ARCHER, CATHRO
AND ASSOCIATES LTD.
CONSULTING GEOLOGICAL ENGINEERS

BOX 4127, WHITEHORSE, Y.T. Y1A 3S9 667-4415 — STANDARD BUILDING, VANCOUVER, B.C. 688-2568

1016 STANDARD BUILDING
510 WEST HASTINGS STREET
VANCOUVER, B.C.
V6B 1L8

Regional Geological Survey

and

Property Geological and Geochemical Survey

Ready	1	12 units	(1-3; 14-19; 25-27)	94L/1E	Liard Mining District
Ready	2	10 units	(1-5; 12-16)	94L/1E	Liard Mining District
Ready	3	15 units	(1-3; 14-19; 25-30)	94L/1E	Liard Mining District
Snow	1	8 units	(1-2; 15-18; 26-27)	94L/1E	Liard Mining District
Et	2	20 units		94L/1E	Liard Mining District
Pig	1	16 units		94K/4W	Liard Mining District
Saint	1,2	40 units		94K/4W	Liard Mining District
	3	12 units	(1-3; 14-19; 25-27)	94K/4W	Liard Mining District
	4	8 units	(1-4;, 13-16)	94K/4W	Liard Mining District
	5	20 units		94K/4W	Liard Mining District
Knot	2	20 units		94K/4W	Liard Mining District
Hole	1,2,3	22 units		94K/4W	Liard Mining District
Gneiss	2	20 units		94K/4W	Liard Mining District
Bob	1-7	108 units		94K/4W	Liard Mining District
Hawk		12 units	(1-4; 13-20)	94K/4W	Liard Mining District
Taga	3,4	32 units		94F/13W	Omineca Mining District
Bear		20 units		94F/13W	Omineca Mining District
Ryte		20 units		94F/13W	Omineca Mining District

Centred on 125°55'E longitude, 58°05'N latitude

Claims owned by Welcome North Mines Ltd.
Survey operated by Welcome North Mines Ltd. for Gataga Joint Venture

R.J. Cathro, B.A.Sc., P. Eng.

R.C. Carne, B.Sc.

February 8, 1978

part 1 of 2

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Itemized Cost Statement

A. Wages (excluding any field time used for staking and 25% of other employment time)

C.A. Main	Prefield	April 19-30	12	$2,550/month	$ 740.00
(Geologist)	"	May 1-12	12		740.00
	Field	May 13-24	12		987.00
	"	June 6-30	25		2,056.00
	"	July 1-7	7		576.00
	Post field	July 8-16	8		494.00
	Holidays	January 11-17	7		432.00
A. Gregson	Prefield	April 6-30	25	$2,100/month	1,313.00
(Geologist)	"	May 1-17	17		864.00
	Field	May 18-24	7		474.00
	"	June 6-30	25		1,750.00
	"	July 1-7	7		474.00
	"	August 19-20	2		135.00
	Post field	July 8-15	8		407.00
	Holidays	August 1-7	7		356.00
	"	December 20-22	3		152.00
C.G. Main	Field	May 13-24	12	$1,275/month	494.00
(Cook)	"	June 6-30	25		1,062.00
	"	July 1-7	7		288.00
	Post field	July 8-16	9		278.00
	Holidays	October 1-6	6		184.00
M. Hawley	Prefield	May 16-17	2	$1,050/month	51.00
(Field Assistant)	Field	May 18-24	7		237.00
	"	June 6-30	25	$1,133/month	944.00
	"	July 1-8	8		292.00
	Post field	July 21-26	6		164.00
	Holidays	September 5-6	2		57.00
G. Matthews	Prefield	May 12-17	6	$1,050/month	153.00
(Field Assistant)	Field	May 18-24	7		237.00
	"	June 6-30	25	$1,133/month	944.00
	"	July 1-7	7		256.00
	"	August 19-31	13		475.00
	"	September 1-5	5		189.00
	Post field	July 8-16	9		247.00
	"	September 6-16	11		302.00
	Holidays	September 17-18	2		57.00

R. Carne (Geologist)	Field	May 24-31	8	$2,550/month	$ 658.00
	"	June 1-30	30		2,550.00
T. Bremner (Geologist)	Field	June 23-30	8	$2,550/month	658.00
	"	July 1-8	8		658.00
	Post field	July 26-31	6		371.00
E. Jensen (Geologist)	Pre field	July 19-20	2	$2,550/month	124.00
	"	August 16-18	3		185.00
	Field	August 19-31	13		1,069.00
	"	September 1-4	4		340.00
	Post field	September 5-15	11		701.00
	Holidays	September 16-17	2		124.00
R. Warner (Field Assistant)	Prefield	August 18	1	$1,425/month	35.00
	Field	August 19-31	13		598.00
	"	September 1-4	4		190.00
	Holidays	October 1-3	3		104.00
A. Colling (Field Assistant)	Field	May 18-19	2	$2,170/month	140.00
	"	July 6-9	4		280.00
	"	July 14-15	2		140.00
C. Chalmers (Field Assistant)	Field	July 27-31	4	$1,705/month	220.00
		Total			$28,006.00

Prefield includes collection of supplies, organizing transport and mobilization to field.

Field includes time spent employed on or concerned with the property.

Post field includes demobilization, organization of data and supplies.

Holidays is payment for work performed on Sundays during "field" employment.

B. Food and Accomodation

Expenses in Whitehorse, Watson Lake and Ross River were incurred during mobilization and demobilization. Field expenses are actual costs for equipment and consumables during the period of field employment as well as expediting support.

Whitehorse	May 12-19	18 mandays	$25/manday	$ 450.00
(Archer, Cathro staff	June 26,30	2 "	"	50.00
house)	July 8-16,27-31	41 "	"	1,025.00
	August 16-19	6 "	"	150.00
	September 4-12	9 "	"	225.00
Watson Lake	July 16	2		72.00
(Belvedere Hotel)				
Ross River (Welcome Inn)	August 20	2		50.00
Claim area	May 19-24)			
	June 6-30)			
	July 1-7)	326 "		7,838.00
	August 19-31)			
	September 1-4)			
				$ 9,860.00

C. <u>Transportation</u>

1. <u>CP Air</u> - mobilizing crew, supervision

R. Cathro - Van. to Whse.	May 23	$ 125.00
A. Gregson - Van. to Whse.	May 12	125.00
G. Matthews - Van. to Whse.	May 12	125.00
M. Hawley - Van. to Whse.	May 16	125.00
R. Carne - Van. to Whse.	May 23	125.00
R. Cathro - Van. to Whse.	July 8	121.00
A. Gelling - Whse. to Watson L.	July 13	43.20
A. Gregson - Whse. to Watson L.	July 13	43.20
R. Cathro - to Whse., Watson L.	Aug. 16	164.20
R. Warner - Whse. to Watson L.	Aug. 16	43.20
R. Cathro - Whse. to Van.	Sept. 13	125.00
M. Hawley - Whse. to Van. (1/2)	Sept. 2	62.50
A. Gregson - Whse. to Van. (1/2)	Sept. 24	62.50
C. Main - Whse. to Van. (1/2)	Sept. 27	62.50
		$ 1,352.30

2. <u>Otter (B.C.-YukonAirways)</u> (25% deleted to allow for staking costs)

5,745 miles at $1.70 mile	May 20,21,25,27 June 16 July 19 August 20,26 September 4	$ 9,766.50
Extra fuel		671.18
		10,437.68
less 25%		2,609.42
		$ 7,828.26

3. Beaver (B.C.-Yukon Airways) (25% deleted to allow for staking costs)

975 miles at $1.35/mile	June 8, 19,23	$ 1,316.25
less 25%		329.06
		$ 987.19

4. Cessna 185 (B.C.-Yukon Airways) (25% deleted to allow for staking costs)

2,406 miles at $1.05/mile	May 30 June 4,10,12,26 July 3 August 25,28	$ 2,526.30
less 25%		631.58
		$ 1,894.72

5. Bell 47G3B2 Helicopter (Trans North Turbo Air) (no staking included)

125.2 hours at $160/hour	May 20-July 18	$ 20,032.00
36.6 hours at $160/hour	August 19-September 6	5,856.00
		$ 25,888.00

6. Archer Cathro trucks (at $800/month plus gas and repairs)

White Ford van, 1 ton	May 15-31	$ 439.00
	June 1-30	916.88
	July 1-15	646.00
	August 17-18	281.00
Red Ford van, 1 ton	May 17-19	133.50
Blue Ford pickup	August 22-24	90.00
		$ 2,506.38

7. Rented Trucks

Hertz 1 ton	May 14-27	$ 561.02
	August 17-September 6	737.81
Hertz 5 ton	July 6-20	456.04
		$ 1,754.87

D. Instrument Rental

SBX 11 single side radio transceiver at $250/month	May 15-31 June 1-30 July 1-15 Aguust 19-31 September 1-4	$ 655.00

E. Analysis (includes cost of preparation)

1. Waters		
453 samples analysed for Zn, SO_4	at 3.20	$ 1,449.60
5 samples analysed for Pb,Zn,SO_4,pH	at 5.00	25.00
33 samples analysed for Pb,Zn,SO_4	at 3.40	125.40
12 samples analysed for Pb,Zn,SO_4,Cu,Mo,Cd	at 5.60	67.20
6 samples analysed for pH,HCO_3,Cl,Ca,F, hardness, conductivity	at 8.00	48.00
2. Silt and Soil Samples		
330 samples analysed for Pb,Zn	at 1.96	646.80
1,415 samples analysed for Pb,Zn,Cu	at 2.44	3,452.60
3. Rock Samples		
51 samples analysed for Pb,Zn,Cu	at 3.16	161.16
54 samples analysed for Pb(leach),Zn	at 32.8	177.12
8 samples analysed for Pb,Zn,Sr	at 5.10	40.80
16 samples analysed for Sr	at 3.00	48.00
6 samples analysed for Pb,Zn,Fe,Mn	at 3.56	21.36
24 samples analysed for Mn,Fe	at 1.56	37.44
3 samples analysed for Pb,Zn,Cu,Ba	at 4.76	14.28
57 samples assayed for Pb,Zn	at 8.40	478.80
26 samples assayed for Ba,Sr	at 10.00	260.00
4 samples assayed for Ba,Sr,Pb,Zn	at 24.00	96.00
		7,149.56
Air freight to Vancouver		355.46
		$ 7,505.02

F. Cost of Preparing Report

1.	Management retainer to Archer, Cathro & Associates to cover organization, supervision, execution, study and compilation of work performed - April 1977 to December 1977	$ 9,000.00
2.	Drafting - April 1977 to December 1977	2,681.00
3.	Office costs, telephone, accounting, xerox copies, map reproductions - April 1977 to December 1977	7,985.00
4.	Wages of those employed preparing report -	
	A. Gregson (Geologist) - September 27-30, October 1-15, December 1-5 - total 24 days at $2,100/month	1,695.00
	R. Carne (Geologist) - October 19-31, November 16-30, December 1-31 - total 59 days at $2,550/month	4,894.00
	C.A. Main (Geologist) - October 1-15 - total 15 days at $2,550/month	1,234.00
		$ 27,489.00
	Total	$115,726.74

Summary of Costs
(Adjusted to delete all staking costs)

Wages		
Prefield	$ 4,205.00	
Field	19,371.00	
Post field	2,964.00	
Holidays	1,466.00	$ 28,006.00
Food and Accomodation		
Hired	2,022.00	
Field costs (consumables)	7,838.00	9,860.00
Transportation		
CP Air mobilization	1,352.30	
Otter	7,828.26	
Beaver	987.19	
Cessna 185	1,894.72	
Bell 47G3B2	25,888.00	
Archer, Cathro trucks	2,506.38	
Rented trucks	1,754.87	42,211.72
Rented Instruments		
Radio		655.00
Analysis		7,505.02
Cost of Preparing Report		
Management and senior supervision by R.J. Cathro	9,000.00	
Drafting	2,681.00	
Office, accounting, stationery, maps	7,985.00	
Wages	7,823.00	27,489.00
Total		$115,726.74

CHAPTER 1 - INTRODUCTION

Gataga Joint Venture (GJV) was formed in April, 1977 by Aquitaine Co. of Canada Ltd., Chevron Canada Ltd., Getty Mining Pacific Ltd. and Welcome North Mines Ltd. for the purpose of staking mineral claims and investigating the significance of geochemical anomalies obtained in 1976 by Castlemaine Exploration Ltd. The property, which is outlined on Figure 1 on the following page, is situated in north-central British Columbia within NTS map-areas 94E (Toodoggone River), 94F (Ware), 94K (Tuchodi Lakes) and 94L (Kechika). The program was based on the existence of strong lead geochemical response from a 60 km long belt of Devonian-Mississippian Gunsteel Fm shale. These shales were considered as a favourable host rock to stratiform zinc-lead-barite mineralization because of their resemblance in age, lithology and barite content to the Canol Formation shale in the Macmillan Pass area of the Selwyn Basin, Yukon, and because previous work by Canex Placer, Texasgulf and others had located sulphide mineralization at several places within the Gataga belt. The 1977 field work was planned and managed by Archer, Cathro & Associates Ltd., and was conducted from its Whitehorse, Yukon office.

Because of inadequate GSC mapping, an unusually large portion of the 1977 GJV program had to be devoted to stratigraphic mapping of the shale units, which are repeated several times across the belt by isoclinal folding and/or thrust faulting. A single mineralized horizon in the shale unit has been traced throughout the map-area. It consists of 1 to 10 m of bedded barite enclosed in a siliceous and pyritic sequence that ranges from 10 to 30 m thick. The most favourable part of this belt has been staked during 1976 and 1977 as 74 two-post claims and 1833 MGS units. GJV is the largest property owner in the district with 799 units.

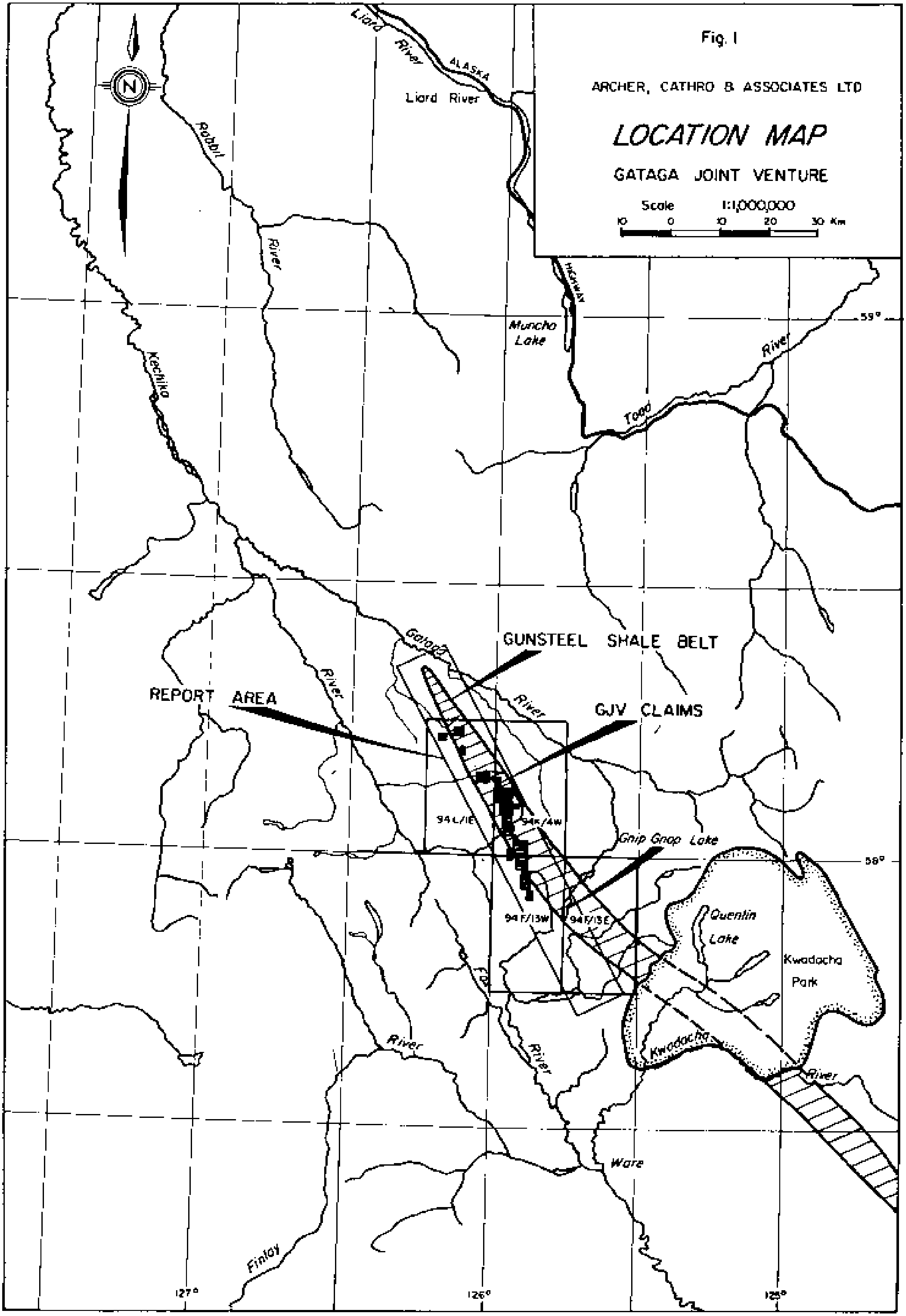


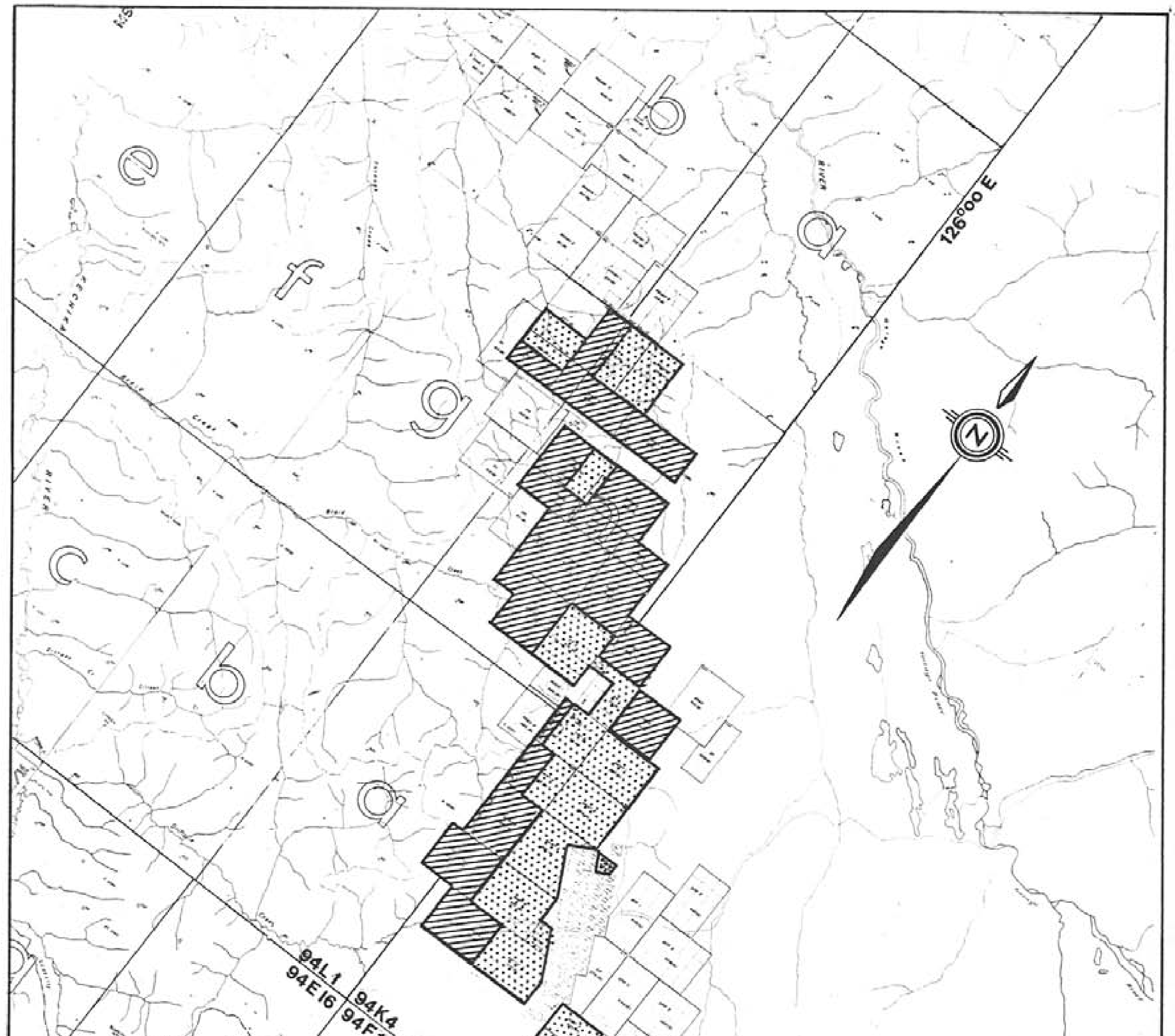
Fig. I
ARCHER, CATHRO & ASSOCIATES LTD
LOCATION MAP
GATAGA JOINT VENTURE
Scale 1:1,000,000
10 0 10 20 30 Km
Liard River
ALASKA
HIGHWAY
Liard River
Rabbit
River
Muncho Lake
Toad River
Kechika
Gataga
River
GUNSTEEL SHALE BELT
REPORT AREA
GJV CLAIMS
River
94L/1E
94K/4W
Gnip Gnap Lake
94F/13W
94F/13E
Quentin Lake
Kwadacha Park
Kwadacha
River
Fox
River
River
Ware
Finlay
59°
58°
127°
126°
125°

GENERAL GEOGRAPHIC DATA

The report area, outlined on Figure 1 is about 80 km long and 10 km wide and is bounded on the southeast end by Kwadacha Class A Provincial Park. The 1977 work was conducted from a camp on the middle of the three Gataga Lakes at the head of South Gataga River. Situated at 57°56'N and 125°43'W, it was called Springiron Lake by Frobisher Ltd. in 1957-58 and was given the informal name Gnip Gnop Lake by CJV. It was serviced from the nearest float base at Watson Lake, Yukon, 290 km to the northwest, where DeHaviland Otter and Beaver, and Cessna 185 aircraft were available from B.C.-Yukon Air Services. Most of the supplies for the program were ferried from Muncho Lake at km 747 on the Alaska Highway, which is 115 km from Gnip Gnop Lake.

PROPERTY HISTORY

The earliest recorded lode exploration in this district took place in 1957 when Frobisher Ltd., a predecessor of Falconbridge, staked the SPA claims over a prominent ferricrete gossan 4 km north of Gnip Gnop Lake. An attempt to sample beneath the gossan with hand trenching and packsack drilling the following year was unsuccessful. The property later reverted to prospector Gerry Davis and was subsequently optioned in 1970 by Kennco, which added the Stag claims and performed a geochemical survey. The showing was restaked as the Red claims in 1973 by John Schussler, who drilled two AQ holes (60 m) the next year. Doug Stelling fringe-staked the Lynn claims for the Stellac Syndicate in 1975 but allowed them to lapse. In 1977, only 5 Red claims were in good standing.



GJV Claims to be forfeited

GJV Claims earning assessment credit

Fig. 2

ARCHER, CATHRO & ASSOCIATES LTD

GJV CLAIMS

GATAGA JOINT VENTURE

Scale 1:250,000

5 0 5 10 Km

In 1970, Geophoto Consultants Ltd. performed a reconnaissance stream sediment survey in this district on behalf of a syndicate. In 1973, three members of the syndicate, Pembina Pipeline Ltd., Sun Oil (Delaware) Ltd. and General Crude Oil Co. Northern Ltd., entered a joint venture with Canex Placer to investigate some of the anomalies. Initial work resulted in the discovery of mineralized float on Driftpile Creek, 16 km northwest of the Spa gossan, in July, 1974. This was staked as 168 two-post type claims and explored with geochemical and geophysical surveys, mapping and hand trenching in 1974 and 1975. Only 68 claims remained in good standing in 1977. During 1976, Castlemaine Exploration performed its previously mentioned geochemical survey and Texasgulf discovered another showing 35 km northwest of Driftpile Creek that was protected with 92 MGS units (5 claims).

A total of 799 units (48 claims) were acquired by GJV during 1977, as shown on Table I. All claims are registered in the name of Welcome North Mines Ltd.

