2.15032

Summary Geological and Geochemical Report

For

Nova Township Prospect

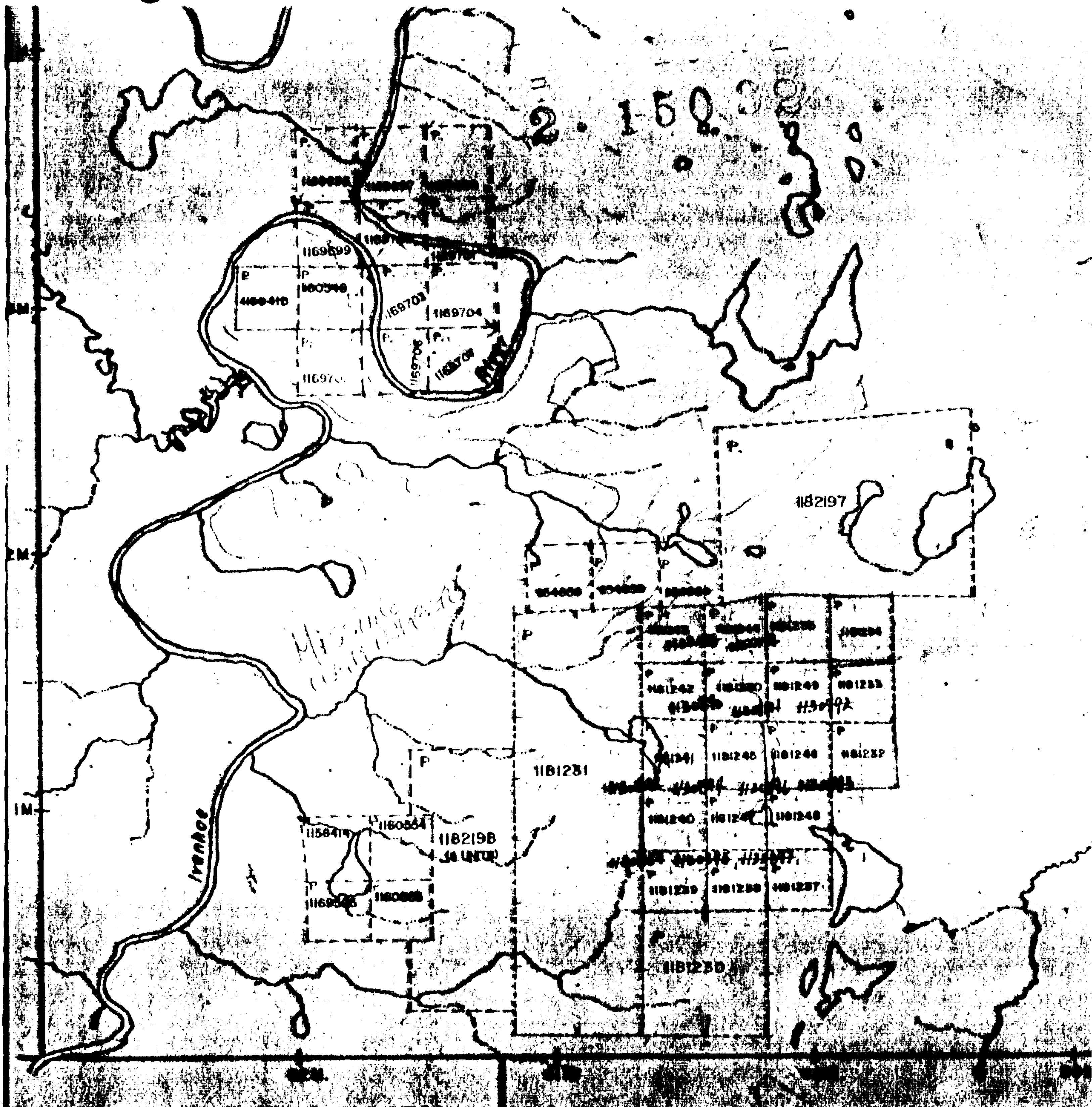
Porcupine Mining Division

Timmins, Ontario

Qual.# 2.3466

April 28, 1993

By: J.K. Filo
HBSc. Geology



OATES TWP. (M.1033)

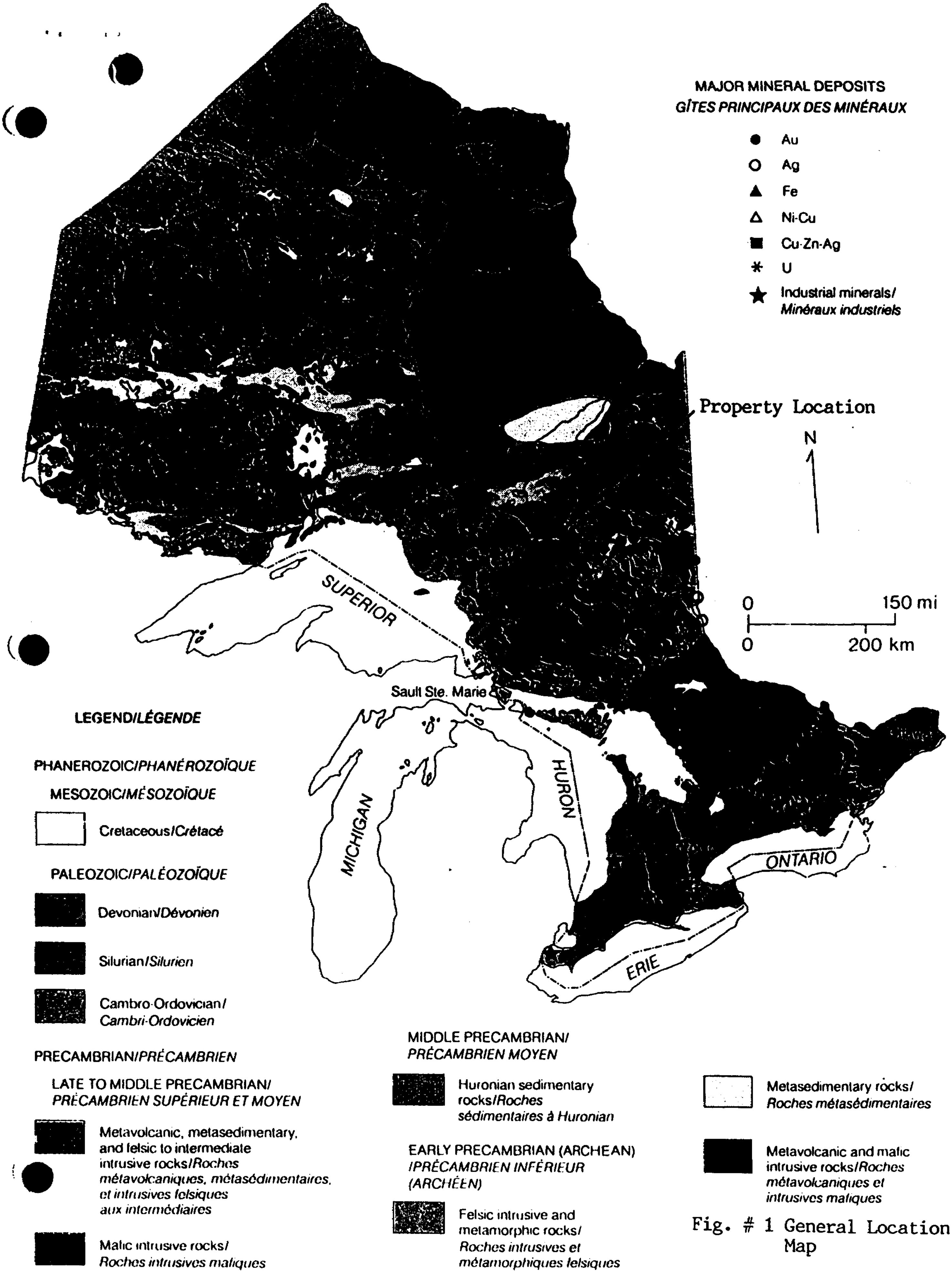


Fig. # 1 General Location Map

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INTRODUCTION

During 1992 Messrs. Filo & Jones carried out geological mapping and prospecting on their Nova Township base metal property as part of a 1992 OPAP project. The purpose of this work was to evaluate the geology of the prospect and examine a number of known mineral occurrences.

Prior to carrying out this program, geological, geochemical and geophysical re-interpretation work was carried out by Orofino Resources via an option agreement. This author only recently acquired this private data and consequently all new geological data from the recent work by this author and work by Orofino will be incorporated into the interpretation portion of this report.

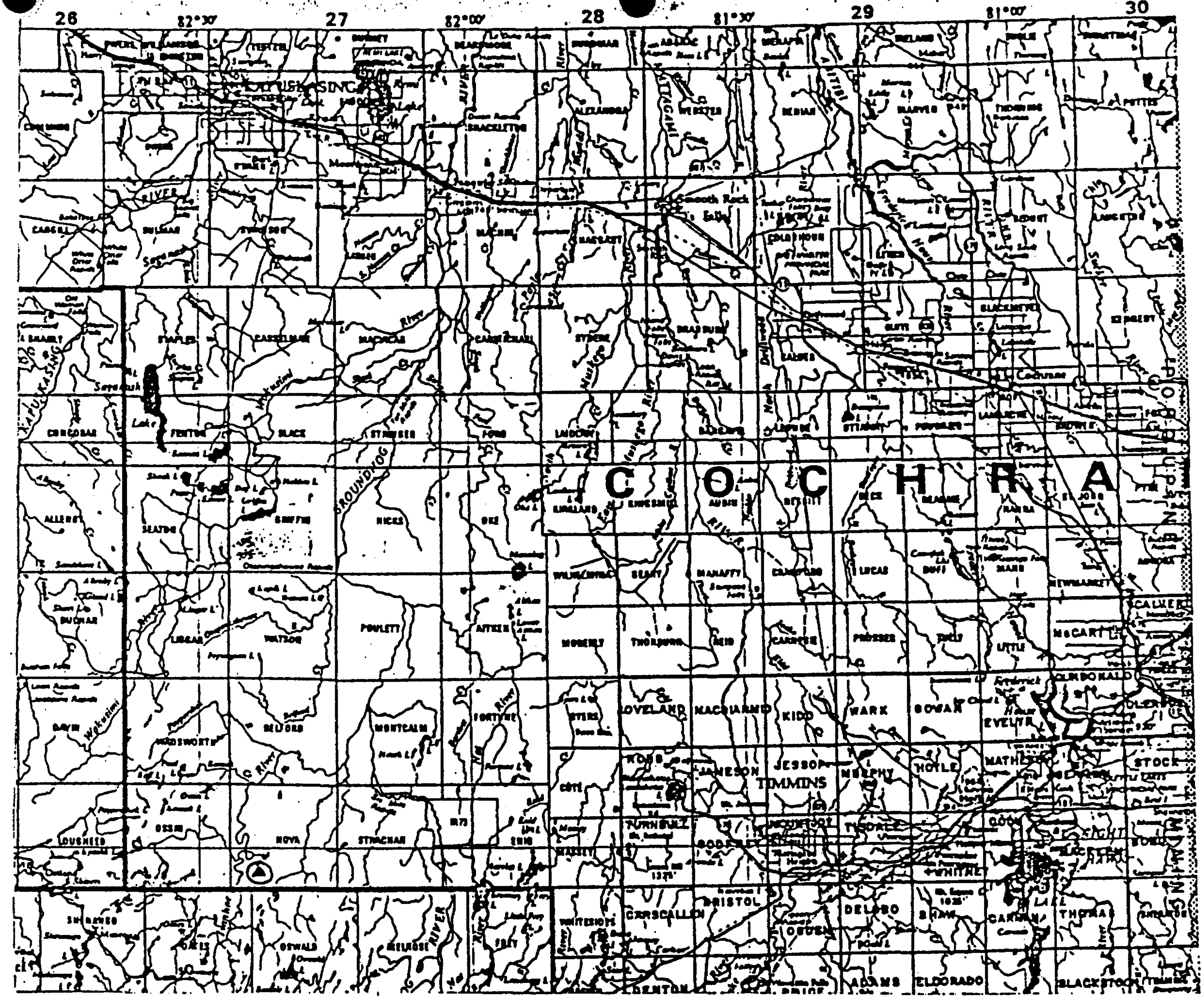


Fig. 35-1 General Location Map (▲)

Nova Twp. Scale: 1:600,000

PROPERTY, LOCATION AND ACCESS

This property consists of 20 contiguous mining claims or 30 units as shown in Fig. S5-2 and it is located in Nova Township roughly 80 kilometres NNW of Timmins, Ontario (Fig. S5-1). Access to the subject property is via all-weather logging road from Malette's Mill in Timmins, Ontario, just off of Highway 101 west. From Malette's Mill it is approximately 95km to the prospect on a series of logging roads which lead to the northern boundary of the property.

PROPERTY HISTORY

Limited exploration work has been carried out on the subject property to date. The details on the current documented history for this claim is presented in point form as follows:

Area Mines 1964 (Assessment File T-879)
Area Mines carried out prospecting and trenching; one drill hole was drilled to test a pyritic zone with minor Cu-Zn mineralization. This hole was located within the central portion of the present subject block. This hole intersected a series of metasediments, chlorite-grunerite schists and quartzite?, with sulphides including pyrite, pyrrhotite, minor chalcopyrite and magnetite.

Canamax 1972 (Assessment File T-721)
Canamax carried out extensive airborne surveys in Nova and adjoining townships and staked a portion of the present subject property. Subsequent ground follow-up showed the presence of felsic volcanics associated with sulphides and minor zinc mineralization. This zone also had a related E-M anomaly, but no drilling was carried out, the claims eventually lapsed.

Filo & Associates 1991
In 1991, Filo & Associates picked up a series of claims covering airborne anomalies from the 1990 O.G.S. airborne survey. These claims covered the old Canamax and Area Mines showings. In September of 1991 the ground was optioned to Orofino Resources.

Orofino carried out line cutting, geological work, and airborne geophysical re-interpretation. The ground was then turned back to Filo & Associates in September of 1992. The work carried out was not filed for assessment and was not public information until April of 1993.

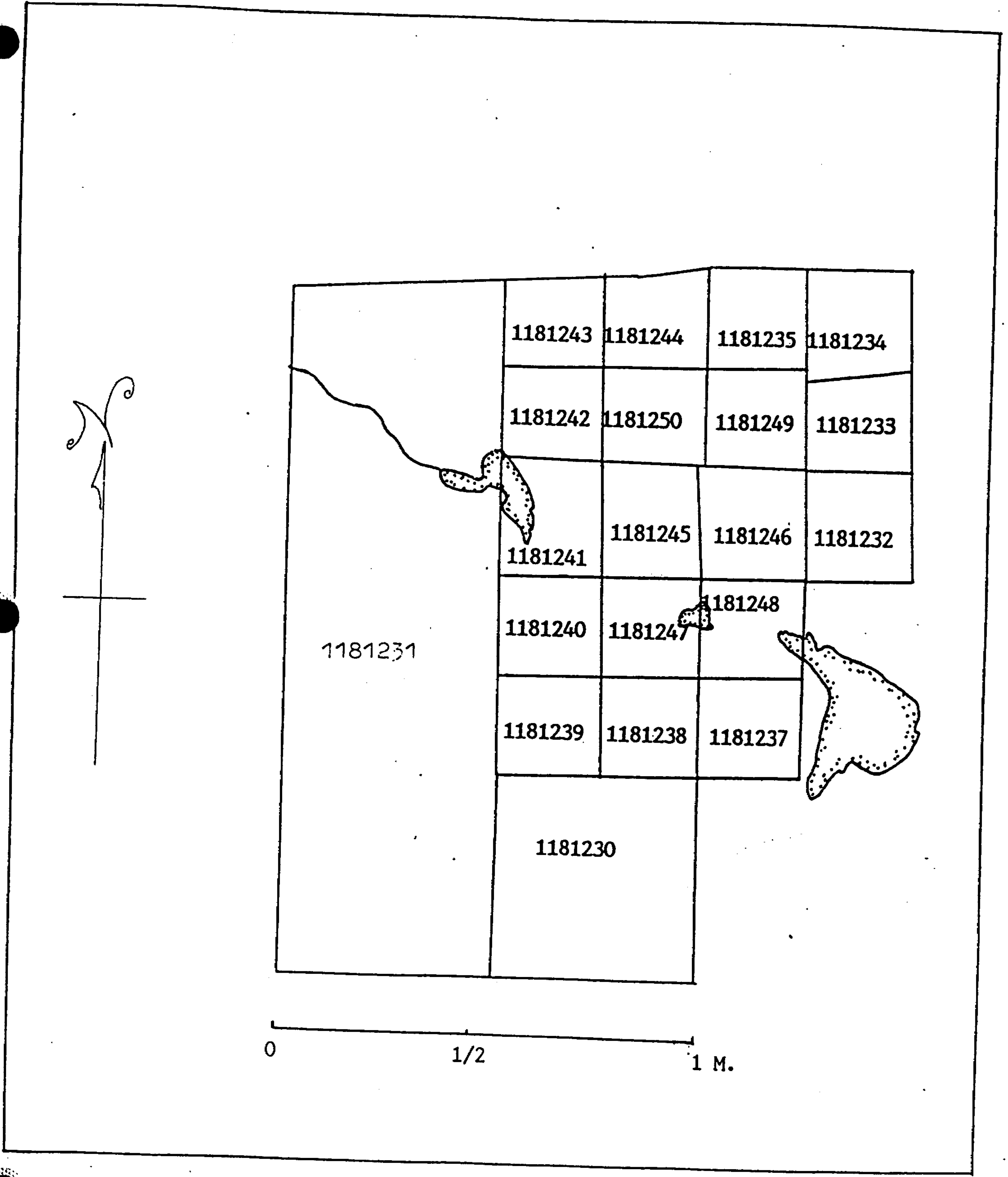


Fig. S5-2 Claim Location Map
Nova Township Prospect

Property Geology

Orofino's Nova Township property is located roughly ten miles east of a major regional structure known as the Kapuskasing High. It has been suggested that this area represented a structurally active zone, possibly caused by the rotation of continental blocks on either side of the zone (O.D.M. Miscellaneous Paper 10). Consequently, there has been extensive metamorphism and structural deformation within this area and in rocks proximal to this structure. The lithological units which make up the Nova Property have been extensively metamorphosed. For the most part they are of almandine-amphilbolite metamorphic facies. In some instances there are areas where the metamorphic overprint has not totally changed the original lithology. Some idea of the original lithologic composition can be ascertained. Preliminary geophysical interpretations (Bonniwell) on the prospect suggest extensive deformation in terms of faulting and folding. Some of this interpretation has been verified from the limited exposure that exists on this prospect. A more detailed account of this property's structural features will be discussed later in this report.

Lithology

The lithology on the subject property has been broken down into six basic groups; metafelsic volcanics, metamafic volcanics, metasediments, felsic intrusives, mafic intrusives, and high grade metamorphic rocks. A brief description of these units and some discussion about them is presented in the following paragraphs:

i) Metafelsic Volcanics

The units which all into this group are rhyolitic sericite schist, dacite tuff, and chert. Only one exposure of rhyolitic sericite schist exists on this prospect. This unit is strongly foliated aphanitic and ranges in colour from greenish to bleached white. Quartz eyes and minor fushite were also noted. Previous whole rock geochem analysis substantiated that this unit is indeed a rhyolite geochemically.

The dacitic tuff has a bleached weathered surface and no fragments. The tuff could be considered an ash tuff. The weathered surface of this unit is bleached white in colour. The fresh surface is grey to dark grey. It sometimes contains quartz eyes and the unit is usually strongly foliated. It is most likely that this foliation is principally a result of metamorphic processes and not a remnant primary tuffaceous feature. In two instances (L2E 100N and L7E 1050N) this dacitic tuff unit becomes extremely foliated and boudinaged and at L2E 100N it eventually grades into a hornblende feldspar gneiss, with substantial feldspar content, both plagioclase and potassic feldspar making up at least 50% of the gneissic unit. This leads the author to believe that some of more felsic gneissic rocks are metamorphic equivalents of the dacitic tuffs. Some tiny red garnets, usually a few millimetres in diameter, are present in gradational transition zones.

The chert horizons that appear are basically bleached white in colour and brecciated with a grey black silicious matrix. The chert horizons may also contained argillaceous horizons and/or metamorphic equivalents of those horizons, i.e. micaceous schists, quartz, feldspar garnet schists. In one instance (L7E 1050N) substantial massive pyrite and pyrrhotite are found within this chert horizon. This area could be termed cherty-sulphide facies iron formation in this one area.

ii) Metamafic Volcanics

Only one outcrop of this unit was found on L12E 125S. This unit is grey black and fine grained to aphanitic. The unit is foliated and some gossan (minor) is associated with the one exposure noted.

iii) Metasediments

Most of the quartzite exposures found exist west of the line zero south of Reference Lake. For the most part, these are bleached white units that are weakly foliated. The fresh surface is white to light grey in most instances and they have a "sugary texture:. The units appear to be mainly made up of quartz (80-90%) and some biotite. In one instance, a quartzite unit (L2W 250N) was somewhat more grey in colour and contained less quartz. This sample may be approaching sub-greywacke according to Pettijohn's classification of sedimentary rocks.

iv) Felsic Intrusives

This category is made up of granite, granodiorite, pegmatite, and quartz veins. The granitic rocks are feldspar rich (40%) and pink in colour, at least 30% of the feldspar content being potassium feldspar. The remainder of the rock is mainly quartz with minor mafic minerals.

