

Mount Nansen Mines Limited

REVIEW-REPORT ON THE MOUNT NANSEN MINE,  
YUKON TERRITORY, CANADA

by

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Vancouver, Canada

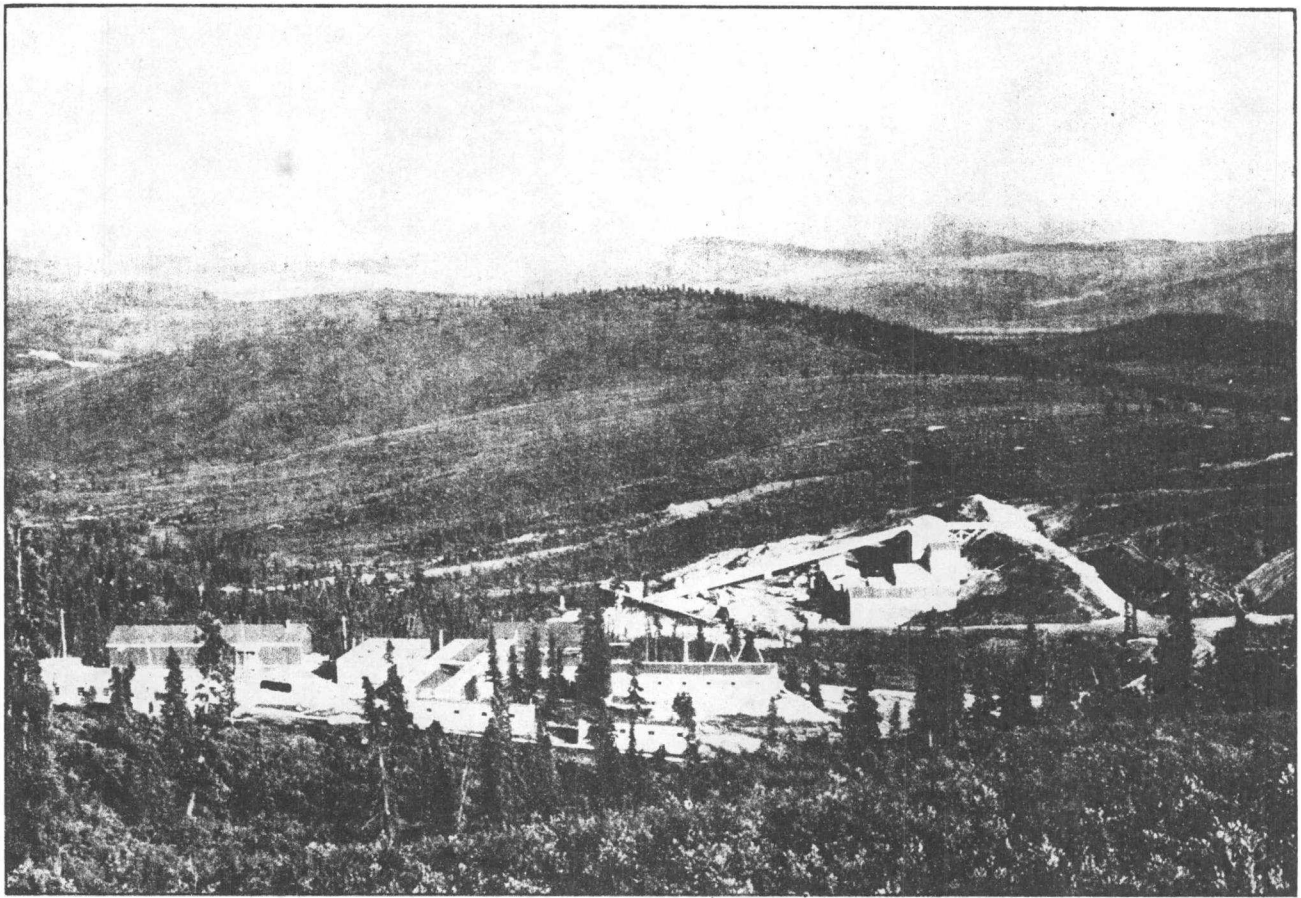
July 17, 1970

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View over-looking part of Mount Nansen Mines Property

## INTRODUCTION

This report is not intended to be a feasibility study, but a review-report of all available data on the geology, mineralogy, metallurgy, and, to a lesser extent, of the mining problems and cost estimates, related with the property of Mount Nansen Mines Limited in general and to the existing mine in particular. Most of the following chapters are taken unchanged from individual reports which were written on specific problems during 1969 and 1970 (see reference list). This explains the rather discontinuous character, the numerous repetitions and the partial lack of a logical thread through this report. Underground exploration and development of the Mount Nansen property, started 1965, subsequently to the acquisition of a controlling interest in Mount Nansen Mines Limited by Peso Silver Mines Limited in 1964. The relatively extensive underground drifting performed by Mount Nansen Mines Limited in 1965, 1967 and 1968 opened up a parallel system of silver - gold vein zones on one level of the Webber mine and on two levels of the Huestis mine. The exploratory and development work was carried out and managed by the company and followed the recommendations of the company's consultant, Dr. D.D. Campbell of Dolmage-Campbell and Associates Limited of Vancouver, B.C.

Parallel to the development of the Mount Nansen prospect, limited underground exploratory and development work was achieved on the adjacent Brown-McDade property, controlled by Charter Oil Company Limited. Purpose of this program was to develop mineable ore which should have been treated in the neighbouring Mount Nansen mill. The results of the development work which did not meet the company's expectations, together with the closing-down of the Mount Nansen mill resulted in the termination of any development plans at Brown-McDade. The authors did some review work on the Brown-McDade mine, however, the results are not included in this report, since this company is not directly related to Mount Nansen Mines Limited due to the particular constellation of the controlling interests at the present moment.

F. Bianchi  
P. S. [unclear]

LOCATION AND ACCESS.

The Mount Nansen property lies in the Carmacks district, Yukon Territory (137°10'W/62°05'N), some 115 miles to the northwest of Whitehorse and 30 miles to the west of Carmacks. From Vancouver the mine is reached by commercial airplane to Whitehorse, then by 100 miles of good gravel road to Carmacks on the Whitehorse - Mayo highway, and finally by 40 miles of all weather gravel road built by the company. Due to the severe influence of rigid winters and spring run-offs and due to the fact that at the moment no regular road maintenance work is carried out, the condition of the access road is deteriorating progressively. Therefore, the road is difficult to use, especially during wet periods. However, the mine can be reached much faster from Whitehorse by float plane, the landing being on Victoria Lake, 5 miles to the southeast, or by land planes making use of the airstrip 2 miles southeast of the mine during the winter months. The property lies at the southeast end of the northwest trending Dawson Range on gently rolling hills, the relief being rather unpronounced. The main ridge, lying between Nansen Creek to the east and Victoria Creek to the west, rises to 5000 feet. Mount Nansen, 5593 feet, is located 6 miles northwest of the mine, and Victoria Mountain, 6136 feet, 6 miles north of the mine. The timberline has an elevation of approximately 4000 feet; thus the lowest sections of the property are covered by forests of white and black spruce, birch and poplar, while the highest sections are covered by grass and shrubs.

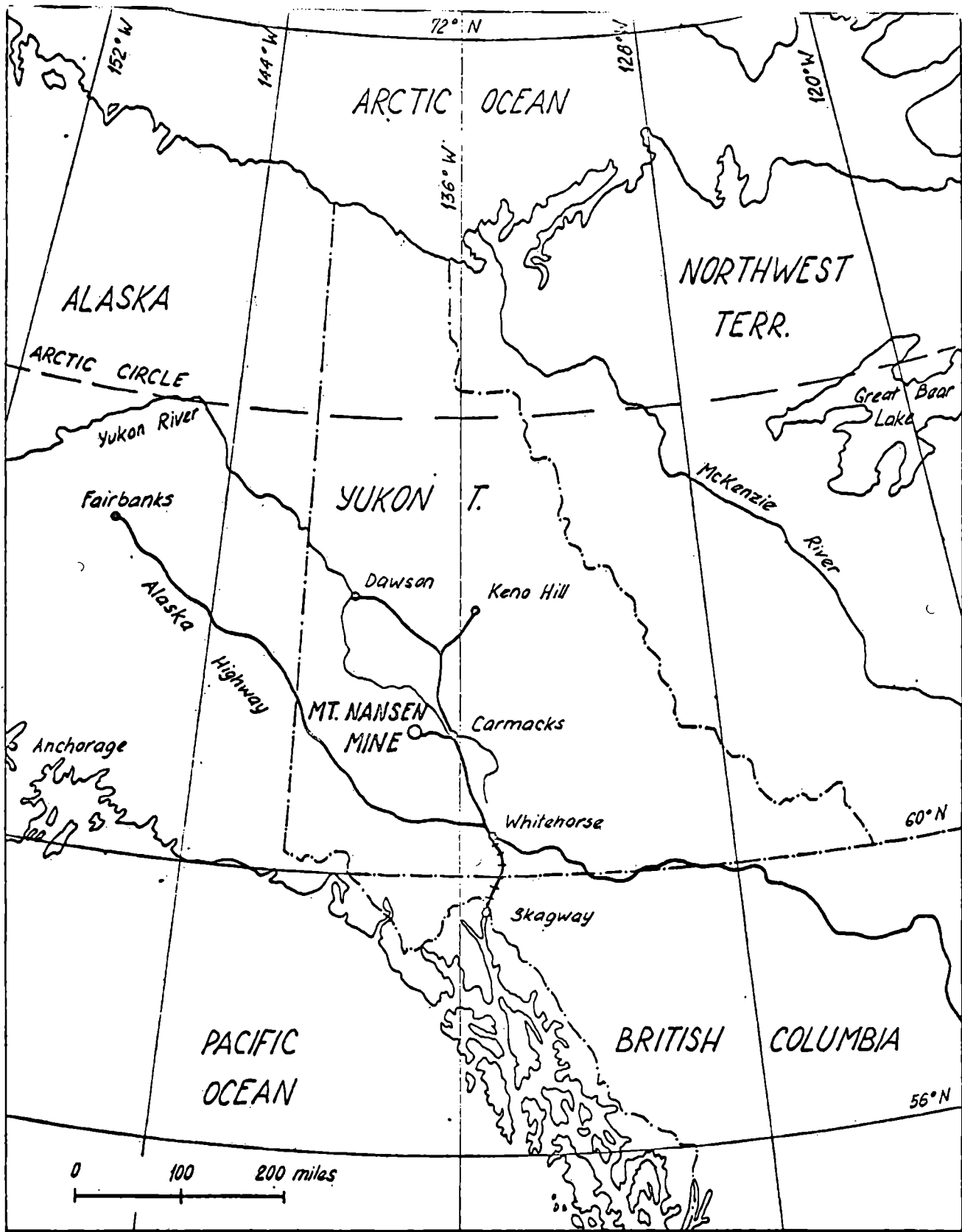


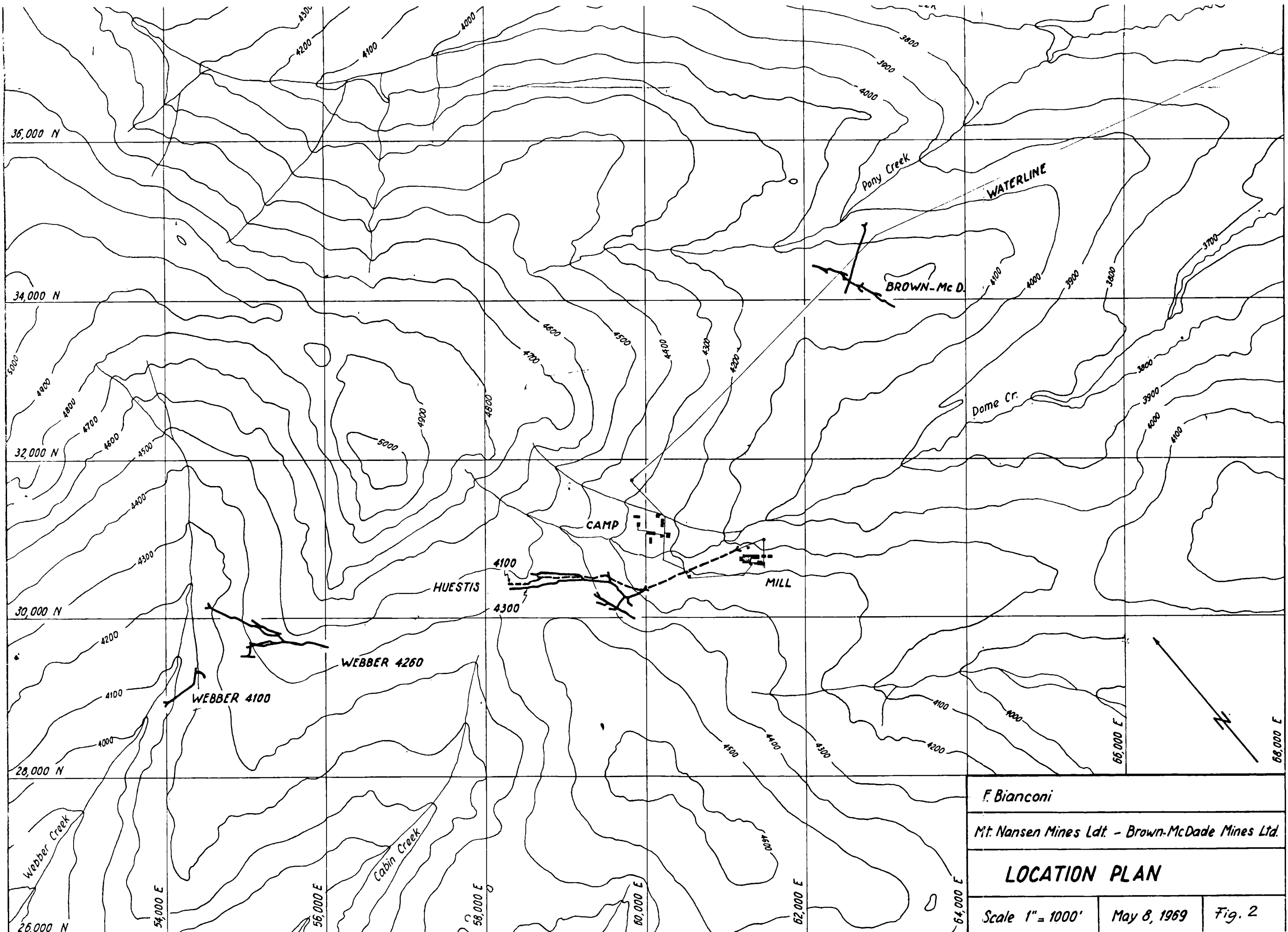
Fig. 1. Mt. Nansen Mines Ltd., Location



comprises 3 four-cycle Waukesha diesels, each driving a Tamper generator of 312 KVA, 250 KW, 440 V capacity, needed for the power supply of mill and camp, and for the 3 Ingersoll Rand compressors (200 H.P., 150 H.P., and 125 H.P.) which provide the compressed air for the Huestis mine. The old Webber Camp provided accommodation for 40 men and was replaced by the permanent camp at Huestis in December 1968. The new camp lies 1200 feet to the west of the mill, at an elevation of 4200 feet, and provides comfortable accommodation for 80 men. The complex consists of:

- 1 Cookhouse
- 1 Recreation hall
- 1 Administration building
- 1 Standby power and boiler unit
- 1 Staff bunkhouse
- 7 Bunkhouses

The assay laboratory lies halfway between the camp and the mill complex. The water supply originates from a deepwell near the confluence of Back Creek and Victoria Creek. The pumphouse has two pumps: an electric pump discharges from the well into a concrete pit in the pumphouse, a diesel pump discharges from the pit to an approximately 12,500 feet long, 4 inch pipeline. This line supplies the 22,000 wood reservoir above the campsite. This tank provides water to the camp and to the 35,000 gal. mill tank through a 4 inch gravity line. All lines are above ground and are heated by thermal cable and wrapped with fibreglass insulation and heavy plastic.



F. Bianconi  
 Mt. Nansen Mines Ltd. - Brown-McDade Mines Ltd.  
**LOCATION PLAN**  
 Scale 1" = 1000'    May 8, 1969    Fig. 2

HISTORY

Widespread activity on gold placers in the Dawson Range started subsequent to the Klondike Gold Rush of 1898 in the early years of this century. The best placers were found in the tributaries of Nansen and Victoria Creek and work was done intermittently since 1907 (Cairnes, 1914). The first primary gold deposit was discovered by P.R. Guder in 1930 at Freegold mountain, 14 miles north of Mount Nansen (Bostock, 1936). One prospect in this area, the La Forma Mine, was first developed in 1934 by the Timmins Corporation, and in 1965 was brought into production as a gold mine by Discovery Mines Limited (Campbell, 1968).

The following is a brief history of the activities in the Mount Nansen area. Most data was obtained from several reports of D.D. Campbell.

- 1943 Prospectors Brown and McDade discovered the first lode in the immediate vicinity.
- 1946 Brown-McDade Mines Limited achieved underground exploration work.
- Conwest Exploration Limited explored the Webber area, and the Huestis Syndicate trenched the Huestis Vein Zone.
- 1947 Activities ceased at Brown-McDade as the results of the exploration were rather disappointing. First metallurgical tests performed on Brown-McDade ore indicated low recoveries for gold and silver.
- 1962-
- 1963 The Mount Nansen Mines Syndicate was formed (Newmont, Noranda, Rio Tinto, Kerr-Adison, Conwest, and Faraday). Extensive trenching of the Webber and Huestis Vein Zones.
- 1963 Mount Nansen Mines Limited incorporated as a Toronto based Company.
- 1964 Peso Silver Mines Limited acquired control of Mount Nansen Mines Limited. Exploration continued.
- 1964-
- 1965 Underground exploration started at Webber and Huestis.
- 1965 Exploratory drilling at Brown-McDade.
- 1967-
- 1968 Following extensive underground exploratory ~~drilling and metallurgical testing~~, a mill was purchased from Minoca Mines Limited at the Eureka property on Vancouver Island and reerected at Mount Nansen.
- ← NO WAY

1968 January 19, the Feasibility Report of Dolmage-Campbell & Associates Limited, of Vancouver, was submitted to the Company. The report is summarized as follows (page 6):

"From the results of our investigations, summarized above, we conclude that the 250 ton/day operation at Mount Nansen Mines Limited in the Yukon, is feasible, very profitable, and in addition holds excellent promise for greatly increased revenue through improved metallurgy and expanded production. In addition, the potential of the deposits indicates a life well in excess of 10 years at 300 tons per day".

1968-

1969 The production period of Mount Nansen started September 1968 and ended April 1969. The rate of production never reached 200 tpd, due to lack of enough stoped ore and to several operational problems. Recoveries and concentration did not meet expectations outlined in the feasibility report and the ore-grade was lower than that of the estimated reserves, since dilution was considerable and the estimated grade too high.

All these factors made the operation uneconomical and by April 1969 the decision was reached to close down the operation.

1969 In May 1969, the day-to-day management of the operation was committed to S & N Mine Management Consultants, Vancouver. A small crew cleaned up the mine site and the underground workings during summer and fall 1969.

1970 During winter and spring 1970 the mine was on a stand-by basis, pending eventual financing for further development work. In March 1970, as it became apparent that no further financing was available, the decision was taken to completely close the mine and since March 15, only a watchman is on the property.

On May 22, Gesellschaft fuer Metallwerte in Zuerich, as the debenture-holder appointed a receiver for Mount Nansen Mines Limited who acts as operator of the company in default.

C L A I M S

Mount Nansen Mines Limited owns 299 mineral claims and 9 fractions. A list of the claims giving their Grant No, Claim Sheet No, and Expiry Date is given below (as updated on May 26, 1970):

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
B.M. No. 1	77668	115-I-3	May 8, 1974
2	77669	"	" " "
3	77670		
4	77671		
5	77672		
6	77673		
7	77674		
8	77675		
9	77676		
10	77677		
11	77678		
12	77679		
13	77680		
14	77681		
15	77682		
16	77683		
17	77684		
18	77685		
19	77686		
20	77687		
21	77688		
22	77689		
23	77690		
24	77691		
25	77692		
26	77693		
27	77694		
28	77695		
29	77696		
30	77697		

TOTAL 30 B.M. CLAIMS

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Joanne No. 1	74283	115-I-3	July 28, 1978
2	74284	"	" " "
3	74285		
4	74286		
5	74287		
6	74288		
7	74289		1974
8	74290		1974

TOTAL 8 JOANNE CLAIMS

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Jeff No. 1	77798	115-I-3	May 8, 1978
2	77799	"	" " "
3	77800		
4	77801		
5	77802		1974
6	77803		"
7	77804		
8	77805		
9	77806		
10	77807		
11	77808		
12	77809		
13	77810		
14	77811		

TOTAL 14 JEFF CLAIMS

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Dome No. 1	73537	115-I-3	June 13, 1978
2	73538	"	" " "
3	73539		" " "
4	73540		" " "
5	73541		" " "
6	73542		" " "
7	73543		" " "
8	73694		July 15, 1978
9	73695		" " "
10	73696		" " "
11	73697		" " "
12	73698		" " "
13	73699		" " "
14	73700		" " "
15	73701		" " "
16	73702		" " "
17	73703		" " "
18	73704		" " "
19	73705		" " "
20	73706	"	" " "
21	73707		" " "
22	73708		" " 74
23	73709		" " "
24	73710		" " "
25	77746		May 8, 1978
26	77747		" " " 74
27	77748		" " " 78
28	77749		" " " 74
29	77750		" " " "
30	77751		" " " "
31	77752		" " " "
32	77753		" " " "
33	77754		" " " 78
34	77755		" " " "
35	77756		" " " "
36	77757		" " " "
37	77758		" " " "
38	77759		" " " "
39	77760		" " " "
40	77761		" " " "
41	77762		" " " "
42	77763		" " " "
43	77764		" " " 74
44	77765		" " " "
45	77766		" " " "
46	77767		" " " "
47	77768		" " " "
48	77769		" " " "
49	77770		" " " 78
50	77771		" " " "

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Dome No. 51	77772	115-I-3	May 8, 1978
52	77773	"	" " "
53	77774		"
54	77775		"
55	77776		
56	77777		
57	77778		
58	77779		1974
59	77780		"
60	77781		
61	77782	"	
62	77783		
63	77784		
64	77785		
65	77786		
66	77787		
67	77788		
68	77789		
69	77790		
70	77791		
71	77792		
72	77793		
73	77794		
74	77795		
75	77796		
76	77797		
78	81842		Sept. 18, 1978
79	81843		" " "
80	81844		
81	81845		
82	81846		
83	81847		
84	81848		
85	81849		
86	81850		
87	81851		1974
88	81852		"
89	81853		1978
90	81854		"
91	81855		
92	81856		
93	81857		1974
94	81858		"
95	81859		
96	81860		
97	81861		
98	82026		
99	81862		
100	81863		
101	81864		
102	81865		
103	81866		
104	81867		
105	81868		
106	81869		

TOTAL 105 DOME CLAIMS

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Dolly No. 1	81938	115-I-3	Sept. 26, 1974
2	81939	"	" " "
3	81940		
4	81941		
5	81942		
6	81943		
7	81944		
8	81945		
9	81970		Oct. 5, 1974
10	81971		" " "
11	81972		
12	81973		
13	81974		
14	81975		
15	81976		
16	81977		
17	81978		
18	81979		
19	81980		
20	81981		
21	81982		
22	81983		
23	81984		
24	81985		
25	81986		
26	81987		
27	81988		
28	81989		
29	81990		
30	81991		
31	81992		
32	81993		
33	81994		
34	81995		
35	81996		
36	81997		
37	81998		
38	81999		
39	82000		
40	82001		
41	82002		
42	82003		
43	82004		
44	82005		
45	82006		
46	82007		
47	82008		
48	82009		
49	82010		
50	82011		

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Dolly No. 51	82012	115-I-3	Oct. 5, 1974
52	82013	"	" " "
53	82014		
54	82015		
55	82016		
56	82017		
57	82018		
58	82019		
59	82020		
60	82021		
61	82022		
62	82023		
63	82024		
64	82025		

TOTAL 64 DOLLY CLAIMS

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Harry No: 1 Fr.	Y26391	115-I-3	Oct. 21, 1973
2 Fr.	Y26392	"	" " "
3 Fr.	Y26393		
4 Fr.	Y26394		
5 Fr.	Y26395		
6 Fr.	Y26396		
7 Fr.	Y26397		
8 Fr.	Y26398		
9 Fr.	Y26399		

TOTAL 9 FRACTIONS

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Stone No. 1	93478	115-I-3	Nov. 1, 1974
2	93479	"	" " "
3	93480		"
4	93481		"
5	93482		"
6	93483		
7	93484		
8	93485		

TOTAL 8 STONE CLAIMS

G

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Bit # 1	93441	115-I-3	Nov. 1, 1974
2	93442	"	" " "
3	93443		
4	93444		
5	93445		
6	93446		

TOTAL 6 BIT CLAIMS

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Betty # 1	93486	115-I-3	Nov. 1, 1974
2	93487	"	" " "
3	93488		
4	93494		
5	93495		
6	93496		
7	93497		
8	93498		
9	93499		
10	93489		
11	93490		
12	93491		
13	93492		
14	93493		
15	93500		
16	93501		
17	93502		
18	93503		
19	93504		
20	93505		
21	93506		
22	93507		
23	93508		
24	93509		
25	93510		
26	93511		
27	93512		
28	93513		
29	93514		
30	93515		
31	93516		
32	93517		

TOTAL 32 BETTY CLAIMS

<u>CLAIM</u>	<u>GRANT NO.</u>	<u>SHEET</u>	<u>EXPIRY DATE</u>
Laura # 1	93447	115-I-3	Nov. 1, 1974
2	93448	"	" " "
3	93449		
4	93450		
5	93451		1978
6	93956		17, "
7	93452		Nov. 1, 1974
8	93453		" " "
9	93454		
10	93462		
11	93463		
12	93464		
13	93465		
14	93466		
15	93467		
16	93468		
17	93469		
18	93470		
19	93471		
20	93472		
21	93473		
22	93474		
23	93475		
24	93476		
25	93477		
26	93455		
27	93456		
28	93457		
29	93458		
30	93459		
31	93460		
32	93461		

TOTAL 32 LAURA CLAIMS

All the D Forms covering the "good standing" of the claims as well as the Group Forms are kept in the office of Mount Nansen Mines Limited.

The claims are renewable by paying \$100 per claim per year in lieu of work or by filing assessment work of \$100 per claim per year. All correspondence referring to the Mount Nansen claims have to be directed to the Mining Recorder in Whitehorse, P.O. Box 1767, Whitehorse, Y.T.

It should also be noted that in the south-east corner of the area held by Mount Nansen the claims border with the Brown-McDade property. This property consists of 40 claims, South No 1-40 which expire on August 30, 1974 and of 30 mineral leases which expire between October 23, 1972 and October 9, 1977. All leases can be renewed for another 21 years by \$200. The covering documents and files of the 40 claims and 30 leases are kept in the office of Brown-McDade Mines Limited. Furthermore six mineral leases belonging to Mrs. Gouder in Carmacks and six mineral claims owned by Silver Standard Mines Ltd. lie to the North of the mine workings in the central portion of the Mt. Nansen property (see claim map).

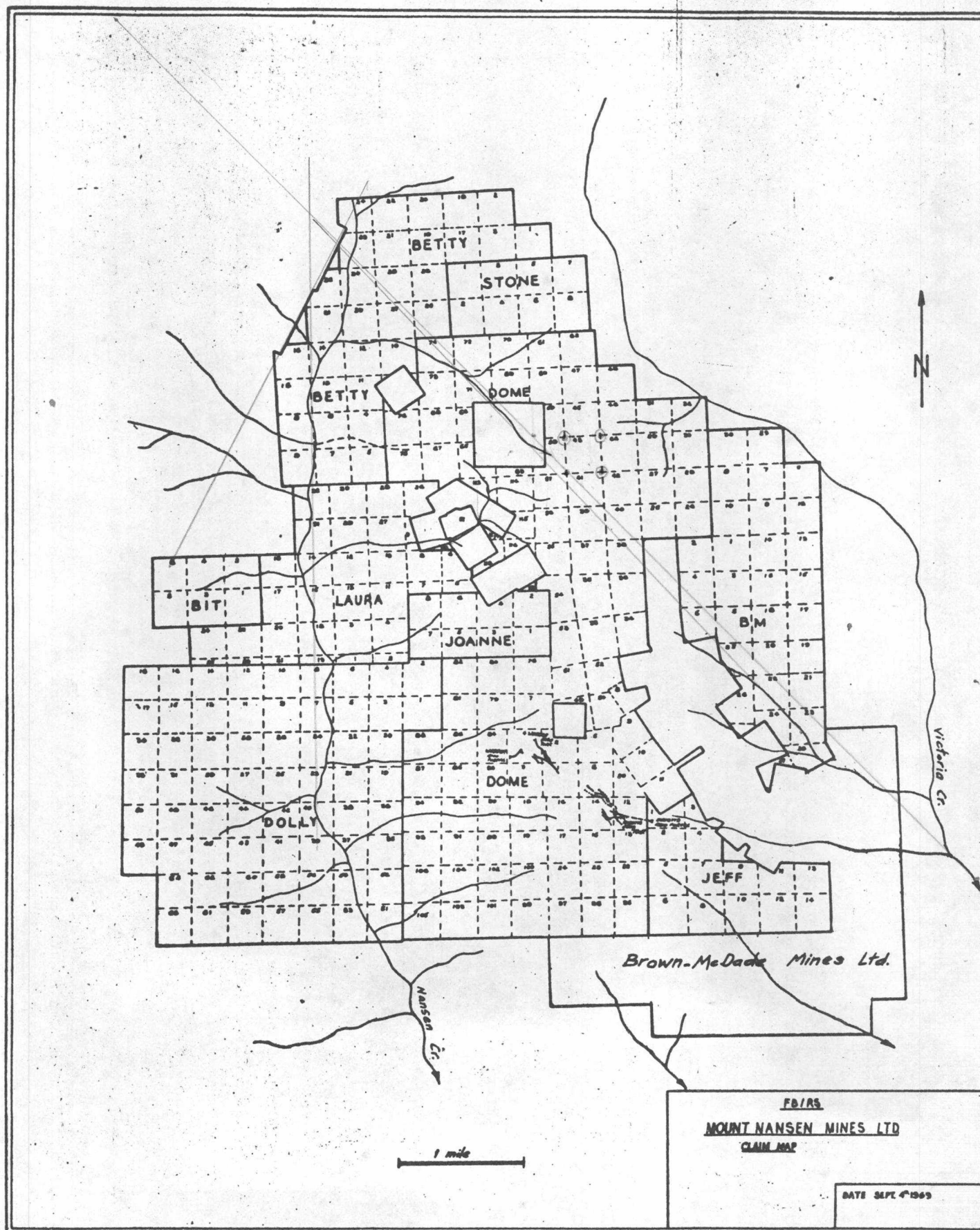


Fig. 3. Claim map

## SUMMARY OF QUARTE MINING ACT - YUKON TERRITORY

The following is a Summary of the Act as it pertains to ordinary administration of claims only. The Act contains much other material which can be referred to if unusual conditions arise.

### Section 12

One person may stake 8 claims in any one year within any 10 miles radius.

### Section 15

Claims are to be a maximum 1500' x 1500' rectangular, and except where a previously located claim is a common boundary.

### Section 38

Claims are to be recorded with the Mining Recorder within 15 days of staking if they are within 10 miles of the Mining Recorder's office. One day extra is allowed for each additional 10 miles. The Mining Recorder issues the claim document Form "B".

### Section 41

Claim is recorded by Mining Recorder on receipt of an Affidavit (Form "A").

### Section 44

Date of the claim is that of the Affidavit and payment of the fee (\$10.00).

### Section 45

The Mining Recorder issues metal tags with the claim numbers thereon and these are to be fixed to the claim posts.

### Section 52

**GROUPING** - Sixteen adjoining claims may be grouped, by notice prior to recording of work by filing Form "E" for recording of work (2 copies!)

If work not recorded claims lapse without notice of cancellation or forfeiture by the Crown.  
Cost \$5.00.

Section 52(4)

To make claims renewable on the same date the Mining Recorder charges \$1.25 cash and \$25.00 in work recording for each 3 months period of extension for each claim.

Section 53

Claim is good for one year. Work of \$100 per year must be recorded within 14 days after expiry date of claim by Affidavit on Form "C" (2 copies) and will receive a Certificate of Work done Form "D".

Excess work up to a total of \$400.00 may be recorded in any one year but must be recorded in the year the work was done. This can be applied to subsequent years - i.e. - up to 4 years.

Cost of Geological Investigations, aerial reconnaissance or other types of preliminary work may be accepted as work during the first 3 years - at the discretion of the Commissioner.

Section 54

If no work done, a claim may be held by payment of \$100.00 per year in lieu of work. Such a payment has to take place within 14 days after the expiry date of the claim.

Section 55

Claim lapses and is open for staking if work is not done or payment made on expiry - no notice required by Crown (See below for work done but not recorded).

If work has been done and not recorded and the claim expires the holder may get it back by recording his work, and paying a penalty of from \$15.00 - \$25.00 up to a 6-months period.

Should the claim be staked by another party during the 6-months period the original holder may get it back by paying the staker's costs of staking and work and the penalty.

Section 57

Work for fractional claims is 50% for those less than 25 acres and full price for over 25 acres.

Section 71

An address for service of every claim holder must be on every Application for Claim, Transfer and Assignment.

Section 79

A claim must be surveyed within one year of notice for such being received from the Surveyor-General.

Section 88

A Transfer or Assignment must be in writing, witnessed, registered with the Mining Recorder, endorsed by the Mining Recorder, who returns one copy to the Assignee.

Section 90

Any document dealing with a claim may be registered with the Mining Recorder.

Section 95

Annual royalty to the Crown:

- upon annual profits in excess of \$10,000.00 and up to \$1,000,000.00 3%
- \$1,000,000.00 to \$5,000,000.00 5%
- \$5,000,000.00 to \$10,000,000.00. 6%
- on the excess above \$10,000,000.00 a proportional increase of 1% for each additional \$5,000,000.00

Statement to be submitted on or before the 1st day of April. Payment on or before the 1st day of October.

Section 96

Leases are for a term of 21 years. They have to be surveyed by a Land Surveyor. First renewal of further 21 years is merely a formality. Further renewals only under terms and conditions as may be prescribed by the Governor in Council.

Forms

Form A: Application for a Full Claim

Form A-1: Application for Fractional Claim

Form B: Record of a Mineral Claim

Form C: Application for a Certificate of Work Affidavit

**Form D: Certificate of Work**  
**Form E: Intention to Group Claims**  
**Form E: Certificate of Improvements**  
**Form G: Notice**  
**Form H: Application for Certificate of Improvements**  
**Form I: Mining Recorder's Certificate**  
**Form J: Survey Notice**

**Fees:**

<b>Record (filing) a Claim</b>	<b>\$10.00</b>
<b>Recording Work (Assessment Work)</b>	
<b>For 1 year</b>	<b>5.00</b>
<b>For 2 years</b>	<b>10.00</b>
<b>For 3 years</b>	<b>15.00</b>
<b>For 4 years</b>	<b>20.00</b>
<b>For 5 years</b>	<b>25.00</b>
<b>Grouping Certificate</b>	<b>5.00</b>
<b>Application for a lease and issue of same</b>	<b>10.00</b>
<b>Rental for whole or fractional mineral claim granted under lease for term of 21 years:</b>	
<b>Up to 51.65 acres</b>	<b>50.00</b>
<b>For each acre fraction thereof over 51.65 acres</b>	<b>5.00</b>
<b>Rental for renewal term of 21 years:</b>	
<b>Up to 51.65 acres</b>	<b>200.00</b>
<b>For each acre of fraction thereof over 51.65 acres</b>	<b>20.00</b>

## GEOLOGY AND PETROLOGY OF THE MOUNT NANSEN AREA

### 1. INTRODUCTION

The geology of the 24 square miles property of Mount Nansen Mines Limited is only known on a regional basis. Detailed mapping is limited to the immediate surroundings of the mine workings. Even here surface mapping is of little use, since it was not performed in a systematical way. The usefulness of the available data is furthermore hampered by the rather confused petrological classification, which varies from author to author.

Since the Mount Nansen area was not covered by ice during the last glaciation the bedrock is covered by up to 50 feet thick overburden. This almost complete lack of outcrops makes surface mapping extremely difficult. Some indications on the surface geology can be obtained by examining the float, where it is not covered by residual soil, volcanic ash and/or decomposed organic matter. Thus the only complete and uniform detailed mapping is that of the underground workings.

The geological map of part of the Mount Nansen property used for this investigation was compiled from the following maps:

- H.S. Bostock (1936): Map 304 A, Carmacks Sheet, G.S.C.  
1" = 4 miles.
- D.D. Campbell (Sept. 1958): Geology Plan of the Nansen Creek Area, 1" = 500'
- W.C. Martin (March 2, 1964): Part of the Mount Nansen Area - Plan showing veins and ore shoots, with generalized Geology - 1" = 400'
- G. Lamont, W. Wilkinson, F. Bianconi (1968):  
Surface and underground detailed Geological Maps -  
1" = 20' / 1" = 400'

Most of the material for the present study was collected during a systematic mapping of the underground workings at Webber and Huestis. The classification and the descriptions of the country rocks are based on a detailed microscopical study of 51 thin sections. The general geological sequence proposed by Bostock (1936) was employed in the following discussions.

## 2. YUKON GROUP

The oldest geological unit in the area is represented by the metamorphic rocks of the Yukon Group which underlie the southern part of the area.

### Lithology

The metamorphic serie does not exhibit a great variation in the lithology. The limestones reported by Bostock (1936) from the South part of the Carmacks district are not present in the Mount Nansen area. In the investigated area the following rock types could be distinguished:

- i) The most common type is a bedded quartz-hornblende gneiss. It forms the bulk of the country rock in the Webber and Huestis Mines. It has a moderate schistosity which is conform to the evident bedding. Dark green, hornblende-rich layers (1-3 cm thick) alternate with white, hornblende-free layers. Under the microscope, the dark layers appear to be formed by euhedral, columnar hornblende (up to 1.5 mm) and plagioclase (An 25-30), with minor sphene. The white layers are formed by fine-grained quartz, plagioclase, potash feldspar and less common by hornblende. The structure is gneissic, and the grain-size ranges from 0.1 mm (quartz) to 0.4 mm (feldspar).
- ii) Biotite-hornblende gneiss and hornblende gneiss to amphibolite. These two types build up thick portions of the Yukon Group and occur for instance in the two Huestis crosscuts and in the Webber 4100 crosscut. The massive to slightly bedded darkgreen rock is medium-grained, and shows a "salt-and-pepper" structure caused by larger white feldspar grains. The two varieties are determined by the presence or absence of biotite. The rock is composed of 30-50 per cent plagioclase (An 30-40), 5-25 per cent quartz, 15-40 per cent hornblende, 0-30 per cent biotite, minor potash feldspar, sphene, apathite and ore-minerals. Garnet and secondary epidote, chlorite and carbonate was observed rarely. Potash feldspar displays diffuse polysynthetic twinning and forms individual anhedral crystals surrounded by extremely fine-grained quartz. The structure is massive or moderate gneissic when the hornblende is oriented. The grain-size is heterogeneous and ranges from 0.05 mm (quartz) up to 1.5 mm (hornblende). Hornblende - poor rock varieties show a weakly developed bedding with selective concentration of the leucocratic minerals, They form the transition to the earlier described group.
- iii) Biotite gneiss The bedded quartz-hornblende gneiss contains numerous layers of biotite gneiss which vary in thickness from 1 cm up to 2 m.

Several varieties occur and are determined by variable contents of quartz and biotite respectively. The biotite rich varieties have a schistose structure with a strongly developed foliation while the more quartz-rich varieties are gneissic. The concentration of leucocratic minerals and the occurrence of monomineralic biotite layers causes locally a tendency to bedded structures. The rocks are usually brown coloured, fine- to medium-grained (0.1 - 0.5 mm). Principal constituents are biotite (30-58 per cent), up to 1 mm long, plagioclase (30 per cent, An 25-35), potash feldspar (0.5 per cent) and quartz (0-30 per cent). Minor constituents are hornblende, sphene, zircon, apatite, opaque minerals and secondary chlorite and carbonate.

iv) Feldspathic quartzite

Quartzites are rare and were found only in the Webber mine where they are enclosed in the quartz hornblende gneisses. The milky white coloured rock is fine-grained, homogeneous in structure, which is massive due to the lack of orientation and to the spherical shape of the minerals. The composition is constant and is dominated by a intergrowth of quartz (20-25 per cent), plagioclase (35-50 per cent, An 20) and microcline (25 per cent, locally in porphyroblasts up to 1 mm). Minor constituents are biotite, apatite, leucocoxene, zircon, pyrite. Secondary minerals are sericite, carbonate, and clay minerals. The term "quartzite" is used in a very large sense and was found useful during field work. Strictly defined the rock is an "aplitic gneiss", and might have derived from metamorphosed graywackes.

v) Wall rock alteration in the Yukon group

Adjacent to the mineralized veins the rocks of the Yukon group are usually strongly altered. The zone of alteration, which runs almost parallel to the veins, has a thickness between 5 and 50 feet. Four basic types of alteration have been detected. However, no apparent zoning of the four types related to the distance from the veins could be established.

a) The most common type is the argillic alteration, which varies in intensity. Where the original rock has been completely altered the resulting rock has a creamy white colour and shows a thin-bedded structure, built up by a fine alternation of soft, argillic layers and hard, quartz-rich layers. This alternation corresponds to the original structure of the rock. The original structure was in a few cases completely effaced and in this case the clay minerals form isometric aggregates up to 4 mm in diameter. Locally, the rock is brecciated, whereby the components clay minerals and hydrothermal quartz are cemented by carbonate. The clay mineral has tentatively been determined as kaolinite, its grain-size

being 0.01 mm. It forms flaky aggregates, usually with few inclusions of quartz and carbonate. The aggregates are pseudomorphous after the feldspars. Locally, the argillic alteration is accompanied by chloritisation of the biotite.

- b) Sericitic alteration is another relatively common type which also affects the feldspars. They are partly or completely transformed into fine aggregates of sericite. The individual sericite lamellae possess a length of 0.01 to 0.4 mm. Locally, the following secondary minerals were observed in this type of alteration: hydrothermal quartz, pyrite, chlorite and carbonate. The original structure of the rock is usually preserved and in the case of the bedded quartz-biotite-hornblende gneiss the resulting rock is an alternation of thin quartz and sericite layers.
- c) Locally, the gneisses of the Yukon Group were found to be partly replaced by carbonate and epidote. The carbonate is developed as anhedral grains of irregular shape, isometric to lathlike. Epidote (and seldom clinozoisite) is embedded in carbonate masses. It is commonly subhedral, clearly zoned and exhibits distinct yellow pleochroism. The two minerals are accompanied by minor quartz, pyrite, and chlorite. Usually, this type of alteration forms massive light-green coloured and fine-grained zones, and displays gradual contacts with the unaltered country rock. The alteration zones possess a symmetric structure, with the carbonate-quartz veins situated in the centre and larger carbonate-epidote zones on both sides. Concentration of pyrite are often encountered at the contact of the carbonate-quartz veins with the two carbonate-epidote zones. In some cases the original thin bedded structure of the rock is preserved.
- d) At immediate contacts of host rock and vein zone or where host rock is included in vein material, silicification is often observed. As in the other alteration types discussed above the silicification usually preserves the original structures. In the case of strong shearing the resulting structure is brecciated. The quartz is very fine-grained (up to 0.01 in diameter), of cherty appearance, and of dark-blue colour. The components are formed by angular carbonate-quartz aggregates. Pyrite is generally abundant and disseminated in both the components and the matrix.

### Metamorphism and Origin

All rock types of the Yukon group have been completely recrystallized during the metamorphism. Since the age of the Yukon Group is believed to be Precambrian to Palaeozoic, and since the overlying late Jurassic to early Cretaceous Nansen Group rocks are not affected by metamorphism, the metamorphic event must have taken place between the Late Palaeozoic and the Jurassic, and could possibly be related to the Tahltanian Orogeny (Early to Middle Triassic). The grade of the metamorphism cannot be defined accurately as no typomorphic minerals are present. However, the paragenesis garnet - hornblende - andesine indicates that the maximum grade corresponds to the amphibolite facies.

For most of the metamorphic rock types a sedimentary origin can be assumed, in agreement with the considerations of Bostock (1936) for the Carmacks area and of Wheeler (1961) for the Whitehorse area. The bedded quartz-hornblende gneisses originated from alternating beds of chert/arenites and clay. Thicker argillaceous interlayers were metamorphosed into biotite gneisses. The feldspathic quartzites might have derived from impure quartz arenites or greywackes. The origin of the hornblende gneisses and amphibolites is uncertain. The wide bodies occurring in both Huestis crosscuts might represent the metamorphic products of basic intrusive or volcanic rocks.

### Structural Relations

The structural relations of the rocks of the Yukon Group are visible only in the underground workings. In all levels the strike is rather constant between north and north 45° east. The dip varies from mine to mine. In the Huestis levels two distinct dips have been observed, one of 30° to the west and the other one of 30° to the east. They define a fold axis which trends south 30° west and plunges up to 20° south. This folding is manifested by small scale folds at several places in both Huestis levels. A large antiform fold having the same axis seems to underly the Huestis area, according to the two distinct dip directions found. In the Webber mine the dip is steeper, between 60° and 70° to the west. This fact enhances the presence of the large antiform fold, since it can be assumed that the Huestis mine lies in the relatively flat crest portion of the antiform fold and the Webber mine in its steeper west flank.

### 3. MOUNT NANSEN GROUP

The Yukon Group is unconformably overlain by the Mount Nansen Group, which is formed by volcanic rocks. The unconformity is not directly exposed but seems to follow the Webber Creek. The Mount Nansen Group occupies the Northern part of the property and is intruded by the younger granites and porphyries. The group is believed to be of late Jurassic or early Cretaceous age (Bostock, 1936).

#### Lithology

In the immediate surroundings of the mine the Mount Nansen group consists essentially of the following two rock types:

#### i) Andesitic Lavas

The best exposures are located on the north part of the Webber Ridge, where the andesite lavas form irregular knobs resistant to weathering.

The lavas are fine-grained, of darkgreen colour, and white-speckled by small feldspar phenocrysts. On the surface they are bleached and of greenish-grey colour. Under the microscope the rock shows a microporphyratic structure. The phenocrysts form approximately 60 per cent of the rock and consist of plagioclase (An 30-40), up to 15 mm in length. The mineral is euhedral, and has polysynthetic twinning. Sometimes a zoned structure was observed. Rare phenocrysts consist of chlorite aggregates pseudomorphous after pyroxene and possibly biotite. The groundmass is formed by an extremely fine-grained intergrowth of acicular plagioclase, irregular chlorite aggregates, abundant ore-minerals (ilmenite-leucoxene and possibly magnetite). Rarely the lavas contain small fragments (up to 2 cm) of granodioritic composition. The structure of the andesitic lava is massive, microporphyratic with a felty groundmass.

The small knob at the top of Webber Creek is formed by a flow (or explosive?) breccia, consisting of up to 10 cm large rectangular to slightly rounded components. They have an andesitic composition and a very fine-grained matrix.

#### ii) Hornblende andesite-porphyry and biotite andesite-porphyry.

Between the Brown-McDade mine and the south end of the Webber ridge the Mount Nansen group is formed by distinctly porphyritic andesite. The rock is darkgreen, medium-grained, and speckled by columnar hornblende and biotite phenocrysts.

The most common variety is a hornblende andesite-porphyry. Its groundmass is made up essentially of plagioclase, (An 35-40) forming small euhedral grains (0.2 - 0.3mm), of scarce quartz grains and of rare epidote, chlorite, biotite, zircon, and sphene, furthermore, the groundmass contains up to an estimated 7 per cent of fine-grained opaque minerals. The ore-microscopical investigation carried

out by Dr. R. Saager revealed the presence of the following minerals, in order of relative abundance. Magnetite forms euhedral crystals with diameters of up to 0.15 mm. The coarser grains contain spinel and ilmenite as exsolution products. Conspicuous is also the occurrence of martite, i.e. an irregular ascendent replacement of magnetite by hematite. Euhedral pyrite, possessing diameters of 0.5 to 0.25 mm, is intergrown with magnetite and locally altered to limonite. Ilmenite is also present in individual grains, which are partially replaced by leucocene. The phenocrysts occurring are hornblende and plagioclase. The hornblende (20-40 per cent of the total volume) has a strong pleochroism from darkgreen to greenish-brown and an extinction angle of  $21^\circ$ , which lead to a tentative determination as hastingsite. The phenocrysts, up to 5 mm in length, are euhedral and occasionally zoned. Where zoning occurs the hastingsite has a homogeneous core free of inclusions and a large rim containing numerous inclusions of the groundmass minerals. Plagioclase phenocrysts are less abundant, they are idiomorphic and zoned. The structure of this rock type is holocrystalline porphyritic. The hornblende phenocrysts show a slight tendency to parallel orientation.