SUMMARY OF WORK PERFORMED

(i) Geological Survey (see Chapter II for details)

The GJV program investigated lead geochemical anomalies from a relatively unexplored belt of black shale that has a strong resemblance to rocks of comparable age and lithology in the Selwyn Basin of Yukon Territory that host important stratiform zinc-lead mineralization. Since the favourable shale units weather recessvely, they are difficult to map at a reconnaissance scale and were not well identified on published 1:250,000 scale GSC maps. For this reason, far more geological mapping was performed in this program than is normally required in reconnaissance mineral exploration, and the crew was weighted heavily with geologists who were familiar with stratigraphy and mineralization in the Selwyn Basin. In addition to measuring the stratigraphic section, this mapping aided in interpreting the structural style in the district and in recognizing the stratigraphic controls on the barite-hosted mineralization. Mapping was done at 1:50,000 scale with some local areas mapped in more detail at 1:5,000 scale. In addition, nine hand trenches were dug and mapped. This 1977 program by GJV represents an original contribution to the stratigraphic, structural and economic geology of northeastern B.C.

Sphalerite and galena showingsoccur locally along a barite horizon within the shale belt but have only been explored in a preliminary fashion with mapping and hand trenching. These showing have demonstrated that the mineralization in the Gataga District is probably of "sedimentary exhalative" or stratiform type and can be expected to have similar metal zoning, mineralogy and geometry to other deposits of this class, such as Tom-Jason (Yukon), Sullivan (B.C.), Meggen and Rammelsberg (West Germany) and McArthur (Australia). This class of deposit is discussed in Chapter IV, with special emphasis on the Tom deposit.

(ii) Geochemical Survey (see Chapter III for details)

Silt and water samples were collected in a reconnaissance fashion to determine regional threshold values to gain a better understanding of the source and method of transport of the heavy metals. Soil and rock samples were also collected on reconnaissance traverses to establish background response from the various sedimentary units. In addition, four areas were soil sampled in a grid fashion. Seventy barite samples were analyzed for extra trace elements.

Total Assays:	Water	495
	Soil and silt	2,650
	Rock	90

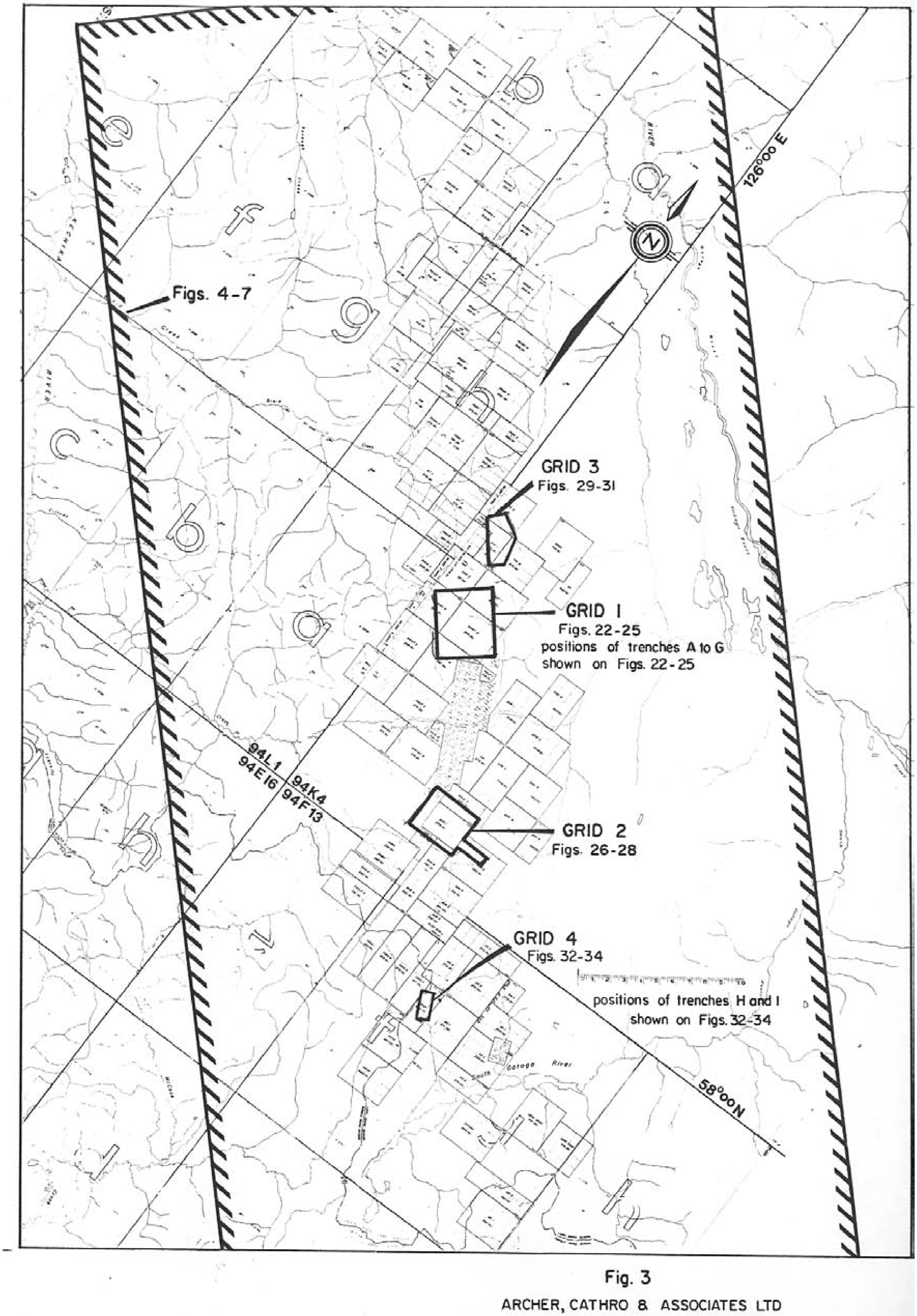


Fig. 3

ARCHER, CATHRO & ASSOCIATES LTD

GJV FIGURE INDEX

GATAGA JOINT VENTURE

(iii) Field Logistics

The main field program was led by Charles (Sandy) Main, who was assisted by geologists Rob Carne, Trevor Bremner and Al Gregson, assistants Gary Matthews and Mark Hawley, and cook Carol Main. A follow-up trenching and detailed prospecting program late in the season was performed by geologist Earl Jensen and assistants Bob Warner and Gary Matthews. Rob Carne assumed the main responsibility for the geological compilation and interpretation in this report. These crews worked under the direct supervision of R.J. Cathro, P. Eng.

The program was supported by a Bell 47G3B2 helicopter on charter from Trans North Turbo Air Ltd., Whitehorse, Y.T. Helicopter useage totalled 152.9 hours in the initial program and another 36.1 hours for the follow-up work.

The following is a summary of field activity during 1977:

March	claims staked by Castlemaine Exploration for GJV
May 15-19	crew and camp gear assembled at Muncho Lake
20-22	set up Gnip Gnop Lake camp
23	field work commenced, work confined to area already staked
26-June 5	extra claims staked
July 7	field work ended
8-9	crew demobilized through Muncho and Watson Lake to Whitehorse
26	preliminary geology and geochemical maps and report completed
August 19	follow-up crew returned to Gnip Gnop Lake camp
September 4	crew demobilized to Whitehorse

(iv) Field Procedures

Members of the crew normally worked individually on day-long prospecting/mapping/sampling traverses. These were planned by the crew chief in consultation with his senior geologists and were guided to a large extent by the emerging geological map. A sketch of the days work, including mapping notes, prospecting data, sample locations and topography were prepared for each traverse. Traverse sheets were sent to the Whitehorse office on a regular basis for photocopying to ensure that the field data would not be completely lost in case of fire or accident.

TABLE 1

GATAGA JOINT VENTURE

CLAIMS STAKED DURING 1977 BY GJV

Claim Name	Record No.	No. Units	Expiry Date	Mining Division
Eagle 1	280	12	20 April, 1978	Liard
2	281	18	" "	"
Hawk	282	20	" "	"
Taga 1	568	16	" "	Omineca
2	569	16	" "	"
3	570	16	" "	"
4	571	16	" "	"
Saint 1	283	20	28 April, 1978	Liard
2	284	20	" "	"
3	285	16	" "	"
4	286	20	" "	"
5	287	20	" "	"
6	288	20	" "	"
Bob 1	289	12	" "	"
2	290	20	" "	"
3	291	20	" "	"
4	292	16	" "	"
5	293	14	" "	"
6	294	20	" "	"
7	295	6	" "	"
Ready 1	296	20	" "	"
2	297	20	" "	"
3	298	15	" "	"
4	299	18	" "	"
5	300	18	" "	"
Knot 2	370	20	14 June, 1978	"
Gneiss 1	371	20	" "	"
2	372	20	" "	"
Pig 1	373	16	" "	"
2	374	16	" "	"
Et 1	375	20	" "	"
2	376	20	" "	"
Phun 1	377	10	" "	"
2	378	14	" "	"
Porc 1	379	8	" "	"
2	380	8	" "	"
3	381	20	" "	"
4	382	20	" "	"
5	383	16	" "	"
Snow 1	384	20	" "	"
2	385	20	" "	"
Will	417	20	11 July, 1978	"
Hole 1	418	6	" "	"
2	419	4	" "	"
3	420	12	" "	"
Bear	666	20	" "	Omineca
Ryte	667	20	" "	"
Here	668	20	" "	"
48		799		

TABLE 2

CLAIMS TO BE HELD BY GJV

This assessment report is being applied only to these claims staked during 1977:

Claim Name	Record No.	Number of Units	Expiry Date	Mining Division	Years	Assessment Years
Hawk	282	12 (1-4;13-20)	20 April, 1978	Liard	3	36
Taga 3	570	16	20 April, 1978	Omineca	3	48
Taga 4	571	16	20 April, 1978	Omineca	3	48
Saint 1	283	20	28 April, 1978	Liard	3	60
Saint 2	284	20	28 April, 1978	Liard	3	60
Saint 3	285	12 (103;14-19;25-27)	28 April, 1978	Liard	3	36
Saint 4	286	8 (1-4;13-16)	28 April, 1978	Liard	3	24
Saint 5	287	20	28 April, 1978	Liard	2	40
Bob 1	289	12	28 April, 1978	Liard	3	36
Bob 2	290	20	28 April, 1978	Liard	3	60
Bob 3	291	20	28 April, 1978	Liard	3	60
Bob 4	292	16	28 April, 1978	Liard	3	48
Bob 5	293	14	28 April, 1978	Liard	3	42
Bob 6	294	20	28 April, 1978	Liard	2	40
Bob 7	295	6	28 April, 1978	Liard	3	18
Ready 1	296	10 (1-5;12-16)	28 April, 1978	Liard	3	30
Ready 2	297	12 (1-3;14-19;25-27)	28 April, 1978	Liard	3	36
Ready 3	298	15 (1-3;14-19;25-30)	28 April, 1978	Liard	3	45
Knot 2	370	20	14 June, 1978	Liard	2	40
Gneiss 2	372	20	14 June, 1978	Liard	3	60
Pig 1	373	16	14 June, 1978	Liard	3	48
Et 2	376	20	14 June, 1978	Liard	3	60
Snow 1	384	8 (1-2;15-18;26-27)	14 June, 1978	Liard	3	24
Hole 1	418	6	11 July, 1978	Liard	2	12
Hole 2	419	4	11 July, 1978	Liard	2	8
Hole 3	420	12	11 July, 1978	Liard	3	36
Bear	666	20	11 July, 1978	Omineca	2	40
Ryte	667	20	11 July, 1978	Omineca	3	60
28		415				1155

T/ . 2

CLAIMS TO BE HELD BY GJV

This assessment report is being applied only to these claims staked during 1977:

Claim Name	Record No.	Number of Units	Expiry Date	Mining Division	Years	Assessment Years
Hawk	282	12 (1-4;13-20)	20 April, 1978	Liard	3	36
Taga 3	570	16	20 April, 1978	Omineca	3	48
Taga 4	571	16	20 April, 1978	Omineca	3	48
Saint 1	283	20	28 April, 1978	Liard	3	60
Saint 2	284	20	28 April, 1978	Liard	3	60
Saint 3	285	12 (103;14-19;25-27)	28 April, 1978	Liard	3	36
Saint 4	286	8 (1-4;13-16)	28 April, 1978	Liard	3	24
Saint 5	287	20	28 April, 1978	Liard	2	40
Bob 1	289	12	28 April, 1978	Liard	3	36
Bob 2	290	20	28 April, 1978	Liard	3	60
Bob 3	291	20	28 April, 1978	Liard	3	60
Bob 4	292	16	28 April, 1978	Liard	3	48
Bob 5	293	14	28 April, 1978	Liard	3	42
Bob 6	294	20	28 April, 1978	Liard	2	40
Bob 7	295	6	28 April, 1978	Liard	3	18
Ready 1	296	10 (1-5;12-16)	28 April, 1978	Liard	3	30
Ready 2	297	12 (1-3;14-19;25-27)	28 April, 1978	Liard	3	36
Ready 3	298	15 (1-3;14-19;25-30)	28 April, 1978	Liard	3	45
Knot 2	370	20	14 June, 1978	Liard	2	40
Gneiss 2	372	20	14 June, 1978	Liard	3	60
Pig 1	373	16	14 June, 1978	Liard	3	48
Et 2	376	20	14 June, 1978	Liard	3	60
Snow 1	384	8 (1-2;15-18;26-27)	14 June, 1978	Liard	3	24
Hole 1	418	6	11 July, 1978	Liard	2	12
Hole 2	419	4	11 July, 1978	Liard	2	8
Hole 3	420	12	11 July, 1978	Liard	3	36
Bear	666	20	11 July, 1978	Omineca	2	40
Ryte	667	20	11 July, 1978	Omineca	3	60
28		415				1155

CHAPTER II - GEOLOGY

Physiography and Geomorphology

The Gataga Joint Venture property lies within an unnamed range of the northern Rocky Mountains, flanked on the southwest by the Kechika River in the Rocky Mountain Trench and on the northeast by the broad Gataga River valley. Within the report area, physiography is typified by long low ridges and valleys which trend NW-SE, parallelling structural strike of underlying sedimentary rocks. These ridges and valleys are cut by NE-SW trending, wide, glacially scoured valleys which contain all major creeks and lakes. Tributaries and headwater drainages flow down NW-SE valleys which results in a trellised drainage pattern. NW-SE trending streams are immature with waterfalls and deeply incised narrow steep-walled canyons common through their length. In contrast, major NE-SW creeks meander through valleys bottomed by recent flood plain and Pleistocene glacio-fluvial and glacio-lacustrine deposits. Although elevations regionally range from 1100 m to 2700 m, relief is locally subdued in areas underlain by shales and clastic sedimentary rocks. Resistant older carbonate rocks which flank the project area to the SW and NE form prominent cliffs.

Treeline is at approximately the 1500 m elevation on south facing slopes, although it becomes much higher in the south. Vegetation in northern valleys is predominately composed of arctic black birch and willows with lesser black spruce in swampy areas and juniper and pine on dry slopes. Thick stands of black spruce and lodgepole pine carpet southernmost valleys.

The Gataga district has been subjected to an old stage of ice sheet glaciation but the most recent Pleistocene glaciation has consisted mainly of alpine and cirque glaciers to the east and west. The main geomorphological effect of the last glaciation was the modification and scouring of the main valleys, local disruption of the drainage pattern and formation of several lakes, downcutting of tributary streams to form several rock canyons, and a general lowering of the water table. This exposed unleached rock to surface or at least resulted in rejuvenation of the leaching cycle at a greater depth. This process resulted in very acidic groundwaters as pyrite was leached from shales. Surface neutralization of springs and seeps has lead to the formation of two types of recent conglomerate:

(i) deposits of calcrete or tufa which form where springs draining calcareous shales of the Ordovician and Silurian Road River shales reach surface (Unit 3 of Figure 4). Formation of calcrete is active at present.

(ii) deposits of limonite-cemented stream gravels or soil (ferricrete) and limonite gossans which form where springs draining pyritic shales of map Unit 7 reach surface (Figures 9 and 10). Springs draining other Devono-Mississippian shales usually do not precipitate iron (Figure 11).

Ferricrete deposits and gossans formed by springs and seeps are commonly exotic, i.e. they occur some distance from outcropping pyritic shales. Exotic gossans are usually formed by precipitation from springs and seeps that exit from fault and fracture zones which cut the shales. Limonite is actively precipitating at several localities in the Gataga area, coating and killing trees and shrubs that lie in the path of gossan growth. The locations of approximately fifty of the most prominent gossans and ferricrete deposits which occur in the project area are shown on Figure 5.

Brown ferricrete deposits and reddish-brown limonite gossans contain ferric iron whereas the weathered Devono-Mississippian black shales are bluish-grey in

Figure 9. Limonite-cemented talus and stream gravel (ferricrete).

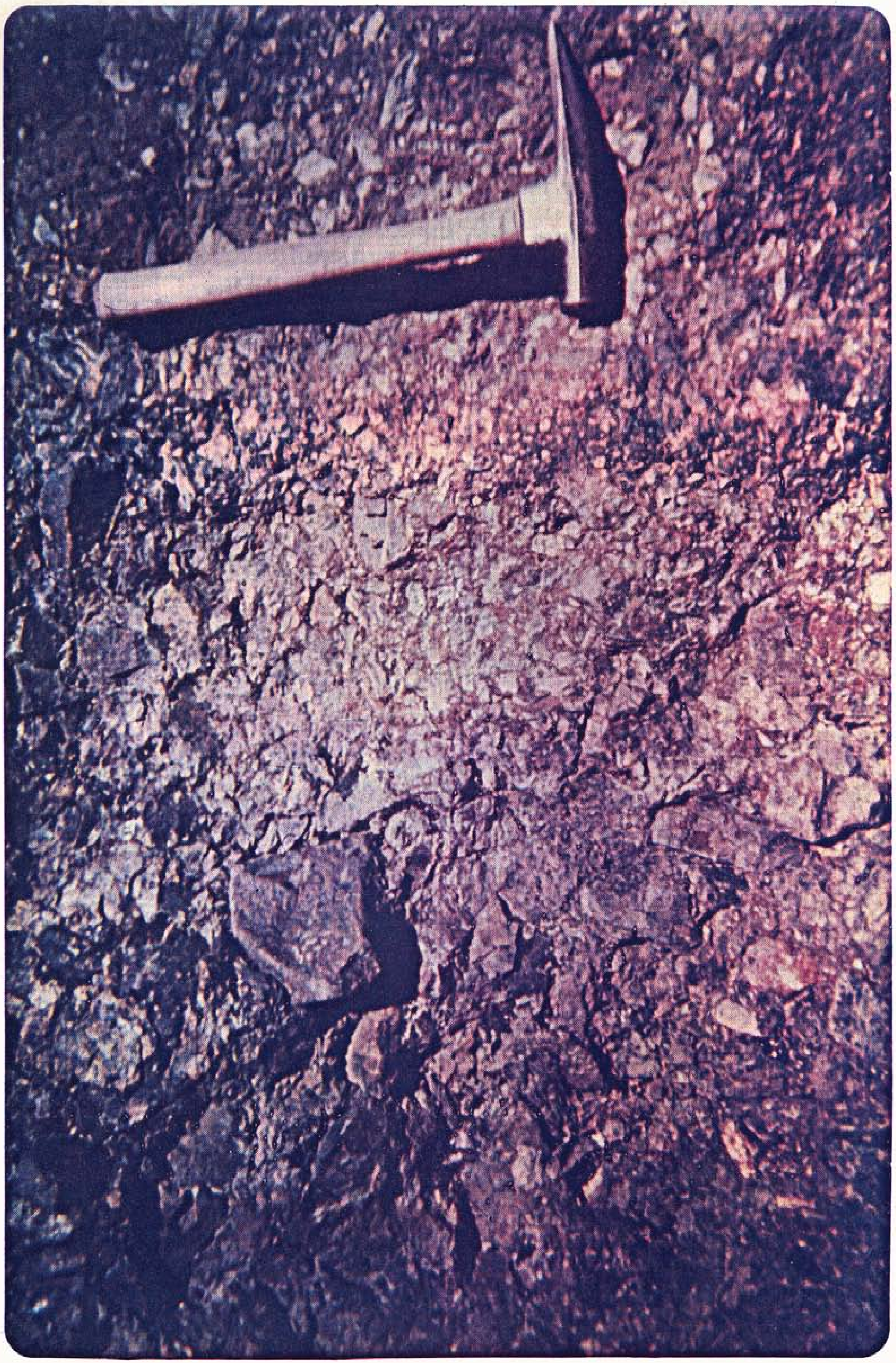


Figure 10. Iron oxide precipitating from a spring near Joe Poole Creek.

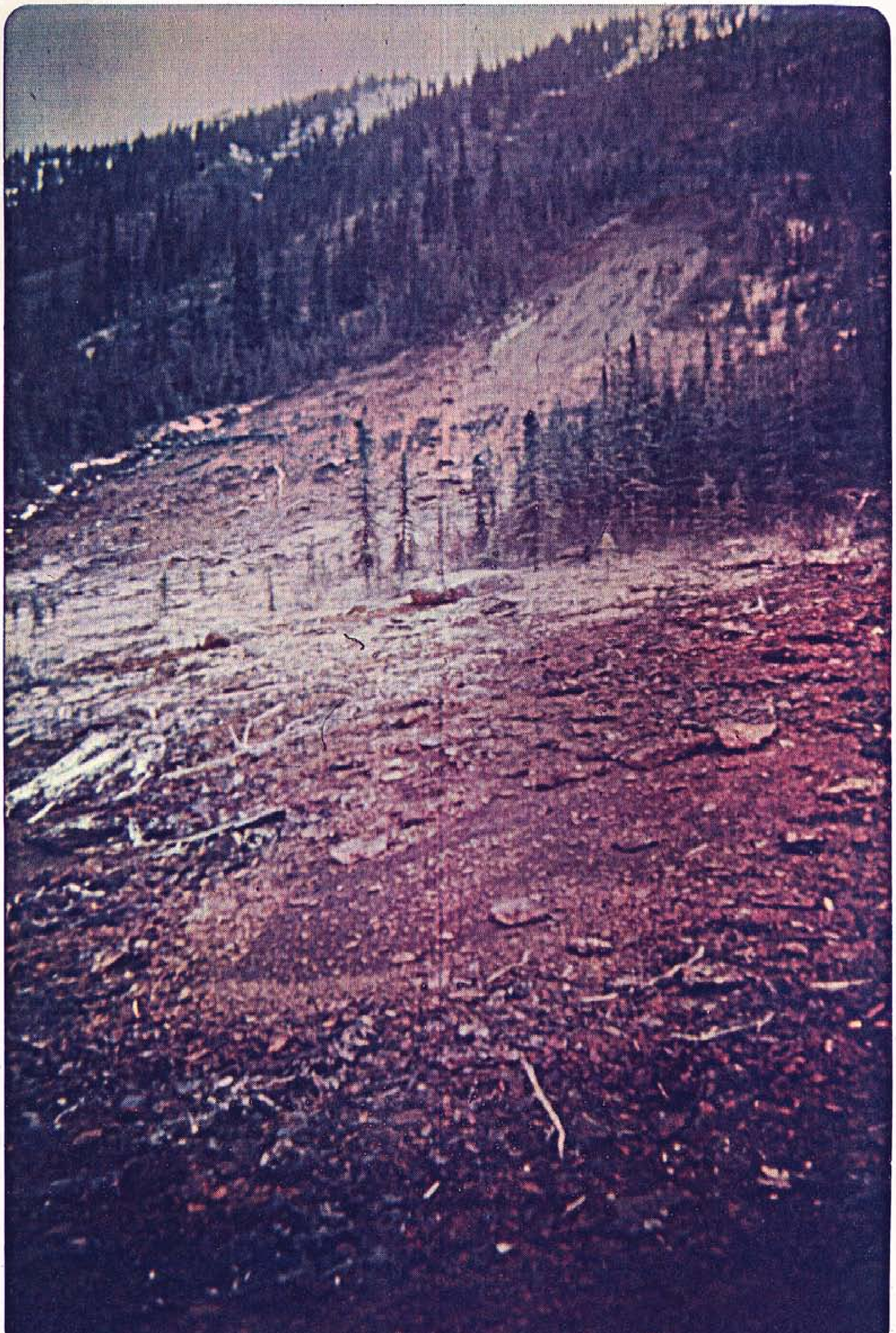
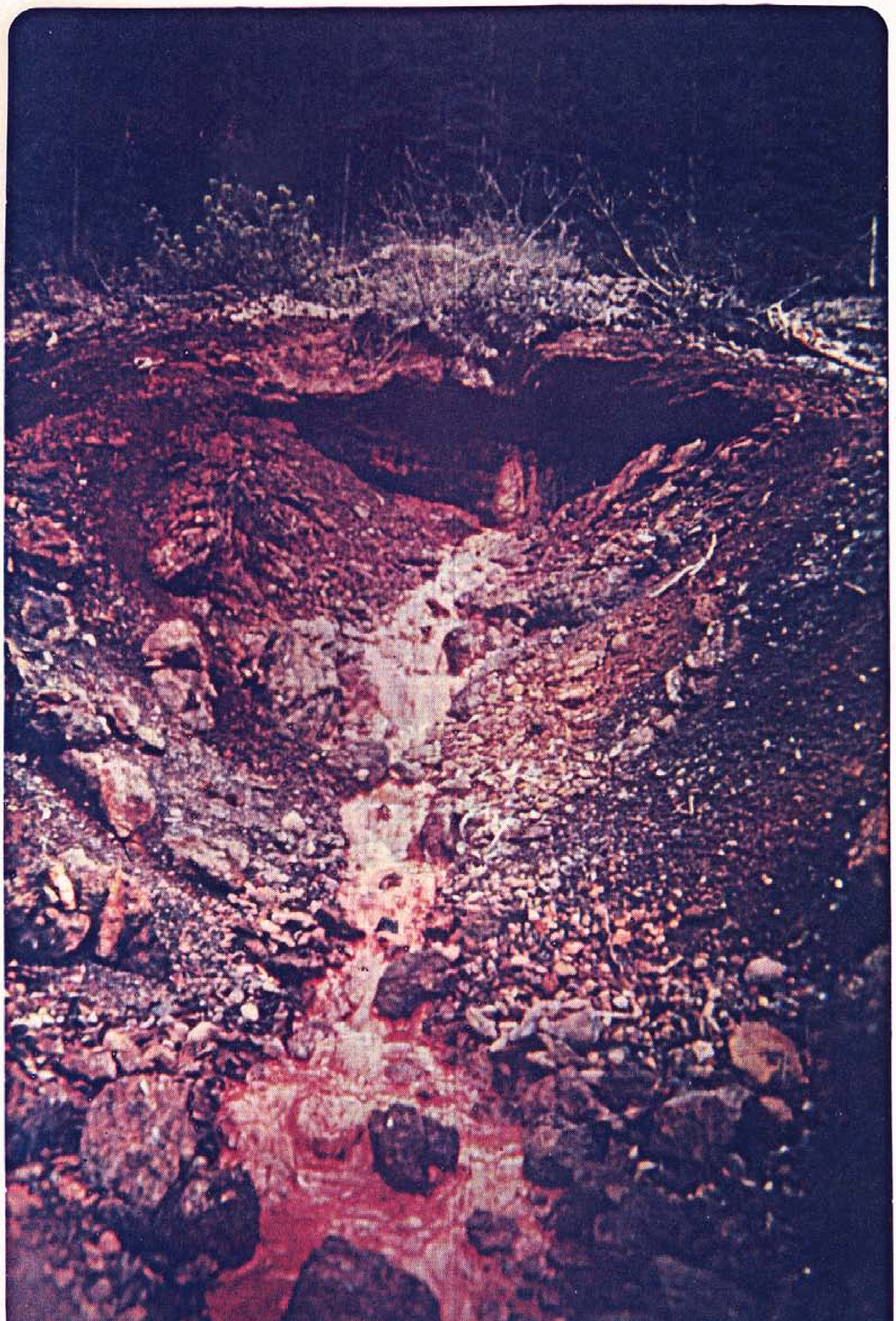


Figure 11. Rusty water running from a seep draining pyrite black shales of Unit 7. Clear water is from a seep draining Unit 6 non-pryitic shales.

