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THE DELINEATION AND INTERPRETATION OF METAL DISPERSION PATTERNS RELATED TO MINERALIZATION IN THE WHIPSAW CREEK AREA, NEAR PRINCETON, B.C.

by

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ABSTRACT

The straightforward application of geochemical exploration techniques in certain areas of British Columbia is severely restricted due to marked variations in the surface environment. These variations create a situation in which anomalous metal distributions in the surface material do not necessarily reflect the incidence of mineralization. A method is described involving deep overburden sampling whereby it has been possible to discriminate localized anomalous zones in depth, associated with mineralization within extensive areas of surficial anomalies. Detailed sampling of the surficial material did not reveal any precise reflection of underlying mineralization. Low grade copper-molybdenum mineralization occurs along the contact between a porphyry intrusive and chloritized extrusives adjacent to a granodiorite intrusive. The area is one of strong relief, bedrock being overlain by glacial material consisting of glacial till and possibly some stratified drift. A thin veneer of colluvial rubble with poor soil development covers the hillslopes while at the base of the slopes, organic debris has accumulated in narrow swamp like areas. Previous geochemical drainage sampling had revealed strong and extensive copper anomalies in certain swamps, and soil sampling the presence of only relatively weak anomalies outside the swamp areas. An I.P. survey carried out over the swamp had indicated localized responses so there was evidence of a metal source within the extensive anomalous swamp area and some of the earlier drilling had intersected minor mineralization. These features suggested that the anomalous metal values in the swamp might not be entirely due to accumulation of metal by organic material from background concentrations or mineralization remote from the swamp.

Soil and organic samples were collected on a grid together with till samples taken from depths up to 30 ft. using a Cobra drill and soil sampler. Overburden sampling extended over selected portions of the anomalous swamp including the area of the geophysical anomaly and onto adjacent freely drained soils. Analyses of the glacial material underlying the swamp revealed localized areas of strongly anomalous copper relative to the broad anomaly in the surface organic material. The most strongly anomalous samples contained sulphide grains distinguishable under the binocular, indicating a mechanical rather than a hydromorphic origin for the anomaly. The zone of mechanically dispersed metal in the till was defined on the basis of the sulphide held copper (ascorbic acid/hydrogen peroxide extractable) and sulphur distribution. Results of drilling carried out simultaneously with the deep auger sampling indicated the more localized anomalies were closely related to interesting mineralization.

INTRODUCTION

The application of geochemical exploration techniques is complicated in certain areas of British Columbia due to marked variations in the surface environment. These variations contribute to a diversity of dispersion mechanisms occurring within a relatively small area and hence the metal distributions in the surface material display varying provenance and relationships to mineralization. In this situation it is of the utmost importance to be able to identify the relationship anomalous metal dispersions have to mineralization, bedrock composition or dispersion processes in the surface environment.

In a number of areas in British Columbia the accumulation of metal has been noted with organic overburden in swamps and in seepage areas due to local variations in the physico-chemical environment (Horsnail & Elliott, 1971). These anomalous concentrations have mostly been regarded as representing accumulation of metal from background concentrations or from mineralization remote from the anomalous locality. The present paper is concerned with an investigation of the nature of metal dispersion in the overburden in a situation where mineralization is spatially associated with anomalous metal contents in the organic overburden in swamps. The purpose of the investigation was to develop criteria for the discrimination of anomalous metal dispersion patterns in the swamp environment indicative of local mineralization from anomalous metal dispersions related to mineralization remote from the swamps, or to accumulation of metal unrelated to mineralization in the swamp environment.

DESCRIPTION OF AREA

The Whipsaw Creek property is located in the Cascade Mountains some 18 miles

Dome Exploration (1963-4), carried out geological, geochemical and geophysical work and some diamond drilling. Copper anomalies in the overburden (>500 ppm) are mainly associated with poorly drained soils and swamp areas draining margins of the stock, and porphyry dykes (Figure 3). Geophysical techniques were employed to indicate geology in unexposed areas and in addition revealed a number of strong I.P. responses. Diamond drilling carried out in the area of the magnetic and I.P. anomalies in the area of the central swamp intersected pyrite mineralization with low copper values in the porphyry stock and volcanics with a tendency for the higher values to be in the volcanics. Further geological mapping and geochemistry were carried out by Amax Exploration Inc. in 1968 together with trenching to expose contacts in the northern and central areas. On the basis of this work it was concluded that the best target for copper lay beneath the swamps at the margin of the porphyry stock, Mustard (1969). Up to 2% copper in the organic rich overburden was attributed to be markedly enhanced due to leaching of copper from bedrock remote from the swamp, downslope movement in the groundwater and concentration in the organic rich material in the swamp, Horsnail and Elliott (1971). In 1969, Texas Gulf Sulphur drilled four drill holes to identify the source of some of these anomalous copper zones in both the northern and central swamp. The hole sited to investigate the anomaly in the northern swamp intersected up to 0.35% Cu in the breccia and Nicola formations. The three holes in the central swamp penetrated narrow zones of mineralization with Cu values of up to 0.58% in quartz veinlets within the Nicola formations, Forsythe (1970).

In 1972, Newmont Mining Corporation of Canada Ltd., contemporaneously with the present investigation drilled six holes in the northern swamp area based on a 150 ms I.P. anomaly overlying the swamp, a broad linear copper anomaly in the B horizon and selected organic samples and to follow-up the mineralized intersections located by T.G.S. in their one hole in the northern swamp area in 1969.

till samples were taken was 30 feet and an average depth was 10 feet. By the compact nature of the basal till, this unit proved relatively resistant to penetration by percussion drilling when compared with the more loosely consolidated overburden overlying the lodgment till. Hence the optimum sampling depth could readily be detected. Local variations in the consistency of the till raises the possibility that in some cases, material other than lodgment till may have been sampled. An alternative procedure to determine the depth to the basal till involves the drilling of one hole to the bedrock surface and then sampling a second hole alongside a short distance above the bedrock/till interface. Using this procedure there remains a possibility of mistaking a boulder in the till for the bedrock surface.