The second variety, the biotite andesite-porphyry is subordinate. Biotite (up to 10 per cent) takes the place of the hornblende. Scarce quartz is also present as phenocrysts (up to 5 per cent)§. The plagioclase (An 25-30) can apparently be correlated with the "dacites" of Bostock (1936, page 31). A thin section of an altered sample of a biotite-hornblende andesite-porphyry indicates the following alterations: hornblende is completely replaced by aggregates of carbonate and chlorite, plagioclase in the groundmass as well as plagioclase phenocrysts are replaced to a varying degree by very fine-grained aggregates of carbonate and sericite. Biotite is not affected by the alteration.

The rocks belonging to the Mount Nansen Group do not show any sign of metamorphism.

#### 4. MESOZOIC INTRUSIVE ROCKS

The Yukon and Mount Nansen Group are intruded by a variety of igneous rocks which, according to Bostock (1936), vary from dioritic to granitic composition. The age of the intrusion has been postulated to be late Jurassic to early Eocene by Bostock (1936), and the intrusion itself has been related to the Coast Range Intrusion Sequence. Bostock's (1936) postulation has been confirmed by a recent K-Ar age determination on biotite and hornblende from granodiorite samples collected in the property of Casino Silver Mines which yielded ages of 95 m.y and 99 m.y (Findlay, 1969, page 27). Of the three major rock types described by Bostock (1936) only the diorites and the

granites are present in the Mount Nansen area. Syenites occur only to the north of the property where they build up Victoria Mountain.

- i) The diorites are rare in the investigated area. In agreement with Bostock (1936), Campbell (1965) describes the dioritic intrusives occurring on the east side of the Webber ridge as "intrusive into or contemporaneous with basalt and in turn intruded by later granitic rocks."

Conflicting with the findings of Bostock (1936) and Campbell (1965) a 20 feet wide vertical dike intruding Tertiary quartz - feldspar porphyry was observed on the Webber 4260 level. This seems to indicate that the diorite dyke is related rather to the Tertiary porphyries than to the Mesozoic "granitic" episode. On the other hand one also has to consider the possibility that some of the porphyries could be related with the granitic episode, and are thus not of Tertiary age but a late phase of the Mesozoic intrusive sequence.

On the Huestis 4100 level a 10 feet wide diorite dyke cuts altered metamorphic gneisses of the Yukon Group and in turn is cut by the mineralized vein. As the dioritic dyke is not associated with known intrusive rock no statement on its age could be made.

In both cases the rock has a darkgreen colour, is fine-to-medium-grained and massive. Principal componentes are hornblende (40-50 per cent) forming subhedral to euhedral columnar grains, and plagioclase (40-50 per cent An 30-35) in irregular grains intergrown with hornblende. The minor components are quartz (0-2 per cent), biotite, epidote, sphene, ore minerals (mostly ilmenite), and apatite. Secondary minerals are carbonate and chlorite in small veinlets.

The structure is massive, equigranular (the grain-size being 0.2 - 0.3 mm). Hornblende shows locally a tendency of parallel orientation.

- ii) The granitic intrusive rocks.

This group in the Mount Nansen area is represented by two lithologic types, porphyritic granite and granodiorite. Good showings of porphyritic granite were exposed in the 4 N Trench situated north of the Webber workings, where the granite intrudes into rocks of the Yukon Group. The granite is medium- to coarse-grained, and is made up of a greenish groundmass containing large phenocrysts of pink potash feldspar, up to 1 cm in length. The structure is weakly tabular, due to the somewhat parallel orientation of the hornblende in the groundmass and of the potash feldspar phenocrysts. This pattern is considered to be primary, since the potash feldspar phenocrysts show no cataclastic signs whatsoever.

The composition of the rock is granitic, the principal components being potash feldspar (50 per cent), albite (20 per cent), oligoclase (15 per cent), quartz (10 per cent), and hornblende (5 per cent). Accessory components are epidote, sphene, apatite, and opaque minerals. The groundmass consists of a heterogeneous intergrowth of medium-grained (0.2 - 0.5 mm) anhedral orthoclase, plagioclase, quartz, hornblende, and the accessory minerals. The rectangular phenocrysts are almost exclusively potash feldspar. It displays no twinning and is homogeneous or locally microperthitic. Some phenocrysts consist of antiperthitic albite. The granodiorite is the major rock type of this group. It builds up a large body underlying the area west of the Webber ridge. It intrudes both the Yukon Group and the Mount Nansen Group, however, no direct contacts have been observed. The best exposures of fresh granodiorite occur in the Brown-McDade crosscut. The granodiorites are massive, medium-to coarse-grained and possess "salt-and-pepper" appearance which is determined by the regular distribution of black hornblende in light coloured feldspar. The granodiorites are composed mainly of oligoclase (50 per cent), orthoclase (25 per cent), quartz (15 per cent), and hornblende (5 per cent). Minor components are biotite, sphene, apatite, epidote, opaque minerals, and secondary chlorite and carbonate. The structure is massive, the grain-size is heterogeneous and varies from 0.1 mm (part of the quartz) to 2 mm (part of the feldspar). In the Brown-McDade crosscut the structure of the granodiorite has been found to be porphyritic. Acid dykes in the granitic bodies are extremely rare (Bostock, 1936, page 37). In the investigated area only aplitic dykes have been found. Several narrow dykes which cut the porphyritic granites are exposed in the earlier mentioned trench, north of the Webber workings. The aplite is fine-to medium-grained, creamy-white coloured, and massive. The main components are quartz, albite and microcline, which form an intergrowth of irregular grains.

##### 5. TERTIARY ACID INTRUSIVES

All the rock types of the above described groups are intruded by a number of porphyry bodies. These bodies vary in size from 100 feet to 1 mile in diameter and display cylindrical to elongated outlines. Contacts are well exposed in the underground workings, where several porphyry plugs have been found to intrude the metamorphic rocks of the Yukon Group. The contacts are sharp and generally are occupied by a thin zone of gouge, indicating movements along the contacts after the solidification of the porphyries. In the Brown-McDade mine a small porphyry zone, parallel to the mineralized vein, cuts the mesozoic granodiorite. Bostock (1936) on his regional map indicates a large porphyry body between the Nansen and the Victoria Creek which intrudes the Mount Nansen Volcanics. According to Bostock (1936) the age of the porphyry intrusion is Tertiary. This statement, however,

is based on only one observation made in the vicinity of Mount Pitt where several porphyry bodies cut through members of the early Tertiary Carmacks Volcanics. Rock types belonging to the Carmacks Volcanics do not occur in the Mount Nansen area. In this context, however, it must be noted that Bostock's map suggests a relation between the porphyries and the Mesozoic granitic intrusions. This indication clearly casts some doubt on the geological sequence proposed by Bostock (1936). New detailed geological investigations presently carried out in the Dawson range should clarify this problem. Typical porphyries are massive, fine-grained to aphanitic, pale-brown coloured and contain numerous phenocrysts of white feldspar and clear quartz, 2-4 mm in length. Porphyry varieties without phenocrysts are abundant although of very limited extent. A coarse-grained porphyry variety found in the Webber 4100 crosscut, can be defined as granite porphyry. Usually the porphyry is sensitive to alteration agents. On the surface the feldspar phenocrysts always are washed out, whereas underground they are decomposed to clay minerals and sericite.

The study of several thin sections revealed the following details: The porphyritic structure is always present, to 70 per cent of the total rock volume is made up by phenocryst which consist of plagioclase, possibly potash feldspar and quartz. Therefore, the rock has been termed quartz - feldspar porphyry. Plagioclase form the most abundant phenocrysts, they are generally euhedral, and locally resorbed. In one case, where plagioclase has a rather basic composition (An 35-40) was the zoned character and the polysynthetic twinning lamellae preserved. The quartz phenocrysts show a bipyramidal habit but as a rule are rounded with resorbed margins. Sporadic hornblende phenocrysts are always altered to chlorite or carbonate, and rare biotite phenocrysts are often bleached and altered to hydrobiotite. The groundmass of the quartz-feldspar porphyry is composed of an intergrowth of quartz and feldspar, which are homogeneous in grain (0.1 - 0.2 mm). Accessory minerals are epidote, zircon, apatite, carbonate, and opaque minerals. The latter occasionally build up to 5 per cent of the total volume of the rock and occur as euhedral grains (0.01 - 0.02 mm) disseminated in the groundmass.

As mentioned earlier, almost all the porphyries are altered to some extent. Both feldspars, phenocrysts as well as the feldspar in the groundmass, are altered to extremely fine-grained, felty masses of clay minerals (kaolinite?) which in turn includes small aggregates of sericite. These aggregates are perfectly pseudomorphous after the original plagioclase grains. Sometimes, the alteration minerals are accompanied by secondary carbonate. The hornblende phenocrysts are always altered, either to chlorite or to intergrowths of carbonate, quartz and opaque minerals. Quartz was found to be the only mineral which is not affected by the alteration but also by shearing forces which caused intensive structural transformations. In extreme cases the porphyry was converted into a foliated rock composed of a pale-brown groundmass and white plated lenses. Typical thin sections show an extremely fine-grained groundmass (less than 0.01 mm

grain-size) of fibrous kaolinite (?), quartz, and opaque minerals, (mostly pyrite, which is largely altered to limonite). Locally, the groundmass exhibits fluidal structures of the type common in mylonitic rocks. The original phenocrysts were laminated and their contours are now lenticular. The process is best documented by the quartz phenocrysts, which were recrystallized to a mosaic of small grains. Some thin sections exhibit a breccia structure, in which the components consist of angular quartz fragments.

## 6. MINERALIZED VEINS

A complex high-angle fault system cuts all the above described rock types. This system strikes northwest to northnorthwest and dips between 70° to 90° to the southwest or south. The system comprises tight faults, gouge-filled faults, and wide shear zones and is partly occupied by the mineralized veins. In the Mount Nansen area the general northwest trend of the mineralized fault system seems to be constant as indicated by the geochemical Ag and As soil anomalies (Campbell, 1968). The faults are probably of the oblique-slip type: the horizontal component (strike-slip) is apparent in a few places, where the contact between the Yukon gneisses and Tertiary (?) porphyries has been horizontally displaced between 20 and 60 feet. The vertical component (dip-slip) is not measurable, since no recognizable marker beds are present. However, some fault-planes on the footwall display distinct polished slickensides. The rake varies considerably; in the Webber mine it is weak, between 7° and 23° to the northwest, which indicates a predominance of the horizontal displacement. In the Huestis mine the rake is steeper, between 42° and 82° to the northwest; here the vertical displacement is probably of the same range as the horizontal one.

The mineralized zones are known to be rather persistent in length: for instance Vein No. 12 in Huestis has been explored underground over a length of 1200 feet, both ends of the drift still being on ore. The maximum known depth is 400 feet. The mineralized veins characteristically exhibit a distinct pattern of diverging to the northwest into two separate branches. Good examples are Vein No. 1 and No. 2 in the Webber mine and Vein No. 11 and No. 12 in the Huestis mine. In some cases the branching point is near or coincides with the contacts between the Yukon gneisses and the Tertiary(?) porphyries with the two branches lying in the latter. This is possibly explained by the different mechanical behaviour of the two rocks units, the porphyries being more competent than the gneisses. Difference in competency might also be the reason for the abrupt changes in the width of the veins at the contact of the two units. In fresh, unaltered porphyries the veins are usually narrower than in the Yukon rocks. This phenomenon is not entirely understood; however, it might be caused by a decrease of intensity of the acting stresses due to the above described branching of the veins.

In the Webber mine a large porphyry body has been intensively sheared and altered with the mineralized vein displaying a width up to 8 feet. However, as indicated above, in small porphyry bodies the veins are characteristically narrow. This feature seems to be directly related to the size of the porphyry body. Insofar that the relatively incompetent Yukon gneisses must have absorbed the bulk of the stresses where they embedded small porphyries. With the result that only branching of the fault took place. In the case of large porphyry bodies the Yukon gneisses were not able to absorb the stress in such an extent. This resulted in a much stronger shearing and in the formation of more pronounced dilatent zones in large porphyries. The latter behaviour corresponds to the grade of competency of the two rock units.

The veins are by no means homogeneous in composition. They usually consist of cherty, blueish-white quartz and of crushed, sheared, or brecciated wallrock inclusions. The footwall, and sometimes also the hanging wall, is defined by gouge planes. Several parallel bands, lenses and stringers of sulphides a few inches to 1 foot in width form the mineralized portion of the vein. The sulphides are fine-grained and macroscopically only arsenopyrite, pyrite, sphalerite, galena, grey copper ore and occasional stibnite can be recognized. Although the mineralized structures are persistent in length and to the known extent also in depth, only relatively short bodies are of economic value as can be seen in the later chapter on the ore reserves. The longest ore-shoots, up to 300 feet, occur in the Huestis mine. In the Webber mine the ore-shoots are never longer than 150 feet and around 50 feet in average.

The vertical continuity of the ore bodies seems to be rather good; however, in the Huestis mine a decrease of the Ag content with increased depth seems to be possible (see statistical investigation). In the case of Webber the ore-shoots can be followed almost vertically from the surface down to the 4260 level. In the Huestis mine the ore-shoots show a rake to the northwest and a more inconstant length in the two levels. As already pointed out earlier, the width of the mineralized veins is also variable. As a general rule, the veins in the Webber mine are narrower than in the Huestis mine, usually between 2 and 3 feet, and the sulphide bands 3 to 6 inches. In the Huestis mine the vein widths are around 4 - 5 feet, the sulphide layers possess a width of up to 2 feet.

#### 7. POST - MINERALIZATION FAULTS

The youngest system of faults strikes north to northeast and is high-angled. These faults offset the country rock as well as the mineralized veins. The system comprises tight and gouge-filled faults, up to 12 feet wide. The displacement is usually anti-clockwise, although this is not a strict rule and cannot be used

as a guide during exploratory drifting. The apparent horizontal displacement reaches up to 120 feet but usually is of much lesser magnitude. The major post-mineralization faults are widely spaced and follow each other 300 to 500 feet apart, while minor faults can occur every few feet. This faulting usually offsets the mineralized vein repeatedly; obviously this pattern implies a very careful stoping procedure.

## 8. SURFICIAL DEPOSITS

The surficial deposits have been studied in considerable detail in the Carmacks district in particular, and in the central and southwestern Yukon in general by Bostock (1936, 1966). The data reported here are mainly taken from this author.

The Nansen area lies to the west and close to the border of the area glaciated during the youngest glacial advance (McConnell advance, late Wisconsin). Since the area has not been glaciated during this advance, no glacial deposits occur. However, Bostock (1936, 1966) reports blue boulder clay in Nansen and Back Creeks at the bottom of placer cuts. These clays are believed to be of glacial origin and are related to the oldest glacial advances, the Nansen and Klaza.

The bottom of Nansen Creek, of Victoria Creek, and of the major tributaries is occupied by sand and minor gravel. They form terraces and plains (i.e. the large plain at the bottom of Victoria Creek at the confluence with the Nisling River), which are sharply cut by the meandering creeks. These deposits are believed to have been "deposited in an ice margin lake on top of moraine enclosing stagnant ice" (Bostock, 1936, p.49).

The rest of the area is almost completely covered by up to 50 feet thick "overburden", which consists of disintegrated, relatively undecomposed bedrock. This explains the extreme scarcity of outcrops, which occur almost exclusively on top of the ridges and on steep gulches.

On top of the disintegrated rock lies a cover of brown residual soil, up to 3 feet thick, containing some rock fragments, followed by 1-2 feet of decomposed organic matter.

A layer of white volcanic ash, 1 foot thick in average, builds the surface cover or an interlayer in the soil. A thorough investigation of this layer and of its origin and age is contained in Bostock (1952). The author defines the ash as "andesitic pumice" and estimates the age to approximately 1400 years. He comes to the conclusion that the volcanic eruption must have taken place in the St. Elias Mountains at the Alaska/Yukon border, some 10 miles south of White River, the crater being now covered by a glacier.

The area lies in the permafrost zone and thereafter soil, disintegrated rock layer, and to an unknown extent also the bedrock are permanently frozen. From the present underground workings it can be gathered that the permafrost reaches a considerable depth, up to 200 feet below surface.

## 9. SUMMARY

The southern part of the Mount Nansen property is underlaid by the oldest rocks, which belong to the Yukon Group, believed to be of Precambrian / Palaeozoic age. The group comprises metamorphic rocks, in prevalence of sedimentary origin, mainly quartz-hornblende gneisses, and minor interlayers of feldspathic quartzites and biotite schists. Furthermore, some rocks are of possible igneous or volcanic origin, i.e. thick conformable bodies of hornblende gneisses and amphibolites.

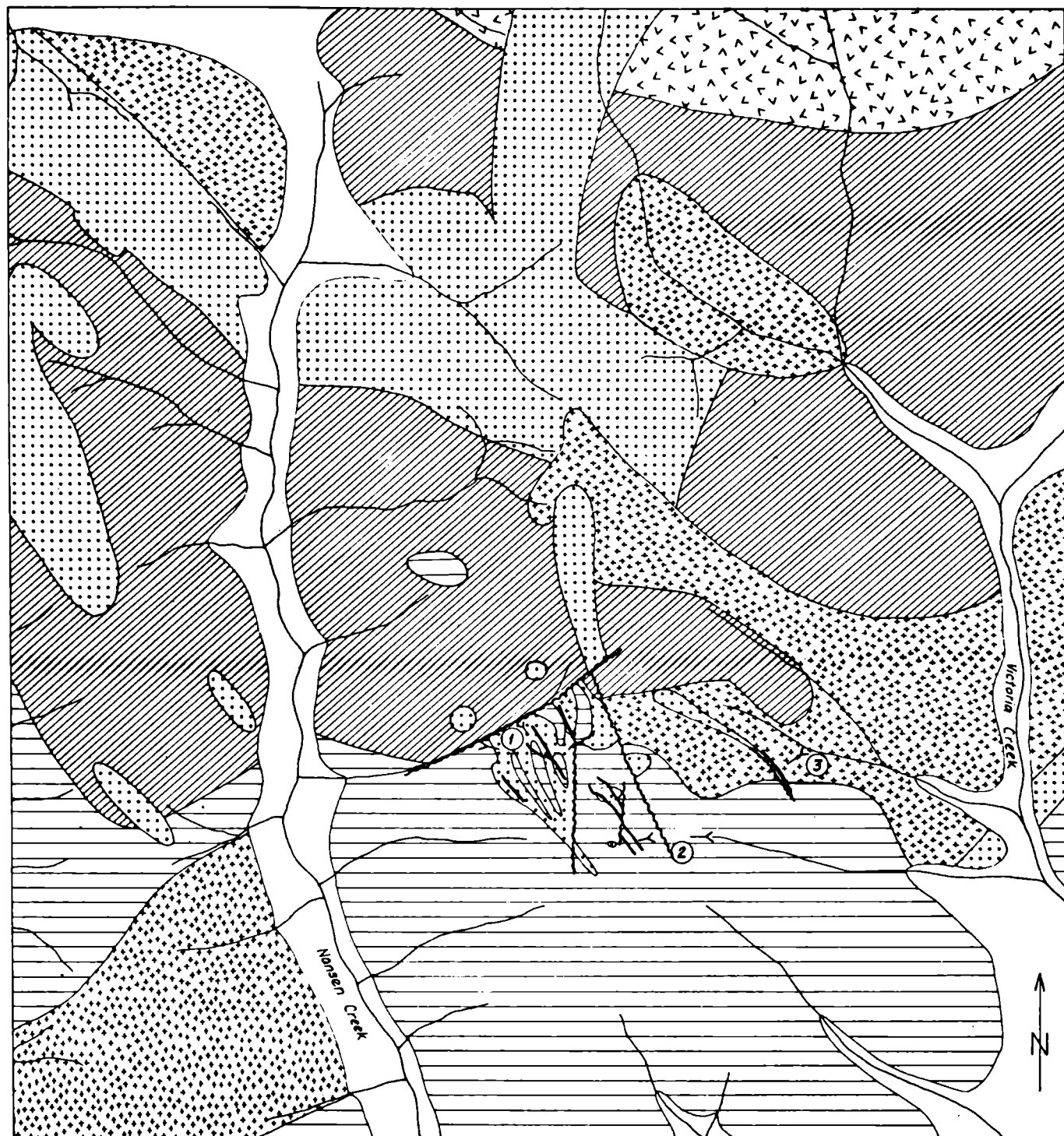
A thick cover of volcanic rocks belonging to the Nansen Group overlies discordantly the Yukon Group and occurs in the middle of the Mount Nansen area. The group, believed to be of Jurassic age, is essentially composed of andesitic lava flows and of andesite porphyries.

The two groups in turn are intruded by porphyritic granites and granodiorites of Cretaceous age. They occur between Webber Ridge, the Brown-McDade mine and Victoria Creek and to the very north of the property. The intrusion is related to the Coast Intrusion sequence.

The youngest rocks in the area are a number of porphyry bodies which cut through all the other rocks. Their age cannot be determined unequivocally. Although generally believed to be of Tertiary age, the possibility that they are a late phase of the granitic episode (Cretaceous to early Eocene) must be considered. This hypothesis is strongly suggested by the spatial relationship between the two rock units. As indicated by the study of the thin sections and by the copper-zinc geochemical soil anomalies, some porphyries are host of a disseminated mineralization, whose nature and intensity has not yet been determined.

Two major systems of high-angle faults are encountered in the Mount Nansen area. The older system trends northwest and is partly mineralized, thus contemporaneous or older than the ore formation. The younger system strikes north to northeast and offsets the mineralizations.

Surficial deposits consist mainly of disintegrated bedrock, alluvial sands and gravels, residual soil and volcanic ash. The area was not covered by ice during the last glacial advance. Permafrost is experienced to a depth of up to 200 feet.



### LEGEND










	Alluvium	Recent		Fault	
	Porphyry Intrusions	Tertiary (?)		Mineralized Vein	
	Granite - Granodiorite	Cretaceous		Adit	1 Webber Mine
	Syenite		2 Huestis Mine	} Mt. Nansen Mines	
	Mount Nansen Volcanics	Jurassic	3 Brown-McDade Mine		
	Yukon Group	Precambrian-Paleozoic			

Fig. 4. General Geology of the Mt. Nansen area

## ORE - MINERALOGY OF THE MOUNT NANSEN ORE-DEPOSIT

### 1. Introduction

The present work has been undertaken in connection with a metallurgical study of the Mount Nansen ores. It was hoped that this investigation also reveals information on the mode of formation of the Mount Nansen ore-deposit.

For the present study, ore-specimens were collected both in the Huestis mine which consists largely of non-oxidized sulphide ore and in the Webber mine which consists of a similar but more or less oxidized ore. Several specimens were also obtained from the ore-dump at the Huestis mine. For the ore-microscopic investigation, altogether 42 polished sections were made on a Rehwald - Depiereux polishing machine. All minerals were identified in polished sections.

### 2. Earlier Investigations

Mineralogical investigations on ore-samples from the Mount Nansen deposit have been carried out by Petruk (1965), Owens (1968) and Schmidt (1969). All these earlier studies were performed in connection with metallurgical investigations for Mount Nansen Mines Limited. Petruk (1965) studied only ore-samples from the Webber mine, one of which was a head sample containing 29.58 oz/ton Ag and 0.42 oz/ton Au. He concluded that the Webber ore is composed chiefly of siliceous rock and breccia and contains minute grains of silver-bearing minerals. Owens (1968) investigated ore from the Huestis mine. He found that the gold is present as inclusions in a number of ore-minerals and the silver as a constituent in freibergite and to a much lesser degree in miargyrite. In addition to these minerals Owens (1968) gives a list of other ore-minerals, mainly sulphides, which occur as masses or disseminated grains in the ore of the Huestis mine. Schmidt (1969) who studied ore from both the Huestis and the Webber mine emphasizes their different nature; the first being a sulphide ore and the latter being largely an oxide ore. He arrived at the conclusion that oxidation of the Webber ore has occurred in situ and that with the exception of Zn very little chemical transport took place. He furthermore suggests that the Webber ore originally had a higher content of jamesonite, and/or bournonite than the unoxidized Huestis sulphide ore.

A critical review of all available mineralogical data from the Mount Nansen ore-deposit was compiled by Saager (1969). He stressed the point that all of the reviewed investigations were carried out with only a few samples which, as indicated by their assay values, must be regarded as rather unrepresentative. The conclusions reached by the earlier investigators of the ore-body should, therefore, be studied with due reserve.

### 3. Occurrence and Paragenesis of the Ore-Minerals

Pyrite is the most abundant ore-mineral in the mineralized veins of the Huestis mine as well as in the country rock of the Mount Nansen ore-deposit. It forms idiomorphic to hypidiorhombic crystals or irregular masses. In the Webber mine the original pyrite has to a large extent altered to limonite-goethite aggregates, which in many instances exhibit pseudomorphic forms after the pyrite. Rudimentary cores of pyrite, in these limonite-goethite pseudomorphs are conspicuous.

In the Huestis and Webber mine two generations of pyrite are present. The older generation pyrite I forms large hypidiorhombic to idiomorphic crystals of a grain-size between 50 microns and 8 mm or irregular aggregates and bands. A weak shattering of pyrite I is relatively common. The irregular pyrite masses sometimes exhibit fine fractures which follow more or less the boundaries of the grains, thus making it possible to recognize the individual grains within the irregular compact pyrite aggregates and bands. Etching of pyrite masses with concentrated  $\text{HNO}_3$  confirmed this observation.

Pyrite I is closely associated and intergrown with the other sulphides and is distinctly corroded and replaced by galena, sphalerite, freibergite, bournonite, boulangerite, jamesonite, and stromeyerite. The cataclastic fractures are usually healed by these replacing sulphides or by gangue quartz. The closest mineral associate of pyrite I, however, is arsenopyrite, with which it displays mutual boundaries, suggesting simultaneous mineralization. Pyrite I and arsenopyrite are regarded as the two earliest minerals in the paragenetic sequence of the Mount Nansen ore-deposit and are conspicuous in the Huestis ore. In some of the polished sections obtained from the Huestis mine it was found that in irregular pyrite aggregates and bands inclusions of freibergite, galena, jamesonite, and boulangerite sometimes amount to more than 50% of the pyrite host, giving it a distinct seave-like appearance. As a rule pyrite I in the Webber ore has fewer inclusions than the pyrite grains of the first generation in the Huestis mine. Anisotropic pyrite grains were observed in two samples from the Webber vein. The distinct anisotropism does not seem to be caused by the polishing method, but can possibly be attributed to differing trace contents of As, Co and Ni in the pyrite (Saager and Mihálik, 1967). Small pores and inclusions of gangue material arranged in crystallographic directions in these anisotropic pyrite grains give them a distinct zonal appearance. No anisotropic pyrite has been observed in polished sections from the Huestis mine.

The second much younger pyrite generation, pyrite II, forms usually more porous and smaller grains. Pyrite II also occurs as encrustations on pyrite I and occasionally on arsenopyrite. Often pyrite II exhibits a skeleton-type structure. The association of pyrite II with other sulphides indicates that it is a late formation. This fact is also underlined by the relative

absence of inclusions in pyrite II and its usually well preserved crystallographic outlines. In the oxide ore of the Webber mine the porous and skeleton-type structures of pyrite II have been much stronger altered by supergenic minerals than the more compact grains of pyrite I.

In the country rock pyrite occurs usually disseminated as well developed crystals. Inclusions are relatively rare but have been observed to be formed mainly by chalcopyrite, pyrrhotite, sphalerite and rutile. Cataclastic fracturing is similar to that in the mineralized veins. Small fractures and shear planes in the country rock are sometimes filled by massive pyrite veinlets which are younger than the main mineralization.

In many portions of the Huestis mine arsenopyrite was found to be the most abundant sulphide. It occurs in typical elongated pseudorhombic crystals, as crystal aggregates and irregular bands. Individual grains and aggregates vary in size from a few microns to about 1.2 mm. Generally, the grain-size of arsenopyrite was found to be smaller than that of pyrite I. Cataclastic fracturing of arsenopyrite is usually less than that of pyrite, which might be attributed to its smaller grain-size. Arsenopyrite is intergrown with other ore-minerals in a similar fashion as pyrite, but has suffered much less replacement by the base metal sulphides and sulphosalts than pyrite I. Under crossed nicols arsenopyrite shows relatively few twinnings and a normal anisotropism, indicating no excessive Co-content.

Arsenopyrite often occurs disseminated and fine grained in the gangue of the mineralized vein zones, especially in the Huestis mine. Small arsenopyrite grains which overgrow larger arsenopyrite crystals indicate that also two generations of arsenopyrite can be observed in the ore-body, however, the development of the younger generation is not as clearly exhibited as for pyrite. The author feels that possibly in analogy with pyrite the disseminated smaller arsenopyrite grains in the gangue, together with the arsenopyrite overgrowth represent the second generation. In the country rock of the deposit, less arsenopyrite has been found than pyrite.

In the oxide ore of the Webber mine arsenopyrite is strongly replaced peripherically and along fractures by earthy supergenic substances including arsenobismite, arsenolite, scorodite and limonite-goethite (Petruk, 1965 and Schmidt, 1969) with perfect pseudomorphic preservation of the original idiomorphic crystals outlines. Of the supergenic alteration products only scorodite and limonite-goethite could be distinctly identified by the present author.

Occasionally, a zone of narrow irregular supergenic covellite occurs between the earthy alteration substances and the residual arsenopyrite cores.

Inclusions in arsenopyrite are very common and are generally formed by the same minerals as in pyrite. The size of the inclusions varies between 10 and 80 microns. It seems that especially freibergite and jamesonite form common inclusions. Smaller disseminated arsenopyrite grains, which possibly belong to the second generation of mineralization are essentially free of other sulphide inclusions.

Sphalerite and chalcopyrite are intimately associated and therefore discussed together. In the Huestis ore sphalerite forms the most abundant base metal sulphide in contrast to the oxidized Webber ore where most sphalerite has been replaced by supergenic minerals. Chalcopyrite occurs usually as numerous exsolution blebs in sphalerite, following grain boundaries and twinning plans. Independent aggregates of chalcopyrite are extremely rare and are usually associated with freibergite.

Sphalerite is medium to fine grained and generally forms irregular masses intergrown with other ore-minerals. In a few instances sphalerite forms thin bands similar to the earlier discussed pyrite and arsenopyrite bands. The grain-size of sphalerite varies between a few microns and approximately 2 mm. In all polished sections sphalerite has a dark appearance and shows deep-red internal reflections under oil immersion, which is typical for iron-rich sphalerite and, therefore, an indication for elevated formation temperatures (Ramdohr, 1960).

The abundance of inclusions in sphalerite is conspicuous. The following ore-minerals form such inclusions: jamesonite, boulangierite, chalcopyrite, and gold. Most of the inclusions formed by chalcopyrite and the base metal sulphides follow some crystallographic pattern, which indicate that the minerals infiltrated along the grain-boundaries of sphalerite or were formed by exsolution and subsequent segregation. The latter indicates prolonged cooling-off times. With pyrite and arsenopyrite sphalerite displays concave boundaries and mantles and corrodes the older pyrite and arsenopyrite generation. The establishment of an age-relationship between sphalerite, jamesonite, boulangierite and bournonite proved to be extremely difficult, since all the three minerals either seem to be contemporaneous with sphalerite, possessing mutual boundaries, or clearly replace sphalerite along fine fractures, grain-boundaries or twinning lamellas. Definitely younger than sphalerite are freibergite and galena, since both minerals migrated into the large sphalerite masses along grain-boundaries, very often replacing the exsolved chalcopyrite blebs.

In the oxide ore of the Webber mine sphalerite is almost completely replaced by goethite and limonite. This observation agrees very well with the analyses given by Schmidt (1969), who found only 0.12 per cent Zn in the oxide ore of the Webber mine as against 15.0 per cent Zn in the unaltered sulphide ore of the Huestis mine. This fact led Schmidt (1969) to the conclusion that complete removal by leaching of the sphalerite has taken place in the oxide ore.  $\text{CO}_2$  was apparently scarce, since no smithsonite has formed. Occasionally covellite has been found to form secondary encrustation, preferably on small rudimentary sphalerite grains in the gangue of the Webber mine; occasionally this covellite in turn again is replaced by malachite veinlets.

Chalcopyrite has only been found in two or three polished sections to form individual small grains. Most commonly chalcopyrite occurs as numerous small inclusions in sphalerite in places associated with galena or freibergite or as irregular roundish inclusions in pyrite I, often together with pyrrhotite or galena forming composite inclusions. The chalcopyrite inclusions in sphalerite represent the bulk of the copper present in the ore-body. Etching of the sphalerite with sodium hypochlorite indicated that the chalcopyrite inclusions must be regarded rather as exsolution than as replacement phenomena. They differ, therefore, distinctly from most of the freibergite and galena inclusions in sphalerite, which are typical replacements.

Relatively common are valleriite exsolution discs in chalcopyrite inclusions both in pyrite and arsenopyrite. A cubanite lamella in a larger chalcopyrite exsolution has been distinctly identified in one polished section from the Huestis mine. The exsolution blebs of chalcopyrite, and the presence of valleriite and of cubanite also point to elevated formation temperatures for the ore-body. The exsolution temperature for valleriite lies between 200 and 250°C (Borchert, 1934) and the exsolution temperatures for cubanite between 250 and 300°C (Ramdohr, 1960).

The occurrence of covellite as encrustations on sphalerite in the Webber mine indicates that during decomposition chalcopyrite inclusions in sphalerite have altered to covellite which subsequently was precipitated on the unaltered sphalerite cores.

Galena is the most abundant lead bearing ore-mineral encountered in the Mount Nansen ore-deposit. Although galena is actually not a silver-mineral it is an important silver-carrier. According to Ramdohr (1960) the miscibility of  $\text{Ag}_2\text{S}$  in  $\text{PbS}$  is limited to 0.4 mol per cent  $\text{Ag}_2\text{S}$  in the binary system  $\text{PbS}-\text{Ag}_2\text{S}$ . Higher silver contents in galena, therefore, relates to microscopic or submicroscopic inclusions of silver minerals such as freibergite, pyrrhotite, argentite, stromeyerite etc. It must be noted, however, that much higher amounts of  $\text{Bi}_2\text{S}_3$  (9 mol per cent at 800°C) are soluble in galena in the system  $\text{PbS}-\text{Bi}_2\text{S}_3$ . Van Hook (1960) concluded that the solubility of Ag in galena may be extensive,

even at low temperatures, when Bi is present and that similar relationships probably prevailed when Sb is present in the system. According to Ramdohr (1960) high contents of Bi and Ag in galena cause anomalous bireflection, which however, was not observed in the Mount Nansen ore. Furthermore, no Bi-minerals could be detected in the polished sections.

Galena occurs largely as masses and disseminated in gangue, pyrite, arsenopyrite and sphalerite. It usually is closely associated with freibergite and also with the sulphosalt minerals. In many cases galena and freibergite strongly replace sphalerite, pyrite and arsenopyrite. Sometimes, however, galena has been observed to encrust freibergite, thus its formation must have been contemporaneous to possibly younger. Galena in turn is distinctly replaced by boulangerite and miargyrite.

In the Huestis ore the outstanding features of galena are its numerous minute inclusions, (around 2 to 20 microns) of jamesonite, boulangerite and of silver-bearing minerals, which, apart from the fact that galena can take Ag into solid solution, make it economically such an important mineral in the Mount Nansen ore-deposit.

In the Webber ore, galena is strongly replaced by descendent anglesite parallel to the (100) direction of the cleavage. Often small amounts of covellite and/or chalcocite were found as encrustations on the galena in the oxide zone. Either galena must have acted as precipitating agent to Cu-bearing solutions, which subsequently formed covellite and chalcocite or these copper-minerals represent alteration products of small chalcopyrite and freibergite inclusions in galena. Lack of CO<sub>2</sub> in the oxide zone apparently precluded the formation of cerussite as a supergenic alteration product of galena.'

Jamesonite, boulangerite, bournonite; of these three sulphosalts present in the Mount Nansen ore-body jamesonite occurs most abundantly, followed by boulangerite. Bournonite has been found predominantly in the oxide ore of the Webber mine. Jamesonite usually forms elongated, flaky, sometimes weakly bent euhedral crystals, the grain-size being 40 microns to 1 mm. The commonly twinned, elongated crystals occur in clusters or show subparallel growth. In some instances jamesonite forms extremely fine grained felty aggregates. The correct age of mineralization of the jamesonite is extremely difficult to establish. Schmidt (1969) writes in this context: "It appears however, that more than one stage of jamesonite mineralization has occurred. Some examples show exceedingly fine grained jamesonite in the interstices between aggregates of euhedral quartz crystals. Some of these interstices were formerly occupied by galena as evidenced by minor residual galena, while others apparently were occupied by some gangue minerals now almost completely replaced by jamesonite. Replacement of euhedral quartz crystals by jamesonite was even occasionally observed. Although in these instances jamesonite has the appearance of a late

stage mineral (possibly the latest sulphide) and is involved in the replacement of almost all the sulphides. In other cases, it has the appearance of an early mineral. It is then coarser grained and frequently occurs as euhedral inclusions in sphalerite and freibergite. According to Ramdohr (1960), jamesonite may be a rather early mineral in some gold-quartz veins, as well as some veins of the Bolivian tin-lead formation." The present author made very analogous observations. It is however believed that the bulk of the jamesonite must be regarded as late in the paragenetic sequence. Together with stromeyerite it is probably the latest of the ascendent minerals.

Very interesting is the tight intergrowth of jamesonite with freibergite and galena. The latter is distinctly replaced along the (100) directions and the grain-boundaries, which resulted in an extremely complex galena /jamesonite intergrowth. Where jamesonite occurs in the oxide zone it alters directly to yellow and greenish bindheimite which occurs as coating on the rocks in the Webber mine. Pseudomorphs of bindheimite after jamesonite are relatively common. Feathery textured bindheimite is often intergrown with anglesite pseudomorphs after galena indicating the earlier described primary intergrowth of galena and jamesonite. Bindheimite is unstable in the soils and cannot be observed in soil samples. According to Boyle (1965) bindheimite tends to accommodate a large number of elements in its structure, particularly Zn, Cu, Ag, As, Cd, Bi, and Sn.

Beudantite may also occur, especially where arsenopyrite is present. It is an alteration product of freibergite, galena and the sulphosalts obtaining As from decomposing arsenopyrite. Beudantite is a green to yellowish supergenic mineral and is microscopically almost identical with bindheimite. As a basic salt beudantite tends to incorporate a large number of available cations and anions in its structure. The beudantite group is isostructural with the alunite group, which also includes argentojarosite. However, this latter mineral which is rather difficult to identify, was not detected in the Mount Nansen ore, neither by Schmidt (1969) nor by the present author.

The relatively high Ag-content of rock samples showing the yellowish, greenish earthy bindheimite - beudantite coating can be explained by the presence of a relatively high Ag-content in the structure of these supergenic minerals and by the possible presence of other secondary silver-bearing minerals. Schmidt (1969) analysed a jamesonite concentrate and found 0.58 per cent Ag and 12.0 per cent Pb. Since Ramdohr (1960) showed that Ag does not go into the jamesonite molecule in a measurable amount it is felt that the above high Ag-content is related to microscopic to sub-microscopic inclusions of Ag-minerals. Such inclusions of Ag-minerals might have contributed to the Ag-content of the bindheimite and beudantite in the Webber mine.

Boulangerite is very difficult to distinguish from jamesonite. It forms less elongated crystals and its reflection colours are more blueish-grey than the yellowish greenish colour of the jamesonite. Twinings do not occur in the boulangerite individuals and this fact, as well as the habit of the crystals has been used as the primary factor to distinguish the two minerals. Boulangerite is a very young mineral in the paragenesis and its association with other ore-minerals is extremely similar to that of jamesonite. In the alteration zone boulangerite is replaced by the same supergenic minerals as jamesonite, and therefore displays similar features.

Bournonite occurs in significant amounts only in the oxide ore of the Webber mine, where it alters directly to bindheimite and if arsenopyrite is present also to beudantite. In the Huestis vein zone bournonite has been found only in extremely minute amounts filling narrow veins in quartz or galena.

The paragenetic relationship of jamesonite, boulangerite and bournonite with respect to the more abundant sulphide minerals is not entirely understood. It seems that some of the jamesonite has been deposited relatively early, possibly contemporaneous with sphalerite. However, most of the sulphosalts show an association with galena, freibergite and gangue quartz, which definitely indicates a late formation of the sulphosalts at the end of the mineralization period marked by the major introduction of Pb, Sb, Cu and S.

As mentioned earlier, jamesonite, boulangerite, and bournonite are not actual silver-minerals, since their small Ag-content originates largely from small microscopic to submicroscopic inclusions of silver-minerals. Due to the relative abundance of jamesonite in the ore of the Huestis mine, this mineral, however, must be regarded as a rather important silver contributor in the sulphide zone of the Mount Nansen ore-deposit. The alteration products of the sulphosalts namely bindheimite, beudantite and possibly also jarosite, which incorporate large amounts of Ag in their structure, are important silver carriers in the oxide zones of the ore-body. The unstability of beudantite and bindheimite and their tendency to be soluble makes it very difficult to treat these Ag-bearing minerals metallurgically.

The most abundant silver-mineral in the Huestis and Webber mine is freibergite. The mineral occurs on irregular aggregates throughout the mineralized veins, its grain-size varying from 10 to 100 microns. Freibergite is intimately intergrown with galena and replaces sphalerite in many cases clearly, following the stringer of the chalcopyrite exsolution droplets in the latter mineral. In many cases sphalerite and chalcopyrite are clearly cut by thin, younger freibergite veinlets. Freibergite very often possesses

inclusions of galena, chalcopyrite and jamesonite. The relationship with jamesonite is a complex one, since often perfect euhedral inclusions of jamesonite in freibergite suggest a relatively early age for jamesonite, generally however, jamesonite clearly replaces freibergite. With galena, freibergite displays usually mutual boundaries indicating a contemporaneous position in the paragenetic sequence. Freibergite and galena are encrusted and locally also replaced by miargyrite, pyrargyrite and stromeyerite. These three silver-minerals, however, have been found only in minute amounts. They are descendent minerals formed even after the deposition of the felty fine grained jamesonite masses which occur as late formations in the interstices between gangue aggregates especially euhedral quartz crystals. A greyish-yellow mineral with a rather similar reflection colour as galena, showing faint anisotropism and distinct oleander-leaf-type twinnings has been tentatively identified as ramdohrite. This mineral has been found in a few polished sections from the Huestis mine, where it is closely associated with freibergite, jamesonite, and galena and apparently of similar age. A conspicuous feature of the ramdohrite is its distinct brittle development, which makes it easy to distinguish from the other rather similar appearing silver-minerals.

Native silver has been observed only in a few polished sections from the Webber ore. It occurs as irregular spongy aggregates in the interstices of gangue minerals or between slightly altered jamesonite flakes, and closely associated with ramdohrite and chalcocite. The occurrence of native silver clearly indicates that it has been formed as secondary mineral, possibly from the alteration of freibergite, argentiferous galena and jamesonite. The occurrence of silver in the oxide ore of the Webber mine has already been reported by Petruk (1965) and by Schmidt (1969). All polished sections from the Huestis mine have been studied very carefully but no native silver was found by the present author.

It is very interesting to note that apart from minor amounts of dispersed native silver, pyrargyrite, miargyrite, stromeyerite and ramdohrite no other sulphidic secondary silver minerals have been found in the oxide ores of the Webber mine. Considering the almost total absence of a supergenic enrichment zone in the oxidized Webber ore and the fact that it carries almost twice as much silver than the sulphidic Huestis ore, it appears that the primary silver mineralization was more abundant in what is now the oxide ore of the Webber mine.

Since argentiferous galena and freibergite exist only in residual amounts in the oxide ore and are heavily altered to a complex assemblage of secondary oxide minerals, it seems that these minerals carry most of the silver content present in the oxide ore. Schmidt (1969) who carried out an  $\text{NH}_4\text{OH}$  extraction, in order to detect Ag-halides, did not find any silver in the filtrate. An X-ray fluorescence analysis of a fairly pure bindheimite sample carried out by Schmidt, revealed accordingly the presence of 1.1 per cent silver, which seems to underline the assumption that most

of the silver present in oxide zone must be searched in direct alteration products of galena and sulphosalts such as argentian-bindheimite, argentian-beudantite and possibly argento-jarosite and argentian-anglosite and not in supergenic enriched secondary silver minerals.

The discussion of the silver-minerals present in the Mount Nansen ore-deposit indicates clearly the mineralogical difference displayed by the two known vein zones. In the sulphidic ore of the Huestis mine, silver occurs primarily in the hypogene freibergite and silver-bearing galena. Submicroscopic to microscopic inclusions of silver-minerals in the abundant jamesonite and boulangierite also contribute to a lesser extent to the Ag-content of the sulphide ore. A variety of secondary silver-minerals were only observed in extremely minute amounts and can be explained as local alterations of primary sulphides and sulphosalts. Apart from a narrow gossan close to the surface where some silver enrichment is encountered, no apparent vertical or lateral zoning of the mineralization has been observed in the Huestis mine. No economic importance can be attributed to these supergenic silver-minerals.

In the oxidized ore of the Webber mine the paragenesis is far more complex. As in the sulphidic ore a narrow completely altered zone exists close to the surface. This gossan is followed by a large diffuse and irregular zone in which secondary oxide minerals telescope the unaltered primary sulphides and sulphosalts. This zone has been exposed in the mine workings to a depth of 200 feet and quite obviously reaches below this level; the exact extent being unknown at the present moment. No marked vertical separation of minerals has been encountered in this diffuse zone and no distinct secondary enrichment zone has been found. Apparently very little migration of silver in solution has taken place. If such migration occurred it happened only over extremely short distances. Apparently, the silver which was liberated and taken into solution as a result of the oxidation and alteration of hypogen silver-bearing minerals was immediately precipitated and incorporated in small amounts in the lattice of the secondary jarosite, beudantite, bindheimite and anglesite. The nature of this silver is unknown, in some minerals, according to Boyle (1968) it replaces lead or copper in others it may be in an absorbed or interstitial form. The secondary minerals are more or less direct alteration products of the hypogen freibergite, jamesonite, boulangierite and the argentiferous galena. Alteration and oxidation of the ore thus took place in situ. The reason for this lack of downward migration of metal bearing watery solutions can be attributed to the permafrost conditions in the ore, which naturally limit any migration to a large extent.

The higher silver content of the Webber ore is thought to be caused by an original higher silver content of the primary ore, which, according to its Pb/Sb ratio also possessed greater amounts of jamesonite, boulangierite and/or bournonite, than the sulphide ore of the Huestis mine.

The occurrence and development of gold in the Mount Nansen ore-body has been studied in great detail, since it brought about considerable metallurgical problems during recovery tests. Gold has been found as small particles intergrown with galena, freibergite, bournonite, sphalerite, pyrite, arsenopyrite, and gangue and as inclusions in pyrite, arsenopyrite, sphalerite and galena. An electron microprobe investigation carried out by the Mineral Science Division in Ottawa showed a fineness of approximately 800 for the gold particles investigated.

Altogether 65 gold grains have been found during the examination of the Mount Nansen ore, they only occur in about one third of the investigated polished sections. This fact illustrates clearly the irregular distribution of the gold in the ore-body. Usually several gold grains were observed in a limited area within one polished section, the remaining area being completely free of gold. No distinct distribution pattern as to the abundance of gold has been found in contrast to Schmidt (1969) who states that gold occurs in abundance in areas characterized by fine grained pyrite. However, gold is distinctly less abundant in polished sections from the Webber mine than in sections from the Huestis mine, which is in good agreement with the average assay values for the two zones; 0.39 oz/ton for Huestis and 0.25 oz/ton for Webber.

42 gold grains occur as inclusions on pyrite and 6 grains as inclusions in arsenopyrite. The grain-size of these inclusions being 5-50 microns with an average of 20 microns. Generally, these gold inclusions occur in the marginal zones of the host minerals and represent infiltrated material. Some of the gold infiltrations form composite inclusions with galena and freibergite. In a few cases, however, small gold inclusions were found in the cores of pyrite and arsenopyrite crystals and show no evidence of infiltration from the outside. 2 gold grains form inclusions in galena and 2 grains occur within euhedral quartz crystals, 1 gold inclusion was found in sphalerite. All these gold inclusions are extremely small in diameter, and although they represent the bulk of the total number of the gold grains observed, they are only a minor amount of the total gold quantity encountered.

Larger gold individuals with diameter of up to 500 microns have been found as intergrowth with galena, freibergite, sphalerite, and bournonite in interstices between arsenopyrite and pyrite or as individual grains. This "free gold" accounts for well over 50 weight per cent of the gold found in the investigated samples.