Figure 12. A large gossan and ferricrete deposit developed below a spring draining pyritic shales of the Gunsteel Formation (Unit 7).



colour, typical of ferrous iron. Overall colour of the gossans, which varies from bright rusty red to dark brown, probably reflects the amount of manganese oxides (black) contained within the iron-rich deposits. Size and shape of gossans and ferricrete deposits are variable, reflecting individual differences in discharge rate of supplying seeps and springs and in the slope of the deposition area. Gossans and ferricrete deposits which are /were supplied by vigorous springs reach sizes in excess of 50,000 m^2 (Figure 12).

Stratigraphy

Introduction

The report area lies within the Kechika Trough, a southwesterly continuation of the much larger Selwyn Basin (Figure 13). Sedimentary rocks exposed in the report area range in age from Cambrian to Lower Mississippian (?). Stratigraphy and facies relationships are summarized in Figures 4 and 14. Until Middle Devonian time, sedimentation was characterized by stable continental shelf deposition with low sedimentation rates. Rapid deposition of a westerly-derived flysch sequence during the Upper Devonian and Lower Mississippian terminated the lower Paleozoic "starved-basin" regime. Upper Devonian and Lower Mississippian lithologies within the report area bear a striking resemblance to rocks which host the Macmillan Pass (Tom and Jason) barite-lead-zinc-silver deposits in Yukon Territory.

CAMBRIAN

Atan Group (Units 1 and 2

Resistant lithologies of the Atan Group regionally occur in two facies:

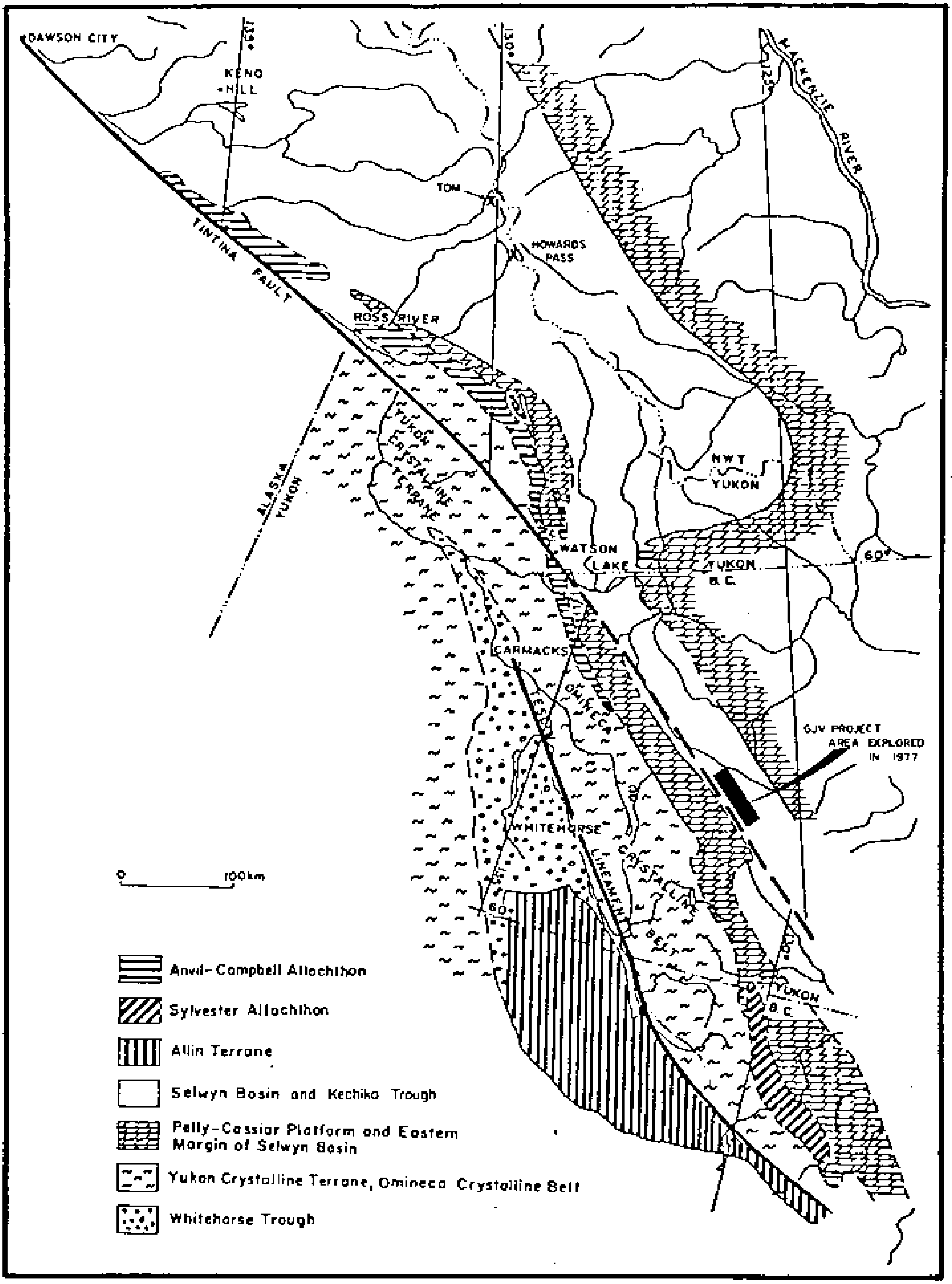


Figure 13 Tectonic map of northeast British Columbia and southern Yukon Territory after restoration of 450 km of right lateral movement on Tintina Fault (after Tempelman-Kluit, 1976).

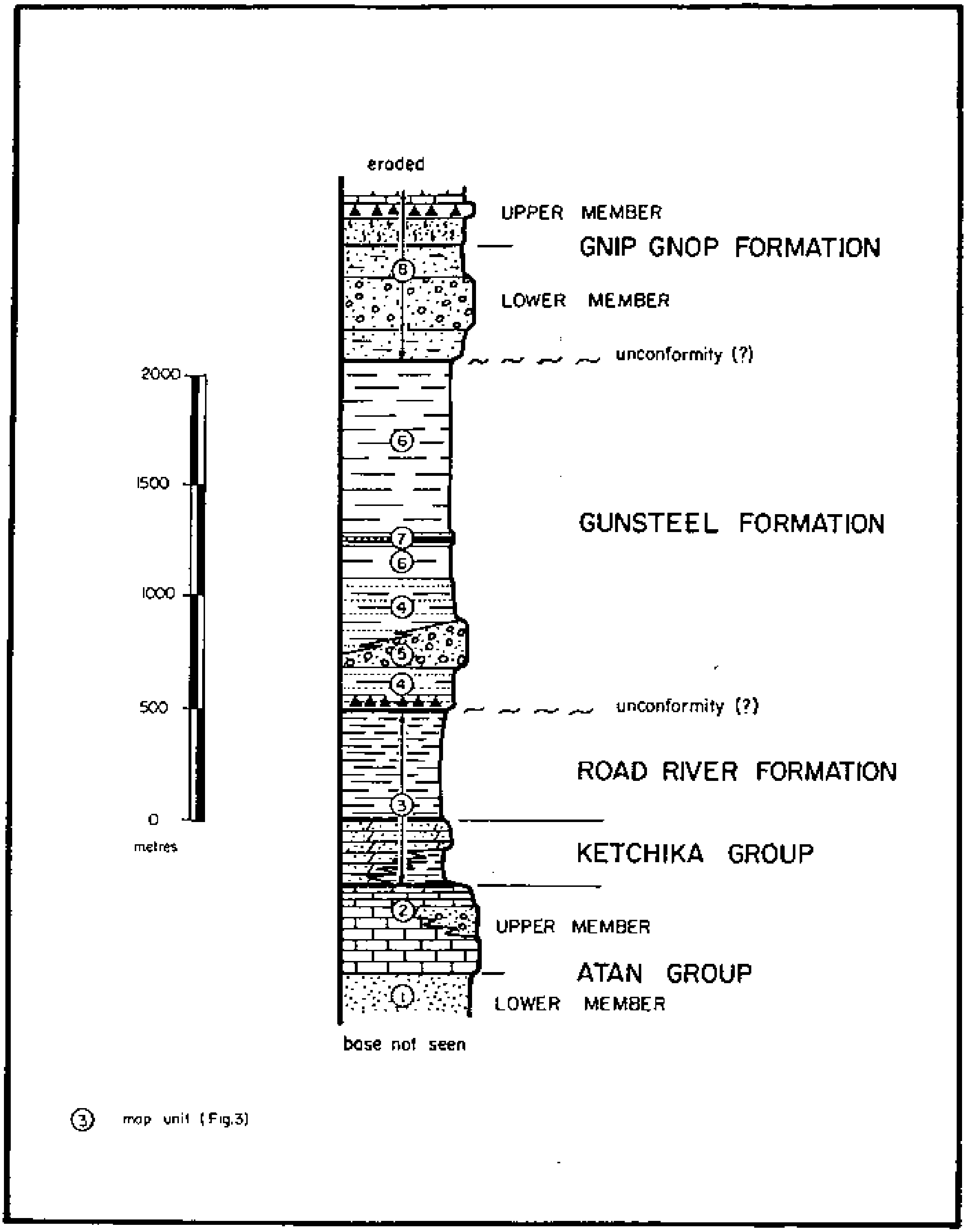


Figure 14 Generalized stratigraphic column (looking south) of Lower Cambrian to Mississippian lithologies; Driftpile Creek area, northeast British Columbia.

an eastern and younger clastic member and a western and partly coeval carbonate facies (Taylor and Stott, 1973). Both form prominent strike ridges within the report area (Figure 15).

Unit 1

The lower member of the Atan Group is identified as Unit 1 on Figure 4. Lithologies consist of thick bedded to massive, brown weathering, well sorted, white quartzite interbedded with lenses of grey to greenish grey calcareous and non-calcareous shale containing pods of grey limestone. According to Taylor and Stott (1973) the clastic succession apparently represents the distal facies of large westerly prograding fanglomerates deposited adjacent to active growth faults.

Unit 2

The upper member of the Atan Group (Unit 2) consists principally of partially dolomitized archeocyathid "patch reef" and biostromal limestone built upon the underlying quartzites. Inter-reef deposits consist, in part, of very coarse and angular, buff weathering, dolomitized limestone conglomerates probably derived as reef-front breccias. In contrast to the reef material, these rocks have been almost completely dolomitized resulting in nearly total replacement of primary textures and lithologies with vuggy , sucrosic dolomite. Orange-brown weathering, grey calcareous argillaceous quartzite and quartzite cobble conglomerate inter-tongued with clastic carbonate beds make up the majority of inter-reef material. These quartzites are poorly sorted and cemented in contrast to the well indurated quartzites of the lower member. Clasts within the conglomerate are poorly sorted, ranging from granule to fist-sized cobbles of well cemented, clean white quartzite possibly derived from Unit 1. Taylor and Stott (1973) report that cobbles of Helikian gabbroic dike material are contained within the conglomerate east of the report area. The quartzite and quartzite pebble conglomerate of the upper member contain up to 5 per cent specular hematite within

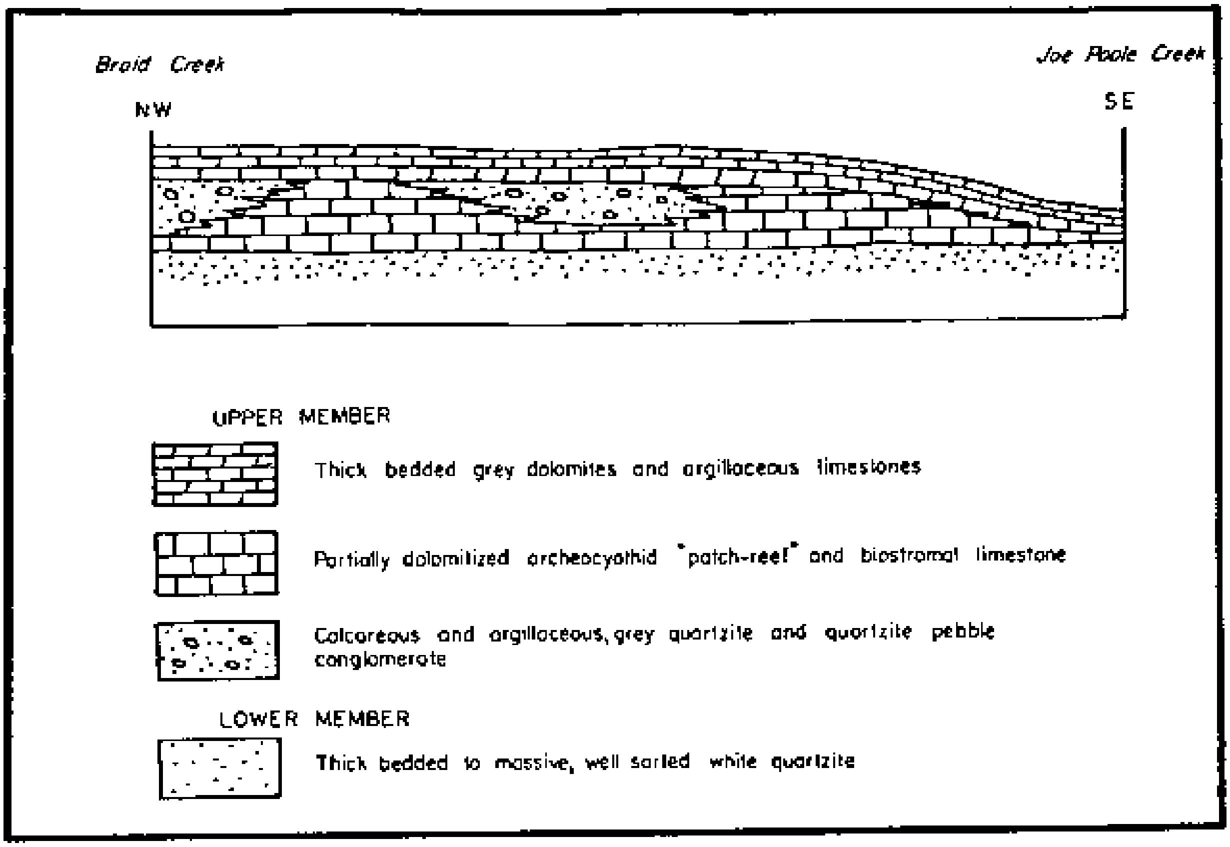


Figure 15 Diagrammatic facies relationships within the Atan Group in the GJV Project area (not to scale).

the matrix. Surface oxidation of hematite probably contributes to the distinctive brown weathering colour of these rocks. The quartzite and, to a lesser degree, the conglomerate of Unit 2 are bioturbated and contain vertical worm burrows up to one cm in diameter which are filled with clean quartz sand in a calcareous matrix. Unit 2 clastic rocks were likely derived from erosion of Unit 1 quartzites and/or continued erosion of older rocks to the east. Reef and inter-reef sediments of Unit 2 are thin or locally missing near Joe Poole Creek in the southwest part of the report area.

A sequence of thick bedded, grey dolomites with interbedded platy argillaceous grey limestones, which forms the upper part of Unit 2, caps the Atan Group sequence in the report area.

Most of the limestone is massive, microcrystalline and structureless. Stromatolite structures and oolites, which are consistent with a shallow water depositional environment for the limestones, were seen in the northeastern part of the report area but are not regionally abundant.

Although no mineralization was seen in Atan Group rocks, some features of the upper member (Unit 2) are worth special mention:

(i) the almost complete dolomitization of reef-front breccia limestones has resulted in extremely high porosity and permeability that has been only partially reduced by secondary sparry dolomite. These are ideal host rocks for "Mississippi Valley-Type" lead-zinc deposits.

(ii) the probable source of Unit 2 inter-reef quartzites and conglomerates was erosion of Proterozoic rocks to the east, which host a number of vein copper deposits of Precambrian age. The stable nature of clasts in the quartzite (predominately quartz) suggests that chemical weathering of the source terrane was fairly intensive.

It is reasonable to assume that copper carried in solution might have been eventually redeposited in Unit 2 quartzites if a suitable chemical trap was present - a situation analagous to the Katanga copper belt of Africa. Specular hematite in the matrix of the quartzite rather than pyrite is evidence for an oxidizing environment of deposition. Suitable reducing environments with available sulphide may have been present in back-reef basins east of the report area.

UPPER CAMBRIAN TO LOWER DEVONIAN (?)

Unit 3

Lithologies of the Upper Cambrian to Lower Ordovician Kechika Group (Jackson et al, 1965) and Ordovician to Lower Devonian Road River Formation (Gabrielse, et al, 1977) underly much of the map area (Unit 3, Figure 4). Because of the complex structure of these rocks and their recessive nature, they were not differentiated during regional mapping. Kechika and Road River rocks, however, are easily distinguished from each other on a local scale.

Kechika Group

Kechika Group consists predominately of thin bedded, buff-brown and grey-brown silty limestones and dolomites with subordinate dolomitic and calcareous siltstones. Many of the siltstones are very finely laminated, suggesting a shallow water, algal origin. Basal lithologies of the Kechika Group, where seen, consist of a highly variable assemblage of sooty, moderately calcareous, black shales containing appreciable interbedded dark grey to black, orange weathering, fetid limestones and calcareous mudstones. Shales are often pyritic and commonly contain Lower Ordovician graptolites while limy units are typically non-fossiliferous. Marcasite nodules up to 10 cm in diameter are common in the fetid limestones.

The contact of basal Kechika Group rocks with Atan Group was not observed due to the recessive nature of the former. Taylor and Stott (1973) suggest that an angular unconformity exists between the two. Field evidence indicates that the contact is partially or even totally faulted within the report area.

Facies relationships within the Kechika Group are difficult to determine because of uncertain structural relationships coupled with lack of outcrop. Shales predominate over limy clastic rocks in lowermost and westerly exposures of the group. The Kechika Group east of the project area consists generally of uniform argillaceous limestone (Taylor and Stott, 1973). This suggests that a westerly progradation of the shoreline with consequent shallowing occurred during deposition of the Kechika Group in the report area.

<u>Road River Formation</u>

The Road River Formation is best exposed where it is thrust over younger rocks of the Gunsteel Formation along the west-central margin of the report area. Lithologies primarily consist of extensive thicknesses of generally calcareous and occasionally pyritic, sooty black shale and mudstone. Basal shales of the formation contain minor black chert interbeds and limestone nodules, lenses, and thin discontinuous beds. Chert beds become more prominent towards the west, increasing in thickness and number while carbonate content of the interbedded shales appears to decrease correspondingly.

Uppermost beds of the Road River Formation consist of brown weathering, medium grey, "flaser bedded" calcareous siltstone and silty limestone. Bedding thickness varies from 1 to 3 cm to greater than 2 m. The term "flaser bedding" is used to describe evenly bedded calcareous siltstone with contorted and disrupted carbonaceous laminae probably resulting from the mixing action of intense bioturbation. With the exception of these rocks, all Road River lithologies are graptolitic, with graptolites ranging in age from Ordovician in basal members to Silurian in upper parts.

True stratigraphic thickness of the package is difficult to determine due to the structural complexity of the area; however, the Road River Formation appears to thicken considerably to the west. This thickening is particularly well defined in the thrust sheet which borders the southwest edge of the report area. Shallow-water marine sediments, correlative with the Road River shales, are present near Cloudmaker Mountain southeast of the Gataga Lakes area (Jackson, et al, 1965). Lithological changes within the Road River Formation and correlative rocks are regionally consistent with deposition on a continental shelf-slope setting. The shelf to slope transition appears to occur along a roughly southeast-northwest trending zone coincident with the central axis of the report area. Road River lithologies west of this zone were probably deposited along a stable continental slope. Flaser-bedded, calcareous siltstones, which are the youngest Road River sediments, are regional in extent, indicating rapid shallowing of the continental shelf and slope during Lower Devonian times.

The depositional environment and resultant lithofacies distribution of the Road River Formation in the Gataga Lakes area are remarkably similar to the regional setting of the Canex-Placer's Howard Pass stratiform lead-zinc deposit 450 km to the northeast along the Yukon-NWT border. According to Morganti (1976), sygenetic base metal deposition at Howard Pass took place on the shale slope between the eastern shallow-water platform carbonate facies and the western deep-water chert facies. Sub-basins formed within a larger basin on the slope were euxinic traps for lead and zinc carried in brines expulsed from dewatering shales. Mineralization occurs at a specific horizon, termed the "active zone", characterized by cyclic sedimentation of siliceous and calcareous argillaceous sediments.

Mineralization of this type was not seen in potentially economic concentrations in Road River lithologies in the project area. However, a zone of siliceous shale approximately 3 m thick contained within a series of siliceous, graphitic shales interbedded with calcareous mudstones and argillaceous cherts which is exposed a few kilometres northeast of Braid Creek contains abundant secondary zinc oxides as surficial coatings and fracture fillings. Two chip samples taken across this zinc-rich horizon assayed:

	Cu (ppm)	Pb (ppm)	Zn (ppm)
Lower 1.5 metres	106	26	3150
Upper 1.5 metres	128	154	2200

While the base metal content of the assayed rock does not approach economic quantities, the existence of a metalliferous shale in rocks which are markedly similar to, and broadly correlative with, host rocks of the Howard Pass deposit is significant. Search for similar mineralization of higher grade should involve the delineation of "basins within basins" according to the model proposed for the genesis of the Howard Pass deposit by Morganti (1976).

MIDDLE DEVONIAN TO MISSISSIPPIAN(?)

Gunsteel Formation (Units 4 to 7)

The central part of the report area is underlain by a series of clastic rocks of the Middle Devonian to Lower Mississippian (?) "Gunsteel Formation" included in map units 4, 5, 6 and 7 (Figure 4). General stratigraphy and facies relationships within the Gunsteel Formation are shown in Figure 16. Lithologies of the Gunsteel Formation exposed in the Tuchodi Lakes map area (94-K) were originally mapped as Ordovician Kechika Group (Taylor and Slott, 1973) but were later reassigned to the Upper Devonian and youngest Mississippian by Gabrielse, et al (1977a) because they overlie Middle Devonian carbonate strata south of Kwadacha River. Correlative rocks are overlain by Lower Mississippian carbonates west of South Gataga Lakes (ibid). The name "Gunsteel Formation" was used for this assemblage by GJV personnel during the 1977 field season following informal Geological Survey of Canada nomenclature.