The application of deep overburden sampling using a hand operated drill in the geochemical exploration areas of glacial till was first demonstrated in Canada in the Chibougamau area, Ermengen (1957a & b). Since that time a variety of sampling procedures and equipment have been employed; Gleeson 1960; Lee 1963; Boniwell and Dujardin 1964; Gleeson & Coope 1967; Fortescue & Hornbrook 1969; Van Tassal 1969; Garrett 1971; Gleeson and Cormier 1971; Skinner 1972. At this time there are two principal methods being employed involving the portable percussion drills of the Atlas Copco Cobra or Pionjar types and machine mounted rotary drills.

In the present investigation the sampling was carried out using an Atlas Copco Cobra percussion drill and soil sampling attachment. The basic procedure is to drive a soil sampler, consisting of a steel casing around a retractable plunger, to the desired depth of sampling which in this study was the basal till of the overburden. At the optimum depth, the soil sampler is rotated to retract the plunger and is then driven another 8 inches thus obtaining sample in the core space left by the retracted plunger. The soil sampler and attached rods are then withdrawn from the ground by a jacking system.

METAL DISPERSION IN SWAMP FROM PROFILE SAMPLING

The profile sampling indicated varying thicknesses of organic material overlying glacial till, the latter being characteristically poorly sorted and consisting of rounded pebbles, sand and clay. The colour of the till varied from grey to blue green characteristic of reducing conditions to a ferruginous brown indicating post-depositional oxidizing conditions. The concentration of organic material decreased from >80% at the surface to <10% in depth (Figure 5). In the central swamp lower pH values occured on the side of the bog adjacent to pyritized bedrock.

The copper content of the till in the central swamp is variously anomalous, with values over 2000 ppm tending to occur on the side of the swamp adjacent to mineralization, relative to a threshold of 100 ppm, in the background swamp. There is a continuation of high copper values with depths in the central part of the swamp, whereas laterally in the swamp copper values decrease with depth. There is no difference in Fe and Mn contents between the anomalous and background profiles. There is a slight increase of Fe and Mn contents with depth although this does not appear to be related to the proximity of mineralization. Detailed examination of some of the till samples from the northern swamp revealed the presence of discrete sulphide grains.

On the basis of the above evidence it was concluded that some at least of the anomalous metal in the till underlying the organic rich swamp was dispersed mechanically, and appeared to have a small displacment from its point of origin. The presence of anomalous copper values in till adjacent to mineralization provided further encouragement that it might prove possible to define the location of mineralization on the basis of till sampling under the swamps. On this basis samples were collected on a grid over part of the northern swamp.

DETERMINATION OF MINERAL FORM OF METAL

From the preliminary investigations it became clear that both reducing and

Nicola contact is grey brown in colour while till underlying the main swamp is as a distinctive grey colouration, the latter indicating reducing conditions.

The direction of glacial movement in the area appears to be from N5°W on the basis of a fabric analysis of stones in trenches adjacent to the northern swamp. The sense of movement is from the north on the evidence of Nicola boulders occurring upslope from the Nicola/Porphyry contact. The degree of dislocation of the basal till, however, is thought to be small on the basis of boulders in the trench which clearly have moved only a small distance from their point of origin.

The distribution of sulphur, presumably indicative of pyrite and chalcopyrite shows a marked concentration along the western margin of the grid and extending eastward underlying the stream and bog associated with the Nicola/Porphyry contact but virtually the entire area of the grid is anomalous compared to the background swamp (Figure 7). This distribution is regarded as reflecting the sulphide distribution remaining after post-depositional weathering of the mechanically dispersed till.

The ascorbic acid/hydrogen peroxide and the nitric acid extractable Cu distributions in the till are basically similar in general form to that of the sulphur, and markedly anomalous relative to the background swamp. The maximum sulphide copper and sulphide plus oxide copper contents of the basal tills from the background swamp is 35 ppm and 85 ppm respectively falling in the lowest data class adopted for contouring the data from the northern swamp area (Figures 8 and 9). However, the sulphur anomaly in the northwest of the grid is not coincident with a markedly anomalous sulphide (ascorbic acid/hydrogen peroxide) copper. The sulphur is thought to represent pyrite although the occurrence of 300-600 ppm. sulphide plus oxide copper possibly indicates that chalcopyrite may have been oxidized. A prominent sulphide held Cu zone occurs in the centre of the area (Figure 8) and a strong sulphide plus oxide Cu anomaly on the

RELATIONSHIP OF ANOMALOUS METAL CONCENTRATION IN TILL TO BEDROCK MINERALIZATION

Six diamond drill holes were collared in the area of the northern swamp by Texas Gulf Sulphur in 1969 and by Newmont Mining Corporation of Canada Ltd. in 1972. The T.G.S. hole intersected 80 ft. of 0.25% Cu in the form of chalcopyrite mineralization along the Nicola - porphyry contact. Newmont drilled 5 holes in the area of the till sampling which was independently in progress at the same time. The diamond drilling was undertaken to investigate the 150 ms. I.P. anomaly, the broad linear copper anomaly in the surface overburden, and to follow up surface indications and the mineralized intersections located earlier by T.G.S. The drilling confirmed a broad zone of low grade mineralization in the Nicola associated with the Nicola/Porphyry contact. Three of these holes (E0.00N 22.00W, E3.50N 23.75 and E7.50N 22.25W) intersected 261 ft. of 0.23% Cu, 185 ft. of 0.21% Cu and 80 ft. of 0.21% Cu respectively in the Nicola. Anomalous areas of copper and to a lesser extent sulphur in the basal till are associated with the significantly mineralized portions of these holes and also that of the T.G.S. hole having regard to the northerly dip of the Nicola - porphyry contact. The remaining two diamond drill holes at D9.50N 14.25W and D9.00N 11.50W, in areas of less marked basal till anomalies intersected respectively 2o ft. of 0.25% Cu, 15 ft. of 0.12% Cu associated with more extensive lower grade zones (Figures 7 & 8). On the basis of these results the metal dispersion in the basal till appears to be a reasonable guide to the degree of mineralization in the bedrock. It is therefore suggested that in areas where dispersion patterns in the surface overburden are not sufficiently localized due to large amounts of hydromorphically derived material, basal till sampling provides a suitable intermediate stage producing relatively precise information as to the location of bedrock mineralization. In this way drilling targets may be defined with much greater precision than might be the case with surface geochemical and geophysical patterns.