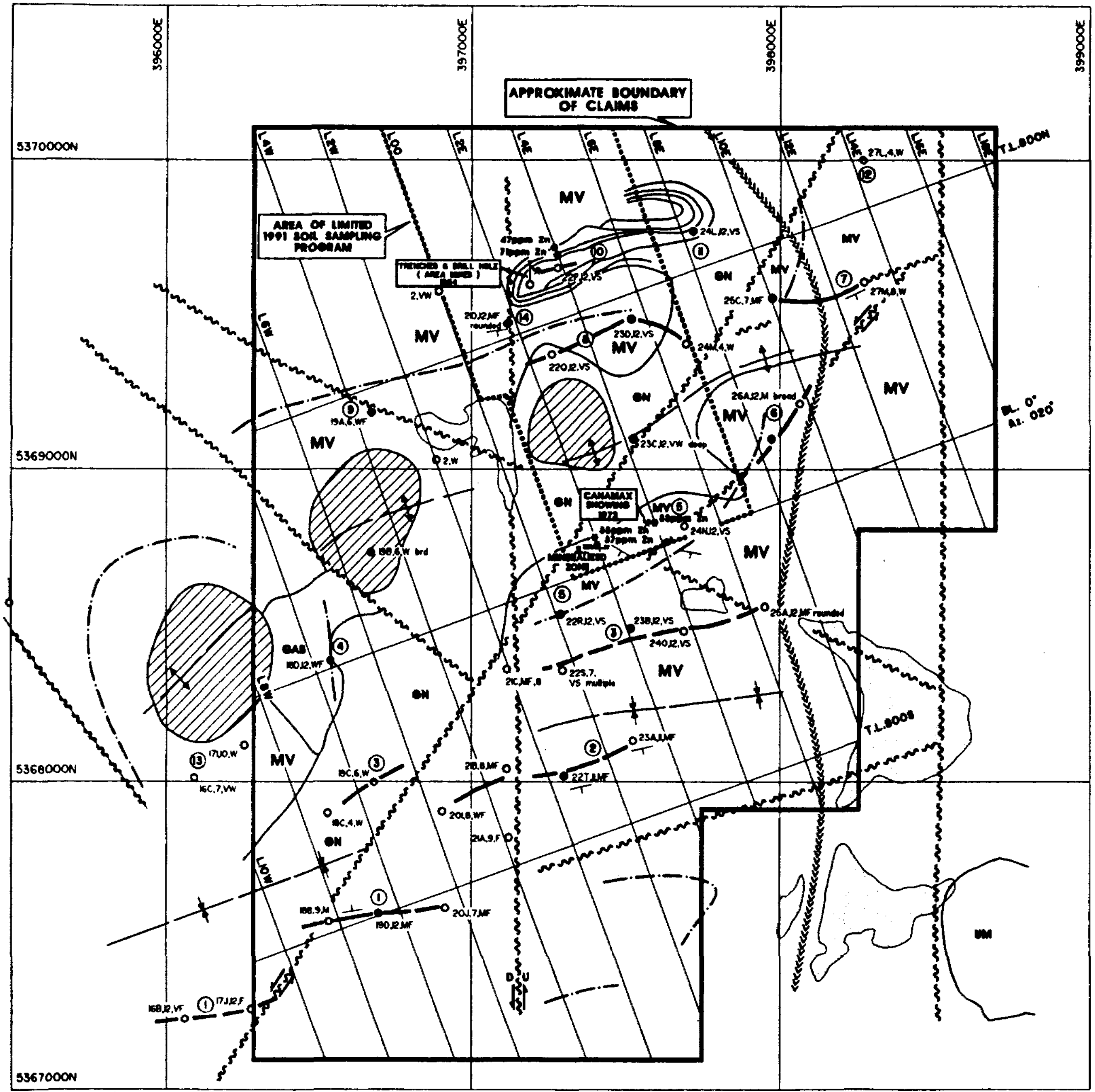
It is difficult to speculate as to what those units were prior to metamorphism; their present composition is explained by the names given to the specific units. It is this author's opinion that the hornblendite and hornblende garnet gneiss units probably represent mafic extrusive or intrusive rocks originally. Mafic remnants relatively unaltered were found to be associated with these units. From field evidence on the subject property and comments by Bennett et al (O.D.M. Miscellaneous Paper 10) it is suspected that the more feldspathic and silicious gneissic rocks are indicative of felsic flows or tuffs and/or sedimentary sequences.

Geological Discussions

A preliminary interpretation of this property's geological structure was made by Bonniwell (1991) utilizing airborne geophysical data and some assessment file data. A copy of his property compilation is shown in Fig. S5-4. For the most part, interpretation utilizing geophysical data is the only type of interpretation that can be made due to the extensive overburden cover.

This author verified this interpretation where geological data was available and refined the interpretation where geology permitted. For the most part, this author concurs with Bonniwell's work. Bonniwell states that there is a major fold axis striking NNE through the southern tip of Reference Lake. This fold axis is considered to be anticline. Field evidence and ground geological evidence in the form of similar strata on both sides of the fold limbs suggests this interpretation is true. Distinct contact bedding dips were not attainable, so it is difficult for this author to say if this fold axis is truly an anticline or not, but for discussion purposes this interpretation will be taken as valid.

This author believes that this large anticline may be small anticlinorium made up of a series of asymmetrical folds as shown from 12E to 7E from 800N to 1100N. These folds also reflect the nature of the folding on a larger property-wide scale as demonstrated in Bonniwell's interpretation. Geophysical interpretation shows a N-S striking fault through Reference Lake. This fault likely

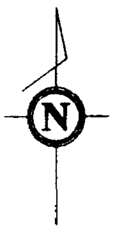


GEOLOGICAL LEGEND:

MV	Metavolcanics 1a Rhyolite / chert 1b Metadacite / tuff 1c Mafic schist
MS	Metasediments 2a Quartzites 2b Meta argillites
GN	Gneiss
GAB	Gabbro
UM	Ultramafic intrusive

ABBREVIATIONS & SYMBOLS:

	Interpreted fault
	Projected fold axes
	Iron-rich marker horizon
▨	Possible volcanic vent
	Inferred geologic contact
○ 24N,J2,VS	AEM anomaly peak with identification, channel decay and description
● 24L,J2,VS	AEM anomaly selected for follow-up
①	AEM conductor axis
★	Prospect showing
●	Soil anomaly location
Vf,m,t	Volcanics, felsic, mafic, interflow sediment
Ium	Intrusion, ultramafic
VW,W,WF	Very weak, weak, weak-fair response
M,MF	Medium, medium-fair response
F,VF,VS	Fair, very fair, very strong response



SCALE 1 : 10,000

0 200 500 1000

METRES

*NOTE Adapted From:

Orofino Resources Inc.

NOVA TWP. PROJECT

TIMMINS, ONTARIO

COMPILATION PLAN

Work by: Peter J Doyle	Date: Dec 1991		Scale: 1 : 10,000
Drawn by: Rodel E. Ortiz	Date: Dec 1991		Drawing No FIG 55-4

exists as there is a distinct change in lithology, foliation, strata orientation, and metamorphic grade from L2E to L2W. Bonniwell shows the anticlinal axis described above cutting across this fault with little or no displacement. He also suggests that on this fault the eastern block has been thrust upwards. Thus the principal movement of this fault must therefore be dip-slip with little or no strike slip movement.

Further, Bonniwell suggested that a portion of the central part of the anticline west of Reference Lake may be underlain by a volcanic vent. Geological evidence suggests this may be indeed true, albeit a distal vent. In this area there are chert horizons, dacitic ash tuffs, and sericitic altered rhyolitic volcanics. No evidence of major explosive volcanism, i.e. "mill rock" usually proximal to a major volcanic centre was observed.

The eastern portion of the property east of the accurate magnetic structure making up the anticlinal fold nose on Bonniwell's maps is likely underlain by mafic volcanics. These volcanics are likely inter-fingered with the dacitic tuffs and folded on a similar pattern relative to the rest of the property. Evidence for this interpretation was taken from government data and the examination of one such outcrop on the property, and a number of outcrops on adjoining ground.

A second volcanic vent is postulated for an area west of Reference Lake as well. Geological evidence to support this interpretation is present on L5W 275N. A dacitic tuff unit was noted here, however, no sericitic alteration was found. Fine disseminated sulphides exist throughout this unit. If the rock in this area had not been so heavily metamorphosed, more convincing evidence for this vent may have been found. For instance, the quartzite units may be of felsic volcanic origin as postulated in other base metal camps associated with high grade metamorphic rock. (Manitouwadge Ontario, Sherridon Manitoba). It is possible that these high grade metamorphic rocks which have little or no evidence of their original rock type left were stratigraphically equivalent to somewhat less metamorphosed dacitic tuffs and felsics east of the fault prior to deformation.

Lastly, Bonniwell suggested that a magnetic high in the extreme west central portion of the property may have been caused by a mafic intrusive. This interpretation was confirmed. A gabbroic intrusive is present in this area.

Other intrusive granite and granodiorite exist on this property as well. These are believed to be the youngest rocks on this property as contact relationship and the presence of rafts of gneissic rock within granitic rocks supports this.

Geochemical Survey Results

A limited geochemical survey was carried out over a portion of the NW quarter of the property between Reference Lake and the large esker along the eastern extremity of the property. Results from this survey were very poor, basically very low back round values were detected. However, it is extremely interesting to note that the weak back round values< particularly zinc, become substantially enhanced locally (3-5 times back round) over know favourable stratigraphy and mineral occurrences.

A contributing factor to the poor results of the soil geochem survey may have been the environment from which they were collected. The author suspects that much of the area covered has little overburden, but subcrop is covered by mainly sandy outwash from the esker, and hence low values.

CONCLUSION

From both geophysical evidence and geology, it is evident that a favourable volcanic environment exists on the Nova Prospect for valcanagenic massive sulphide deposits.

This author believes that there are distinct similarities in the geology relative to known distal exhalative deposits in higher grade metamorphic terrain such as those found in Sherridon Manitoba and Manitouwadge, Ontario. Such similarities include cherty sulphide facies iron formation with associated gneissic and sericitic rhyolites such as those found at Geco in Manitouwadge. There are also hornblende garnet gneissic rocks in contact with quartzite units. Usually these contacts are associated with a number of pyrite and pyrrhotite occurrences. This environment is similar to that found in Sherridon, Manitoba at the formerly producing Sherritt Gordon Mine. The reader may review the papers enclosed in the appendix of this report and draw comparisons for himself.

Further, the prospect also contains documented occurrences of copper and zinc, and a series of new and unexplored conductors which may be indicative of a Cu-Zn volcanogenic massive sulphide deposits.

RECOMMENDATIONS

The following recommendations should be considered for this prospect:

1) Carry out a HLEM survey and magnetic survey over the property to define airborne conductors and help with any further geological interpretation.

2) Carry out diamond drilling in esker or swamp covered areas where priority conductors exist and no other work can be done to further enhance or write off these conductors. It would be advisable to carry out drilling on the conductors south of the baseline during winter as this area is covered in spruce bog and it is fairly wet.

3) A stripping, trenching, and sampling program should be considered for the area around L5E 1050N. Also, trenching and sampling should be considered for the around L5W 275N as well to test mineralized areas associated with the quartzite units southwest of Reference Lake. Other trenching and sampling priorities could be assigned when full assay results are in for this project.

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APPENDIX 1

✓ J.K.F.

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Page 1 of 2

Geochemical Analysis Certificate

1W-4230-SG1

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Project: NOVA
Attn: P.T.DOYLE/T.N.MCKILLEN/J.K.FILO

Date: OCT-23-91
Copy 1. BOX 143,1 FIRST CAN.PLACE,TOR M5X 1C7
2. 535 BARTLEMAN,TIMMINS,ONT. P4N 4X2
3. FAX TO 416-367-3250

We hereby certify the following Geochemical Analysis of 49 SOIL samples submitted OCT-21-91 by J.K. FILO.

Sample Number	Cu ppm	Zn ppm
L7E BL 0	2	8
L7E 25N	2	25
L7E 50N	1	12
L7E 75N	2	11
L7E 100N	1	3
L7E 125N	1	6
L7E 150N	3	9
L7E 175N	3	10
L7E 200N	3	10
L7E 225N	3	11
L7E 250N	3	11
L7E 275N	4	9
L7E 300N	2	8
L7E 325N	2	7
L7E 350N	2	9
L7E 375N	3	9
L7E 500N	1	7
L7E 525N	3	11
L7E 550N	2	10
L7E 575N	1	5
L7E 600N	3	13
L7E 625N	3	21
L7E 725N	3	25
L7E 750N	1	6
L7E 1025N	2	9
L7E 1050N	2	11
L7E 1075N	3	13
L7E 1100N	3	16
L7E 1125N	2	10
L7E 1150N	2	10

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Sample Number	Cu ppm	Zn ppm
L7E 1175N	2	13
L7E 1200N	1	9
L7E 1225N	2	12
TL8N 25E	2	7
TL8N 50E	1	6
TL8N 75E	1	3
TL8N 125E	1	8
TL8N 225E	4	12
TL8N 250E	2	9
TL8N 275E	1	5
TL8N 325E	2	11
TL8N 350E	1	6
TL8N 375E	2	13
TL8N 425E	1	8
TL8N 450E	2	14
TL8N 475E	1	10
TL8N 525E	1	4
TL8N 550E	2	10
TL8N 575E	2	9

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We hereby certify the following Geochemical Analysis of 48 SOIL samples submitted OCT-21-91 by J.K. FILO.

Sample Number	Cu ppm	Zn ppm
LINE 3E BL0	1	1
LINE 3E 25N	1	1
LINE 3E 50N	1	1
LINE 3E 75N	2	11
LINE 3E 100N	3	18
LINE 3E 125N	1	1
LINE 3E 150N	1	1
LINE 3E 175N	1	1
LINE 3E 200N	3	7
LINE 3E 225N	7	21
LINE 3E 250N	1	1
LINE 3E 275N	3	7
LINE 3E 300N	2	13
LINE 3E 325N	1	1
LINE 3E 350N	4	15
LINE 3E 375N	1	1
LINE 3E 400N	6	17
LINE 3E 425N	2	8
LINE 3E 450N	2	7
LINE 3E 475N	3	16
LINE 3E 625N	1	1
LINE 3E 650N	1	1
LINE 3E 675N	1	4
LINE 3E 700N	1	1
LINE 3E 725N	1	2
LINE 3E 750N	3	8
LINE 3E 775N	2	7
LINE 3E 800N	4	10
LINE 3E 825N	1	3
LINE 3E 850N	3	8

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Sample Number	Cu ppm	Zn ppm
LINE 3E 875N	2	10
LINE 3E 900N	6	10
LINE 3E 925N	5	9
LINE 3E 950N	5	6
LINE 3E 975N	3	7
LINE 3E 1000N	2	10
LINE 3E 1025N	1	4
LINE 3E 1050N	4	8
LINE 3E 1075N	3	7
LINE 3E 1100N	1	1
LINE 3E 1150N	1	1
LINE 3E 1175N	2	6
LINE 3E 1200N	1	2
LINE 3E 1250N	3	11
LINE 3E 1275N	4	7
LINE 3E 1300N	1	1
LINE 3E 1325N	2	4
LINE 3E 1350N	3	7

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Sample Number	Cu ppm	Zn ppm
LINE 0 1450N	5	13
LINE 0 1425N	1	4
LINE 0 1400N	2	7
LINE 0 1375N	3	11
LINE 0 1350N	3	12
LINE 0 1325N	3	15
LINE 0 1175N	21	20
LINE 0 1150N	7	15
LINE 0 1125N	3	9
LINE 0 1100N	2	8
LINE 0 1075N	2	9
LINE 0 1050N	2	8
LINE 0 950N	4	18
LINE 0 925N	6	22
LINE 0 900N	2	10
LINE 0 850N	5	17
LINE 0 825N	3	8
TL8N 0+00	1	4
LINE 0 775N	1	5
LINE 0 750N	4	11
LINE 0 725N	2	7
LINE 0 700N	2	4
LINE 1E 1375N	5	20
LINE 1E 1350N	6	16
LINE 1E 1325N	3	9
LINE 1E 1300N	1	5
LINE 1E 1175N	2	8
LINE 1E 1150N	5	12
LINE 1E 1125N	2	9
LINE 1E 1100N	2	8

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Sample Number	Cu ppm	Zn ppm
LINE 1E 1075N	2	10
LINE 1E 1050N	3	11
LINE 1E 1025N	1	7
LINE 1E 1000N	3	9
LINE 1E 975N	3	12
LINE 1E 925N	2	7
LINE 1E 900N	4	11
LINE 1E 875N	2	7
LINE 1E 850N	8	14
LINE 1E 825N	2	8
LINE 1E 800N	2	9
LINE 1E 775N	2	6
LINE 1E 750N	1	4
LINE 1E 725N	2	10
LINE 1E 700N	3	13
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LINE 1E 550N	5	16
LINE 1E 525N	6	15
LINE 1E 500N	4	9
LINE 1E 450N	3	13
LINE 1E 400N	4	11
LINE 1E 375N	5	16
LINE 1E 350N	2	10
LINE 1E 325N	1	8
LINE 1E 200N	1	8
LINE 1E 175N	1	8

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Sample Number	Cu ppm	Zn ppm
LINE 1E 150N	1	6
LINE 1E 125N	1	4
LINE 1E 100N	4	21
LINE 1E 75N	2	13
LINE 1E 50N	1	6
LINE 1E 25N	1	10
BLO100E	1	6
LINE 2E BLO	1	8
LINE 2E 25N	1	4
LINE 2E 50N	2	13
LINE 2E 75N	13	35
LINE 2E 100N	5	37
LINE 2E 125N	2	13
LINE 2E 150N	1	5
LINE 2E 175N	1	5
LINE 2E 200N	2	8
LINE 2E 225N	1	7
LINE 2E 250N	2	7
LINE 2E 275N	1	4
LINE 2E 300N	1	4
LINE 2E 325N	3	10
LINE 2E 350N	5	19
LINE 2E 375N	3	15
LINE 2E 400N	5	16
LINE 2E 425N	4	21
LINE 2E 450N	3	13
LINE 2E 475N	2	7
LINE 2E 500N	2	8
LINE 2E 525N	3	11
LINE 2E 550N	4	13

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Geochemical Analysis Certificate

1W-4231-SG1

Company: *OROFINO RESOURCES LTD.*
Project: *NOVA*
Attn: *P.J.DOYLE/K.N.MCKILLEN/J.K.FILO*

Date: OCT-25-91
Copy *1. BOX 143,1 FIRST CAN.PLACE,TOR M*
2. 535 BARTLEMAN,TIMMINS, ONT. P4N
3. FAX TO 416-367-3250

We hereby certify the following Geochemical Analysis of 118 SOIL samples submitted OCT-21-91 by J.K. FILO.

Sample Number	Cu ppm	Zn ppm
LINE 2E 575N	1	4
LINE 2E 600N	4	12
LINE 2E 625N	1	3
LINE 2E 650N	1	4
LINE 2E 675N	1	4
LINE 2E 700N	12	15
LINE 2E 725N	2	9
LINE 2E 750N	3	11
LINE 2E 775N	2	11
LINE 2E 800N	2	10
LINE 2E 825N	2	8
LINE 2E 850N	4	11
LINE 2E 875N	1	7
LINE 2E 900N	2	11
LINE 2E 950N	2	7
LINE 2E 975N	3	11
LINE 2E 1000N	2	10
LINE 2E 1025N	3	10
LINE 2E 1050N	1	5
LINE 2E 1075N	1	5
LINE 2E 1100N	2	8
LINE 2E 1125N	1	5
LINE 2E 1150N	1	5
LINE 2E 1175N	1	4
LINE 2E 1200N	2	9
LINE 2E 1350N	4	13
LINE 2E 1375N	1	7
LINE 2E 1400N	2	10

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We hereby certify the following Geochemical Analysis of 53 SOIL samples submitted OCT-21-91 by J.K. FILO.

Sample Number	Cu ppm	Zn ppm
BL0400E	2	6
LINE 4E 25N	5	29
LINE 4E 50N	1	5
LINE 4E 75N	16	83
LINE 4E 100N	2	14
LINE 4E 125N	2	11
LINE 4E 150N	3	18
LINE 4E 175N	2	7
LINE 4E 200N	4	16
LINE 4E 225N	2	8
LINE 4E 250N	2	10
LINE 4E 275N	5	12
LINE 4E 300N	3	11
LINE 4E 325N	1	6
LINE 4E 350N	3	12
LINE 4E 375N	1	5
LINE 4E 400N	3	10
LINE 4E 425N	3	13
LINE 4E 450N	2	7
LINE 4E 475N	7	18
LINE 4E 500N	14	29
LINE 4E 525N	9	20
LINE 4E 550N	2	9
LINE 4E 575N	3	10
LINE 4E 600N	6	17
LINE 4E 625N	2	8
LINE 4E 650N	1	7
LINE 4E 675N	3	11
LINE 4E 700N	1	6
LINE 4E 750N	3	11

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Date: OCT-25-91
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We hereby certify the following Geochemical Analysis of 53 SOIL samples submitted OCT-21-91 by J.K. FILO.