Unit 4

The lowermost 30 to 100 m of Unit 4 are characterized by an alternation of silty shale ("gritty" shale and "pinstripe" shale) with medium bedded (5 cm to 15 cm thick), black, bluish-black weathering, argillaceous chert. Chert and limestone are generally present in minor amounts although an unusually thick section of chert alternating with silty shale outcrops on a ridge north and west of the Canex Placer Driftpile Creek showing. This cyclic alteration of fine-grained siliceous sediments and pelagic limestone with clastic rocks probably represents the sedimentological transition between the "starved-basin" regime of the underlying Road River sediments and "flysch-type" deposition of the overlying Gunsteel Formation.

A 1.5 to 2.2 metre thick sequence of very fine-grained, chalky white weathering, very kaolinitic and moderately siliceous grey shale overlies basal cherts and siltstones of Unit 4 where they are exposed east of the Driftpile Creek

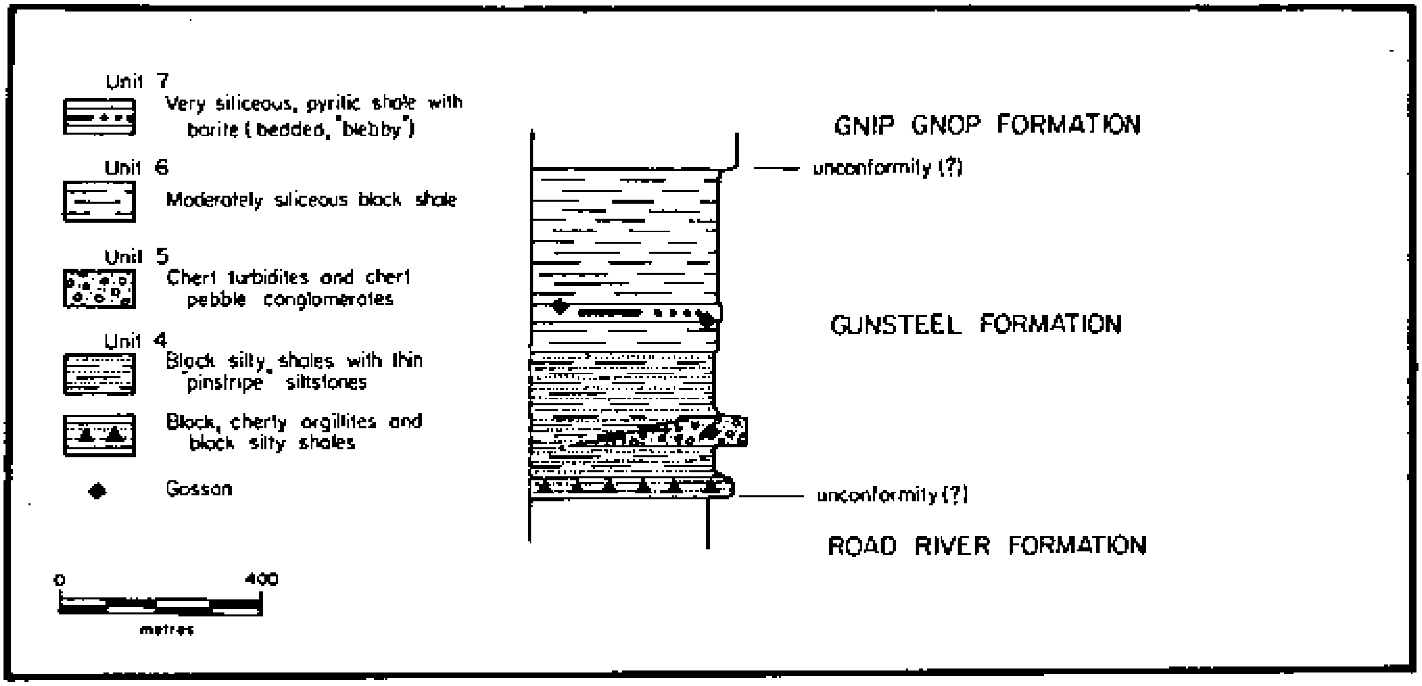


Figure 16 Diagrammatic stratigraphic column showing lithologies and facies relationships of the Gunsteel Formation (Units 4, 5, 6 and 7).

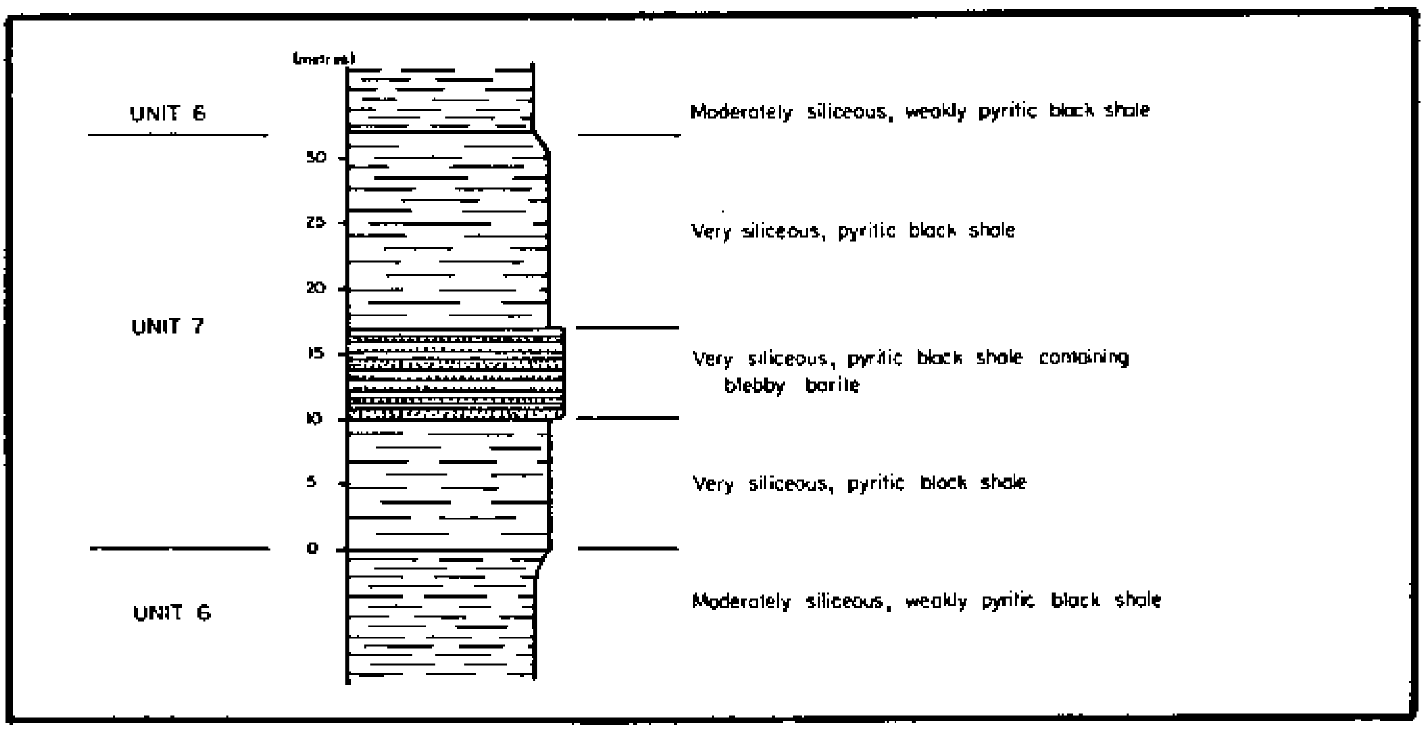


Figure 17 Stratigraphic column through "blebby" barite facies of Unit 7 of the Gunsteel Formation. Section located 6 km soutwest of Canex-Placer's Driftpile Creek property.

showing. These rocks outcrop discontinuously along strike for a distance of 5 km to the southeast. Ghostly shard-like fragments which were seen in hand specimens suggest that it may be, in part, a submarine tuff horizon. In a few localities, white weathering shales contain spherodial nodules 2 mm to 5 mm in diameter made up of radiating, black, acicular crystals of barite rimmed with fibrous chalcedony.

The bulk of Unit 4 rocks consist of a variable thickness (200 m to 500 m) of light blue-grey weathering, moderately siliceous, generally silty, non-calcareous black shale. Although they are similar to overlying rocks of Unit 6 northwest of Driftpile Creek, these shales are regionally distinguished by their generally low silica content (i.e. relative hardness) and their high percentage of silt-size material. Silt is present as an evenly distributed "grit", as "pinstripe" siltstone laminae, and as 2 cm to 8 cm thick, porous and ungraded siltstone beds. "Gritty" and "pinstripe" shales are generally non-pyritic while porous siltstone beds commonly contain appreciable amounts of pyrite.

Unit 5

Unit 5 is a wedge-shaped series of greywackes, mainly chert arenites and siltstones with minor chert pebble conglomerates, that occurs within Gunsteel Formation silty shales of Unit 4. Unit 5 is best exposed on strike ridges southeast of the GJV camp at Gnip Gnop Lake. The material of these rocks was deposited by turbidity currents and associated mechanisms in a prograding submarine fan assemblage during deposition of Unit 4 shales. Concurrent deposition of silty shales of Unit 4 and turbidites of Unit 5 is illustrated by the gradual lateral gradation between the two rock types. In several locations "pinstripe" shales of Unit 4 can be traced along well exposed strike ridges until they coarsen and thicken to recognizable turbidites which are mapped as Unit 5. On a regional scale the two map units can be differentiated by shale/siltstone ratios. Unit 4 silty shales have overall shale/siltstone ratios much greater than ten while Unit 5 turbidites are characterized by shale/stilstone ratios of much less than one.

Coarse clastic rocks of Unit 5 display a marked turbidite facies development in the southern part of the report area, progressively fining to the northeast (Figure 18). Turbidity current directions determined from orientations of tool and prod marks, basal scours and cross-laminations indicate a southwesterly provenance for the sediments, complimenting their facies development across the project area. Turbidites grade from proximal beds in the southwest that are comprised of thick sequences of unsorted conglomerates and Bouma (1962) A and B beds (Figures 19 & 20), to lateral and distal equivalents in the northeast that are primarily composed of Bouma B, C, D and E divisions.

Due to the variability of parameters, such as velocity and initial volume of individual turbidity flows, facies relationships within tubidite assemblages must be referred to in an overall sense. For instance, beds within a facies designated as "proximal" may individually be classed as "distal turbidites" because of their initially lower volume or velocity of transport. Facies designations were based on the combined characteristics of a large number of beds in a given stratigraphic section.

Proximal Facies

Proximal turbidites of Unit 5 are primarily composed of thick (3 to 5 m) AB beds. Clast size ranges from silt to cobbles, generally consisting of very well

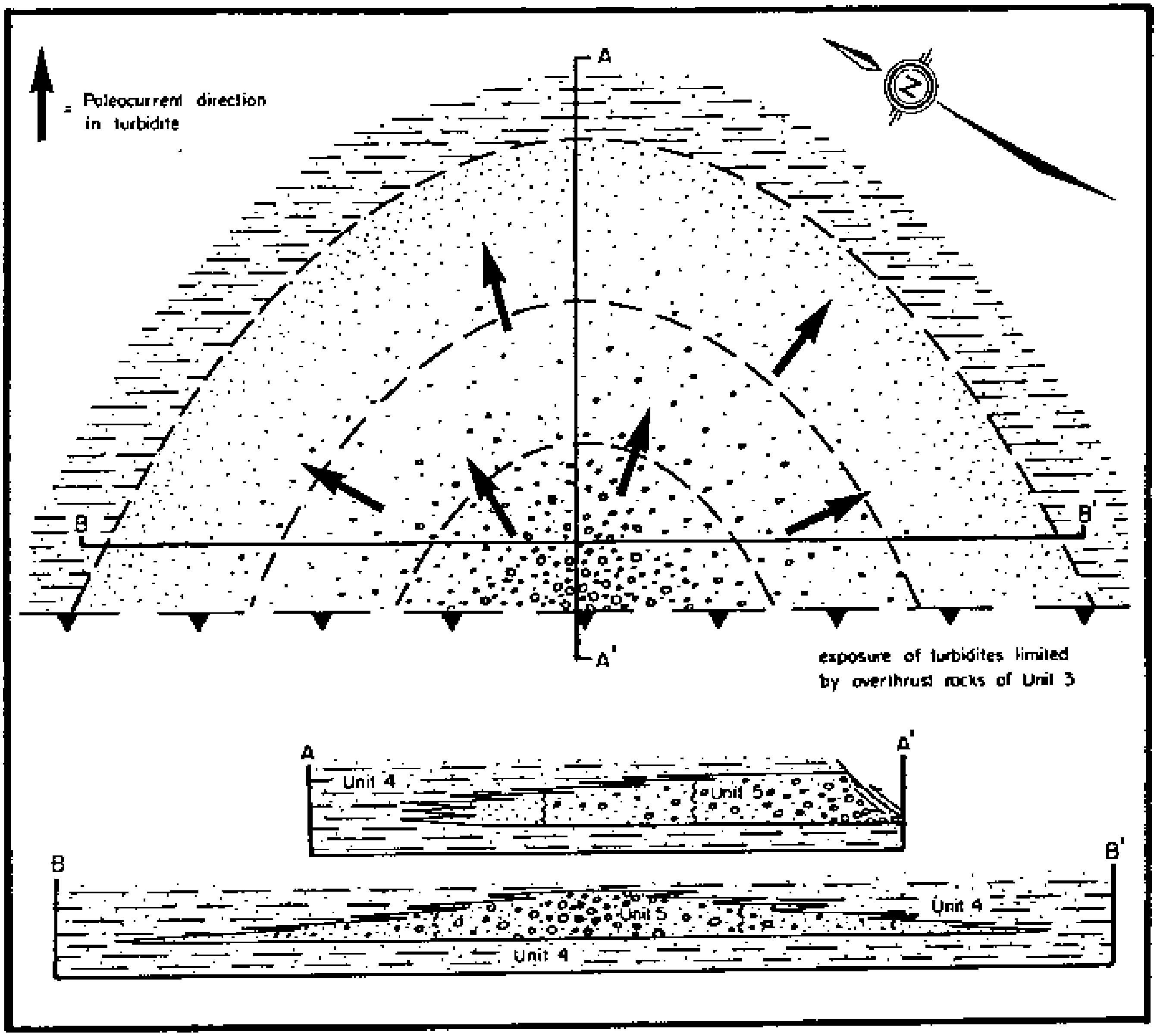


Figure 18 Diagrammatic facies relationships of a turbidite fan occurring within the GJV project area (no scale implied).

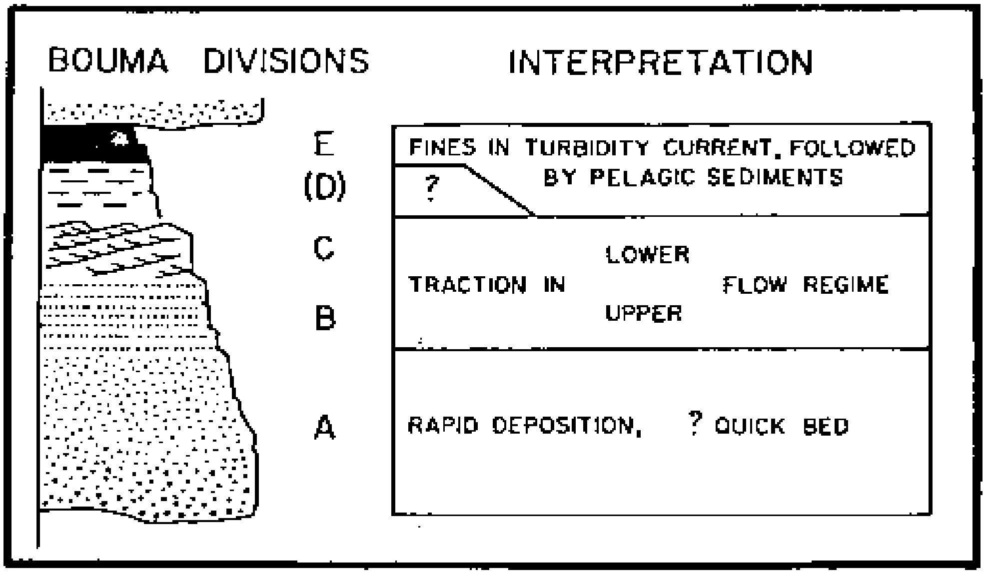


Figure 19 Divisions of the Bouma turbidite model:
A – graded or massive sandstone or conglomerate;
B – parallel laminated sandstone;
C – ripple cross-laminated fine sandstone;
D – faintly laminated siltstone;
E – shale, partly deposited by turbidity current, partly hemipelagic (after Walker, 1976).

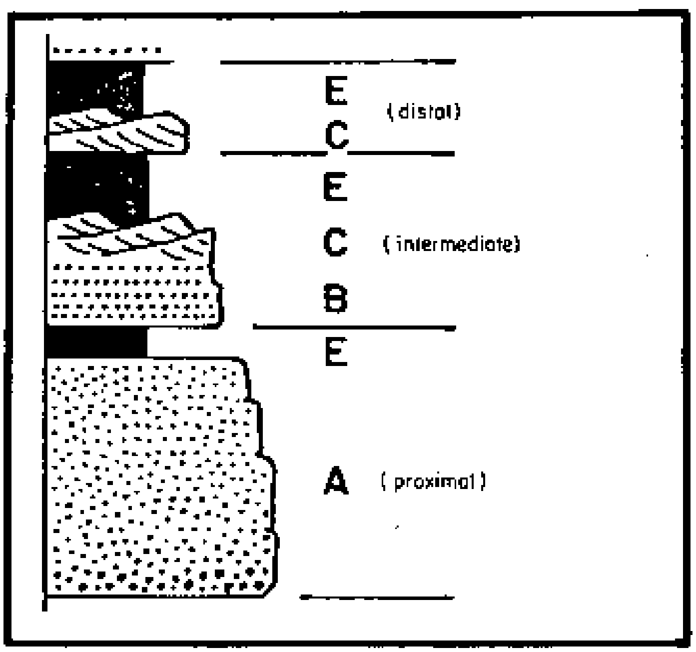


Figure 20 Hypothetical sequence of three turbidites described as AE (proximal), BCE (intermediate), CE (distal)[after Walker, 1976].

rounded white, grey and black chert. Unsorted and ungraded chert pebble conglomerates occur as elongate, lenticular bodies which were probably emplaced as debris flows filling submarine channels. These conglomerates reach 10 m in maximum thickness in westernmost exposures, thinning rapidly to the northeast along their long axes.

Intermediate Facies

The intermediate turbidite facies of Unit 5 is composed of an interbedded mixture of classical proximal and distal turbidite suites (AB to AE as well as BE and CE). Individual beds range in thickness from 0.5 to 2 m. Coarsest clasts are rarely larger than granule size. Coarse-grained, unsorted debris flow conglomerates are rare. Massive beds of well sorted, coarse sandstone with diffuse parallel laminae and occasional dish structures were probably deposited as grain flow deposits. Unlike debris flow channel fillings, however, grain flows are commonly sheet-like in character. Grain flow deposits are characteristically very porous and pyritic. Their average thickness ranges from 4 cm to 10 cm.

Distal Facies

Turbidites of the distal facies are finer grained, thinner and more fully developed than those of the intermediate facies. Shale members (DE beds) are the dominate lithology of the distal facies; coarser grained B and C beds are present but they are commonly thin and discontinuous.

Gradation of the distal facies Unit 5 turbidites into silty shales of Unit 4 is gradual and the mapped contact is, for the most part, arbitrary. Along a well-exposed strike ridge southeast of Joe Poole Creek, silty shales and "pinstripe" siltstone beds of Unit 4 can be traced laterally until they grade into turbidites of the distal and, finally, intermediate facies of Unit 5. Deposition of the turbidite fan was therefore contemporaneous with deposition of parts of Unit 4 silty shales. "Pinstripe" shales of Unit 4 are probably lateral equivalents of turbidite fans of Unit 5.

Rapid turbidite facies changes within the project area are probably indicative of a fairly proximal sediment source. The well-rounded nature of chert clasts may indicate high energy erosion in the source terrane (i.e. fluvial or beach processes) rather than simple mass wasting of unstable submarine slopes. This abrupt appearance of southwesterly derived coarse clastic material in the Gunsteel succession is likely indicative of a rapidly uplifted source terrane immediately southwest of the project area.

Plant fragments seen in turbidites of Unit 5 and correlative silty shales of Unit 4 were submitted, via K.M. Dawson, to the Geological Survey of Canada for identification and dating. These fossils show a definite "woody" fibrous structure, in contrast to the non-fibrous nature of Paleozoic tree-ferns. Woody plants evolved at the close of the Devonian period which places a maximum age on the enclosing rock. The presence of tree fragments is also indicative of a subaerial source terrane.

Unit 6

Unit 6 is composed of bluish silver-grey weathering, moderately siliceous, non-calcareous black shales,which can be distinguished from underlying silty shales of Unit 4 by a generally higher silica content (probably as cement) and much finer grain size. Differentiation of the two units becomes difficult northwest of Braid Creek where Unit 6 shales contain appreciable silt-size material as an evenly distributed "grit". Pyrite is always present in Unit 6 although it usually occurs in trace amounts, likely as finely disseminated framboids. Oxidation of this pyrite occasionally gives the unit a weak rusty-brown weathering aspect.

Thickness of Unit 6 is difficult to determine, as a complete stratigraphic section from Unit 4 to 8 is not found undisturbed anywhere in the report area. The complex nature of the structural geology prohibits extrapolation of stratigraphy along strike or down dip to estimate the thickness. In any case, the maximum observed thickness for Unit 6, over 500 m, occurs in the Driftpile Creek area, 2 km southwest of the Canex Placer showing.

Unit 7

Unit 7 is a distinctive horizon of regional extent consisting of very siliceous shale and chert containing anomalously high amounts of pyrite. This horizon, which varies in thickness from 10 m to 40 m thick, occurs near the base of Unit 6. It contains all major stratiform barite occurrences in the project area, including barite-lead-zinc mineralization on Canex Placer's Driftpile Creek property. This barite, pyrite, and silica-rich horizon usually weathers a distinctive pale buff-brown colour although the typical weathering colour of the unmineralized portions is silver-grey. In general, the shale weathers recessively although it is somewhat more resistant than shales of Unit 3. The more siliceous member containing pyrite and barite is the most resistant part of the unit, sometimes forming long, low ridges with occasional outcrops on the bottom of glaciated valleys where topography is normally subdued. However, in the vicinity of the lead-zinc mineralization on the Canex Placer property and GJV's Saint claims, this siliceous unit is very recessive and weathers quickly to a muddy soil that is unvegetated above treeline. Shales of Unit 7 immediately overlying the baritic horizon are uniformly very siliceous and commonly very pyritic, forming competent, blocky fracturing lithologies with a rusty-brown weathering colour.

The base of Unit 7 consists everywhere of relatively thick bedded, very siliceous black shale. Pyrite is common throughout the unit, usually occuring as minute disseminated fromboids and rarely as concentrations of framboids in beds less than 5 mm in thickness. Silica content of the shales is very high, except for very thin,evenly spaced, non-siliceous,black shale beds that form conspicuous partings. Bedding thickness of the siliceous shales varies from 3 cm to 10 cm. These rocks commonly contain very large chert-carbonate septarian nodules.

Barite occurs in two principal modes: (i) most commonly as "blebby", late diagenetic(?) flattened nodules, sometimes approaching massive quantities but always stratiform in nature; and, (ii) as very fine-grained, massive, bedded accumulations. (i) Grey "blebby" barite occurs as concentrations along laminae within specific beds of very siliceous, pyritic black shales. Aside from the extensive accumulations of barite, these rocks are identical in morphology and composition to underlying basal shales of Unit 7. Thickness of barite-bearing beds varies from 2 to 15 cm, usually separated from each other by a variable thickness (2 to 5 cm) of pyritic, siliceous, non-baritic shale. Flattened nodules or blebs of barite grade upwards with the coarsest and largest at the base of each bed of baritic shale and the finer sizes towards the top. In this fashion, the overall occurrence of barite in successive shale beds exhibits a markedly cyclic nature. Apparent size-grading and cyclicity of barite bodies within certain shale beds are assumed to be features of episodic, diagenetic formation of barite although the actual mechanisms for this process are not fully understood. A stratigraphic column through "blebby" barite-bearing rocks of Unit 7 is shown in Figure 17 following page 23.