The delineation of areas of mechanically dispersed, anomalous sulphur and ascorbic acid/hydrogen peroxide extractable or sulphide held copper in the basal till served to outline a broad zone of low grade mineralization in the Nicola, with the more strongly anomalous areas associated with the more interesting mineralization. Although it is possible that in strongly oxidizing environments the sulphides may have been completely oxidized and the copper transported out of the system in the groundwater the most reliable targets, indicative of mineralization in the associated bedrock, are coincident areas of anomalous sulphur and sulphide held copper. The applicability of these procedures in other areas of the Cordillera will be dependent on the local glacial history and dispersion conditions, factors that should be considered prior to any contemplated usage of the procedure.

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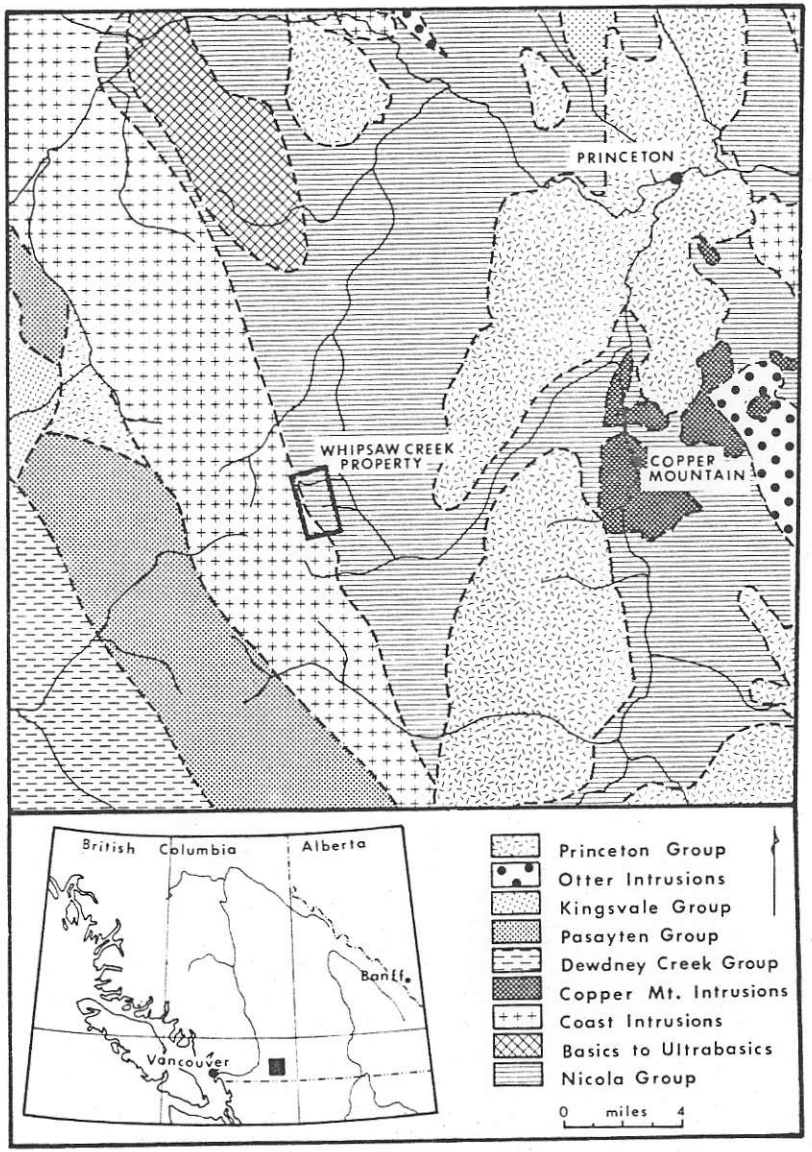

Fig. 1: Location of area and regional geology, (after Rice 1960 and Preto 1972).

