area is flat and locally derived slate-rich till forms a veneer <1m thick over the bedrock. Areas near old mine workings could not be sampled because of waste piles.

Thorpe and Thomas (1976) found <1 ppb gold in barren wall rocks at Oldham. The contrast between the wall rocks and the relatively rich ore should emphasize a glacial dispersal train of gold in till, even though the total surface area of gold-bearing subcrop was small. The map of gold abundances in till (Fig. 2) shows a discrete dispersal train down-ice from the area that had the richest ore and the widest veins. Gold abundances are mainly low. The causes of the gaps and highs in the pattern are unknown.

The map for arsenic (Fig. 3), although it clearly points the way to the gold-bearing structure, is quite different from the gold map. Although it is not necessary that the two maps be identical, because arsenic and gold are geochemically dis-

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

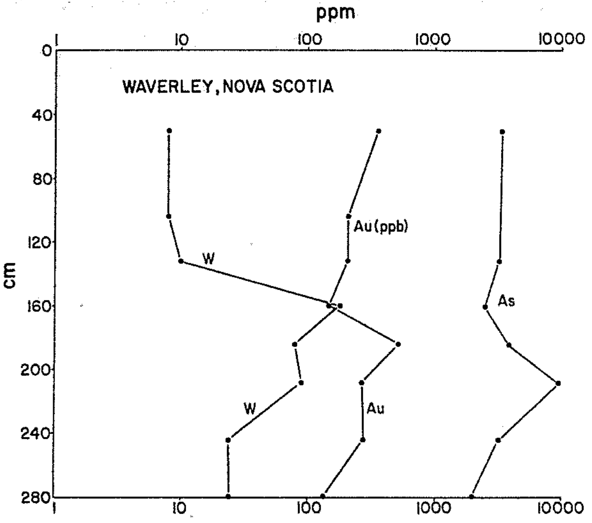

FIGURE 4. Variations in W, Au and As abundances in the <63 μm fraction of till in a vertical section at Waverley. Vertical scale is depth below surface.

similar elements, one can speculate on some possible causes of this difference:

1. Arsenic is enriched along the whole domal structure; gold is enriched mainly on its east end. This explains the lack of gold-rich till in the northwest part of the grid (Fig. 2).
2. The wrong grain size fractions may have been used for analysis of one or both elements. Because the gold was coarse grained in the ore, a sand-sized fraction might have more clearly defined a map pattern of glacial dispersal. Gold concentrations in the <250 mesh fraction may be related only to small amounts of gold smeared on other grains. In the case of arsenic, a finer fraction, such as <2 μm, probably would have produced higher contrast.
3. Gold and arsenic abundances may be partly hydromorphic; the two elements may behave differently in the groundwater system.

The lack of exposures at Oldham made it impossible to estimate gold abundances that could be found in a section of oxidized till a short distance down-ice from gold occurrences. Samples were collected, however, from a 3-m section about 200 m down-ice from the abandoned gold mine at Waverley, about 15 km from Oldham (Fig. 4). The occurrence at Waverley is similar to that at Oldham, except that the host rocks are highly arsenical greywackes and scheelite was present in the ore. Gold is present in the till in uniformly high amounts, 150 to 500 ppb, and arsenic contents are very high, 0.2 to 0.95 per cent by assay. If it is assumed that the W in the till is purely a clastic component (scheelite, identified in these samples by SEM), and that scheelite and gold have exactly the same bedrock source, their curves should be parallel. Because the curves deviate, it could be said that the gold has been redistributed hydromorphically in the upper metre of the section, but such an interpretation is tentative.

Onaman River, Ontario

The Onaman River grid is about 80 km north of Beardmore. The Onaman area has been extensively prospected for base metals and gold, and the grid itself is about 7 km south of the old Tashota Nipigon gold mine. The area studied has numerous sulphide boulders, rich in copper, silver and gold, in malachite-cemented till (Fig. 5). Research on gold in till was done near Beardmore (Closs and Sado, 1981), with encouraging results.

The area sampled has a gently rolling topography and is completely covered by calcareous till (25 to 35% $CaCO_3$ equivalent in the <63 μm fraction of unleached samples), usually more than 3 m thick. The carbonate component of the till was derived from Paleozoic rocks in the James Bay Lowlands, 130 km to the northeast, as shown by the presence of fossiliferous limestone pebbles in the till. The till is overlain in low areas by varved clayey silt, which restricted the area that could be sampled. Samples were collected in the area down-ice from what is called the No. 2 zone, which is the northeast corner of the grid. Copper-silver-gold mineralization occurs there in quartz lenses in Archean mafic volcanic rocks (Thurston, 1980).