Sample Number	Cu ppm	Zn ppm
LINE 4E 775N	1	6
LINE 4E 800N	1	5
LINE 4E 825N	1	5
LINE 4E 850N	2	12
LINE 4E 875N	2	12
LINE 4E 900N	4	20
LINE 4E 925N	1	5
LINE 4E 950N	2	11
LINE 4E 975N	1	8
LINE 4E 1000N	11	71
LINE 4E 1025N	7	47
LINE 4E 1050N	3	15
LINE 4E 1075N	2	7
LINE 4E 1100N	3	13
LINE 4E 1125N	1	6
LINE 4E 1150N	6	14
LINE 4E 1200N	1	10
LINE 4E 1250N	1	5
LINE 4E 1275N	1	4
LINE 4E 1300N	3	10
LINE 4E 1325N	1	6
LINE 4E 1350N	2	11
LINE 4E 1375N	2	8

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We hereby certify the following Geochemical Analysis of 84 SOIL samples submitted OCT-21-91 by J.K. FILO.

Sample Number	Cu ppm	Zn ppm
LINE 5E 50N	3	19
LINE 5E 75N	1	5
LINE 5E 100N	1	4
LINE 5E 125N	1	3
LINE 5E 150N	1	6
LINE 5E 175N	1	5
LINE 5E 200N	2	8
LINE 5E 225N	2	11
LINE 5E 250N	3	22
LINE 5E 275N	1	4
LINE 5E 300N	3	13
LINE 5E 325N	3	12
LINE 5E 350N	1	5
LINE 5E 375N	1	6
LINE 5E 400N	1	5
LINE 5E 425N	4	13
LINE 5E 450N	2	8
LINE 5E 475N	1	4
LINE 5E 500N	2	8
LINE 5E 525N	1	4
LINE 5E 650N	2	11
LINE 5E 675N	1	8
LINE 5E 700N	3	13
LINE 5E 725N	1	3
LINE 5E 750N	2	12
LINE 5E 775N	1	5
LINE 5E 800N	1	8
LINE 5E 825N	3	11
LINE 5E 850N	3	11
LINE 5E 875N	3	10

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3. *FAX TO 416-367-3250*

We hereby certify the following Geochemical Analysis of 84 SOIL samples submitted OCT-21-91 by J.K. FILO.

Sample Number	Cu ppm	Zn ppm
LINE 5E 900N	3	13
LINE 5E 925N	2	13
LINE 5E 950N	3	20
LINE 5E 975N	6	10
LINE 5E 1000N	3	17
LINE 5E 1025N	3	16
LINE 5E 1050N	2	15
LINE 5E 1075N	2	12
LINE 5E 1100N	1	9
LINE 5E 1125N	1	15
LINE 5E 1150N	1	5
LINE 5E 1175N	1	7
LINE 5E 1200N	1	5
LINE 5E 1225N	3	9
LINE 6E BLO	1	3
LINE 6E 25N	1	2
LINE 6E 50N	2	9
LINE 6E 75N	1	4
LINE 6E 100N	1	7
LINE 6E 125N	2	9
LINE 6E 400N	3	10
LINE 6E 425N	2	9
LINE 6E 450N	1	5
LINE 6E 475N	1	7
LINE 6E 500N	2	11
LINE 6E 525N	1	4
LINE 6E 550N	3	10
LINE 6E 575N	2	5
LINE 6E 600N	1	6
LINE 6E 625N	2	11

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2. *535 BARTLEMAN,TIMMINS, ONT. P4N*
3. *FAX TO 416-367-3250*

We hereby certify the following Geochemical Analysis of 84 SOIL samples submitted OCT-21-91 by J.K. FILO.

Sample Number	Cu ppm	Zn ppm
LINE 6E 700N	2	16
LINE 6E 725N	1	10
LINE 6E 750N	2	13
LINE 6E 775N	1	3
LINE 6E 800N	3	16
LINE 6E 825N	3	12
LINE 6E 850N	1	8
LINE 6E 875N	1	3
LINE 6E 900N	3	15
LINE 6E 925N	3	21
LINE 6E 950N	2	20
LINE 6E 975N	1	10
LINE 6E 1000N	1	7
LINE 6E 1025N	2	7
LINE 6E 1050N	2	9
LINE 6E 1075N	2	12
LINE 6E 1100N	3	12
LINE 6E 1125N	1	5
LINE 6E 1150N	1	12
LINE 6E 1175N	1	8
LINE 6E 1200N	1	5
LINE 6E 1225N	2	13
LINE 6E 1250N	1	10
LINE 6E 1275N	3	9

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Precambrian Sulphide Deposits

H.S. Robinson Memorial Volume

Edited by
R.W. Hutchinson, C.D. Spence
and J.M. Franklin

The Geological Association of Canada
Special Paper 25
1982

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R.W. Hutchinson, C.D. Spence and J.M. Franklin, Geological Association of Canada
Special Paper 25, 1982

THE SHERRITT GORDON MASSIVE SULPHIDE DEPOSIT

P.A. Goetz
Teck Corporation, 425-1st Street S.W. Calgary, Alberta T2B 3L8

E. Froese
Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8

ABSTRACT

The Sherritt Gordon deposit at Sherridon, Manitoba consists of stratiform orebodies, about 5 m thick, interlayered with quartz-rich gneisses of the Sherridon Group. The ore is composed of pyrite, pyrrhotite, chalcopyrite, and sphalerite. The coarse grain size, the abundance of pyrrhotite, and the presence of gahnite indicate that the orebodies, together with the enclosing rocks, have been metamorphosed. The massive ore is separated from the host rock by a narrow zone of disseminated sulphides. Although there is no alteration zone below the deposit, cordierite-anthophyllite rocks along the same stratigraphic horizon probably represent metamorphosed detritus of hydrothermally altered rocks clastically transported to the present site of deposition prior to metamorphism. The sulphides may have been either similarly sedimented from a suspension or, alternatively, chemically precipitated from a brine. Although the Sherridon Group has been correlated with the alluvial Missi Group of the Flin Flon-Snow Lake belt, calc-silicate gneisses in the Sherridon Group suggest a marine environment. Also, in contrast to most successions in the Missi and Sherridon Groups, the Sherridon Group in the vicinity of Sherridon includes volcanic rocks. This suggests that volcanic activity in a marine environment may have been essential for the formation of the Sherritt Gordon deposit.

RÉSUMÉ

Le dépôt de Sherritt Gordon, Manitoba, consiste en amas sulfurés stratiformes d'environ 5m d'épaisseur, interstratifiés dans les gneiss très quartzeux du groupe de Sherridon. Le minerai se compose de pyrite, pyrrhotite, chalcopyrite et sphalérite. Le grain grossier, l'abondance de pyrrhotite et la présence de gahnite sont preuves que ces gisements ont été métamorphisés en même temps que les roches encaissantes.

Le minerai massif est séparé de la roche encaissante par une mince zone à sulfures

disséminés. Bien qu'il n'y ait pas de zone d'altération visible sous le dépôt, on trouve le long du même niveau stratigraphique des roches à cordiérite-anthophyllite qui représentent probablement des détritus de roches altérées hydrothermalement et transportées à leur place actuelle avant le métamorphisme. Les sulfures ont été soit sédimentés à partir d'une suspension, soit précipités chimiquement à partir d'une solution saline. Bien que le groupe de Sherridon ait été correlé avec le groupe alluvial de Missi dans le ceinture de Flin Flon-Snow Lake, les silicates calciques du groupe de Sherridon suggèrent un environement marin. De même, à l'inverse de la pluspart des successions rencontrées dans les groupes de Missi et de Sherridon, la succession au voisinage de Sherridon même comprend des roches volcaniques. Ceci suggère qu'une activité volcanique en milieu marin a joué le rôle essentiel dans la formation du dépôt de Sherritt Gordon.

INTRODUCTION

The Kisseynew gneisses grade through a metamorphic transition into lower grade metamorphic rocks of the Flin Flon-Snow Lake belt (Fig. 1) commonly considered to be of Aphebian age (Sangster, 1978). In the Flin Flon-Snow Lake belt, volcanic rocks and interlayered greywacke and shale of the Amisk Group are overlain by lithic arenites of the Missi Group. Robertson (1953) subdivided the Kisseynew gneisses into the Nokomis Group and the Sherridon Group and Bailes (1971, 1980) suggested a correlation with the sedimentary part of the Amisk Group and with the Missi Group, respectively. In the vicinity of Sherridon, the Sherridon Group consists of both metasedimentary and metavolcanic rocks exposed in a crescent-shaped structural basin surrounded by quartzofeldspathic gneisses, migmatites, and granitoid gneisses of the Nokomis Group. In this particular locality, rocks of the Nokomis Group do not resemble metamorphosed Amisk sedimentary rocks, indicating that the Nokomis Group may include rocks which have no equivalents in the Amisk Group. In contrast to most successions in the Missi Group, the Sherridon Group contains calc-silicate gneisses. Only in an area east of Wekusko Lake, does the Missi Group include calc-silicate gneisses (Bailes, 1976; Bailes, pers. commun., 1981). Volcanic rocks, which are atypical of the Sherridon Group, are present in the Sherridon area. In the Missi Group volcanic rocks have been reported only in the area east of Wekusko Lake (Frarey, 1950; Shanks and Bailes, 1977).

The Sherridon basin, straddling two one-mile map sheets (Bateman and Harrison, 1946; Robertson, 1953), has recently been mapped by Froese and Goetz (1981). The disposition of lithologic units (Fig. 2) suggests a continuous, single-facing succession from the margin towards the centre of the structural basin. This interpretation, in contrast to Tuckwell's (1979) suggestion of possible facing reversals, implies that early isoclinal folding did not produce major repetitions of strata. The origin of various rock types within the Sherridon Group has been considered by Goetz (1980); in the absence of primary features, deductions were based on compositions and rock associations. The main rock type of the Sherridon Group is a quartz-rich gneiss, derived from a lithic arenite. Several discontinuous layers of amphibolites, derived from volcaniclastic rocks and tholeiitic lavas, form part of the Sherridon Group. Copper-zinc deposits occur along two horizons within the quartz-rich gneiss. The stratigraphically lower horizon includes the Sherritt Gordon orebodies and the Park Lake and Jungle Lake deposits; the second horizon includes the Bob Lake and Fidelity deposits and a surface prospect near Lost Lake (Fig. 2). Cordierite-

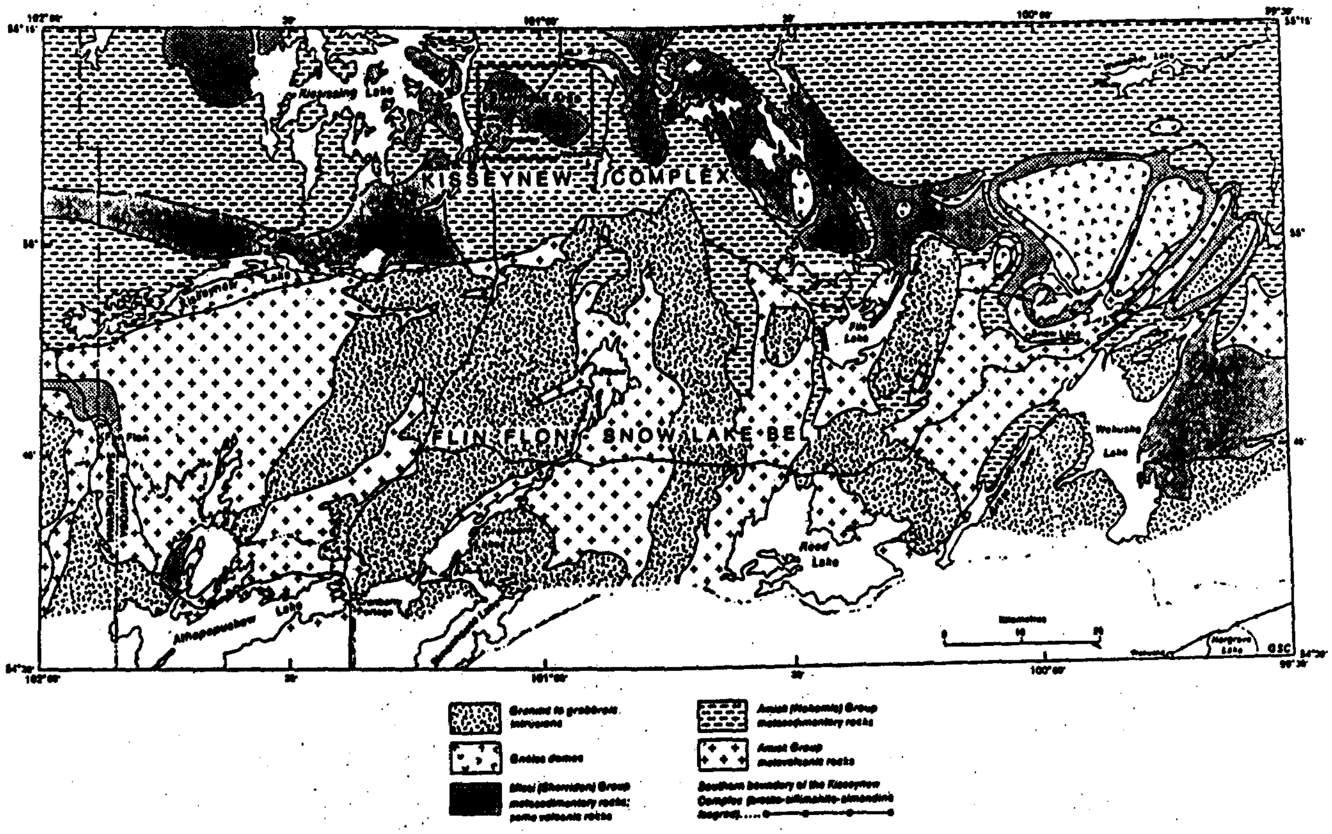


Figure 1. Location and geological setting of the Sherridon area (from Froese and Goetz, 1981).

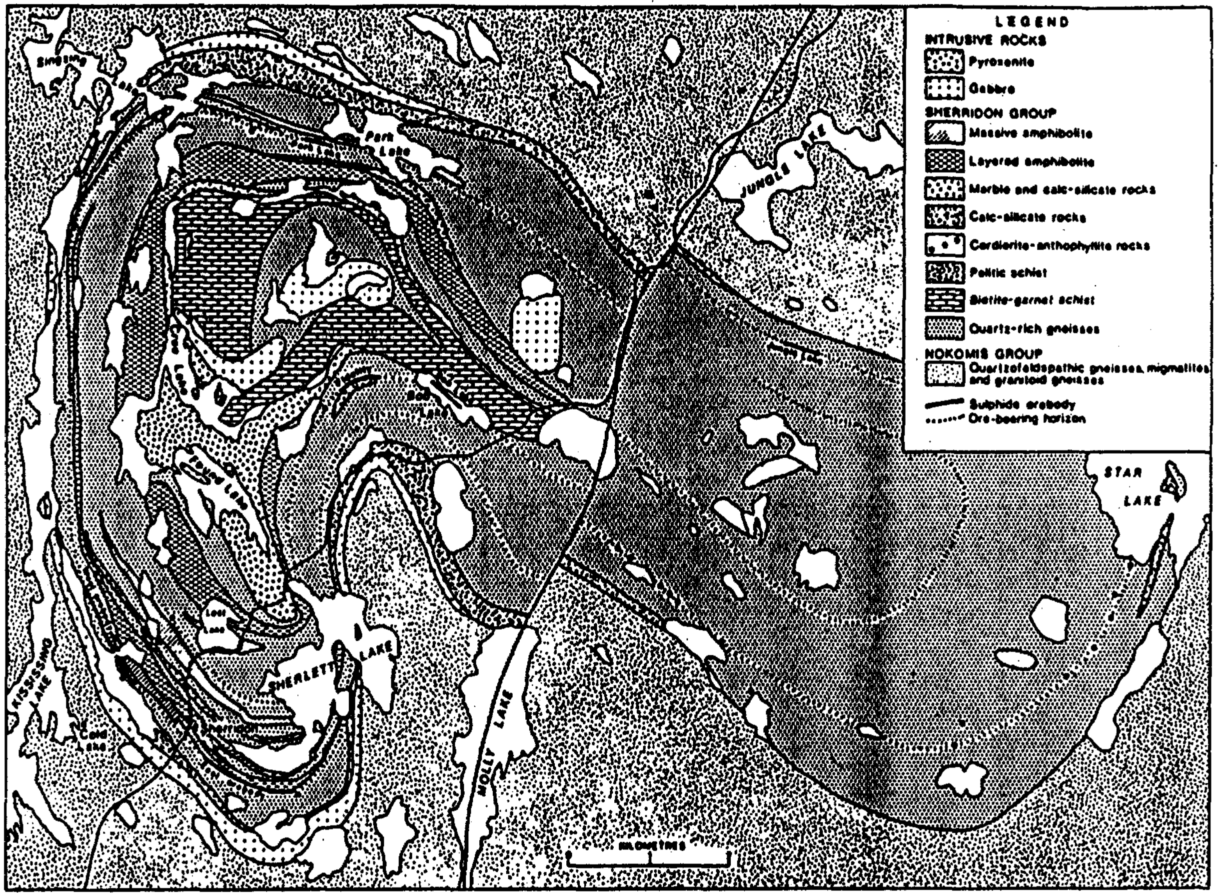


Figure 2. Geological sketch map of the Sherridon area (from Froese and Goetz, 1981).

anthophyllite rocks are present along the mineralized horizons in several places and a thin layer of pelitic schist, locally with disseminated sulphides, connects the Sherritt Gordon west orebody with the Park Lake deposit. Calc-silicate rocks and marble constitute an appreciable portion of the Sherridon Group. Thin layers of a siliceous rock, probably metamorphosed chert, with disseminated pyrrhotite, are present within the calc-silicate rocks. These rocks typically contain only trace amounts of copper and zinc.

Small isoclinal folds represent the earliest recognized deformation. The rocks display one prominent foliation parallel to lithologic contacts, probably produced by this deformation. The structural basin itself presumably was the result of an interference of two fold systems which deformed the foliation and gave rise to a less prominently developed lineation of greatly varying orientation. The grade of metamorphism is uniform, corresponding to that of the upper amphibolite facies. The sulphide ores have also been subjected to metamorphism as indicated by coarse grain size, abundant pyrrhotite, and the presence of gahnite (Sangster and Scott, 1976).

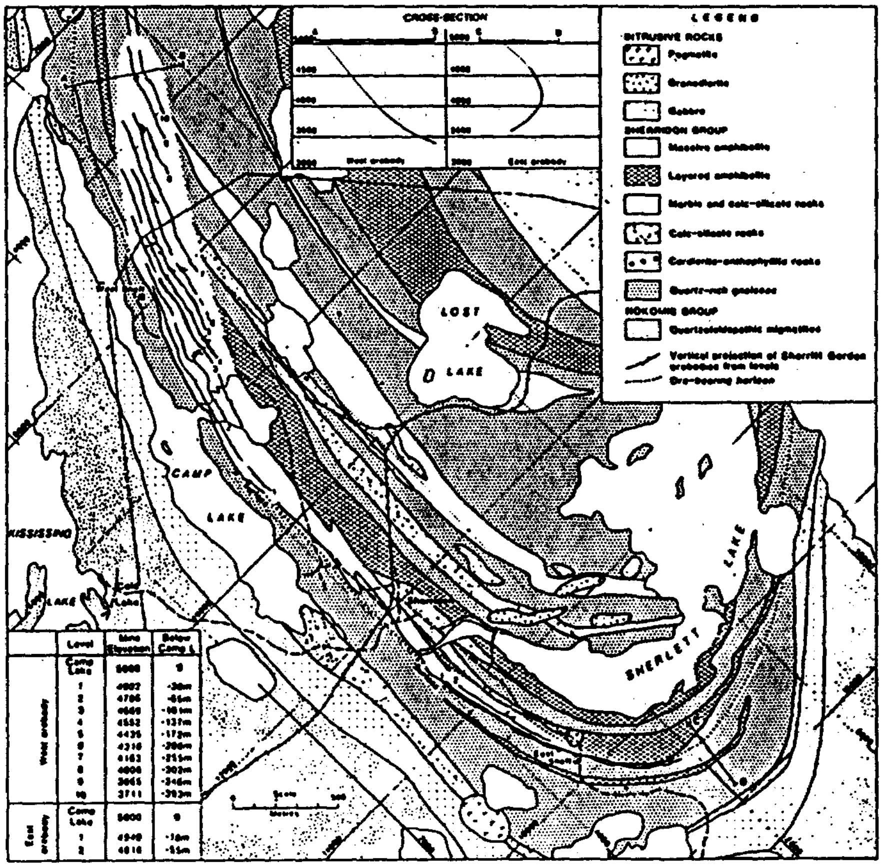
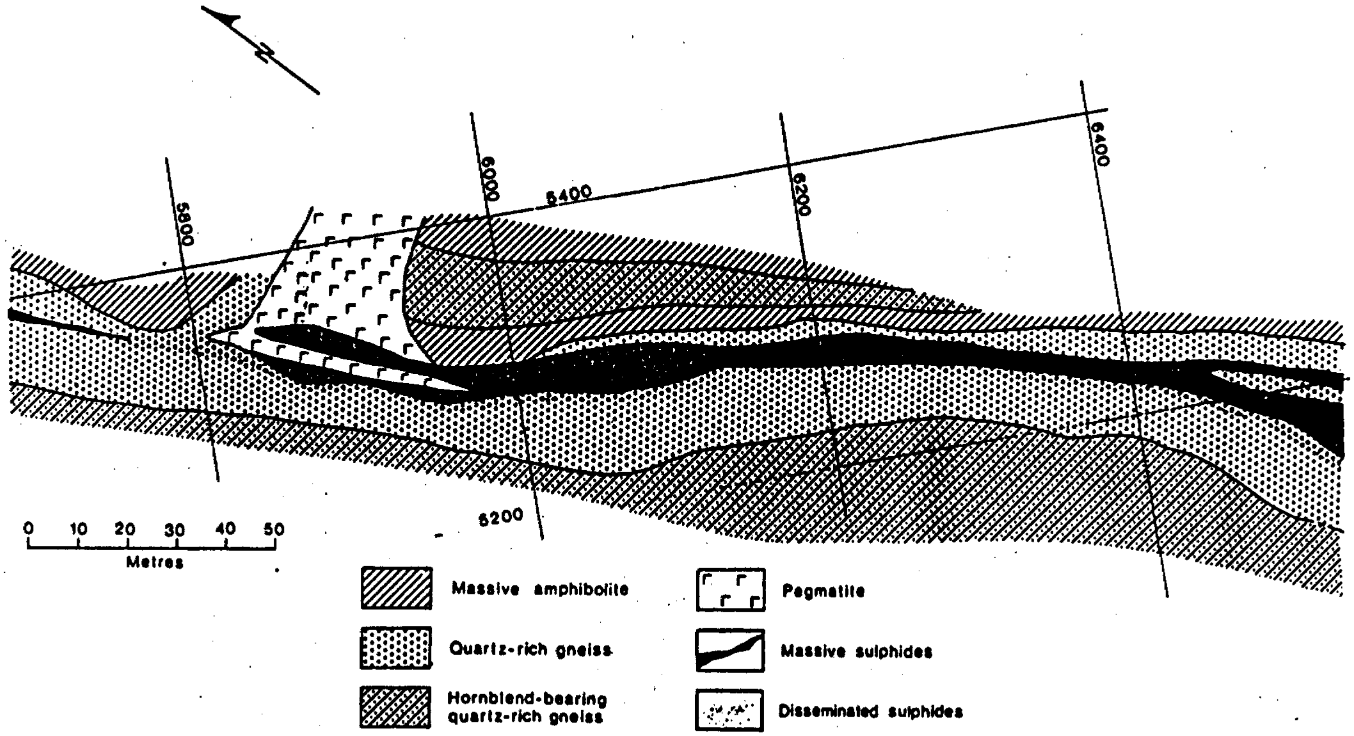


Figure 3. Surface geology of the Sherritt Gordon deposit. Level plans compiled from unpublished maps of Sherritt Gordon Mines Limited (from Froese and Goetz, 1981).