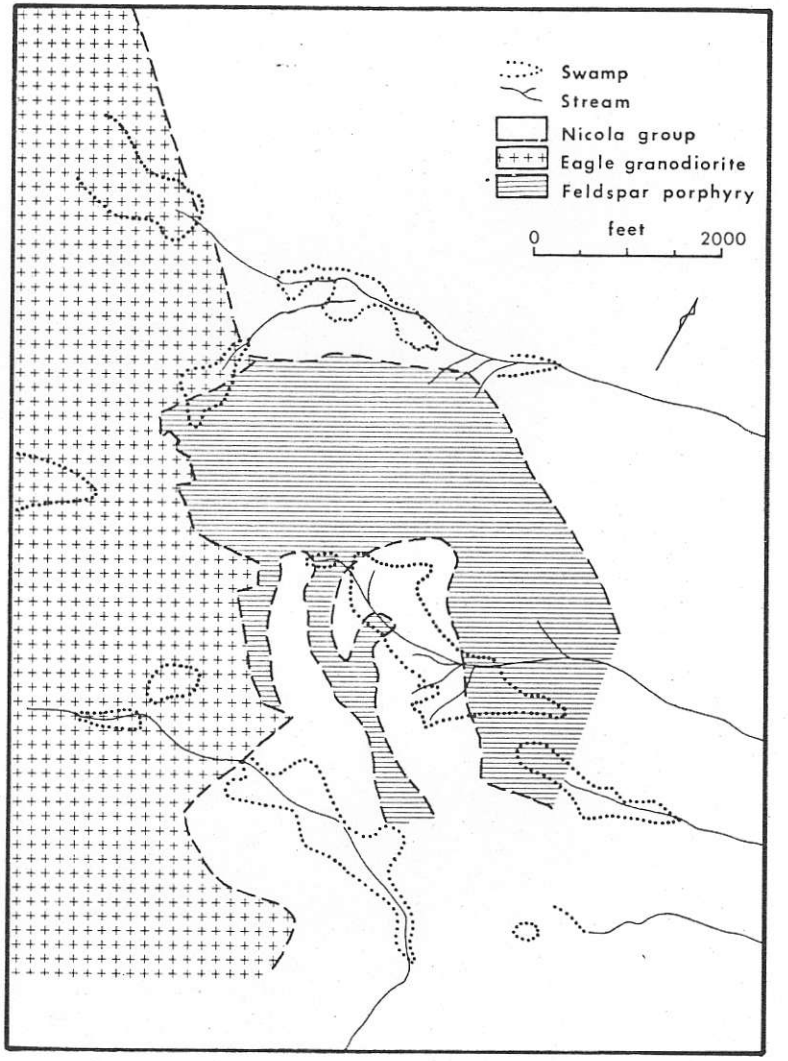

Fig. 2: Geology of Whipsaw Creek Property, (after Mustard, 1969).

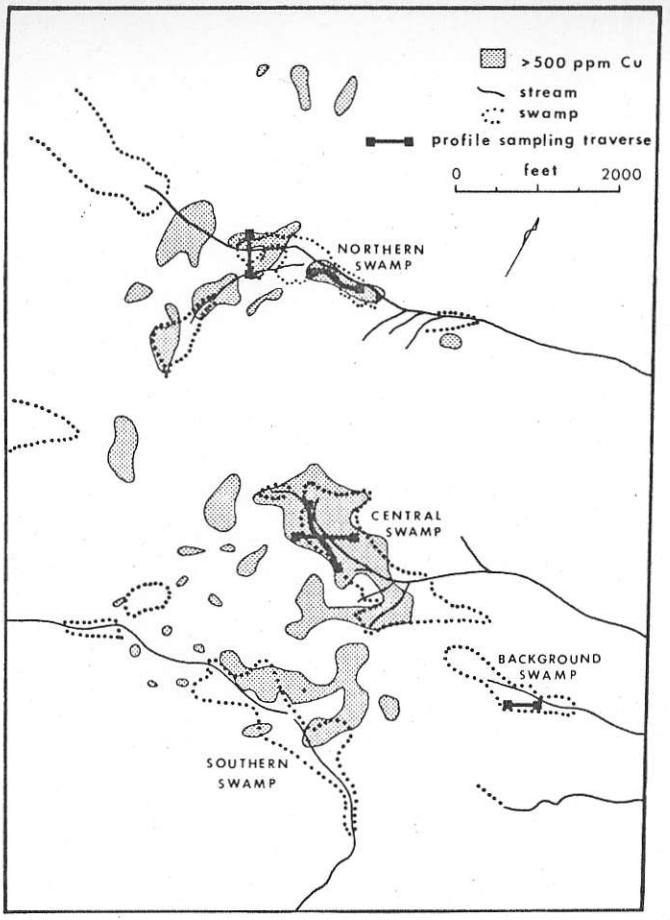

Fig. 3: Relationship between copper distribution and swamps.

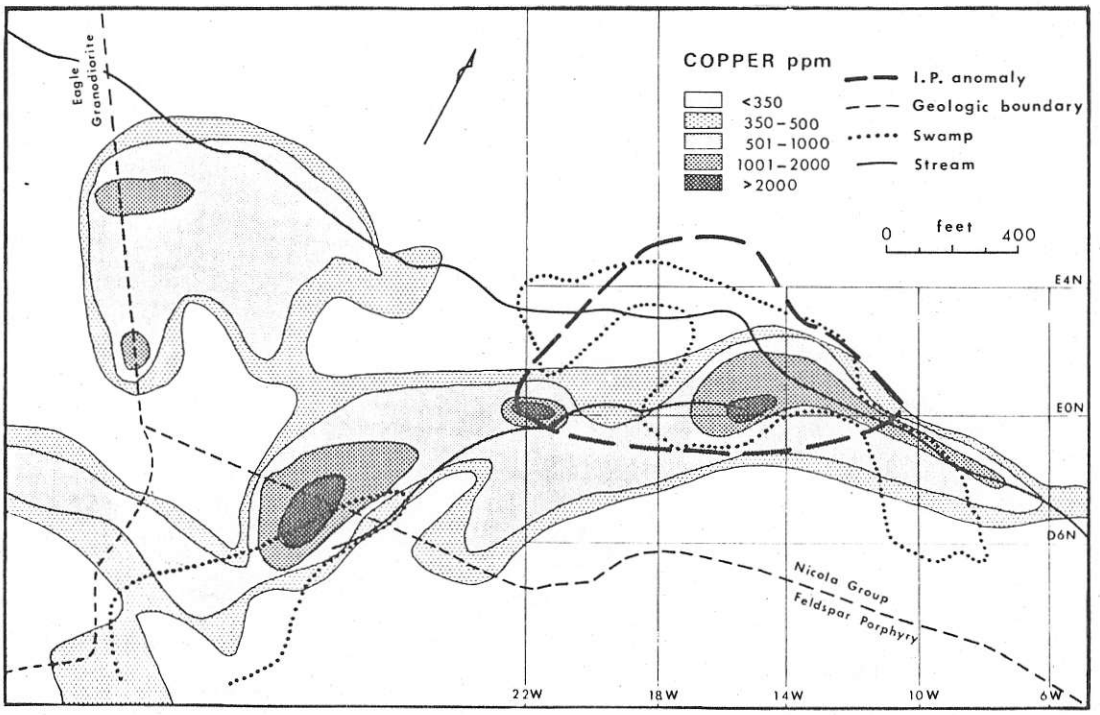

Fig. 4: Copper distribution associated with northern swamp, (after Newmont Mining Corporation of Canada).