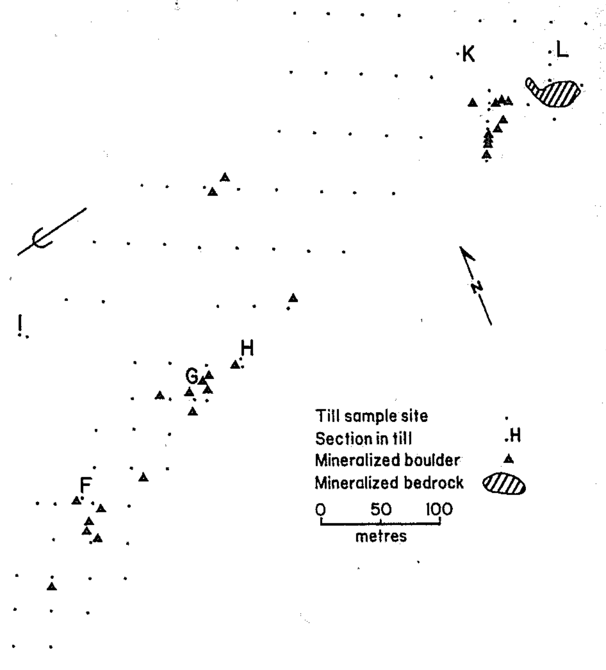

FIGURE 5. Sample plan of the Onaman River grid.

The distribution of mineralized boulders and elevated abundances of copper, silver and zinc (not shown) in till define a dispersal train that extends up to 600 m down-ice from the No. 2 zone (Figs. 6, 7). Each map has elevated metal abundances distributed in a flame-shaped pattern with abrupt edges.

The pattern mapped for gold (Fig. 8) is not similar to those of Cu, Ag, or Zn, although some of the mineralized boulders were rich in all four metals. Neither can it be assumed that Au and As are associated. The pattern of high As abundances (Fig. 9) is different from the Au and from the Cu-Ag-Zn patterns, but it is virtually the same as the patterns of high Co and Ni abundances (not shown). Because of the Co-Ni-As association and the occurrence of smaltite about 400m south of the centre of the grid (D. Thorsteinson, pers. comm.), it is inferred that there is an unknown smaltite occurrence up-ice from the area of elevated abundances of Co, Ni and As in the till. This metal source probably is not at the same location as either the Au or the Cu-Ag-Zn source. The overlapping patterns of greater abundances of unrelated metals illustrate glacial mixing of components derived from different sources, a principle of glacial dispersal described by Shilts (1980).

Several of the mineralized boulders are richer in Au and Ag than the No. 2 zone, from which they supposedly were derived. This may mean that there is an unkown Au-Ag source up-ice from the boulders. Although some of the high Au and Ag assays were caused by biased sampling of sulphide-rich portions of the boulders, some were also caused by leaching of chalcopyrite and pyrrhotite from the boulders, which left a quartzose limonitic boxwork that is enriched in Au and Ag. Typically, the limonitic remnant of the boulder is surrounded by a rim of limonite-cemented till, which is in turn encased by a rim of malachite-cemented till. Although the central limonitic remnant contains Au and Ag, the cemented rims do not.

In a further attempt to isolate the sources of gold in the till

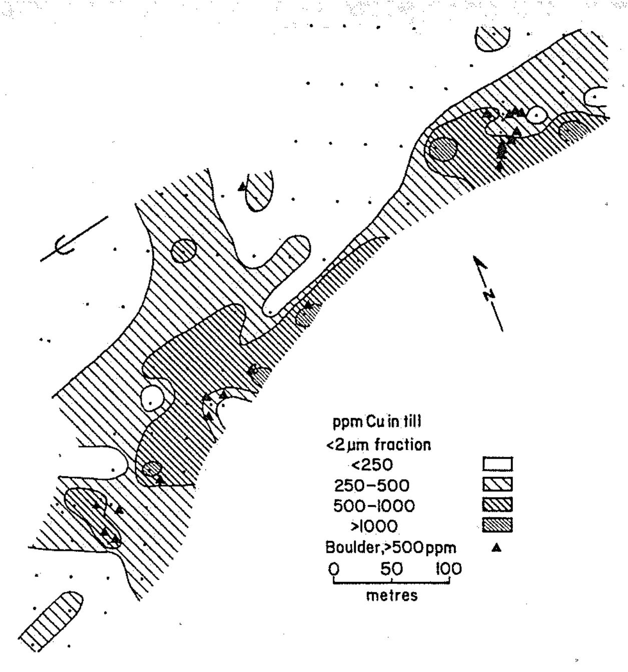

FIGURE 6. Copper abundances in the <2 μm fraction of till at Onaman River.