N
5800
6000
6200
6400
5400
5200
0 10 20 30 40 50
Metres
Massive amphibolite
Quartz-rich gneiss
Hornblend-bearing quartz-rich gneiss
Pegmatite
Massive sulphides
Disseminated sulphides

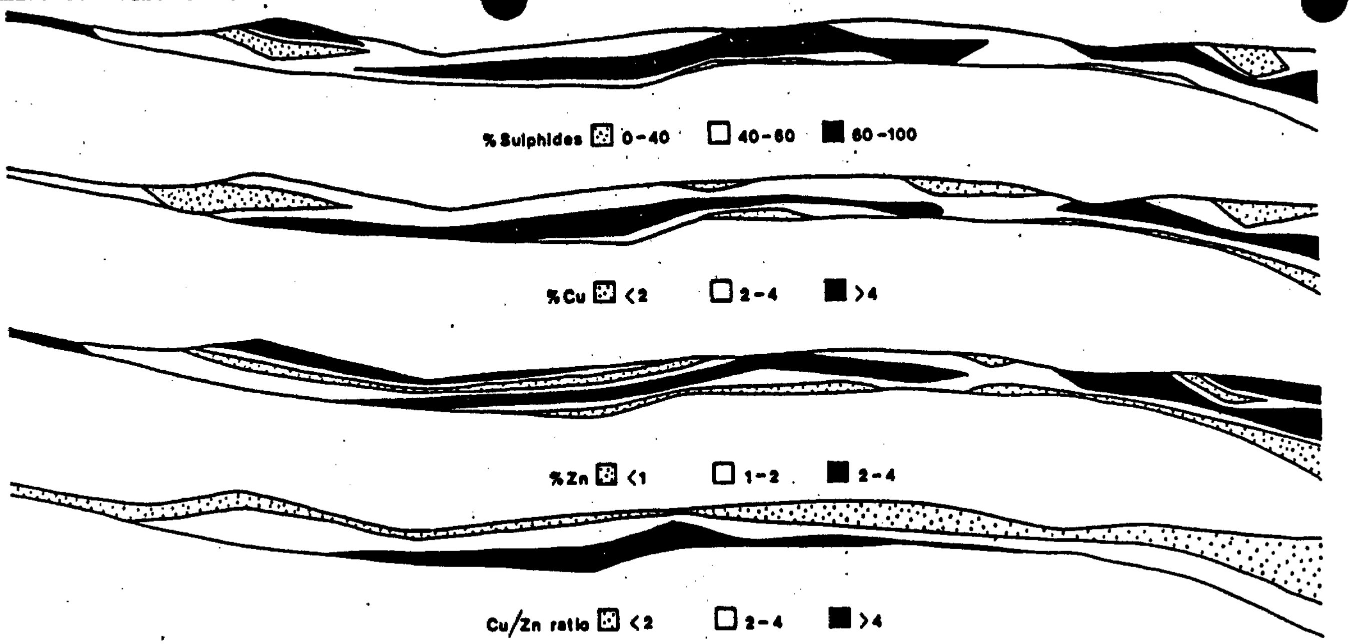


Figure 4. Geology and zoning of a portion of the 3. level of the west orebody of the Sherritt Gordon deposit. Compiled from unpublished information of Sherritt Gordon Mines Limited (from Froese and Goetz, 1981).

SHERRITT GORDON OREBODIES

The surface geology in the vicinity of the Sherritt Gordon mine is shown in Figure 3. The orebodies, about 5 m thick, occur as two lenticular layers of massive and disseminated sulphides and as irregular remobilized masses (offshoot orebodies). A total of 7 739 506 tonnes were mined from 1931 to 1951 (Davies *et al.*, 1962). Farley (1949) gave an "overall average grade" of 2.45% copper, 2.97% zinc, 0.62 g/tonne Au, and 19.9 g/tonne Ag, but it is not clear whether this refers to the Sherritt Gordon deposit as a whole or to the east orebody only. Early ore reserve calculations gave the following grades (Sherritt Gordon Mines Limited, 1930):

	tonnes	Cu%	Zn%	Au g/tonne	Ag g/tonne
East orebody	785 780	2.14	5.78	0.65	26.1
West orebody	2 968 215	2.91	2.76	0.62	32.2
West orebody (low grade area)	1 012 871	1.40	0.80	0.41	42.0
Total tonnes and grade	4 766 866	2.46	2.84	0.58	33.3

During the exploration stage, the deposit was described by Wright (1929, 1931), Bruce (1929, 1933), and by the staff of Sherritt Gordon Mines Limited (1930). A brief note (Derry, 1942) was followed by a more detailed account (Farley, 1948, 1949). The surface geology has been mapped by Bateman (1944) and Goetz (1980). The ore is contained entirely in quartz-rich gneiss. Even where it occurs close to an amphibolite layer on the northeast side of the deposit, the ore is separated from the amphibolite by a narrow layer, one to 3 m thick, of quartz-rich gneiss. From the dip reversal of the east orebody, Bruce (1933) deduced an easterly plunge, whereas the west orebody has a northerly plunge (Farley, 1949). The shape of the orebody is shown by vertical projections of mine workings (Fig. 3).

MINERALOGY AND ZONING

The mineralogy of the ore is simple. The dominant opaque minerals are pyrite, pyrrhotite, chalcopyrite, and sphalerite. Sphalerite coexisting with pyrite and pyrrhotite has a composition of 13±1 mole per cent FeS (Goetz, 1980). Magnetite is rare. A few exsolution blades of cubanite are present in chalcopyrite. The gangue minerals are those of the host rock composed of quartz-rich gneiss with small interlayers of calc-silicate gneiss: quartz, plagioclase, biotite, almandine, hornblende, clinopyroxene. Gahnite is present in a few specimens. There is one occurrence of sapphirine in a cordierite-anthophyllite rock (Froese and Goetz, 1981). This association has also been noted in another metamorphosed sulphide deposit (Raymond *et al.*, 1980).

The distribution of minerals and zoning on a part of the third level of the west orebody is shown in Figure 4. The Zn/Cu ratio increases towards the east, i.e., into the centre of the Sherridon structural basin. Accepting an upward increase of the Zn/Cu ratio in massive sulphide deposits (Sangster and Scott, 1976), this feature is the best indicator of stratigraphic facing in the Sherridon area. Farley (1949) mentioned a relatively sharp hanging wall contact and a gradational footwall contact characterized by disseminated sulphides, but most level plans (e.g., Fig. 4) show disseminated sulphides on both sides of the orebody. There is no zone of stringer ore below the orebody. Cordierite-anthophyllite rocks are present along the mineralized stratigraphic horizon but do not form an alteration zone underlying the orebody. Ore reserve estimates indicate pronounced lateral zoning in the east orebody and weak lateral zoning in the west orebody (Fig. 5).

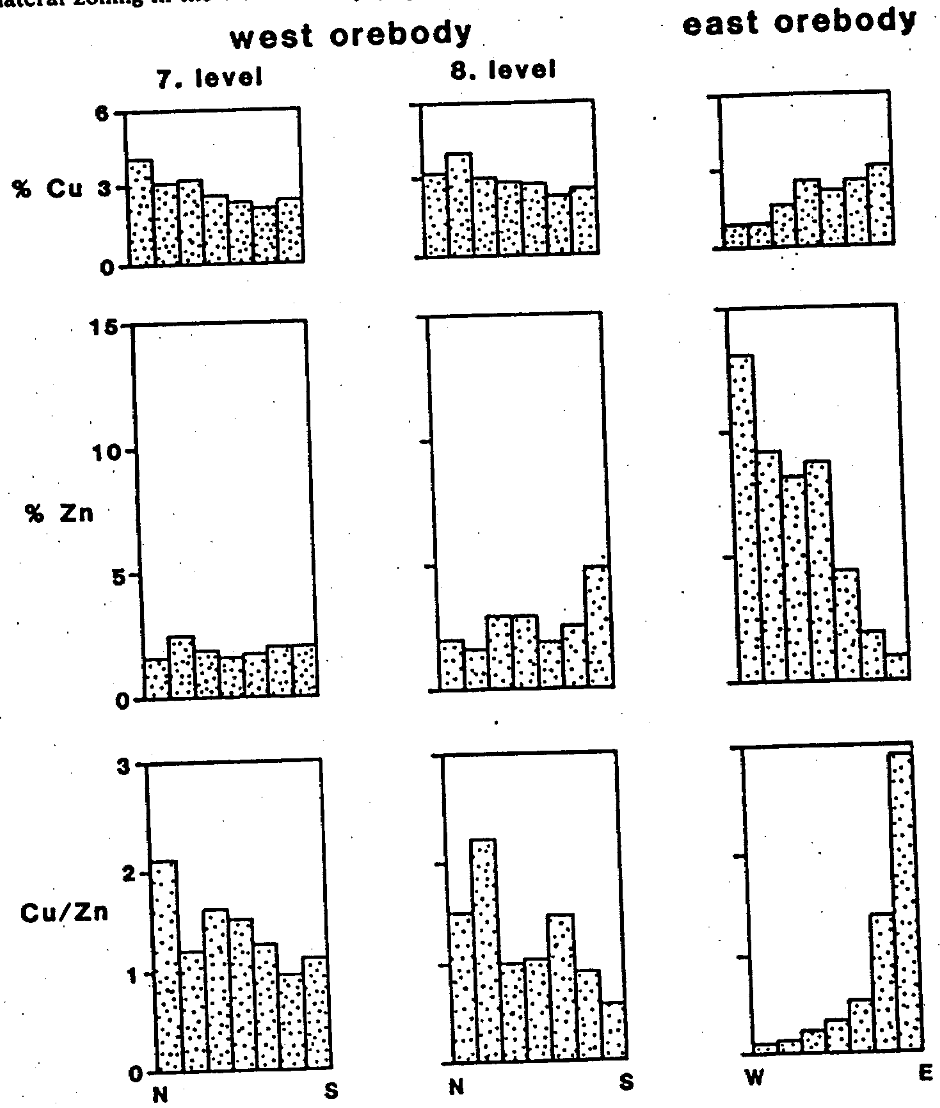


Figure 5. Lateral zoning of the Sherritt Gordon deposit. Compiled from unpublished ore reserve estimates of Sherritt Gordon Mines Limited (from Froese and Goetz, 1981).

ENVIRONMENT OF DEPOSITION

The Sherridon Group, which hosts the Sherritt Gordon deposit has been correlated with the Missi Group in the Flin Flon-Snow Lake belt (Bailes, 1971). At Flin Flon, the Missi sandstone is composed largely of quartz grains and volcanic rock fragments (Mukherjee, 1974; Stauffer, 1974) and may be termed lithic arenite. Froese and Goetz (1981) consequently regarded the quartz-rich gneiss of the Sherridon Group as metamorphosed lithic arenite. This interpretation is consistent with the present composition. Pollock (1964) also suggested that similar rocks in the Duval Lake area, west of Sherridon, were derived from subgreywacke (i.e., lithic arenite). Despite its correlation with the Missi Group, the Sherridon Group displays distinct differences. For example, cross-bedding is common in the Missi Group and fluviatile conglomerates are present in many places, features which suggest an alluvial fan deposit (Mukherjee, 1974). By comparison, the metamorphosed lithic arenite units near the base of Sherridon Group are thin-bedded and contain calc-silicate layers ranging in size from small partings to mappable units. Thus the Sherridon Group probably is a marine deposit and may represent the subaqueous portion of an alluvial fan that spread by eroding the volcanic terrain of the Flin Flon-Snow Lake belt. In the vicinity of Sherridon, the Sherridon Group includes volcanic rocks. In other areas, volcanic rocks are not present in the Sherridon Group. With the exception of an area east of Wekusko Lake (Frarey, 1948; Shanks and Bailes, 1977), this is also true of the Missi Group. Here the Missi Group also includes calc-silicate gneisses (Bailes, 1976; Bailes, pers. commun., 1981).

The high content of Cu and Zn in the Sherritt Gordon deposit and the presence of some volcanic rocks in the nearby Sherridon Group suggest a volcanogenic origin. The large lateral extent of the orebodies and the absence of underlying alteration zones indicate a distal volcanogenic deposit, i.e., one deposited away from the hydrothermal vent (Large, 1977). Following Turner and Gustafson (1978), Goetz (1980) proposed that the sulphides of the Sherritt Gordon deposit were precipated from hot brines moved great distances from their source area. It has been suggested that sulphides could also be transported by sediment gravity flows (Schermerhorn, 1970; Henley and Thornley, 1979; MacGeehan *et al.*, 1981; Walker and Barbour, 1981). Features of clastic sedimentation have been reported from the Iberian pyrite belt (Schermerhorn, 1970, 1978), from some Japanese volcanogenic deposits (Clark, 1971; Lambert and Sato, 1974), from the Norita mine in Quebec (MacGeehan *et al.*, 1981), and from the Buchans deposits (Thurlow and Swanson, 1981). This method of transport could have played a role in the formation of the Sherritt Gordon orebodies.

Cordierite-anthophyllite rocks are associated with many metamorphosed sulphide deposits and have been interpreted as metamorphosed hydrothermally altered rocks (Froese, 1969; Whitmore, 1969). In the Sherridon area, cordierite-anthophyllite rocks are present as lenses along stratigraphic horizons; some occurrences are associated with sulphide mineralization. The stratabound nature of the cordierite-anthophyllite rocks in the Sherridon area was pointed out by Robertson (1953). Recently, similar rocks have been interpreted as metamorphosed volcanogenic chlorite-rich muds laid down on the sea-floor (Schermerhorn, 1978) and as metamorphosed distal deposits of chloritic rocks produced by fumarolic activity (Warren, 1979). Cordierite-anthophyllite rocks require chloritic rocks as precursors and these could be produced by hydrothermal alteration. Chloritization is a common process in hydrothermal alteration which involves the selective dissolution and removal of calcium and sodium, producing a rock depleted in these elements and enriched in aluminum. Thus, mafic rocks could acquire the composition of a quartz-chlorite mixture and felsic rocks could become chloritized by a combination of some aluminum with iron and magnesium from the hydrothermal solution (Large, 1977). The protolith of the cordierite-anthophyllite rocks of the Sherridon area might have been detritus of hydrothermally altered rocks, transported to their present site either as a fine suspension in a brine (Wilkinson, 1976; Goetz, 1980) or as a sediment gravity flow (Middleton and Hampton, 1976).

In the Sherridon area, a favourable environment for the deposition of a distal volcanogenic deposit includes the presence of volcanic rocks in the predominantly sedimentary Sherridon Group and the occurrence of pelitic rocks and cordierite-anthophyllite rocks along the ore-bearing stratigraphic horizon.

ACKNOWLEDGEMENTS

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GEOLOGY OF THE GECO BASE METAL DEPOSIT

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ABSTRACT

The Geco Cu-Zn-Ag deposit lies within a highly deformed sequence of Archean metasedimentary and metavolcanic rocks located near the interface between the Quetico and Abitibi-Wawa Belts.

Three distinct types of mineralization occur within the deposit: disseminated chalcopyrite-pyrrhotite-pyrite, massive pyrite-pyrrhotite-sphalerite-chalcopyrite and disseminated pyrite-sphalerite. The massive sulphide and pyrite-sphalerite zones contain important amounts of silver. All the above mineralization occurs within a dragfolded quartz-muscovite schist interbedded between a lower altered mafic volcanic unit and an overlying quartzite unit containing siliceous iron-formation.

The folding which developed the present Manitouwadge Synform and related Geco drag fold also caused foreshortening and remobilization of the mineralized horizons. The amphibolite grade of metamorphism at Geco is indicated by zones of abundant sillimanite, anthophyllite, garnet and cordierite.

Stratigraphy, alteration, metal zoning, and age relationships between known intrusions and the majority of the sulphide zones, indicate that Geco is a syngenetic-stratiform base metal deposit which has been overturned.

RÉSUMÉ

Le gisement de Cu-Zn-Ag de Geco est encaissé dans une série très déformée de roches métasédimentaires et métavolcaniques archéennes localisées près limites des ceintures de Quetico et de l'Abitibi-Wawa.

Trois types distincts de minéralisation existent dans le gisement: disséminé à chalcopyrite-pyrrhotite-pyrite, massif à pyrite-pyrrhotite-sphalérite-chalcopyrite et disséminé à pyrite-sphalérite. Les sulfures massifs et les zones de pyrite-sphalérite contiennent des quantités importantes d'argent. La minéralisation est située dans un pli d'étirement d'un niveau de

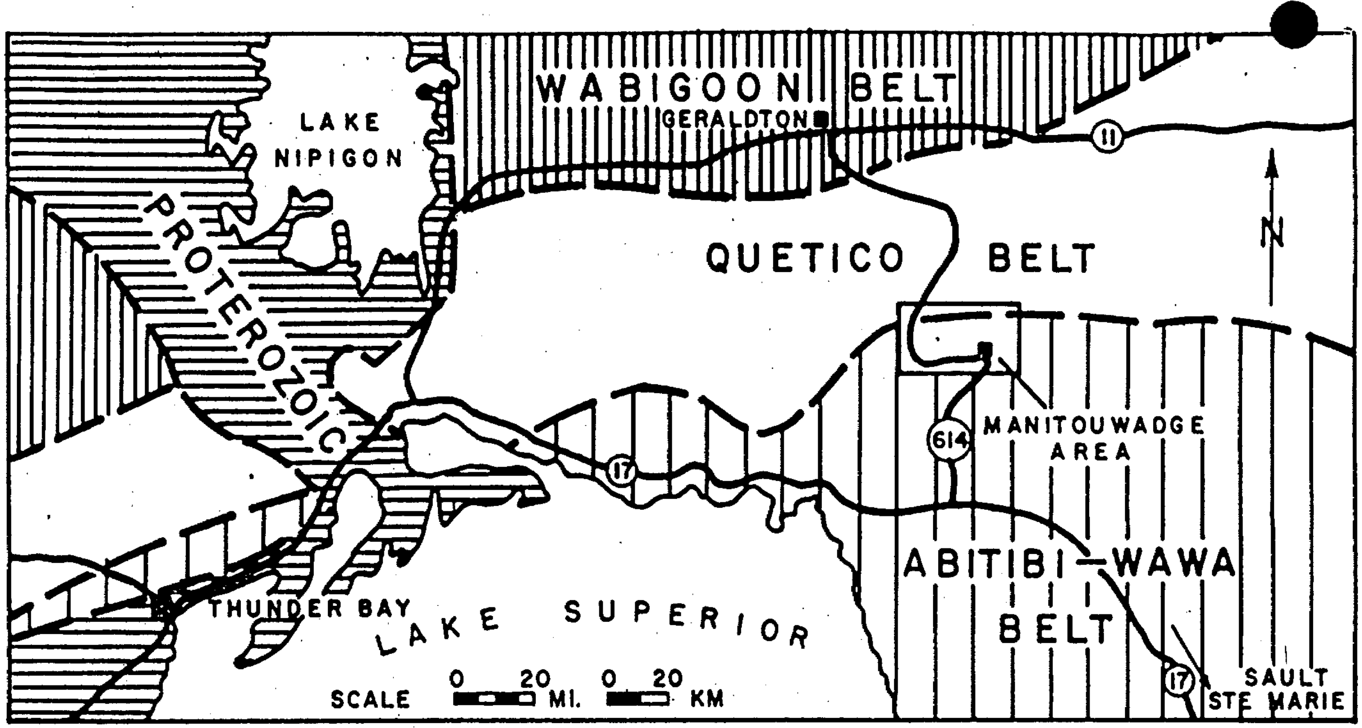

Figure 1. Location map, Manitouwadge area.

schiste à quartz et muscovite, intercalé entre une unité inférieure volcanique mafique et altérée et un [illegible]eau supérieur de quartzite contenant une formation ferrugineuse siliceuse.