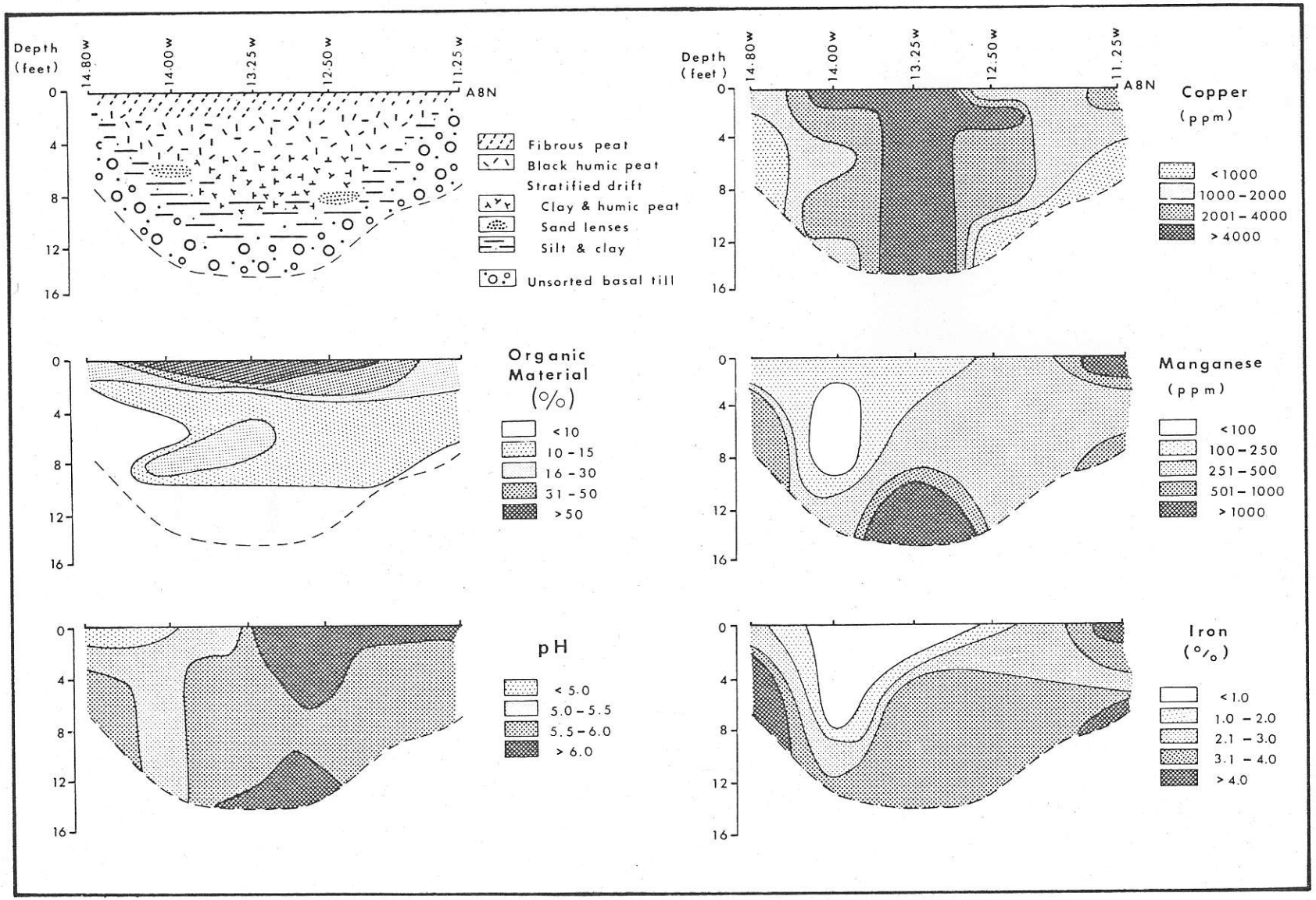

Fig. 5: Overburden profile, pH, organic matter, copper manganese and iron concentration in section through Central Swamp.