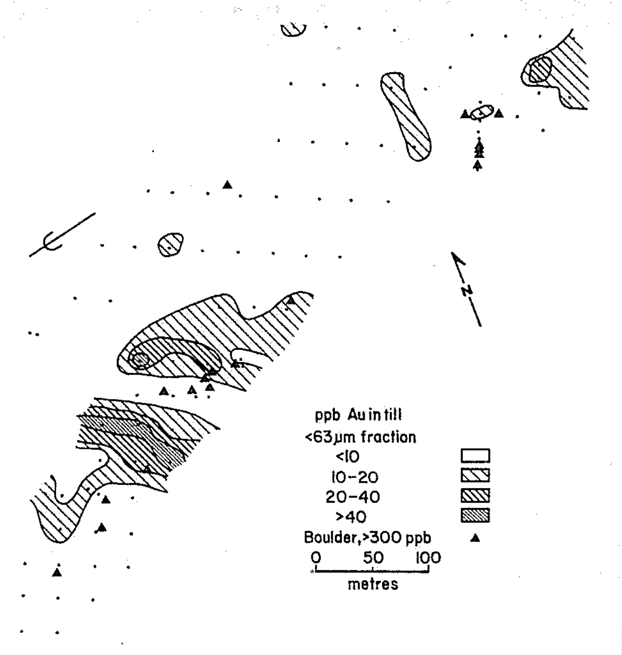

FIGURE 8. Gold abundances in the <63 μm fraction of till at Onaman River.

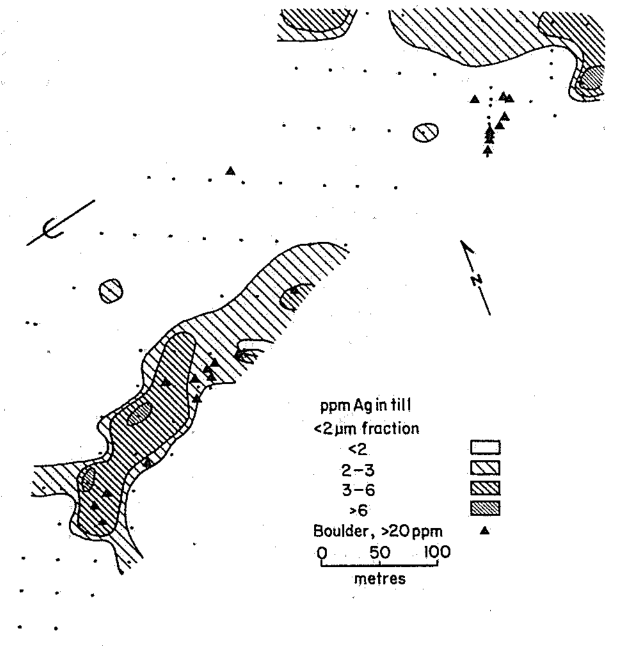

FIGURE 7. Silver abundances in the <2 μm fraction of till at Onaman River.

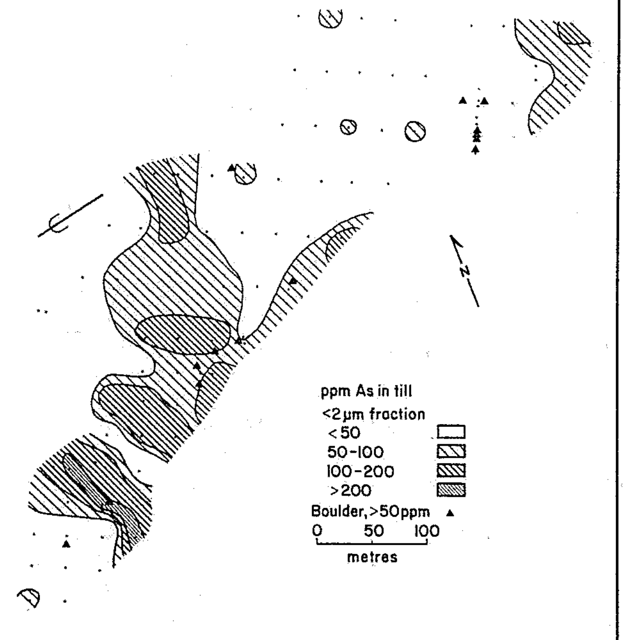

FIGURE 9. Arsenic abundances in the <2 μm fraction of till at Onaman River.