L[illegible]issement qui est à l'origine de l'actuel synforme de Manitouage et du pli d'étirement de Geco qui lui est associé, a aussi causé le raccourcissement et la remobilisation des niveaux minéralisés. Le métamorphisme est de degré amphibolite tel qu'indiqué par des zones riches en sillimanite, anthophyllite, grenat et cordiérite.

La stratigraphie, l'altération, la zonalité des métaux et les âges relatifs des intrusions connues et de la majorité des zones sulfurées indiquent que Geco est un amas sulfuré syngénétique et stratiforme qui a été inversé.

INTRODUCTION

The Geco Cu-Zn-Ag deposit is in the Manitouwadge mining camp, in the Thunder Bay Mining District of northwestern Ontario, 320 kilometres east of Thunder Bay (Fig. 1); and lies 5 kilometres east of the town of Manitouwadge. The Manitouwadge area has been severely glaciated yet displays moderate to high relief. The higher areas have abundant bedrock exposure whereas the lower areas are covered by glacial tills.

In 1931 Dr. J. E. Thomson of the Ontario Department of Mines located copper-bearing gossans near the northeastern arm of Manitouwadge Lake. Little work was done in the area until 1953, when three Geraldton prospectors – Forster, Barker and Dawd – staked the gossans described by Thomson. Subsequent work outlined the Geco orebody and initiated one of the largest staking rushes in Canadian mining history. This led to the discovery of the Willroy, Willecho and Nama Creek orebodies west of Geco. Production began at Geco in September, 1957, based on an ore reserve of 13.8 million tonnes. Table I gives production and current ore reserve statistics for the entire mining camp.

REGIONAL GEOLOGY

General Stratigraphy and Structure

The Manitouwadge mining camp is located along the northern edge of the Abitibi-Wawa metavolcanic belt, near its interface with the Quetico metasedimentary belt; both of which are part of the Superior Province of the Precambrian Shield (Fig. 1). The interface between these two Archean belts is transitional and their age relationship is controversial. Published regional mapping in the area was carried out by Thomson (1932), Pye (1957), Coates (1968 and 1970), Milne (1968, 1969 and 1974) and Giguere (1972); however, most of the conclusions presented here on the regional geology and structure, are based on detailed mapping by geologists of Noranda Mines Ltd., Geco Division (Fig. 2).

The supracrustal sequence in the Manitouwadge area has been highly metamorphosed to form gneisses and schists locally of the almandine-amphibolite grade of regional metamorphism. In the Manitouwadge area, this sequence may be subdivided into four distinct, conformable, east-west trending units which, from north to south are: 1) Quetico paragneisses, 2) granitized felsic and mafic gneisses, 3) the Manitouwadge Mine Series (metavolcanic and metasedimentary gneisses and schists) and 4) granitized felsic gneisses.

TABLE I
Production history and reserves of the Manitouwadge district.

PROPERTY		PRODUCTION				RESERVES			
		Tonnes	%Cu	%Zn	Ag g/t	Tonnes	%Cu	%Zn	Ag g/t
Total for Geco		26,933,742	1·97	4·01	61·4	23,182,032	1·88	3·73	52·5
Willroy Camp	Willroy	4,180,997	All processed by the Willroy mill			Ceased operations in 1977			
	Willecho	3,502,159							
	Nama Creek	236,988							
Total for Willroy		7,920,144	0·94	4·59	60·3				
Total for Manitouwadge Mining Camp		Total production				34,853,886	1·73	4·14	61·2
		Total reserves				23,182,032	1·88	3·73	52·5
		Camp total				58,035,918	1·79	3·97	57·6

These rocks have undergone at least two major periods of deformation. The folds of the initial and dominant period were formed about a series of 055° to 070°-trending axes. The Manitouwadge area is considered to be located on the overturned limb of a major fold developed during this period. Individual folds in this system are typically assymetrical and vary in amplitude from several centimetres to tens of kilometres. A second fold system is believed to have developed about a series of northwest-trending axes. Though difficult to illustrate on an outcrop scale, such folds are indicated by a systematic broad scale undulation in plunge of the northeast-trending folds. Interaction of these fold systems has developed four major structures (Fig. 2). From west to east these are the Blackman Lake Antiform, the Manitouwadge Synform, the Banana Lake Antiform and the Moshkanabi Lake Synform. All known orebodies are contained in the Manitouwadge Synform.

The oldest known intrusions in the area are isolated lenses of metagabbro associated with mafic orthogneiss. Widespread granitization, possibly of Algoman age has produced hybrid rocks, some of which are truly intrusive. Locally, these are represented by pegmatite dykes up to 100 m thick and by various rocks of granitic to granodioritic composition. Diabase dykes up to 70 m thick intrude all rocks in the area and generally follow the major fault trends which are north, northeast, and northwest. These faults appear as prominent regional lineaments and typically have near-vertical dips. They exhibit strike-slip movement with only minor displacements.

Manitouwadge Mine Series

Following Pye (1957), the Manitouwadge Mine Series has been subdivided into four generally continuous conformable units best seen in the Manitouwadge Synform (Fig. 3). These are: 1) The Hornblende Schist Group, a 1600 m thick band of mafic schist which Pye (1957) considered to be mafic waterlain meta-volcanic rocks; 2) the Grey Gneiss Group, a zone up to 1500 m thick, divided into upper and lower subunits, of felsic to intermediate gneiss with interbedded quartzite and iron-formation near its northern edge; 3) the Sericite Schist Group, a band of felsic schist generally

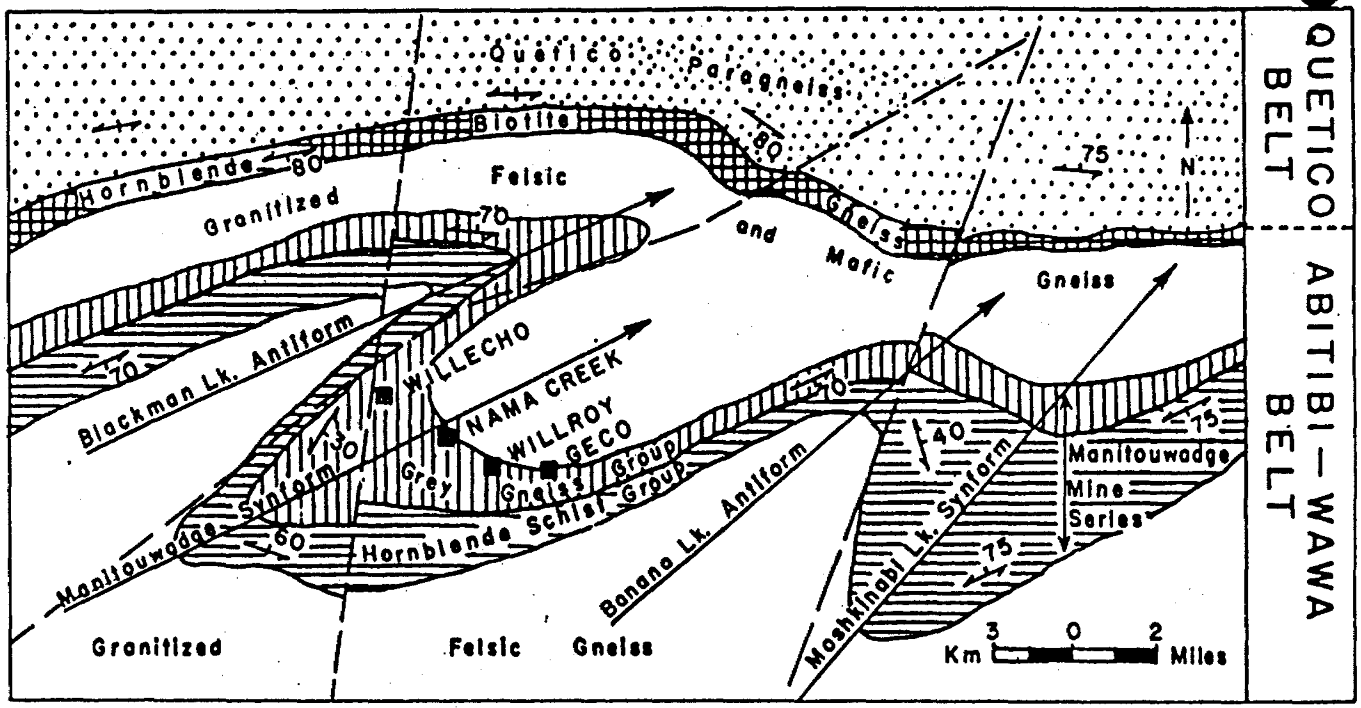

Figure 2. Regional geology, Manitouwadge area.

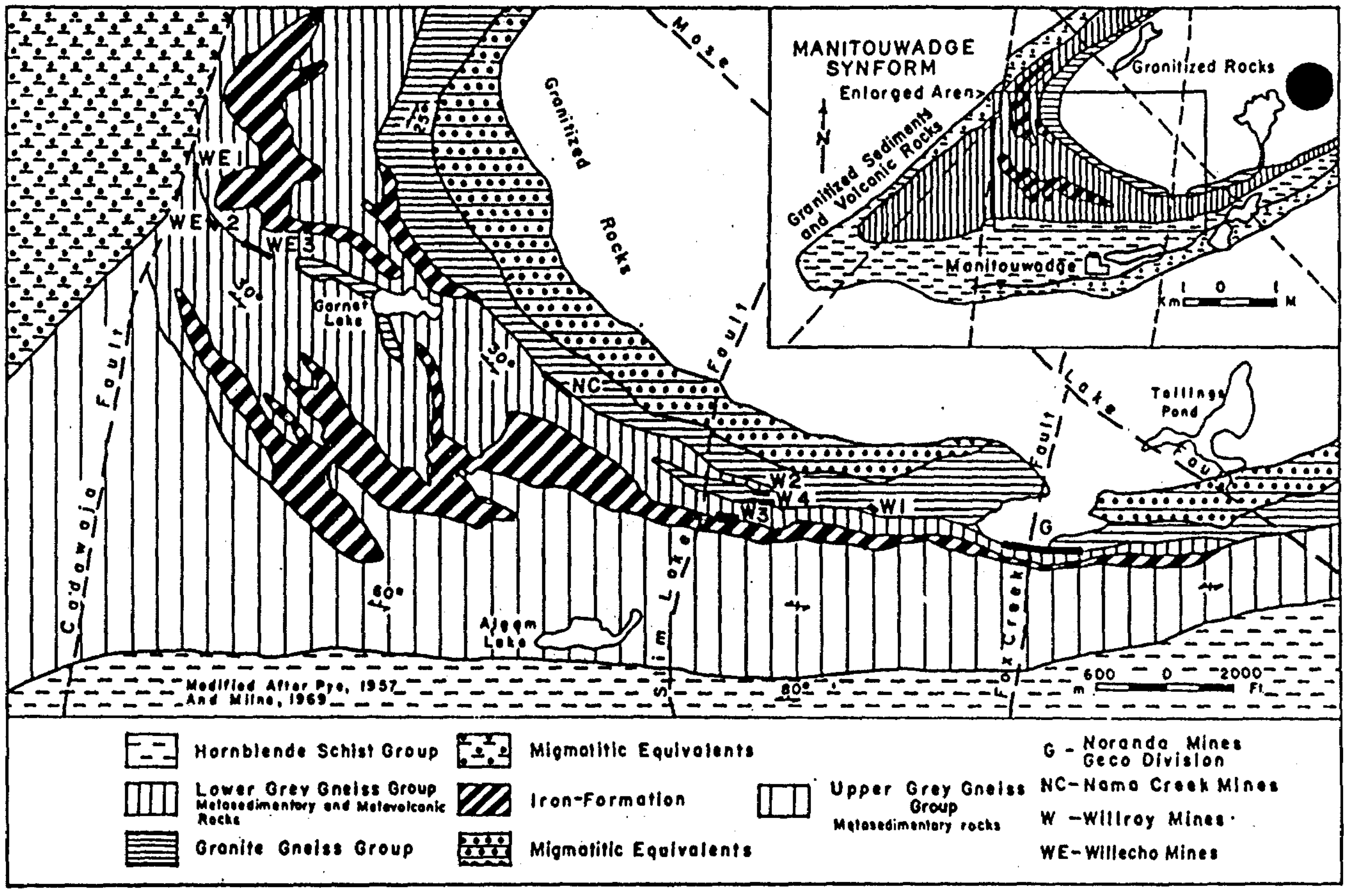

Figure 3. Geology of the Manitouwadge syncline between Willecho and Geco.

les[illegible]an 200 m thick (not shown in Fig. 3) which hosts the Geco orebodies and is pos[illegible]y of volcano-sedimentary derivation; and 4) the Granite Gneiss Group, a 700 m thick zone of altered intermediate to mafic gneiss. This latter group forms the northern edge of the Mine Series and grades rapidly into highly granitized rocks characteristic of those found throughout the core of the Manitouwadge Synform.

Previous workers mapping in the Manitouwadge Synform considered the Hornblende Schist Group to be the lowest stratigraphic member of the Mine Series. Reliable top determinations are rare and this interpretation is based chiefly on present structural position of the units in the synform. Recent regional mapping (Fig. 2) however, shows the reverse stratigraphic sequence in the eastern and western portions of the area. The writers therefore consider the entire Manitouwadge Synform to represent an overturned portion of the Manitouwadge Mine Series, with the Granite Gneiss Group forming the basal member of this series.

MINE GEOLOGY

Introduction

The geology of the deposit has been described by Langford (1955), Pye (1957), Brown and Bray (1960), Milne (1969) and Watson (1970). Specific aspects of the deposit have been discussed by McNiece (1956), Pushkar (1960), Graham (1967), Mookerjee and Dutta (1970), Suffel *et al.* (1971), Bannerjee (1972) and Alldrick (1974). W.L. Brown and R.C.E. Bray were employees of Geco Mines Limited and were responsible for much of the initial geological interpretation. Their unit nomenclature is still in use.

The Geco deposit is located on the south limb of the Manitouwadge Synform and is associated with a complimentary, easterly plunging, "Z"-shaped drag fold. The deposit contains three types of sulphide zones which occur in the northern, lower members of the Manitouwadge Mine Series (Fig. 4): 1) a disseminated chalcopyrite-pyrrhotite-pyrite zone located at the Granite Gneiss/Sericite Schist contact (4/2 Cop-

TABLE II

Average major element compositions of main rock types in the Mine Series, Geco.

ROCK TYPE	SiO_2	Al_2O_3	Total Fe	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	
Granite	70·57	15·17	1·51	0·52	1·78	4·51	3·49	0·27	0·05	0·02	
Qtz Diorite	61·54	15·57	5·58	3·16	4·23	3·37	2·42	0·65	0·26	0·10	
Hnb. Schist	50·60	14·64	10·57	5·74	8·75	2·29	0·63	1·23	0·27	0·23	HORNBLENDE SCHIST GROUP
Qtz-Fel-Bio Gn	64·80	12·82	8·76	2·09	3·17	2·29	2·20	0·21	0·05	0·66	GREY GNEISS GROUP
Siliceous IF	67·43	0·40	24·76	1·42	1·80	0·00	0·03	0·04	0·00	0·54	
Chloritic IF	66·22	0·74	25·92	1·94	2·21	0·30	0·08	0·03	0·12	1·65	
Bio Quartzite	76·64	11·70	2·03	0·44	0·36	3·12	4·45	0·11	0·00	0·03	
Ser. Schist	84·53	7·58	1·77	0·37	0·19	0·32	1·74	0·09	0·01	0·01	SERICITE SCHIST GROUP
Ser Schist Bio'c	71·23	10·56	6·05	2·79	0·31	0·73	3·17	0·13	0·01	0·04	
Ser-Sill Schist	78·67	9·80	3·93	1·98	0·19	0·24	1·63	0·11	0·00	0·02	
Qtz-Bio-Anth Hfls	69·90	8·77	11·30	4·32	0·23	0·20	0·70	0·10	0·01	0·05	
Bio-Anth-Cord Gn	51·25	13·08	20·56	6·83	1·28	0·15	0·26	2·92	0·58	0·26	GRANITE GNEISS GROUP
Bio-Sill Gneiss	74·09	12·03	5·04	3·27	0·21	0·07	2·05	0·29	0·06	0·06	
Bio-Hnb Gneiss	45·53	15·88	16·11	6·71	6·39	1·43	0·78	2·41	0·33	0·41	

per Zone), 2) a massive pyrite-pyrrhotite-sphalerite-chalcopyrite zone and associated disseminated chalcopyrite-pyrrhotite-pyrite zone in the Sericite Schist Group (Main Orebody) and 3) a disseminated pyrite-sphalerite zone at the Sericite Schist/Grey Gneiss contact (8/2 Zinc Zone).

Mine Stratigraphy

The rocks at Geco have undergone high rank metamorphism and deformation which have obscured many of the original features of this deposit. Despite this, the main rock units may be further subdivided to show a significant internal succession. The stratigraphic columns in Figure 4 relate this internal stratigraphy to that of the Manitouwadge Mine Series. Table II gives typical whole rock analyses for the major rock units at Geco.

Granite Gneiss Group

Only the upper portion of this complex group of medium- to coarse-grained, highly altered, mafic to intermediate gneisses is exposed on surface and in underground workings. Based on this exposure and a series of deeper diamond drill holes this group can be subdivided into biotite-hornblende gneiss, biotite gneiss, biotite-sillimanite gneiss and biotite-anthophyllite-cordierite gneiss members. Garnet is common in all the members. The biotite-hornblende gneiss is found in the western and lower portions of the group and is not encountered to any extent in the underground workings. The biotite, biotite-sillimanite and biotite-anthophyllite-cordierite gneisses are interbedded and individual units are up to 5 m thick. The garnetiferous biotite-sillimanite and biotite-anthophyllite-cordierite gneisses are most abundant near the overlying Sericite Schist Group.

The biotite and biotite-sillimanite gneisses can be differentiated only on sillimanite content as they grade into one another both laterally and vertically. They typically contain 20 to 40% biotite, 15 to 30% quartz, 10 to 20% feldspar, 10 to 20% hornblende, 0 to 15% sillimanite and 0 to 15% garnet (all mineral percentage compositions are estimated from hand speciments). Sillimanite typically occurs as elongated clusters up to 2 cm in length and garnet (almandine) as porphyroblasts up to 2 cm across. Magnetite is a common accessory mineral.

The biotite-anthophyllite-cordierite gneisses typically contain 5 to 20% biotite, 10 to 50% anthophyllite, 5 to 35% cordierite, 0 to 10% quartz. Accessory minerals include feldspar, staurolite, chlorite, magnetite and spinel. Anthophyllite rosettes, up to 5 cm across, are developed parallel to foliation and cordierite is found interstitial to these rosettes where it is commonly altered to pinite.

Although erratic lenses of fine-grained disseminated chalcopyrite are present throughout the group, no mineable zones have yet been located.

Sericite Schist Group

The Sericite Schist Group is a series of highly altered felsic schists which conformably overlies the Granite Gneiss Group. Typically ranging up to 200 m in width, this key horizon contains all the known orebodies at Geco.