Where deformation of enclosing rocks is relatively intense, "blebs" of barite are commonly restructured along cleavage planes producing bodies with elliposidal cross sections, elongated along axial planes of small and large scale folds. In addition, barite-bearing shales often show evidence of fairly intense soft-sediment deformation such as slump structures, chaotic bedding and broken, contorted laminae. Late diagenetic timing of the deformation is confirmed by the differentation of axial planes of soft sediment folds from axial planes of later folds outlined by elongation of barite bodies.

(ii) Massive, bedded barite appears to occur at the same stratigraphic position as blebby barite, although the genetic relationship between the two has yet to be determined. At one location, on the Red claims 4 km northwest of the GJV camp on Gnip-Gnop Lake, blebby baritic shales grade laterally into massive bedded barite. In addition, pyritic and siliceous black shales that host bedded barite deposits are virtually indistinguishable from shales which form the footwall and hanging wall to blebby barite-bearing shales.

Bedded barite occurs as a finely laminated,greyish-white to almost black rock with a massive character. Interbedded black shales are thin and very siliceous. Deposits of bedded barite range in thickness from less than one metre to over 20 m and have a lateral extent of between a few tens of metres and nearly one kilometre. Barite of this type does not contain appreciable amounts of pyrite.

Light greyish- white barite is invariably interbedded with discrete pyrite laminae and thin beds of grey chert. Barite of this type was only seen in exposures of Unit 7 that are immediately peripheral to the Driftpile Creek showing, where similar light coloured barite is the gangue mineral interlaminated with lead and zinc sulphides. According to petrographic work performed on these rocks by Wise (1974), light grey barite interlaminated with sphalerite and galena occurs as small interlocking tabular grains. Elongation of crystals is parallel to bedding planes. Galena and sphalerite occur as anhedral grains, interstitial to barite and as discrete laminae containing minor euhedral barite crystals.

An unusual type of barite was seen within Unit 7 along the boundary of Kwadacha Wilderness Park, near 57°47'N and 125°30'W. This barite is massive and structureless, black in colour and very fetid. Uppermost beds consist of poorly sorted barite conglomerate with very well rounded clasts ranging from sand-size to boulders as large as 25 cm in diameter. Barite clasts are identical to, and presumably derived from, underlying bedded barite. Enclosing shales are very siliceous but distinctly non-pyritic.

Several characteristics of Upper Devonian shales of the Gunsteel Formation (Units 4, 6 and 7) can be used as field criteria to distinguish them from similar shales in the older Road River Formation of Unit 3:

(i) Road River shales and mudstones are generally calcareous while Gunsteel shales are invariably non-calcareous.

(ii) quartz-calcite veins commonly cut across Road River shales while shales of Unit 4, 6 and 7 contain quartz and, occasionally, quartz-barite veins.

(iii) springs draining older shales commonly precipitate calcrete (tufa) deposits where they reach the surface, forming calcareous crusts on vegetation and cementing unconsolidated surficial deposits to a depth of several metres.

(iv) the contact between the two shale formations can be reliably mapped from a distance using the marked dissimilarity of their weathering characteristics.

Road River shales of Unit 3 are relatively soft, moderately calcareous and very carbonaceous and consequently weather very recessively. Gunsteel shales, on the other hand, are much more resistant to physical and chemical weathering processes. In most places, the contact between the two formations is shown by an abrupt change in relief. Road River Formation shales generally have a high carbon content and a non-siliceous matrix. They break down rapidly to form a soft, black, very fine grained soil that supports a dense cover of vegetation, especially water-loving types such as lilies, saw-grass and willows. Overland flow of water predominates over infiltration during heavy rainfall, resulting in deep runoff trenches and landslide and mudflow scars on hillsides. Gunsteel shales, in contrast, are much more resistant to breakdown by chemical and physical weathering. Soil development on ridges and sidehills is very weak. Infiltration capacity of areas underlain by shales of the Gunsteel Formation is consequently very high and they support very little vegetation at higher elevations. A distinct colour change marks the Gunsteel-Road River contact. Unit 3 shales of the Road River Formation weather to a dull, dark blue-black colour, while exposures of Gunsteel shales are characteristically silver-grey weathering.

MISSISSIPPIAN OR YOUNGER

Gnip Gnop Formation (Unit 8)

Gnip Gnop Formation is an informal name coined by CJV personnel for rocks overlying the Gunsteel Formation which are mapped as Unit 8. These formations were not separated by the Geological Survey (Gabrielse et al, 1977a).

The Gnip Gnop Formation is divided into two distinct lithologic members.

The lower member consists of 60 to 120 m of calcareous and non-calcareous, brown weathering greywackes and siltstones and mudstones. The upper member is comprised of a sequence of interbedded calcareous siltstones, limestones and cherts.

Basal beds of the lower member of the Gnip Gnop Formation consist of extensively bioturbated, buff-brown and grey weathering siltstones with thin interbedded brown shales and calcareous siltstones. A 5 to 6 m thick succession of light grey weathering, dark grey argillaceous mudstones occurring within these rocks contains small (less than 0.5 cm) nodules composed of stellate crystals of barite. When wet, the mudstones emit a strong "earthy" odour, suggesting that kaolinite is a major component of the rock. The association of kaolinite-rich rocks with minor diagenetic barite is suggestive of genesis by submarine weathering (halmyrosis) of volcanic ash.

The bulk of the lower member of the Gnip Gnop Formation consists of a variable thickness of resistant, brown-grey weathering, arkosic chert greywackes which were deposited as turbidites and debris flow. They are composed primarily of very well rounded chert granules and sand, very similar in nature to chert clasts forming framework grains of Gunsteel Formation turbidites and debris flows. Arkosic clasts are completely altered to clay minerals. Relict textures in these clasts suggest a porphyritic source material, most likely volcanic rocks.

Depositional mechanism for coarse clastic rocks of the Gnip Gnop Formation are very similar to those determined for coarse clastic rocks of the underlying Gunsteel Formation (Unit 5). Lower beds are made up of thick (3 to 5 m) AB turbidite divisions and massive, thick bedded, unsorted debris flow conglomerates, probably deposited as proximal channel fillings. Up section, proximal turbidites give way rapidly to intermediate and distal turbidite AE and BE beds, suggesting initially rapid uplift and subsequent erosion of the source terrane. The texture and feldspathic nature of some clasts suggests that this source terrane may be volcanic in part. Thickness of tubidites varies from less than 30 m to greater than 150 m. The thickest accumulation occurs directly west of the GJV camp at Gnip Gnop Lake.

Current direction determinations, turbidite facies relationships and petrology indicate that the Gnip Gnop turbidites were derived from the same general source terrane as turbidites of the Gunsteel Formation.

The lower member of the Gnip Gnop Formation is conformably capped by a 30 to 60 m thick succession of recessive, poorly cemented, rusty weathering, brown sandy siltstones and sandstones with interbedded black silty shales. These rocks were probably deposited as distal turbidites.

Upper Member

The upper member of the Gnip Gnop Formation was only seen in a small area south of Joe Poole Creek. Lithologies consist of brown weathering, brown and grey, calcareous and dolomitic, bioturbated siltstones and mudstones interbedded with minor black, calcareous shaly mudstones, black chert and black, fetid limestones. Two thick units of medium bedded (20 to 30 cm) black and brown chert occur within this section.

Structural Geology

Rocks within the map-area form a narrow linear belt that strikes northwest. Although they are essentially unmetamorphosed, these rocks are structurally very complex. On a gross regional scale, the project area occupies a broad synclinorium compressed against an anticlinorium of more resistant older rocks to the east.

In many areas, bedding is difficult to distinguish from axial plane cleavage due to the uniformly featureless nature of most lithologies, especially on weathered surfaces. Where bedding is distinguishable, the absence of geopetal features in shales and some coarser clastic rocks makes the distinction between overturned and upright bedding almost impossible.

Problems with structural interpretation are further complicated by the generally very recessive nature of most lithologies coupled with abrupt and often diachronous facies changes. Where structural data is not available, outcrop patterns of Unit 7 (baritic shale, barite and pyritic shale) and Unit 5 (turbidites), both of which are relatively resistant and have abundant geopetal features, were used for structural interpretation. Three cross-sections through the map area are shown in Figure 21 on the following page.

Structural styles vary between rock units. In general, carbonate rocks and quartzites of the Atan Group deform competently. Tectonic shortening is reflected in normal faults and large-scale , broad open folds. The more incompetent nature of shales and thin bedded clastic rocks of the Kechika Group, Road River Formation and Gunsteel Formation is reflected in tight isoclinal folding

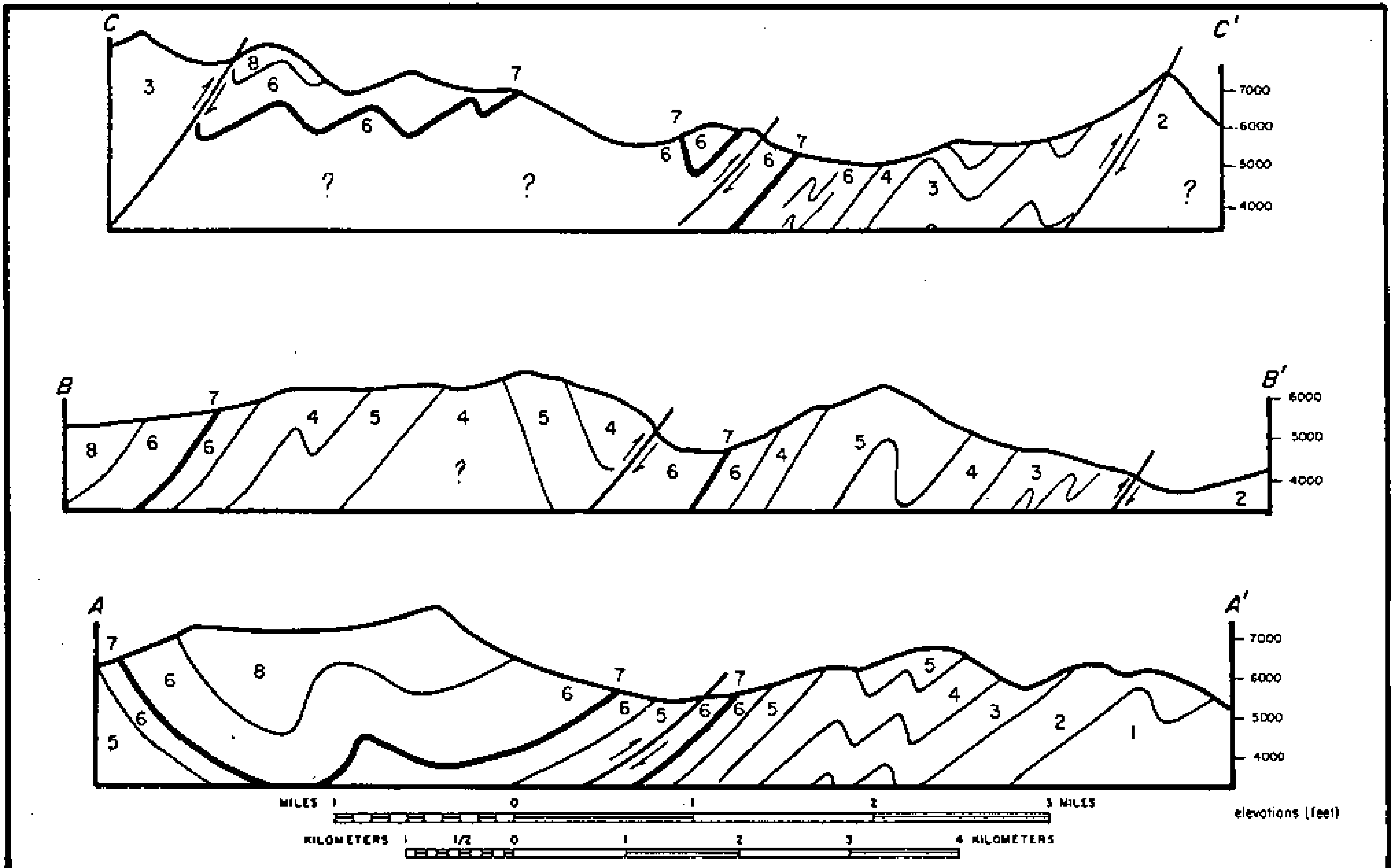


Figure 21 SW-NE geologic cross-sections of the GJV project area mapped during 1977. Refer to Figure 3 for legend and location of the section.

accompanied by thrust faulting. Within these rocks, structural competency varies from package to package. For instance, turbidites of map Unit 5 are much more resistant to deformation than enclosing shales. Consequently, turbidite fans which behave as relatively rigid plates are separated by strike-slip faults from less competent rocks along structural strike.

Regional structural strike is approximately 135°-140°. Strike ridges and valleys dominate the topography and most unit contacts are marked by some sort of topographic expression.

The project area occupies a large synclinorium or graben. Northeast and southwest margins of the structure seem to truncate lithological boundaries, suggesting that they are faults. The southwest margin is likely a thrust fault although sufficient evidence to prove or disprove this hypothesis was not seen. Intermittent zones of quartz-cemented, brecciated, mylonitized and tightly folded rock correspond with this lineament.

Because most of the project area is underlain by uniform shales without distinctive bedding, mesoscopic folds are hard to recognize and structural analysis is difficult. Mesoscopic folds that were delineated by outcrop patterns of marker horizons such as Unit 7 are almost always open folds with axes plunging southeast at low angles (10° to 20°). Axial planes of these folds, as outlined by cleavage orientations, generally dip steeply to the southwest (70°-80°). Northwest of Gataga Lakes, regional bedding dips are consistently to the southwest apart from a few odd attitudes that may be fold hinges. Overturning of folds and/or thrust faulting in such cases is the only means of explaining the constant dip direction and repetition of lithological packages seen here.

On a smaller scale, a profusion of macroscopic folds can be seen in walls of canyons and cirques which cut across the regional strike. These folds commonly are hundreds of metres in amplitude and range from very tight isoclinal to kink folds. Many of these folds are slightly overturned with both limbs dipping southwest.

Mineralization

Stratigraphy and metallogeny of the Kechika Trough (see Figure 13) are markedly similar to those of the eastern Selwyn Basin near the Yukon-Northwest Territories border. Syngenetic stratiform mineralization of two ages occurs in the Gataga Lakes area of the Kechika Trough. Ordovician and Silurian calcareous shales of the Road River Formation (Unit 3) host zinc mineralization of an age and type broadly correlative with the Howard Pass, Yukon deposit of Canex Placer. Younger Steel shales and turbidites host barite-lead-zinc mineralization in the Canol Formation at Macmillan Pass, Yukon. Although a fault bounded basin of deposition for stratiform mineralization has not been recognized at Driftpile Creek, flanking turbidite fans may have restricted seawater encough to have produced basinal euxinic conditions necessary for syngenetic sulphide deposition.

Anomalous concentrations of base metals have been recognized within Road River shales near the headwaters of Braid Creek. Whole rock analysis of shales revealed weak zinc mineralization but detailed prospecting was not carried out along strike.

Gunsteel shales of Upper Devonian to Lower Mississippian age host numerous stratiform barite occurrences and several stratiform barite-lead-zinc showings within the report area. All barren and mineralized barite occurrences lie within map-unit 7, a single stratigraphic horizon of regional extent. Details of the mineralogy within this horizon and variation along its exposed length have been summarized in this section dealing with stratigraphy. However, several features of the relationship between this unit and base-metal mineralization are worth special mention. In addition to stratiform barite-lead-zinc occurrences, unit 7 contains highly anomalous amounts of iron sulphide, silica and barium. This association is rare in normal sedimentary environments and, as such, is indicative of a widespread chemical sedimentation event that may have been related to submarine exhalation of hydrothermal fluids on a regional scale. The mechanism that produced local concentrations of base metal mineralization with the barite are not fully understood but are discussed in more detail in Chapter IV.

Mineralization within this horizon has been investigated at four localities within the Gunsteel Formation shale belt.

(i) Canex Placer Driftpile Creek Property

The Driftpile Creek barite-lead-zinc prospect was discovered during a reconnaissance stream sediment survey performed in 1970 by Geophoto Consultants Limited. Follow-up sampling confirmed the geochemical anomaly but no mineralization was discovered and the anomaly was attributed to a high background caused by metalliferous shales. Following acquisition of the geochemical data in 1973, Canex Placer geologists prospected the ground and discovered float boulders of pyritic black shale containing sphalerite and galena. Later work consisted of grid soil sampling, geologic mapping and hand trenching in 1974 and 1975, and a shootback-type EM survey in 1975. The EM survey was done in an attempt to map the shale distribution under overburden and trace massive pyrite zones. The information contained here has been obtained from

Canex Placer reports filed for assessment credit (Wise, 1974; Kowalchuk and Rivera, 1976).

Although overburden cover is thin, detailed examination of mineralization on the Canex Placer property is difficult because the pyritic shale host rocks are weathered and oxidized to a depth of up to 3 m. In addition, outcrops of the enclosing Gunsteel Formation total less than one percent of the surface area.

Soil samples were analyzed for zinc, lead, barium and silver. Zinc response shows a background level of 100 to 300 ppm and an anomalous threshold of about 500 ppm. Background levels for lead range up to 250 ppm while anomalous values are greater than 500 ppm. Anomalous barium response is in the 1% to 8% range. Silver values are erratic although a threshold value of 2 ppm is indicated.

Lead values correlate well with barium contents of soils. Lead and barium anomalies, in turn, show a strong correlation with the location of massive pyrite mineralization as interpreted from the EM survey. Lead-zinc and silver-barium-lead correlations are weak. Erratic zinc and silver response probably reflect their greater mobility in acidic soils. Large anomalous areas along Driftpile Creek which are not associated with EM conductors probably result from glacial dispersion of mineralization from showings.

Barite-lead-zinc mineralization is exposed in trenches through thin soil cover in an area of low to moderate relief near the centre of the property, about 4500 m north of Driftpile Creek. Galena, sphalerite and pyrite occur as fine-grained, thin laminations in thin bedded, black to grey barite. This finely laminated nature makes visual estimation of grade virtually impossible. Interbedded pyritic black shales may also host significant stratiform mineralization although complete oxidation of pyrite has reduced the rock to a limonitic, grey clay that generally assays low in lead and zinc. The best assays obtained by Canex Placer from the trenches are tabulated below:

TABLE 3

Canex Placer Assays - Driftpile Property

Trench	Coords N	Coords E	Sample Length (m)	Pb (%)	Zn (%)	Ag (ppm)	Ba (%)
Upper Driftpile Creek	50	1850	6.0	0.25	2.07	NA	11.0
	(bounded on the west by)		12.1	0.02	0.07	NA	14.2
74 - 3	1150	1850	7.6	0.06	0.44	NA	19.0
74 - 5	4100	1900	18.2	3.43	0.39	NA	5.6
		(including)	3.0	8.05	1.17	5.8	6.1
75 - 3	4150	1950	7.0	3.05	2.08	6.9	4.7
		(including)	3.0	5.28	4.30	5.5	9.9
75 - 7	170S	235	10.6	0.15	0.25	4.8	12.8

NA = not assayed

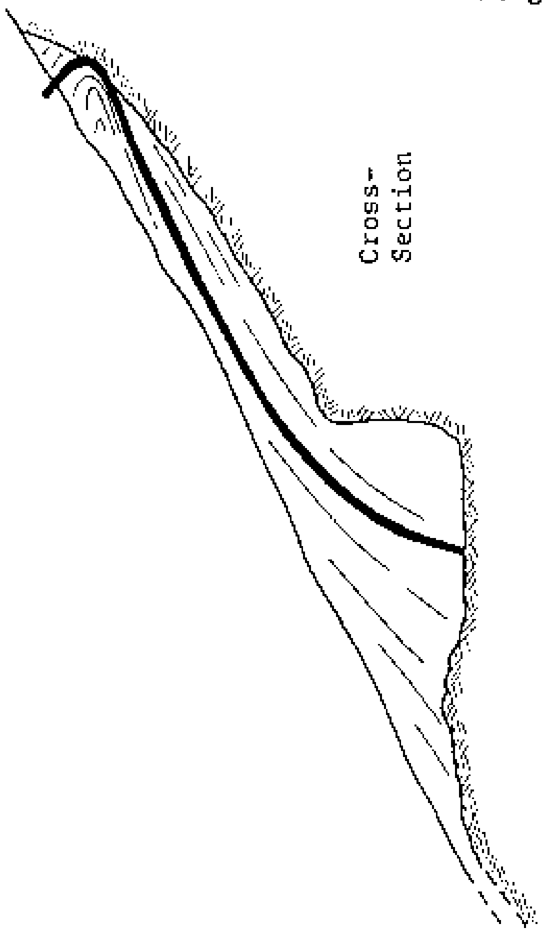
Canex Placer geologists estimated that 250,000 tons of stratiform mineralization grading 10% combined lead and zinc with 8% barium could be present in a tabular body with a strike length of 160 m and a thickness of 3 m, postulating a 160 m down-dip continuity in grade and thickness. Since grades were derived from weathered trenches and only a small part of the total strike length of the geochemically and geophysically anomalous horizon was tested by trenching, they further suggested that the size potential of the property is in the order of tens of millions of tons with a significantly higher grade (Kowalchuk and Rivera, 1976).

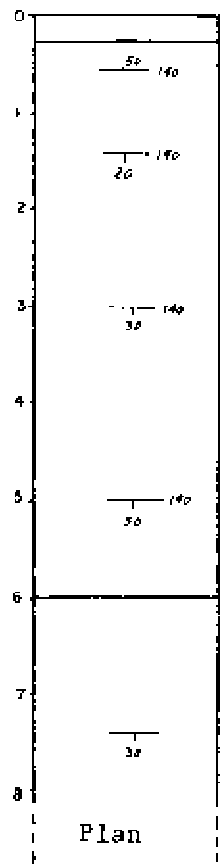
According to Canex Placer reports, galena and sphalerite with associated barite are contained within two discrete EM conductors with associated soil geochemical anomalies that are thought to represent massive pyrite beds in pyritic black shales. These conductors are estimated to be 1 to 10 m thick and 60 to 150 m apart. Mapping by GJV personnel, however, has suggested that mineralization at Driftpile Creek is correlative with a single pyritic, barite and siliceous shale horizon of regional extent that is repeated by folding and/or thrust faulting, giving the impression of several horizons.

(ii) GJV Saint Claims

The Saint claims were staked to cover the strike extension of the Canex Placer mineralization to the northwest. Geology and lead response of both silt and soil are similar on both properties. Preliminary grid soil sampling and mapping at the southeast end of the Saint claims (Grid 1) are plotted on Figures 22 to 25. This work has shown that numerous lead anomalies in soil coincide with poorly exposed barite-bearing rocks of Unit 7. Anomalous lead values continue off both ends of the grid. Geologic mapping was hampered by the generally poor nature of bedrock exposure. Although Grid 1 occurs in an area of moderate relief and overburden cover is thin, extreme oxidation and leaching of the barite-bearing pyritic rocks of Unit 7 has reduced most of the lithologies to a black, viscous mud. Despite these problems, the distinctive character and weathering colour of Unit 7 aided in developing a picture of the complex structural geology. Further geological interpretation was hampered by the local fine-grained nature of Unit 4 that prevented its distinction from overlying Unit 6. Further definition of the geology on the property will require patient and detailed mapping on a small scale.