In the Webber ore the gold grains were found to be generally smaller than in the Huestis ore. Several grains display intimate intergrowth with secondary limonite, and bindheimite/beudantite and possibly represent resistant remnants of gold inclusions in completely weathered primary minerals (pyrite, arsenopyrite, etc.).

In the paragenetical sequence, gold falls within the mineralization period of galena, freibergite, and the hypogene sulphosalts. The gold inclusions in the centres of arsenopyrite and pyrite crystals, which evidently were not infiltrated into the sulphides, are considered to be primary features which represent contaminations of the host mineral, similar to the earlier discussed pyrrhotite, galena and chalcopyrite inclusions in pyrite and arsenopyrite. Two generations of gold are therefore contemplated.

The development of the gold in the Mount Nansen ore-body indicates that the bulk of the precious metal occurs as "free gold", intimately intergrown with the contemporaneously emplaced galena, freibergite and sulphosalts. Minor amounts of gold also form inclusions in pyrite and arsenopyrite and it is felt, that it is this portion of the gold - approximately 35% of the total gold content - which could not be recovered in a satisfactory way during the short production period of Mount Nansen. The larger "free gold" particles are, by their nature, relatively easy to recover, either by a gravity method or by flotation.

Macroscopically, stibnite is encountered occasionally in the Huestis ore. During the present microscopic investigation stibnite was found in six polished sections. It forms elongated fibrous to columnar, usually twinned crystals. In all polished sections, in which stibnite was observed it occurs relatively abundant, which also explains that even as a minor constituent of the Mount Nansen ore-body it has been found macroscopically. Etching with KOH was used in a few cases where stibnite was difficult to distinguish from jamesonite. The association of stibnite with other ore-minerals indicates a young position in the paragenetic sequence. Wolfsbergite was detected in one polished section from the Huestis ore, where it was associated with extremely coarse grained stibnite.

Rutile was found predominantly in the country rock and in the gangue of the Webber ore where it forms strongly shattered roundish grains, generally associated with titanite. Usually rutile is distinctly older than pyrite I by which it is replaced. In one polished section obtained from disseminated mineralized country rock rutile forms composite aggregates together with ilmenite. Cubes of magnetite were found in only one polished section from the Huestis No. 12 Vein, where they are associated with pyrite and sphalerite.

#### 4. Conclusions

The study of the association and occurrence of the ore-minerals from the Mount Nansen ore-deposit indicates the following paragenetical sequence:

Pyrite I and arsenopyrite are the oldest minerals present, both minerals are contaminated by minor amounts of pyrrhotite, chalcopyrite and gold. These minerals were followed by an early but minor formation of jamesonite and in turn by sphalerite and chalcopyrite. As last phase the lead, antimony and silver bearing minerals stibnite, galena, freibergite, jamesonite, boulangerite, bournonite, miargyrite, and stromeyerite were emplaced. It is felt that during this mineralization period which was marked by a major introduction of Pb, Sb and Ag also the major portion of the gold present in the ore-body was emplaced. The relatively late introduction of the gold is also illustrated by its comparatively low fineness. Pyrite II apparently has been emplaced towards the end of the last mineralization period.

In the Webber mine supergenic alteration has affected the mineralogy considerably. However, the premafrost conditions, which prevail in the Mount Nansen area limited chemical transport by watery solution to a large extent. The alteration therefore occurred essentially in situ, and no vertical separation of the minerals and no secondary enrichment zone has been observed. The oxide minerals which telescope into the zone of sulphide minerals must be regarded as the youngest paragenetical generation.

The following metallurgical comments can be made in respect to the recovery of silver and gold:

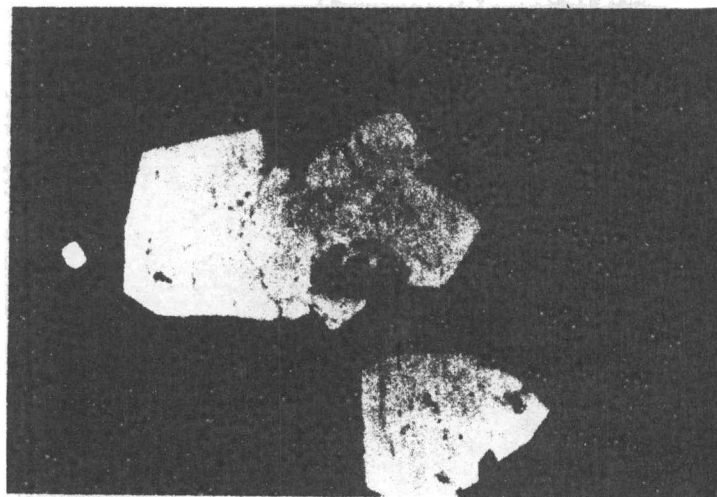
Silver occurs as major constituent, in solid solution or as minor contamination in the following minerals: Native silver, freibergite, miargyrite, pyrargyrite, galena, jamesonite, boulangerite, bournonite, and the oxide minerals beudantite, bindheimite, anglesite, and argentojarosite. In the sulphide ores, only freibergite, galena and possibly jamesonite/boulangerite occur in economically important amounts. It can be expected that these minerals do not pose severe problems in a flotation plant. The rather unstable silver-bearing supergenic minerals which are present in the oxide ores, however, can go into solution during flotation and subsequent washing. Silver, therefore, can be lost to a certain extent in the course of such a concentration. Accordingly, flotation tests carried out on oxide ore from Webber indicated that a silver loss of 30 to 50 per cent must be expected. The silver loss is higher, the longer the concentrate is washed, which can be explained satisfactorily by the instability and solubility of the silver bearing oxide minerals. One can therefore assume that flotation of sulphide ore from Mount Nansen, yielding good recovery, is feasible. The oxide ore, however, should be treated by another process than flotation to avoid silver losses.

Gold occurs as primary inclusions in pyrite and arsenopyrite, as peripheral inclusions in a number of sulphide minerals and as "free gold" forming intergrowth with galena, freibergite and sulphosalts. The "free gold" which forms the bulk of the gold present in the Mount Nansen deposit is relatively easy to recover, either by gravity processes, by flotation or cyanidation. Primary inclusions and some of the peripheral inclusions which generally are extremely minute are in the contrary far more difficult to recover. Due to their size these particles are difficult to liberate and require an extremely fine milling of the feed. It seems that best recoveries could be obtained by <sup>flotation</sup>flotating a pyrite-arsenopyrite concentrate which subsequently is roasted and cyanided. The problems experienced in the recovery of gold are quite clearly illustrated by the metallurgical tests where the best gold recoveries obtained ranged from 80% to 85%. The remaining unrecovered 20 to 15% must have been present in the form of minute gold inclusions which were not liberated during milling and thus escaped recovery.

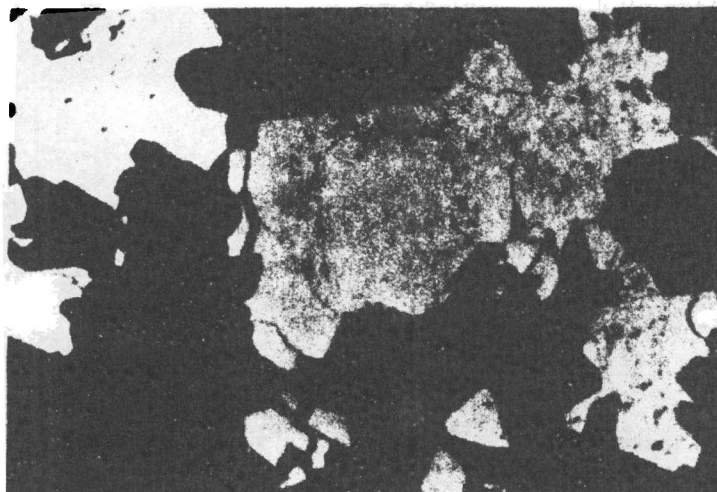
List of minerals present in the Mount Nansen ore-body

Pyrite	$\text{FeS}_2$	Miargyrite	$\text{AgSbS}_2$
Arsenopyrite	$\text{FeAsS}$	Ramdohrite	$\text{Pb}_3\text{Ag}_6\text{Sb}_6\text{S}_{13}$
Galena	$\text{PbS}$	Titanite	$\text{CaTiSiO}_6$
Sphalerite	$\text{ZnS}$	Rutile	$\text{TiO}_2$
Chalcopyrite	$\text{CuFeS}_2$	Ilmenite	$\text{FeTiO}_3$
Freibergite	$(\text{Cu}, \text{Ag})_3\text{SbS}_3$	Magnetite	$\text{Fe}_3\text{O}_4$
Jamesonite	$\text{Pb}_4\text{FeSb}_5\text{S}_{14}$	Covellite	$\text{CuS}$
Boulangerite	$\text{Pb}_5\text{Sb}_4\text{S}_{11}$	Chalcocite	$\text{Cu}_2\text{S}$
Bournonite	$\text{CuPbSbS}_3$	Malachite	$\text{Cu}(\text{CO}_3)(\text{OH})_2$
Pyrrhotite	$\text{FeS}$	Limonite-Goethite	$\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$
Cubanite	$\text{CuFe}_2\text{S}_3$	Anglesite	$\text{PbSO}_4$
Valleriite	$\text{Cu}_3\text{Fe}_4\text{S}_7$	Scorodite	$\text{Fe}(\text{AsO}_4) \cdot 2\text{H}_2\text{O}$
Stromeyerite	$\text{CuAgS}$	Bindheimite	$\text{Pb}_2\text{Sb}_2\text{O}_7 \cdot n\text{H}_2\text{O}$
Pyrargyrite	$\text{Ag}_3\text{SbS}_3$	Beudantite	$\text{PbFe}_3(\text{AsO}_4)(\text{SO}_4)(\text{OH})_6$
Nat. Silver	$\text{Ag}$	Plumbojarosite	$\text{PbFe}_6(\text{SO}_4)(\text{OH})_{12}$
Nat. Gold	$\text{Au}$		
Stibnite	$\text{Sb}_2\text{S}_3$		

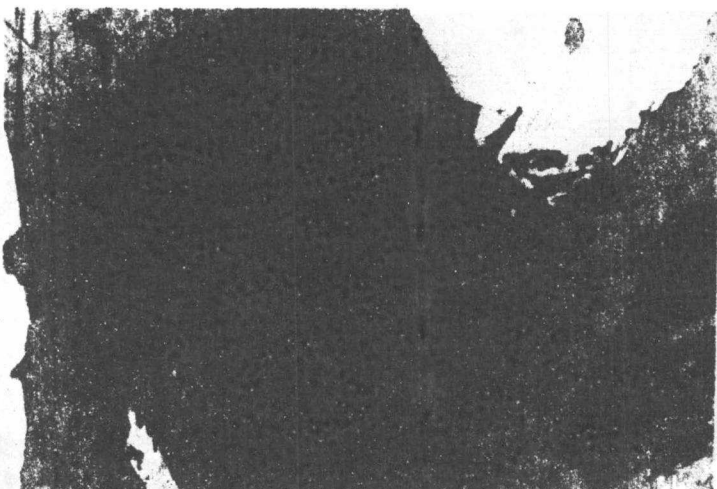
Country rock, Huestis mine:  
Slightly fractured pyrite crystal  
(white) in gangue (black) re-  
placing an older, somewhat round  
grain of rutile (grey)  
Oil immersion, 350x



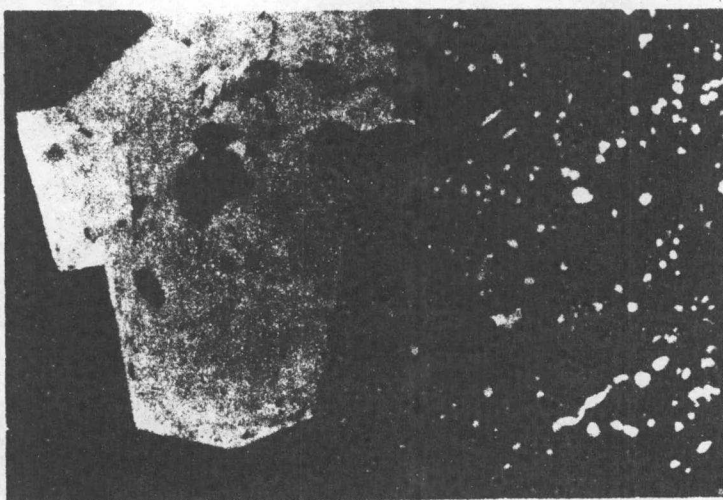
Huestis mine: Pyrite aggregates  
(white) in gangue (black) Note  
the porous skeleton-type pyrite  
which overgrowth a compact  
slightly fractured grain of  
pyrite I in the centre of the  
photomicrograph.  
Oil immersion, 350x



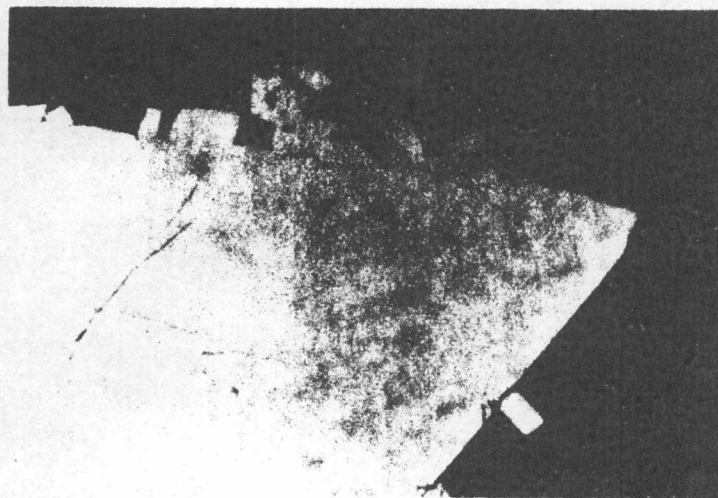
Huestis mine: Pyrite (white  
strongly replaced by stromeyerite  
(grey) On the right hand side  
of the photomicrograph stro-  
meyerite is intergrown with  
freibergite (dark grey) on the  
left hand side it encompasses  
2 tabular crystals of stibnite  
(dark grey with a polishing  
mistake) and borders an elon-  
gated crystal of jamesonite  
(slightly brighter than st  
meyerite)  
Oil immers 350x



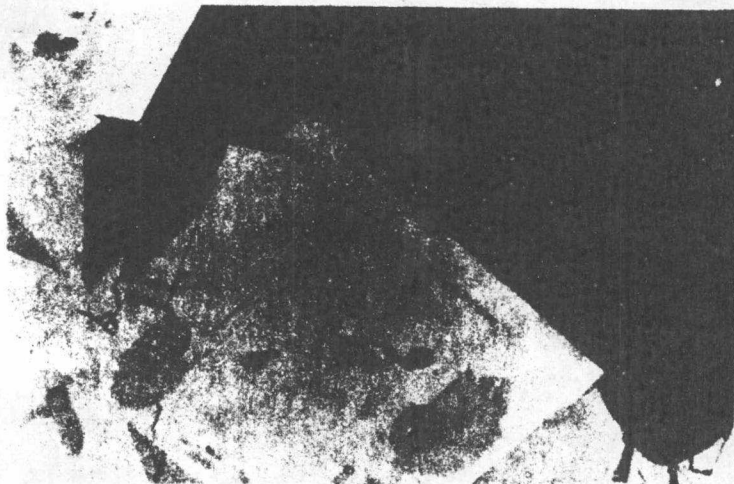
Huestis mine: Pyrite I (white) with porous encrustations of pyrite II. Sphalerite (grey) containing exsolution blebs of chalcopyrite (white) replaces pyrite. Freibergite (slightly darker than chalcopyrite) forms minor infiltrations and veinlets in sphalerite and replaces chalcopyrite clearly in the upper left hand corner of the photomicrograph. Gangue (black). Oil immersion, 350x



Huestis mine: Arsenopyrite (white) showing overgrowth of a younger arsenopyrite generation. Gangue (black). Oil immersion, 350x

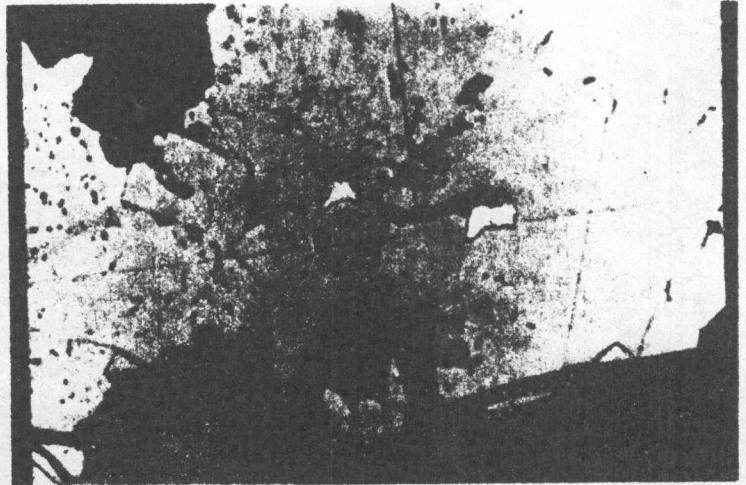


Huestis mine: Arsenopyrite (white) distinctly replaced by galena (grey). Inclusions of stromeyerite (dark grey) in arsenopyrite, centre of the photomicrograph. Oil immersion, 350x



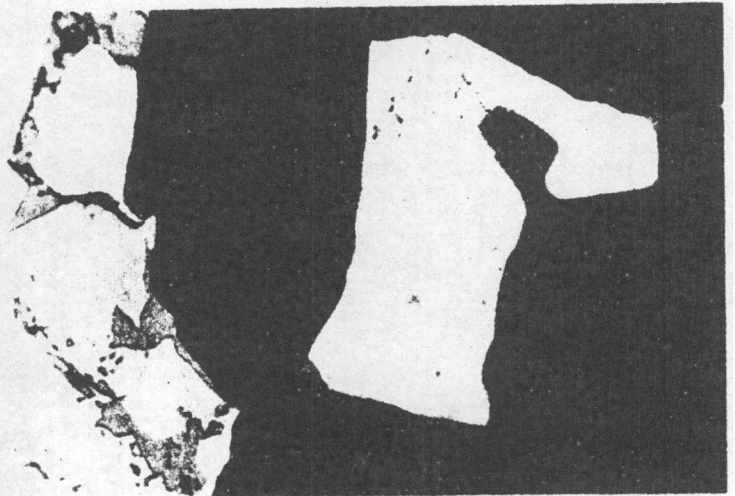
Huestis mine: Intergrowth of pyrite, (white) arsenopyrite (slightly darker than pyrite) galena (grey) and freibergite (dark grey). In this case pyrite is younger than arsenopyrite, it also contains far more inclusions. Freibergite and galena clearly replace pyrite. Two gold inclusions (white, strong relief) occur at the grain boundaries of arsenopyrite with pyrite and are distinct infiltrations.

Oil immersion, 350x



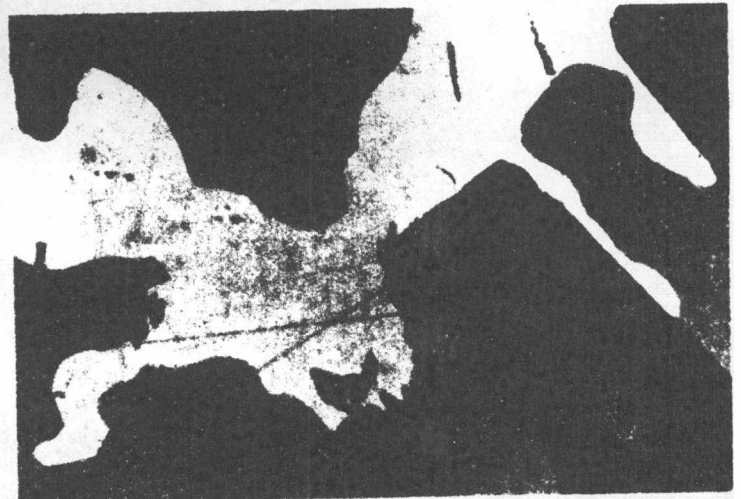
Huestis mine: Gold (white) intergrown with galena (grey) and sphalerite (dark grey). Gold forms together with galena distinct infiltrations in arsenopyrite (white, distinct relief). With galena gold forms mutual boundaries, indicating contemporaneous emplacement.

Oil immersion, 350x



Huestis mine: Intergrowth of gold (white and distinctly scratched) with galena (grey), jamesonite (dark grey) and arsenopyrite (slightly whiter than galena and harder). Gold displays with galena mutual boundaries, whereas with jamesonite the boundaries are rugged and interfingered, suggesting a replacement of gold by jamesonite.

Oil immersion, 350x



Webber mine: Intensive alteration of arsenopyrite crystals (white) into loose ill-defined secondary minerals (grey), possibly scorodite, arsenolite and limonite-goethite which are perfectly pseudomorph after the primary arsenopyrite grains.

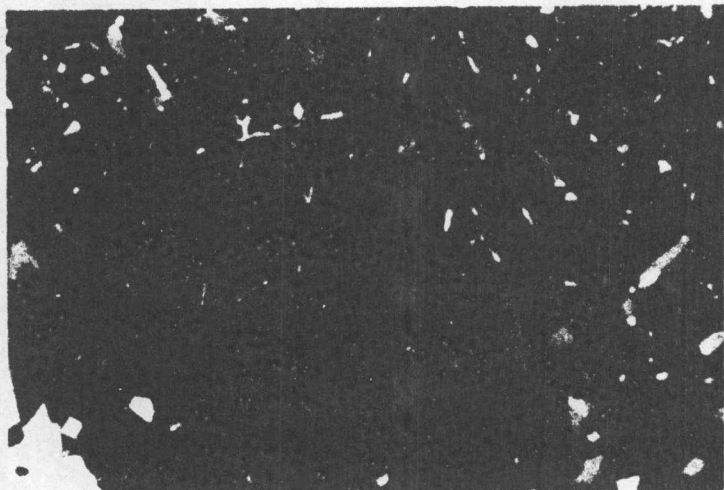
Oil immersion, 350x



Huestis mine: Sphalerite (dark grey) with numerous inclusions of freibergite (grey) and chalcopyrite (white) which distinctly follow crystallographic directions.

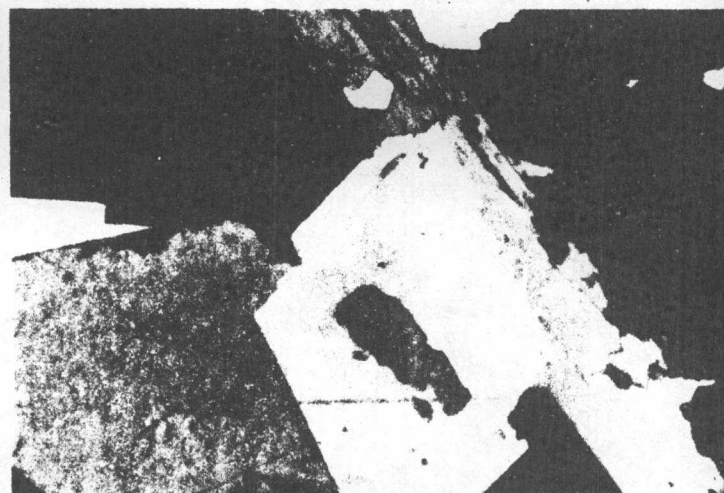
In this case sphalerite is an important Ag-carrier due to the numerous minute inclusions of freibergite.

Oil immersion, 350x



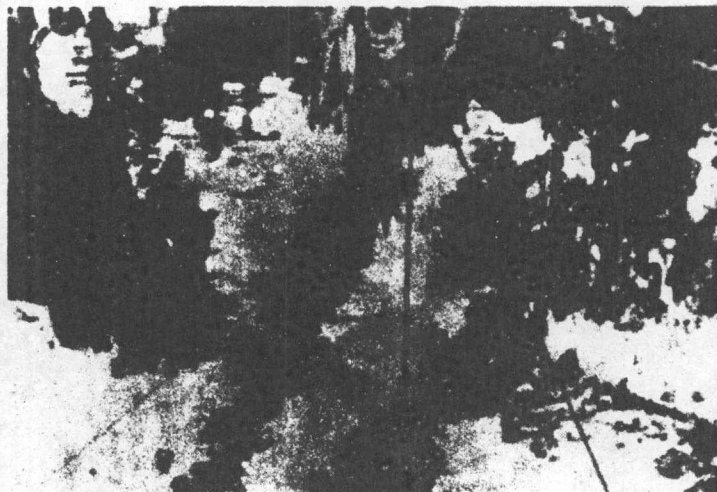
Huestis mine: Complex association of stibnite (grey) in the left hand corner of the photomicrograph, arsenopyrite (white), jamesonite (white, elongated crystal) and sphalerite (dark grey). The jamesonite clearly replaces the sphalerite and corrodes arsenopyrite. Bournonite (grey) forms an inclusion in the centre of the arsenopyrite.

Oil immersion, 350x



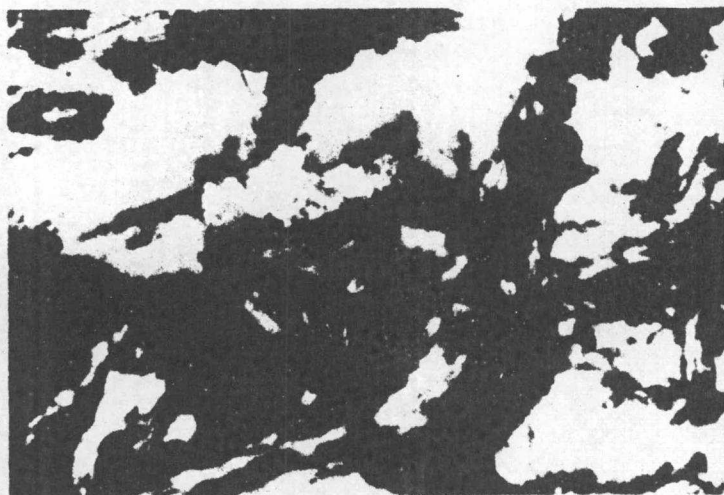
Webber mine: Chalcocite (white) strongly replaced by malachite (grey) in distinct parallel directions. Malachite is intergrown with other secondary minerals, mainly goethite (dark grey).

Oil immersion, 350x



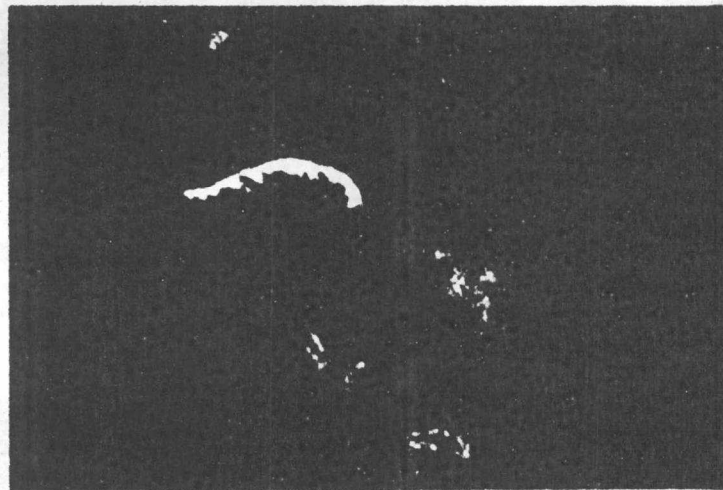
Webber mine: Remnants of arsenopyrite (grey) replaced by ill-defined alteration products, possibly scorodite and/or arsenolite (dark grey). Native silver (white) forms a loose spongy aggregate in the interstices of the arsenopyrite pseudomorphs.

Oil immersion, 350x

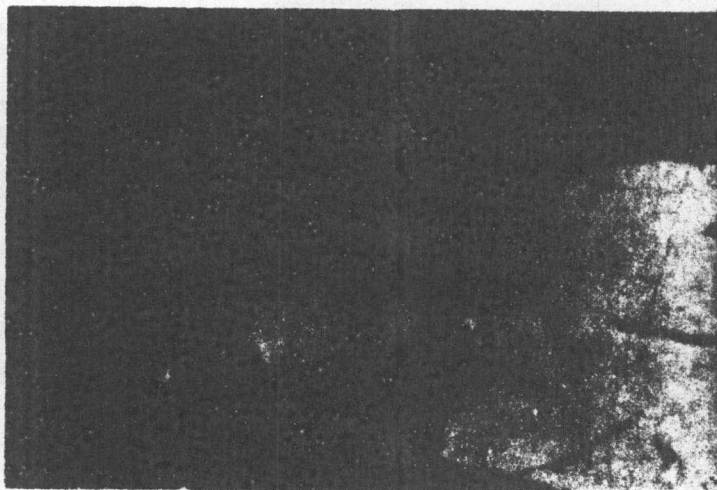


Webber mine: Arsenopyrite (grey) forming minute grains which are strongly replaced by pseudomorphous alteration products (dark grey). In the centre of the photomicrograph a resistant remnant of a gold inclusion (white) which originally completely altered

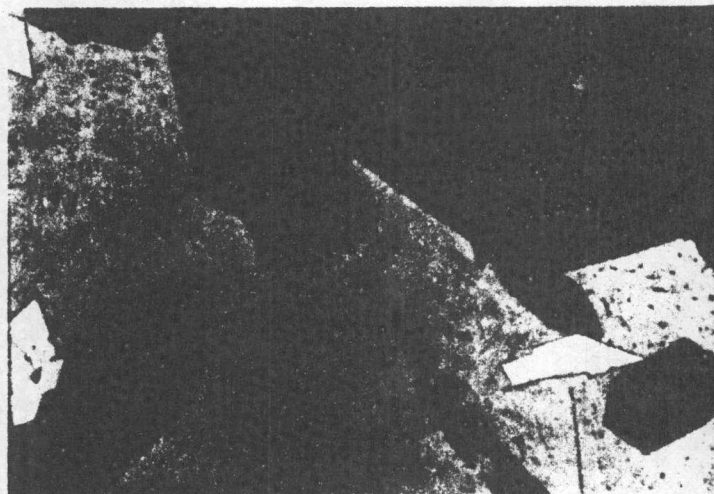
e.  
0x



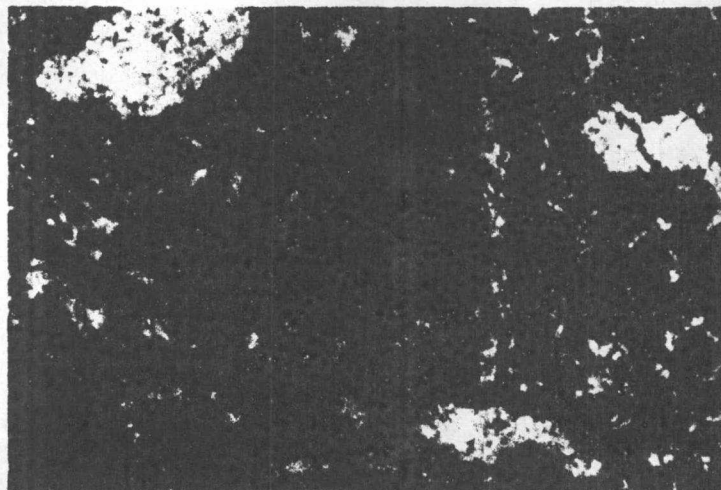
Huestis mine: Intergrowth of freibergite (dark grey), galena (grey) and chalcopryrite (white). Galena distinctly replaces freibergite and forms a thin veinlet which cuts through the freibergite and the chalcopryrite. Two small inclusions of jamesonite (grey) occur in freibergite at the top of the photomicrograph.  
Oil immersion, 350x



Huestis mine: Elongated jamesonite lamellas (dark grey) replace galena (grey) and arsenopyrite (white). Euhedral gangue quartz (black) is only very weakly replaced by the sulphides.  
Oil immersion, 350x



Webber mine: Strongly altered association of jamesonite, boulangierite and galena. The original elongated crystals of jamesonite are still distinctly visible. Remnants of galena, jamesonite and boulangierite (white). Anglesite, beudantite and bindheimite (grey). Gangue (black).  
Oil immersion, 350x



## STATISTICAL ANALYSES OF MINE ASSAY DATA

### 1. INTRODUCTION

During recent calculations of the Mount Nansen ore-reserves the question arose, how many channel samples per drift face are needed in order to obtain optimal dependability for delineating ore-shoots and calculating ore-reserves. Similar considerations were already carried out by Campbell (1965) who writes in his review report on the geology and ore-reserves "Initially, each face was sampled wall to wall by three channels cut at 6, 4 and 2 feet above track. Also every round was muck sampled by taking a random handful from the top of every second or third car so that about a powderbox of samples was garnered to represent the round. After 200 feet of ore (Webber) it was found that the erratics expected in the ore did not occur and that for most faces the three channels would be about the same." Sampling was subsequently reduced from three to two channels per face at 2.5 and 5 feet above rail. It is obvious that the assaying expences incurred during drifting could be lowered considerably if only one instead of two channels per face can be sampled without markedly changing the endresult.

The numerous and detailed silver and gold values which are available from the assay plans of the Huestis 4300 and 4100 level and from the Webber workings presented a unique opportunity to study the distribution of the two precious metals in three different parts and elevations of the Mount Nansen ore-body. The data furthermore allowed to investigate if the assay values correspond with the observed mineralogical and geological features and if depth has an influence on the ore-grade. It was found that graphical methods provide the most convenient way to accomplish such statistical analyses.

### 2. SAMPLING, ASSAYING AND MEASURING METHODS

The samples were obtained from two, three to five inches wide channels, cut horizontally across the face of exposed ore, at 2.5 and 5 feet above track. Customarily, the samples are spaced 5 to 7 feet apart along the strike of the vein, depending on the length of the round. Each channel consists at least of three different samples; taken from the hanging wall and foot-wall of the mineralized vein and from the mineralization itself. Commonly, each of the fractions which together constitute one channel sample, possess a different width, a fact which had to be considered when calculating a standard base for the channel samples. The fractions were analysed separately by the conventional fire assay method. All the fire assays were carried out at the mine laboratory by the mine assayer and check samples were run by a commercial assaying office in Whitehorse.

According to the assay plans the limits of detection were 0.01 oz/ton for gold and 0.1 oz/ton for silver. The precision generally was within 5 per cent, however, for low grade ore it was considerably worse.

The different assay values obtained from the individual fractions of the channels together with their particular width are given on the assay plans of the mine. For the present study as well as for the ore reserve calculations a standard channel width of 4 feet was chosen since it corresponds with the minimal stopping width feasible at the Mount Nansen ore-body. The channels were reduced in such a way that they contain the entire mineralized portion of the vein, plus the adjacent barren or weakly mineralized country rock, making up the balance to the 4 feet. Therefore, it is obvious that for the calculated reduced 4 feet channels the weight of the mineralized vein is of far greater influence than for the actual sample channels. It is also important to note that a homogeneous gold and silver mineralization is assumed for the country rock adjoining the mineralized vein when calculating the 4 feet standard channels.

The reduction to 4 feet of a 7 feet wide channel consisting of three individual samples is given in the following example.

Actual 7 feet channel:

	width	Au	Ag
Country rock, hanging wall	3.5	0.05 oz/ton	1.2 oz/ton
Mineralized vein	1'	0.8 oz/ton	9.4 oz/ton
Country rock, foot wall	2.5'	Nil	Trace

Reduced 4 feet standard channel:

	width	Au	Ag
Country rock, hanging wall	1.5'	0.05 oz/ton	1.2 oz/ton
Mineralized vein	1'	0.8 oz/ton	9.4 oz/ton
Country rock, foot wall	1.5	Nil	Trace
	<u>4'</u>	<u>0.22 oz/ton</u>	<u>2.35 oz/ton</u>

3. INVESTIGATION ON THE REDUCTION OF THE NUMBER OF SAMPLE CHANNELS PER FACE.

As mentioned earlier the possibility of reducing the number of sample channels has already been studied by Campbell (1965) who recommended to decrease the sampling to two channels per face at 2.5 and 5 feet above track. The present work was undertaken to investigate if a further reduction of the sample channels is feasible. For this reason, channels from a number of ore-shoots from the Huestis 4300 and 4100 levels and from the Webber mine were chosen and their gold and silver assay values analysed. Of each investigated ore-shoot the means, standard deviations and coefficients of variations were separately computed for the

gold and silver values of the upper and lower 4 feet wide standard channels (Table 1).

**TABLE 1: Statistical parameters of gold and silver values.**

	N	$\bar{x}$ oz/t	Gold		Silver		
			$S_x$ oz/t	$V_x$	$\bar{y}$ oz/t	$S_y$ oz/t	$V_y$
<b>HUESTIS 4100</b>							
<b>H 41 - 12 - 593</b>							
upper channels	31	0.33	0.18	0.53	7.1	5.0	0.71
lower channels	31	0.32	0.19	0.60	8.1	6.7	0.82
<b>H 41 - 12 - 588</b>							
upper channels	33	0.56	0.39	0.69	8.8	8.9	1.01
lower channels	33	0.64	0.55	0.86	10.9	13.4	1.22
<b>H 41 - 12 - 585</b>							
upper channels	42	0.87	0.68	0.78	13.6	10.1	0.7
lower channels	42	0.87	0.58	0.67	10.5	7.7	0.73
<b>HUESTIS 4300</b>							
<b>H 43- 12 - 595</b>							
upper channels	11	0.55	0.50	0.91	15.6	19.7	1.25
lower channels	11	0.56	0.55	0.98	13.2	15.3	1.16
<b>H 43 - 12 - 594</b>							
upper channels	35	0.63	0.48	0.76	24.0	45.6	1.90
lower channels	35	0.72	0.55	0.76	23.9	23.4	0.98
<b>H 43 - 12 - 585</b>							
upper channels	26	0.43	0.27	0.61	18.3	21.5	1.17
lower channels	26	0.49	0.42	0.86	15.7	12.9	0.82
<b>WEBBER</b>							
<b>119</b>							
upper channels	11	0.13	0.10	0.76	8.4	8.7	1.04
lower channels	11	0.19	0.14	0.73	10.8	9.6	0.89
<b>121</b>							
upper channels	8	0.24	0.11	0.45	25.5	21.7	0.85
lower channels	9	0.34	0.21	0.63	46.5	38.1	0.82
<b>W 43 - 1-588</b>							
upper channels	12	0.70	0.36	0.51	52.1	31.8	0.61
lower channels	12	0.64	0.54	0.85	40.2	24.7	0.62

N = Number of channels per ore-shoot;  $\bar{x}$ ,  $\bar{y}$  = Mean value,  $S_x$ ,  $S_y$  = Standard deviation;  $V_x$ ,  $V_y$  = Variation coefficient.

From Table I it is apparent that the mean values for the upper and lower channels are remarkably similar. Great discrepancies occur only in the Webber ore-shoots where the gold grade is low and thus the influence of analytical errors great. One has also to consider that the Webber ore was affected by supergenic alteration which resulted in some chemical redepositions. The standard deviations usually are large, especially for silver, which indicates wide dispersion for this metal in the Mount Nansen ore-body. The distribution of gold was found to be somewhat more homogeneous. These features are even better demonstrated by the coefficients of variation which enable to compare the different distributions independent of their respective quantities. For gold, the coefficients of variations are always smaller than 1.00, that is the standard deviation is always smaller than the mean. For silver, the coefficients of variation are in almost half of the cases larger than 1.00, i.e. the standard deviations in these cases are larger than the mean values.

The large coefficients of variation obtained indicate that laterally - the direction in which the samples were collected - the gold and silver grades of the ore are rather inhomogeneous. It seems therefore possible that more reliability could be added to ore-grade calculations and ore-shoot delineation by spacing the channels in 3 feet intervals along the vein instead of the presently used 6 feet distance. The introduction of three feet channel intervals implies that during exploratory drifting face and back channels must be alternated.

As shown on Table I the mean values of the lower and upper channels from one particular ore-shoot are in most cases reasonably similar, both for gold and silver. The deviations from the average value of the upper and lower channels usually lie between 5 per cent and 10 per cent of the average value and never exceed 20 per cent. Since the lower and upper channels deviate so little from their average it seems appropriate to assume that no real improvement is achieved by using two channels instead of one. For this reason it is suggested that only one channel per face is sampled, preferably at 3 feet above rail.

One furthermore must consider that in exploratory drifting no assay values are available between levels, a distance which at Mount Nansen amounts to 200 feet. It is therefore statistically extremely improbable that 2 channels per drift face situated vertically 2.5 feet apart and with a vertical interval of 200 feet to the next sample pair would improve the results of ore estimations. It is however suggested that a closer sample spacing along the vein in the drifts could lead to improved results of such calculations.

#### 4. THE DISTRIBUTION OF GOLD AND SILVER IN THE MOUNT NANSEN ORE-BODY.

The gold and silver assay values were also studied to determine the distribution of the two elements within the Mount Nansen ore-body and to investigate the influence of the supergenic alteration, the geological setting and the mineralogy on the

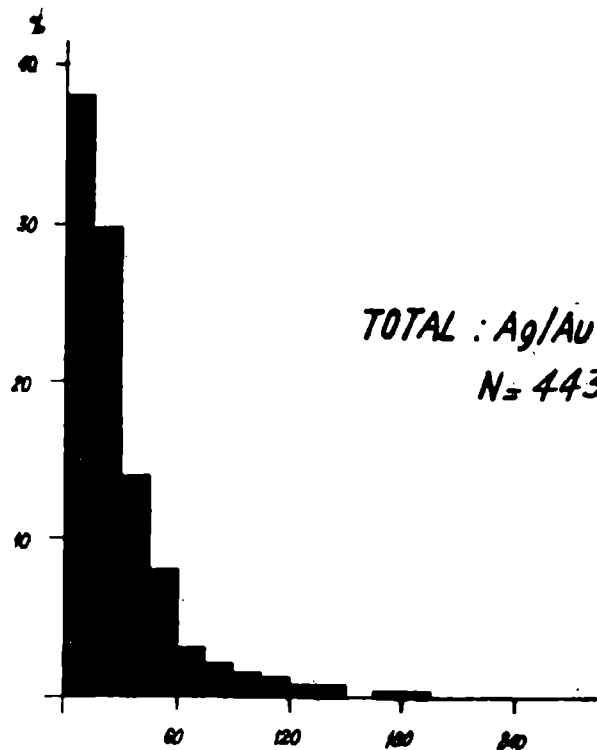
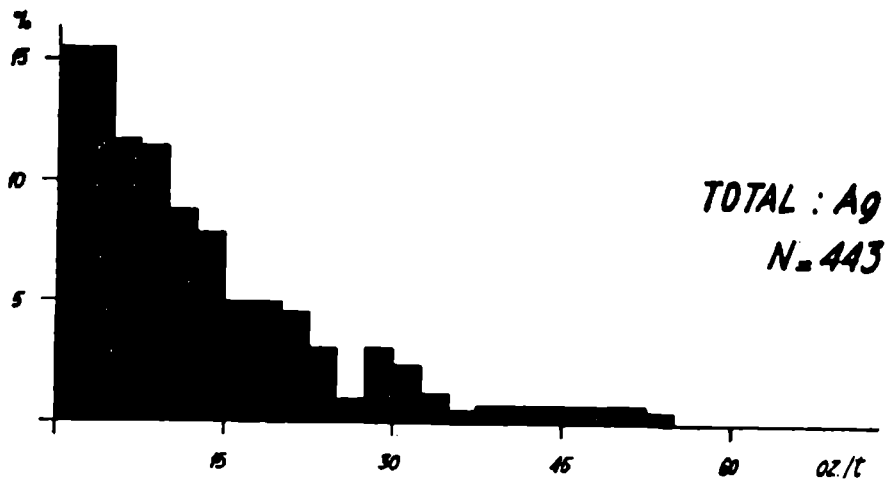
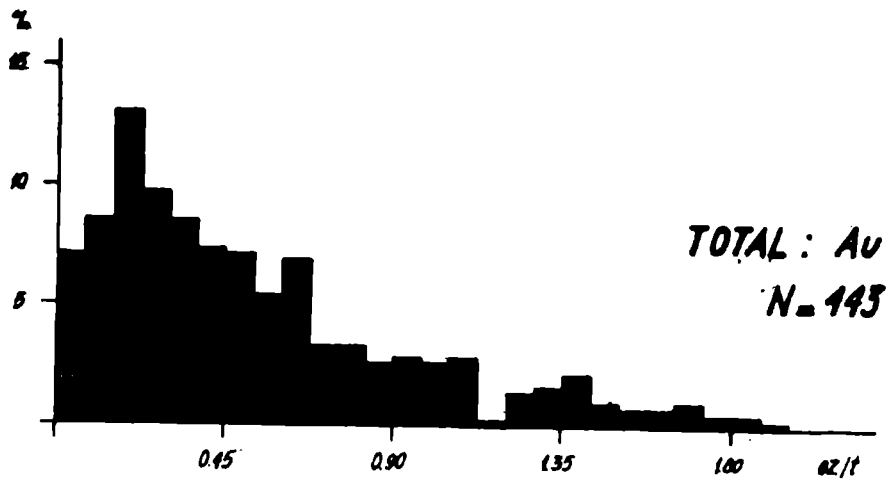
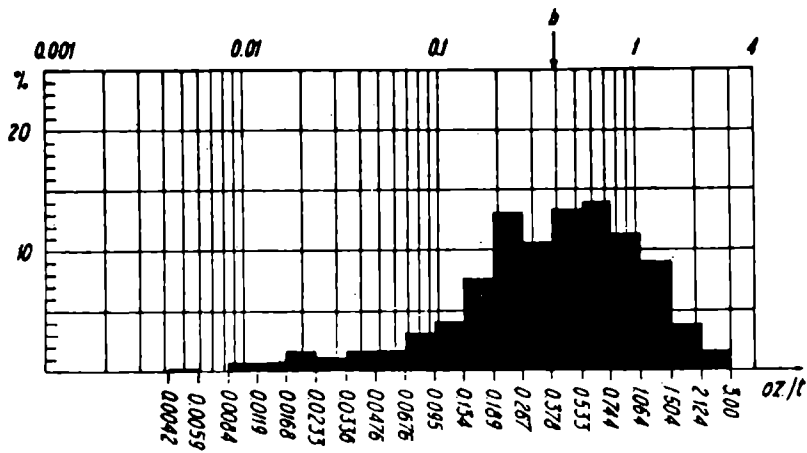
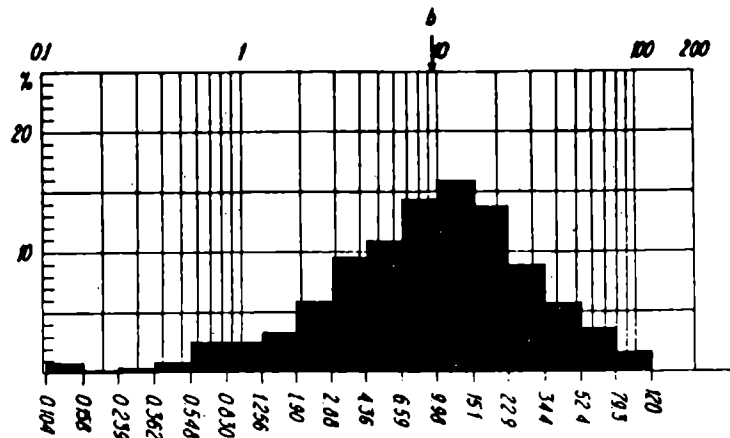


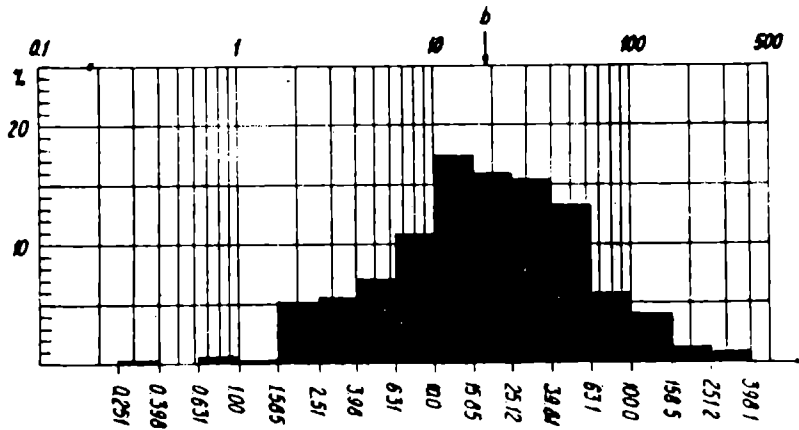
Fig. 5. Relative frequency histograms on arithmetic graph paper of all the investigated gold, silver, and Ag/Au values from the Mt. Nansen orebody



TOTAL Au  $N=443$   $b=0.395$



TOTAL Ag  $N=443$   $b=9.4$



TOTAL Ag/Au  $N=443$   $b=18.6$

Fig. 6. Relative frequency histograms on logarithmic graph paper of all the investigated gold, silver, and Ag/Au values from the Mt. Nansen orebody

abundance of the two precious metals. To obtain information on the relative abundance of gold and silver in respect with each other the Ag/Au ratio of the individual gold and silver values was computed and the resulting ratios statistically treated in the same way as the individual gold and silver values.