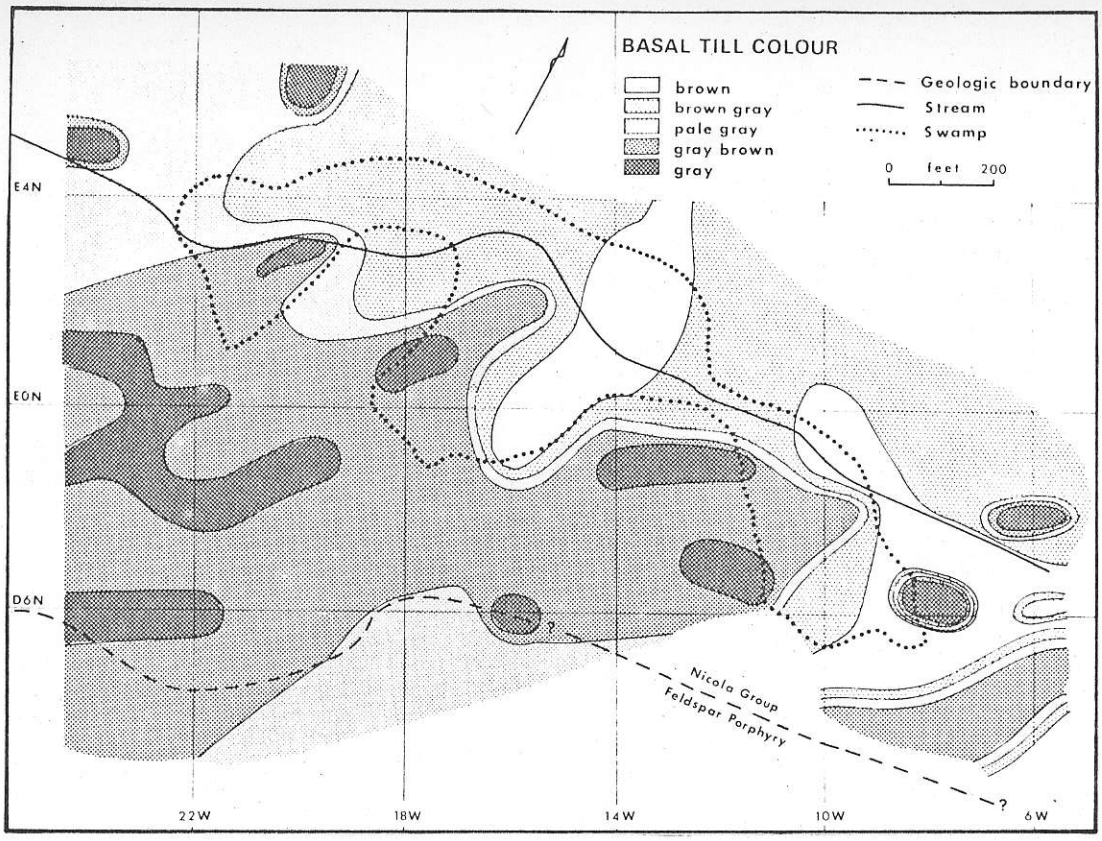

Fig. 6: Basal till colour in northern swamp.

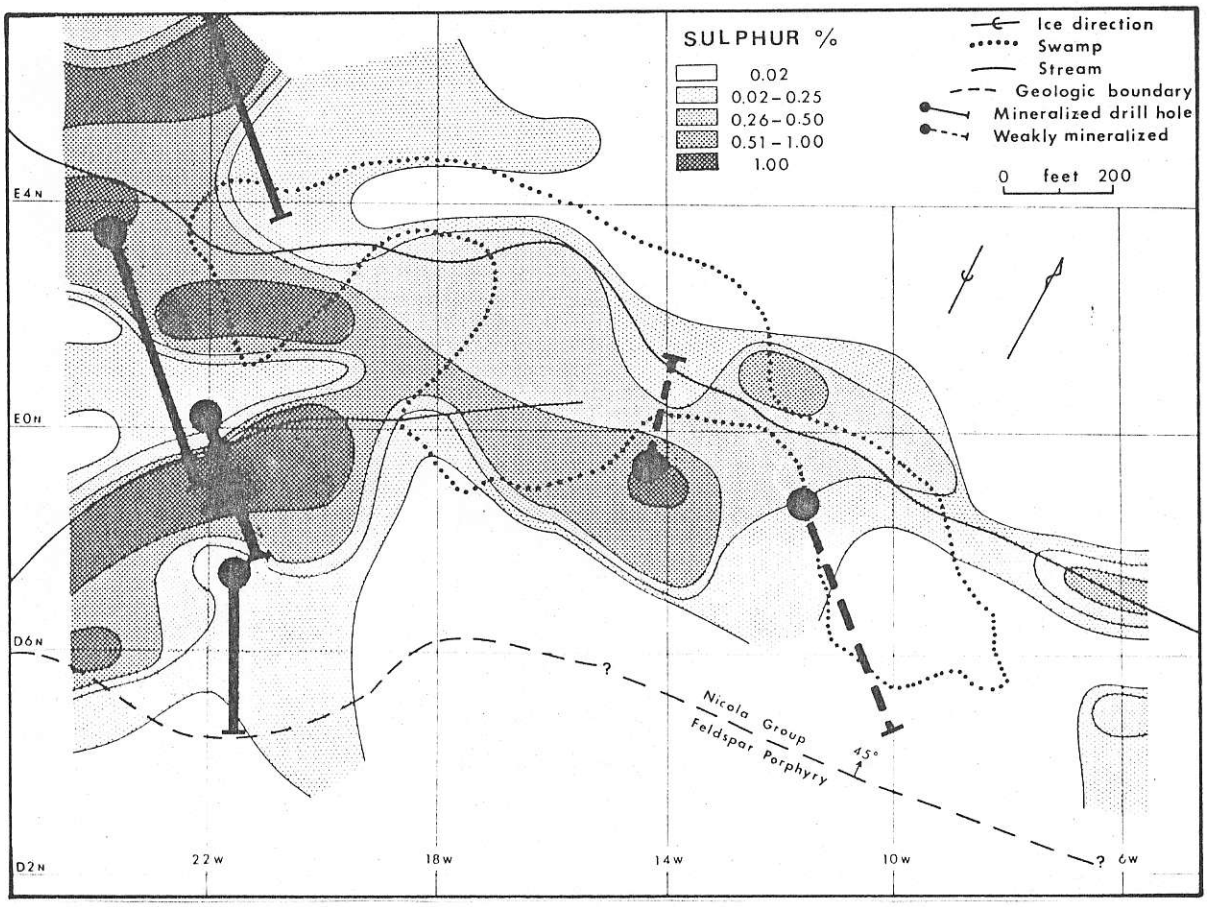

Fig. 7: Sulphur content of basal till in northern swamp.