The lowest ore horizon, the 4/2 Copper Zone; a thin zone of disseminated chalcopyrite, pyrrhotite, and pyrite; generally occurs at the base of this group. Ranging

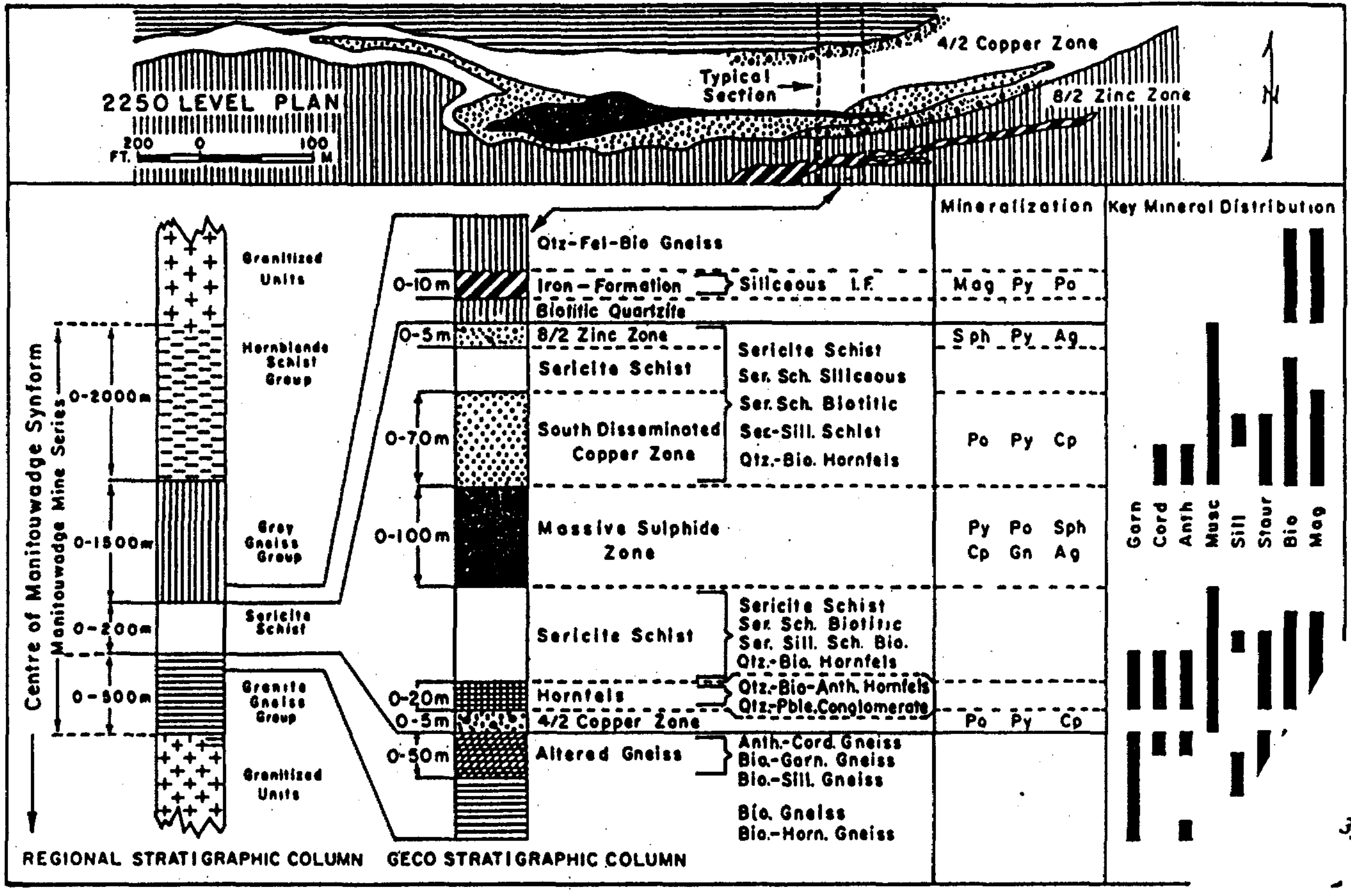

Figure 4. Schematic stratigraphic columns illustrating generalized stratigraphic relationships of sulphide zones, Geco Min

from a few cm to 5 m in thickness, this sulphide zone is usually overlain by a 5 to 20 m t[illegible] band of quartz-biotite-anthophyllite hornfels. This peculiar unit is typically medium- to coarse-grained, poorly foliated and shows a highly variable composition. The major minerals are: 50 to 80% quartz, 5 to 15% biotite and 5 to 20% anthophyllite. Accessory minerals include cordierite, staurolite, garnet, spinel, sericite, sillimanite, plagioclase and diopside. The more mafic and coarser-grained varieties of the hornfels resemble the anthophyllitic members of the Granite Gneiss Group. A distinct marker band known as quartz-pebble conglomerate occurs locally at the base of this hornfels. Up to 3 m thick, this band contains discus-shaped quartz pebbles averaging 10 cm in diameter in a biotite-anthophyllite matrix. This band contains low grade copper mineralization – some of which is gradational into the underlying 4/2 Copper Zone.

Overlying the hornfels unit is the typical sericite schist which can be subdivided into two members: 1) sericite-sillimanite schist, best developed in the lower and eastern portions of the group, and 2) sericite schist, more common in the upper part of the group. The sericite-sillimanite member is typically medium- to coarse-grained, grey to black, well foliated, and shows a distinct spotted texture. It is found as 0.5 to 5.0 m thick bands generally displaying gradational contacts with other schist members and contains 50 to 60% quartz, 5 to 15% biotite, up to 10% muscovite and 3 to 20% sillimanite. The distinct spotted appearance of this rock is caused by white knots or bundles of sillimanite up to 3 cm in diameter which are aligned parallel to foliation. As a rule, this member is poorly mineralized and contains significant amounts of magnetite which occurs both as irregular blebs in the dark biotitic groundmass and as tiny (1-2 mm) crystals in the cores of sillimanite bundles.

The sericite schist member is typically medium- to coarse-grained, buff colored and displays highly developed schistosity and crenulations. This schist can be further divided into various submembers based on relative amounts of quartz, muscovite and biotite. Individual bands of these schists range from 0.5 to 10 m thick. Where best developed the sericite schist has a pearly white luster and is composed of 40 to 70% quartz and 30 to 60% muscovite. Accessory minerals are biotite, sillimanite, garnet, feldspar and magnetite. Locally, where the quartz content is high, the term "siliceous" is used, and where significant amounts of biotite occur, the schists are termed "biotitic".

The Main Orebody is located in the upper half of the Sericite Schist Group and is composed of a 0.1 to 100 m thick zone of massive pyrite, pyrrhotite, sphalerite and chalcopyrite overlain by a zone of disseminated sulphides. This overlying sulphide zone is essentially siliceous sericite schist containing disseminated chalcopyrite, pyrrhotite and pyrite. Throughout the disseminated zone, but more commonly around the upper and lower margins of the massive sulphides, a unit termed "quartz hornfels" is locally present. This siliceous unit contains near-massive concentrations of fine-grained chalcopyrite. Locally displaying intrusive-like textures, this member may represent a remobilized phase of the sulphide zone.

The upper disseminated portion of the Main Orebody grades upward through a band of poorly mineralized sericite schist into the overlying 8/2 Zinc Zone. The 8/2 Zinc Zone is essentially a 1 to 5 m wide band of schist containing disseminated to near-massive concentrations of sphalerite and pyrite which marks the top of the Sericite Schist Group.

Grey Gneiss Group

The Grey Gneiss Group conformably overlies the Sericite Schist Group. Characteristically unaltered, this Group contains interbedded biotitic quartzite, quartz-feldspar-biotite gneisses and iron-formation. The upper members of this group are not present in the mine area.

The biotitic quartzite predominates in the lower 30 m of the group. It is a well banded, fine-grained, light grey to buff-colored rock typically containing 80% quartz, 15% potash feldspar and 5 to 15% biotite. Accessory minerals include sericite, plagioclase, amphibole, garnet, pyrite and magnetite.

The quartz-feldspar-biotite gneiss is the most common rock of the Grey Gneiss Group in the mine area. It is a medium- to coarse-grained, light to dark grey gneiss essentially composed of 40% quartz, 40% potash feldspar and 20% biotite. Accessory minerals are hornblende, sericite, garnet, plagioclase and magnetite.

Bands of iron-formation are found in the lower 100 m of this group. Typically lenticular, individual bands generally do not exceed 300 m in length and range from 1 to 10 m thick. Two types are present: 1) siliceous iron-formation and 2) chlorite-garnet iron-formation. The siliceous iron-formation is by far the more common and consists of 60 to 70% fine-grained quartz; up to 20% combined magnetite, pyrite and pyrrhotite; and 5 to 30% biotite. Accessory minerals include garnet, feldspar, amphibole and pyroxene. Although it displays a glassy, dark grey to black appearance on fresh surfaces, older exposures are usually highly oxidized. Siliceous iron-formation generally shows well-developed banding where significant amounts of pyrite, pyrrhotite or magnetite are present. Although near-massive concentrations of iron sulphides and oxides are present, siliceous iron-formation does not contain mineable mineralization.

The chlorite-garnet iron-formation is found only in the western and eastern extremities of the mine near the Sericite Schist/Grey Gneiss contact, and therfore is not often seen in the mine workings. Typically dark and siliceous, it displays no obvious banding but shows a distinct ropy, fibrous texture due to the habit of chlorite and biotite, which bend about garnet porphyoblasts that are up to 1 cm in diameter. The magnetite content is similar to that of the siliceous iron-formation but here magnetite occurs as small massive blebs. Known to grade laterally into garnetiferous quartz-feldspar-biotite gneiss, the iron-formation commonly contains minor amounts of disseminated pyrite and pyrrhotite and is locally associated with sphalerite mineralization of the 8/2 Zinc Zone.

Intrusive Rocks

The oldest intrusions are quartz diorite dykes which are found throughout the mine area but are most abundant between the Main Orebody and the Granite Gneiss Group, where they constitute upwards of 30% of the rock. Compositionally similar to the quartz-feldspar-biotite gneisses of the Grey Gneiss Group, they show highly variable textures. Averaging 1 m thick, these dark grey to black dykes may locally reach 10 m in thickness. They typically cut gneissosity at very low angles (less than 10°) and for this reason their intrusive nature can be questioned; however, they are everywhere foliated parallel to their contacts.

Younger, well foliated mafic dykes are occasionally encountered in the mine. These dark green dykes, composed mainly of hornblende and biotite, are most common in the Grey Gneiss Group and are known to transect the quartz diorites. These dykes are believed to be genetically related to the Hornblende Schist Group.

A later series of pegmatite and granite dykes is common throughout the mine area. These felsic dykes occur on all scales and are typically parallel to the axial planes of the major folds (northeast to east). Within the Sericite Schist Group these dykes display appreciable thinning where they have been partially transposed into the plane of schistosity. These dykes cut all major rock units except the massive sulphide orebody; although they commonly occur as remnants in this zone. Recent work on the pegmatite and granite dykes indicates they have diverse compositions. Although some of these dykes may be true igneous intrusions, others may have formed by metasomatic processes.

The youngest intrusions are diabase dykes (Pye 1957, Milne 1969, 1974) which follow the major fault systems in the area. These dykes range from a few cm to 20 m in thickness and cut all other rock types in the mine area. Typically fine-to coarse-grained, and black to dark green in colour, these dykes are commonly equigranular but locally contain plagioclase phenocrysts.

ORE ZONES

The isometric projection in Figure 5 shows the relative positions of the ore zones and host rocks at Geco. The inset illustrates the distribution of these zones in longitudinal section.

4/2 Copper Zone

The 4/2 Copper Zone is a tabular, vertically dipping, fine-to medium-grained chalcopyrite-pyrrhotite-pyrite orebody. The sulphides are contained in a highly siliceous matrix and are present in both massive and disseminated concentrations.

This zone attains mineable grades in the lower and eastern portion of the mine area where it averages 2 m in thickness. The typical 4/2 Ore Zone consists of a high-grade, near-massive sulphide core containing quartz "eyes" and wall-rock fragments, which grades outwards into the poorly mineralized host rocks. The fine-grained massive core often appears veined or remobilized but the orebody itself is conformable with the host rocks, though it locally shows sheared contacts. Eastward, along its strike, the orebody contains increased amounts of sphalerite and pyrite. A series of randomly oriented, very coarse grained quartz-cordierite "dykes" are found along its upper contact. These "dykes" contain erratic mineralization, are typically less than 1 m thick, have sharp contacts with upper host rocks and pinch out rapidly upwards, probably within 3 m.

Main Orebody

The lower portion of the Main Orebody consists of a massive coarse-grained sulphide zone which contains in excess of 60% combined sulphides, up to 10 to 30% wall-rock remnants and locally, an abundance of quartz and mica gangue. This zone forms the major mineable orebody and typically contains 10 to 60% pyrite, 5 to 30%

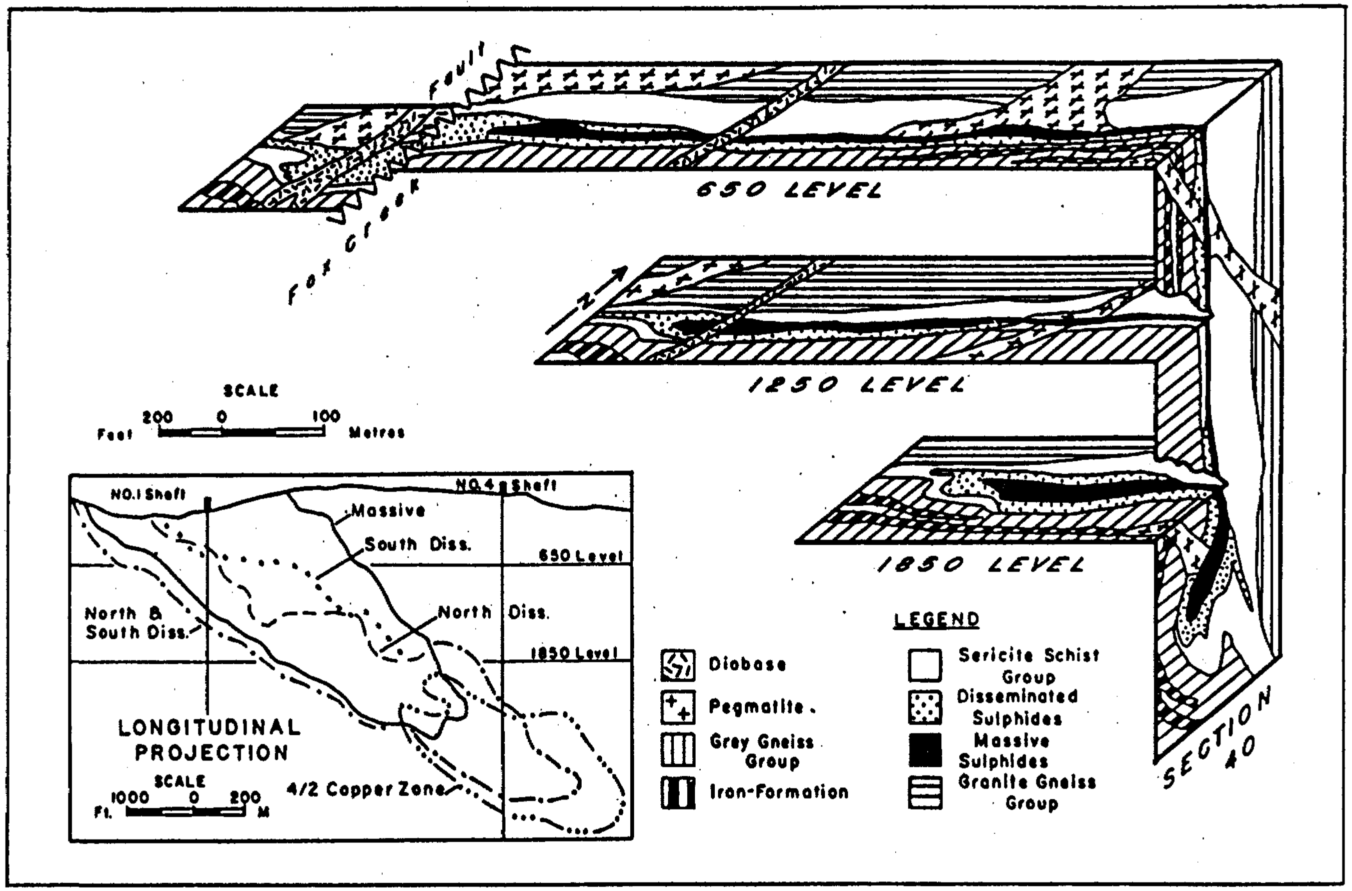

Figure 5. Isometric diagram, west end of Geco deposit, and longitudinal projection showing relative positions of various sulphide zones.

sphalerite, 5 to 30% pyrrhotite, 2 to 25% chalcopyrite and minor galena and silver. This orebody also contains recoverable amounts of gold, bismuth and cadmium as well as non-recoverable amounts of tin. Ranging from less than 1 m up to 100 m in thickness, this vertically dipping orebody attains a maximum strike length of 975 m on the 250 Level of the mine and has been outlined down plunge for 1750 m. As with the overlying disseminated orebody this zone reaches maximum thickness in the western portions of the mine near the drag fold. The massive zone is thus "teardrop" shaped and gradually thins upwards and to the east.

Within this massive sulphide horizon, pyrite, the predominant sulphide, occurs both as disseminated coarse-grained, subhedral to euhedral crystals and in fine-to coarse-grained massive form. Individual crystals display crushed, rolled or brecciated textures and locally appear to be porphyroblastic. Sphalerite is most commonly associated with the pyrite-rich portions of this ore zone where it occurs as finer-grained, subhedral to anhedral grains surrounding or locally filling fractures in the pyrite grains. The sphalerite- and pyrite-rich ore occasionally shows crude banding. Pyrrhotite and chalcopyrite are intimately associated and generally form a very fine-grained, poorly crystalline matrix for the more coarsely crystalline sphalerite - pyrite. Both pyrrhotite and chalcopyrite show flow textures and may embay or form fracture fillings in other sulfides. Chalcopyrite also occurs as fine-grained inclusions within individual sphalerite crystals. Galena is present primarily as thin selvages surrounding quartz diorite dyke remnants.

The massive sulphide zone appears to be a conformable stratiform horizon; however its contact relationships with host rocks and known intrusions are complex. The massive sulphides locally appear discordant to the sericite schist host and often contain abundant remnants of intrusive rocks such as pegmatite and quartz diorite dykes. This zone shows a complex mineral paragenesis which has been described in detail by Pye (1957).

The upper portion of the Main Orebody consists of a disseminated sulphide zone which typically contains 5 to 6% chalcopyrite, 8 to 10% pyrrhotite and 4 to 5% pyrite. These sulphides occur as blebs and stringers parallel to schistosity in the siliceous sericite schist host. Within the disseminated zone, these mineralized schists alternate with weakly mineralized bands of biotitic, siliceous and sillimanitic schist. Ranging from 0 to 70 m thick, this zone continues down plunge for 200 to 300 m beyond the massive portion of the Main Orebody. It attains maximum thickness in the lower and western portions of the mine where it is overthickened by the Geco drag fold. Eastward, beyond the limits of the underlying massive sulphides, this disseminated zone thins and splits into narrow chalcopyrite stringers which locally are discordant with schistosity.

Narrow isolated lenses of disseminated sulphides also occur below the massive Main Orebody in the underlying schists and are termed "north ore" lenses. Although it is evident that much of this north ore may be a separate sulphide zone there are also occurrences which suggest that these lenses may be dislocated or attenuated portions of the main disseminated zone.

8/2 Zinc Zone

The 8/2 Zinc Zone is a tabular, fine-to coarse-grained sulphide zone containing sphalerite, pyrite and important amounts of silver. Though it occurs almost everywhere along the Grey Gneiss/Sericite Schist contact, it is best developed in the lower and eastern portions of the mine. Typically ranging in thickness from 1 to 5 m, this zone can locally be subdivided into disseminated and near-massive members. The lower disseminated member consists of fine-grained sphalerite and pyrite in sericite schist. This low grade (1 to 5% zinc) member locally directly overlies the disseminated portion of the Main Orebody and grades upwards into the high-grade (5 to 15% zinc) near-massive member of the zone. Generally averaging 1 m in thickness, this member may also contain minor amounts of chalcopyrite (up to 1%) and locally shows alternating pyrite- and sphalerite-rich bands.

COPPER-ZINC DISTRIBUTION IN THE MASSIVE SULPHIDES

The metal distribution in the massive sulphides reflects primary distribution as well as the effects of metamorphism and structural adjustments including recrystallization, local remobilization, boudinage etc. (Suffel *et al.*, 1971; Vokes, 1968). The present thicknesses of the sulphides show dominant structural control, being greatest in the folded, lower western margins of the zone (Fig. 6). The highest grades of zinc follow the central portions of the massive sulphide zone down plunge. Zinc is however, fairly uniformly distributed throughout the zone and shows only limited remobilization. Copper, on the other hand commonly shows evidence of considerable remobilization. Above 1650 Level, the best grades of copper are fold-related. Below 1650 Level, the high-grade copper values leave this fold system and cross the plunge

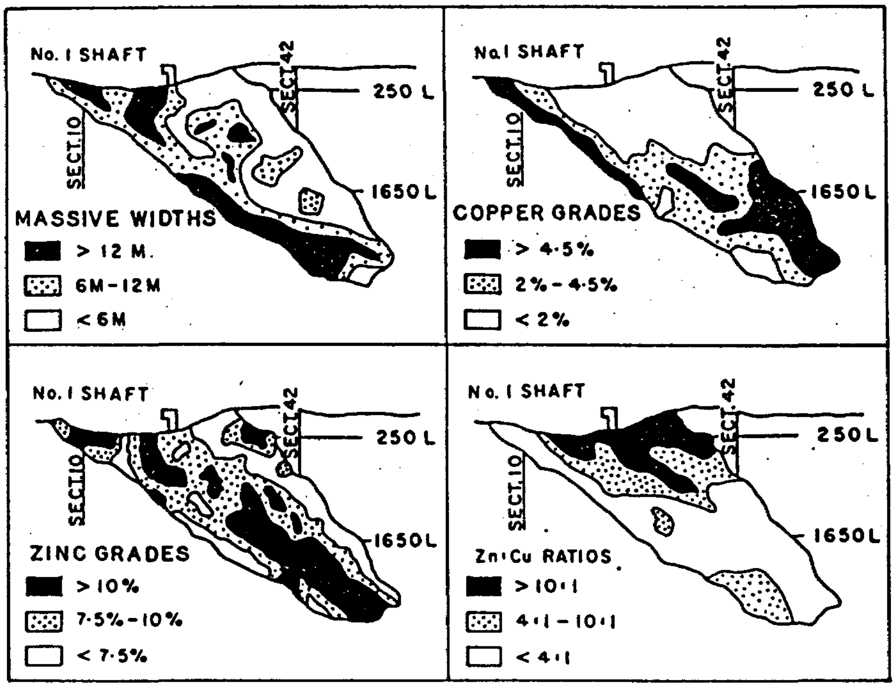

Figure 6. Widths and metal distribution of the massive sulphide zone, Geco Mine.

of the massive zone. The zinc to copper ratios show a similar pattern as they are controlled primarily by the copper grades. The horizontal trend below 1650 Level is not completely understood, but may, in part, represent primary copper distribution.