Figure 5 shows the "total" arithmetic frequency histogram of all the 443 gold, silver and Ag/Au values investigated in the Mount Nansen ore-body. The histogram for gold indicates an asymmetrical curve possessing positive skewness, whereas for silver and Ag/Au reverse J-shaped curves were obtained. Since the distributions are essentially non-parametric and according to Ahrens (1957) lognormal distribution patterns appear to be the most applicable to the results of most geochemical surveys the arithmetic distributions were plotted on arithmetic-logarithmic graph paper where they approach lognormal distributions (Fig. 6). A lognormal distribution is defined by two parameters, one is dependent on the mean value, the other on the character of value distribution. The latter indicates the range of the distribution. According to Matheron (1962) it seems that the lognormal law fits usually very well in the case of low-grade deposits like gold but for high-grade deposits the experimental distributions are generally negatively skewed because of the limitations towards the high values.

#### Grouping of values.

A correct grouping of the assay values into an adequate number of classes is necessary if same precision is to be attained in the statistical analyses. The modulus of the intervals should be directly proportional to the precision of the analyses, i.e. a more precise analyses requires a smaller modulus. Lepeltier (1969) who discusses the method, uses for statistical work 15 to 25 intervals, with the restriction that the width of a class, expressed logarithmically must be kept equal to or smaller than half of the standard deviation (Shaw, 1964).

3 variables are important:  $n$  = number of points necessary to draw the curves;  $R$  = range of distribution of the values as expressed by the ratio of the highest to the lowest value present in the population and  $\log. \text{int.}$  = the width of the classes, expressed logarithmically.  $\log. \text{int.}$  is linked with  $n$  and  $R$  as follows:

$$\log. \text{int.} = \frac{\log R}{n}$$

$$R = \frac{\text{highest value}}{\text{lowest value}}$$

$n$  lies between 15 and 25.

For the present study the variable  $n$  has been selected as 17 for gold, 17 for silver and 16 for Ag/Au, the resulting width of the logarithmic intervals ( $\log. \text{int.}$ ) being 0.150, 0.180 and 0.200.

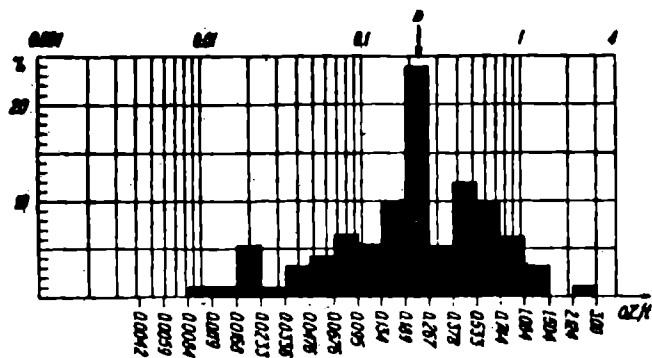
After determining the logarithmic intervals, the arithmetic class limits for gold, silver and Ag/Au were calculated and listed on tables and the histogram subsequently constructed on logarithmic-arithmetic graph paper (Fig.6). All the histograms on arithmetic-logarithmic paper indicate bell-shaped curves which - although for gold and silver displaying a weak negative skewness - approach lognormal distributions.

The fit of the distribution with a lognormal pattern can be checked graphically by plotting the cumulative frequency curve of the distribution on logarithmic probability paper. On such graph paper the cumulative frequency curve of a lognormal distribution has the form of a straight line, As can be seen on Figure 8 where the distributions are plotted on logarithmic probability paper, the points for Ag/Au fit extremely well a straight line. The line for silver is broken at about 80 per cent and the line for gold is broken twice at approximately 80 per cent and 20 per cent. Employing the graphical method given by Liozon (1961), a confidence check was carried out to test the hypothesis  $H_0$  that the straight line or the respective segments in the case the silver and gold lie within the channel delineated by the 0.95 level of confidence. The confidence channels are inversely proportional to the size of the population considered, i.e. large population have a narrower channel than small populations. Actually, the Pearson's test should be employed to check that a distribution fits a lognormal pattern. This however is an involved operation and it is felt that the graphical method used is not only much faster but also accurate enough for the present type of study.

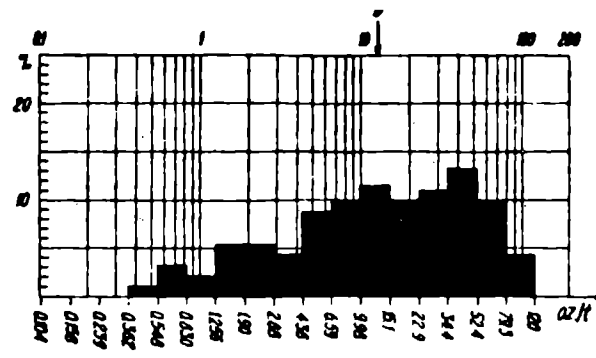
In this context, the following problems also had to be considered; at which value to start the cumulative frequencies and at which value to plot them, since on the probability scale the values for 0 per cent and 100 per cent are rejected. This means that the frequency value for 100 per cent cannot be plotted, the value for 0 per cent never occurs and therefore can be neglected. As low values possess a low precision the procedure of Lepeltier (1969) was followed and the frequency cumulated from the highest to the lowest values. The lowest class therefore corresponds with the frequency 100 per cent which, as discussed above, in the probability scale is rejected.

For plotting, the cumulative frequencies the lower class limits were used. This allows to compare directly and without corrections curves constructed from different log.int. classes. Using the class centres for plotting the curves would have entailed an error of excess on the control tendency parameters (Lepeltier, 1969).

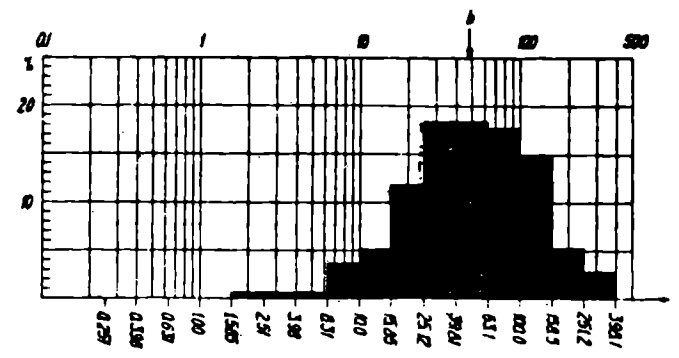
As earlier shown the main purpose for plotting the cumulative frequency curve for the various populations is to check how they fit lognormal distributions. In addition, the curves allow us to find graphically b-values (background) and s-values



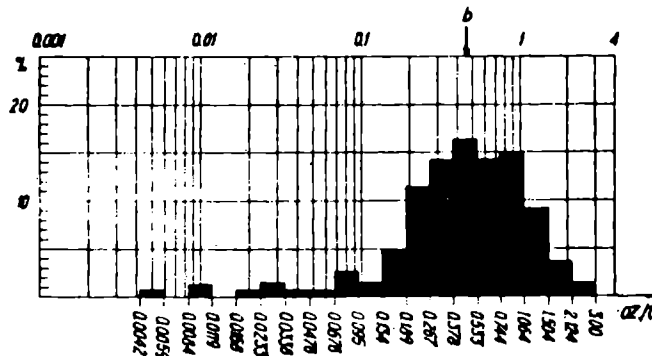
WEBBER. AU  $N=92$   $b=0.23$



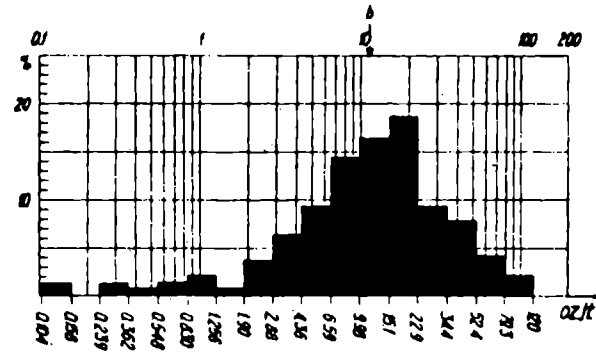
WEBBER. Ag  $N=92$   $b=128$



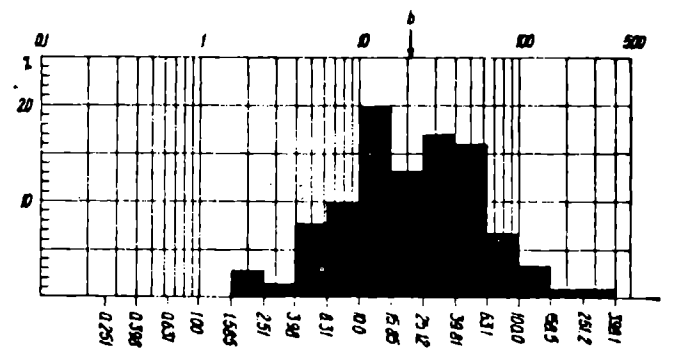
WEBBER Ag/Au  $N=92$   $b=48$



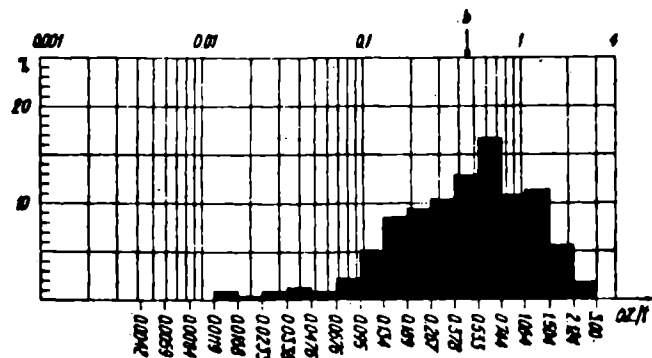
HUESTIS 4300. AU  $N=140$   $b=0.456$



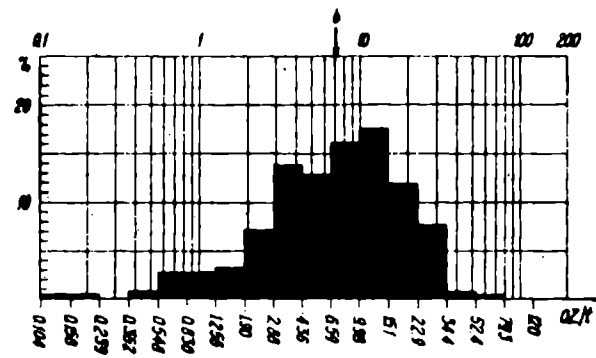
HUESTIS 4300 Ag  $N=140$   $b=114$



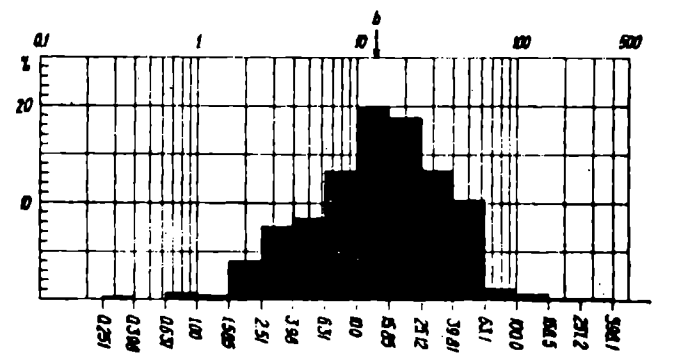
HUESTIS 4300 Ag/Au  $N=140$   $b=21$



HUESTIS 4100. AU  $N=210$   $b=0.45$

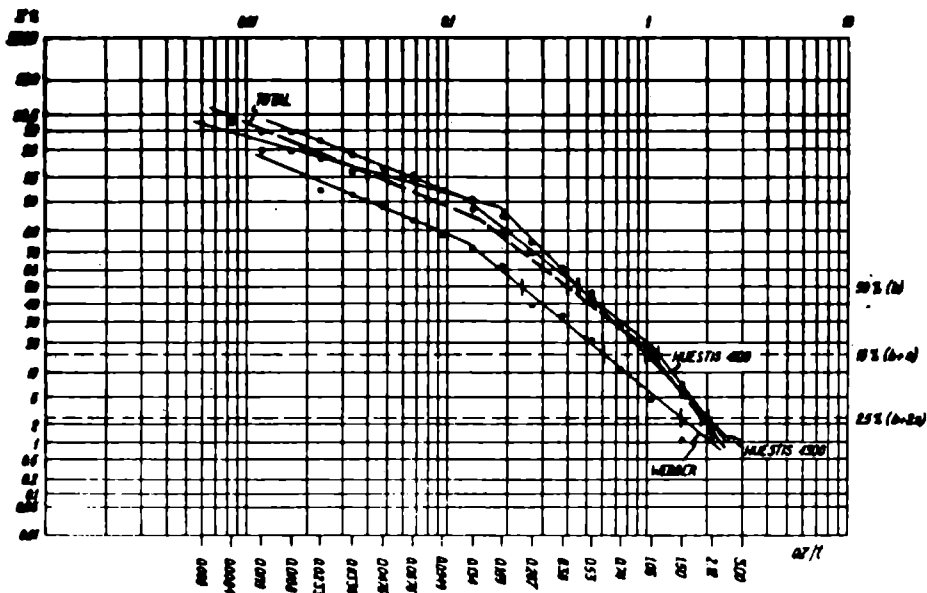


HUESTIS 4100 Ag  $N=210$   $b=71$

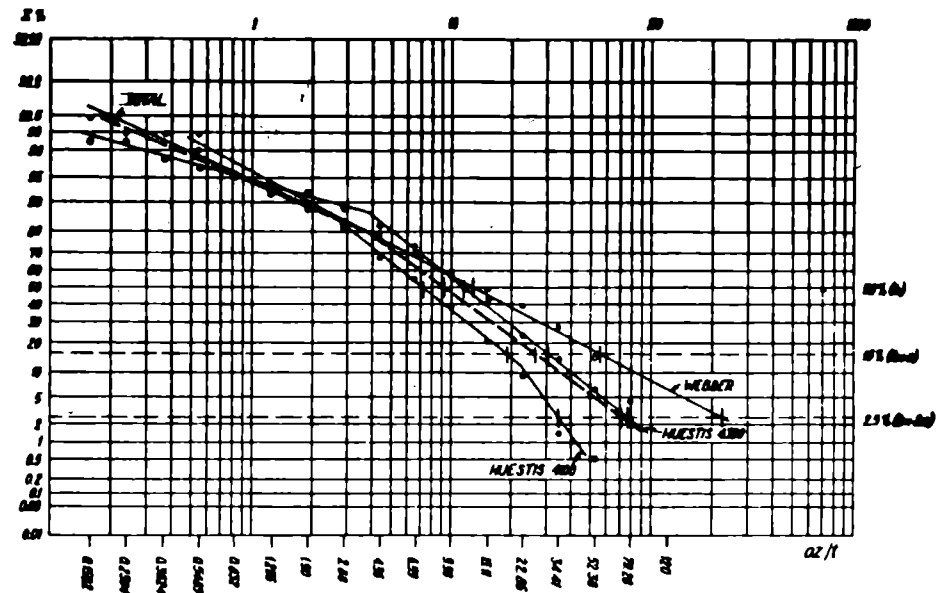


HUESTIS 4100 Ag/Au  $N=210$   $b=13.2$

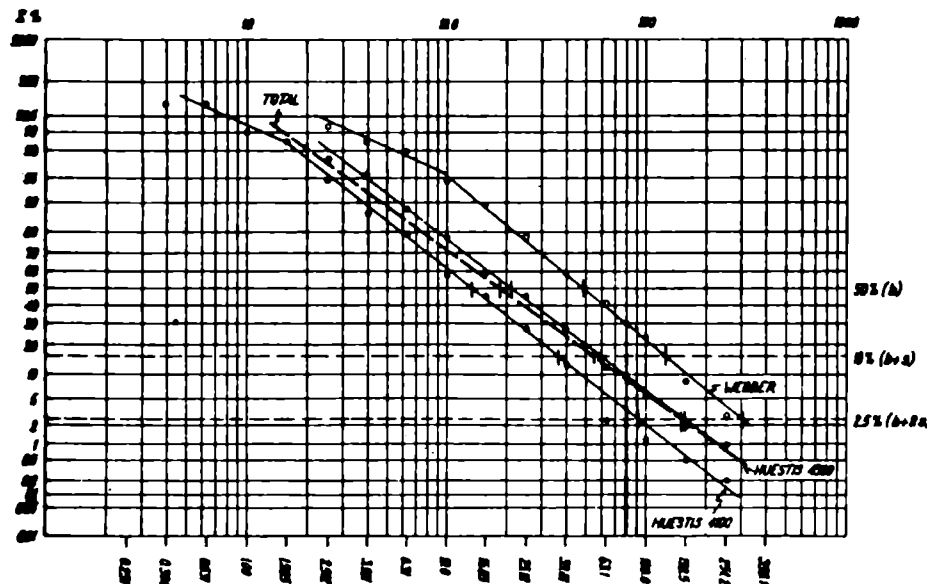
Fig. 7. Relative frequency histograms on logarithmic graph paper of the investigated gold, silver, and Ag/Au values from the individual sections of the Mt. Nansen orebody



GOLD



SILVER



SILVER/GOLD

Fig. 8. Cumulative frequency distribution on logarithmic-probability paper of the gold, silver, and Ag/Au values from the three individual sections (—) and of the "total" (----) Mt. Nansen orebody.

- Webber
- Huestis 4300
- Huestis 4100

(standard deviation) of each particular distribution.

The b-value is given by the intersection of the cumulative frequency curve with the 50 per cent ordinate. In the case of a perfect lognormal distribution b corresponds with the mean, the mode, (most frequent value), the median (halfway point of the readings when they have been arranged in order of size), and the geometric mean. As seen on Figure 6, none of the b-values coincide with the most frequent value class, this already is an indication that we do not deal with perfect lognormal distributions.

The s-values (standard deviation) are also obtained from the probability graph as the abscissa of the intersection of the cumulative frequency curve with the 16 per cent ordinate, since for a normal distribution b is the mean and 68.27 per cent of the population fall between  $b + s$  and  $b - s$ , i.e. one standard deviation on either side of the mean. Accordingly, 95.45 per cent of the points fall within  $b + 2s$  and  $b - 2s$ , and the value of  $b + 2s$  therefore is given at the intersection of the cumulative frequency curve with the 2.5 per cent ordinate. Since we deal with logarithms we have to consider the ratios and not the absolute values established:

In other words, the geometric deviation  $s'$  is calculated as follows:

for the upper limit:

$$s' = (b + s) / b \quad \text{or} \quad \log s' = \log (b+s) - \log b$$

for the lower limit:

$$s' = b / (b - s) \quad \text{or} \quad \log s' = \log b - \log (b-s)$$

Multiplying or dividing the background by the square of the geometric deviation gives for the same reason a range which includes 95.45 of the values or two standard deviations on either side of the mean ( $b + 2s$ ), ( $b - 2s$ ).

Since all reasoning is carried out on logarithms, the deviation has to be expressed by a logarithm  $\underline{S = \log s'}$  and is called the coefficient of deviation. The background b and the coefficient of deviation S are the two statistical parameters which define a lognormal distribution.

#### 1) Gold

The relative frequency distribution on arithmetic-logarithmic graph paper for gold values obtained from Webber, Huestis 4100 and Huestis 4300 is shown on Figure 7. For all the three localities the distributions are bell-shaped and fit reasonably well lognormal populations, as indicated by the shape of the cumulative frequency curves on Figure 8.

The histogram clearly show the different gold contents found in the two sections of the Mount Nansen Mine. For the two Huestis levels the distributions are somewhat similar and possess identical b-values (see Table 2). In our case, where the distribution is not perfectly lognormal, b corresponds

only with the median and thus is not identical with the mean, modus and geometric mean. Furthermore, Huestis 4300 and Huestis 4100 possess relatively similar mean values and coefficients of deviation. For Webber, the b-value as well as the mean are substantially lower, whereas the coefficient of deviation is identical to the one of the Huestis 4100 level (Table 2).

TABLE 2: Statistical parameters of gold, silver and Ag/Au values from the Mount Nansen ore-body.

	Gold				Silver				Ag/Au		
	$\bar{x}$ oz/t	b oz/t	s'	S	$\bar{x}$ oz/t	b oz/t	s'	S	b	s'	S
Huestis 4300	0.53	0.45	2.15	0.33	20.0	11.4	2.63	0.42	21.0	2.79	0.45
Huestis 4100	0.58	0.45	2.62	0.42	10.1	7.1	2.66	0.43	13.2	2.65	0.42
Webber	0.35	0.23	2.61	0.42	24.6	12.8	4.30	0.63	48.0	2.63	0.42

x: mean; b: background (median); s': geometric deviation;  
S: coefficient of deviation.

The parameters indicate that the dispersion of the gold values is relatively constant within the Mount Nansen ore-body. However, a distinct difference in grade is apparent between the Huestis and the Webber mine, the ore from the latter carrying only about half the amount of the gold found in the Huestis ore. This corresponds well with the mineralogical observations where gold was detected only in extremely minute amounts in sections prepared from Webber ore. The ore-reserve calculations which indicate an overall grade of 0.25 oz/ton gold for Webber and 0.39 oz/ton gold for Huestis seem to agree with these observations.

The cumulative frequency curves for gold shown on Figure 8 also indicate the higher gold grade of the Huestis ore compared with the grade of the Webber ore. Both frequency lines of the Huestis ore coincide to a large extent and no actual trend along the dip of the vein could be observed in the Huestis mine. Interesting is the fact that all cumulative frequency curves display a negative break in the vicinity of the 0.15 oz/ton abscissa and 80 per cent ordinate (Figure 8). This break is also manifested by the distinctly negative skewness of the gold frequency distributions on Figure 7, which is caused by an excess of low values in essentially lognormal distributions. This almost regular behaviour of the gold values might be caused by the presence of 2 generations of gold in the Mount Nansen ore-deposit. Ore-microscopical observations revealed that the first generation occurs in the form of "true" gold inclusions in pyrite and arsenopyrite grains. They are relatively common but possess always extremely minute diameters and therefore contribute only subordinate amounts to the total gold present, even if their distribution is extensive. The second and younger gold generation is formed by relatively scarce but large aggregates

of "free" gold which were emplaced late during the mineralization period of galena, freibergite and the hypogene sulphosalts. The "free" gold forms by nature of its occurrence the bulk of the gold present in the ore although it is far less encountered than the small gold-inclusions of the first generation.

#### ii) Silver

All the frequency distributions of silver are bell-shaped and display a more or less pronounced negative skewness. For the two Huestis levels the fit with a lognormal distribution is worse than for gold which is distinctly revealed by the more complex cumulative frequency curves (Figure 7 and 8). The population of Webber, however, exhibits a much better fit and plots as straight line in the cumulative frequency distribution on Figure 8. The means and b-values for Webber and Huestis 4300 are relatively similar, whereas for Huestis 4100 the two parameters are only about half as large. The coefficients of deviation S are identical for the two Huestis levels and about 50 per cent larger for the Webber mine (Table 2).

For the Webber ore the mean-, b- and s'-values indicate a high but relatively inhomogeneous and strongly deviated silver content. The close fit with a lognormal distribution as revealed by the cumulative frequency curve indicates that the population is relatively homogeneous. From the mineralogical observations it can be deduced that the high silver content of the oxide Webber ore is primary and not caused by supergenic enrichments. That the alteration took place in situ without involving large transportation distances seems to be underlined by the almost ideal lognormal distribution of the silver values at Webber which indicate that the original (one generation?) pattern of the silver distribution is still preserved in the altered ore.

For the two Huestis levels the coefficients of deviation S of silver are identical, indicating the same degree of homogeneity throughout the developed portion of the mine. Webber on the other hand has a far greater coefficient of deviation and thus a worse homogeneity. The means and b-values obtained for the two Huestis levels, however, are vastly different. The 4300 level possesses for both variables much higher values which are relatively similar to the ones of Webber. The high silver-grade of the upper Huestis level cannot be explained by irregular silver enrichments in the upper portions of the veins, since mineralogical observations revealed no significant amounts of supergenic ore-minerals in this level. The identical coefficients of deviation found in the two Huestis levels seem to underline the mineralogical findings. The higher silver values encountered in the 4300 level therefore is regarded as a primary feature. In the Huestis mine a downdip decrease of the silver content has to be considered as probable if the observed gradient continues further downwards.

The cumulative frequency curves for the two Huestis levels are relatively complex, both curves have a break in the vicinity of the 3 oz/ton abscissa and 85 per cent ordinate, a second break occurs in the Huestis 4100 curve at the 22 oz/ton abscissa and 10 per cent ordinate. The reason why the unaltered sulphides ore of the Huestis mine displays more complicated frequency curves than the strongly and variably altered Webber ore, which possesses a straight cumulative frequency line, is not understood. It might be explained as follows; in the Webber mine only one major period of silver mineralization took place, whereas in the Huestis mine two such periods occurred, resulting in the negative break of the frequency curves at about 3 oz/ton. The excess of low values can possibly be attributed to an early generation of silver-bearing jamesonite which has been found in polished sections from Huestis ore, where jamesonite occurs as disseminated grains together with pyrite and arsenopyrite. In the Webber ore the early jamesonite generation seems to be missing.

#### 111) Ag/Au ratio

The ratio of the gold and silver values has been investigated in order to find out the variation of the two precious metals with respect to each other. The silver values were divided by the gold values to receive ratios larger than 1. All the Ag/Au ratios form bell-shaped curves which fit remarkably well lognormal distributions as can be seen from Figure 8, where all cumulative frequency curves plot as straight lines over a wide range of the frequency. The b-values of the distribution histograms (Table 2) demonstrate clearly the already discussed features i.e. highest relative silver grade in the Webber ore, and in the Huestis mine a trend indicating a relative decrease of the silver-content down-dip from the 4300 level to the 4100 level. S-values for the three distributions are almost identical which is also graphically demonstrated by the almost parallel development of the cumulative frequency lines in Figure 8. The 3 lines are parallel but displaced according to their Ag/Au ratios with Webber possessing the highest and Huestis 4100 the lowest values.

All the cumulative frequency curves for gold and for the two Huestis levels, also the cumulative frequency curves for silver possess negative breaks close to the 80 per cent ordinate. Accordingly, the 3 cumulative frequency curves of the Ag/Au ratios must plot as straight lines. This means that the excess of low silver values correspond with excesses of low gold values; or in other words, a relatively high correlation between gold and silver values must be assumed. This fact has been investigated in Figure 9 from which also the correlation coefficient  $r$  was obtained by using the graphical method given by Lepeltier (1969). The correlation coefficient  $r$ , gives a rigorous measure of the degree of dependency. It is found by constructing a correlation cloud in

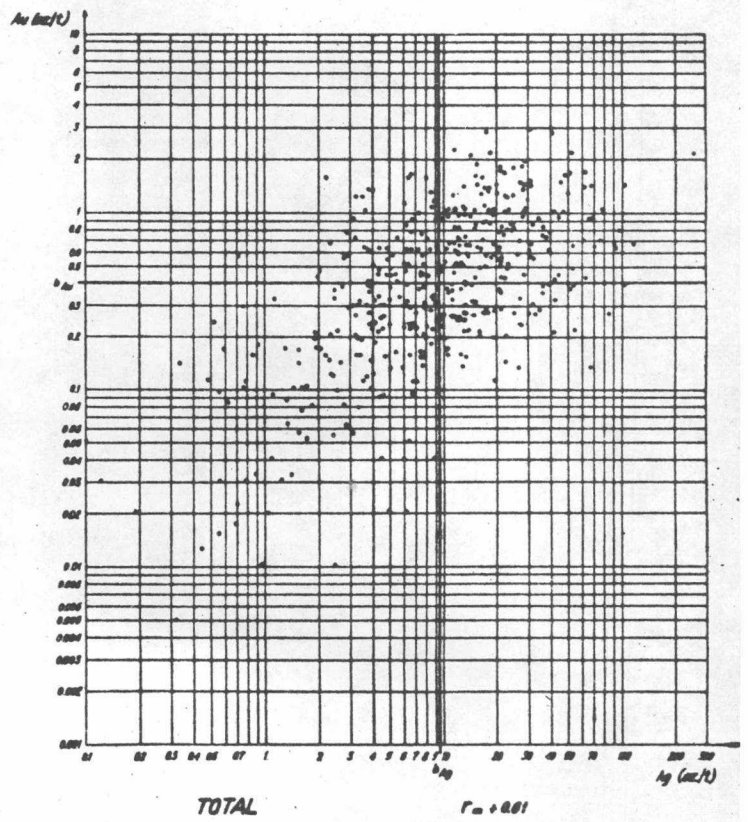
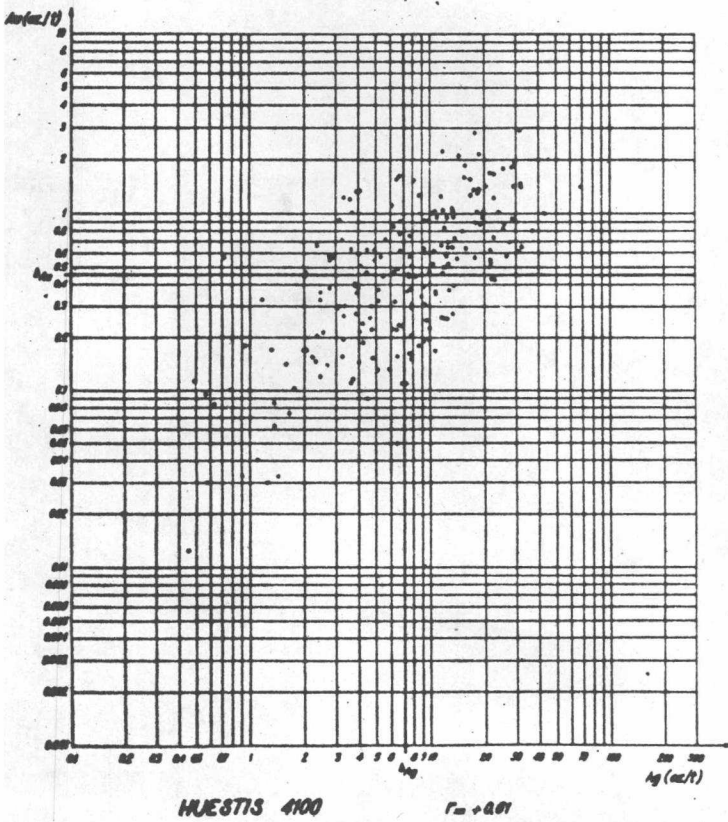
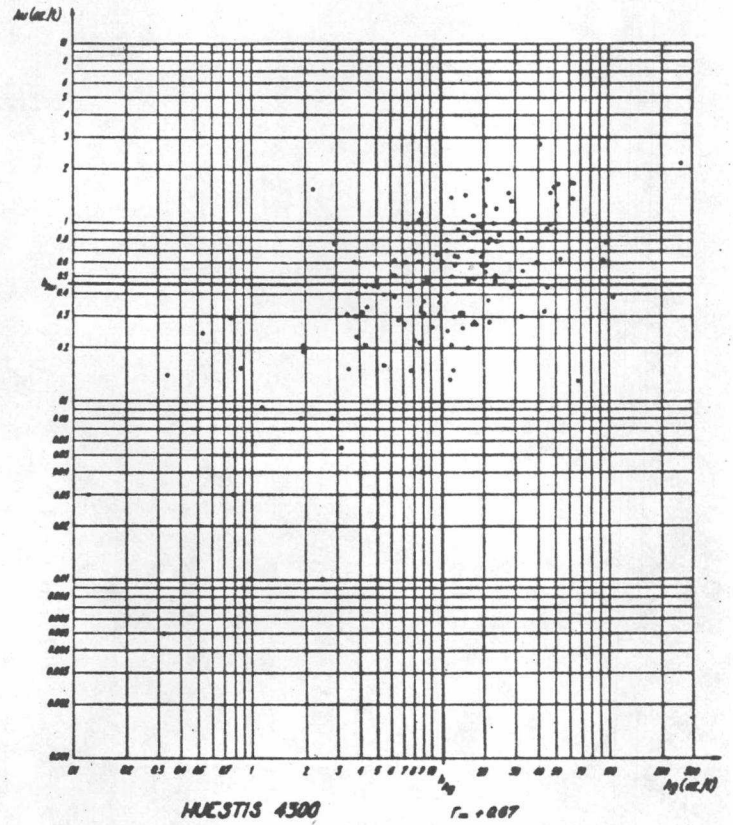
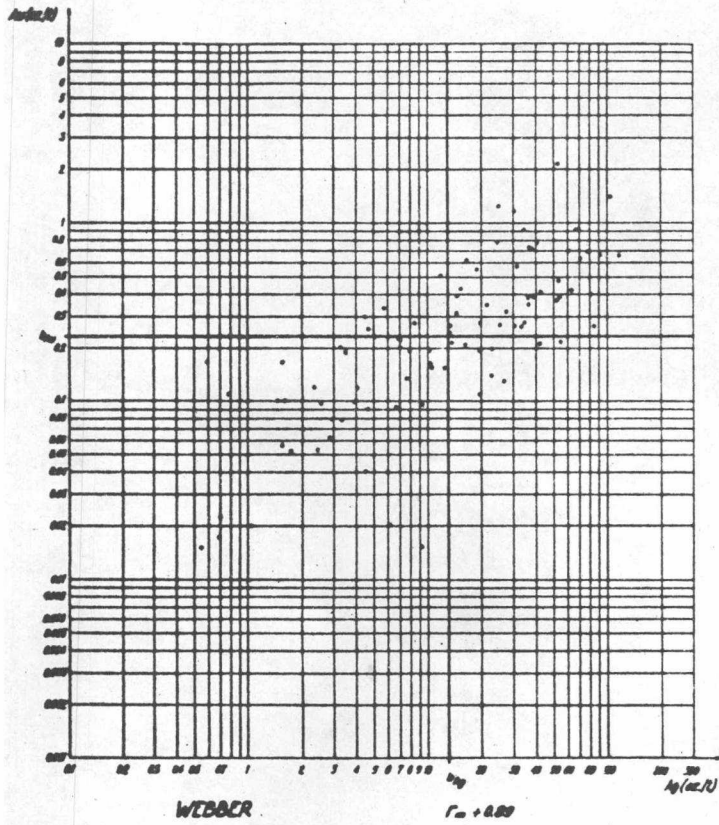


Fig. 9. Scatter diagrams of the investigated silver and gold values of the three individual sections and of the "total" Mt. Nansen orebody

full logarithmic coordinates, the cloud is then divided into four sections  $n_1$ ,  $n_2$ ,  $n_3$ , and  $n_4$  by plotting the b-values of the two elements as abscissa and ordinate respectively. The number of points in each sector are counted and the coefficient of correlation calculated using the formula:

$$r = \sin \left[ \frac{\pi}{2} \cdot \frac{N_1 - N_2}{N_1 + N_2} \right]$$

where  $N_1$  = number of points in  $n_1$  and  $n_3$

$N_2$  = number of points in  $n_2$  and  $n_4$

The following correlations were obtained:

Webber	$r = + 0.89$
Huestis	$r = + 0.61$
Huestis	$r = + 0.67$
Total	$r = + 0.61$

All the correlation clouds have elliptical shapes with the main axes sloping  $+ 45^\circ$  (Fig.9). Since  $\pm 1$  represents perfect correlation and 0 no correlation, the correlation at Webber is much better than the one at Huestis which for both levels is almost identical. The high correlation of silver and gold found in the largely oxidized Webber ore can be considered a further indication that the chemical transport caused by the supergenic alteration of the ore occurred only over small distances and that no secondary enrichment zones were formed. Primary features of the gold-silver distribution are therefore still reasonably well preserved.

## 5. SUMMARY AND RESULTS

The statistical analyses of the available assay data from the Mount Nansen ore has been treated separately for the Webber mine, consisting to a large extent of altered oxide ore and the two levels of the Huestis mine consisting of sulphide ore. The investigation revealed the following results:

- A. The number of sample channels per face during exploratory or development drifting can safely be reduced from 2 to 1 channel without seriously influencing ore-reserve calculations or ore-shoot delineations, for the mean values of the upper and the lower channels deviate from their average usually only 5 to 10 per cent and in extreme cases never more than 20 per cent. Since horizontally the distribution of gold and silver seems to be far less homogeneous than vertically, an improvement of the results can possibly be ob-

tained if the sample channels are spaced along the vein in 3 feet intervals instead of the 6 feet intervals used in the past.

- B. From the analyses of the gold and silver distributions in the Webber and Huestis ore various observations made during ore-reserve calculations and mineralogical and geological investigations were confirmed.
- a) Webber possesses the highest silver content followed by Huestis 4300 and 4100 (Table 2, Figure 7 and 8). The latter indicates the existence of a down-dip silver gradient from Huestis 4300 to 4100. If such a decrease continues to further depths is presently unknown.
  - b) The redistribution of silver during the supergenic alteration of the Webber ore occurred only over extremely limited distances. The high correlation between gold and silver found in the Webber ore indicates that no supergenic enrichments took place and that the primary gold-silver distribution is still preserved to a large extent. It must therefore be assumed that originally the Webber ore carried more silver than the Huestis ore.
  - c) Huestis has a distinctly higher gold content than Webber with both Huestis levels having almost identical values (Table 2, Figures 7 and 8).
  - d) The absolute deviation of gold has in all cases been found to be smaller than that for silver indicating a less homogeneous distribution for the latter metal (Table 2).
  - e) The cumulative frequency curves of the silver and gold values and of the Ag/Au ratios indicate a relative high degree of dependency which was confirmed by the correlation analyses (Figures 8 and 9). A substantial genetical relationship of the two metals must therefore be considered.
  - f) The negative skewed distributions of gold (Figure 7 as well as the negative breaks in the cumulative frequency curves (Figure 8), indicate an excess of low gold values which possibly can be attributed to the first generation gold inclusions which occur within the first generation of pyrite and arsenopyrite as opposed to the second generation "free gold" which was emplaced during a relatively late stage of the mineralization and forms the bulk of the gold present.
  - g) The negative breaks observed for the silver cumulative frequency curves of the two Huestis levels (Figure 8) indicate that possibly two periods of silver mineralizations occurred. A subordinate older phase during the emplacement of silver-bearing jamesonite and a younger

main phase during the emplacement of freibergite, silver-bearing galena and the hypogene silver-bearing sulphosalts. For Webber the cumulative frequency curve for silver is a straight line indicating only significant period of silver mineralization (Figure 9).

## DISCUSSION ON THE ORIGIN AND GENESIS OF THE MOUNT NANSEN ORE BODY.

As discussed earlier, geological, geochemical and mineralogical observations indicate that the Mount Nansen ore body must be genetically related to the acidic porphyries of late Cretaceous to early Tertiary age. In the Mount Nansen area these porphyries are as a rule closely associated with syenitic, granodioritic, and granitic rocks which are contemporaneous and possibly directly related to the Coast Intrusive sequence. These relationship suggests that the porphyries are not a separate intrusive unit, but rather a late phase of the late Mesozoic granitic event.

In the vicinity of Mount Nansen the porphyry bodies display a striking pattern. They usually are elongated and trend northwest whereas porphyry bodies of cylindrical shape are comparatively seldom encountered. From the regional map of Bostock (1936) it is apparent that the northwest trend found in the Mount Nansen area has a regional character and exists over the entire southeastern portion of the Dawson Range. It is interesting to note that the northwest trending sequence of porphyry intrusions is confined to the highest elevations of the Dawson Range. To the northeast of the Dawson Range, porphyry intrusions seem to be absent, inspite of the presence of large granitic masses. The conspicuous linear concentration of the porphyries led the authors to the hypothesis that the Dawson Range represents a pronounced "dome-like" tectonical structure. This structure was a tectonical weak zone which must have been active before the intrusion of the porphyries and thus acted as avenue for them. Subsequent to the intrusion of the porphyries a system of dilatant high-angle faults and shear zones were formed, and mineralized to a various degree.

From underground observations it seems that during this tectonic phase, relative competent rocks, i.e. large porphyry and granitic bodies, suffered more intensive shearing than the more incompetent gneisses of the Yukon Serie or small porphyry and granitic bodies. The strongly sheared rocks being more dilatant and thus more permeable were generally better mineralized. This pattern is extremely well demonstrated in the western portion of Webber and the western end of Huestis 4100. At the present moment it is however unknown to what an extent the difference in chemistry of the basic Yukon Serie gneisses and of the more acid intrusives influenced the above outlined ore control.

It is thought that the mise en place of the ore-veins took place subsequent to the emplacement of the porphyries. The mineralogical investigation revealed a more or less classical hydrothermal paragenesis, with pyrite I and arsenopyrite being the oldest sulphides followed by an early formation of jamesonite, and in turn by sphalerite and chalcopyrite. As a late phase the lead, antimony, and silver bearing minerals were deposited, together

with the major portion of the gold. The presence of chalcopyrite exsolutions in sphalerite as well as the presence of vallerite and cubanite indicates a rather high formation temperature for these minerals. Geochemical and mineralogical investigations showed that the composition of the mineralizing liquids was rather inhomogeneous and that for instance the Webber ore had a different primary composition than the Huestis ore, the same seems to be applicable for the Brown-McDade ore. Geochemical studies furthermore revealed a relative constant gold content in the entire investigated deposit and a possible downdip decrease of the silver grade in the Huestis ore body. The development and distribution of the different mineralized veins distinctly point to a relationship with the porphyry intrusion. The available data does presently not allow to give preference to one of the two following metallogenetical explanations.

- i) A "true" hydrothermal origin as a conclusive phase of the Cretaceous - early Tertiary magmatic event. The porphyries and the mineralized veins are in this case regarded as two phases of the same intrusive episode.
- ii) A pseudohydrothermal origin caused by the intruding porphyries which acted as a source of heat and structural deformations and also released volatiles. These processes mobilized primary disseminated sulfide minerals together with some gold and silver and other elements in the rocks of the Yukon Serie, which migrated into zones of dilatancy represented by the fault and shear system. Such an interpretation follows more or less the explanations given by Boyle (1961, 1963, 1965, 1968) for various Canadian ore deposits.

A young post-mineralization fault system has displaced the ore bodies and caused some local enrichments. In the Webber mine supergenic alteration has considerably affected the mineralogy. However, the permafrost condition, which prevail in the Mount Nansen area limited chemical transport by watery solution to a large extent. The alteration therefore occurred essentially in situ, and no vertical separation of the minerals and no secondary enrichment zone has been observed. The oxide minerals which telescope to a certain amount into the zone of sulfide minerals must be regarded as the youngest paragenetical generation. In the Huestis mine supergenic alteration is limited to the sub-outcrop of the mineralized veins.

A recent soil survey of the Mount Nansen area indicated the presence of several copper anomalies which coincide reasonably well with the known porphyry bodies. This feature can possibly be related to porphyry copper mineralizations and poses immediately the question on the relationship between the gold-silver veins and the copper anomalies. Are the two mineralizations related with each other, and with the porphyry intrusions and thus

of "true" hydrothermal origin or have the two mineralizations a different genetical origin? This question cannot be answered at the present moment. However, it is interesting to note that several known classical porphyry copper deposits in the southwestern United States and also the new Casino Silver discovery further northwest in the Dawson Range (Findlay, 1969) occur together with silver-gold vein-deposits of the type found at Mount Nansen.

## GEOCHEMICAL EXPLORATION

Two major geochemical surveys have been carried out in the Mount Nansen property.

- i) A soil sampling survey was initiated in 1967 to discover additional gold-silver veins. Analyses of the samples were undertaken for silver and arsenic. About one third of the property was covered by this survey and altogether 15914 samples were taken and 7957 samples analysed. Details of this survey are given by Adamson in his report "Geochemical Soil Survey 1967" (April 15, 1968).
- ii) From the 15914 samples taken in the 1967 survey 500 samples were selected during April 1970, representing an 800 feet quadratic grid. The samples were analysed for copper, zinc, and molybdenum to investigate the possibility of copper mineralizations in the Mount Nansen area. Details of this survey are given below:

### A) The Gold - Silver Survey 1967.

The bases for the survey technique are firstly the work of the G.S.C. carried out at Cobalt, Ontario, where a number of narrow silver bearing veins were detected beneath as much as 50 feet of ablation till cover and secondly a geochemical survey carried out at Arctic Gold and Silver Mines at Carcross, Y.T. The Arctic survey indicated that the best and most reproducible results were obtained from the humic layer, just below the grass roots. This corresponds with the findings of the G.S.C. in Cobalt, Ontario. At Arctic the samples were analysed for Pb, As, Zn, and MoS<sub>2</sub>, the latter two were found to be ineffective and Pb was considered not to be necessary to use in large scale geochemical surveys, from the standpoint of being unnecessarily costly and redundant. The survey thus was limited to arsenic and silver. It must be noted, however, that Coope (1966) who undertook geochemical studies in the Dawson Range has found zinc and especially antimony to be extremely useful markers to pin-point the suboutcropping silver-gold mineralizations.

The samples were taken on lines 400 feet apart at a spacing of 50 feet between samples. Only alternate samples were analysed at the laboratories of Bondar-Clegg & Company, North-Vancouver. Silver was determined by hot acid extraction, followed by atomic absorption, arsenic was analysed also by hot acid extraction followed by the modified Gutzite method.

All the detected silver anomalies are consistent in width and position from sample line to sample line. The arsenic anomalies spread over greater width and were found to be less consistent. Arbitrarily the background value for silver has been taken at 0 to 1 ppm, values higher than 1,9 ppm were considered anomalous and values above 4 ppm as highly anomalous. For arsenic the background values were taken from 5 to 25 ppm, values exceeding 25 ppm were considered anomalous.

It is apparent, that arsenic anomalies are less useful than silver anomalies, however they aid in confirming and delineating the silver anomalies, therefore priority has been given initially to the silver values.

Adamson found a number of geochemical zones, all of which follow the general pattern and strike more or less north and northwest, the latter are usually the best trends (see attached maps). Adamson concludes that due to the soil survey many additional veins in the Mount Nansen district will probably be found by bulldozer trenching of the silver and arsenic anomalies. He feels that the present reserves have a conservative potential of an eleven times expansion and that there is reasonable justification for at least doubling this potential since many of the designated anomalies possess a linear continuity well in excess of the ore developed to that date. To investigate the soil anomalies, Adamson recommends bulldozer trenching at 400 feet intervals followed up by drilling or drifting.

## B. The Copper/Zinc Survey 1970

The discovery of a very large copper mineralisation in the property of Casino Silver Mines Limited, some 70 miles to the North West of our property, during 1969, has given rise to a considerable staking rush, covering the entire Dawson Range between Mount Nansen and Casino. In The Northern Miner of March 26, 1970, Casino Silver Mines Limited reports: "an estimated 1,164,000,000 tons having an average grade of 0.30% Copper (Cu) and 0.04% molybdenite (MoS<sub>2</sub>). Maximum values intersected in drill holes showed 1.291% Cu and 0.030% MoS<sub>2</sub> over 210 feet.

The fact that the Casino mineralisation occurs in an geological setting almost identical to that of the Mount Nansen area (Tertiary porphyry bodies intruding Mesozoic granites and Palaeozoic to Precambrian metamorphic series) has already led the authors in November 1969 to the following conclusion: "In Anbetracht der neuentdeckten interessanten Kupfermineralisation von Casino Mines sollten Ueberlegungen ueber die Extension solcher Vorkommen in unser Gebiet durchgefuehrt werden". (Geologisches Arbeits-Programm Periode Januar - Juni 1970 - November 27, 1969). Subsequently, various other memos and monthly reports dealing with the base metal exploration have been prepared and an initial geochemical investigation was recommended. Since a geochemical survey of silver and arsenic has earlier been carried out on about one third of our property (see Fig./5), the soil samples being stored at a local assay laboratory, the logical step was to carry out the initial geochemical program on a number of selected soil samples from the silver-arsenic survey.

It was hoped that this initial program reveals the following information:

- i) Usefulness of copper, zinc and molybdenum as geochemical indicators.
- ii) Relationship between silver-arsenic anomalies and copper, zinc, and molybdenum anomalies.
- iii) Relationship between the local geology and the copper, zinc, and molybdenum anomalies.

For this reason, 500 soil samples have been selected from the 15,000 original samples used in the original 1967 survey. They represent a 800 ft quadratic grid over the entire area investigated during the 1967 geochemical survey. The samples were taken from the B-Horizon (residual soil below the humus layer, generally -1 foot). The samples were analysed for copper (Cu), zinc (Zn) and molybdenum (Mo) by Bondar-Clegg Laboratories

(North Vancouver, B.C.), using atomic absorption: the lower limit of detection for the three elements apparently was 1 ppm (equal 1 gram per metric ton).