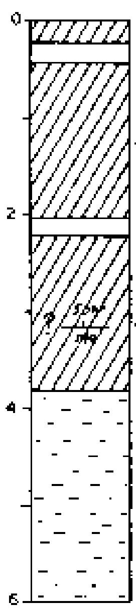
Seven hand trenches were dug over lead anomalies on the grid. Geology and assay values of the rocks encountered in the trenches are summarized in Figures 35 and 36 on the following two pages. All barite encountered was less than





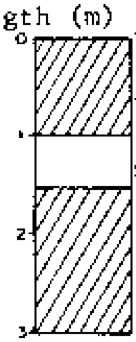
Assays (%) Pb	Zn	Description
		cherty rusty argillite
.04	.09	banded grey and black massive barite with occasional thin blebby bands, pyrite common
.03	.19	as disseminations, and often associated with
.01	.09	darker coaly bands. Thin cross cutting carbonate veins trending
.02	.20	060/70N are common probably related to the quartz-witherite
.02	.13	veins noted nearby. Minor red zinc reaction noted at
.02	.08	scattered intervals.
		end of massive barite
.02	.05	
		scattered thin blebby barite beds, except
.02	.06	

TRENCH A - Line 10N at 1W



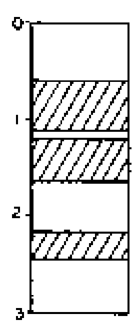
Assays (%) Pb	Zn	Description
		barite 10 cm thick
.01	.02	
		barite 10 cm thick
.01	.01	cherty argillite, well cleaved at 140/vert.
.01	.01	fine platy shale with minor argillite and silicified or cherty argillite

TRENCH B - Line 15N at 4E



Assays (%) Pb	Zn	Description
.01	.02	yellow stained strongly cleaved argillite
.01	.01	massive blebby barite trending 140/55
.01	.02	argillite as above

TRENCH E - 100 m S of Line 0 at 2E



Pb	Zn	Description
.03	.04	unconsolidated rubbly soil
.01	.03	argillite talus
		argillite talus
.01	.05	argillite talus
.02	.05	unconsolidated rubbly soil

TRENCH G - 100 m N of Line 0 at 2E

(Note: all trenches oriented with top to the north)

Fig. 35 *HAND TRENCHING - SAINT CLAIMS*

GATAGA JOINT VENTURE

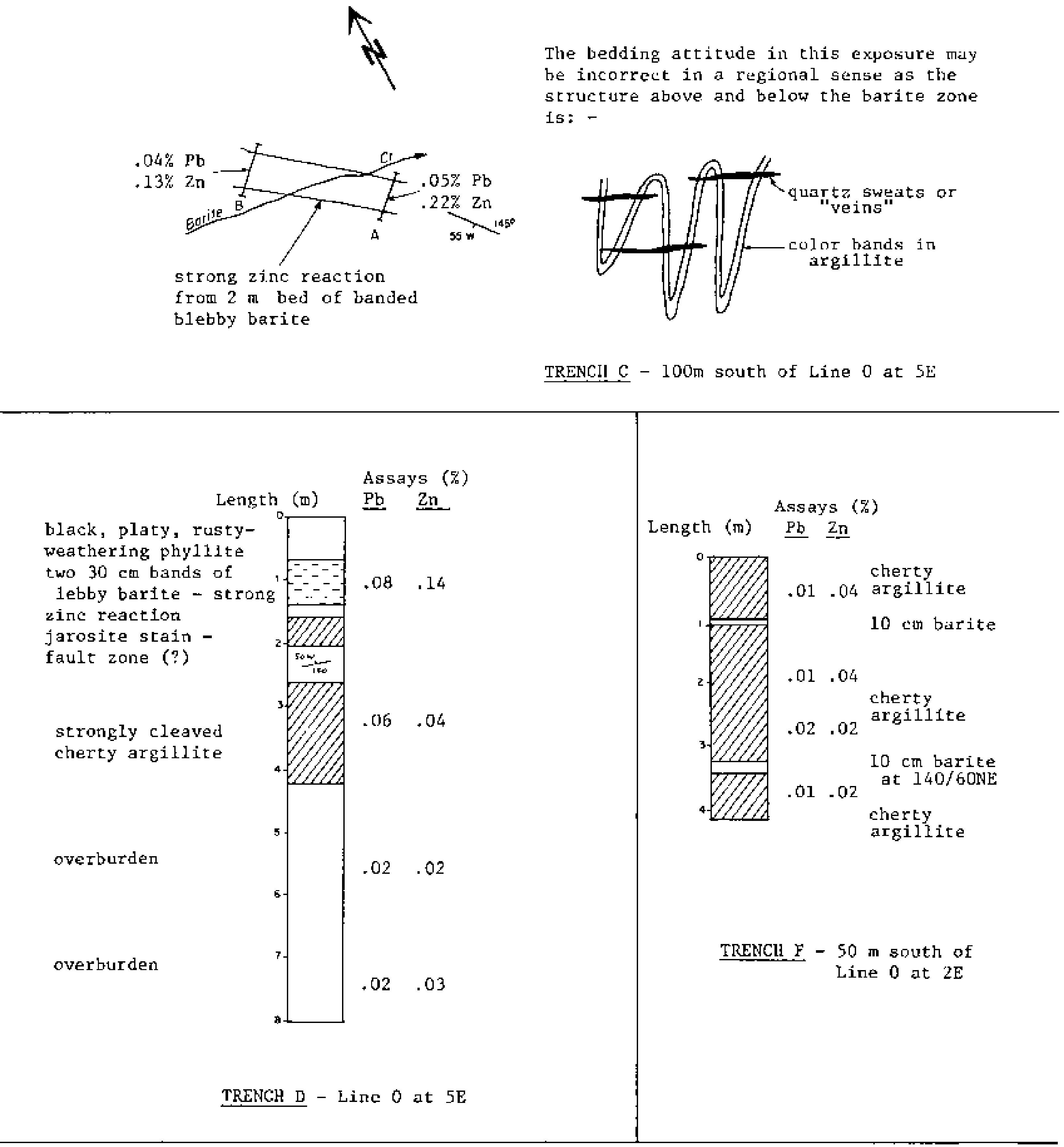


Fig. 36 *HAND TRENCHING – SAINT CLAIMS*

GATAGA JOINT VENTURE

(Note: all trenches oriented with top to the north)

4 m thick and weakly mineralized (less than 0.3% combined Pb and Zn). No mineralized float was discovered in the course of prospecting.

Assays of barite zones in trenches and barite float from the area do not satisfactorily explain the strength of soil lead anomalies. Since, as previously mentioned, rocks of Unit 7 are heavily oxidized and leached on surface, the trenches may not have penetrated deep enough to encounter fresh mineralization. An alternate explanation may be that lead is contained within adjacent pyritic shales that were not exposed by trenching. However, the intimate association of lead and zinc with bedded barite on the adjoining Driftpile Creek property favours the former hypothesis.

One of the strongest soil anomalies (4000 ppm Pb) occurs near the north end of Grid 1. Prospecting traced the source of high lead values to a narrow, weakly mineralized quartz vein along a steeply dipping fault zone. A chip sample across the vein returned 2.2% Zn and 0.03% Pb across 2.0 m. The samples probably did not adequately represent the true lead content, which was estimated visually as approximately on per cent.

(iii) GJV Bear Claims

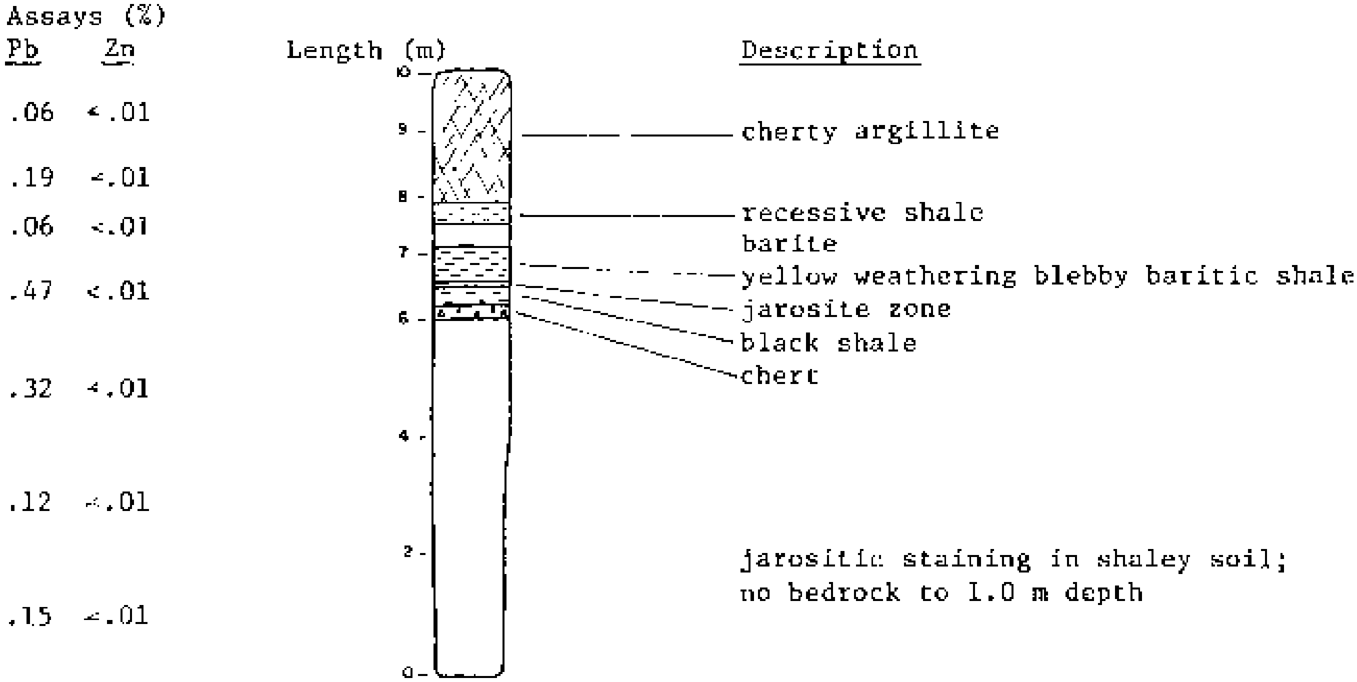
The Bear claims, located 5 km northwest of Gnip Gnop Lake, have a relatively simple geological setting. Barite of Unit 7 and enclosing sedimentary rocks of Units 4, 6 and 8 are well exposed in the limbs of a northwest-trending syncline. The section is repeated along the west edge of the property by a southwest dipping thrust fault. Numerous gossans and ferricrete deposits are developed on, and downslope from, pyritic and baritic shales of Unit 7. Barite occurs as both the blebby and massive bedded varities along a single stratigraphic horizon.

Grid soil geochemistry of the property, shown on Figures 33 to 34 (in pocket) defines a target area at least 1.5 km in strike length that extends northwest onto the Taga claim.

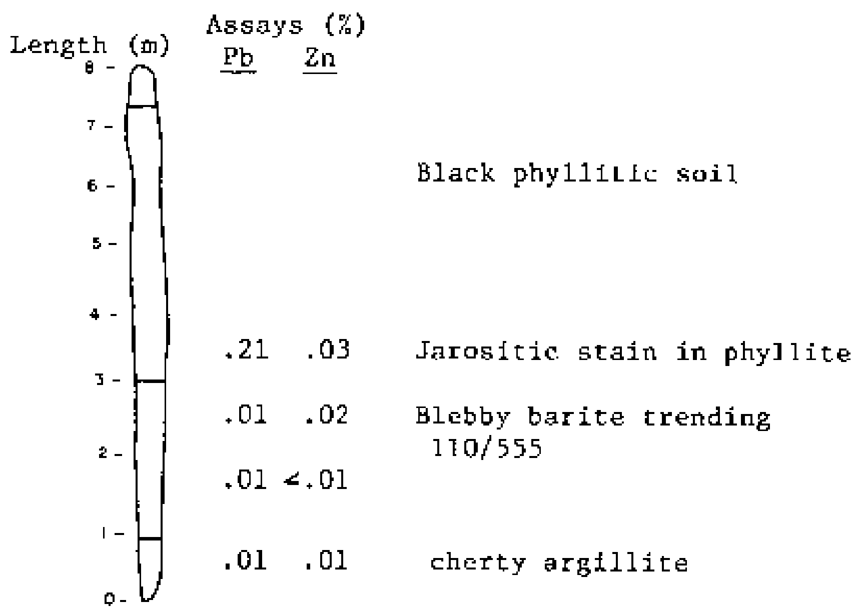
The bedded barite and pyritic shale occurrences on the property were hand trenched to determine if they were the source of the lead anomalies ranging from 110 ppm to greater than 4000 ppm in silt and 340 ppm to 2520 ppm in soils. Descriptions and assay values of the trenches are shown in Figure 36 on the following page. Weak mineralization encountered in the trenches does not explain the strong soil and silt anomalies. Like the Driftpile Creek mineralization and barite-bearing pyritic shales on the Saint claims, these rocks are extensively leached and oxidized on surface and presumably to a considerable depth. At the northwest end of the grid the lead anomaly clearly extends uphill above the highest recognized barite outcrops. This anomaly, which could be caused by a repetition of the baritic horizon through folding or thrust faulting, is more difficult to prospect because it is buried under scree from the overlying Gnip Gnop Formation. No work has been done on the west limb of the syncline. Future work on this property should consist of packsack drilling or deeper trenching.

(iv) Red Claims

The Red claims, owned by J. Shussler, are situated about 3 km north of the GJV camp at Gnip Gnop Lake. They were originally staked in 1958 as the much larger Spa group by Frobisher Ltd. (Falconbridge), which trenched and packsack drilled two large gossans. Ferricrete from drill core assayed up to 4% Zn, 1.5 oz/ton Ag and trace amounts of Cu, Pb and V. Water from seeps and springs that produced the exotic gossans contained as much as 6000 ppb Zn. The gossans and ferricrete deposits



TRENCH A - Line 50N at 50W



TRENCH B - Line 550N at 150W

(Note: both trenches oriented with top to the west)

Fig. 37 *HAND TRENCHING - BEAR CLAIMS*

GATAGA JOINT VENTURE

are situated down-slope from a bedded barite deposit contained within Unit 7 of the Gunsteel Formation. Cyprus Anvil optioned the claims in 1977 during a regional reconnaissance program of the area but found no indication of significant mineralization on the property.

Barite Analysis

Representative specimens of barite were collected during regional mapping and geochemical prospecting and were analysed for their trace element contents in Pb, Zn, Sr, Fe and Mn. This study was conducted to determine if any regional zoning is present in barite of Unit 7 that would lead to the detection of hidden exhalative centres. The Ba/Sr ratio of barite crystallizing from a brine of uniform composition should theoretically vary with distance from the exhalative centres since substitution of the slightly larger Sr ion in the $BaSO_4$ crystal lattice is temperature-dependent. Fe/Mn ratios were determined with the expectation that they would vary with distance from exhalative centres, since Mn is less stable in seawater than Fe.

Results of this survey are plotted in Table 4. Barite samples are divided into six categories on the basis of their modes of occurrence:

Type I - massive bedded, grey barite of Unit 7.

Type II - massive bedded, grey barite of Unit 7 containing interbedded sphalerite and galena at Canex Placer's Driftpile Creek property.

Type III - minor occurrences of barite nodules in Unit 8.

Type IV - miscellaneous quartz-barite vein and breccia occurrences.

Type V - black, fetid, bedded barite of Unit 7.

Results of statistical analysis of the data, including ranges, means and standard deviation of Ba/Sr and Fe/Mn ratios for several types of barite are

Table 4

Analysis of Barite Specimens

Sample No.	Pb (ppm)	Zn (ppm)	Ba (%)	Sr (ppm)	Fe (%)	Mn (ppm)	Ba/Sr	Fe/Mn	Type	Location
851	220	7600	37.6	2150	0.85	1120	174.9	7.6	II	Canex
852	35	2040	45.3	950	.35	125	476.8	28.0	I	GJV Saint
853	5	15	48.4	1550	.30	20	312.3	150.0	V	CJV Taga
854	5	10	50.9	1650	.10	15	308.5	66.7	I	United Mls
855	2	5	53.6	2900	.05	10	184.8	50.0	I	Red Cr.
856	5	5	44.3	2500	.15	20	177.2	75.0	V	
857	10	5	54.5	1200	.10	10	454.2	100.0	I	GJV Bob
858	2	10	54.6	2850	.05	5	191.6	100.0	V	
859	15	30	17.7	1900	.55	50	93.2	110.0	II	United Mls.
860	5	20	35.2	1900	.55	40	182.3	137.5	II	- Red Cr.
861	5	20	47.5	2150	.05	5	220.9	100.0	II	
862	770	10	53.7	1450	.10	5	370.3	200.0	I	GJV Bear
863	1.01%	45	52.5	1550	.02	5	338.7	40.0	I	
864	50	110	0.5	500	1.50	445	10.0	33.7	IV	CJV CneSet
865	30	4300	44.1	2250	.15	910	196.0	1.6	I	GJV Saint
866	5.53%	12.90%	0.2	250	.80	20	8.0	400.0	IV	CJV Ready
867	7.60%	1.02%	49.1	1500	.60	20	327.3	300.0	Ia	
868	1.49%	14.60%	31.6	700	2.10	120	451.4	175.0	Ia	
869	6.69%	1680	50.8	1450	.65	15	350.3	433.3	Ia	Canex
870	11.90%	4.71%	35.1	1550	.45	105	226.4	42.9	Ia	
871	11.40%	3.84%	51.5	2150	.95	50	239.5	190.0	Ia	
872	1080	880	28.2	2150	.20	15	131.2	133.3	II	CJV Bob
873	370	155	21.0	950	.75	25	221.0	300.0	II	
874	375	200	36.2	1450	.75	115	249.7	65.2	I	CJV Saint
875	390	125	51.5	5000	.05	5	103.0	100.0	V	Veladener Cr.
876	5000	3.36%	49.5	1200	.10	55	412.5	18.2	Ia	
877	3680	2640	0.7	500	> 10.00	690	14.0	145.0	IV	
878	410	910	43.8	600	.20	180	730.0	11.1	Ia	Canex
879	360	400	50.2	1300	.15	10	386.1	150.0	Ia	
880	250	195	39.4	110	.30	20	358.2	150.0	Ia	
881	420	340	40.3	3350	.30	10	120.3	300.0	IV	CJV Bear
882	1160	120	44.3	1200	3.75	5	369.2	7500.0	I(?)	
883	80	165	1.4	100	4.95	80	140.0	618.8	IV	4 km SE Camp
884	1960	1080	18.4	1100	4.30	260	167.3	165.4	I	CJV Saint
885	65	30	3.7	600	.50	20	61.7	250.0	III	CJV Ryte

Type I - Bedded barite of Unit 7
Tyle Ia - Mineralized bedded barite of Unit 7 at Driftpile Creek showing
Tyle II - Blebby barite of Unit 7
Type III - Nodular barite of Gnip Gnop Fm
Type IV - Quartz-barite veins and breccia fillings
Type V - Black, fetid bedded barite of Unit 7

Table 4 (cont'd)
Analysis of Barite Specimens

Sample No.	Pb (ppm)	Zn (ppm)	Ba (%)	Sr (ppm)	Fe (ppm)	Mn (ppm)	Ba/Sr	Fe/Mn	Type	Location
886	115	35	45.9	950	.50	5	483.2	1000.0	I	GJV Saint
887	170	65	4.1	600	.85	545	68.3	15.6	IV	GJV Ryte
888	25	60	46.1	1550	.50	5	297.4	1000.0	I	GJV Saint
889	10	80	48.2	1550	.50	10	311.0	500.0	I	Texasgulf
890	1	178	49.3	3500	.55	85	140.9	64.7	I	
891	66	590	48.6	2120	.35	35	229.2	100.0	I	GJV
892	66	950	48.6	1870	.20	30	259.9	66.7	I	Saint
893	4	42	52.5	1650	.10	35	318.2	28.6	I	Grid 1
894	32	52	31.8	1450	.60	15	219.3	400.0	I	
895	198	132	40.1	1200	.45	60	334.2	75.0	I	
896	6	10	0.1	250	.30	30	4.0	100.0	IV	GJV Ready
897	6	46	42.1	2150	1.00	5	195.8	2000.0	I	GJV
898	2	160	46.0	4550	.10	1600	101.1	0.6	I	Hole
899	24	285	26.0	2400	1.10	40	108.3	275.0	II	
900	4	88	43.8	3350	.65	10	130.7	650.0	I	GJV
901	1	14	1.1	500	.70	25	22.0	280.0	IV	Saint
902	24	58	45.0	2400	.55	2	187.5	275.0	I	Serem
903	12	30	0.2	<250	.70	15	8.0	466.7	IV	
904	2	56	43.7	2850	.50	10	153.3	500.0	I	GJV Ready
905	6	60	9.2	500	2.00	420	184.0	47.6	I	GJV Hole
906	4	18	27.5	2150	1.35	90	127.9	150.0	II	United Red
907	48	82	7.5	750	2.30	180	100.0	127.8	I	GJV Saint
908	2	24	47.0	2150	.30	60	218.6	50.0	I	Grid 1
909	36	86	6.3	450	.90	10	140.0	900.0	II	Serem
910	400	980	36.5	2850	.75	145	128.1	51.7	I	GJV Saint
911	450	1200	28.9	2790	1.10	225	103.6	48.8	I	Grid 1
5526	1	2	53.4	4800	.05	2	112.3	250.0	V	Boundary of
5527	1	40	30.6	3400	.40	10	90.0	400.0	V	Kwadacha
5528	1	12	45.3	4400	.20	5	103.0	400.0	V	Park
5529	4.86%	800	53.8	1400	.10	5	384.3	200.0	Ia	
5530	> 4000	740	30.7	1000	.30	5	307.0	600.0	II	Cantex
5531	12.00%	0.65%	44.1	1200	2.10	100	367.5	210.0	Ia	
5532	10.80%	2.86%	40.9	2100	4.40	125	194.8	352.0	Ia	
5533	10.80%	1.70%	40.5	1900	4.55	175	213.2	260.0	Ia	

Type I – Bedded barite of Unit 7
Type Ia – Mineralized bedded barite of Unit 7 at Driftpile Creek showing
Type II – Blebby barite of Unit 7
Type III – Nodular barite of Gnip Gnop Fm
Type IV – Quartz-barite veins and breccia fillings
Type V – Black, fetid bedded barite of Unit 7

listed in Table 5 on the following page. Although population size of each class is too small to be statistically valid, mean Ba/Sr ratios for each type appear to differ significantly. The high standard deviation of the mean in every class except Type II "blebby" barite indicates significant variation within each class. Ba /Sr ratios for Type I bedded barite were tested by linear regression analysis against distance along strike from the Driftpile Creek deposit to define this variability. However, this relationship showed a very weak correlation of 0.23. The log-normal relationship had a much lower correlation coefficient of 0.09. These determinations, coupled with the high standard deviation of the mean for bedded barite, probably indicates that variation of Ba/Sr ratios within the deposit is sufficient to mask any regional trends that may exist. Variation within the deposit could be caused by changes in temperature during crystallization of barite or by changes in the initial Ba/Sr ratio by mixing with seawater. A large standard deviation of the mean for Ba/Sr ratios of samples collected from the Driftpile Creek showing, which is assumed to be one deposit, substantiates this conclusion. A more rigorous statistical treatment of the data, such as multiple regression analysis or analysis of covariance, would require a much higher population density. The prohibitive cost of analysis of a large number of barite samples negates the usefulness of such a survey unless used as an exploration tool to detect zoning within a specific deposit.

Ba/Sr ratios of Type II "blebby" barite show a low standard deviation from the mean value. Regional variation is very low indicating uniformity of conditions leading to crystallization. This supports the hypothesis of a diagenetic origin for blebby barite as discussed in an earlier section.

TABLE 5

Ranges, Means and standard deviation for data given in Table 1 for barite of Types I, Ia and II

TYPE OF BARITE	NUMBER OF SAMPLES	Ba/Sr				Fe/Mn			
		MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE	STANDARD DEVIATION
Bedded (I)	26	100.0	483.2	218.0	193.3	0.6	2000	321.1	543.6
Bedded, mineralized (Ia)	13	194.8	730.0	357.0	138.9	11.1	352.0	201.9	115.4
"Blebby" (II)	10	93.2	220.9	170.8	10.0	7.6	900.0	271.3	275.0

Fe/Mn ratios do not significantly differ between classes when their overall high standard deviations from the mean is taken into consideration. High variability within the deposit probably masks any regionally significant zonation.

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CHAPTER III - GEOCHEMISTRY

Introduction

The GJV program had access to lead, zinc, copper and uranium assays obtained during a reconnaissance stream sediment (silt) sampling program conducted by Castlemaine Exploration in 1976. This survey had outlined several unstaked areas with moderately anomalous lead response comparable to that from the Canex Placer property, which suggested that the source was probably a single shale unit. This unit was also suspected of being the source of the numerous limonite gossans reported from this district.

In addition to silt, GJV sampled soil, rock and water to determine primary distribution in the stratigraphic section and secondary dispersion in the weathering cycle. Sampling these additional materials also served as a check on the reliability of silt sampling, which is poor from shales of the same age in the Selwyn Basin. The geochemical survey aided in mapping the shale unit that hosts the mineralization and located undiscovered surface showings as well as indicating the source of the limonite gossans.

Field and Laboratory Technique

Samples were collected in prenumbered kraft paper bags (soil and silt), in plastic bags (rock) and in 250 ml plastic bottles (water). All samples were shipped air freight to Chemex Labs Ltd., North Vancouver, B.C. for analysis. Soil and silt samples were dried, screened to a minus 80 mesh fraction and analyzed routinely for copper, lead and zinc using a nitric-perchloric acid extraction and atomic absorption spectrometry (AAS). Some of the rock samples were also analyzed for iron and manganese, using the same technique, and for barium and strontium using a hydrofluoricphosphoric acid extraction and AAS. A portion of the minus 80 mesh fraction from each sample was stored permanently at the lab.

Water samples were tested for pH at the base camp using a small portable meter. At the lab, they were carefully vacuum filtered through Watman GF/c 0.45 micron glassfibre paper to remove all suspended sediment. The filtrate was returned to the original bottle and was retained with the filtered residue for possible future analysis. An aliquot of the filtrate was then assayed for SO_4 content, adjusted to a pH of 2.5 to 3.0 with the addition of 3M HNO_3 and analyzed for zinc using the APDC/MIBK method, in which the element was chelated or complexed with ammonia pyrrolidine dithiocarbamate (APDC) and extracted into the organic solvent methyl isobutyl ketone (MIBK). After the organic and aqueous phases separated, the metal content of the MIBK fraction was determined by AAS.