and boulders, several crushed samples were examined with a scanning electron microscope. Two points of interest came out of the SEM work:

1. No free gold grains were seen in any samples, even boulders that contained 22 g/t (0.66 oz per ton by assay), probably because gold grains could be absent from the small samples required for SEM. Moreover, 22 g/t (22 ppm) gold dissolved in sulphide minerals would be almost impossible to detect with the SEM.
2. Gold-rich boulders were invariably found to contain bismuthinite, sometimes in large amounts. The ore at the Tashota Nipigon mine also carried bismuthinite (Moorhouse, 1939), suggesting that part of the mineralization at Onaman River may be genetically similar to the Tashota Nipigon ore. Significant Bi concentrations were not detected in the $<2\mu$m fraction of the till samples.

Within the Onaman River grid, there is Cu-Ag-Au-Bi mineralization in the No. 2 zone. There may also be a Au-Ag-Bi source, either as part of the No. 2 zone subcrop or separate from it. If this source is separate from the No. 2 zone, it may underlie the centre of the grid in the area of the up-ice end of the patterns of elevated abundances of Au and Ag in the till (Figs. 7, 8). A Co-Ni-As source, probably a weak one, is indicated by till geochemistry.

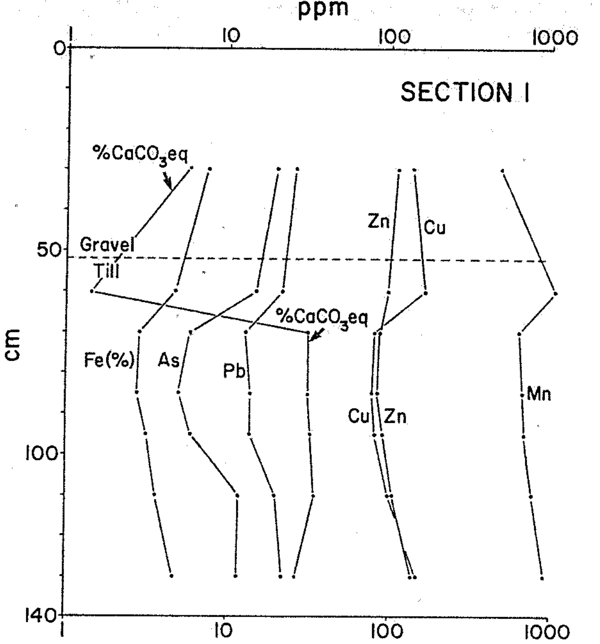

FIGURE 10. Variations in Fe, As, Pb, Cu, Zn and Mn abundances in the <2 μm fraction of till and gravel from section I (Fig. 5) at Onaman River. Per cent $CaCO_3$ equivalent was determined on the <63 μm fraction. Vertical scale is depth below surface.

Vertical Variations of Till Geochemistry

Vertical sections in the upper 2 m of oxidized till were sampled at Onaman River to observe variations in metal abundances. The logarithmic metal concentration curves are smooth, but difficult to interpret. Section I (Fig. 10) is a background site, outside the dispersal train. There, Cu and Zn abundances were about 100 ppm, As abundances were about 7 to 20 ppm, Au was not detected and Ag abundances were less than 1 ppm. Vertical variation in metal abundances is low, i.e., the curves are smooth. Note the depth of carbonate leaching at about 65 cm. The presence or absence of carbonate minerals probably has a strong control on the mobility of several of the metals in this region of carbonate-bearing till.

Profiles inside the dispersal train are difficult to interpret because the curves of metal abundances are not similar from section to section. Inside the dispersal train, at Section G (Fig. 11), Cu rises from 100 ppm at the base to 4000 ppm half way up the section, then falls to about 1000 ppm near the surface. At section H (Fig. 12), Cu rises from about 100 ppm at the base to 1500 ppm near the surface, a large difference from section G, even though the two sites are only 50 m apart.