## II. GENERAL GEOLOGY OF THE AREA (See Fig. 14)

Figure 14 illustrates the geological setting of the area. In this context it must be stated that Fig. 14 was compiled from several geological maps:

- 1936 H.S. Bostock, Map 304A, Carmacks Sheet, G.S.C.
- Sept. 1958 Nansen Creek area - Geology Plan - 1" = 500' - D.D. Campbell
- March 2, 1964 Part of the Mount Nansen Area - Plan showing veins and ore shoots with generalized Geology - 1" = 400' - W.C. Martin
- 1968 Surface and underground detailed geological mappings - 1" = 20' / 1" = 400' - G. Lamont, W. Wilkinson, F. Bianconi.

Only the immediate surroundings of the mine workings have been mapped in detail: the rest, especially the South half of the property is only covered by the regional mapping of Bostock (1936). Generally the geological mapping in the unglaciated Dawson Range is severely hampered by the almost total absence of outcrops and thick overburden (up to 50 feet). Indications of the bedrock can only be obtained from rocks collected in the float. Even this float is partly covered by decomposed organic matter, residual soil and volcanic ash. Very often the float has been found to be strongly leached and/or oxidized.

The oldest rocks in the investigated area are represented by the Yukon Group metamorphic rocks, which are believed to be of Precambrian/Paleozoic age. In the area the Yukon Group is mainly composed by banded, medium grained quartz - hornblende - gneisses and hornblende - gneisses. Quartzites and biotite schists form minor constituents of the group. These rocks generally have N-S to NE-SW strike and are dipping moderately to steep West to Northwest. The southern half of the investigated area is formed by the Yukon Group.

A thick cover of volcanic rocks overlays discordantly the Yukon Group in the North of the area. These rocks belong to the Nansen Group, which is believed to be of Jurassic age. In the investigated area the Nansen Group is essentially composed of andesitic to basaltic lava flows and of porphyritic andesites. Volcanic breccias and agglomerates form a small plug 3000 feet to the East of the Webber adit.

Porphyritic granites and granodiorites of Cretaceous age intrude the two former groups and occur between Webber Ridge and Brown-McDade and to the very North of the area. This granitic episode can be correlated with the main Cordilleran batholith.

The youngest rocks of the area are a number of porphyry bodies which cut through all the other rocks. They are supposedly of Tertiary age. Two main types can be distinguished: quartz - feldspar porphyries and feldspar porphyries. The geological maps indicate that the gold - silver mineralisations are related to these porphyries.

A set of faults which were probably active before the intrusion of the porphyries have disturbed the original geological setting. These fault zones were zones of weakness along which the porphyries intruded. They also seem to control the gold - silver mineralisation to a certain extent.

A younger fault system has offset the mineralized zones and all geologic units.

### III. RESULTS

#### 1. Molybdenum (Mo).

In the studied area molybdenum has proven to be virtually absent in the soil samples. In only about 20% of the samples the element was detected. Generally the detected values were 1 ppm, however one sample showed 4 ppm and one 8 ppm Mo. Due to the scarcity of Mo no contour map has been drawn and no statistical analysis has been undertaken. Although Mo - analyses have not been found suitable in the present survey, we feel it worthwhile that the element is analysed in future stream sampling projects and to a limited extent in systematic soil sample studies.

#### 2. Copper (Cu) (Fig. 10 and 12).

In all the soil samples copper values were obtained, the variation being from 4 ppm to 231 ppm. The average copper value is 18.51 ppm. The arithmetic distribution shows strong negative skewness, most values laying between 4 and 20 ppm. For this reason all the values were plotted on logarithmic scale and showed an approximate lognormal distribution (see Fig. 10). The statistical evaluations of the values followed the method given by C. Lepeltier (1969).

A lognormal distribution curve is defined by two parameters; one dependent on the mean value, and the other dependent on the character of value-distribution. Generally the lognormal law fits very well for low-grade deposits; however, in the case of high-grade deposits the experimental distributions are generally negatively skewed because of the limitations towards the high values.

A cumulative frequency curve has then been plotted; it gives the integral curve of the lognormal frequency distribution.

On probability log-paper the cumulative frequency of a lognormal distribution has the form of a straight line. This is shown in Fig. 2, where the values for copper fit fairly well a straight line between 1% and 94%, suggesting therefore a lognormal distribution. This was checked by a graphical test to test the hypothesis  $H_0$  that the straight line does represent a lognormal distribution at a 0.95 level of confidence (not shown on Fig. 2). Since the points fall within the graphically plotted confidence limits  $H_0$  could be confirmed.

As the cumulative frequency curve fits a lognormal distribution, the following parameters can be determined:

$b$  = background, it gives an idea of the average concentration level of an element. In the case of a perfect lognormal distribution  $b$  corresponds with the mode (most frequent value), the median (50% of the values lie above and 50% of the values below  $b$ ), and the geometric mean.

$s = \log s'$ , it is the scatter of the values around  $b$ , the coefficient of deviation or standard deviation. 68.26% of the population falls between  $b-s$  and  $b+s$ .

$s' = \frac{b+s}{b}$ , it is the geometric deviation.

$s'' = 100 \cdot s/b$ , this is the relative deviation or the coefficient of variation.

$t$  : Since  $\log t = (\log b) + 2s$  it follows:

$t = b \cdot s^2$ , this is the threshold value. Statistically  $t$  depends on the probability level chosen; geologically Lepeltier (1969) takes it as the upper limit of fluctuation of  $b$ . The values equal or higher than  $t$  are considered to be anomalous.

Practically  $t$  and  $b$  are read directly on the graph as the abscissa of the intersection of the distribution line with the 2.5% ordinate and the 50% ordinate respectively. In other words, in a lognormal distribution approximately 2.5% of the values are anomalous. It is important to note the importance of the deviation ( $s$ ) in the estimation of the threshold, since two population might have the same background ( $b$ ) but different threshold ( $t$ ) if their coefficients of deviation ( $s$ ) are different.

In the studied area the parameters for copper are as follows:

$b = 15$  ppm (background)

$s' = 1.87$  (geometric deviation)

$s = 0.27184$  (coefficient of deviation, standard deviation).

$s'' = 1.8\%$  (coefficient of variation)  
 $t = 52.5$  ppm (threshold)

It is interesting to note that the background value is approximately 3 ppm lower than the arithmetic mean. 15 ppm Cu must be considered the background value for the investigated area and values above 50 ppm Cu are anomalous. To simplify the distribution pattern, in the contour map (Fig. 4), two contours have been drawn, 30 ppm and 50 ppm. According to the statistical analyses all areas within the 50 ppm contour lines must be considered as anomalous.

#### Zinc (Zn) (Fig. // and /2).

All samples showed zinc values, the arithmetic mean being 51.86 ppm. The 500 zinc analyses were plotted and statistically treated in the same manner as copper. The lognormal distribution histogram is given in Fig. 1. The zinc distribution shows the same pattern as copper but indicates higher values. This is more evident on Fig. 2 where the curve of the cumulative frequency distribution is a straight line between 1.5% and 99.9%. That is between these two limits the distribution is almost perfectly lognormal. Below 1.5% the values belong to a different lognormal distribution, indicated by the break in the line at 180 ppm. The following five parameters for Zn were obtained from the graph:

$b = 39$  ppm (background)  
 $s' = 2.05$  (geometric deviation)  
 $s = 0.311$  (coefficient of deviation)  
 $s'' = 0.7975\%$  (coefficient of variation)  
 $t = 164.1$  ppm (threshold)

For zinc the background is 21.86 ppm lower than the arithmetic mean. In Fig. 4 the zinc values are contoured at 100 ppm and 160 ppm. All the values laying within the 160 ppm contour are anomalous. A comparison of the zinc and copper values shows that the background of Cu is about half of that of zinc. The threshold value of copper is approximately three times smaller than that of zinc. This is a statistical evidence that in the investigated area zinc occurs in excess of copper. In other words, in a randomly selected soil sample one has to expect a higher zinc than copper content.

The parameters  $s'$  and  $s$  for zinc and copper have been found to be reasonably close; this is also graphically demonstrated by the two straight lines for Cu and Zn which are almost parallel (see Fig. 2). These similarities indicate that the two populations, Cu and Zn, have an almost identical lognormal distribution, which means that the scattering of the Cu and Zn

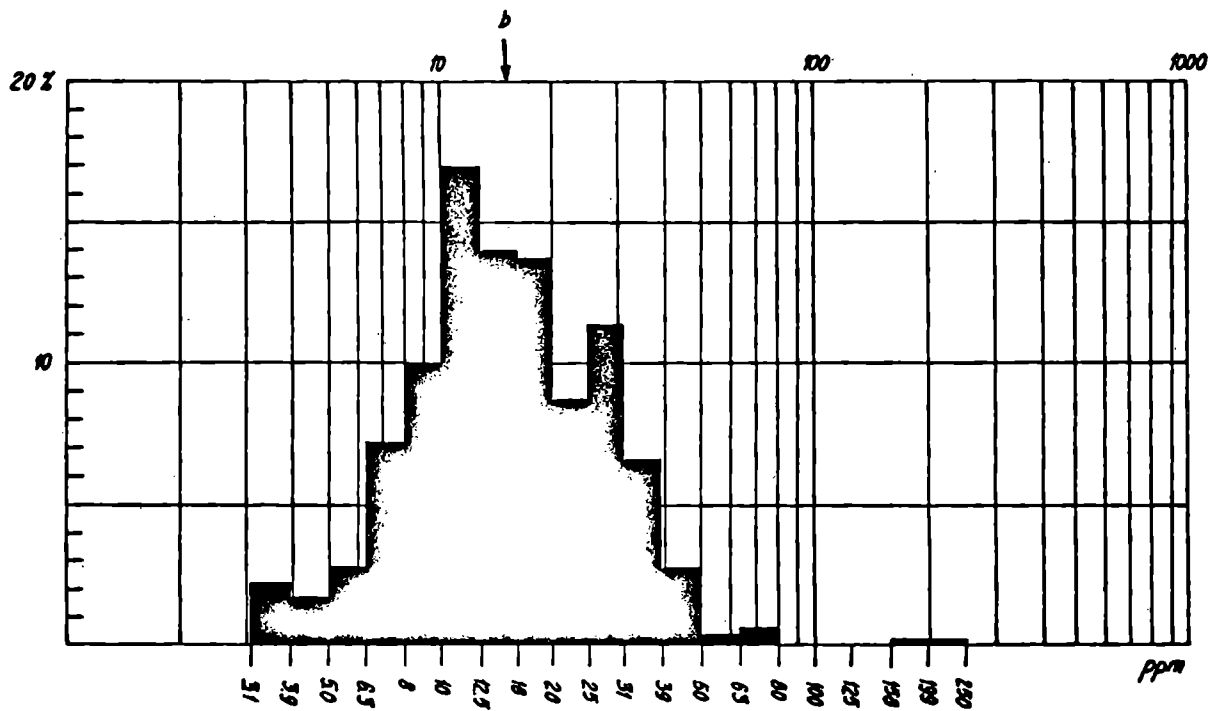


Fig. 10: Histogram for Cu  $N = 499$   $b = 15$  ppm

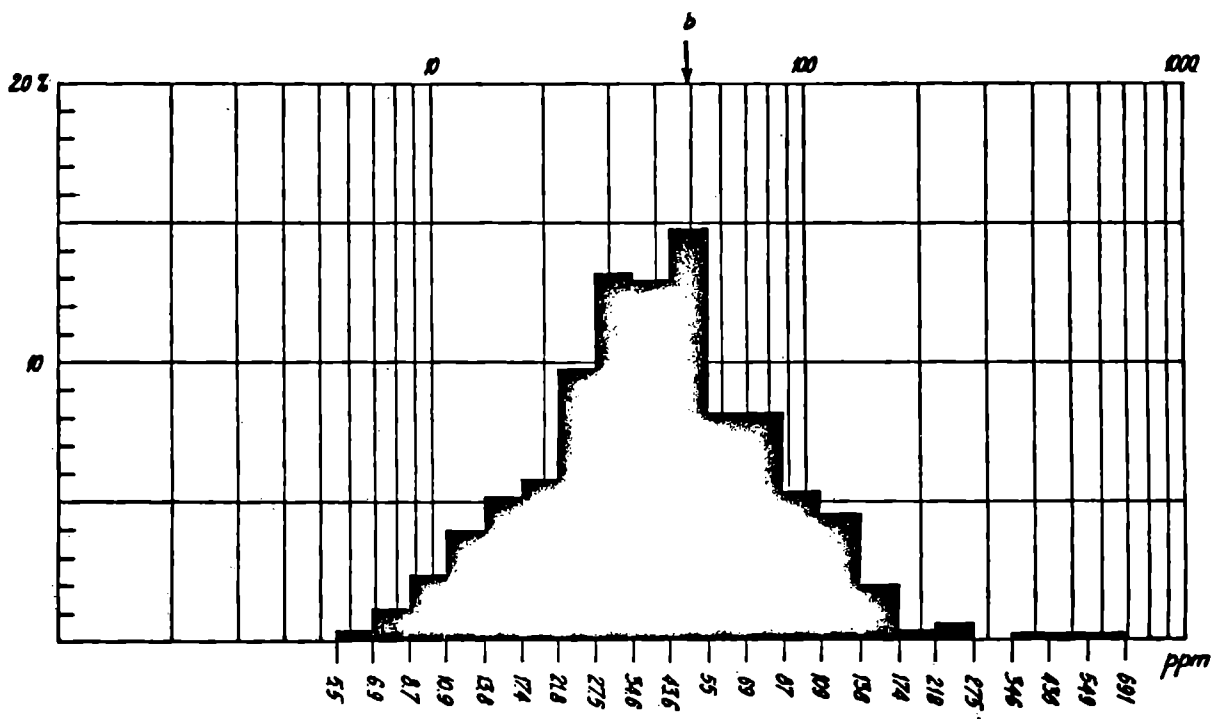


Fig. 11: Histogram for Zn  $N = 499$   $b = 39$  ppm

values around their background can be regarded as identical, even if the arithmetic values for Cu and Zn are vastly different.

#### IV. CORRELATION COPPER / ZINC

In a polymetallic mineralisation, with two or more elements lognormally distributed, a positive correlation between them can generally be expected. This geological relationship between two elements can be expressed by the coefficient of correlation  $r$ , which gives a rigorous measure of the degree of dependency. Lepeltier (1969) gives a graphical way to estimate  $r$  by constructing a correlation cloud in full logarithmic coordinates. The cloud is divided into four sectors  $n_1, n_2, n_3, n_4$  by plotting the background values of the two elements as abscissa and ordinate respectively (Fig. 3). The number of points in each sector are counted and the coefficient of correlation calculated with the formula:

$$r = \sin \left[ \frac{\pi}{2} \cdot \frac{N_1 - N_2}{N_1 + N_2} \right]$$

In the investigated area the coefficient of correlation between zinc and copper is:

$$r = + 0.62$$

The cloud has elliptical shape with the main axis sloping + 45°. Since +1 represent perfect correlation and 0 no correlation, the value +0.62 represents a rather weak positive correlation. Geologically this means that the spatial patterns of the zinc and copper distribution are similar only to a limited extent (see Fig. 4). In other words, copper can not be used as a pathfinder for zinc and viceversa.

#### V. GEOLOGICAL IMPLICATIONS

Fig. 5 shows the geochemical anomalies of copper and zinc superimposed on the general geology. Also indicated are the silver/arsenic anomalies obtained from the original geochemical survey carried out by Dolmage, Campbell and Associates, 1967. In connection with the present study the silver and arsenic values of the 1967 survey were statistically treated in the same fashion as the Cu and Zn values. The anomalies given by Dolmage Campbell have subsequently been modified in Fig. 4.

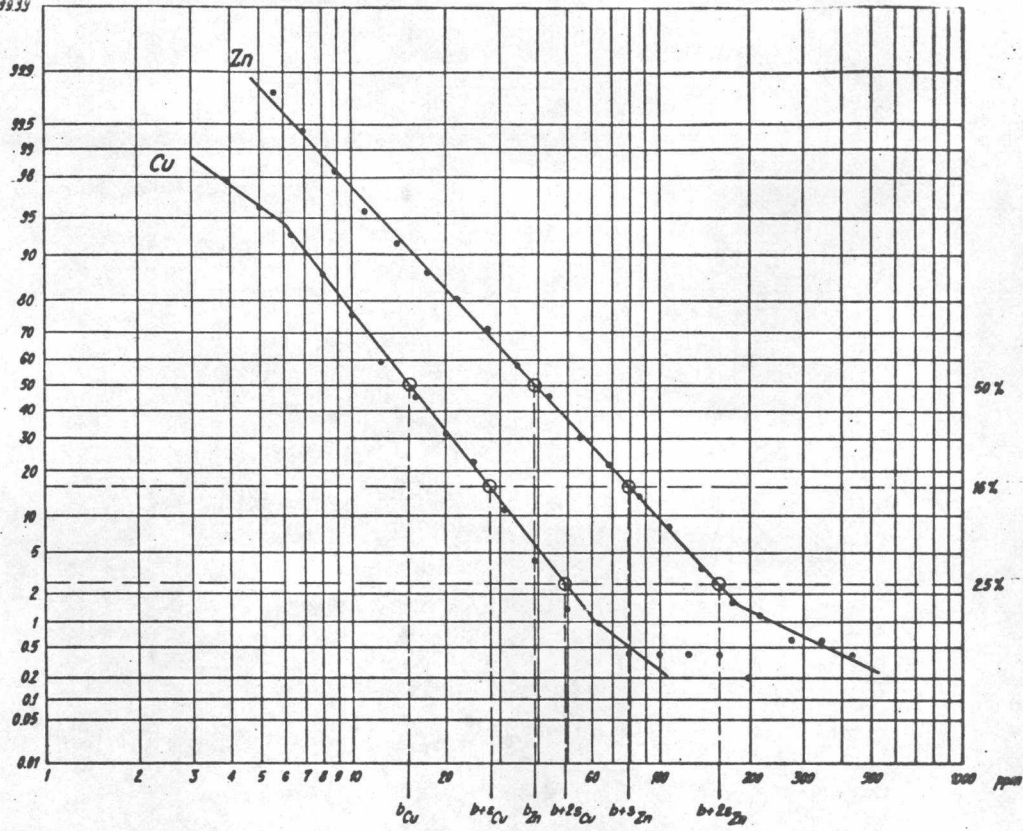


Fig. 12: Cumulative Frequency Distribution for Cu and Zn

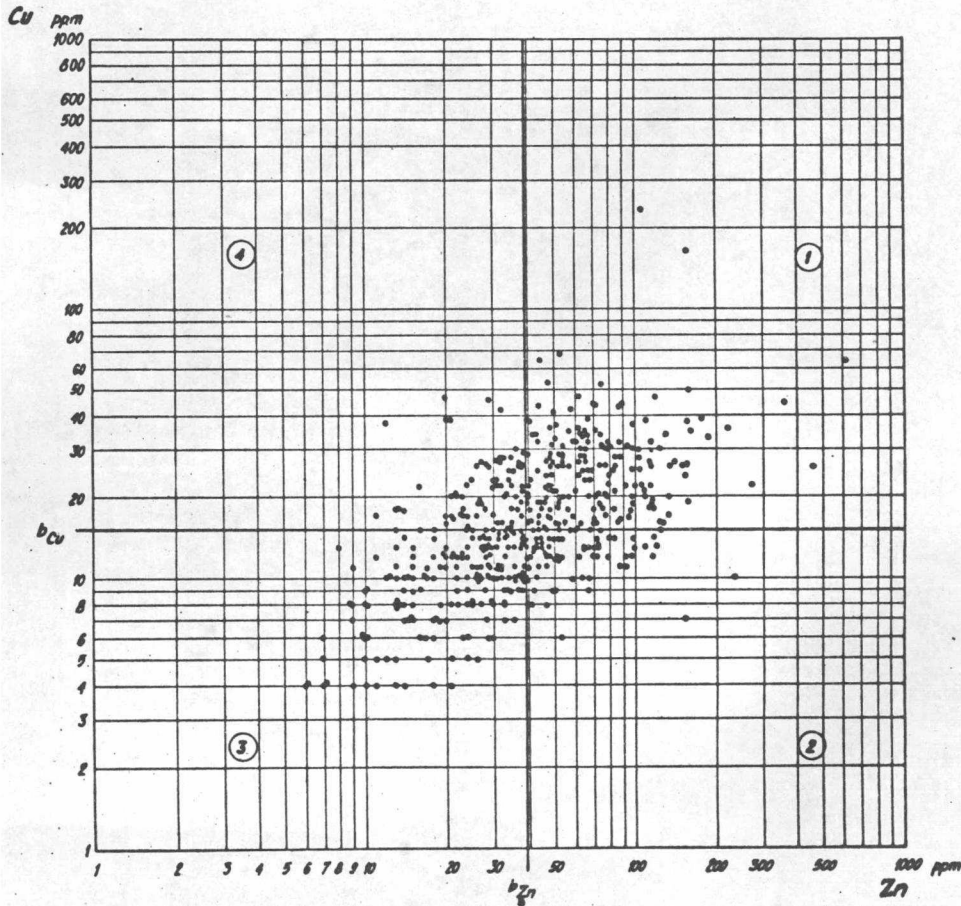


Fig. 13: Correlation diagram between Cu/Zn

$r = 0.66$

Most silver/arsenic anomalies in the southern portion can only be classified as "suspected" anomalies since their values are lower than the threshold values, or not anomalous.

As indicated by Figure /4, five strong copper anomalies and eight strong zinc anomalies have been detected. In the North corner of the area two anomalies of copper and zinc are superimposed. Minor superimposed anomalies of the two elements occur in the central part of the area. All anomalies exhibit somewhat circular outlines with diameters of up to 1,500 ft. It is interesting to note that most of the common copper/zinc anomalies lie on the more linear, generally North-South trending, silver/arsenic anomalies. They furthermore seem to be associated with the porphyry plugs. From the map it also becomes apparent, that the silver/arsenic anomalies are possibly related to the porphyry intrusions, and that they are furthermore controlled by the major faults.

The geological genetical distribution of the Cu, Zn, Ag/As-anomalies indicates not only a close relationship among the four elements but also among the four elements as a group and the porphyry bodies. This suggests that the Cu anomalies might be caused by low-grade disseminated copper mineralisations within the porphyry bodies. This type of copper mineralisation has been found at Casino Silver Mines. It must be stressed, however, that firstly the anomalies are based on a too largely spaced sampling grid, and secondly that the anomalies do not give any indication on the size and grade of the copper mineralisation by which they were caused. They only outline target areas for further detailed exploration.

## VI. CONCLUSIONS

The discussed geochemical survey has been primarily undertaken to investigate the following points:

- i) if the copper anomalies show a significant pattern;
- ii) if they are related to the silver/arsenic anomalies;
- iii) if they are related to the porphyry bodies.

As was demonstrated earlier all these points could be answered positively. There is a close relationship between copper/zinc anomalies, silver/arsenic anomalies and porphyry bodies.

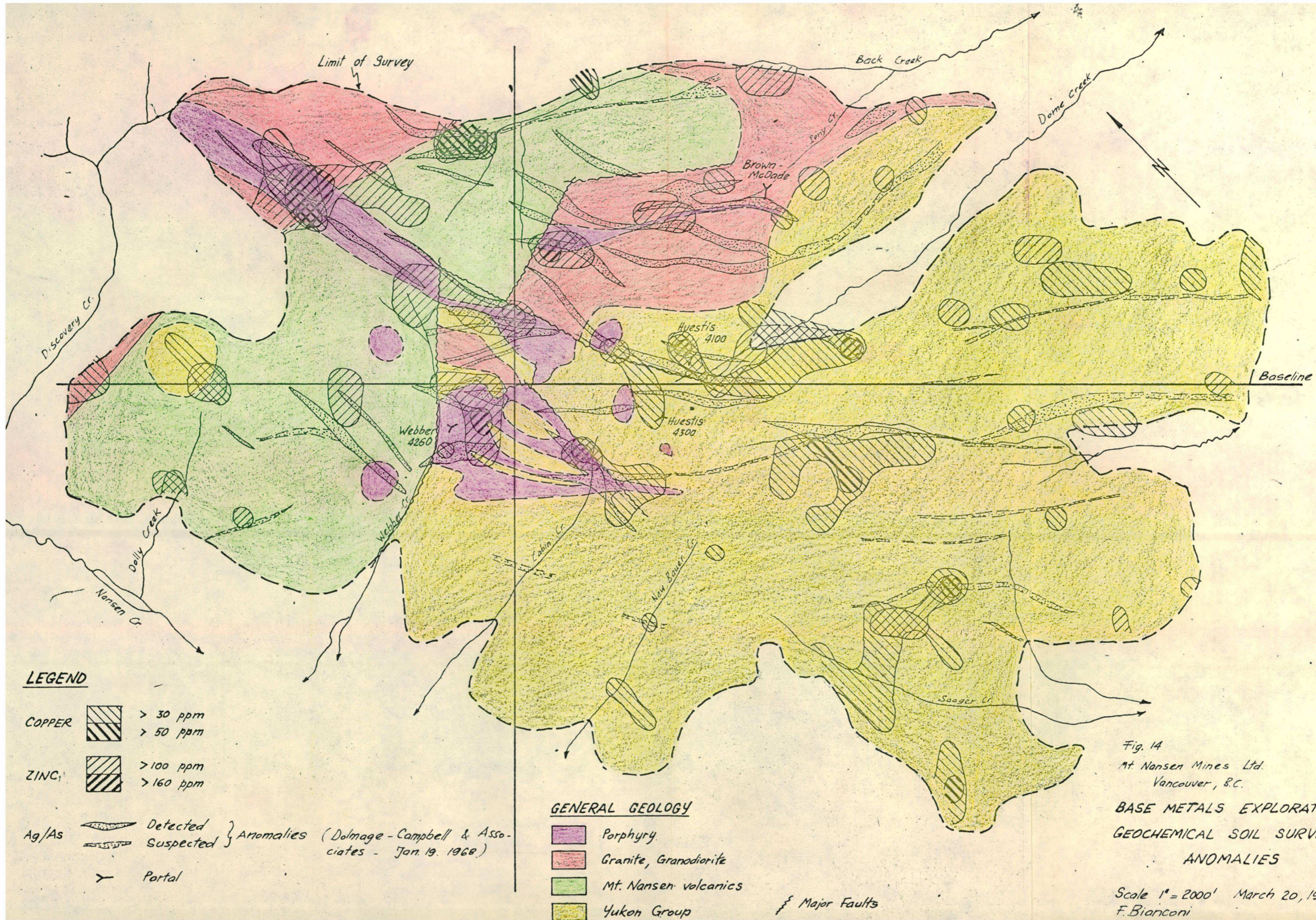
## VII. RECOMMENDATIONS

As can be seen from Figure /5 the present soil sampling survey covers only the South-East corner of our entire property. The





obtained results therefore definitely warrant an extension of the geochemical exploration over the entire area. A further reason for expending the exploration is given by the presence of a large porphyry body in the Northern section of our property as indicated by the regional geologic map of Bostock (1936).


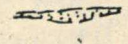

In order to avoid expensive systematical soil sampling in the presently unexplored area, it is recommended to carry out a stream sampling program. Using this method the sediments are collected systematically in all the streams and creeks. This should give almost total coverage of the whole prospecting area, since Nansen Creek and Victoria Creek together with their subsidiaries drain the Mount Nansen property in an almost perfect and very detailed way (see Figure 15). By doing a stream sampling survey it is anticipated that the area can be geochemically covered in a period of about six weeks. Such a survey should then outline target areas for detailed soil sampling programs, analogous to the above discussed initial geochemical survey.

For the recommended stream sampling survey a field party of four people is considered to be a minimum, especially if some regional geological mapping is carried out. Due to the relatively large extent of the area and the rugged terrain, a versatile four-wheel drive vehicle is a must to give quick access to the entire area and to facilitate transport, and to minimize timeconsuming camping as much as possible. Unfortunately none of our companies is in possession of such a vehicle which can be operated on a cheap basis. A so called "Pug" was therefore put into the attached budget. The field period for such a program is generally from the beginning of June until middle of September.



**LEGEND**

- COPPER**
-  > 30 ppm
  -  > 50 ppm
- ZINC**
-  > 100 ppm
  -  > 160 ppm

- Ag/As**
-  Detected
  -  Suspected
- } Anomalies (Dolmage-Campbell & Associates - Jan. 19, 1968)
-  Portal

**GENERAL GEOLOGY**






-  Porphyry
  -  Granite, Granodiorite
  -  Mt. Nansen volcanics
  -  Yukon Group
-  Major Faults

Fig. 14  
 Mt. Nansen Mines Ltd.  
 Vancouver, B.C.  
**BASE METALS EXPLORATION  
 GEOCHEMICAL SOIL SURVEY  
 ANOMALIES**  
 Scale 1" = 2000' March 20, 1970  
 F. Bianconi

ORE RESERVES

## INTRODUCTION

Dr. D.D. Campbell, Consulting Geologist for Mount Nansen Mines Limited, calculated ore reserves for Mount Nansen and associated properties in various reports issued during the year 1968. Tonnages and grades as shown in these reports were conflicting and inconsistent as no defined mining widths were established or assumed. In Dr. Campbell's reports assumed mining widths varied from two to four feet, however stopes in the mine have averaged 4.3' in width. While a reasonable figure of four feet was used in working out the Huestis reserves, the Webber reserves were calculated on far narrower widths, which was explained as follows: "It is felt that by the time the narrow shoots in the mine are to be extracted the mining procedures will be refined to the point that widths of less than four feet will be readily mined" (Report dated December 10, 1968, Page 2). The report does not outline or recommend mining procedures which might cut mining widths to less than four feet but it is a foregone conclusion that any such technique would result in increased mining costs as the wall rock adjacent to the veins is badly fractured and must be supported if minimal stope widths are to be obtained. Dilution due to overbreak explains the low grade ore presently being extracted from the producing stopes.

In view of past performance and experience, it would follow that a average stope width of four feet should be assumed when calculating ore reserves.

The figures given in this report were based on assays of samples taken from drifts, stopes, raises and diamond drill holes. Dr. Campbell's definitions relating to type of ore reserve were used, as outlined below:

Proven ore - Ore within 30 feet of completely exposed and sampled ore; whether drift, raise or on surface.

Probable ore - Ore within 30 feet of proven ore. Ore drilled off by test holes and partially exposed by drift or crosscuts (For 30 feet from the level). Ore within a 30 ft. radius of a diamond drill hole intersection.

In the case of the Webber zones, wherever the surface ore shoots match the underground shoots in position, grade, etc., as most of them do, the entire intervening section between the proven ore boundaries is categorized as probable ore. In most places this has been verified at least in part by overburden drill holes and, in the case of the main ore shoot, by a raise through to the surface.

Possible ore - Extensions of probable ore in well established ore shoots 60-100 feet to the proposed 4100 Level or to the surface.

Potential ore tonnages, or in other words ore which may reasonably be expected to be found in the future, are not included in this report as they are speculative in nature. These estimates will be included in a later report.

For ore reserve calculations high erratic assays were cut to 1 oz.Au/ton and 100 oz.Ag/ton. A specific gravity of eleven cubic feet per ton is used as the tonnage factor. Gross ore values were calculated using \$37.50 (Can) Gold and \$2.00 (Can) Silver prices. These prices were used to ensure realistic gross values and to conform with earlier reports.

## ILLUSTRATIONS

Attached to this report please find seven drawing showing plans and cross sections of the vein systems with estimated tonnages and grades.

Fig 16 Plan: 4260 Level, Webber Mine  
 Fig 17 Plan: 4100 Level, Huestis Mine  
 Fig 18 Plan, 4300 Level, Huestis Mine  
 Fig 19 Plan, 4100 Level, Brown-McDade Mine  
 Fig 20 Section: Webber Vein System  
 Fig 21 Section: Huestis Vein System  
 Fig 22 Section: Brown-McDade Vein System

## 1. ORE RESERVE DETAILS

### A. WEBBER MINE

In the Webber Mine two converging veins have been followed underground and on the surface. These veins strike NW-SE and dip very steeply to the SW. The veins are narrow, rarely ex-

ceeding two feet in width, and generally high grade. Assays of samples from 2 Vein have returned up to 200 oz/silver per ton. As the ore is highly oxidized it is reasonable to assume that these high values are due to secondary enrichment and that the grade will decrease in depth. These high grade veins can be extracted profitably at 100% dilution. Since this ore is oxidized it is believed that cyanidation must be used for maximum recovery of precious metals.

Further exploration and development are required at the Webber Mine as very little work has been done to date. The 4100 Level has not yet reached the lower projections of the veins cut on the 4260 Level, while work on the 4260 is limited and no attempt has been made to trace the veins to the east.

Webber ore reserves are shown in detail in Table 1. Also refer to Illustrations 16 and 20.

Table 1: WEBBER MINE - ORE RESERVES (December 31, 1968)

Ore Shoot No.	Proven Ore (tons)	Probable Ore (tons)	Possible Ore (tons)	Grade		Gross Value can.\$/ton	
				Gold (oz/ton)	Silver (oz/ton)		
Vein 1	101	1,259	491	982	0.17	4.83	15.10
	105	436			0.42	54.00	123.75
			491	982	0.27	13.30	36.70
			1,036		0.34	33.70	80.15
	107	764	764	2,418	0.23	11.95	32.50
		5,614			0.44	36.40	89.30
	119	1,036			0.38	8.32	30.90
		2,072	1,036	3,281	0.16	9.00	24.00
			4,144		0.27	8.66	27.40
	120	1,418	3,618	2,245	0.06	4.65	11.50
	121	1,181			0.47	19.70	57.00
		1,091	545	1,727	0.27	29.30	68.70
			2,589		0.37	24.50	72.80
122	1,745	5,235	2,763	0.13	6.29	17.40	
LCS	763	763	1,526	0.38	10.00	34.25	
IAS	1,472	1,472	2,944	0.17	7.40	21.15	
Vein 2	129		1,309	2,727	0.16	6.33	18.60
	130	1,909			0.37	30.50	74.90
			1,745	3,636	0.06	15.00	34.25
			5,200		0.21	22.70	53.30
	131	981	981	1,554	0.13	7.47	19.80
	134	1,090	1,090	1,727	0.14	8.86	23.00
	136	1,036			0.30	4.30	19.85
		2,836	1,418	4,490	0.54	41.50	103.25
			3,800		0.42	27.90	71.50
	S-End	872	872	1,744	0.31	11.20	34.00
	139	436	436		0.18	17.30	41.35
	146	763	1,926	1,209	0.23	5.24	18.75
	153	763	1,100		0.30	13.00	37.25
			1,636		0.08	5.38	13.75
	154		1,745	3,636	0.17	12.10	30.57
		3,490		0.48	16.50	51.00	
157	3,490	3,490	10,763	0.31	13.80	39.20	
TOTAL	33,027	52,422	50,354				

Note: Calculated at 4.0 feet mining width.

Total reserves are summarized as follows:  
(December 31, 1968)

Proven Ore	33,027 Tons	@ 0.30 oz.Au/t	and 19.3 oz.Ag/t
Probable Ore	52,422 Tons	@ 0.25 oz.Au/t	and 14.4 oz.Ag/t
Possible Ore	50,354 Tons	@ (0.23) oz.Au/t	and (13.8) oz.Ag/t
<u>Total</u>	<u>135,803 Tons</u>		

The Cabin Creek vein which lies some 400 feet south of the Webber Mine should be included in the Webber ore reserves. This vein was located by surface trenching over a length of some 700 feet. The vein is open at both ends of the trench.

Table 2: ORE RESERVES - CABIN CREEK VEIN  
(December 31, 1968)

Probable Ore	4,358 Tons	@ 0.26 oz.Au/t	and 50.7 oz.Ag/t
<u>Possible Ore</u>	<u>4,358 Tons</u>	<u>@ 0.26 oz.Au/t</u>	<u>and 50.7 oz.Ag/t</u>
<u>Total</u>	<u>8,716 Tons</u>		

The total ore reserves for the Webber Mine and Cabin Creek vein are shown in Table 3. (The corresponding values from Dr. Campbell's report are shown in parentheses).

Table 3: COMBINED RESERVES OF WEBBER AND CABIN CREEK  
(December 31, 1968)

Proven	33,027(33,700) t	@ 0.30(0.42) oz.Au/t	and 19.3(32.8) oz.Ag/t
Probable	<u>56,780(52,400)</u>	<u>0.25(0.35)</u>	<u>17.2(22.8)</u>
Subtotal:	89,807(86,100)	0.27(0.38)	18.0(23.2)
Possible:	<u>54,712(55,825)</u>	<u>0.23(----)</u>	<u>16.7(----)</u>
TOTAL	<u>144,519(141,925)</u>	@ <u>0.25(----)</u> oz.Au/t	and <u>17.5(----)</u> oz.Ag/t

Comparing figures shows a significant difference in values. The reason for these differences is that the reserves in this report are based on a four foot mining width while Dr. Campbell based his calculations on two and three foot widths.

The pictures that one gets from the total reserves has to be interpreted with caution. That is to say, one deals with average values that include high-grade ore bodies as well as poorer ones. It seems, therefore, to be appropriate to subdivide the ore reserves into four categories according to gross value, as follows:

- Ore bodies with gross value \$40/ton or more;
- " " " " " between 30 and 40 \$/ton;
- " " " " " between 20 and 30 \$/ton;
- " " " " " less than 20 \$/ton.

This distribution is shown by using different colors in the attached sections (Fig.20)

Table 4: TOTAL RESERVES OF WEBBER AND CABIN CREEK ARRANGED ACCORDING TO GROSS VALUE (December 31, 1968)

Class	tons	%	Average Values		
			Au(oz/t)	Ag(oz/t)	Gross Value (\$/t)
40\$/t or more	64,693	45	0.358	28.640	70.70
\$30-40	25,620	18	0.224	12.295	33.00
\$20-30	20,328	14	0.181	8.440	23.70
less than \$20 per ton	33,878	23	0.130	5.680	16.25
Total	<u>144,519</u>	<u>100%</u>			

From the foregoing table it may be seen that 45% of the Webber ore has a value of over \$40.00 per ton, (Averaging \$70.70 per ton) and that 63% of the ore has a gross value of over \$30.00 per ton. As most of the gross value is associated with the silver content, the market price of silver has a strong influence on the ore value. A one dollar increase in the price of silver would result in an increase of \$17.50 in the gross ore value.

## B. HUESTIS MINE

During 1968 exploration efforts were concentrated in the Huestis Mine, at which time 12 Vein on the 4100 level was developed along some 700 feet of its length. Diamond drilling traced 13 Vein over a length of 700 feet. As a result of this work, ore reserves in the Huestis Mine were nearly doubled. Twelve Vein, located on the 4100 level, correlated very well with the 12 Vein on the 4300 level. It was found that values along dip were very erratic and that no control could be determined.

There is a parallel system of veins in the Huestis Mine, as summarized below. Numbering runs from north to south.

- 11 Vein: Low grade. Very little minable ore.
- 12 Vein: Most of the reserves are blocked in this vein.
- 13 Vein: To date only traced by diamond drilling on the 4300 level.
- 15 Vein: Cut by only one diamond drill hole.
- 17 Vein: Cut by only one diamond drill hole.

Total ore reserves figures are shown in Table 5 and in Illustrations 17, 18, and 21. Tonnage calculations are based on four surface trenches (Vein is 4.1 feet wide and averages 0.68 oz. Au/t and 31.7 oz. Ag/t) as well as underground sampling in mine headings and stopes. Assays from surface trenches were higher than those obtained from corresponding underground sampling and this is attributed to secondary enrichment close to surface.

Table 5: HUESTIS MINE - ORE RESERVES (December 31, 1968)

Vein No.	Ore Shoot No.	Proven Ore (tons)	Probable Ore (tons)	Possible Ore (tons)	Grade		Gross Value (can.\$/t)
					Gold (oz/t)	Silver (oz/t)	
11	628	1,745	1,745		0.28	1.4	13.30
12	608	764	700		0.29	5.1	21.00
	609			1,309	0.48	6.6	31.20
	610		1,200		0.30	7.0	25.25
	595	1,309	1,636	1,309	0.23	14.0	36.60
	594	7,288	1,781		0.58	19.2	60.15
		6,545	2,618	5,236	0.31	8.3	28.20
			8,600		0.44	13.7	44.40
	591	1,254	600	927	0.36	10.0	33.50
		2,126	1,090	2,180	0.22	4.1	16.45
			3,490		0.27	6.2	22.50
	590	4,036	1,363		0.35	4.6	22.30
			1,363		0.30	10.1	31.45
				1,818	0.32	7.4	26.80
		1,909	954	1,909	0.20	1.2	10.00
			4,800		0.28	3.1	16.70
	588	2,526	1,090		0.19	4.7	16.50
			1,090		0.91	48.3	140.60
			2,909	0.55	26.5	73.60	
	6,708	2,454	4,908	0.43	8.8	33.70	
		5,872		0.31	6.7	25.00	
585	6,618	2,836	8,036	0.32	10.8	33.60	
	3,599	2,944	10,470	0.70	11.4	49.00	
		10,254	1,472	0.51	11.1	41.30	
	DDH 27		1,309	0.65	10.8	46.00	
13	595	1,309	1,309		0.32	14.3	40.60
	DDH5-16		15,272		0.20	8.4	24.30
15	DDH 12		1,309		0.52	3.8	27.10
17	DDH 12		1,309		0.22	5.8	19.85
Mill	---		1,036		0.41	4.1	23.60
TOTAL		47,736	80,024	42,483			

NOTE: Calculated at 4.0 feet mining width.

The total reserves of the Huestis Mine are contained in Table 6 (in parentheses are the corresponding values from Dr. Campbell's reports).

Table 6: TOTAL RESERVES IN THE HUESTIS MINE (December 31, 1968)

Proven:	47,736(41,425)t	@ 0.38(0.52)oz.Au/t	& 9.70(11.5)oz.Ag/t
Probable:	<u>80,024(49,650)t</u>	<u>0.36(0.47)</u>	<u>9.42(10.1)</u>
Subtotal:	127,760(91,075)t	0.37(0.50)	9.55(10.8)
Possible:	<u>42,483(71,445)t</u>	<u>0.44(----)</u>	<u>10.52(----)</u>
TOTAL:	<u>170,243(162,520)t</u>	<u>0.386(----)oz.Au/t</u>	<u>9.78(----)oz.Ag/t</u>

The following assumptions may be derived from Table 6:

- Metal contents, as calculated by the author, are lower than those worked out by Dr. Campbell, particularly gold. Tonnages as calculated by the author were also lower.

Comparing the reserves for the Webber Mine to the Huestis Reserves it can be seen that gold assays in Huestis are some 50% higher, (0.386 oz/t vs. 0.25 oz/t) while silver assays are about 100% lower, (9.78 oz/t vs. 17.5 oz/t). The gross value per ton in the Webber Mine is approximately 30% higher than that of the Huestis (can.\$44.50/ton vs. can.\$34.05/ton)

Taken on the whole the Huestis ore is lower in grade than the Webber ore and consequently has a lower gross value per ton. Total reserves in the Huestis mine, categorized according to gross value are as shown in Table 7. Gold price was taken at \$37.50 per oz. and silver at \$2.00 per oz.

Table 7: TOTAL RESERVES IN THE HUESTIS MINE, categorized according to gross value (December 31, 1968)

<u>Class</u>	<u>Tons</u>	<u>%</u>	<u>Average Values</u>		<u>Gross Value</u>
			<u>Au(oz/t)</u>	<u>Ag(oz/t)</u>	
40\$/t or more	54,334	32	0.57	14.7	50.90
\$30-40	41,267	24	0.35	10.2	33.80
\$20-30	51,259	30	0.28	7.3	25.20
less than \$20/t	<u>23,383</u>	<u>14</u>	0.23	3.1	14.90
TOTAL	<u>170,243</u>	<u>100%</u>			

In the case of the Huestis Mine, the high-grade ore reserves (more than \$40/ton) represent almost exactly one-third of the

total reserves, significantly less than in the Webber Mine (45%).

The reserves of the Huestis Mine have somewhat increased during the first months of 1969. The drift along Vein 12 in a westerly direction (on Level 4100) was continued with very good results. Assays from the first 70 feet of the new drift shows average returns of 0.7 oz.Au/t and 14.0 oz.Ag/t over an average width of 4.0 feet, corresponding to a gross value of \$54.25/t. Dr. Campbell maintains correctly that "there is an ample immediate room at the Huestis Mine to develop new ore reserves northward on No.'s 11 and 12 veins as well as to depth" (report of December 10, 1968, page 9) One may add that the same is true for Vein 13 on Level 4300, as well as for both Vein 1 and Vein 2 in the Webber Mine.

Also correctly, Dr. Campbell maintains (same report, same page) that "the 50% increase in the proven-probable reserves in 1968 by the results from one drift (4100 level, No. 12 vein), is an excellent return for development and gives an encouraging indication of the potential for continued development in this mine."

## C. BROWN-McDADE MINE

At the time of the author's visit to the Brown-McDade Mine the portal had been sealed for some time and it was impossible to enter due to poor air. This property will be examined after adequate ventilation has been provided.

Dr. Campbell (Reports of November 10, 1965 and January 19, 1966 reports two veins, numbers 1 and 2, which were explored underground and on surface. Underground drifts have traced the veins for some 1100 feet on strike while surface location was accomplished by a series of trenches. Limited diamond drilling was also done to locate down dip extension of the veins.

Ore reserves are outlined in table 8 and Illustrations 19 and 22. It should be noted that the vein widths in Brown-McDade are generally in excess of four feet and that vein widths were used to calculate ore reserves. It should also be noted that only ore located by underground headings was considered for reserve calculations. Ore exposed by surface trenching has not yet been correlated to underground workings and was therefore eliminated from reserve calculations.

Table 8: ORE RESERVES IN THE BROWN-McDADE MINE  
(December 31, 1968)

Ore Shoot No.	Width (feet)	Reserves			Grade		Gross Value (can.\$/t)	
		Proven (tons)	Probable (tons)	Possible (tons)	Gold (oz/t)	Silver (oz/t)		
1 Vein	1N-2	5.1	1,530	1,530	1,530	0.41	1.68	18.75
	1N-1	4.6	3,889	3,889	3,889	0.51	6.07	31.25
	1S-1	4.9	3,341	3,341	3,341	0.41	3.92	23.20
2 Vein	2N-1	4.0	2,400	2,400	2,400	0.34	9.11	31.00
	2S-1	4.0	2,181	2,181	2,181	0.116	4.36	13.10
	2S-2	12.5	-----	4,091	4,091	0.31	9.31	30.25
	2S-3	6.0	-----	3,109	3,109	0.29	7.74	26.35
	2S-4	4.0	-----	1,309	1,309	0.48	3.86	25.70
TOTAL			13,341	21,850	21,850			

Table 9 contains a compilation of the total reserves in the Brown-McDade Mine ( in parentheses are the corresponding values from Dr. Campbell's report of January 19, 1968).

Table 9. TOTAL RESERVES IN THE BROWN-McDADE MINE  
(December 31, 1968)

Proven:	13,341(16,380)t	@ 0.38(0.50)oz.Au/t	& 5.3(6.6)oz.Ag/t
Probable:	<u>21,850(26,720)t</u>	<u>0.36(0.51)</u>	<u>6.3(6.1)</u>
Subtotal:	35,191(43,100)	0.34(0.51)	5.9(6.3)
Possible:	<u>21,850(11,440)</u>	<u>0.36(0.44)</u>	<u>6.3(6.6)</u>
Total:	<u>57,041(54,540)</u>	<u>0.364(0.49)</u>	<u>6.1(6.6)</u>

In addition to the above values the following should be noted:

The mineralogical and structural patterns at Brown-McDade differ significantly from those found at both the Webber and Huestis Mines. The veins are wider, up to 12.5 feet in places but generally averaging between four and five feet in width. The overall grade is lower, particularly silver. To illustrate this point gross ore values have been calculated and are outlined in Table 10.

Table 10. TOTAL RESERVES IN THE BROWN-McDADE MINE,  
CATEGORIZED ACCORDING TO GROSS VALUE

<u>Class</u>	<u>tons</u>	<u>%</u>	Average Values		
			Au(oz/t)	Ag(oz/t)	Gross Value (\$/t)
40\$/t or more	--	0			
\$30-40	27,049	48	0.40	7.9	30.85
\$20-30	18,859	33	0.38	5.2	24.60
less than					
\$20/t	<u>11,133</u>	<u>19</u>	0.24	3.25	15.40
<u>Total</u>	<u>57,041</u>	<u>100%</u>			

From the above table it can be seen that none of the Brown-McDade reserves fall into the \$40.00 category. The highest grade ore has a gross value of \$31.25, much lower than that of the Webber or Huestis zones. On the other hand, the second class represents almost 50% of the total reserves (with an average gross value of can. \$30.85/ton).

It should also be noted that exploration and development at the Brown-McDade is limited and that substantial additional work is required before a fair estimate of Brown-McDade potential can be evaluated.