Results

The 1976 Castlemaine survey consisted of several hundred silt samples within an area that extended much further northwest and north than the 1977 program. Thus it provided a good statistical indication of background levels for the various metals from all of the lithological units in the district. Response was generally higher from the black shales than from the other units in all metals. The following anomalous levels were established by Castlemaine (all in ppm):

	Cu	Pb	Zn	U
Background	<40	<38	<339	<2.8
Possibly Anomalous	40-57	38-76	339-987	2.8-7.9
Probably Anomalous	58-75	77-114	988-1637	8.0-13.2
Definitely Anomalous	>75	>114	>1637	>13.2

The GJV sampling included a more detailed silt survey, the results of which are plotted with soil and rock assays on Figures 5 to 8 in the pocket. The GJV assays confirmed the previous work and defined the anomalies more closely. The following are selected assay ranges from stream sediment samples draining the Gunsteel Formation (all in ppm):

	Cu	Pb	Zn
Canex Placer property	50-80	84-2200	1100- 4000
Saint claims - GJV	38-235	92-310	1000-3900
Gunsteel shale with no known mineralization	2-100	1-30	900-2000
Silt from rusty seeps and springs	4-34	1-160	375- 4000

These results demonstrate how difficult it is to distinguish between the zinc content of silt draining normal versus mineralized shale and also show that copper is not a useful indicator metal in this district.

Soil and rock samples were collected on reconnaissance mapping/prospecting traverses and on four grids where the presence of the barite horizon and/or strong lead response in silts has been documented. Soil assays for copper, lead and zinc over Grids Two and Three are shown on Figures 26 to 31 on the following pages. Results for Grid One are given in Figures 22 to 25 (in the pocket) while Grid Four assays are plotted on Figures 32 to 34 (in the pocket). The locations of the Grids are shown on Figure 3. Grid One is situated at the northwest end of the Canex Placer property and was discussed in the chapter on mineralization.

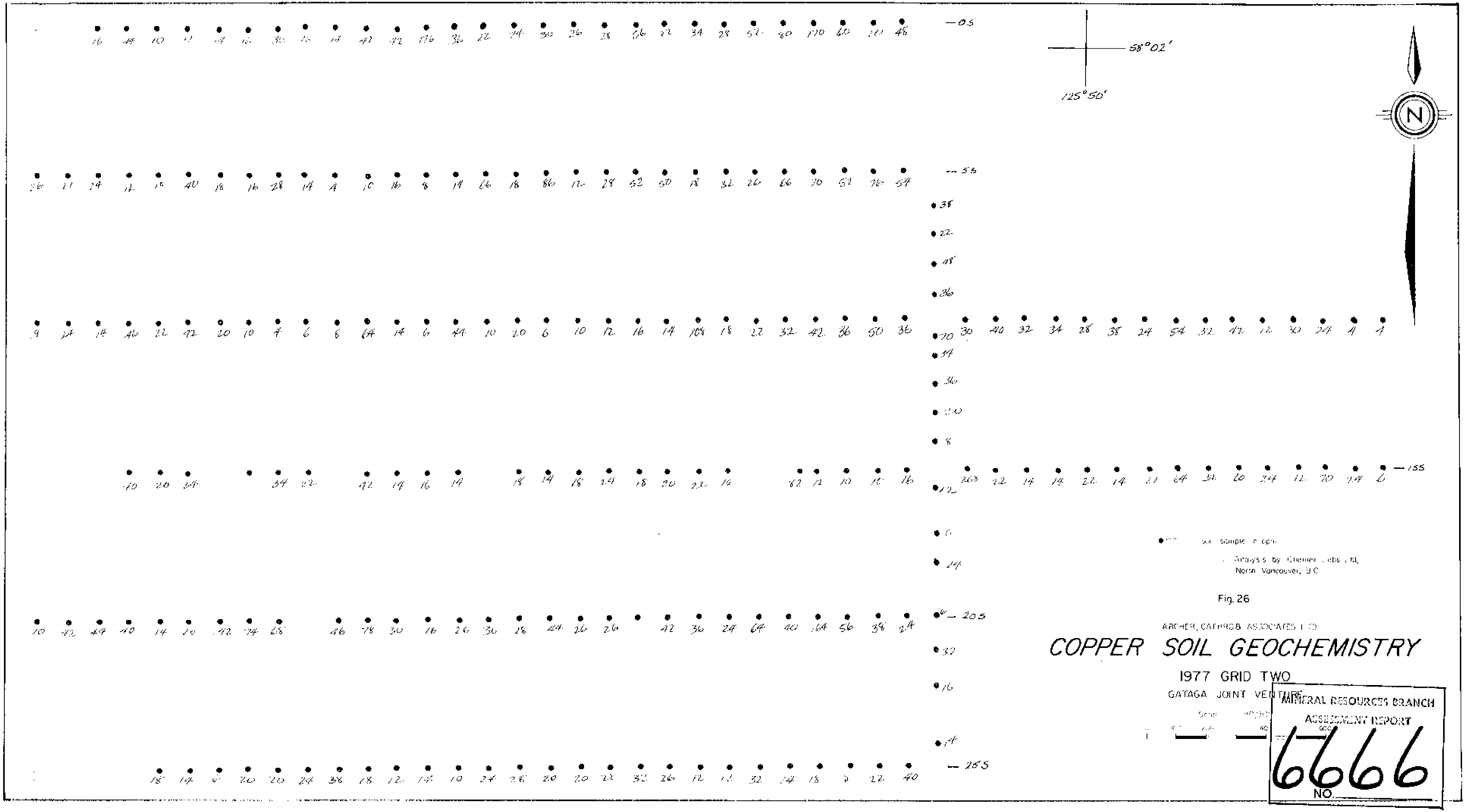


Fig. 26

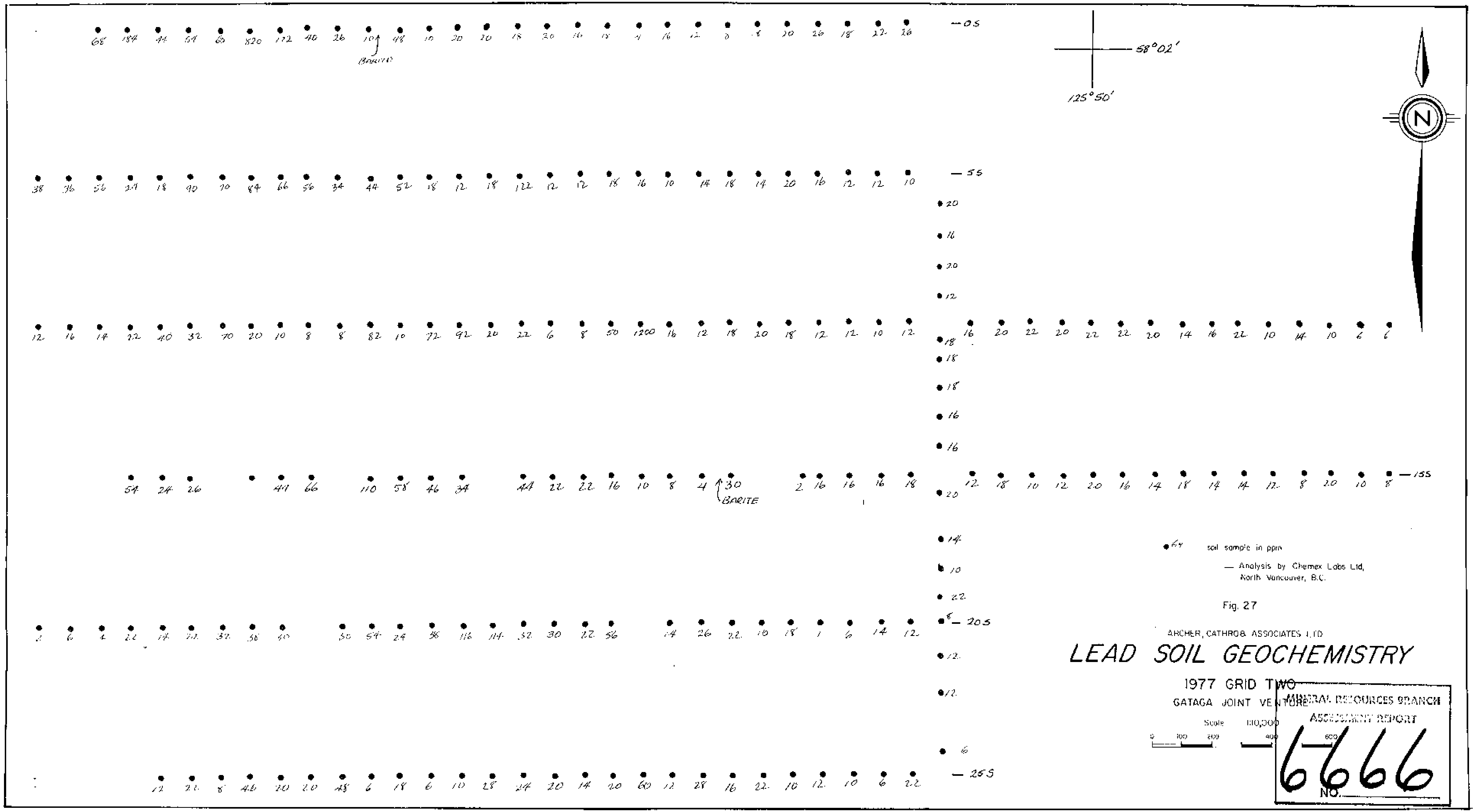
ARCHER, CATHRO & ASSOCIATES LTD

COPPER SOIL GEOCHEMISTRY

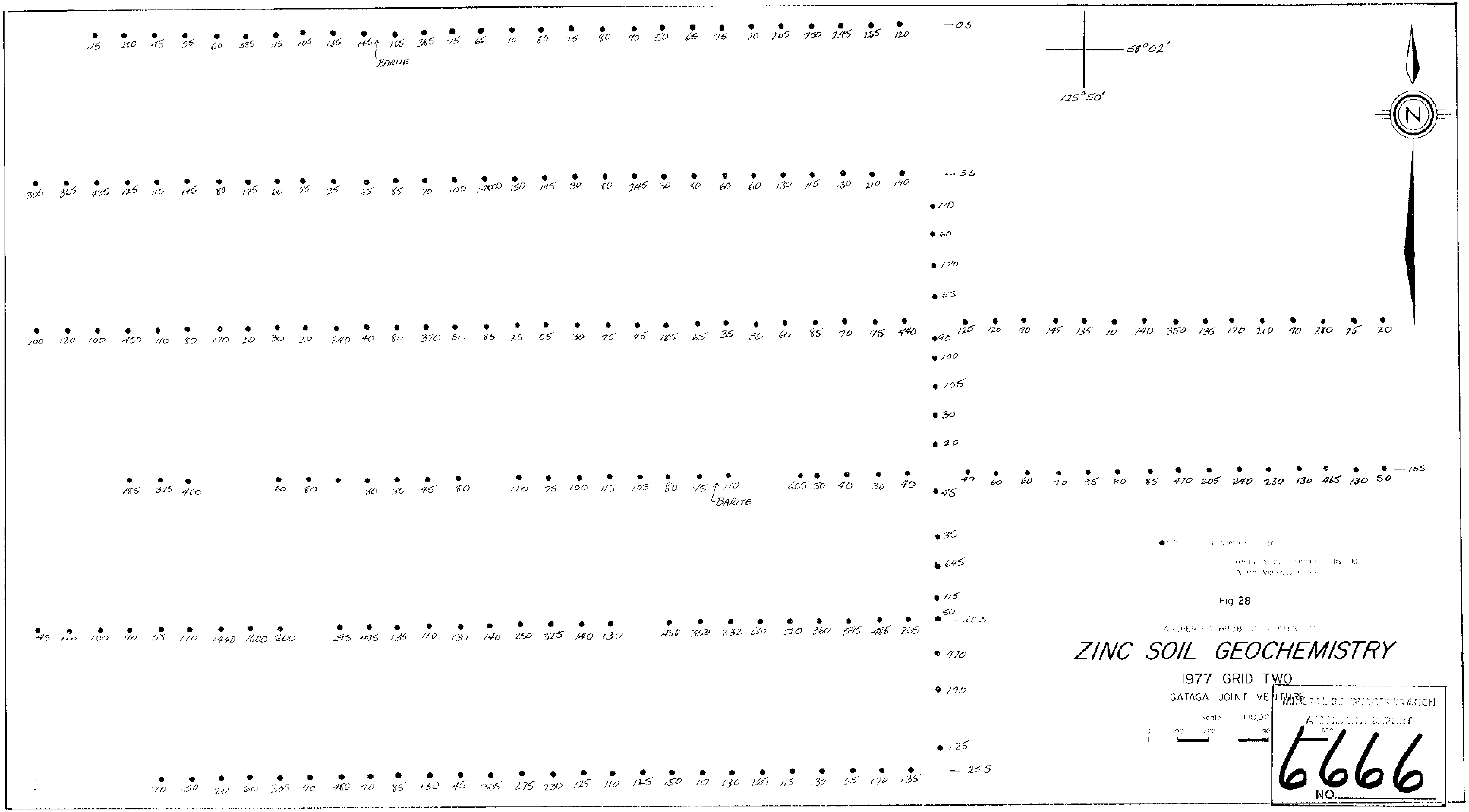
1977 GRID TWO

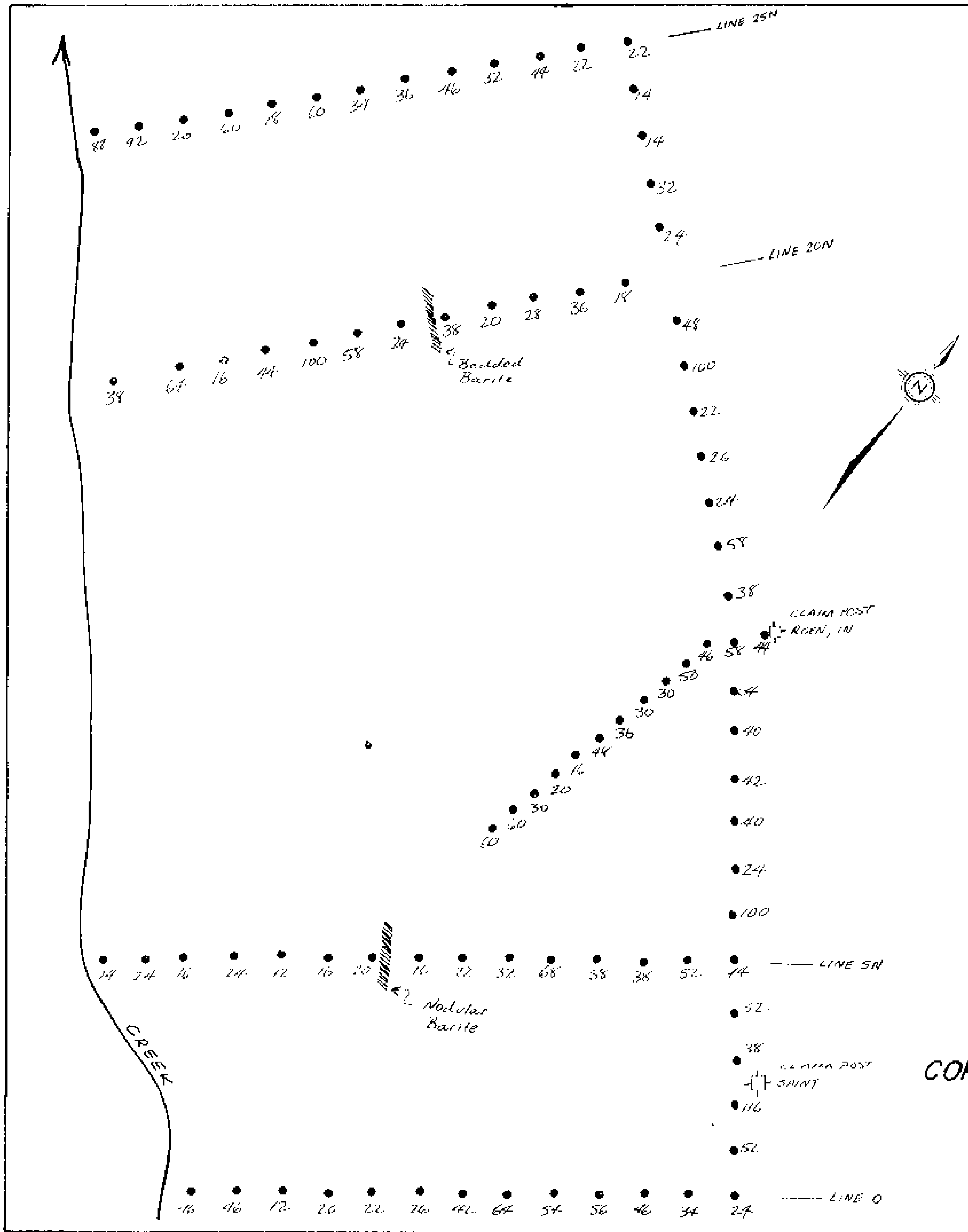
GATAGA JOINT VENTURE

Analysis by Chemex Labs Ltd, North Vancouver, B.C.



58°02'
125°50'
N
— 0S
— 5S
— 15S
— 20S
— 25S
BARITE
BARITE
soil sample in ppm
— Analysis by Chemex Labs Ltd, North Vancouver, B.C.
Fig. 27
ARCHER, CATHRO & ASSOCIATES LTD
LEAD SOIL GEOCHEMISTRY
1977 GRID TWO
GATAGA JOINT VENTURE
Scale 1:10,000
0 100 200 400 600
MINERAL RESOURCES BRANCH
ASSESSMENT REPORT
NO. 6666


58°02'
125°50'
N
BARITE
BARITE
Fig 28
ZINC SOIL GEOCHEMISTRY
1977 GRID TWO
GATAGA JOINT VENTURE
6666
NO.



• 64 soil sample in ppm

Analysis by Chemex Labs Ltd
North Vancouver, B.C.

Fig. 29

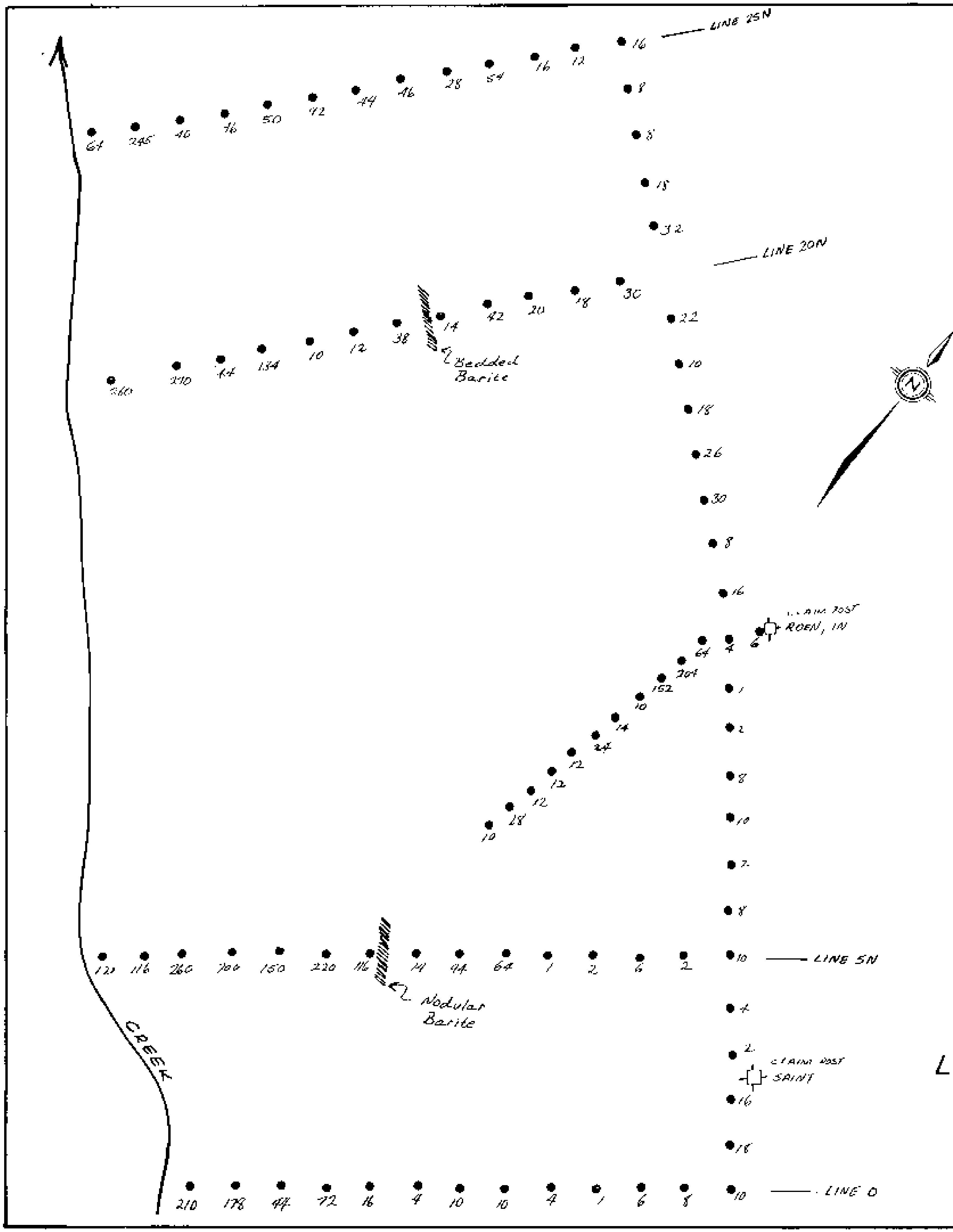
ARCHER, CATHRO & ASSOCIATES LTD

COPPER SOIL GEOCHEMISTRY

1977 GRID THREE

GATAGA JOINT VENTURE

0 100 200 400 600 metres



● 64 soil sample in ppm

Analysis by Chemex Labs Ltd, North Vancouver, B.C.

Fig. 30

ARCHER, CATHRO & ASSOCIATES LTD

LEAD SOIL GEOCHEMISTRY

1977 GRID THREE

GATAGA JOINT VENTURE

0 100 200 400 600 metres

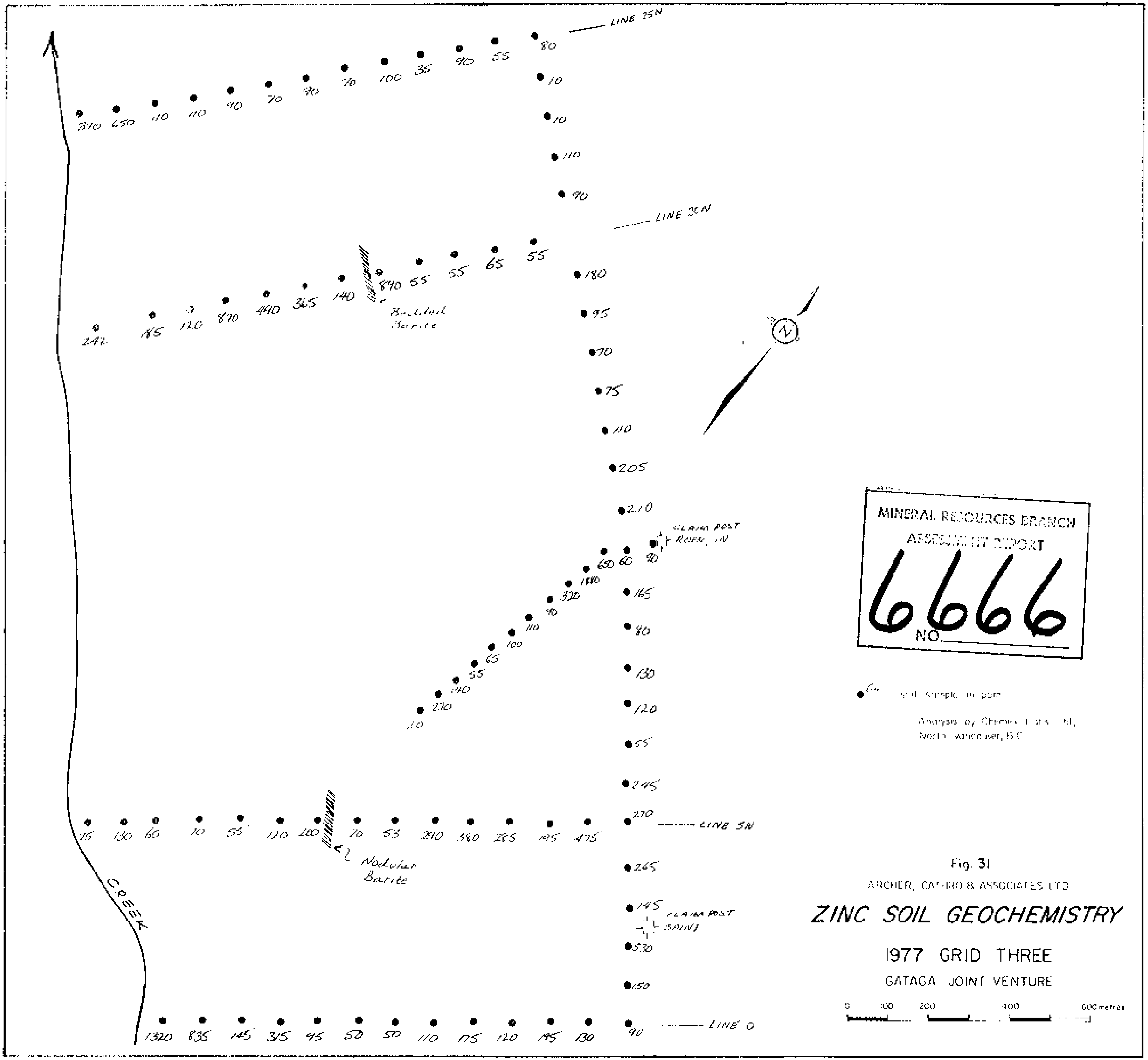


Fig. 31

ARCHER, CATHRO & ASSOCIATES LTD

ZINC SOIL GEOCHEMISTRY

1977 GRID THREE

GATAGA JOINT VENTURE

Grid Two is located in a valley bottom at the southeast end of the Canex Placer property and is crossed by the baritic and pyritic shales of Unit 7. Most of the grid is mantled with variable thicknesses of glacial and fluvial drift. Anomalous silt assays were obtained but prospecting proved of little value and the grid sampling was conducted as an experiment. The assays on Grid Two are uniformly low in all metals, probably because of the masking effect of overburden.