MINE STRUCTURE

High-grade regional metamorphism formed the gneisses and schists of the Manitouwadge Mine Series. The gneissosity and schistosity were developed parallel to the original bedding. Tight isoclinal folding described as typical of many high-grade metamorphic terrains cannot be demonstrated in the Manitouwadge area. No structural or stratigraphic evidence for such initial folds can be found, and examples of original bedding discordant to schistosity are not known.

The Geco deposits have undergone several phases of folding which possibly developed during a late stage of metamorphism. The dominant fold pattern at the mine belongs to the northeast fold system which is also strongly developed regionally. Typically assymetrical and "Z"-shaped in plan, folds belonging to this system are found underground on scales ranging from several centimetres up to tens of metres. Most of the fold-related features at Geco can be attributed to this stage of deformation. These include the Geco drag fold and numerous smaller-scale folds of a similar pattern, well-developed crenulations, and strong boudinage. Numerous shear zones which formed parallel to the axial planes of this fold system transposed quartz diorite dykes and, to a lesser extent, pegmatite and granite dykes into the plane of the foliation. Within the mine area, the majority of northeast trending folds have well-defined northeasterly plunges. Undulation downplunge however, of many of these folds may reflect the influence of a second deformation.

An unusual series of "Z"-shaped, west plunging folds similar in style to the northeast folds are intimately associated with northeasterly striking pegmatite dykes. Typically less than 10 m in amplitude, these folds are widespread underground. It is not certain how these folds developed; their direct association with pegmatite dykes suggests that they were generated by these dykes; yet in style, they resemble the northeast folds and may represent a refolded portion of this system.

The dominant structure throughout the mine is the Geco drag fold which is best outlined by the Grey Gneiss/Sericite Schist contact (Figs. 4, 5). This "Z"-shaped fold is open and poorly developed at surface but down plunge, it develops into a more complex fold. Attaining an overall easterly plunge of 30°, this fold undulates down its length in a series of step-like structures. The Main Orebody also reflects the Geco dragfold. Where the dragfold is well developed, the massive sulphide body attains its distinct teardrop shape and the overlying disseminated zone is wrapped around the massive zone. The development of this fold produced thickening, strong boudinage and numerous tight crenulations. Boudinage is best displayed by the massive zone but occurs to some extent in many of the mine units. Two sets of crenulations are found and are best developed in the Sericite Schist Group. The dominant set is east-plunging and is locally accompanied by a weaker, second set oriented perpendicular to the dominant set. Shearing associated with the development of the fold systems is most intense near the margins of the more competent units. Macroscopic and microscopic adjustment to the folding have resulted in the partial transposition into the plane of foliation of many otherwise discordant features.

Two regional faults affect the mine area. The main fault is the north trending, vert[illegible]y dipping Fox Creek Fault (Fig. 5). This left-hand, strike-slip fault, which is 15 to 30 m wide, presents a mining problem on the western end of the deposit where it has displaced the ore zone laterally for up to 60 m. The Mose Lake Fault occurs in the extreme eastern end of the property, strikes northwesterly, and is principally a right-hand, strike-slip fault. This fault zone averages 10 m in width, dips vertically and shows lateral displacement of up to 60 m.

METAMORPHISM

Metamorphic assemblages in the mining camp are complex and no complete study of these assemblages has yet been undertaken at Geco. Regionally, the Mine Series reaches the almandine-amphibolite grade; whereas at Geco, the upper subfacies of this grade is indicated by abundant sillimanite. Both the timing and sequence of metamorphic events are difficult to establish. Within the deposit it is difficult to separate syngenetic alteration characteristics from the regional metamorphic effects. The intensity of metamorphism is demonstrated by the local remobilization of the sulphide zones and by partial melting of the more siliceous units ("pegmatized" zones). Specific aspects of the sulphide recrystallization were discussed by Suffel *et al.* (1971).

DISCUSSION

The Geco deposit displays features which can be interpreted to support both syngenetic and epigenetic processes of ore deposition. The authors favor the syngenetic model and consider the ore deposit to be an integral part of the Geco stratigraphic succession in the Manitouwadge Mine Series.

Stratigraphy and Alterations

Primary features and textures of the original rock units at Geco have been subsequently obscured by intense regional metamorphism. Without such primary features, the true nature of the original host rocks will remain problematic. The present authors believe that the Granite Gneiss Group forms the basal member of the Manitouwadge Mine Series. At Geco this unit is considered to represent the footwall strata above which the ore zones developed. The diversity of the group is shown by the chemical data (Table II). This Group is interpreted as a series of mafic and intermediate volcanic rocks locally containing interbedded siliceous sedimentary and possibly volcaniclastic rocks. It is possible however, that some of the mafic members were pelitic sediments. A peculiar member termed "stretched pebble gneiss" has been outlined within this Group north and west of Geco (Watson, 1970). Although this rock may have formed in several ways, it may represent a coarse pyroclastic unit similar to those found in many Archean base metal camps.

At Geco, the upper portions of the Granite Gneiss Group and locally, the lower portions of the overlying Sericite Schist Group are dominated by biotite-, anthophyllite- and cordierite-rich gneiss and schist. The Mg-Fe enrichment and Na-Ca-K depletion shown by these members (Table II) indicates that they may represent the highly altered footwall rocks typical of volcanogenic deposits (Sangster, 1[illegible] Sangster and Scott, 1976). These altered units, though only roughly outlined to [illegible]te, typically do not show strong discordancies to foliation and may in fact represent altered stratigraphic units and not the more typical pipe-shaped feeder system. Alternatively, such feeder pipes may now be difficult to recognize, having been partially transposed into the plane of gneissosity during development of the Manitouwadge Synform. Regardless of their present distribution, these Mg-rich gneisses are considered to represent a high-grade metamorphic equivalent of primary "chloritic" alteration zones developed in the footwall units by the initial ore-forming solutions.

Pods and lenses of these Mg-rich units are locally present in the overlying biotitic, sillimanitic and siliceous members of the Sericite Schist Group. Na-K depletion continues through these upper schists but Ca depletion is not evident and the overall Mg-Fe enrichment, though present, is less intense. The high silica content of these upper schists may indicate that these units have been highly silicified.

Although the parent material of the schists cannot be established definitely, their spatial association with, and broad chemical similarities to the overlying biotitic quartzites indicate that they may be related to the quartzite unit. Quartzite flanking the Sericite Schist Group is locally sericitic, and distinguishing between the two units is sometimes difficult. These quartzites represent the lateral equivalents of a sequence of quartz-feldspar-gneisses outlined by Milne (1969, 1974). Figure 3 shows the lateral distribution of these felsic gneisses in the synform. The high alumina content of this group indicates that they were not likely formed as chemical precipitates. Rather, we consider these siliceous gneisses to represent highly metamorphosed felsic volcanic or detrital volcanogenic sedimentary rocks. Thickening rapidly westward, these gneisses attain maximum thicknesses in the hinge area of the syncline near Willecho. Over-thickening of the siliceous gneisses in this area is considered in part a primary depositional feature and may indicate relative proximity to a major volcanic centre. Despite its strongly developed alteration, thinning of this unit near the Geco deposit may indicate that the Geco orebody formed at a greater distance from a volcanic centre than did the other deposits of the camp (Timms and Marshall, 1959; Chown, 1957).

The Sericite Schist Group, is intimately associated with base metal mineralization and is believed to have developed by the interaction of ore-forming solutions with the pre-metamorphic equivalents of the siliceous gneiss series. These units now lie beneath a thick series of biotite and quartz-feldspar-biotite gneisses of intermediate compositions. These gneisses form the upper member of the Grey Gneiss Group and are considered to have developed from a series of intermediate volcaniclastic or detrital sediments. The transition from felsic (quartz-feldspar) to intermediate (quartz-feldspar-biotite and biotite) gneisses marked the close of base metal deposition and was accompanied by the precipitation of iron-formation. Within the mining camp, ore-related alteration does not occur above the main iron-formation sequence. At Geco, this alteration stops below the iron-formation at the upper contact of the Sericite Schist Group. The iron-formations are characteristically low in alumina and are therefore considered to have been chemical precipitates, perhaps indicating a period of waning clastic sedimentation and volcanism.

The close of sedimentation in the Mine Series is marked by the deposition of the

Hornblende Schist Group. These mafic schists are considered to represent a thick ser[illegible]f basalts and andesites deposited in a submarine environment – perhaps indi[illegible]ting the beginning of a new volcanic cycle.

Orezones and Metal Zoning

Metal zoning at Geco is similar to that of other Archean massive base metal deposits. This zoning can be shown both vertically and laterally in the deposit, i.e. both across and along strike. Figure 4 illustrates the strong vertical zoning. The sulphide zones, from the basal 4/2 Copper Zone to the overlying iron-formation series are considered to represent a complete cycle of mineralization. Metal distribution grades upward through the deposit from disseminated chalcopyrite-pyrrhotite-pyrite to massive pyrite-pyrrhotite-sphalerite-chalcopyrite, disseminated chalcopyrite-pyrrhotite-pyrite and finally, pyrite-sphalerite sulphide zones. The ore zones in this cycle are directly related; whereas the iron-formations, which mark the close of this cycle, typically occur in the unaltered rocks immediately above the deposit. Within each ore zone some degree of lateral Cu-Zn-Fe zoning can be recognized. This lateral zoning is most apparent in the massive sulphide portion of the Main Orebody (Fig. 6) even though the detailed internal metal zoning in this body is complex.

The basal copper-rich ore zones, including the 4/2 and other erratic zones below the massive, show local discordancies to stratigraphy, have fine-grained "remobilized" or perhaps "intrusive" textures and are often spatially related to Mg-rich rock units. These zones may represent the mineralized channelways for the ore-forming solutions whose original discordancies to stratigraphy may have been largely obscured by structural and metamorphic events including transposition and remobilization of sulphides, etc. The uppermost 8/2 Zinc Zone however, is typically stratiform and locally shows weak sulphide banding. The Main Orebody, though partially remobilized, shows only minor discordancies to its host schists and is therefore also considered stratiform. On its lower eastern margin however, the massive sulphide portion of this orebody thins rapidly and grades laterally into a high-grade disseminated copper zone. This zone often contains discordant copper stringers and is locally associated with Mg-rich hornfels, which suggests that it may possibly be related also to the 4/2 Copper Zone.

CONCLUSIONS

Many of the primary features of the Geco deposit have been obscured by high-grade regional metamorphism and intense deformation; however, the general stratigraphy, wall-rock alteration and metal zoning of the original deposit can still be recognized. These latter features are very similar to those described as typical in Archean volcanogenic massive sulphide deposits. It is therefore concluded that Geco is a syngenetic ore deposit which has subsequently undergone intense metamorphism and deformation.

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and ir[illegible]ulphides lie in various sheared rocks on Yakushavich Island and Collins Point (Figure 25).

The area is covered by four aeromagnetic maps published by the Mines Branch: Kississing, Sherridon, Kisseynew and Bartlett. Airborne electro-magnetic surveys have been conducted by companies over large areas east and west of Sherridon.

The Sherritt Gordon Mine

The Sherritt Gordon mine was located 100 miles north of The Pas. Copper-zinc ore was discovered on the property in 1922. Production began in 1931 and continued to June 1932, when operations were suspended because of the low price of copper. Mining was resumed on August 1st, 1937, and was carried on continuously until the ore reserves were exhausted and milling stopped in September, 1951. The mine equipment and many of the town buildings were then moved to the new mine at Lynn Lake. The production of metals from the mine was: copper 366,244,801 lbs., zinc concentrate (50 per cent) 148,961 tons; gold 101,026 oz., silver 3,218,324 oz. The total value of production was $58,732,366, from 8,531,352 tons milled.

The East and West orebodies of the Sherritt Gordon mine together formed an unusually long sulphide deposit having a combined total length of almost 16,000 feet, of which 3,600 feet, between the two orebodies, carried no ore. Both were enclosed in gneisses that are highly metamorphosed sedimentary and volcanic derivatives and that formed the southwest limb of an overturned syncline. The rock forming the footwall of the deposit was gneissoid quartzite; the hanging-wall rock was garnetiferous hornblende gneiss. Pegmatite commonly occurred along both footwall and hanging wall peripheries and as isolated blocks and fragments within the ore zone. These blocks and fragments were considered to be residuals of unreplaced host rock.

The ore was relatively coarse grained and ranged from the massive to the disseminated type. The metallic sulphides in the deposit in order of their abundance were pyrite and pyrrhotite (2-1 ratio), chalcopyrite, sphalerite (marmatite), and minor chalmersite; subordinate amounts of gold and silver were recovered. The insoluble gangue content of the ore-bearing material averaged about 35 per cent.

The Bob Lake deposit also occurs within a pegmatite sill that lies along the east limb of an overturned anticline superimposed on the main syncline (Figure 27).

Farley (1948) was of the opinion that deformational thrusting accompanied by invasion of granite along an upward and south to north direction produced drag-folding, anticlinal folding, and faulting within the main syncline. The pegmatite injection was believed to have occurred during this period of deformational movement; the resultant stresses initiated shear fractures along the contacts of rocks of widely different competencies, i.e., a brittle quartzite and a hornblende gneiss. The parallelism between the major pegmatite sills and the axial planes of the folds suggests this period of disturbance. Further structural deformation followed the intrusion of the pegmatite, with accompanying differential movement taking place in the direction of the plunge and parallel to the axial planes of the folds. Fracturing within the more competent pegmatite sill created openings for ingress of ore-forming solutions.

From 20 to 25 per cent of the ore in the mine occurred in offshoot orebodies. At intervals along the main ore zone, fractures were developed in the hanging wall at acute angles to the main zone of fracturing. Pegmatite from the main sill channel

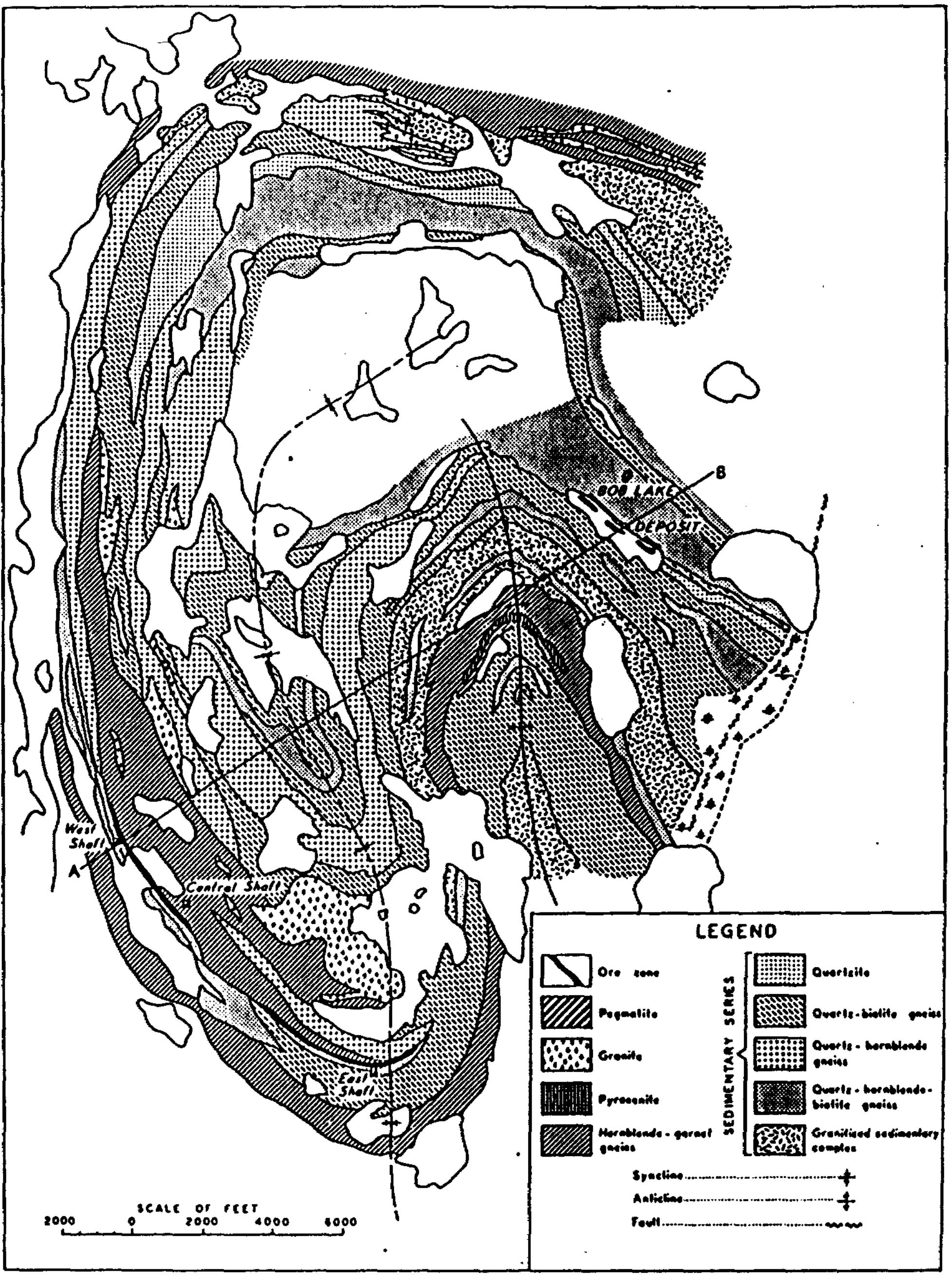

FIGURE 27 *Geology of Sherritt Gordon Mine Area, Sherridon*

was injected into these fractures to form dyke-like masses normal to the parent sill. The major offshoot fracture zones developed along east-plunging drag-folds. The dyke-like masses of pegmatite were subjected to deformational movement, previously described; the same processes of fracturing and ore replacement have taken place within the offshoot structures as in the main zone.

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Ministry of
Northern Development
and Mines

Ministère du
Développement du Nord
et des Mines

Geoscience Approvals Section
933 Ramsey Lake Road
6th Floor
Sudbury, Ontario
P3E 6B5

Telephone: (705) 670-5853
Fax: (705) 670-5863

July 28, 1993

Our File: 2.15032
Transaction #: W9360.00096

Mining Recorder
Ministry of Northern
Development and Mines
60 Wilson Avenue
1st Floor
Timmins, Ontario

Dear Sir/Madam:

Subject: APPROVAL OF ASSESSMENT WORK CREDITS ON MINING CLAIMS
P1181231 ET AL IN NOVA TOWNSHIP

The assessment work credits for Geology and Assays, Sections 12 and 17 of the Mining Act Regulations, have been approved as outlined on the original submission.

Please note that the original submission was filed under Geological and Geochemical surveys. There was insufficient data provided to allow the information to remain under the Geochemical section. The submission has however been approved at full value under the above-mentioned sections.

The approval date is July 27, 1993.

If you have any questions regarding this correspondence, please contact Lucille Jerome at (705) 670-5855.

Yours sincerely,

Ron C. Gashinski
Senior Manager, Mining Lands Section
Mining and Land Management Branch
Mines and Minerals Division

lj/dm

cc: Resident Geologist
Timmins, Ontario

Assessment Files Library
Toronto, Ontario

TWO CLAIMS

Ministry of
Northern Development
and Mines
Ontario

Report of Work Conducted After Recording Claim

Mining Act

Transaction Number
W9360.00096

Personal information collected on this form is obtained under the authority of the Mining Act. This information will be used for correspondence. Questions about this collection should be directed to the Provincial Manager, Mining Lands, Ministry of Northern Development and Mines, Fourth Floor, 159 Cedar Street, Sudbury, Ontario, P3E 6A5, telephone (705) 670-7264.

2.15032

Instructions:
- Please type or print and submit in duplicate.
- Refer to the Mining Act and Regulations for requirements of filing assessment work or consult the Mining Recorder.
- A separate copy of this form must be completed for each Work Group.
- Technical reports and maps must accompany this form in duplicate.
- A sketch, showing the claims the work is assigned to, must accompany this form.