## 2. TOTAL RESERVES

## A. MOUNT NANSEN MINES LIMITED (Webber and Huestis)

The figures shown in Table 11 and *Diagram 1* show the total combined reserves in the Webber and Huestis Mines.

Table 11. TOTAL RESERVES IN THE MOUNT NANSEN MINES LIMITED (Webber and Huestis) (December 31, 1968)  
In parentheses are the corresponding values taken from Dr. Campbell's report of December 10, 1968.

Proven:	80,763(75,125)t	@ 0.347(0.474)oz.Au/t	13.626(16.98)A
Probable:	<u>136,804(102,050)</u>	<u>0.314(0.429)</u>	<u>12.637(16.37)</u>
Subtotal:	217,567(177,175)	0.3265(0.45)	13.004(16.6)
Possible:	<u>97,195(127,270)</u>	<u>0.3217(---)</u>	<u>13.900(----)</u>
Total:	<u>314,762(304,445)t</u>	<u>0.325(----)</u>	13.3086(---)

A comparison of the author's tonnages and grades with those given in Dr. Campbell's report shows a variation in tonnage and grade. These variations are chiefly due to the different approaches taken in calculating the reserves in the Webber Mine. Ore reserves calculated at various gross values are shown in Table 12 and *Diagram 2*.

Table 12. TOTAL RESERVES IN THE MOUNT NANSEN MINES CATEGORIZED ACCORDING TO GROSS VALUE (December 31, 1968)

Class	tons	%	Average Values		Gross Value (\$/t)
			Au(oz/t)	Ag(oz/t)	
40\$/t or more	119,027	38	0.45	22.3	61.65
\$30-40	66,887	21	0.31	11.0	33.50
\$20-30	71,587	23	0.25	7.6	24.80
less than \$20/t	<u>57,261</u>	<u>18</u>	0.17	3.9	14.35
Total	<u>314,762</u>	100%			

An examination of the above shows that 38% of the total reserves lie in the \$40.00 and above class with a gross value of \$61.65 per ton and that an additional 21% of the total reserves fall in the \$30.00 to \$40.00 class (averaging can.\$33.50/ton).

## B. MOUNT NANSEN MINES LTD. AND BROWN-McDADE MINES LTD.

Total reserves are increased if the Brown-McDade ore is considered. Including the Brown-McDade reserves in the total is justified as this property is adjacent to the Huestis mine and the ore can be economically treated at the Huestis mill. As the veins in the Brown-McDade Mine are wide and easily minable, mining costs could be substantially lower than those expected in Webber and Huestis. Total ore reserves, including Brown-McDade are shown in Table 13 and *Diagram* 1.

Table 13. TOTAL RESERVES MOUNT NANSEN AND BROWN-McDADE MINES (December 31, 1968) (no corresponding values in Dr. Campbell's report).

Proven:	94,104 t @	0.352 oz.Au/t	and	12.445 oz.Ag/t
Probable:	<u>158,654</u>	<u>0.320</u>		<u>11.766</u>
Subtotal:	252,758	0.332		12.018
Possible:	<u>119,045</u>	<u>0.328</u>		<u>12.580</u>
TOTAL:	<u>371,803</u>	<u>0.331</u>		<u>12.198</u>

The average gross value is can.\$36.80/ton (with Au can.\$37.50/oz and Ag can.\$2.00/oz).

Total ore reserves including Brown-McDade were calculated at various gross values and the results are summarized in Table 14 and *Diagram* 2.

Table 14. TOTAL RESERVES IN THE MOUNT NANSEN AND BROWN-McDADE MINES, CATEGORIZED ACCORDING TO GROSS VALUE.

Class	tons	%	Average Values		Gross Value
			Au(oz/t)	Ag(oz/t)	
40\$/t or more	119,027	32	0.46	22.3	61.65
\$30-40	93,936	25	0.34	10.1	32.75
\$20-30	90,446	24	0.28	7.1	24.75
less than \$20/t	<u>68,394</u>	<u>19</u>	0.18	4.4	16.90
TOTAL:	<u>371,803</u>	<u>100%</u>			

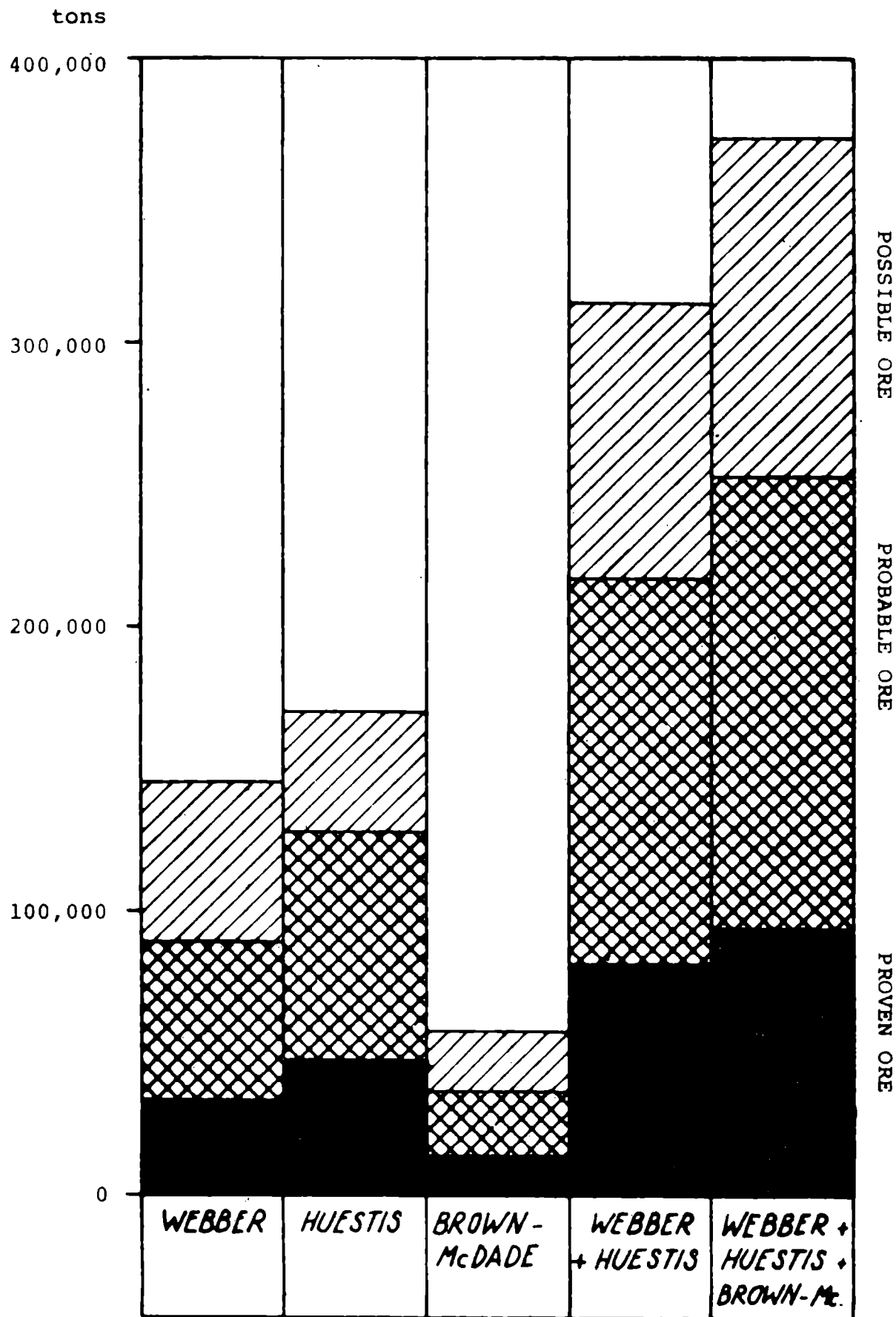


Diagram 1: Total reserves in the Webber, Huestis, and Brown-McDade Mines

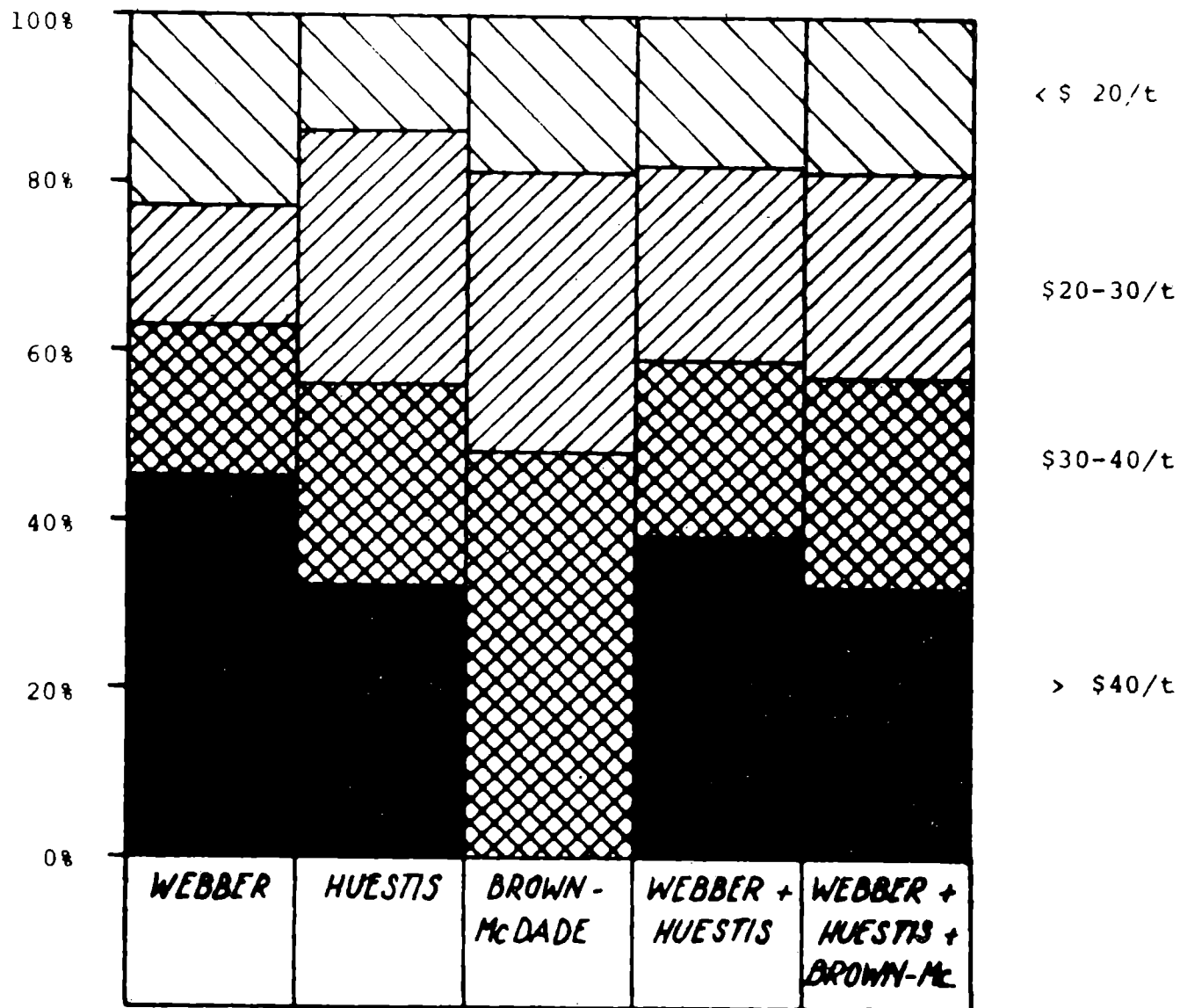


Diagram 2: Classification of the Ore Reserves according to Gross Value

It can be seen that reserves with a gross value of \$40/t or more, constitute one-third of the total (with an average gross value of \$61.65/ton!) Another 25% of the total reserves have an average gross value of \$32.75/ton. One must not forget, however, that these figures deal with the total reserves (proven, probable and possible ore); and that only part of these reserves are accessible and ready for mining.

### 3. CONCLUSIONS

At this point a few considerations relating to total gross values in relation to production can be made. Assuming a mill throughput of 200tpd (tons per day) and a recovery of 90%, the following picture is presented:

#### Life and Gross Value of the Reserves (200t/day and 90% recovery Au and Ag)

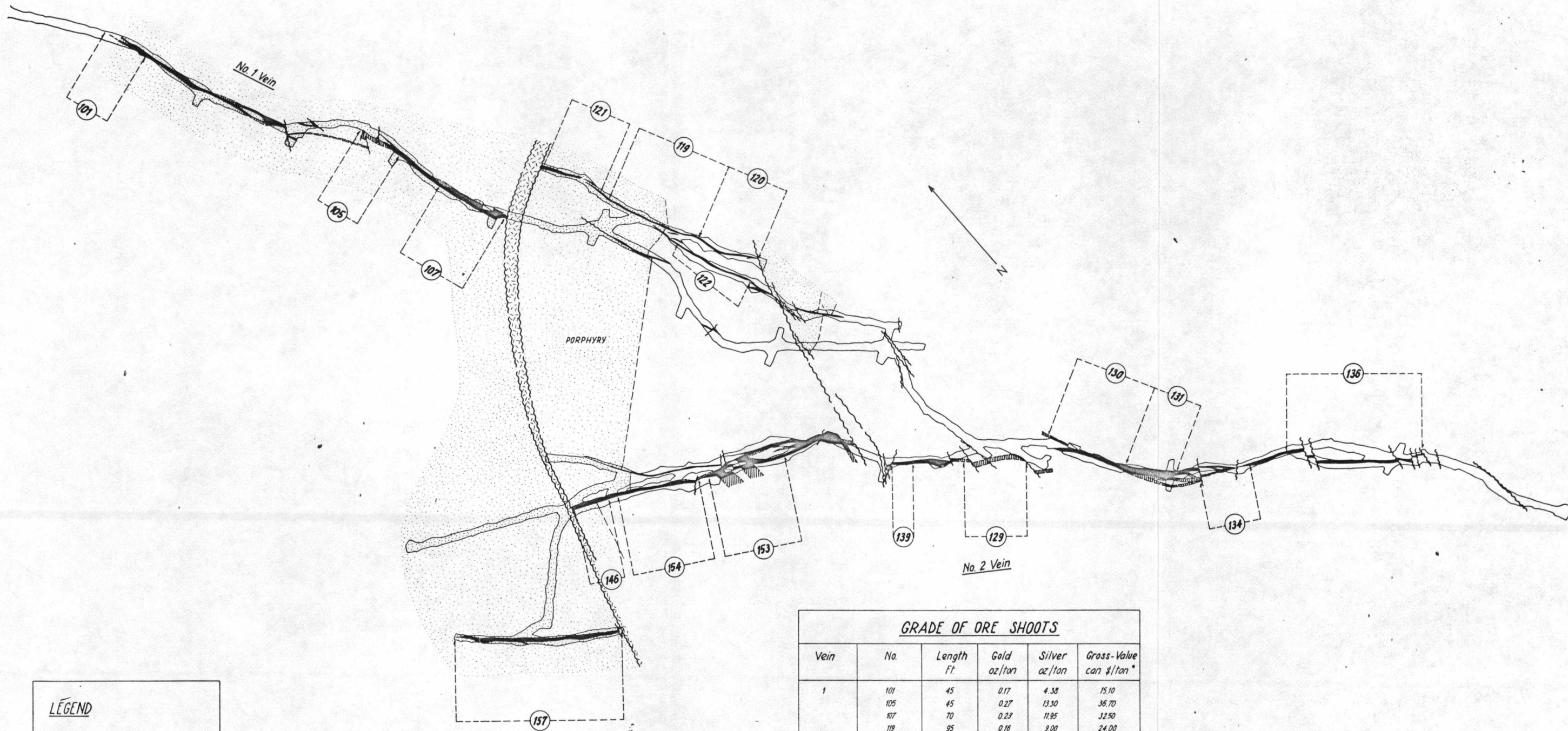
- a. PROVEN RESERVES: 94,104 tons corresponding to a life of 470 days and a gross value of \$3,215,000.
- b. PROVEN AND PROBABLE RESERVES: 525,758 tons, corresponding to a life time of 1264 days and a gross value of \$8,300,000.
- c. PROVEN, PROBABLE AND POSSIBLE RESERVES: 371,803 tons, corresponding to a life of 1859 days and a gross value of \$12,420,000.

One should not lose sight of the fact that only one third of the reserves lies in the plus \$40.00 class and that if present mining costs of over \$40.00 per ton are maintained then only 32% of the reserves are economical. If costs are reduced to \$30.00 which is certainly feasible, then 57% of the reserves are economic. If costs can be further reduced to 25.00 per ton then 80% of the listed reserves would fall into the minable class.

Another possibility which would increase the amount of economic ore would be an increase in the price of gold and/or silver. Considering an increase in silver price to \$3.00 per oz and production costs of \$30.00 per ton, then 80% of the reserves are economically minable and gross values would increase from \$36.80 to \$49.00 per ton.

If the present high production costs are maintained it is recommended that mining be carried out as outlined below:

- Mine the high-grade ore bodies (\$40/ton or more);
- Reduce production costs from the current \$43.80/ton to \$30/ton (or even \$25/ton);
- Parallel with the lowering of production costs, mine and mill average-grade ore bodies;
- Mine the low-grade ore bodies together with the high-grade when the silver price rises to such a point that they become economic.
- At the same time increase sharply, in order to convert probable and possible reserves into proven ones.

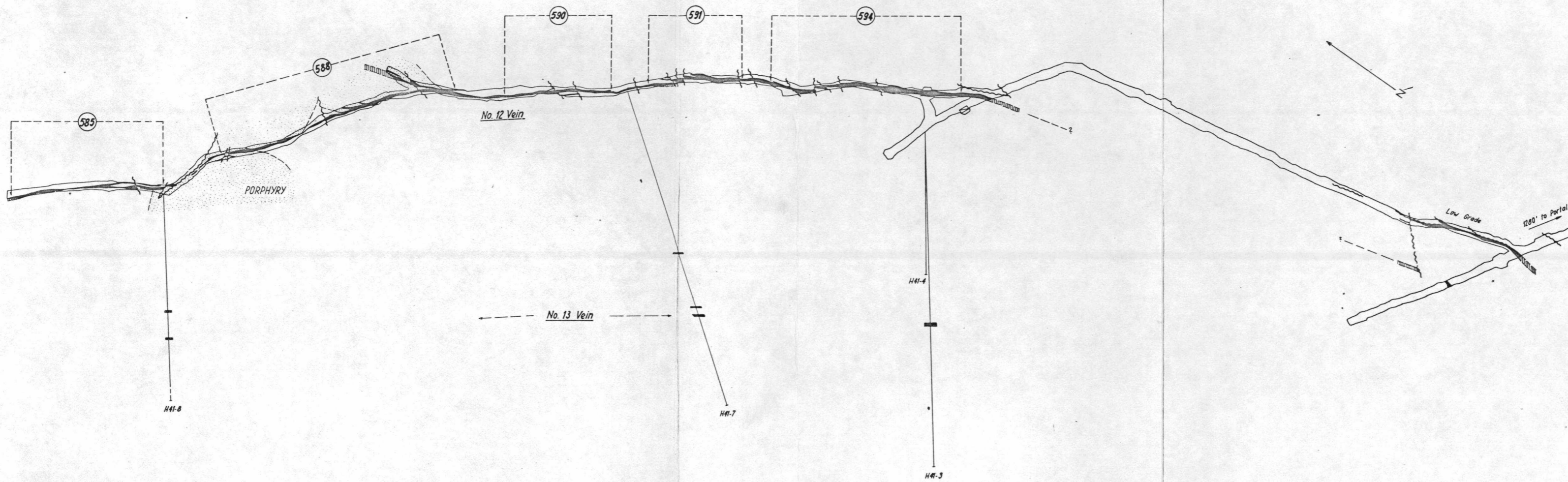


**LEGEND**

- Ore Shoot
- Vein Zone in drift
- Vein Zone in walls
- Fault
- Wide mass of gouge
- Raise

GRADE OF ORE SHOOTS					
Vein	No.	Length Ft.	Gold oz/ton	Silver oz/ton	Gross-Value can \$/ton*
1	101	45	0.17	4.38	15.10
	105	45	0.27	13.30	36.70
	107	70	0.23	11.95	32.50
	119	95	0.16	3.00	24.00
	120	65	0.06	4.65	11.55
	121	50	0.27	29.30	68.70
	122	80	0.13	6.29	17.40
2	129	60	0.16	6.33	18.60
	130	80	0.06	15.00	32.25
	131	45	0.13	7.47	19.80
	134	50	0.14	8.66	23.00
	136	130	0.54	41.50	103.25
	139	20	0.18	17.30	41.35
	146	35	0.23	5.24	18.75
	153	75	0.08	5.38	13.75
154	80	0.17	12.10	30.50	
157	160	0.31	13.80	39.20	
		Width: 4'	* @ 37.50 \$/oz Au 2.00 \$/oz Ag		

F. Bianconi **114-3-5**  
 Mt. Nansen Mines Ltd., Vancouver, B.C.  
 Ore Shoots  
**WEBBER VEINS ZONES**  
**4260 ADIT LEVEL**  
 Scale 1" = 100' April 1969 Fig. 16



**LEGEND**

- Ore shoot
- Vein zone in drift
- Vein zone in walls
- Ore intersection in drill hole
- Fault
- Raise

**GRADE OF ORE SHOOTS**

Vein	No.	Length Ft	Gold oz/ton	Silver oz/ton	Gross Value can \$/ton*
12	585	160	0.70	11.4	49.00
	588	255	0.43	6.6	33.70
	590	100	0.20	1.2	10.00
	591	100	0.22	4.1	16.45
	594	200	0.31	8.3	28.20

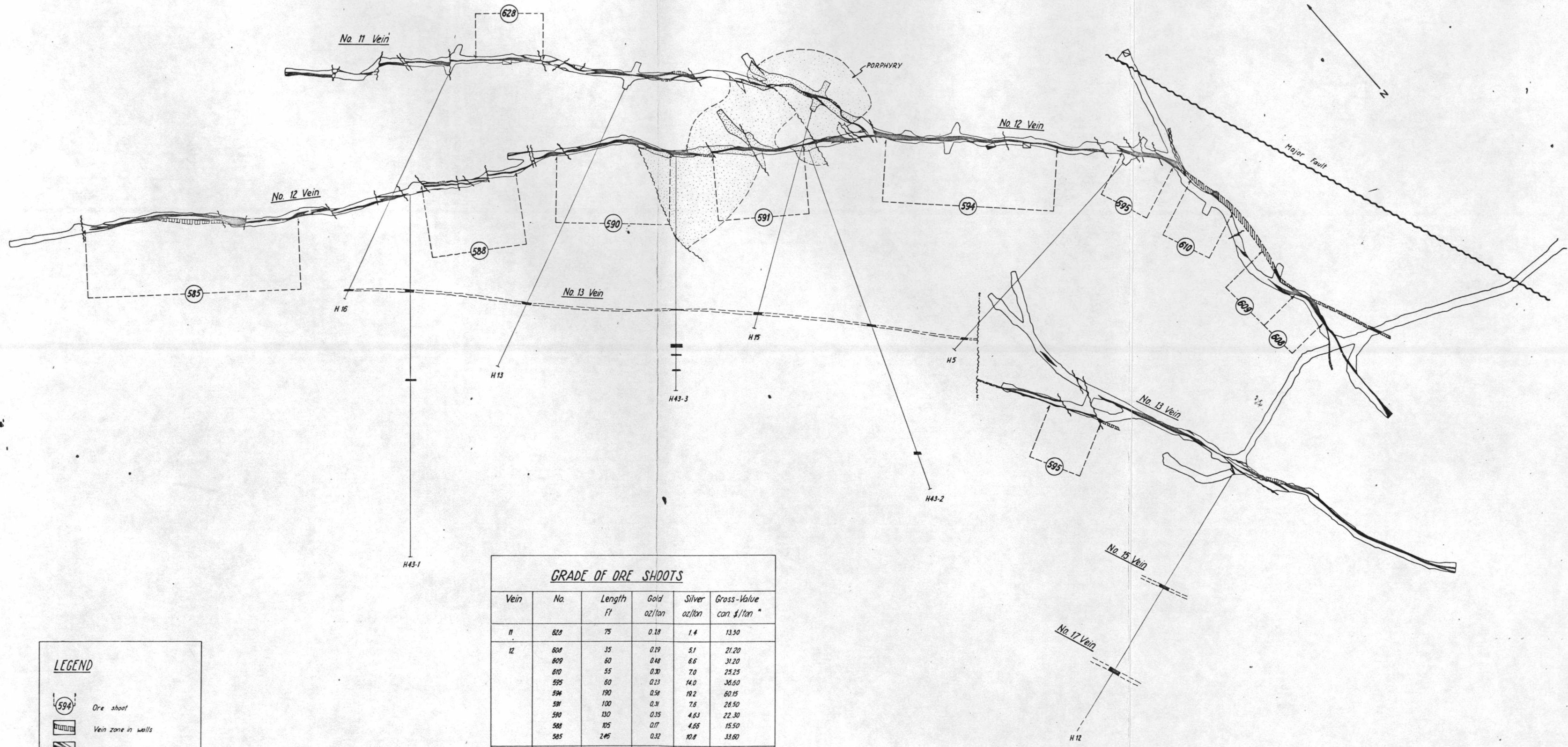
Width: 4'      \* @ 37.50 \$/oz Au  
2.00 \$/oz Ag

F. Bianconi **114-4-1**

Mt Nansen Mines Ltd., Vancouver, B.C.

Ore Shoots  
**HUESTIS VEIN ZONES**  
4100 ADIT LEVEL

Scale 1" = 100'    April 1969    Fig. 17



**LEGEND**

- Ore shoot
- Vein zone in walls
- Vein zone in drift
- Ore intersection in drill hole
- Fault
- Ore pass, Raise

**GRADE OF ORE SHOOTS**

Vein	No.	Length Ft	Gold oz/ton	Silver oz/ton	Gross-Value can \$/ton *
11	628	75	0.18	1.4	13.30
12	608	35	0.19	5.1	21.20
	609	60	0.48	6.6	31.20
	610	55	0.30	7.0	25.25
	595	60	0.23	14.0	36.60
	594	190	0.58	19.2	60.15
	591	100	0.31	7.6	26.50
	590	130	0.35	4.63	22.30
13	588	105	0.17	4.66	15.50
	585	245	0.32	10.8	33.00
	595	60	0.32	14.3	40.60
15	H5-H16	700	0.20	8.4	24.30
	H12	?	0.52	3.8	27.10
17	H12	?	0.22	5.8	19.85

Width: 4'

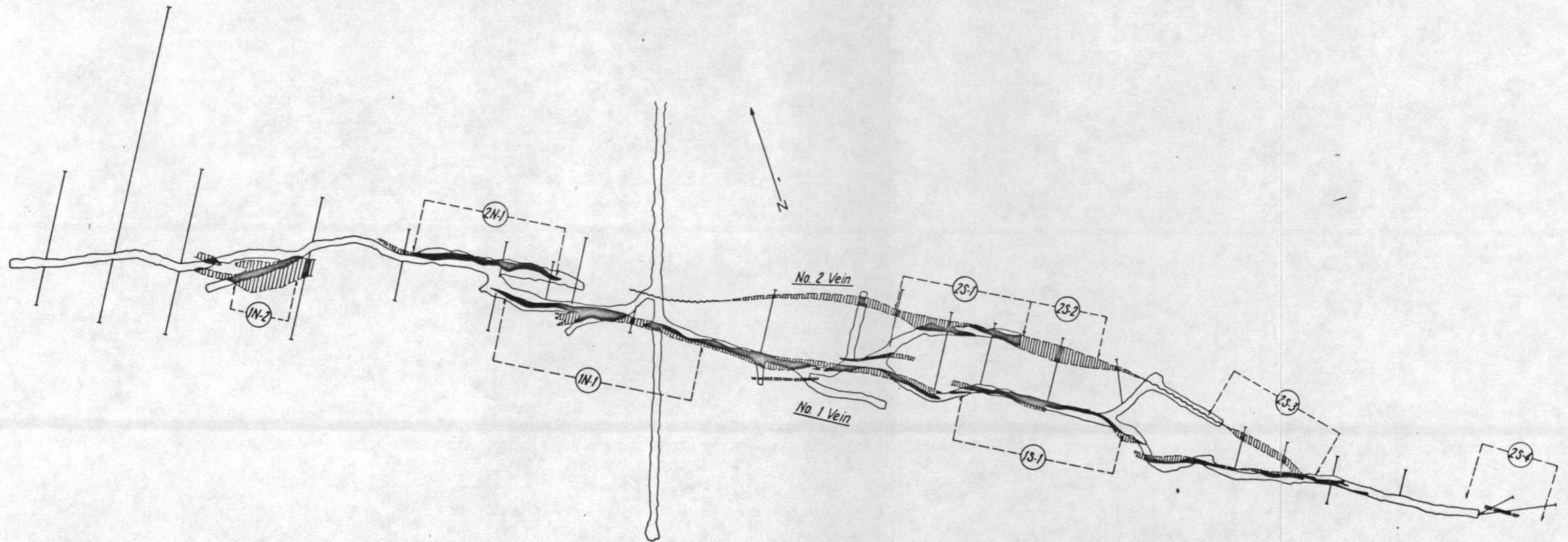
\* @ 3750 \$/oz Au  
2.00 \$/oz Ag

F. Bianconi **114-3-6**






Mt. Nansen Mines Ltd., Vancouver, B.C.

Ore Shoots  
**HUESTIS VEIN ZONES**  
4300 ADIT LEVEL

Scale 1" = 100'    April 1969    Fig. 1'B



**LEGEND**

-  Ore shoot
-  Vein zone in drift
-  Vein zone in walls
-  Ore intersection in drill hole
-  Fault

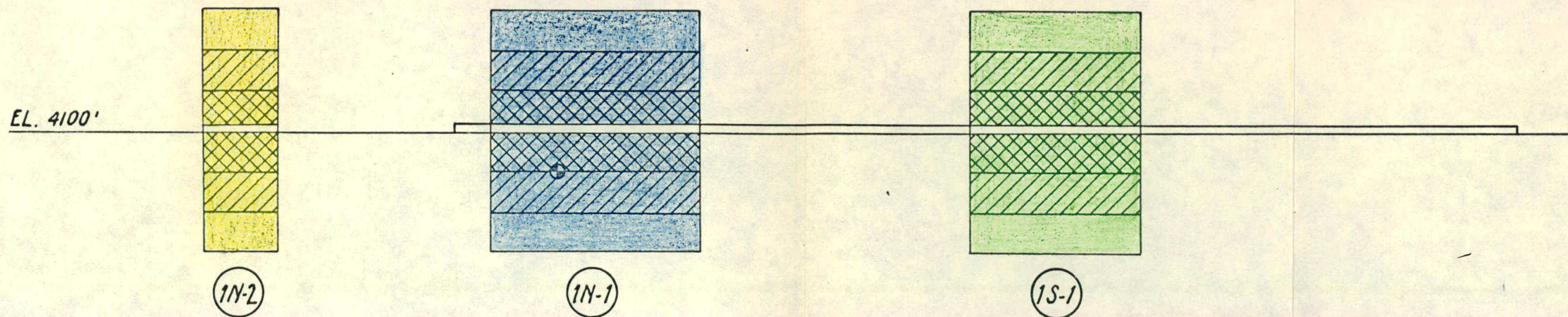
GRADE OF ORE SHOOTS					
Vein	No.	Length Ft.	Gold oz./ton	Silver oz./ton	Gross-Value can \$/ton
1	1N-2	55	0.41	1.68	18.75
	1N-1	155	0.51	6.07	31.25
	1S-1	125	0.41	3.92	23.50
2	2N-1	110	0.34	9.11	31.00
	2S-1	100	0.12	4.36	13.20
	2S-2	60	0.31	9.31	30.25
	2S-3	95	0.29	7.74	26.35
	2S-4	60	0.48	3.86	25.70

Width: 4'-12"

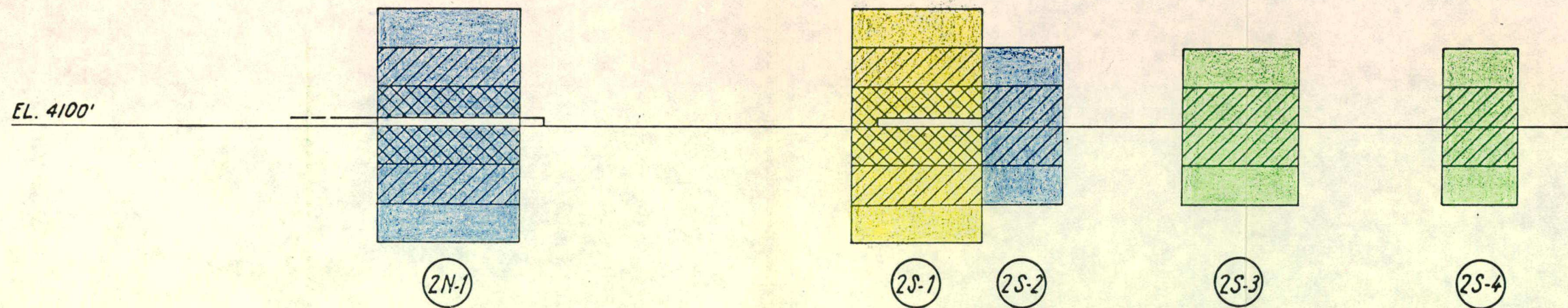
@ 3750 \$/ton Au  
2.00 \$/ton Ag

F. Bianconi	<b>614-4-3</b>
Mt. Nansen Mines Ltd., Vancouver, B.C.	
Ore Shoots	
<b>BROWN-McDADE VEIN ZONES</b>	
4100 ADIT LEVEL	
Scale 1" = 100'	April 1969 Fig. 19





No. 1 Vein






No. 2 Vein



**LEGEND**

-  Proven Ore
-  Probable Ore
-  Possible Ore
-  Diamond Drill Hole  
(Ore, Nil)

*Value (can \$/ton)*

-  30-40
-  20-30
-  < 20

F. Bianconi

Mt. Nansen Mines Ltd., Vancouver, B. C.

Longitudinal vertical section

**BROWN McDADE VEINS  
ORE RESERVES**

Scale 1" = 100' April 1969 Fig. 22

MINABLE ORE RESERVES

In an earlier report by the author (April 24, 1969) the total ore reserves for Mount Nansen Mines Limited, as for December 31, 1968, were reported as follows:

Proven ore:	80,763 t @ 0.347 oz.Au/t and	13,626 oz.Ag/t
Probable ore:	<u>136,804 t @ 0.314</u>	<u>12,637</u>
Subtotal:	217,567 t @ 0.3265	13.00
Possible ore:	<u>97,195 t @ (0.3217)</u>	<u>(13.900)</u>
TOTAL:	314,762 t @ 0.325 oz.Au/t and	13.31 oz.Ag/t

Since that time the ore reserves did not change significantly. If on one hand the very limited exploration and development work performed underground during 1969 added some ore tonnage (ore shoot 585 in the Huestis 4100 level), on the other hand the ore stoped out from both the Huestis levels during the short milling operation compensated the total balance. The purpose of this report is not to up-date the given total ore reserves, but to indicate that part of the total ore reserves, which are minable profitably.

MINABLE ORE RESERVES are defined as portions of the mineralisations which meet the following requirements or criteria:

- A. Only ore above the deepest present level of the two mines, the Webber 4260 level and the Huestis 4100 level, is included in this computation. This criterion eliminates a large portion of the total reserves; (approximately 1/3) for instance, all ore in the Webber mine between the 4260 level and the initiated 4100 level (see Fig.4 in report dated April 24, 1969 and the ore below the Huestis 4100 level (see Fig.2/, same report) In other words, this ore is present (some of it even under the proven category), but it is not accessible. It will become accessible only by developing a deeper level (Webber 4100, Huestis 3900, the former being proposed for the next development stage).
- B. For the same reason as item A., all ore which is not developed by drifting must be excluded from the minable reserves. This eliminates ore only exposed at the surface (Cabin Creek vein) and probable and possible ore indicated by drilling (for instance 13 Vein in both Huestis levels), or approximately 1/6 of the total reserves. This ore will also become minable by means of drifting. (Proposed development includes only 13 Vein; Cabin Creek would be considered only in a second stage).

C. From the total ore reserves a third class of mineralisation has to be eliminated in order to obtain realistic minable reserves, namely such portions which cannot be mined profitably, or approximately 1/6 of the total reserves. Several factors determine the profitability limit; the cardinal being cut-off grade, milling recovery, and metal prices. For the present computation the following figures are used:

- (i) Cut - off grade. During the past operation (Sept. 68 / April 69), the total mining, milling, transportation and smelting costs were about \$43.50/ton; it is obvious and proved that these costs were by far too high and resulted from poor management and control. The present estimation of the total costs, as compiled by our mining engineer, R.C. McCombe, indicates \$38.00/ton ore at a production rate of 150 tpd, \$35.00/ton ore at a production rate of 200 tpd, and \$31.70/ton ore at a rate of 300 tpd. It must be noted that these cost estimations imply several assumptions; for instance, a concentration ratio ore: concentrate of 15:1. Obviously a better concentration ratio, as the result of a more efficient milling operation, would lower considerably the transportation costs, the smelter penalties etc., thus lowering the total costs and the cut-off grade. The present ore reserves do not allow a larger rate than 200 tpd, so one must assume a present cut-off grade of \$35.00/ton.
- (ii) Milling recovery. This factor has not yet been determined reliably. Accurate figures should be obtained with the next metallurgical testing. From the past laboratory work it seems feasible to reach optimum recoveries of 90% gold and silver and a concentration ratio of 10:1 or more. Cut-off price and recoveries combined lead to the conclusion, that **only** ore having a gross value of \$39.00/ton should be mined. However, some ore having a gross value of less than \$39.00/ton has been included in the present computation. This for two reasons. The first one is of geological nature: since the grade (and consequently the gross value of an ore shoot is not constant in the vertical direction, some portions of lower grade have to be included in order to mine out higher grade sections which lie between low-grade sections. The second reason is of more "philosophical" nature and was one of the battlefields during the conflicts with Chapman's people. If one considers only ore having a gross value of more than the cut-off grade, the resulting tonnage of ore will have an average grade much higher than the cut-off grade itself,

and the resulting tonnage will be very low. The low tonnage would imply a lower rate of production and the lower rate of production would increase the cut-off grade, and so require a further high-grading. These considerations have already been exposed in all details in earlier reports and correspondence (Memo from F.B. - R.S. - R.Mc. to Mr.H.Willi, Nov.7, 1969, letter from F.B. - R.S. to Chapman, Wood and Griswold Ltd., Dec.4, 1969). As a conclusion of the above explained it was felt to be a correct procedure to take into account also some ore which has a gross value lower than the cut-off grade.

- (iii) Metal prices. The third factor which must be considered in the computation of the minable reserves is the price of gold and silver. The importance of this factor is obvious. An increase of the metal prices will result in an increase of the gross value of the ore (and thus of the profit); on the other hand, this would also mean that ore below cut-off grade at current metal prices would become minable at increased metal prices. For the present computation the following prices were used:  
Can.\$37.50 oz.Au and Can.\$2.00 oz.Au.

CONCLUSIONS. After elimination of the above mentioned three categories of ore and mineralisation the resulting total minable reserves are:

108,855 tons @ 0.386 oz.Au/t and 15.45 oz.Ag/t,

44,855 tons grading 0.338 oz.Au/t and 20.28 oz.Ag/t from the Webber Mine and 64,000 tons grading 0.42 oz.Au/t and 12.06 oz.Ag/t from the Huestis Mine.

The location of the ore is given in detail in tables 1 and 2. For plans and sections refer to the author's report dated April 24, 1969.

Profit. At 200 tpd these reserves would last for 500 days, or approximately 1 1/2 years. The profit of mining these reserves is estimated to be as follows:

- (i) @ can.\$37.50/oz.Au and \$2.00/oz.Ag, and 90% recovery of gold and silver:
- |               |                     |
|---------------|---------------------|
| Gross Value   | \$45.38/ton         |
| Recovered     | \$40.84/ton         |
| - Costs       | <u>\$35.00/ton</u>  |
| Net Profit    | \$ 5.84/ton         |
| Total Profit: | <u>\$635,888.00</u> |

(ii) @ can.\$40.00 oz.Au and \$2.50 oz.Ag, and 90% recovery of gold and silver:

Gross Value	\$54.07/ton
Recovered	\$48.66/ton
- Costs	<u>\$35.00/ton</u>
Net Profit	\$13.66/ton

Total Profit      \$1,487,369.00

Table 1. WEBBER MINE - MINABLE RESERVES (March 11, 1970)

## PROVEN ORE

<u>Ore Shoot</u>	<u>tons</u>	<u>Grade</u>	<u>Gold</u> (oz/t)	<u>Silver</u> (oz/t)
105	436		0.42	54.00
107	5,614		0.44	36.40
119	1,036		0.38	8.32
	1,000		0.16	9.00
121	1,181		0.47	19.70
	545		0.27	29.30
130	1,900		0.37	30.50
136	1,000		0.30	4.30
	1,400		0.54	41.50
139	200		0.18	17.30
157	1,745		0.31	13.80
<b>TOTAL:</b>	<b><u>16,057</u> tons @</b>	<b><u>0.39</u> oz.Au/t</b>		<b><u>26.05</u> oz.Ag/t</b>

Gross Value: Can.\$66.725/ton @ Can.\$37.50/oz.Au and  
Can.\$2.00/oz.Ag.

## PROBABLE ORE

<u>Ore Shoot</u>	<u>tons</u>	<u>Grade</u>	<u>Gold</u> (oz/t)	<u>Silver</u> (oz/t)
105	490		0.27	13.30
119	4,144		0.27	8.66
121	2,589		0.37	24.50
130	880		0.06	15.00
	5,200		0.21	22.70
136	3,800		0.42	27.90
139	200		0.18	17.30
154	880		0.17	12.10
	3,490		0.48	16.50
157	1,745		0.31	13.80
<b>TOTAL:</b>	<b><u>23,418</u> tons @</b>	<b><u>0.314</u> oz.Au/t</b>		<b><u>17.82</u> oz.Ag/t</b>

Gross Value: Can.\$47.40/t @ Can.\$37.50/oz.Au and  
Can.\$2.00/oz.Ag.

## POSSIBLE ORE

Ore Shoot 157

Total: 5,380 tons (@ 0.31 oz.Au/t and 13.80 oz.Ag/t)

Gross Value: (Can.\$39.20/t) @ Can.\$37.50/oz.Au and Can.\$2.00/oz.Ag.

## TOTAL WEBBER

44,855 tons @ 0.338 oz.Au/t and 20.28 oz.Ag/t

Gross Value: Can.\$53.20/t @ Can.\$37.50/oz.Au and Can.\$2.00/oz.Ag.

Table 2: HUESTIS MINE - MINABLE RESERVES (March 11, 1970)

## PROVEN ORE

<u>Ore Shoot</u>	<u>tons</u>	<u>Grade</u>	<u>Silver</u>
		Gold (oz/t)	(oz/t)
585	3,200	0.73	12.5
	2,800	0.32	10.8
588	2,540	0.17	4.66
	800	0.43	8.8
590	480	0.35	4.6
591	600	0.36	10.0
594	2,000	0.58	19.2
595	550	0.23	14.0
TOTAL:	<u>12,970</u> tons @	<u>0.437</u> oz.Au/t	<u>11.06</u> oz.Ag/t

Gross Value: can.\$38.50/t @ can.\$37.50/oz.Au and can.\$2.00/oz.Ag.

## PROBABLE ORE

<u>Ore Shoot</u>	<u>tons</u>	<u>Grade</u>	<u>Gold</u> (oz/t)	<u>Silver</u> (oz/t)
585	2,830		0.32	10.8
	13,700		0.52	11.6
588	1,090		0.91	48.3
	1,090		0.17	4.6
	5,870		0.31	6.7
590	1,360		0.30	10.1
	1,360		0.35	4.6
591	600		0.36	10.0
594	8,600		0.44	13.7
595	900		0.23	14.0

Total: 37,400 tons @ 0.431 oz.Au/t and 11.84 oz.Ag/t

Gross Value: Can.\$39.80/t @ Can.\$37.50/oz.Au and Can.\$2.00/oz.Ag.

## POSSIBLE ORE

<u>Ore Shoot</u>	<u>tons</u>	<u>Grade</u>	<u>Gold</u> (oz/t)	<u>Silver</u> (oz/t)
585	8,030		(0.32)	(10.8)
588	2,900		(0.55)	(26.5)
590	1,800		(0.32)	(7.4)
591	900		(0.36)	(10.0)

Total: 13,630 tons (@ 0.371 oz.Au/t and 13.64 oz.Ag/t)

Gross Value: (Can.\$41.20/t) @ Can.\$37.50/oz.Au and Can.\$2.00/oz.Ag.

## TOTAL HUESTIS

64,000 tons @ 0.42 oz.Au/t and 12.06 oz.Ag/t

Gross Value: Can.\$39.85/t @ Can.\$37.50/oz.Au and Can.\$2.00/oz.Ag.

POSSIBILITIES OF INCREASING THE MINABLE RESERVES.

There are several possibilities which can increase the minable reserves:

- A. The most obvious possibility is to explore for new veins and to develop drill-indicated, already known veins. Some proposals in this regard are indicated in the report dated Oct. 17, 1969, by F.B. - R.S. - R.Mc.: "Preliminary Budget and Comments, Period Oct. 1, 1969 to April 30, 1970", where the authors outline a minimum exploration and development program. This program should convert drill-indicated ore into minable ore (Huestis 4300 level, 13 Vein; possibly 20,000 tons), convert possible ore below level into minable ore (drifting of Webber 4100 level, 2 Vein, 20,000 tons plus, depending on how much drifting), and finally should find new ore in both drifts, (Huestis 4100 and 4300 levels, continuation of 12 Vein to the west), and drillings, (15 and 17 Veins on the Huestis 4300 level, 12 and 13 Veins in the Huestis 4100 level, 1 and 2 Veins in the Webber 4260 level).
- B. Another possibility of increasing the tonnage of the minable reserves is a lower cut-off grade. This can be the result of the following factors:
- (i) An increased production rate, which reduces mining, milling and overhead costs. Here we have a vicious circle, since in order to increase the production rate one has to increase the ore reserves; the ore reserves can be increased by a lower cut-off grade; and in turn, the cut-off grade can be reduced by increasing the production rate. In the case of Mount Nansen the egg is definitely the ore, the chicken being the production rate; in other words: more minable ore has to be added to the present reserves by exploration and development work. This additional ore would then permit an increased production rate; this would reduce the cut-off grade, and finally, the reduced cut-off grade would convert lower grade ore into minable one.
  - (ii) A more efficient metallurgy. Better recoveries and/or better concentration ratio than anticipated would reduce the total costs and/or increase the profit margin. This is equal to say that the cut-off grade would be lower.

(iii) An increase in metal prices. An increase in metal prices would also add tonnage to the minable reserves. This applies especially for silver, as explained in this example. Assume a mineralisation grading 15 oz. Ag/t. At can.\$2.00/oz.Ag the gross value would be \$30.00/ton, also not minable. At can.\$3.00/oz.Ag the gross value would increase to can.\$45.00/ton, making this ore minable.

C. Another important factor is represented by the mining technique used for the extraction of the ore. Not enough attention and time were spent on this problem, previously and to date. The method used at Mount Nansen during the past was a simple shrinkage stoping. The experienced average mining width was by far too high (5.46 feet). Since the calculated ore reserves were based on a assumed mining width of 4 feet, the experienced mining width of 5.46 feet represented 36.5% additional dilution of the ore grade. This was one of the main reasons for the failure of the operation.

Our mining engineer, Robert McCombe, made some suggestions on the mining procedures (report "Preliminary Budget and Comments, Oct. 17, 1969) and he stated: "In summation, it is believed certain that, if proper mining procedures are followed, stope widths of four feet or less can easily be achieved". If stoping width of less than four feet can really be achieved, this would imply an increase of the grade of the ore mined. This would make lower grade ore minable, thus further increasing the total reserves. Some investigations should take place on the feasibility of stoping very narrow veins (not minable at four feet stoping width), by means of resuing or cut-and-fill techniques.

METALLURGYSummary of Laboratory Work

Mineralogical and metallurgical investigations revealed clearly the presence of two ore types in the known workings of the Mount Nansen property. The ore in the Huestis section is a complex sulfide ore, arsenopyrite, pyrite, sphalerite, jamesonite, galena and freibergite being the main constituents. The ore in the Webber section is primarily an oxide ore. Its constituents are rather difficult to determine. However, they seem to be a complex assemblage of bindheimite, anglesite, and various other alteration products of the sulfides present in the Huestis ore. Geological implications give rise to the assumption that with increased depth the Webber ore will gradually change its nature into a sulfide ore. The mineralogical investigation carried out by Hazen indicates that the primary Webber sulfide ore differs from the Huestis sulfide ore inasmuch as it might carry higher Ag and Sb contents.