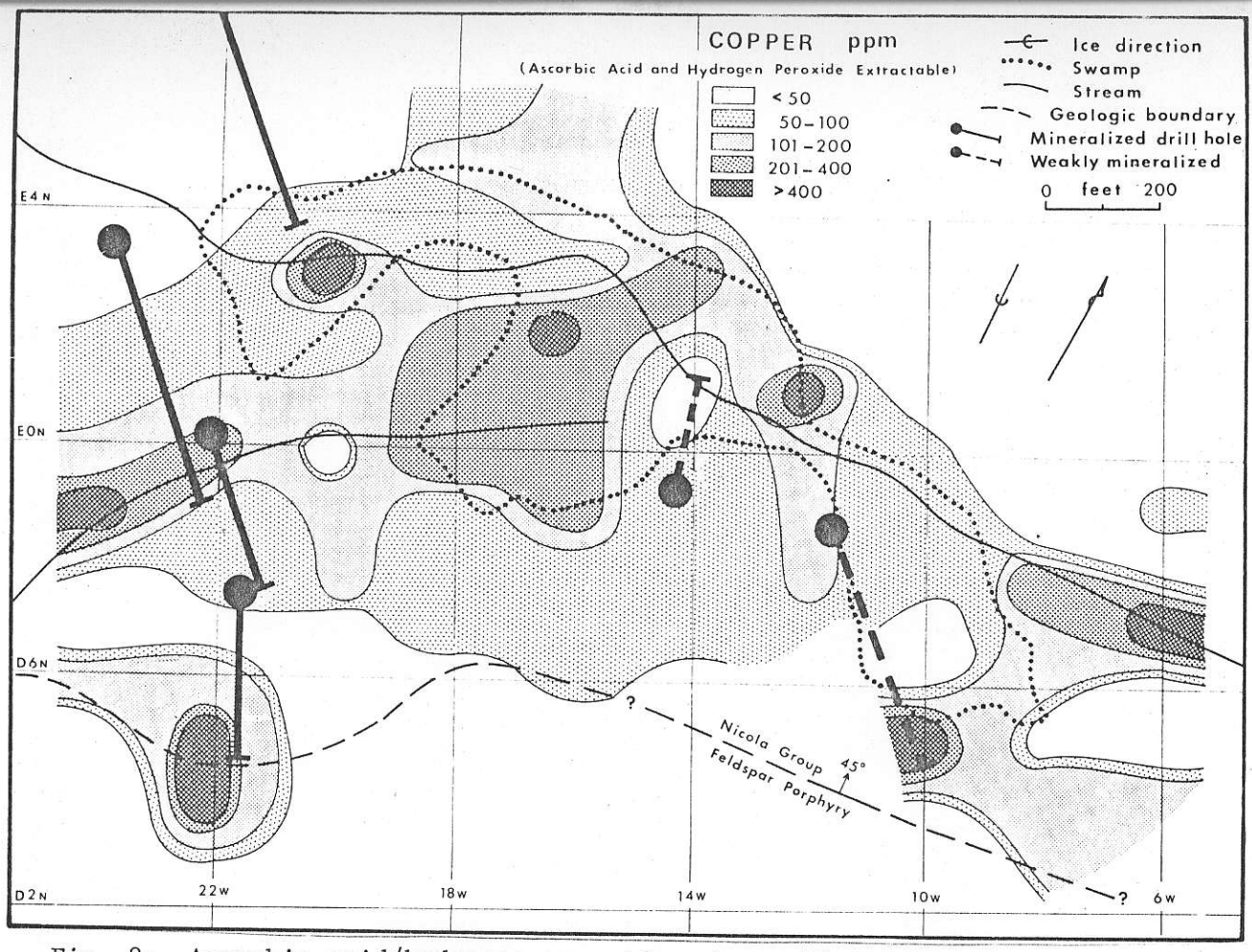

Fig. 8: Ascorbic acid/hydrogen peroxide extractable copper content of basal till in northern swamp and relationship to mineralization revealed by drilling.