The difficulty in interpretation arises because the till sheet is not metal-rich through its full thickness. In effect, the profiles were excavated in a till sheet that contains a discrete lens of metal-rich till that makes up the dispersal train. The phenomenon of an apparently homogeneous till sheet that encloses a lithologically discrete dispersal train has been described by Shilts (1976) and Geddes (1980). A dispersal train contained within a till sheet is obvious only where the characteristic component in the train is abundant or unusual (Hyvärinen *et al.*, 1973; DiLabio, 1981). In section H, the dispersal train makes up only the upper 40 cm of the till sheet, whereas in section G the dispersal train makes up at least the full thickness of the exposure, 240 cm.

Gold abundances in these and other till sections seem to be highest where the till is metal-rich, associated with high abundances of copper and silver, and therefore high gold abundances are not confined to any particular till horizon.

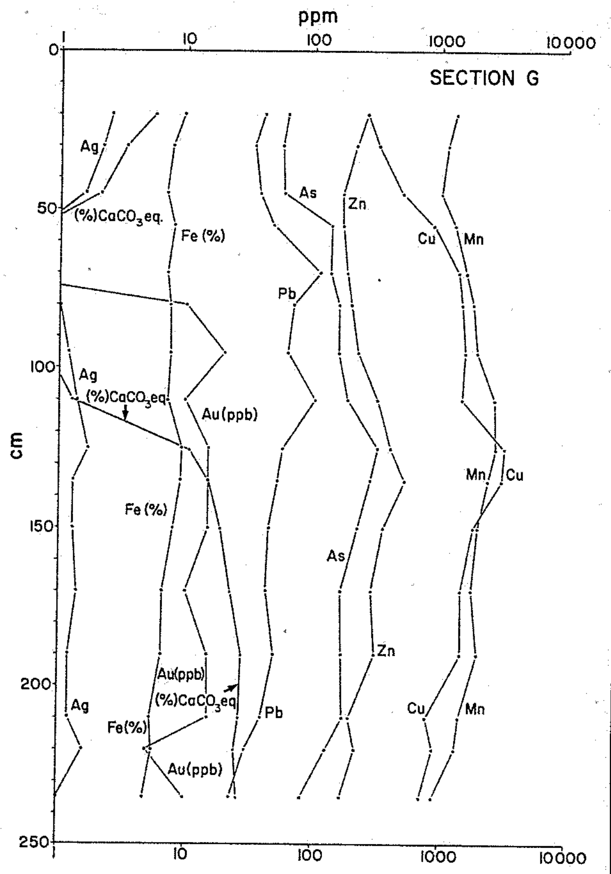

FIGURE 11. Variations in Ag, Fe, Pb, As, Zn, Cu and Mn abundances in the <2 μm fraction of till from section G (Fig. 5) at Onaman River. Gold abundances and per cent $CaCO_3$ equivalent were determined on the <63 μm fraction. Vertical scale is depth below surface.

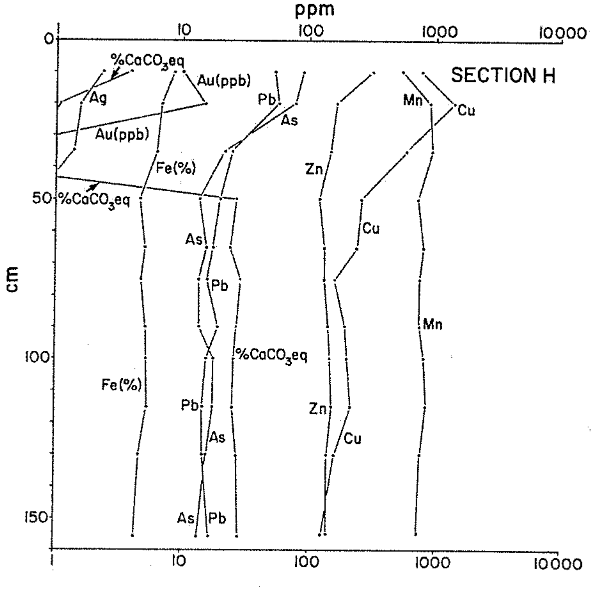

FIGURE 12. Variations in Ag, Fe, As, Pb, Zn, Cu and Mn abundances in the <2 μm fraction of till from section H (Fig. 5) at Onaman River. Gold abundances and per cent $CaCO_3$ equivalent were determined on the <63 μm fraction. Vertical scale is depth below surface.

Conclusions

These data have been presented in order to provide examples of the map patterns produced by glacial dispersal and to show some of the controls on the lithology of till. The patterns of data are thought to be typical for the types of metal occurrences and glaciation in the sampled areas.

Acknowledgments

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