The present ratio between sulfide and oxide ore is approximately 6 : 4. Naturally, this ratio is subject to changes in the course of mining, however, one never can expect to mine exclusively sulfides as long as mining operations are carried out in shallow depths. This implication is confirmed by the presence of oxidized ore in all the trenches and by the presence of highly oxidized ore in the 4100 level at Brown-McDade.

Metallurgical tests carried out separately on the two ore types indicate a good recovery and concentration for both the sulfide and the oxide ore.

## 1) Huestis ore.

The best recoveries and concentration of this ore has been achieved by making use of a jig followed by selective flotation of a "silver - lead" concentrate and a "gold" concentrate (Test 152 - 1 by Britton).

	Jig	Ag-Pb	Au	Total
conc. ratio	38.5	20	5.4	4.2
rec. Au	8.4%	11.4%	74.5%	94.3%
rec. Ag	0.8%	86.2%	9.1%	96.1%

The recovery is good but the concentration ratio is rather poor due to the fact that the "gold" concentrate is of low grade. Roasted tests performed on other bulk concentrates indicates an approximately 25% reduction of the weight, an 80 - 90% reduction of the Sb content. The gold loss and silver loss experienced was 2.5 - 3.5% and 0.2 - 1.6% respectively (March 18, 1968, Britton).

These tests indicate that such an approach followed by cyanidation of the roasted "gold" concentrate would yield both a high recovery and a high concentration for the sulfide ore.

A flotation of a bulk concentrate yielded:  
(Test 151 - 7 by Britton):

conc. ratio	5.4
rec. Au	90.6%
rec. Ag	95.5%

The cyanidation of the tailings seems to be uneconomical.

## 2) Webber ore.

Best results were obtained by straight cyanidation of the oxide ore (Test 8, Ottawa)

conc. ratio	---	consumption NaCN	6.8 lbs/ton ore
rec. Au.	82.6%	consumption CaO	13.6 lbs/ton ore
rec. Ag	84.2%		
Ag. time	24 hrs.		

Gravitative concentration followed by flotation yielded a poor recovery and a moderate concentration ratio.  
(Test 27, Ottawa).

	Jig	Table	Flot.	Total
conc. ratio	71	100	13	9.9%
rec. Au	2.0%	3.2%	29.9%	35.1%
rec. Ag	9.8%	13.5%	57.3%	80.6%

Flotation followed by cyanidation of tailings indicate a reasonable recovery and concentration (Britton No. 9, 1964)

	Flot.	Cyanid. of tailings	Total
conc. ratio	11.24%	---	11.2
rec. Au	30.9%	71.1%	80.0%
rec. Ag	76.3%	73.0%	93.6%

NaCN consumption	2.8 lbs/ton ore
CaO consumption	10.0 lbs/ton ore

The grade of the heads used in this test was much too high.

The above tests indicate that economically the best results for the Webber ore can be achieved by straight cyanidation.

## 3) Huestis and Webber

Composite samples of the sulfide and oxide ore have been tested excessively both by Britton, using a 1 : 1 mixture and by Ottawa using a 6 : 4 mixture. Several approaches have been performed and the following "best" results were obtained.

Flotation of a bulk concentrate. (Test 152 - 6, Britton)

conc. ratio	4 - 6.6
rec. Au	85%
rec. Ag	91%

The Webber ore portion used for this test was not representative having a too low degree of oxidation. The recoveries obtained in this test must therefore be considered to be rather optimistic.

Flotation of a sulfide and oxide concentrate.

(Test 152 - 5, Britton, this test has been used as a base for the feasibility study of Campbell).

	Sulfides	Oxides	Total
conc. ratio	3.9 - 6.1	13.7 - 60	3 - 5.6
rec. Au	89.7 - 82.8%	3.8 - 1.6%	93.5 - 84.4%
rec. Ag	91.8 - 86.4%	3.3 - 1.6%	95.1 - 88.0%

The same considerations as for test 152 - 6 must be made in this test. This is the reason why practically all of the gold and silver is recovered in the sulfide concentrate.

Flotation of a bulk concentrate followed by cyanidation of flotation tailings (Test 33, Ottawa).

	Flotation	Cyanidation of Tailings	Total
conc.	7.5 - 11.7		7.5 - 11.7
rec. Au	83.3 - 60.4%	43.6%	77.7 - 90.6%
rec. Ag	89.0 - 83.8%	76.8%	96.2 - 97.4%

This is the best test carried out on composite samples. By using this approach most of the metals recovered in the flotation derive from the Huestis sulfide fraction and most of the metals recovered in the cyanidation derive from the Webber oxide fraction.

From the discussion of the above tests it seems desirable that the oxide and sulfide ores are treated separately. The treatment of a composite ore has the disadvantage that in the cyanide stage a large volume must be handled. More than 50% of this volume is derived from the sulfide fraction and contains very limited amounts of gold and silver which economically do not justify a cyanide treatment. This conclusion is solely based on the presently available metallurgical data and does not comprise any operational considerations.

## The Milling Operation at Mount Nansen

The Mount Nansen mill (flotation plant) was in operation during six months, from September 23, 1968 to April 8, 1969 for a total of 191 operating days. An attempt to compile a metallurgical balance for this period is given here.

The compilation shown in the attached table is based on the daily mill reports of the Mill-Superintendent, Mr. C. Coffey. The table contains all data pertaining to the mill operation, that is, tonnages of heads, of concentrate and of tailings, ratio ore/concentrate, gold - silver assays and contents and the recoveries.

However, this compilation is of little value and has to be analysed critically since most of the data are calculated. Only the concentrate and tailing grade and the concentrate tonnage are observed values. Since most of the values were calculated the metallurgical balance is perfect, but there are no possibilities to control its validity.

It is attempted to explain the calculations of the metallurgical balance by using one example, chosen at random from the daily mill reports (Jan. 12, 1969).

Date - January 12, 1969

SDT Reported Milled - 189

SDT Concentrate Produced - 12.1005

Assay	Au Oz/Ton	Au Oz/Ton	
Heads	.420	10.140	
Conc.	2.571	76.458	
Tails	.100	1.700	
R/C Au			7.72
R/C Ag			8.86
SDT of feed indicated - Au			93
SDT of feed indicated - Ag			107
		Average	$\frac{200}{2} = 100$

Reported 100 SDT

### Metallurgical Balance

<u>Au</u>	SDT	Assay Au	Oz Au	%Recovery	R/C
Heads	100	.399	39.900	100	
Conc.	12.1005	2.571	31.110	77.95	8.3/1
Tails	87.8995	.100	8.790	22.05	
<u>Ag</u>	SDT	Assay Ag	Oz Ag	%Recovery	R/C
Heads	100	10.74	1074.611	100	
Conc.	12.1005	76.458	925.182	86.09	8.3/1
Tails	87.8995	1.700	149.429	13.91	

- 1) SDT (short dry tons) Reported Milled - 189 tons. Since there was no weightometer installed at the mill, the mill-feed was estimated at the conveyor belts, which connect the fine ore bins and the ball mills. 1 foot of ground ore was taken from the conveyor periodically, and weighted on a oldfashioned balance. The speed of the conveyor belt was estimated and the mill-feed then calculated from the two values. This value of course is affected by a number of errors, i.e. variations of the ore - volume on the conveyor belt, variation in the speed of the conveyor belt, etc.
- 2) SDT (short dry tons) concentrate produced - 12.1005 tons. This value can be considered as fairly correct, since it was obtained by direct weighting on a modern scale. The moisture content was determined in the assay laboratory and subtracted from the obtained weight.
- 3) Assay values: these are the assays as reported by the resident assayer. It is difficult to estimate the error of the assays: the only check available were the check assays done by the Whitehorse Assay Office. The comparison of the results supplied by the mine assayer and by Whitehorse shows a good agreement in the higher grades, but larger discrepancies in the low grades.

A calculation of the metallurgical balance, based on the above values does not tally; see following example:

SDT reported milled: 189 tons  
 SDT concentrate produced: 12.1005 tons  
 Ratio ore: concentrate: 15.6192  
 Tailings: 176.8995 tons

<u>Gold balance</u>		
Heads	0.420 oz/ton	(assayed)
(a) or	79.38 oz	(oz/ton x tons feed)
Concentrate	2.571 oz/ton	(assayed)
(b) or	31.1104 oz	(oz/ton x tons concentrate)
Recovery	39.19%	
Tailings	0.100 oz/ton	(assayed)
(c) or	<u>17.69 oz</u>	(oz/ton x tons tailings)

(c) is also equal (a) - (b), in this case:  
 (c) = 79.38 - 31.1104 = 48.2696 oz,  
 which is almost three times larger than the other figure.

Silver balance

		10.14 oz/ton	(assayed)
a)	or	1916.46 oz	(assay x tons feed)
		76.458 oz/ton	(assayed)
b)	or	925.18 oz	(assay x tons concentrate)
		42.28%	
		1.7 oz/ton	(assayed)
c)	or	<u>300.73 oz</u>	(assay x tons tailing)

or (c) = (a) - (b) = 1916.46 - 925.18 = 991.28 oz

Here, the difference is even larger.

Cy Coffey has discovered these large discrepancies very soon during the operation and attributed them to a wrong mill-feed tonnage. During October 1968, the discrepancies were sometimes so large, that the calculated recoveries are higher than 100%! Starting December 1, 1968, Coffey introduced a new calculation of the metallurgical balance, based on the assays and on the weight of the concentration only.

His calculation of the metallurgical balance is as follows:

1) Concentration ratio calculated from the assays:

If	a=	Grade of heads	( known )
	b=	Grade of concentrate	( known )
	c=	Grade of tailings	( known )
	x=	Tonnage of concentrate	( known )
	y=	Tonnage of tailings	(unknown)
	x+y=	Tonnage of heads	(unknown)

Then

$$\begin{aligned} (x+y) \cdot a &= bx + cy \\ ax + ay &= bx + cy \\ x \cdot (b-a) &= y \cdot (a - c) \\ y &= x \cdot \frac{(b - a)}{(a - c)} \end{aligned}$$

Concentration ratio is

$$\begin{aligned} \frac{x + y}{x} &= \frac{x + \frac{x \cdot (b - a)}{(a - c)}}{x} \\ &= 1 + \frac{b - a}{a - c} \\ &= \frac{a - c + b - a}{a - c} = \frac{b - c}{a - c} \end{aligned}$$

Concentration ratio =  $\frac{\text{conc. grade} - \text{tailing grade}}{\text{heads grade} - \text{tailing grade}}$

In our example it results:

$$\begin{aligned} R/c \text{ Au} & \text{ (concentration ratio indicated by Au)} = 7.72 \\ R/c \text{ Ag} & \text{ (concentration ratio indicated by Ag)} = 8.86 \end{aligned}$$

And:

$$\begin{aligned} \text{SDT of feed indicated by Au} & = R/c \text{ Au} \times \text{tons concentration} = 93 \text{ tons} \\ \text{SDT of feed indicated by AG} & = R/c \times \text{tons concentration} = 107 \text{ tons} \\ \text{Average} & = \frac{93 + 107}{2} \text{ tons} = 100 \text{ tons} \end{aligned}$$

From this calculated mill-feed, Cy Coffey calculated the grade of the heads solving the equation  $(x + y) \cdot a = bx + cy$  after a.

$$a = \text{head assay} = \frac{bx + cy}{x + y}$$

In our example:

$$\begin{aligned} \text{calc. head assay Au} & = 0.399 \text{ oz/ton} \quad (\text{assayed: } 0.42) \\ \text{calc. head assay Ag} & = 10.74 \text{ oz/ton} \quad (\text{assayed: } 10.14) \end{aligned}$$

From these calculated figures we obtain:

$$\begin{aligned} \text{Concentration ratio from calculated feed} & = 8.3 \\ \text{(concentration ratio from estimated feed)} & = 15.6) \\ \text{Recovery Au from calculated feed} & = 77.95\% \\ \text{(Recovery Au from estimated feed)} & = 39.19\% \\ \text{Recovery Ag from calculated feed} & = 86.09\% \\ \text{(Recovery Ag from estimated feed)} & = 48.28\% \end{aligned}$$

In other words: Cy Coffey, not having a weightometer in the mill, was forced to calculate his heads (tons and grade) back from the best reliable data he had at disposal, namely concentrate weight and assays of heads, concentrate and tailings. The error of the calculated mill feed is directly affected by the errors of the assays. The total mill-feed is directly affected by the errors of the assays. The total mill-feed over the six months of production is as follows:

i) from estimates at the conveyor belt	<u>22,633 tons</u>
ii) from the calculations	<u>18,017 tons</u>
iii) from the engineer's reports (ore from mine and stockpile)	<u>20,431 tons</u>

- i) Was already discussed and can be considered of no value,
- ii) is used in the metallurgical summary for the operation and is probably too low;

iii) was also estimated, since there is no weightometer in order to weigh the loaded cars. The tonnage factor was also only estimated and was never determined. The engineer reported 6920 tons coming from the stockpile and 13,511 tons coming from the stopes. Here again there is another discrepancy, since the engineer reports 14,224 tons pulled from the stopes.

The conclusion of these considerations is that the actual total tonnage of mill-feed lies probably somewhere between 18,000 and 21,000 tons, and that the total mill-feed of 18,017 tons is given in the summary table represents probably a minimum.

If this is correct, then the reported average concentration ratio of 12.2 has to be considered as a minimum and the reported average recoveries of 60.5% for gold and of 79.1% for silver have to be considered as maxima.

## Collecting of Metallurgical Samples

On February 6, 1970, we were informed by Mr. Mercier on a management decision to collect the samples for the metallurgical tests prior to the shut-down of the present caretaker operation at the mine. I went to the mine on February 12, where I supervised the collection and the proper storage of the samples. The operation was terminated on February 27, 1970.

The samples were collected following partly the scheme proposed by Hazen Laboratory. They asked for one small sample weighing approximately 1 ton, taken from at least 30 points along the vein, and one large sample, weighing approximately 10 tons, taken in the same manner, from each of the mines, the Huestis and the Webber. Total required: 2 tons of "small" samples and 20 tons of "large" samples.

The attached lists and maps furnish a detailed inventory of all the samples taken and give information on bag number, ore shoot, exact location and weight. Although the lists and maps are self-explanatory, some remarks on the actual technique used for collecting the samples are needed.

### A) "Small" Samples

1. Huestis mine. A total of 28 samples were collected in the Huestis mine, 14 from the 4300 level, 14 from the 4100 level. They are stored in separate canvas bags, numbered according to the attached list. They were taken from 12 ore shoots, in both the drifts and the stopes. Since the samples were taken across 4' width, the material should have an average grade close to the one calculated for the Huestis mine, namely 0.42 oz.Au/ton and 12.06 oz.Ag/ton. One "sample", No 29, is of concentrate from the previous milling operation; it was obtained from Huestis ore and assayed 1.87 oz.Au/ton and 77.01 oz.Ag/ton. This concentrate could be used as a "sweetener". The material includes all fractions from the fine up to coarse fragments (8 inches) and is generally dry, with exception of samples 15 to 21, taken from a wet section of the mine.
2. Webber mine. A total of 34 samples were collected in the Webber mine. (4260 level) from 12 ore shoots. The sampling was difficult here, since the ground is hardly frozen and since we had no pneumatic hammer, so the sampling had to be done with the scaling bar. 29 samples were taken across 4' width; 5 (no 59 to 63) are handpicked ore, partly of high grade, which can be used as a "sweetener", if necessary to reach the calculated average grade of the Webber Mine, 0.338 oz.Au/ton and 20.28 oz. Ag/ton. The material includes all fractions from the fine up to coarse fragments (8 inches) and is partially wet, due to the presence of ice in the drifts.

The 63 samples, totalling 4,148 lbs., are presently stored at Whitehorse (Warehouse of Canadian Mine Services)

It must be noted that the composite sample should assay approximately 0.39 oz.Au/ton and 15.5 oz.Ag/ton. This is the average grade estimated for the present accessible ore reserves.

B) "Large" Samples

In order to obtain the 20 tons of bulk samples within a reasonable time, the samples were taken from only few selected points. These points were drilled and blasted.

1. Huestis. 6 tons were obtained from four points at the 4100 level and 4 tons from two points at the 4300 level. The reason for taking only six sample points is that most of the ore shoots are partly stoped. This condition makes the collection of large samples in the stopes impossible.
2. Webber. The 10 tons were obtained from 5 sampling points. Because of the fact that the samples were taken from only few points, their average grade could be fairly different from the calculated average grade of the ore reserves. Therefore, the samples were stored individually, in order to make a blending possible.

The 11 samples, totalling 20 tons, are presently stored at Carmacks, Y. T.

HUESTIS: Small samples for metallurgical testing

LEVEL	BAG	ORE SHOOT	LOCATION	WEIGHT (lbs)
HUESTIS 4300 LEVEL	1	H43 - 12 - 585	Stope, 72' east of W-Manway	77
	2	H43 - 12 - 585	Stope, 51' east of W-Manway	78
	3	H43 - 12 - 585	Stope, 23' east of W-Manway	65
	4	H43 - 12 - 585	Stope, 20' west of E-Face	82
	5	H43 - 12 - 588	Station H54 + 58' west	71
	6	H43 - 12 - 588	Station H54 + 21' west	73
	7	H43 - 12 - 590	Stope, 50' east of W-Face	74
	8	H43 - 12 - 590	Stope, 43' west of E-Face	61
	9	H43 - 12 - 591	Station 651 + 58' east	58
	10	H43 - 12 - 591	Station 651 + 95' east	69
	11	H43 - 12 - 594	Stope, Chute No.1, broken ore	80
	12	H43 - 12 - 594	Station 613 + 79' east	63
	13	H43 - 13 - 595	Station 645 + 39' west	62
	14	No. 13 Vein	Face, Station H99 + 79' west	68
HUESTIS 4100 LEVEL	15	H41 - 12 - 585	Station H97 + 77' west	78
	16	H41 - 12 - 585	Station H97 + 30' west	74
	17	H41 - 12 - 585	Station H97 + 5' east	83
	18	H41 - 12 - 585	Station H96	74
	19	H41 - 12 - 585	Station H94 + 50' west	66
	20	H41 - 12 - 585	Station 713 + 20' west	87
	21	H41 - 12 - 585	Station 713 + 10' west	96
	22	H41 - 12 - 588	Stope, East Face	64
	23	H41 - 12 - 588	Drift between Chutes No. 2 & No.3	63
	24	H41 - 12 - 590	Station D1 - 18 + 7' west	63
	25	H41 - 12 - 591	Station D1 - 16 + 5' west	73
	26	H41 - 12 - 591	Station D1 - 15 + 2' east	67

27	H41 - 12 - 594	Stope, West Face + 20'	70
28	H41 - 12 - 594	Stope, East Manway + 5' West	74
29	Concentrate	Huestis 4100 + Huestis 4300	<u>77</u>
TOTAL WEIGHT			<u>2,090</u>

WEBBER: Small samples for metallurgical testing

BAG	ORE SHOOT	LOCATION	WEIGHT (lbs)
30	W43 - 2 - 558	Stope, Station 148 + 20' west	69
31	W43 - 2 - 558	Stope, Station 148 + 30' west	56
32	W43 - 2 - 558	Stope, Station 148 + 47' west	59
33	W43 - 2 - 558	Stope, Station 148 + 67' west	77
34	W43 - 2 - 558	Stope, Station 148 + 82' west	82
35	W43 - 2 - 558	Stope, Station 148 - 102' west	64
36	W43 - 2 - 558	Stope, Station 148 + 122' west	63
37	W43 - 2 - 558	Stope, Station 135 + 12' west	70
38	134	Station 133 + 4' west	62
39	131	Station 132 + 11' west	69
40	131	Station 131 + 26' east	76
41	130	Station 130 + 32' east, raise bottom	51
42	139	Station 138 + 2' west	69
43	139	Station 139 + 3' east	69
44	W43 - 2S - 551	Stope, East Face + 10'	54
45	W43 - 2S - 551	Stope, East Face + 26'	66
46	W43 - 2S - 551	Stope, East Face + 44'	65
47	W43 - 2S - 551	Stope, East Face + 77'	56
48	W43 - 2S - 551	Stope, East Face + 90'	62
49	W43 - 2S - 551	Stope, East Face + 113'	57

50	146	Station 154 + 57' west	62
51	154	Station 154A + 20' west	70
52	121	Face + 5' east	64
53	121	Face + 36' east	70
54	119	Face + 73' east	72
55	122	Station 122 + 10' to Station 120	68
56	107	Station 108 + 35' west	55
57	107	Station 108 + 67' west	43
58	107	Station 108 + 90' west	64
59	W43 - 2 - 558	Stope, Station 148 + 92' west	33
60	W43 - 28 - 551	Stope, East Face + 95' west	29
61	121	Face + 15' east	36
62	131	Station 131 + 30' east	42
63	139	Station 139 + 5' east	<u>54</u>

## Note:

59, 60, 61, 62 & 63  
are handpicked ore  
from bulk samples.

Total Webber 2,058

Total Huestis 2,090

**TOTAL HUESTIS & WEBBER 4,148**

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HUESTIS: bulk samples for metallurgical testingHUESTIS 4100 LEVEL

1 - Stope	H41 - 12 - 588, between chutes No 4 & 5	approx. 1 ton
2 - Ore shoot	H41 - 12 - 585, Station 713+10' west	approx. 2 tons
3 - Ore shoot	H41 - 12 - 585, Station 713+55' west	approx. 1,5 tons
4 - Ore shoot	H41 - 12 - 585, Station H97+38' west	approx. 1,5 tons

HUESTIS 4300 LEVEL

5 - Ore shoot	H43 - 12 - 588, Station H54+6' west	approx. 2 tons
6 - Ore shoot	H43 - 12 - 591, Station H20+23' west	approx. <u>2 tons</u>
		<u>Total approx. 10 tons</u>

WEBBER: bulk samples for metallurgical testingWEBBER 4260 LEVEL

1 - Stope	W43 - 2 - 558, Station 148+92' west	approx. 2 tons
2 - Stope	W43 - 2S - 557, East Face + 95' west	approx. 0.5 tons
3 - Ore shoot	121, Face + 15' east	approx. 2.5 tons
4 - Ore shoot	131, Station 131 + 30' east	approx. 2.5 tons
5 - Ore shoot	139, Station 139 + 5' east	approx. <u>2.5 tons</u>
		<u>Total approx. 10.0 tons</u>

TOTAL HUESTIS & WEBBER: approx. 20.0 tons  
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## THE PRODUCTION AT MOUNT NANSEN

As pointed out in the historical review, the Mount Nansen mine was in production during a short period of seven months, from September 1968 until April 1969. However, during the entire production period the operation was not profitable. Hafliðson (1969) reports an operating loss at the mine of \$157,699 - or \$48.27 per ton of ore - for January 1969, and of \$118,314 - or \$28.98 per ton of ore - for February 1969. The factors which made the operation uneconomical can be divided into the three major groups: mining, metallurgy, and metal prices.

### 1. Mining

At the time the mill went into production in September 23, 1968, the mine was not ready to sustain a 200 tpd milling operation. While a minimum of necessary underground exploratory drifting had been completed, practically no development work was achieved. No raises were driven between the two Huestis levels or between the upper Huestis level and the surface. This implied a somewhat "blind" stoping, since no information on the vertical development of the vein structures and of the ore grade were available. When production started not one ore shoot has been stoped and only little stope preparation has been completed. This was the main reason that the mill-feed from September till the end of December 1968 consisted of 60 per cent low-grade development muck, which was obtained from the stockpile. Naturally, the considerable amount of development muck lowered the mill head grade drastically.

From January 1969 until April 8, 1969 the mill feed consisted exclusively of stoped ore from both Huestis levels. Although no more development muck was included the head grade did not increase remarkably. This was the result of a severe dilution experienced in the stopes. The average width of the stopes - weighted over the length of the lifts - has been 5.46 feet, the most narrow lift having a width of 4.2 feet and the widest, not taking into account the No. 1 lifts, a width of 6.14 feet. The average stope width of 5.46 feet represented an additional dilution of 36.5% to the projected ore grade calculated for a mining width of 4 feet.

The stoping technique used was simple shrinkage stoping. McCombe maintains in his Report "Preliminary Budget and Comments" (October 17, 1969) that it should be possible to limit the stoping width to four feet or even less, using shrinkage stoping under a strong supervision and applying an appropriate bonus system. In other words, one has to assume that the experienced average width of 5.46 feet was the result of poor supervision, lack of exploratory raises and a wrong bonus system. The latter did not penalize overbreak, but helped to increase waste tonnage. However, it has to be stressed that the wallrocks are intensively fractured, faulted, and sheared, which obviously is responsible for poor stability and the breaking in of barren rock fragments which diluted the ore. This is especially the case

in the ore shoots of the upper levels, close to the surface. In the lower Huestis level, toward the western end of the present workings the geotechnical conditions of the walls are already much better. No alternative extraction methods have been seriously considered to date. The present authors feel that in some ore shoots resuing or cut-and-fill would be more suitable mining techniques and possibly would allow to extract very narrow veins without diluting the ore. This aspect however requires considerable further research work by an experienced mining engineer.

During the production period, the operating costs were by far too high, \$60.80 per ton of ore in January, \$43.84 per ton of ore in February 1969 (Hafliðson, March 21, 1969 report). The mining costs alone accounted for \$35.10 per ton of ore, and \$25.36 per ton of ore respectively. According to McCombe (report April 10, 1970) in an efficient operation the operating costs should be as follows: \$35.00 per ton of ore at a production rate of 200 tpd, and \$31.70 per ton of ore at a production rate of 300 tpd.

## 2. Metallurgy

The milling results too did not meet the expectations during the 191 days of the operation. The lack of a working cyanide plant - of which only the frame building is finished - had serious implications for the operation of the mine. Since the ore could not be cyanided the higher grade oxide ore from the Webber mine could not be treated. With only the flotation plant working the entire mining operation (stope preparation, stope production, development, exploratory drilling and drifting) was limited to the sulphide ore of the two Huestis levels. This concentration necessarily resulted in a lack of flexibility in the underground operation.

The results of the milling operation are summarized in the metallurgical balance (see chapter "Metallurgy"). Although only sulphide ore was treated, the experienced recoveries were considerably lower than those indicated by the metallurgical laboratory work. The average recoveries were approximately 60% for gold and 79% for silver with best monthly average recoveries of 71.7% for gold and of 91.3% for silver. These low recoveries can partly be explained by the very low grade heads, partly by the fact that only a bulk concentrate was floated and cleaned twice. This process not only resulted in a low recovery but also in a very poor concentration ratio of 12.2:1 so that the grade of the concentrate was relatively low. These two factors necessarily caused extremely high transportation costs, which were \$5.30 per ton of ore in February 1969. They also caused high smelter charges and penalties, \$3.76 per ton of ore in February 1969. The total transportation/smelting costs in February 1969 thus being \$8.06 per ton of ore. According to McCombe (report April 10, 1970), with a good management and a satisfactorily operating concentrator this total figure should be much lower:

for a concentration ratio of 10 : 1, \$7.43 per ton of ore  
 for a concentration ratio of 15 : 1, \$4.75 per ton of ore  
 for a concentration ratio of 20 : 1, \$3.45 per ton of ore.

In this context it also must be noted that the concentrate was shipped in wooden boxes, an inefficient system which also contributed to the high transportation costs. For more details on the metallurgical problems see the chapter on Metallurgy and the reports of Bronson, and Coffey.

### 3. Metal Prices

The only factor affecting a successful operation, which is not influenceable by management, is the fluctuation of the metal prices. If one considers the average grade of the present minable reserves, i.e. 0.38 oz. gold per ton and 15.45 oz. silver per ton, it becomes evident that the fluctuations in the silver prices have a much greater influence on the gross value of the ore than the variations of the gold price. An increase of \$1.00 per oz. in the gold price would increase the gross value by only \$0.38 per ton of ore, whereas an increase of \$1.00 per oz. in the silver price would increase the gross value by \$15.45 per ton of ore. In other words, the recent decrease of the gold price did not seriously affect the gross value of the ore. On the contrary, the variations in the silver price can determine whether the mine production is economical or not.

At the time the mine went into operation, in September 1968, the silver was quoted at Can.\$2.40 per oz., already downwards from the peak of Can.\$2.50 per oz., on March 14, 1968. In October 1968, the quoted price was already down to Can.\$2.50 per oz., and in April 1969, when the operation was closed down, the price was at Can.\$1.90 per oz. The total decrease of Can.\$0.50 per oz. experienced during the production period represented a decrease of the gross value of the Huestis ore of about Can.\$5.00 per ton, which was a further serious negative element contributing to the eventual closing of the mine.

COSTS

The following figures are the costs for a 300 tons per day operation as estimated by R.C. McCombe, Mining Engineer for Mount Nansen during the period October 1969 - May 1970. All details are contained in his report entitled "Interim Feasibility Study, Costs Estimates and Economics, Mount Nansen Mine", dated April 10, 1970.

<b>A. Administration</b>	<b>\$/ton</b>	<b>\$/ton</b>
Whitehorse Office	0.39	
Mount Nansen Office	0.61	
Mine Office	0.39	
Mill Office	0.14	
Catering	1.50	
Housing and Accommodation	<u>0.22</u>	
		<b>3.25</b>
<b>B. Mining</b>		
Stoping	4.32	
Stope Preparation	0.97	
Tramming	1.34	
Auxiliary Mining	0.96	
Development - 480 ft/month	2.14	
Exploration - 150 ft/month	0.73	
Diamond Drilling - 900 ft/month	<u>1.07</u>	
		<b>11.53</b>
<b>C. Milling</b>		
Conveying	0.14	
Crushing	0.28	
Grinding	0.60	
Flotation	0.48	
Filters, thickeners	0.15	
Cyanidation	0.47	
Plant Maintenance	<u>0.37</u>	
		<b>2.49</b>
<b>D. Support</b>		
Engineering Office	0.20	
Geology Office	0.19	
Machine Shop & Garage	0.71	
Electric Shop	0.23	
Motor Pool	0.87	
Warehouse	0.12	
Assay Office	0.49	
Water Supply	0.21	
Road Maintenance	0.27	
Heating	0.30	
Power & Compressed Air	1.90	
General Maintenance	0.37	
Portable Compressors	<u>0.56</u>	
		<b><u>6.42</u></b>

(23.69)

	\$/ton	\$/ton
		(23.69)
E. <u>Smelting</u>	4.75	<u>4.75</u>
Subtotal		(28.44)
F. <u>Contingencies, 5%</u>		1.42
G. <u>Equipment Replacement</u>		<u>0.69</u>
TOTAL		<u>\$30.55/ton</u>

The additional equipment required is estimated to cost \$185,000. The costs of mill modifications and possibly of a cyanide plant are not estimated, since they are dependent on the results of the metallurgical tests.

The total personnel for a 300 tons per day operation is estimated as follows:

	<u>Staff</u>	<u>Hourly Pay</u>
<u>Company</u>	14	60
<u>Contract</u> (Driller & Cookhouse)	<u>1</u>	<u>8</u>
<u>TOTAL</u>	<u>15</u>	<u>68</u>

## CONCLUSIONS AND RECOMMENDATIONS

The ore deposit of Mount Nansen Mines Limited is a relatively high-grade system of narrow silver / gold veins. The present total minable reserves are as follows:

108,855 tons @ 0.386 Au per ton and 15.45 oz. Ag per ton.

The total ore reserves are estimated to be:

314,762 tons @ 0.325 oz. Au per ton and 13.31 oz. Ag per ton.

From these figures the marginal character of the deposit is apparent and it has to be stressed, that any economic production is improbable before a steady silver price in the range of can.\$2.25 per oz. Ag to can.\$2.50 per oz. Ag is reached.

In addition to the usual problems involved in the mining of narrow vein deposits the following points must be stressed:

- i) The relatively remote and northern location of the mine creates a number of problems, such as difficult and costly maintenance of the access road, expensive power supply and heating, frequent turnover of manpower, and rigid winters.
- ii) The presence of permafrost makes underground and surface work complicated, especially any construction work and trenching.
- iii) The thick overburden complicates geological mapping and exploration work.

Most of these problems can only be solved by a strict and capable management at the mine site itself, and not by remote control from Vancouver or elsewhere.

The work undertaken by the authors led to the following recommendations in connection with the present caretaker operation and possible production at the Mount Nansen mine.

### a) Claims

The first claim block which expires in the Mount Nansen property is the group embracing the Harry Fractions No 1-9. Their expiry date is October 21, 1973. By that date, if no representation work is available, it is recommended to make the prescribed payment in lieu of work to renew the claims.

### b) Office

Apart from 1 Olivetti Calculator, 1 Chubb-Mosler-Taylor safe, 2 map cabinets (Steel Equipment, Hamilton) and 1 drawing-table, Mount Nansen Mines Limited seems not to be in possession of any other office furniture in Vancouver. All files are stored in one filing cabinet. Lists of the files, of the maps, and

of the books are enclosed in this report. It is intended to store all the remaining office material, the books and all the soil samples in a warehouse in Vancouver.

c) Watchman

The mine site has to be supervised and protected by a watchman. Due to the remoteness and isolation involved with this position it is desirable to have a mature couple staying at the mine site. He should have basic mechanical knowledge. Radio communication, a pick-up, a ski-boo, and preferably a bombardier are mandatory equipment for the watchman. The main duties of the watchman are to guard camp, mine, and mill buildings and installations, and to perform minor maintenance work at vehicles and road. Great care has to be taken that the mine is at no time left without watchman, since this is a condition for the insurance coverage.

d) Camp

Provided regular maintenance by the watchman is undertaken, no serious problems in connection with camp buildings and services should arise in the next few years. The water supply from the water-well should be disconnected permanently, the pumpshaft hauled to the surface and drained. To secure a water supply the watertank then should be filled with surface water during the summer months. During winter, water can be obtained either from the tank, which necessitates heating, or by melting of snow. During the summer months, all the wooden tanks in the mill must be filled with water to prevent their deterioration. The present propane stock at the mine camp should last for the next 2-3 years, However, gas and fuel stock has to be checked every summer, so that the necessary supply can be hauled into the camp during fall, when the road is frozen.

It must be noted that the 40 miles road from the mine to Carmacks has to be maintained by the company. This maintenance is difficult and expensive during the winter months and spring runoffs. It should be stressed that discontinuation of road maintenance must lead to a rapid deterioration of the road and thus eventually prevents access by car to the mine site.

e) Carmacks

The present value of the land parcel owned by the company at Carmacks is estimated to be at least \$7,000 and is bound to increase in the future. It is therefore recommended to carry on paying the yearly taxes of approximately \$300.00. At the moment, two unoccupied trailers owned by Mount Nansen Mines Limited, are stationed on this ground. If no immediate use of the two trailers is foreseen, they should be sold.

f) Equipment

Large portions of the equipment at the mine site - especially the power plant - has been purchased second hand. It is therefore necessary, before any new operation is undertaken, that a competent survey of all equipment, machinery and vehicles is undertaken by a mechanical engineer in order to determine which parts can be repaired and used economically and which parts have to be replaced. Estimates by a former mechanic at Mount Nansen indicate that the repair costs are at least \$50,000.

g) Exploration and Development

The geochemical silver soil-survey of 1967 and subsequent trenching indicated the presence of several mineralization zones in the immediate surroundings of the present workings. It is therefore felt that future exploration for additional silver-gold ore reserves should be carried out in the immediate vicinity of the present workings. In order to eliminate the very costly surface exploration it is recommended to concentrate initially to the underground workings, inasmuch as there are a number of positive indications for the horizontal as well as the vertical extension of the known vein systems.

Detailed exploration and development plans are given in the report "Preliminary budget and comments" dated October 17, 1969 by Bianconi-McCombe-Saager. The program outlined in this report is the minimum necessary work which has to be performed in order to increase the present ore reserves to a productivity level.

h) Mining

Research work and preferably some actual testing should be undertaken in order to investigate the most economical mining technique and to determine if a four feet maximum mining width is feasible with shrinkage stoping. Any average width over 4 feet would dilute the ore to an uneconomic grade at foreseeable silver prices.

i) Metallurgy

Further metallurgical laboratory test work is mandatory, since the experienced results during the production period are totally unacceptable, both for the gold- and silver recoveries as well as for the concentration ratio (see "Review report on Metallurgy" dated December 9, 1969 by Bianconi - Saager). Samples for the laboratory work have already been collected and are stored at the company's lot in Carmacks and partly in Whitehorse. The hitherto existing investigations indicate that some alterations of the present mill complex (crushing, milling and flotation plant) are necessary for optimum flotation of the sulphide and oxide ore.

The research work should also cast some light on the feasibility of a roasting and cyanide plant. In this context it has to be pointed out that although the frame structure for the cyanide plant has been finished, only a part of the plant is actually at the mine site (see report of C.Coffey). The whereabouts of the rest is unknown. It also must be stressed that the decision to construct a cyanide plant was not supported by complete laboratory work; it is therefore highly uncertain if the planned circuit actually is suitable for Mount Nansen.

k) Transport

Calculations on the previous system of ore-concentrate transport in plywood boxes indicated that this system was uneconomical. Feasibility studies for different means of transportation should be undertaken.

l) Copper

Apart from the gold-silver mineralization there exists a reasonably good possibility for low-grade porphyry copper mineralizations in the property. Initial exploratory work has been undertaken (see chapter "Geochemistry") and it is strongly recommended to pursue with geochemical, geophysical, and geological work in order to determine target areas for more detailed exploration.

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LIST OF FILESDRAWER NO. 1

## A. CLAIMS

- Claim Manual
- Claims, General, Forms, Schedules, Mining Act  
Yukon Territory, Bill C-187 Water Act
- Claims Index, Books # 1-5
- Grant No. and Expiry Dates
- General
- Mount Nansen - Brown-McDade Claim General Correspondence
- Mount Nansen - Brown-McDade Regrouping 1969
- Mount Nansen, Claims Assessment Work 1968/1969
- Surface Rights
- Licence for Water Pipeline Land in Carmacks  
Claim documents  
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- BM
- Joanne
- Jeff
- Dome
- Dolly
- Stone
- Bit
- Betty
- Laura
- Harry

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Dolmage-Campbell Reports  
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(see References List)

Other Reports  
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- F.L. Croteau B
- L. Green
- R.S. Haflidson
- Hazen Research Laboratories
- Dr. S.E. Jerome A
- Dr. S.E. Jerome B

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- Ottawa, Department of Energy & Mines
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- Watts, Griffis & McOuat
- L.G. White
- Dr. D. Weisser

## DRAWER NO. 2

### A. PROGRESS REPORTS

- Weekly Progress Reports 1968
- Weekly Mine Progress Reports 1967/1968
- Weekly Progress Reports 1967
- Monthly Progress Reports (Camp)
- Weekly Progress Reports (Camp)
- Weekly Progress Reports (Originals)

### B. ENGINEERING AND GEOLOGY

- Weekly Geological Report - 1969
- Weekly Geological Report - 1968
- Weekly Progress Reports - 1968
- Weekly Geology Report - 1967
- Weekly Geological Report - 1966
- Weekly Progress Reports - 1966
- Weekly Geological Reports - 1965
- Weekly Progress Reports - 1965
- Weekly Progress Reports - 1964

### C. ORE RESERVE CALCULATIONS

- **Raises, grade calculations**
- Stope grades
- Accessible reserves
- Mount Nansen - Brown-McDade ore reserves calculations
- Webber 4260 ore grade calculations
- Huestis 4100 ore grade calculations
- Huestis 4300 ore grade calculations
- Huestis 4300 grade of ore shoots
- Ore estimates reports

### D. DIAMOND DRILLING

- Diamond Drilling, Logs
- Diamond Drilling, Reports
- Diamond Drilling, Drifting
- Diamond Drilling, Underground - J.R. Williams
- Mount Nansen property, overburden drill holes

## E. METALLURGICAL

- Correspondence
- Cy Coffey
- Bronson, Interior Eng. Services
- Sampling 1969 / 1970
- Stanley Gray
- Department of Mines, Ottawa 1965 - 1969
- Cominco Tests 1968
- Britton Res. 1969
- Britton Res. 1968
- Britton Res. 1967
- Britton Res. 1966
- Britton Res. 1964 / 1965
- Flow Sheets
- Contracts - Smelter
- Smelter Returns
- Recovery Mill
- Milling Summaries

## F. DAILY MILL REPORTS

- Daily Mill Report, April 1969
- Daily Mill Report, March 1969
- Daily Mill Report, February 1969
- Daily Mill Report, January 1969
- Daily Mill Report, December 1968
- Daily Mill Report, November 1968
- Daily Mill Report, October 1968
- Daily Mill Report, September 1968
- Mill Reports

## G. PRODUCTION

- Mining Summaries  
September 23, 1968 - April 15, 1969
- Stope tonnages

## Monthly Production Reports:

- 
- April 1969
  - March 1969
  - February 1969 (missing)
  - January 1969
  - December 1968
  - November 1968
  - October 1968
  - September 1968
  - August 1968
  - July 1968
  - June 1968
  - May 1968
  - April 1968
  - March 1968
  - February 1968

Monthly Production Reports:  
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- January 1968

- Mine Operation

H. EQUIPMENT

- Purchase of Mill and Equipment Minoca Mines Ltd.
- Transport of Mill and Equipment Yreka
- Equipment General
- Correspondence F. Faulkner
- Purchase Orders
- Standby Pump
- Kitchen Inventories
- Landrover, Jeep
- Calculators
- Equipment Operating Instructions
- Copying Machine 3M

J. GEOLOGY

- Thin sections- polished sections
- Geology
- Photographs
- Resident geologist duties, Memos
- Geochemical Survey 1967
- Geochemical Copper
- Statistical Investigation A
- Statistical Investigation B

K. SURVEY

- Topographical Map White Hosford & Impey Survey

DRAWER NO. 3

A. DEVELOPMENT

- M. Swizinsky
- General Program
- Mine Sampling
- Mine Sampling, Longhole Drilling
- Surface Exploration Survey
- Water
- Power
- Objectives and Schedules, General Program
- Objectives and Schedules, Annual Mine Reports
- Proposed Development 1969
- Scheduling

## B. ASSAY REPORTS

- Diamond Drilling Assays
- Assay Reports 1969
- Assay Reports 1968
- Assay Reports 1967
- Sample Reports 1969
- Sample Reports 1968
- Sample Reports 1967
- Sample Reports 1966
- Sample Reports 1965

## C. ADMINISTRATION

- Geochemical
- Assaying
- Employment Applications Staff
- Applications Mining Engineer
- Applications Mine Geologist
- Administration Personnel Applications
- Expediting
- Engineering
- General Contractors
- Government Statistical Requests
- William C. Martin
- Procedure Mines
- Metallurgical
- Metallurgical (Lakefield Research of Canada)
- Metallurgical (Seymour Laboratory)
- Government Agencies (Department of Mines & Techn. Surveys)
- Diamond Drilling
- McPhar Geophysics Ltd.
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- Drafting
- Miscellaneous
- Periodicals
- Mining Association of B.C. Correspondence
- Pilot Plant
- B.C. and Yukon Chamber of Mines
- Atomic Absorbtion
- Mount Nansen and Peso Reports 68/69 Draft

DRAWER NO. 4, CABINET NO. 13

## A. FINANCIAL AND INVENTORIES

- Inventory, Original, April 1969
- Inventory, April 1969
- Inventory, November 1968
- Minoca Mines, Agreements
- Inventory, Memoranda

- Inventory, and Appraisal of Equipment and Furniture
- Inventory, Miscellaneous
- Inventory, List of Maps in Vancouver
- Inventory, List of Maps at Mine
- Inventory, List of Library
- Financial: Costs Operating-Profitability Estimate
- Financial: Costs Operating Requirements
- Financial: Code Account of Costs (R.C. McCombe)
- Financial: Costs Estimates October 1969 - April 1970
- Financial: Road Grant

#### B. MONTHLY STATEMENTS

##### Monthly Cost Statements

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September 1967  
 October 1967  
 November 1967  
 December 1967  
 January 1968  
 February 1968  
 March 1968  
 April 1968  
 May 1968  
 June 1968  
 July 1968  
 August 1968  
 September 1968  
 October 1968  
 November 1968  
 December 1968  
 January 1969  
 February 1969

#### C. CLAIM BOOK # 2

Mount Nansen Mines Limited  
 Brown-McDade Mines Limited

#### D. CURRENT CORRESPONDENCE

- Mining Inspector
- S & N Correspondence Reports
- Metall Correspondence
- Metall Accounting
- Nearburg-Gratton Correspondence
- Metallgesellschaft Correspondence

#### E. EXPLORATION

- Copper Exploration
- Mount Freegold Area 1964.