Recorded Holder(s): David V. Jones / T.K. Filo		Client No.: 149868 / 131784
Address: General Delivery Porcupine Ont / Pontiac		Telephone No.: ~~26~~ 235-2424
Mining Division: Porcupine	Township/Area: Nova Twp	M or G Plan No.
Dates Work Performed From: Sept. 1/91	To: Nov 11/92	

Work Performed (Check One Work Group Only)

	Work Group	Type
☐	Geotechnical Survey	Geology & Geochem Survey
☐	Physical Work, Including Drilling	Linecutting
☐	Rehabilitation	
☐	Other Authorized Work	
☐	Assays	Soil Sample Assays for Geochem
☐	Assignment from Reserve	

RECEIVED
MAY 20 1993
MINING LANDS BRANCH

RECORDED
MAY - 5 1993
Receipt

Total Assessment Work Claimed on the Attached Statement of Costs $ $25161.00

Note: The Minister may reject for assessment work credit all or part of the assessment work submitted if the recorded holder cannot verify expenditures claimed in the statement of costs within 30 days of a request for verification.

Persons and Survey Company Who Performed the Work (Give Name and Address of Author of Report)

Name	Address
T.K. Filo	535 Bartleman Timmins Ont.
D Jones	Porcupine General Delivery Porcupine

(attach a schedule if necessary)

Certification of Beneficial Interest * See Note No. 1 on reverse side

I certify that at the time the work was performed, the claims covered in this work report were recorded in the current holder's name or held under a beneficial interest by the current recorded holder.	Date: May 3/93	Recorded Holder or Agent (Signature): D V Jones

Certification of Work Report

I certify that I have a personal knowledge of the facts set forth in this Work report, having performed the work or witnessed same during and/or after its completion and annexed report is true.

Name and Address of Person Certifying: J.K. Filo 535 Bartleman Timmins Ont.

Telepone No.: 268-9045	Date: May 3/93	Certified By (Signature)

For Office Use Only

Total Value Cr. Recorded: $25,161.00	Date Recorded: May 5th/93	Mining Recorder: D White	Received Stamp: PORCUPINE MINING DIVISION RECEIVED MAY 5 1993 TB (c) 8:30
	Deemed Approval Date: Aug. 3rd/93	Date Approved	
	Date Notice for Amendments Sent		

0241 (03/91)

Numéro de rapport sur les travaux exécutés pour l'affectation de la réserve	Numéro de claim	Nombre d'unités	Valeur des travaux d'évaluation exécutés sur ce claim	Valeur affectée à ce claim	Valeur transférée de ce claim	Réserve : travaux à réclamer à une date ultérieure
	1181231 ~~[illegible]~~	14	9366	8386	980	0
	1181230 *	4	2808	1600	1208	0
	1181239 ✓	1	670	599	70	1
	1181238 ✓	1	670	599	22	49
	1181237 ✓	1	670	599	71	0
	1181240 ✓	1	670	599	71	0
	1181247 ✓	1	670	599	71	0
	1181248 ✓	1	670	599	71	0
	1181241 *	1	808	599	209	0
	1181245 * ✓	1	802	599	203	0
	1181246 * ✓	1	802	599	203	0
	1181232 ✓	1	670	400	270	0
	1181242 * ✓	1	802	599	203	0
	1181250 * ✓	1	802	599	203	0
	1181249 ✓	1	670	599	71	0
	1181233 ✓	1	670	400	270	0
	1181243 * ✓	1	802	599	203	0
	~~[illegible]~~ SEE		SEE NEXT PAGE	SEE NEXT PAGE	SEE NEXT PAGE	SEE NEXT PAGE
	Nombre total de claims		Valeur totale des travaux exécutés	Valeur totale des travaux qui a été affectée	Total transféré	Réserve totale

Les crédits que vous réclamez dans le présent rapport peuvent être réduits. Afin de diminuer les conséquences défavorables de telles réductions, veuillez indiquer l'ordre dans lequel vous désirez qu'elles soient appliquées à vos claims. Veuillez cocher (✓) l'une des options suivantes :

1. ☐ Les crédits doivent être réduits en commençant par le dernier claim sur la liste.
2. ☐ Les crédits doivent être réduits également entre tous les claims figurant dans le présent rapport.
3. ☐ Les crédits doivent être réduits selon l'ordre donné en annexe.

Si vous n'avez pas choisi d'option, la première sera appliquée.

Note 1 : Exemples d'intérêts bénéficiaires : cessions non enregistrées, ententes sur des options, ententes sur des options, protocoles d'entente, etc. relatifs aux claims.

Note 2: Si les travaux ont été exécutés sur un terrain faisant l'objet de lettres patentes ou d'un bail, veuillez remplir ce qui suit:

Je certifie que le titulaire enregistré possédait un intérêt bénéficiaire sur le terrain faisant l'objet de lettres patentes ou d'un bail, au moment où les travaux ont été exécutés.	Signature	Date

W9360.00096

Numéro de rapport sur les travaux exécutés pour l'affectation de la réserve	Numéro de claim	Nombre d'unités	Valeur des travaux d'évaluation exécutés sur ce claim	Valeur affectée à ce claim	Valeur transférée de ce claim	Réserve : travaux à réclamer à une date ultérieure
2.15032	1181244 ✓ *	1	801	599	54	148
	1181235 ✓	1	669	599	70	~~0~~
	1181234 ✓	1	669	400	264	~~0~~
	~~1182 [illegible]8~~	~~8~~				
	1182198	8	~~0~~	4792	~~0~~	~~0~~

	Nombre total de claims		Valeur totale des travaux exécutés	Valeur totale des travaux qui a été affectée	Total transféré	Réserve totale
	~~[illegible]~~ 21		25161	24963	4792	198

Les crédits que vous réclamez dans le présent rapport peuvent être réduits. Afin de diminuer les conséquences défavorables de telles réductions, veuillez indiquer l'ordre dans lequel vous désirez qu'elles soient appliquées à vos claims. Veuillez cocher (✓) l'une des options suivantes :

1. ☐ Les crédits doivent être réduits en commençant par le dernier claim sur la liste.
2. ☐ Les crédits doivent être réduits également entre tous les claims figurant dans le présent rapport.
3. ☐ Les crédits doivent être réduits selon l'ordre donné en annexe.

Si vous n'avez pas choisi d'option, la première sera appliquée.

Note 1 : Examples d'intérêts bénéficiaires : cessions non enregistrées, ententes sur des options, protocoles d'entente, etc. relatifs aux claims.

Note 2: Si des travaux ont été exécutés sur un terrain faisant l'objet de lettres patentes ou d'un bail, veuillez remplir ce qui suit:

Je certifie que le titulaire enregistré possédait un intérêt bénéficiaire sur le terrain faisant l'objet de lettres patentes ou d'un bail, au moment où les travaux ont été exécutés.	Signature	Date

0241 (05/91)

Ontario

Ministry of
Northern Development
and Mines

Min[illegible]e du
Développement du Nord
et des mines

Statement of Costs for Assessment Credit

État des coûts aux fins du crédit d'évaluation

Mining Act/Loi sur les mines

Transaction No./N° de transaction
W9360. 00096

2.15032

Personal information collected on this form is obtained under the authority of the **Mining Act**. This information will be used to maintain a record and ongoing status of the mining claim(s). Questions about this collection should be directed to the Provincial Manager, Minings Lands, Ministry of Northern Development and Mines, 4th Floor, 159 Cedar Street, Sudbury, Ontario P3E 6A5, telephone (705) 670-7264.

Les renseignements personnels contenus dans la présente formule sont recueillis en vertu de la **Loi sur les mines** et serviront à tenir à jour un registre des concessions minières. Adresser toute quesiton sur la collece de ces renseignements au chef provincial des terrains miniers, ministère du Développement du Nord et des Mines, 159, rue Cedar, 4e étage, Sudbury (Ontario) P3E 6A5, téléphone (705) 670-7264.

1. Direct Costs/Coûts directs

Type	Description	Amount Montant	Totals Total global
Wages Salaires	Labour Main-d'oeuvre		
	Field Supervision Supervision sur le terrain		
Contractor's and Consultant's Fees Droits de l'entrepreneur et de l'expert-conseil	Type LINECUTTING (FORPRO)	16,400	
	K. FILO GEOLOGY	6800	
	ASSAYER	1061	24261
Supplies Used Fournitures utilisées	Type		
Equipment Rental Location de matériel	Type		

ED
MA 1993
RANCH

Total Direct Costs Total des coûts directs 24261.

Note: The recorded holder will be required to verify expenditures claimed in this statement of costs within 30 days of a request for verification. If verification is not made, the Minister may reject for assessment work all or part of the assessment work submitted.

2. Indirect Costs/Coûts indirects *

** **Note:** When claiming Rehabilitation work indirect costs are not allowable as assessment work.
Pour le remboursement des travaux de réhabilitation, les coûts indirects ne sont pas admissibles en tant que travaux d'évaluation.

Type	Description	Amount Montant	Totals Total global
Transportation Transport	Type TRUCK TRAVEL 15	900	
	TRIPS @ 200km @ 30¢		
	1km		
			900
Food and Lodging Nourriture et hébergement			
Mobilization and Demobilization — Mobilisation et démobilisation			

RECORDED
MAY 5 1993

Sub Total of Indirect Costs Total partiel des coûts indirects 900

Amount Allowable (not greater than 20% of Direct Costs) Montant admissible (n'excédant pas 20 % des coûts directs)

Total Value of Assessment Credit (Total of Direct and Allowable indirect costs) **Valeur totale du crédit d'évaluation (Total des coûts directs et indirects admissibles** [illegible]

25161

Note : Le titulaire enregistré sera tenu de vérifier les dépenses demandées dans le présent état des coûts dans les 30 jours suivant une demande à cet effet. Si la vérification n'est pas effectuée, le ministre peut rejeter tout ou une partie des travaux d'évaluation présentés.

Filing Discounts

1. Work filed within two years of completion is claimed at 100% of the above Total Value of Assessment Credit.
2. Work filed three, four or five years after completion is claimed at 50% of the above Total Value of Assessment Credit. See calculations below:

Total Value of Assessment Credit		Total Assessment Claimed
	× 0.50 =	

Remises pour dépôt

1. Les travaux déposés dans les deux ans suivant leur achèvement sont remboursés à 100 % de la valeur totale susmentionnée du crédit d'évaluation.
2. Les travaux déposés trois, quatre ou cinq ans après leur achèvement sont remboursés à 50 % de la valeur totale du crédit d'évaluation susmentionné. Voir les calculs ci-dessous.

Valeur totale du crédit d'évaluation		Évaluation totale demandée
	× 0,50 =	

Certification Verifying Statement of Costs

I hereby certify:
that the amounts shown are as accurate as possible and these costs were incurred while conducting assessment work on the lands shown on the accompanying Report of Work form.

that as T. H. FILO I am authorized
(Recorded Holder, Agent, Position in Company)

to make this certification

Attestation de l'état des coûts

J'atteste par la présente :
que les montants indiqués sont le plus exact possible et que ces dépenses ont été engagées pour effectuer les travaux d'évaluation sur les terrains indiqués dans la formule de rapport de travail ci-joint.

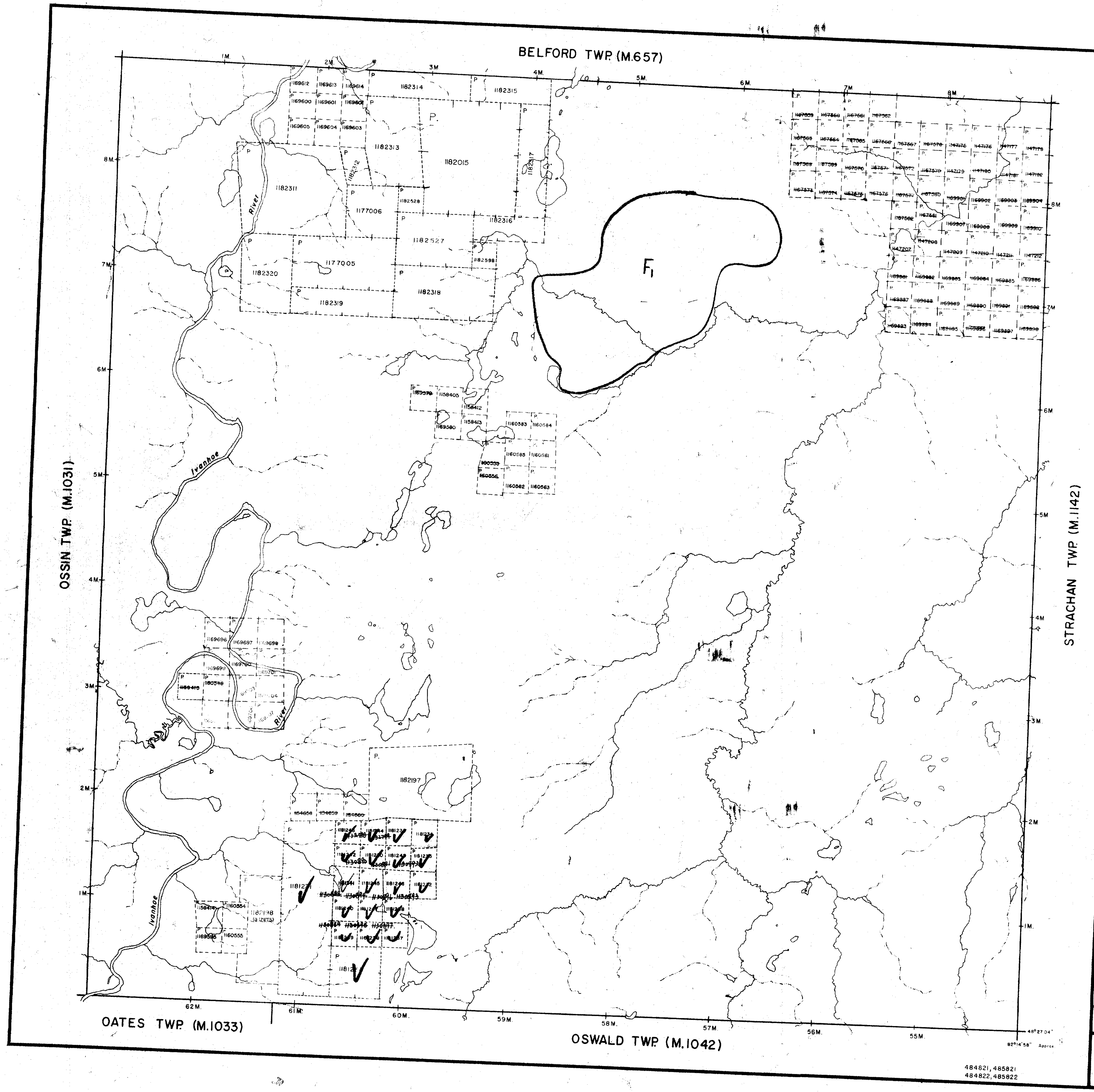
Et qu'à titre de ______ je suis autorisé
(titulaire enregistré, représentant, poste occupé dans la compagnie)

à faire cette attestation.

Signature

Date MAY 3/93

Nota : Dans cette formule, lorsqu'il désigne des personnes, le masculin est utilisé au sens neutre.



THE TOWNSHIP OF

NOVA

DISTRICT OF
COCHRANE

PORCUPINE
MINING DIVISION

RECEIVED
MAY 20 1993
MINING LANDS BRANCH

SCALE: 1-INCH = 40 CHAINS

LEGEND

PATENTED LAND	Ⓟ
CROWN LAND SALE	C.S.
LEASES	Ⓛ
LOCATED LAND	Loc.
LICENSE OF OCCUPATION	L.O.
MINING RIGHTS ONLY	M.R.O.
SURFACE RIGHTS ONLY	S.R.O.
ROADS	═
IMPROVED ROADS	═
KING'S HIGHWAYS	═
RAILWAYS	─
POWER LINES	─
MARSH OR MUSKEG	▨
MINES	⚒
CANCELLED	C.

NOTES

400' surface rights reservation along the shores of all lakes and rivers.

F1 THIS TWP. SUBJECT TO FORESTRY ACTIVITY IN 1993-94 GORDON COSENS F.M.A.

PORCUPINE MINING DIVISION
RECEIVED
MAY 19 1993

THE INFORMATION THAT APPEARS ON THIS MAP HAS BEEN COMPILED FROM VARIOUS SOURCES, AND ACCURACY IS NOT GUARANTEED. THOSE WISHING TO STAKE MINING CLAIMS SHOULD CONSULT WITH THE MINING RECORDER, MINISTRY OF NORTHERN DEVELOPMENT AND MINES, FOR ADDITIONAL INFORMATION ON THE STATUS OF THE LANDS SHOWN HEREON.

PLAN NO.- M.1030

ONTARIO
MINISTRY OF NATURAL RESOURCES
SURVEYS AND MAPPING BRANCH

M.1030

NOVA TWP.

M.1030

MAP SYMBOLS

Beaver Lake

Excessively Wet Area (swamp)

Claim Post (Located / Calculated)

25 METRE
CUT FALL/91

Assumed Contact

LITHOLOGICAL LEGEND

1) Fe[illegible]
(b) Dacite Tuff
(c) Chert

3
(a) Quartzite

4) Felsic Intrusive
4d)

5) Mafic [illegible]
5a) Gabbro

6)
6b) Hornblende [illegible]
Silicified [illegible]

F.G.R.E # S5-3

GEOLOGICAL SURVEY
NOJA TOWNSHIP
(SECTION B - NORTH PART)

DATE: NOV. 21/92 | SCALE: 1:2500
DRAWN: D. JONES | FIELD WORK: D. JONES + K. FILO

SCALE
(METRES)
0 25 50 75 100 125 150

B-15082

210

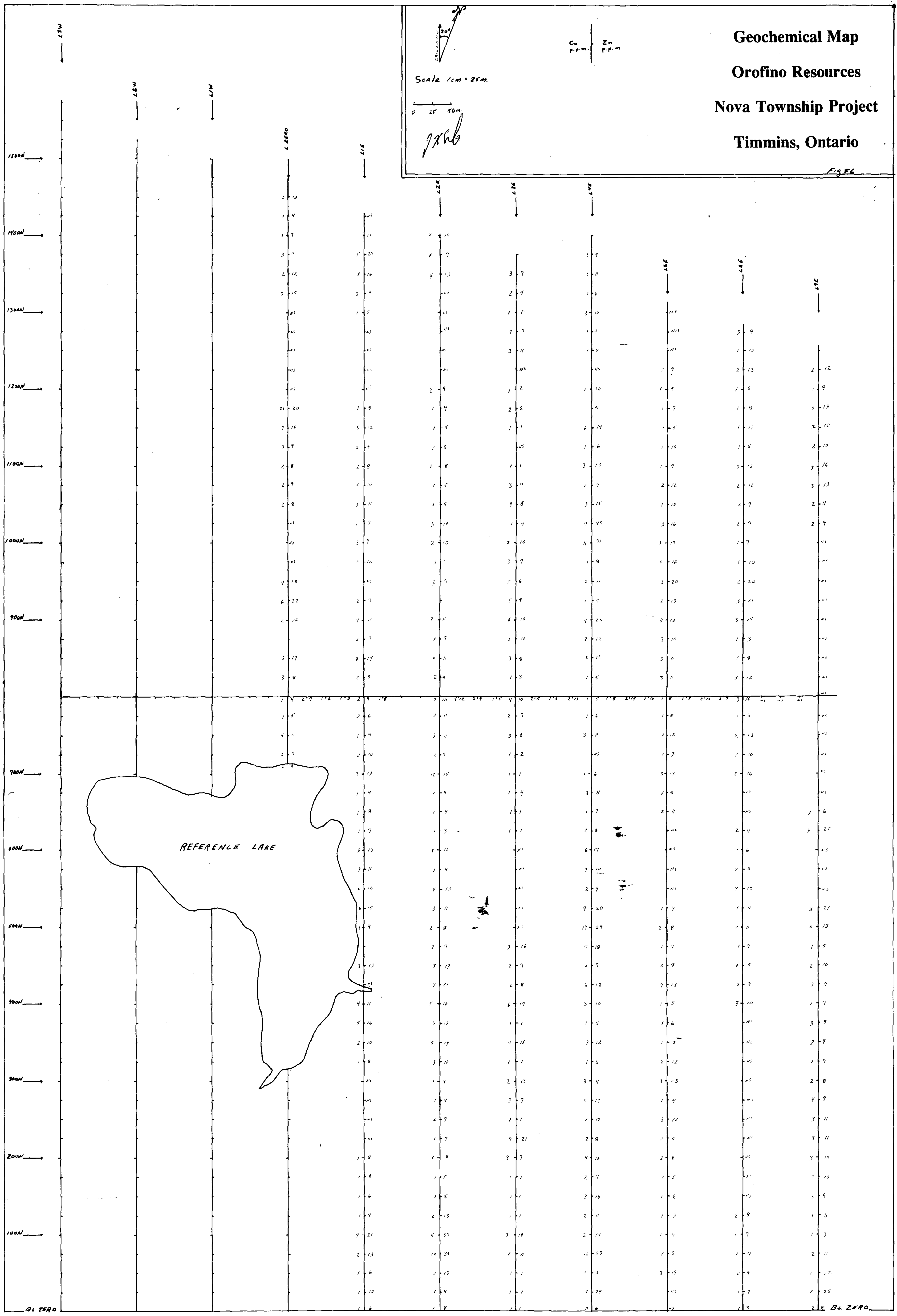
2.13032

FIGURE # 55-3

GEOLOGICAL SURVEY
NOVA TOWNSHIP
(SECTION A SOUTH PART)

DATE : NOV. 12/92
SCALE : 1:2500
DRAWN : D. JONES
FIELD WORK : D. JONES + K. FILO

2.15032



Geochemical Map

Orofino Resources

Nova Township Project

Timmins, Ontario