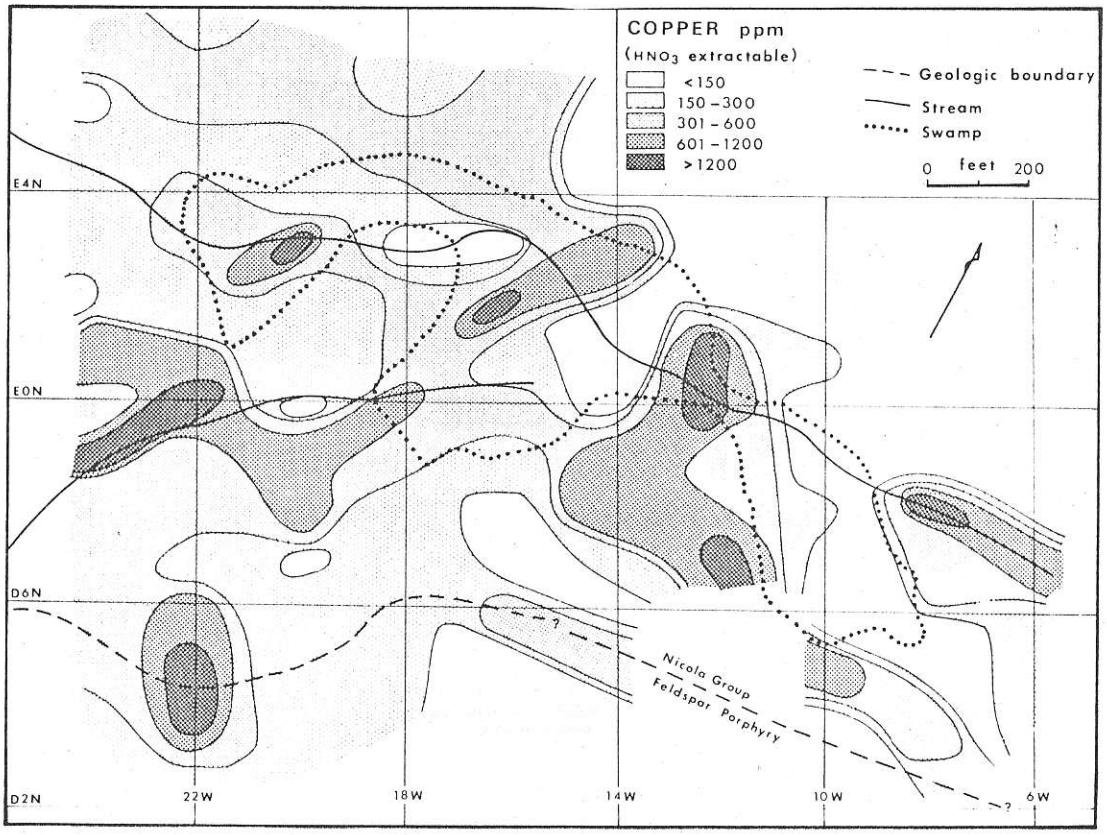

Fig. 9: 25% HNO_3 extractable copper content of basal till in the northern swamp.

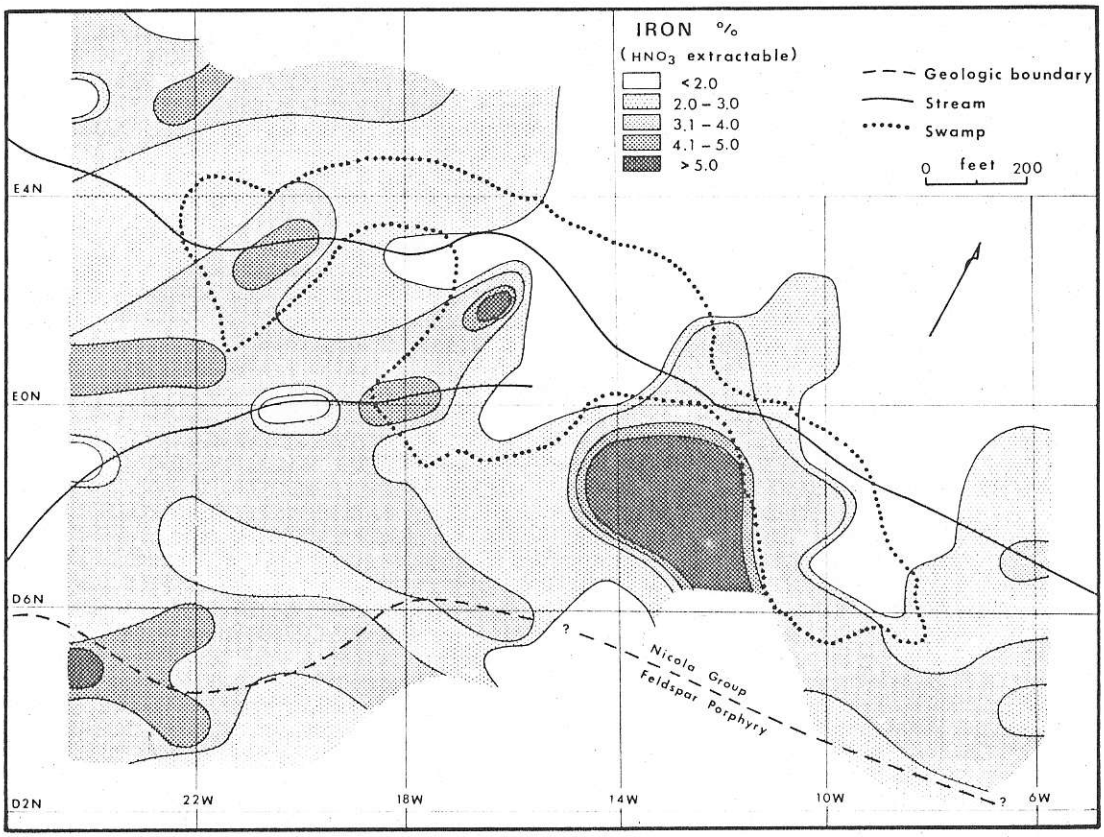

Fig. 10: 25% HNO_3 extractable iron content of basal till in the northern swamp.

TABLE I: Extractability of copper in limonites and pyrites using different digestion procedures.

Sample		HF, $HClO_4$, HNO_3 Cu (ppm)	% Extractability 25% HNO_3	% Extractability Ascorbic Acid/ Hydrogen Peroxide
Limonite	#1	117	51	15
	#2	1400	89	13
	#3	>40000	< 92	<5
Pyrite	#1	100	85	70
	#2	58	78	78
	#3	395	100	95

TABLE 2: Cost analyses of deep overburden drilling.

AREA	DRILLING EQUIPMENT	MEAN OVERBURDEN THICKNESS (FEET)	MEAN COST/FOOT ($)		REFERENCE
			DIRECT COST	TOTAL COST	
Galena Hill-Keno Hill Yukon	Combination Rotation - Percussion Tractor Mounted	110	1.45-1.65		Van Tassell (1969)
Timmins, Ontario	Tri-Cone Rotary	125	3.15-3.25		Mannard (Pers. Comm.)
St. Lawrence, Newfoundland	Tri-Cone Rotary	15		6.69	Tilsley (Pers. Comm.)
Abitibi Clay Belt	Tri-Cone Rotary Cobra-Type Percussion	78 N/A Max. Depth 70	7.36 (4.08-13.25) 3.50		Skinner (1972)
Val D'Or, Quebec And Oka, Quebec.	Pionjar-Type Percussion	50	0.50-2.00		Gleeson & Cormier (1971)
Abitibi Clay Belt	Pionjar-Type Percussion	48	2.10		Gleeson (pers. comm.)
Princeton, B.C.	Cobra Type Percussion	10	1.00		Present Study