LIST OF MAPSCode Account of Maps

<u>WORKING</u>	<u>ITEM</u>	<u>LEVEL</u>	<u>NUMBER</u>
1 Mount Nansen	01 General	0 Surface	Block (K20...)* or Running Number
2 Webber (U/G)	02 Topography-Surveying	1 Sections	
3 Huestis (U/G)	03 Claims	2 4500 Level	*(after mine grid)
4 ---	04 Geology	3 4300 Level	
5 Brown-McDade (Surface)	05 Structure	4 4100 Level	
6 Brown-McDade (U/G)	06 Petrology	5 3900 Level	
-- --	07 Mineralogy	6 3700 Level	
-- --	08 Geochemistry	-- --	--
	09 Geophysics	-- --	--
	10 Metallurgy		
	11 Trenches		
	12 Drilling		
	13 Assays		
	14 Ore reserves		
	15 Mill - Construct.		
	16 Proposed development		
	17 Miscellaneous		
	-- --	--	--
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Example: 204-3E20 = Webber, Geology, 4300 Level, Block E20

204-0-12 = Mount Nansen, Surface, Geochemistry, Plan No. 12

GENERAL

- 101-0-1 Mt.Nansen- Location Plans. 1"=140 miles  
and 1"=20 miles - Jan. 19/1968 -  
Dolmage, Campbell. PRINT
- 101-0-2 Location of underground workings with Mine  
Grid (Webber, Huestis, Brown-McDade).  
1" = 1000' - May 5/1969 - F.Bianconi.  
TRANSPARENT
- 101-0-3 Location Plan, with contours 100'.  
1" = 1000' - May 8/1969. TRANSPARENT
- 101-0-4 Surface - 1" = 400' - May 5/1969 - F.Bianconi  
TRANSPARENT
- 101-0-5 Mine Grid - 1" = 1000' - Feb. 11/1968 -  
Wilkinson PRINT
- 101-0-6 General Plan showing property boundary  
& geochemical soil survey -  
1" = 1/2 mile - Sept./69 F. Bianconi  
TRANSPARENT

TOPOGRAPHY

- 102-0-1\* Topographic Map - Nansen Creek - 1" = 500' -  
 Aug./1964 - Hunting Survey Corp. Ltd. -  
 Toronto. 1 TRANSPARENT ORIGINAL  
 3 TRANSPARENT PRINTS  
 (1 at mine)
- 102-0-2\* Topographic Map - Nansen Creek - 1" = 1000'.  
 Aug./1964. 1 TRANSPARENT ORIGINAL  
 3 TRANSPARENT PRINTS  
 (1 at mine)
- 102-0-3\* Topographic Map - Nansen Creek - 1" = 1000'.  
 Aug./1964. 1 TRANSPARENT ORIGINAL  
 3 TRANSPARENT PRINTS  
 (1 at mine)
- \* In File room (yellow container)
- 102-0-4 Mt. Nansen: Horizontal Control Plan of Sur-  
 vey for added control & townsite area.  
 Aug. 12/1967 - W.H.I. PRINT
- 102-0-5 Plan showing horizontal and vertical control -  
 1" = 400' - Oct. 17/1967 - White , Hosford  
 & Impey - Whitehorse. TRANSPARENT
- 102-0-6 Composite Plan of Survey Work performed in  
 mine area - April 5/1968 - 1" = 400'.  
 TRANSPARENT
- 102-0-7 Mt. Nansen Mines Ltd. Plan showing roads,  
 trenches, underground workings, triangulation  
 stations, buildings. 1" = 100' - No date.  
 TRANSPARENT
- 102-0-8 Topographic map of millsite area. 1" = 50' -  
 Oct. 6/1967 - W.H.I. TRANSPARENT
- 102-4-1a Huestis 12 Veins. Longitudinal section - Sto-  
 pes - Monthly Progress - 1" = 100' - 1969 -  
 F.Bianconi TRANSPARENT  
 1 PRINT
- 102-4-1b Same WORKING TRANSPARENT

TOPOGRAPHY

- 102-0-9 Mt. Nansen, Trenches, Claim Posts, Tracks -  
1" = 400' - 1968 - C.H. Broadbent  
PRINT
- 102-0-12 Camp & Millsite Area -1" = 100'-Aug.14/1968  
P.S. PRINT
- 102-0-11 Triangulation Stations & some Claim Posts -  
1" = 400' - 1968 PRINT
- 102-0-13 Topographic map of the Mount Nansen property  
(from aerial photographs)  
Scale approx. 1" = 1000' June 15, 1970  
F. Bianconi 1 TRANSPARENT  
1 SEPIA

CLAIMS

H 103-0-1 Mt. Nansen and Brown-McDade - Claim Map -  
Sheet 115-I-3 COLOURED PRINT

H 103-0-2 Mining claims - Mt.Nansen Area - 1" = 1 mile -  
Apr. 20/1964 TRANSPARENT

103-0-10 Claim map, with topography - 1" = 100' -  
Sept. 2, 1969 - F. Bianconi / R.Saager  
1 TRANSPARENT  
1 PRINT

103-0-5A Port of Dome Claim & post of Brown McDade-  
1" = 400' - No date  
PRINT

103-0-5B Claims, Work Sheet - 1" = 400' G.Lamont -1968  
PRINT

103-0-6 Map showing worked claims to accompany certi-  
ficate of work - Form C (Oct.1/68 - Sept.30/69)  
1" = 400' PRINT

103-0-8 Claim Staking, Harry Group, Discovery Cr.Area  
(Reference Sheet 115 - I - 3) -  
1" = 1000' - G.G.L. - Oct. 1968  
PRINT

103-0-7a Mt. Nansen Mines Ltd., Claim map showing  
7b claim renewal - 2" = 1 mile - 1968 -G.G.L.  
7c 1 PRINT of each  
7d  
7e Same map, different claim groups

103-0-9 Expiring date of claims and leases -  
1"- 1000" - Sept.3, 1969 -  
F. Bianconi / R. Saager  
1 TRANSPARENT  
2 PRINTS

103-0-11 Mt. Nansen Mines Ltd., Claim Map showing claim  
renewal - 1" = 1/2 mile - Sept. 4, 1969  
TRANSPARENT



GEOCHEMISTRY

Geochemical Results - 1" = 400' - Apr./1968 - Dolmage,  
Campbell.           PRINTS                           TRANSPARENTS

108-0-1	N.W. Block	N.W. Block
108-0-2	N.E. Block	N.E. Block
108-0-3	S.W. Block	S.W. Block
108-0-4	S.E. Block	S.E. Block
108-0-5	Missing	Central East Block
108-0-6	Missing	Central West Block

108-0-7   Geochemical anomalies superimposed on mine  
grid - Webber, Huestis - 1" = 400' - Oct. 25/  
1968 - G.Lamont                                   COLOURED PRINT

108-0-8   Geochemical Soil Survey Anomalies - 1" = 2000'  
Jan./1968 - Dolmage, Campbell.                   PRINT

108-0-9   Geochemical Soil Survey Anomalies - Silver and  
Arsenic - 1" = 1000' - Jan. 19/1968 - D.D.Cam-  
pbell.   PRINT

108-0-10   Topography - Mt.Nansen area - Geochemical  
Soil Survey - 1" = 1000' - May 12/1969 - F.Bian-  
coni.   TRANSPARENT  
2 PRINTS

108-0-11   Mt. Nansen Mines, Geochemical Results, Divide  
Claims - 1" = 400' - Sept./1968 - Dolmage, Camp-  
bell.   COLOURED PRINT

108-0-12   Geology Sketch Map of Divide Claim Group -  
1" = 1000' - Sept./1968 - Dolmage, Campbell.  
   COLOURED PRINT

108-0-13   Proposed Trenching - Geochemical Soil Survey  
Anomalies - 1" = 1000' - April 15/1968 -  
Dolmage, Campbell   PRINT

108-0-14   Soil Survey Grid - Associated Geological  
Services - 1" = 1000' - 1967  
   WORKING PRINT

108-0-15   Base metals Exploration, Geochemical Soil Survey,  
Anomalies - 1 " = 2000'  
March 20, 1970  
F. Bianconi

METALLURGY

110-0-1    Flow sheet - Initial bulk concentrate -  
            Jan. 19/1968 - Dolmage, Campbell.    PRINT

TRENCHES

H111-0-1 Divide Group - Plan of trenches -  
1" = 100' - 1958/1963 COLOURED TRANSPARENT

H111-0-2 Huestis Zone - Preliminary mapping of  
trenches showing sample locations -  
1" = 100' - Oct./1964. TRANSPARENT

H111-0-3 Divide Property - 1" = 100' - July/1964 -  
F.Huss TRANSPARENT

H111-0-4 Gold Claims, Carmacks - Cat trenches D-8 -  
1" = 500' - Aug./1964 - F.Huss. TRANSPARENT

H111-0-5 Penny Claims, Carmacks - Cat trenches D-7 -  
1" = 500' - Aug./1964 - F.Huss. TRANSPARENT

111-0-6 Webber Vein Zones, Surface Geology and Assays -  
1" = 20' - Connelly - Sept./1964.  
TRANSPARENT  
1 COLOURED PRINT

111-0-7 Webber Vein, Trenches (Showing assay values  
and rudimentary geology) - 1" = 100' - No date -  
Campbell & Connolly PRINT

111-0-8 Mt.Nansen, Webber/Huestis Area - Surface Geo-  
logy and trenches - 1" = 400' - Oct. 25/1968 -  
G.Lamont. COLOURED PRINT

111-0-9 Trench Geology and Assay, Anomalies L-M-O -  
1" = 40' - Sept. 28/1968 - G.Lamont.  
COLOURED PRINT

111-0-10 Trench Geology and Assay, Anomalies L-M-O -  
1" = 40' - Sept. 30/1968 - G.Lamont.  
COLOURED PRINT

111-016 Huestis Trenches, Geology - 1" = 20' - 1964  
Tom Connelly COLOURED TRANSPARENT

DRILLING

- 112-0-1 Cabin Creek Vein, Diamond Drill Holes -  
1" = 40' - Dec. 30/1967 - Wilkinson PRINT
- 112-0-2 Cabin Creek Vein, Vertical Longitudinal Section  
showing Diamond Drill Holes - 1" = 40' -  
Jan. 20/1968 - Wilkinson PRINT
- 112-0-3 Cabin Creek Vein, Section 4, DDH CC-4 - 1" = 40' -  
Dec. 30/1967 - Wilkinson PRINT
- 112-0-4 Cabin Creek Vein, Section 5, DDH CC-5 - 1" = 40' -  
Oct. 4/1967 - Wilkinson PRINT
- 112-0-5 Cabin Creek Vein, Section 6, DDH CC-6 - 1" = 40' -  
Oct. 4/1967 - Wilkinson PRINT
- 112-0-6 Cabin Creek Vein, Section 7, DDH CC-7 - 1" = 40' -  
Oct. 4/1967 - Wilkinson PRINT
- 112-0-7 Cabin Creek Vein, Section 8, DDH CC-8,9 & 10 -  
1" = 40' - Oct. 4/1967 - Wilkinson PRINT
- 112-0-8 Cabin Vein Drilling - 1" = 200' - July 22/1967  
D.D. Campbell PRINT
- 112-0-9 Webber No.2 Vein, Dry Drilling - No Scale -  
No date - No author PRINT



ORE RESERVES

114-0-1 Diagram #1 - April/1969 - F. Bianconi.  
TRANSPARENT

114-0-2 Diagram #2 - April/1969 - F. Bianconi.  
TRANSPARENT

H114-3-1 Webber 4265 Adit, Vein Geology and Ore  
Shoots - 1" = 40' - July/1966. PRINT  
W. M. Sharp

H114-3-2 Webber 1 & 2 Vein, Longitudinal Vertical  
Projection, Ore Shoots - 1" = 40' - July/1966  
W. M. Sharp PRINT

H114-3-3 Huestis 4300 Adit - Vein Geology and Ore  
Shoots - 1" = 40' - July/1966 - W. M. Sharp.  
PRINT

H114-3-4 Huestis, Vertical Projection, Ore Shoots  
12 & 13 Veins - 1" = 40' July/1966-W. M. Sharp  
PRINT

114-3-5 Ore Shoots, Webber 4260 Adit Level, -  
1" = 100'-April/1969 - F. Bianconi  
TRANSPARENT

114-3-6 Huestis 4300 Adit Level, Ore Shoots - 1"= 100'  
April/1969 - F. Bianconi. TRANSPARENT

114-3-7 Webber 4260 Adit Level, Ore Shoots - 1" = 40'  
April/1969 - F. Bianconi. TRANSPARENT

114-3-8 Huestis 4300 Adit Level, Ore Shoots - 1" = 40'  
April/1969 - F. Bianconi. TRANSPARENT

114-4-1 Huestis 4100 Adit Level, Ore Shoots - 1" = 100'  
April/1969 - F. Bianconi. TRANSPARENT

114-4-2 Huestis 4100 Adit Level, Ore Shoots - 1" = 40'  
April/1969 - F. Bianconi. TRANSPARENT

114-4-3 Webber, Longitudinal Section, 1 & 2 Veins -  
1" = 100' - April/1969 - F. Bianconi.  
TRANSPARENT

114-4-4a Huestis Veins, Ore reserves, Longitudinal  
Section - 1" = 100' - April/1969 - F. Bianconi.  
TRANSPARENT

114-4-4b Same. WORKING TRANSPARENT

MILL - CONSTRUCTION - ETC.

115-0-1 Humphrey Constr. - Cafeteria/Cookhouse -  
 Sheet 1. PRINT  
 115-0-2 Same - Sheet 2. PRINT  
 115-0-3 Material Bills  
 115-0-4 Proposed Tailing Pond - 1" = 50' - May/1968  
 W.H.E. PRINT  
 115-0-5 Plan Showing Waterwells and Pipeline -  
 1" = 200' (plan & sections) - July 16/1968  
 TRANSPARENT  
 115-0-6 Town and Millsite (Plan showing buildings and  
 proposed building locations) - 1" = 100' -  
 Feb. 14/1969 - Hideck. TRANSPARENT  
 115-0-7 Townsite, Carmacks - 1"=20' - May/1968  
 PRINT  
 115-0-8 Townsite Plan - 1" - 20' - A.H. PRINT  
 1 Set STEEL FAB. DRAWINGS - Versatile Drafting - May/1968  
 115-0-209-100 Flow Diagram (1 PRINT each)  
 200 Site Plan  
 201 Isometric View  
  
Crusher Building  
 300 Elevations  
 301 General Arrangement - Floor Plan  
 302 General Arrangement - Sections  
 303 General Arrangement - Coarse Ore Bin  
 304 Concrete Foundation - Plan  
 305 Concrete Foundation - Sections - Sheet 1  
 306 Concrete Foundation - Sections - Sheet 2  
 307 Concrete Foundation - Sections - Sheet 3  
 308 Building Framing  
 309 Crusher Floor Framing  
 310 Screen Floor Framing  
 311 Chute Details - Sheet 1  
 312 Chute Details - Sheet 2  
 313 Chute Details - Sheet 3  
 314 Skirting Details - Sheet 1

MILL - CONSTRUCTION - ETC.Conveyors

400 Conveyor No. 1 - General Arrangement  
 401 Conveyor No. 1 - Sections & Detail - Sheet 1  
 402 Conveyor No. 1 - Sections & Details - Sheet 2  
 403 Conveyor No. 1 - Head Assembly Details

( 1 PRINT EACH )

115-0-209-404 Conveyor No. 1 - Transfer Bin & Shed  
 405 Transfer Bin - Grizzly, Chute & Misc. Steel  
 406 Conveyor No. 1 - Modification to Tail Assembly  
 407 Conveyors No. 2 & 6 - General Arrangement  
 408 Conveyors No. 3,4 & 5 - General Arrangement  
 409 Conveyors No. 3,4 & 5 - Sections & Details  
 410 Conveyors No. 3 & 4 - Fabrication Details  
 411 Conveyors No. 7 & 8 - General Arrangement  
 412 Conveyor No. 5 - Fabrication Details

Mill Building

500 Elevations 501 Chute Details  
 502 General Arrangement - Fine Ore Bins - Sections  
 503 Fine Ore Bin Shed - Framing  
 504 General Arrangement - Floor Plan  
 505 General Arrangement - Sections  
 506 General Arrangement - Sub-Floor Plan & Sections  
 507 Concrete Foundations - Plan  
 508 Concrete Foundations - Sections - Sheet 1  
 509 Concrete Foundations - Sections - Sheet 2  
 510 Floor Framing - Sheet 1  
 511 Floor Framing - Sheet 2  
 512 Piping Isometric  
 513 Piping Plan  
 514 Piping Sections  
 515 Misc. Details - Sheet 1  
 516 Launderers & Chutes - Sheet 1  
 517 Launder & Chutes - Sheet 2  
 518 Misc. Steel Details - Sheet 1  
 519 Misc. Steel Details - Sheet 2  
 520 Wing Sect. - Concrete Plan  
 521 Concrete Foundation - Sections - Sheet 3  
 522 Skirting Details - Sheet 2  
 523 Concrete Foundation - Sections - Sheet 3  
 524 Pallet Loading Bins  
 525 Concrete Foundation - Section - Sheet 4  
 526 Concrete Foundation - Sections - Sheet 5

Power House

600 Elevations MISSING  
 601 General Arrangement - Floor Pl. MISSING  
 602 General Arrangement - Sections MISSING

603	Building Framing	MISSING
604	Concrete Floor Plan	
605	Concrete Sections	
606	Concrete Sections - Reinforcing Steel	
	<u>Access Ramp</u>	
701	Coarse Ore Access Ramp - Section and Elevation	
702	Coarse Ore Access Ramp - Plan & Details	
	<u>Administration Building</u>	
115-0-244-1	Elevations & Sections	
2	Floor - Plan	
	<u>Mine Dry Building</u>	
115-0-245-1	Elevations & Sections	
2	Floor Plan	
		( 1 PRINT each)
115-0-D-754-210-501	Electrical - One Line Diagram - Powerhouse	
502	Electrical - One Line Diagram - Crushing Plant	
503	Electrical - One Line Diagram -Concentrator	
504	Electrical - Detail Powerhouse Distribution	
505	Electrical-Elementary Diagram Generator Control	
115-0-D-754-211-501	Mechanical - Plan-Air & Heating Distribution	
502	Mechanical - Heat Recovery Schematic	
503	Mechanical Powerhouse - General Arrangement-Plan	
504	Mechanical -Powerhouse - Section 'A-A'	
505	Mechanical -Powerhouse - Section 'B-B'	
506	Mechanical -Powerhouse - Section 'C-C'	
507	Mechanical-Mine Dry Building - Heating Layout	
508	Mechanical-Concentrator - Heating Layout - Sheet 1 of 2	
509	Mechanical-Concentrator - Heating Layout - Sheet 2 of 2	
510	Mechanical-Crushing Plant - Heating Layout	
511	Mechanical-Warehouse - Heating Layout	
512	Mechanical-Powerhouse Equipment	
513	Mechanical-Administration Building - Heating Layout	
115-0-293-1	Recreation Building - Floor Plan	
115-0-293-2	Recreation Building - Section & Elevators	
115-0-293-3	Foundation Plans f. Misc. Details	
115-0-D-9324	Waste Heat Recovery Package Unit	
115-0-68-3-501-1	Proposed Gravity Rollcase	

115-0-9	Coarse Ore Access Road - April 1/1968 - E.K.T.	PRINT
115-0-10	250 KW Generator, 3 Req. - Feb. 14/1968 - Northern Engine & Equipment (B.C.) Ltd.	PRINT
	<u>Cyanide Building</u>	
115-0-E-3795	Foundation Plan & Details	PRINT
E-3796	Floor Plan and Elevations	PRINT
E-3797	Sections & Details	PRINT

PROPOSED DEVELOPMENT

H116-0-1 Drilling Program & Alternatives - Cabin Creek Vein -  
1" = 40' - Sept.11/1967 - P.J.S.      TRANSPARENT

H116-3-1 Proposed Drilling Program, Huestis 4300 - 1" = 40' -  
Aug. 2/1968 - Wilkinson      TRANSPARENT

116-4-1 Huestis 4100 level, 12 Drift, Present Situation  
& proposed crosscut - 1" = 40' - May 9/1969 -  
F.Bianconi & R.Saager      TRANSPARENT

116-4-2 Huestis 4100 level, 12 Drift, 585 Ore Shoot,  
Proposed Drilling Program - 1" = 40' - May 9/1969 -  
F.Bianconi & R.Saager      TRANSPARENT

116-4-3 Huestis 4100 level, Proposed Diamond Drill Holes  
Program - 1" = 40' - Oct. 7,1969 -  
F. Bianconi & R. Saager      TRANSPARENT

116-3-2 Huestis 4300 level, proposed Diamond Drill  
Holes Program - 1" = 40' - Oct. 9/1969 -  
F. Bianconi & R. Saager      TRANSPARENT

116-4-4 Webber Composite, Proposed Diamond Drill Holes -  
1" = 40' - Nov. 25/1969 -  
F. Bianconi & R. Saager      TRANSPARENT

116-0-2 Proposed Exploratory Drill Program  
1" = 1000', April 21, 1970  
F. Bianconi      TRANSPARENT

WEBBER  
LIST OF MAPS



GEOLOGY

204-3-1 Webber Vein Zones, Surface Samples and under-  
ground Development - 1" = 1000' - July/1965 -  
D.D.Campbell PRINT

Underground Geology - 1" = 20' - 1968/1969 - F.Bianconi  
TRANSPARENT  
1 COLOURED PRINT  
1 PRINT  
of each

204-3-E20  
204-3-E21  
204-3-F21  
204-3-G21

204-4-D22  
204-4-E22

Underground Geology - 1" = 40' - 1968/1969 - F.Bianconi  
TRANSPARENT  
1 COLOURED PRINT  
1 PRINT  
of each

204-3-EF-20/21

204-4-DE-21/22

DRILLING

- 212-3-1 Webber Adit, 4260 Level, Drillholes -  
1" = 40' - Sept. 1/? - PRINT
- 212-3-2 Webber Adit, Location of DDH & Testholes as  
well as proposed Testholes - 1" = 40' -  
Sept. 18/1965 PRINT
- 212-3-3 Webber 4265 Adit, Longholes & DDH - 1" = 40' -  
Feb./1967 - C.D. COLOURED PRINT
- 212-3-4 Webber Adit with DDH Locations - 1" = 40' -  
Jan. 31/1966 - P.B. PRINT
- 212-4-1 Webber 4100 -Crosscut, DDH W41-1, with Geology -  
1" = 20' Sept. 4/1968 - G. Lamont  
COLOURED PRINT
- 210-3-1 Webber 4260 level, metallurgical testing:  
location of samples  
1" = 100' Feb. 24, 1970  
F. Bianconi

ASSAYS

Assay Plans 1" - 20' (Originals at mine) 1 PRINT of each

a= Face (and Back) Samples

b= Car Samples

213-3-E20 a	213-4-E22 a
213-3-E20 b	213-4-E22 b
213-3-E21 a	
213-3-E21 b	
213-3-F21 a	
213-3-F21 b	

Other Plans

	213-3-E20	Testholes, 105 ore shoot - 1" = 20' - Apr. 7/1968 - Wilkinson	PRINT
obsolete	<del>213-3-E21</del>	<del>No. 2 Vein, 551-Stopes, No. 2-lift - 1" = 20' -</del> <del>May-4/1968 - Wilkinson</del>	<del>PRINT</del>
obsolete	<del>213-3-F21</del>	<del>No. 2 Vein, 558-Stopes, No. 1-lift - 1" = 20' -</del> <del>Apr. -29/1968 - Wilkinson</del>	<del>PRINT</del>
	213-3-F21	Testholes, 139 ore shoot - 1" = 20' - March 19/1968 - Wilkinson	PRINT
	213-3-F21	Raise site at station 130 + 30', Back samples - 1" = 20' - Jan. 22/1968 - Wilkinson	PRINT
	213-3-F21	Raise No. 2 - 1" = 10' - Dec. 10/1967 - Wilkin- son	PRINT
	213-3-EF/21	Webber Adit, Face Samples - 1" = 20' - Sept. 19/1965 - P.B.	TRANSPARENT
	213-3-EF/21	Webber Adit, Car Samples - 1" = 20' - Oct. 11/1965 - P.B.	TRANSPARENT
	213-3-E/20.21	Webber Adit, Face Samples - 1" = 20' - Oct. 13/ 1965 - P.B.	TRANSPARENT
	213-3-E/20.21	Webber Adit, Car Samples - 1" = 20' - Oct. 13/ 1965 - P.B.	TRANSPARENT
	213-3-F21	Webber Adit, Assay Plan for Sept. report - 1"=40' - Aug. 8/1965 - Hampton	PRINT
	213-3-EF/21	Webber, Crosscuts 2N Drift - 1" = 20' - Feb. 15/1966 - P.B.	PRINT
	213-3-EF/21	Webber Adit - 2N Drift - 1" =20' - Jan. 26/1966 - P.B.	PRINT

213-3-EF/21 Webber Adit, 2N Drift, Testholes, Sludge Samples -  
1" = 20' - Feb. 15/1966 - P.B. PRINT

Assay Plans of Stope - Lifts in extra folder

(Original at mine)

PRINTS

Assay Plans 1" ~ 20' (Originals at mine)  
213-4-E22 a = Face (and Back) Samples

213-4-E22 b = Car Samples

1 PRINT of each

HUESTIS

LIST OF MAPS

TOPOGRAPHY

302-4-1 Huestis, Longitudinal Section - 1" = 40' - No  
date - PRINT

302-4-2 Same - 1" = 100' PRINT

Underground Survey - 1" = 20' (Originals at mine)

1 PRINT of each

302-3-L20  
302-3-K20  
302-3-J20

302-4-N19  
302-4-M19  
302-4-M20  
302-4-L20  
302-4-K20  
302-4-J20

Underground Survey - 1" = 100' (Originals at mine)

1 PRINT of each

302-3-K.L/20  
302-3-H.J/20  
302-3-J.K.L.M.N. / 20.21  
302-4-M.N/19.20  
302-4-K.L/19.20  
302-4-H.J/19.20

302-3-J.K.L.M.N. / 20.21  
302-4-J.K.L.M.N. / 20.21

GEOLOGY

304-3-L20 645 Ore Shoot, Sketch Plans, Sections - 1" = 20' -  
 Feb. 16/1968 - Wilkinson COLOURED TRANSPARENT

304-4-1(Section) Huestis 12 Vein, Longitudinal Section of  
 12-590 & 12-588 Ore Shoots - 1" = 40' -  
 June 24/1968 - Wilkinson COLOURED PRINT

304-4-2(Section) Huestis 12 Vein, Partial Longitudinal Section-  
 1" = 40' - Aug. 6/1968 - Wilkinson  
 COLOURED PRINT

304-4-3 Huestis Area Composite - 1"=1000' -  
 June 1965 - R.R.D. COLOURED PRINT

Underground Geology - 1" = 20' - F.Bianconi - 1968/1969

1 TRANSPARENT  
 1 COLOURED PRINT  
 1 PRINT  
 of each

304-3-L20  
 304-3-K20  
 304-3-J20  
 304-3-L21

304-4-N19  
 304-4-M19  
 304-4-M20  
 304-4-L20  
 304-4-K20

Underground Geology - 1" = 40' - F.Bianconi - 1968/1969

1 TRANSPARENT  
 1 COLOURED PRINT  
 1 PRINT  
 of each

304-3-KL-19/20

304-4-MN-19/20  
 304-4-KL-19/20

DRILLING

- 312-3-1 Huestis 4300 Level, DDH - 1" = 40' - Feb./1967 -  
E.P. PRINT
- 312-3-2 Huestis 4300 Level, DDH - 1" = 40' - Sept. 1/? -  
PRINT
- 312-3-3 Huestis 4100 & 4300 Composite - 1" = 100' -  
Jan. 14/1969 - J.Taylor COLOURED PRINT
- 312-3-4 DDH H-26, with Geology - 1" = 20' - Jan. 6/1968 -  
Wilkinson COLOURED PRINT
- 312-3-5 DDH H-28 & H-29, 12 NW Drift Geology - 1" = 20' -  
Nov. 28/1967 - Wilkinson COLOURED PRINT
- 312-3-6 DDH H-27 & H-30, with Geology - 1" = 40' - Nov. 28/  
1967 - Wilkinson PRINT
- 312-3-7 No. 13 Vein, Position of DDH H-5, H-13, H-15,  
H-16, H43-1, H43-2, H43-3 - 1" = 100' - Nov. 13/1968 -  
E. Smith PRINT
- 312-3-8 DDD H43-1, with Geology - 1" = 20' - Sept. 14/1968 -  
G.Lamont COLOURED PRINT
- 312-3-9 DDH H43-2, with Geology - 1" = 20' - Sept. 23/1968 -  
G.Lamont COLOURED PRINT
- 312-3-10 DDH H43-3, with Geology - 1" = 20' - Oct. 15/1968 -  
E.Smith COLOURED PRINT
- 312-3-11 DDH H43-4, with Geology - 1" = 20' - Oct. 22/1968 -  
E.Smith COLOURED PRINT
- 312-3-12 Huestis 4300 Level, Geology and DDH -  
1" = 40' - Feb. 1/1969 - J.Taylor  
COLOURED PRINT
- 312-4-3 Huestis 4100 Level, Geology and DDH -  
1" = 40' - COLOURED PRINT
- 310-3-1 Huestis 4300 level, metallurgical testing:  
Location of samples 1" = 100' Feb.24, 1970  
F. Bianconi
- 310-4-1 Huestis 4100 level, metallurgical testing:  
Location of samples 1" = 100' Feb.24, 1970  
F. Bianconi

ASSAYS

Assay Plans 1" - 20' (Originals at mine) 1 PRINT of each

a = Face (and Back) Samples  
b = Car Samples

313-3-K20 a  
313-3-K20 b  
313-3-L20 a  
313-3-L20 b

313-4-K20 a  
313-4-K20 b  
313-4-L20 a  
313-4-L20 b

Other Plans

313-3-L-19/20 a Huestis Adit 4300, Face Samples - 1" = 20' -  
Sept. 24/1965 - P.B. TRANSPARENT

313-3-L-19/20 b Huestis Adit 4300, Car Samples - 1" = 20' -  
Oct. 6/1965 - P.B. TRANSPARENT

313-3-KL/20 a Huestis Adit 4300, Face Samples - 1" - 20' -  
Aug. 2/1965 - P.B. TRANSPARENT

313-3-KL/20 b Huestis Adit 4300, Car Samples - 1" - 20' -  
Sept. 28/1965 - P.B. TRANSPARENT

obsolete ~~313-3-K20---Stope-43-12-590---Lift-No.-1---1"=20'---May-1/1968 -~~  
Wilkinson PRINT

obsolete ~~313-3-K20---Stope-43-12-591---Lift-No.-1---1"=20'---May-15/68 -~~  
Wilkinson PRINT

obsolete ~~313-3-K20---Stope-43-12-585---Lift-No.-2---1"=20'---Nov.-7/68 -~~  
E. Smith PRINT

obsolete ~~313-3-K20---Stope-43-12-590---Lift-No.-2---1"=20'---Nov.-15/68 -~~  
E. Smith PRINT

obsolete ~~313-3-K20---Stope-43-12-590---Lift-No.-3---1"=20'---Nov.-20/68 -~~  
E. Smith PRINT

313-3-K20 Raise at 590 Stope, W-Face - 1" = 5' - Dec. 3/1968 -  
E. Smith PRINT

obsolete ~~313-3-L20---Stope-43-12-594---Lift-No.-1---1"=20'---No-date -~~  
Wilkinson PRINT



# MOUNT NANSEN MINES LIMITED

420-475 HOWE STREET  
VANCOUVER 1, BRITISH COLUMBIA  
CANADA

AREA CODE 604  
TELEPHONE 681-1385

January 26, 1971.

Cyprus Exploration Corp. Ltd.,  
1101 - 510 West Hastings St.,  
Vancouver 2, B.C.

Dear Sirs:

This is a list of the Mount Nansen claims which are divided into three groups, as discussed with you yesterday:

## GROUP 1

Claims retained by Mount Nansen Mines Limited for the mine operation:

Dome 1 to 18 inclusive, 20, 21, 22; 49 to 52 inclusive;  
78 to 84 inclusive; 86 and 95.

Jeff 1 to 14 inclusive.

## GROUP 2

Claims on which Cyprus has a right to perform exploration but eventual silver veins found on these claims are owned 100% by Mount Nansen Mines Limited:

Bit 1 to 6 inclusive.

Laura 16 and 17.

## GROUP 3

Claims covered by the Option Agreement between Cyprus and Mount Nansen. Silver veins which are found on these claims are given to Mount Nansen Mines Limited, Cyprus Exploration Corp. Ltd. retaining a 5% interest:

All Mount Nansen claims, excluding Groups 1 and 2.

Yours very truly,

MOUNT NANSEN MINES LIMITED

*F. Bianconi*

F. Bianconi.

FB/rh  
c.c. F.T.G. Chester  
D.M. Mercier

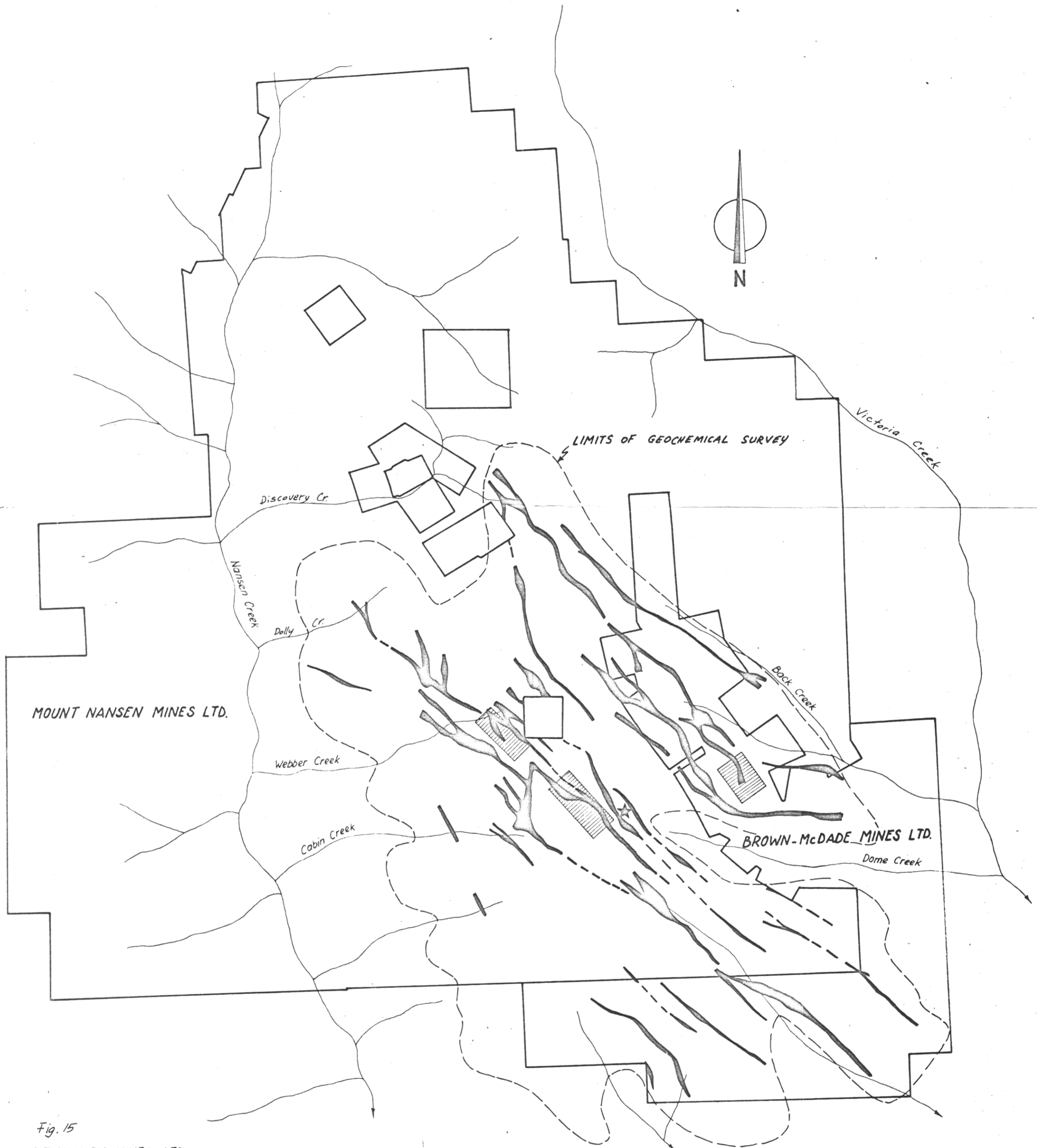





Fig. 15

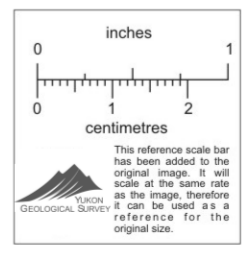
MT. NANSEN MINES LTD.  
 Vancouver British Columbia

**GENERAL PLAN**  
 SHOWING

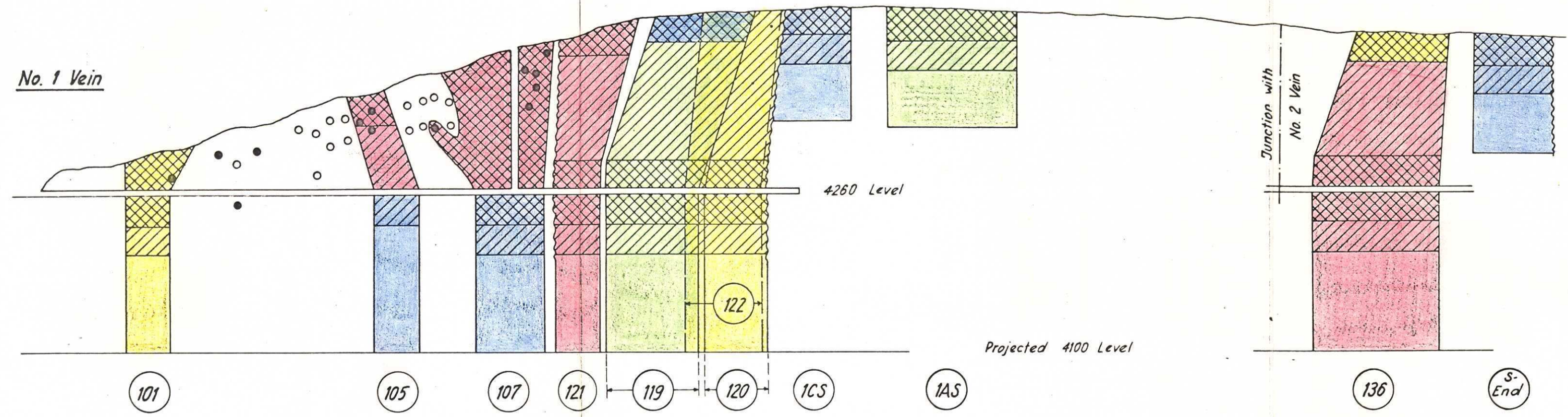
**GEOCHEMICAL SOIL SURVEY ANOMALIES**  
 CARMACKS DISTRICT, YUKON T.

**LEGEND**

-  Underground Development
-  Geochemical Soil Anomaly (Ag and/or As)
-  Camp and Mill Site



No. 1 Vein



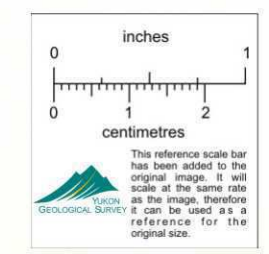
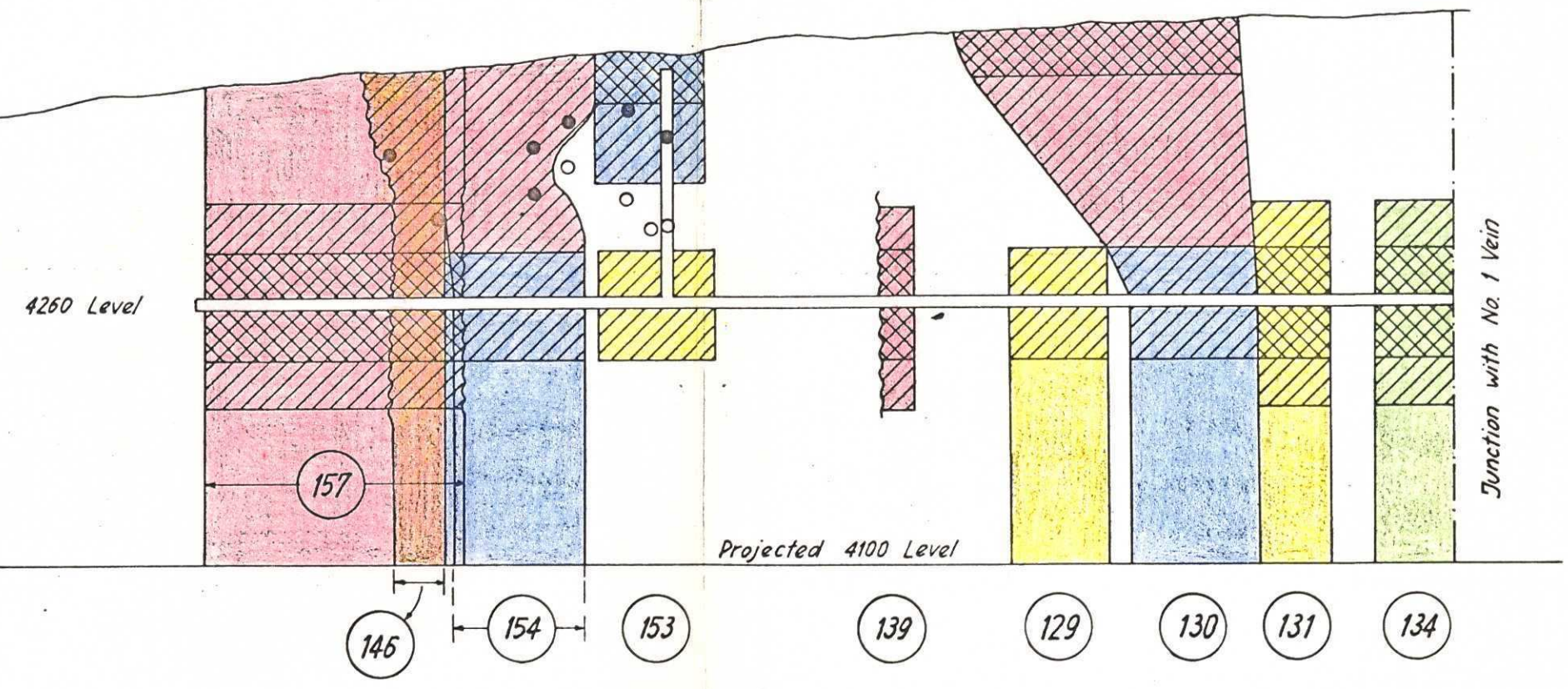
**LEGEND**

- Proven Ore
- Probable Ore
- Possible Ore
- Fault
- Overburden Hole (Ore, Nil)

**Value (can \$/ton)**

- 40 or more
- 30-40
- 20-30
- <20

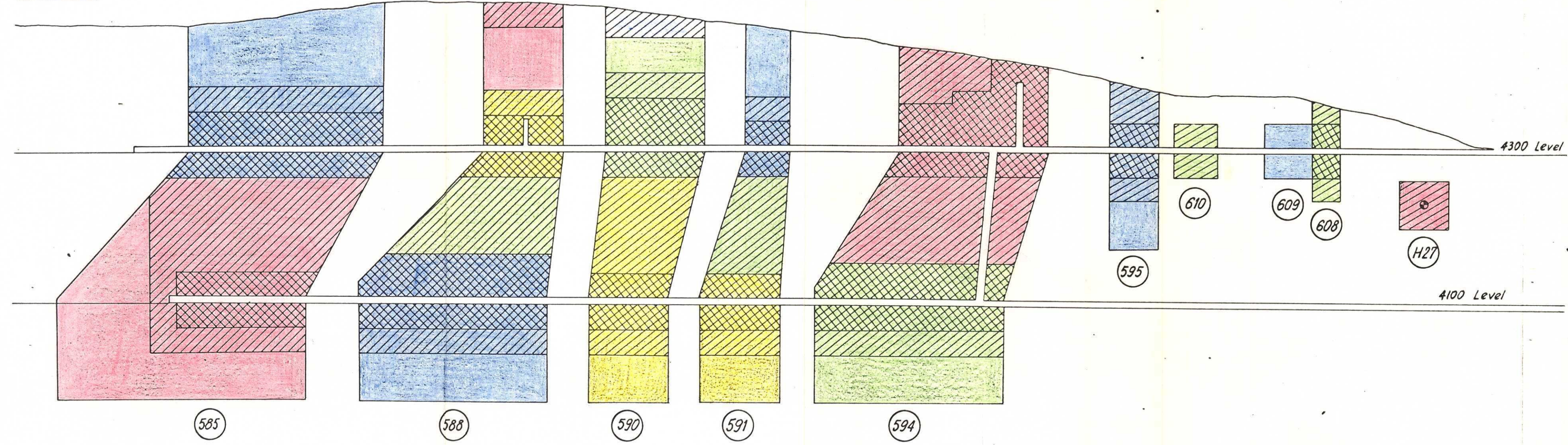
No. 2 Vein



F. Bianconi  
 Mt. Nansen Mines Ltd., Vancouver, B.C.  
 Longitudinal vertical section  
**WEBBER VEINS  
 ORE RESERVES**

Scale 1" = 100'    April 1969    Fig. 20

No. 12 Vein



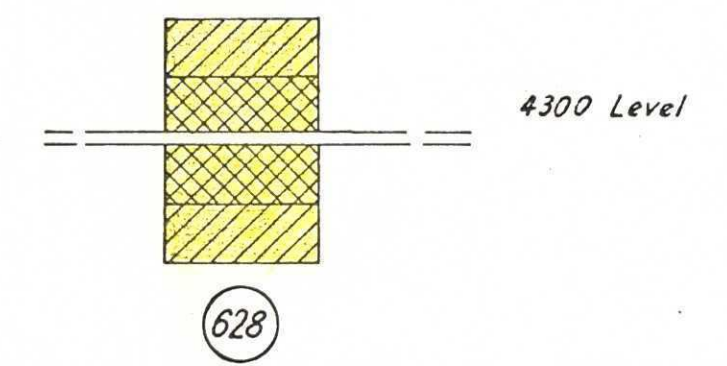
LEGEND

- Proven Ore
- Probable Ore
- Possible Ore
- Diamond Drill Hole (Ore, Nil)

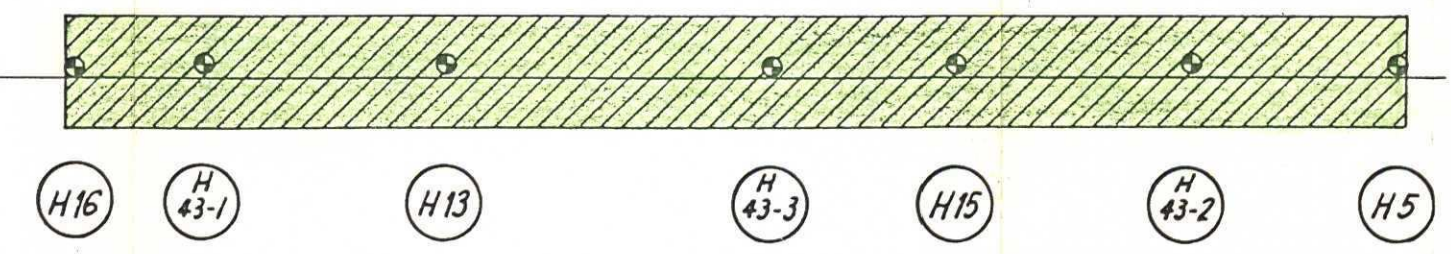
Value (can \$/ton)

- 40 or more
- 30-40
- 20-30
- < 20

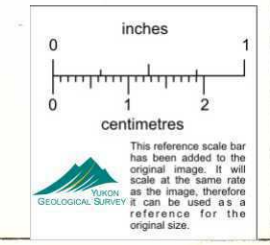
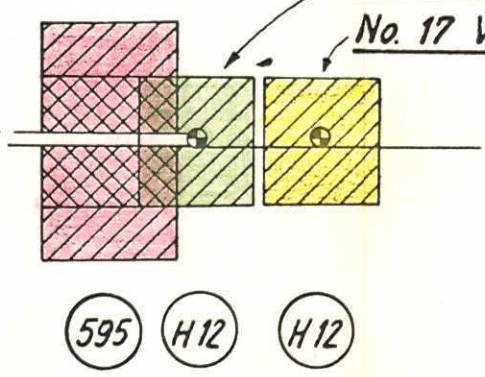
No. 11 Vein



No. 13 Vein



No. 15 Vein  
No. 17 Vein



F. Bianconi  
 Mt. Nansen Mines Ltd., Vancouver, B.C.  
 Longitudinal vertical section  
**HUESTIS VEINS**  
**ORE RESERVES**  
 Scale 1" = 100" April 1969 Fig. 21

SUMMARY OF MOUNT NANSEN MILLING OPERATION  
(SEPTEMBER 23, 1968 to APRIL 8, 1969)

	Days Operating	Tons ore milled ( calc.)	Aver. tons/day (calc.)	Concentrate		Av. Ratio ore:conc. ( calc.)	Tailings tons ( calc.)	GOLD BALANCE						SILVER BALANCE							
				tons ( obs.)	tons/day ( calc.)			Heads		Concentrate		Recovery Au % ( calc.)	Tailings		Heads		Concentrate		Recovery Ag % ( calc.)	Tailings	
								oz/ton ( calc.)	oz Au ( calc.)	oz/ton ( obs.)	oz Au ( calc.)		oz/ton ( obs.)	oz Au ( calc.)	oz/ton ( calc.)	oz Ag ( calc.)	oz/ton ( obs.)	oz Ag ( calc.)		oz/ton ( obs.)	oz Ag ( calc.)
8 SEPT.	8	390	48.7	18.9780	2.37	20.5	371	0.121	47.200	0.878	16.670	35.3	0.082	30.530	2.372	925.300	16.543	313.969	33.9	1.648	611.331
OCT.	24	2,265	94.4	184.0903	7.67	12.3	2,081	0.256	580.866	1.409	259.356	44.6	0.154	321.510	5.100	11,549.790	45.664	8,406.342	72.8	1.510	3,143.448
NOV.	30	3,967	132.2	226.7940	7.56	17.5	3,740	0.230	916.595	1.730	392.457	42.8	0.140	524.048	5.015	19,897.868	50.545	11,465.453	57.6	2.255	8,432.415
DEC.	31	2,353	75.9	175.0210	5.65	13.4	2,178	0.224	526.140	2.024	354.265	67.3	0.078	170.975	4.442	10,453.100	53.921	9,437.392	90.3	0.558	1,215.372
69 JAN.	31	3,270	105.5	273.3980	8.82	12.0	2,996	0.268	876.724	2.269	620.304	70.7	0.085	256.410	6.570	21,489.930	65.234	17,834.915	83.0	1.219	3,653.018
FEB.	28	4,083	145.8	436.1000	15.57	9.4	3,647	0.315	1,284.937	2.112	921.094	71.7	0.099	363.861	7.887	32,201.977	63.455	27,672.778	85.9	1.242	4,529.299
MARCH	31	1,343	43.3	128.4430	4.14	10.5	1,214	0.273	366.349	1.693	217.463	59.3	0.122	148.754	6.428	8,633.856	61.396	7,885.871	91.3	0.624	757.975
APRIL	8	346	43.3	32.6465	4.08	10.6	313	0.240	84.000	1.583	51.689	61.5	0.103	32.311	6.690	2,312.340	62.447	2,038.697	88.2	0.874	273.643
TOTAL	191	18,017		1,475.4708			16,540		4,682.811		2,833.298			1,848.399		107,464.141		85,055.417			22,616.501
AVERAGE			94.3		7.72	12.2		0.260		1.920		60.5	0.112		5.965		57.646		79.1	1.367	

EL. 4400'

4300'

4200'

4100'

4000'

3900'

SURFACE

H4300 DRIFT

H4300 PORTAL

H43-12-585

H43-12-588

H43-12-590

H43-12-594

H41-12-585

H41-12-588

H41-12-594

H4100 DRIFT




60,000 E

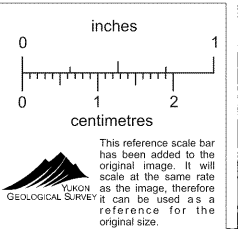
58,000 E

58,500 E

59,000 E

59,500 E

-  February 1969
-  January 1969
-  December 1968
-  November 1968
-  Earlier



F. Bianconi  
 Mt. Nansen Mines Ltd., Vancouver, B.C.

LONGITUDINAL SECTION - STOPES  
 HUESTIS MINE - 12 VEIN  
 MONTHLY PROGRESS

Scale 1" = 100'      1989      102-4-1a