Grid Three covers a hillside with moderate relief and reasonably good talus exposure that lies along strike of the mineralized belt from Grid One. Weakly anomalous lead and zinc assays probably correspond to the anomalously high trace metal content of Unit 7 on a regional scale, since detailed prospecting of the relatively well exposed barite-bearing shales did not reveal any visible signs of mineralization.

Grid Four, on the Bear claims, is situated at and above timberline on a steep slope where metal dispersion in soil should be very high. It was sampled during the follow-up program in late August and was not assayed for copper. It was discussed previously in the chapter on mineralization.

Within the report area, anomalous threshold in soil is about 75 ppm lead and anything above 150 ppm is considered moderately anomalous. Response of up to 4000 ppm and over was obtained from soil in several places. Zinc geochemistry was found to be less useful than lead because the high background of the shale reduces the anomalous contrast, and this metal travels much further from the source than lead. Soil assays of up to 2000 ppm zinc are common in areas where rock assays show a very low zinc content. Copper assays of soil were consistently low.

Rock assays were obtained mainly from Gunsteel Formation shale and only occasionally from neighbouring units. The limited amount of sampling done in 1977 indicates that the metal content of the Gunsteel shale is lower than average for black shale except near the siliceous and baritic horizon. Normal background (in ppm) is in the ragne 1 to 6 lead, 20 to 640 zinc, and 2 to 48 copper.

The water sampling was done as a test to compare the hydrogeochemical response of the Gunsteel Formation shale with that from the age-equivalent Canol Formation in the Selwyn Basin. Previous work by Archer, Cathro has shown that oxidation of sulphide-barite mineralization in the Canol Formation produces extremely acidic and metal-rich water and results in the formation of ferricrete gossans where spring water reaches surface. Waters with pH as low as 2.5 that contain up to several thousand ppb Zn, up to 1000 ppm SO_4 and very high levels of Mn and F have been sampled in the MacMillan Pass district. Corresponding silt samples have produced only weakly anomalous values, presumably because the metal contained in the water is not precipitated until the pH drops to a more neutral range several miles downstream. The strong acidity is attributed to the oxidation of both finely disseminated pyrite in the enclosing shales as well as to more massive, laminated sulphides in the deposits.

In contrast to the MacMillan Pass area, where most gossans are consolidated, bluish black in colour and often partially eroded away, the Gataga district contains a much greater abundance of limonite gossans and most of these are still active or only weakly consolidated and have a bright red or blackish-red colour. Most of the gossans have formed at springs draining the siliceous, pyritic and baritic horizon of the Gunsteel shale although a few were also seen in other members of the Gunsteel Formation. Silt and rock sampling of the gossans and ferricrete shows they are consistently low in lead and copper and only weakly anomalous in zinc.

Water response in the Gataga district (see Figure 5 in pocket) is completely different from that observed at Macmillan Pass, with fairly neutral pH levels between 6.5 and 7.5. The following assay ranges were obtained from waters draining known mineralization:

	Zn (ppb)		SO_4 (ppm)	
	Normal Range	Isolated Peak	Normal Range	Isolated Peak
Canex Placer property	125–330	500	$<$5–40	105
Saint Claims - GJV	100-370	2700	$<$5–35	-
Gunsteel shale with no known mineralization	17–750	10,000	$<$5-320	-

The small stream assaying 10,000 ppb (10 ppm) Zn gave a corresponding silt assay of 14 ppm Pb, 20 ppm Cu and 1400 ppm Zn.

The water assays conflict with field observations and are not easily explained. The high response from apparently unmineralized shale indicates that most of the zinc and sulphate in the water is probably derived from disseminated pyrite. The relatively low sulphate levels, particularly from known mineralization, is probably an indication that oxidation of pyrite and other sulphides is proceeding at a very slow rate or that the sulphides are tightly contained in insoluble barite. However, the amount of limonite precipitating from springs that drain Unit 7 of the Gunsteel Formation is out of all proportion to the amount of pyrite seen on surface or to the lower hardness and neutral pH of the water. Possible explanations are that pyrite is abundant but deep weathering prevents its recognition on surface; or that spring waters are acidic in the oxidation zone but are neutralized by slightly calcareous wallrocks before they reach surface.

CHAPTER IV - REVIEW OF SHALE-HOSTED ZINC-LEAD DEPOSITS

Introduction

In recent years a distinct genetic family of shale-hosted zinc-lead deposits has been recognized worldwide in rocks ranging in age from Middle Proterozoic (Helikian) to Upper Devonian. These large stratiform ore-bodies have been variously referred to as "shale-hosted massive sulphide deposits", "distal volcanogenic deposits", "McArthur-type" deposits and "sedimentary exhalative deposits". The latter term is now gaining the most universal acceptance.

The Canadian Cordillera is richly endowed with the Sullivan, Howard Pass and Tom-Jason (Macmillan Pass) deposits. The McArthur (H.Y.C.) deposit in Australia, and Meggen and Rammelsberg deposits of West Germany are other examples of this deposit type. Each of these examples except Howard Pass is described briefly in this chapter, with emphasis on stratigraphic and tectonic setting, size, mineralogy and grade, in order to demonstrate that the Gataga mineralization belongs to this family.

Although these deposits are to some extent unrelated in time and space, they share many common characteristics. Variation in morphology, grade and metal distribution between deposits can be explained satisfactorily by differences in physio-chemical characteristics of the exhalative brines responsible for their formation. Current theories on the genesis of this type of mineralization, including temperature and salinity of the brines, are discussed in order to develop a useful exploration model. The discussion begins with a detailed description of the Tom deposit, which is the subject of an M.Sc. thesis investigation currently being conducted at U.B.C. by Carne. This information has great bearing on the mineralization in the Gataga district because of its geographic proximity and its stratigraphic and mineralogical similarities. It is included here in such detail because this information is unpublished and otherwise unavailable. Additional details of the other deposits can be obtained from the comprehensive bibliography contained at the end of this section.

TOM DEPOSIT

The Macmillan Pass area, Yukon is centred on the Canol Road near the Northwest Territories boundary (Figure 38). The Tom deposit, discovered in 1951 by Hudson Bay Mining and Smelting, has conservative ore reserves of 9 million tons averaging 8.6% Pb, 8.4% Zn and 2.8 oz/ton Ag. The adjoining and cogenetic Jason deposit was discovered in 1974 by Ogilvie Joint Venture (C.L. Smith, Brinco Ltd., Mitsubishi Metal Corp. and Ventures West Capital Ltd.). Reserves have not been released but average grades, style of mineralization and size of the deposit are similar to the Tom deposit (C.L. Smith, pers. comm. 1977).

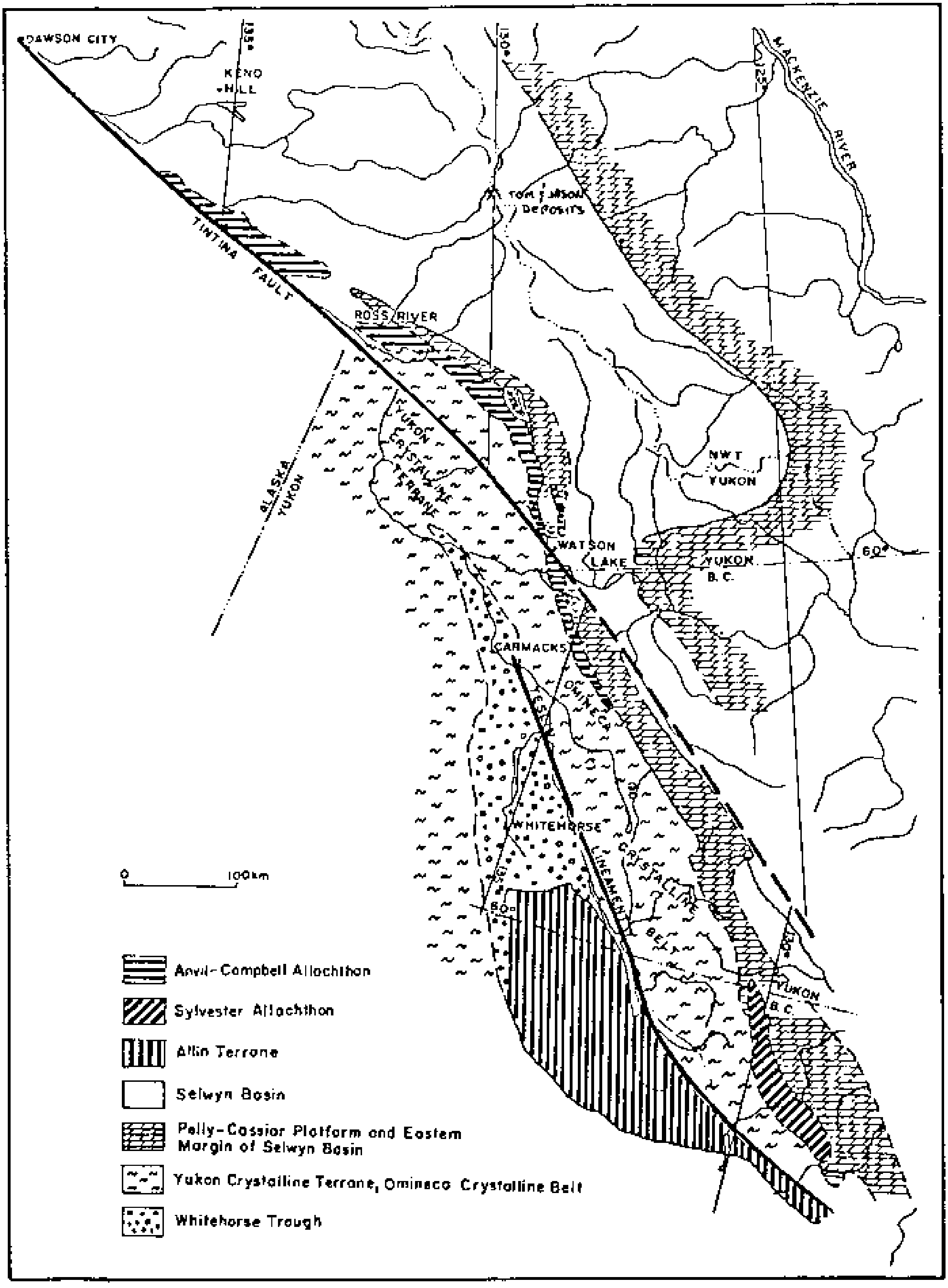


Figure 38 Tectonic elements of Yukon Territory after restoration of 450 km of post-Paleozoic right-lateral movement along Tintina Fault. Location of Selwyn Basin and Tom and Jason Ba-Pb-Zn deposits at MacMillan Pass are shown (after Tempelman-Kluit, 1977).

(1) Stratigraphy

The Macmillan Pass area lies along the northeast margin of the Selwyn Basin tectonic province, where Proterozoic to Middle Devonian sedimentation was characterized by stable continental shelf deposition (Figure 38.). Flyschoid lithologies of the Canol Formation, host to the Tom and Jason mineralization, and overlying Imperial Formation mark the change to eugoclinal depositional environments in Upper Devonian time. Generalized stratigraphy of the Macmillan Pass area is summarized in Figure 39.

The Ordovician to Lower Devonian Road River Formation, comprised of black, thin bedded cherts, fetid limestones and carbonaceous, slightly calcareous shales, is unconformably overlain by the Canol Formation. Because of the very recessive nature of Road River sediments, the precise nature of this contact is not known. Field evidence suggests that relief along the unconformity is subdued, probably indicating scouring by deposition of overlying clastic rocks rather than uplift and subsequent erosion by subaerial exposure.

Coarse clastic rocks of the Canol Formation are primarily composed of well rounded chert clasts ranging in size from sand to cobbles. Uplift, exposure and subsequent erosion of the basinal cherts of the Road River Formation within the Selwyn Basin has been suggested as a possible source terrane. The base of the Canol Formation consists of interbedded siltstones and silty shales that were probably deposited as distal turbidites, and coarse grained chert pebble conglomerates, that were deposited as scattered debris flows. Paleocurrent directions for this unit derived from sole markings and flute casts indicate a northerly direction of transport. An unusual characteristic of these rocks in the Macmillan Pass area is the total oxidation and almost complete leaching of cubic, euhedral pyrite as

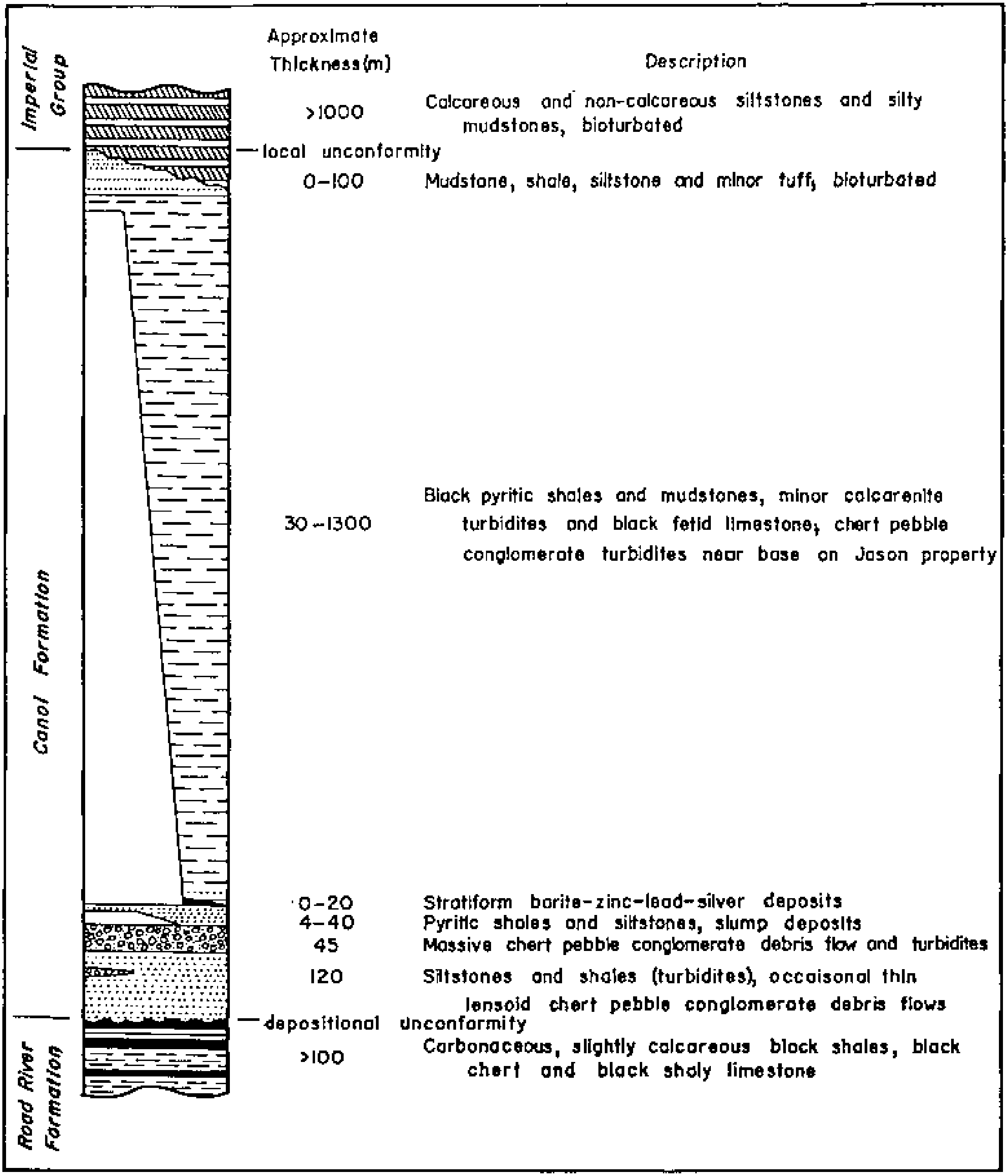


Figure 39 Generalized stratigraphic section of Canol Formation at Macmillan Pass (from Carne, in prep.)

well as an apparent enrichment of oxidized iron occurring as earthy hematite cement. Since this feature is always present, even at a considerable depth in diamond drill cores, it must represent oxidation that occurred soon after deposition. Matrix of the turbidites and shales has been almost completely altered to a felted mass of fine-grained sericite and kaolinite. Textural evidence suggests that alteration and oxidation of pyrite occurred simultaneously.

Oxidized and altered siltstone and shale beds are overlain by intensely silicified, massive chert pebble conglomerate that is 100 to 120 m thick near the deposit but locally increases to over 300 m. Poor sorting, lack of sedimentary structures and massive nature, supported by modal analyses of grain size, suggest that the conglomerate was emplaced in a single event as a large debris flow, perhaps triggered by earthquakes or oversteepening of a rapidly prograding delta-front to the southwest. Intense silicification of these rocks has resulted in replacement of the fine clay size matrix by cryptocrystalline quartz. Intergranular porosity and permeability of the rock is virtually absent.

Massive chert pebble conglomerate is overlain by approximately 15 m of coarse grained turbidites. Chert framework clasts in the turbidites are identical in nature to those of the conglomerate. Direction of sediment transport, as indicated by flute casts and tool marks, is to the northeast. Large scale slump structures in the turbidites underlying the Tom mineralization indicate that instability occurred after deposition of the beds, resulting in mass wasting to the northwest, approximately at right angles to original deposition on a fairly gently northeast sloping seafloor.

A variable thickness of pyritic siltstones and shales deposited as thin bedded turbidites, mudflows, and debris flows forms the footwall to stratiform barite-lead-zinc mineralization. Thickness of these rocks increases rapidly to the northwest. Much of the unit is composed of chaotic accumulations of severely contorted and slumped bedding.

The mineralized horizon is overlain by pyritic, siliceous and relatively carbonaceous shale containing at least three thin,black,fetid limestone beds. Thickness of the unit is locally variable, increasing from a fairly consistent regional thickness of around 30 m to over 1300 m in the Macmillan Pass area.

A restored cross-section through the Tom deposit using the top of the Canol Formation as a horizontal datum plane is shown on Figure 40.

Rapid thickening of pyritic siltstones and shales, which underlie mineralization, and of overlying pyritic shales was caused by deposition in areas of differential subsidence. A rapidly subsiding basin northwest of the zone of flexure shown on Figure 40 is characterized by slumped and contorted bedding in siltstones and pyritic shales and underlying coarse chert turbidites. Since chert turbidites were deposited by northerly flowing currents on a relatively flat seafloor, subsidence must have initially occurred after deposition of this unit and continued through deposition of the remainder of the Canol Formation.

(II) Economic Geology

The Tom and Jason deposits are stratiform accumulations principally composed of finely interlaminated sphalerite, galena, pryite and barite. Both are known to be similar in style and tenor of mineralization. Because very limited information about the Jason deposit has been published, discussion will be limited to the Tom deposit.

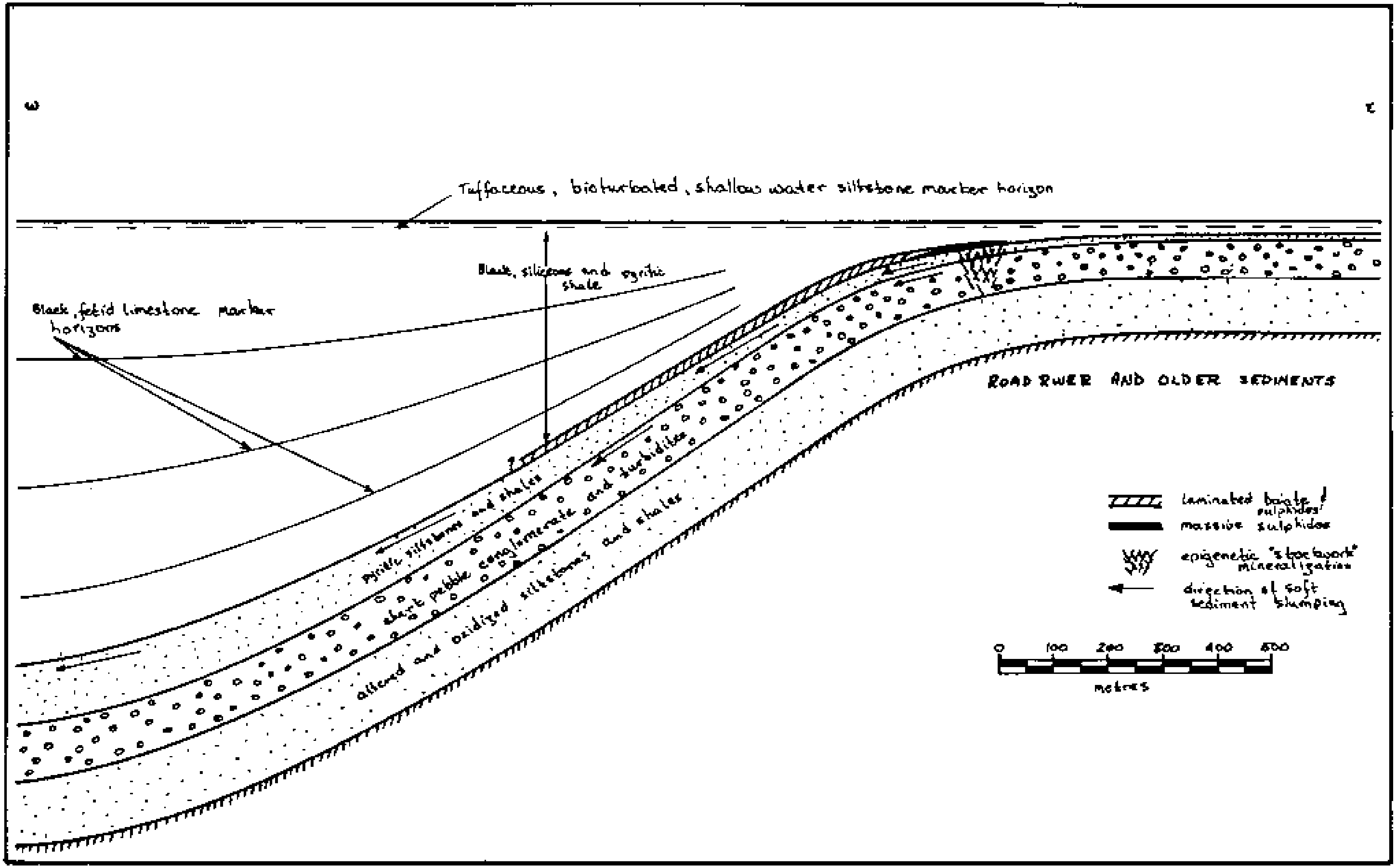


Figure 40. Restored cross-section through the Canol Formation during lower Mississippian time (from Carne, in prep.)

Tom mineralization occurs in two tabular bodies on opposite limbs of a partially eroded north-south trending anticline. The East Zone is 162 m long, 3 to 20 m thick and dips vertically. The West Zone is a tabular body 1200 m long and 3 to 60 m thick (10 m average thickness) that dips 70° west. It has been explored to a depth of 200 metres below surface. Both the West Zone and East Zone occupy the same stratigraphic position and were probably contiguous before they were separated by erosion of the anticlinal crest.

A structurally restored true stratigraphic section of part of the West Zone derived from logging of underground drill core is shown in Figure 41. Seven distinct types of stratiform mineralization are recognized:

(A) massive, poorly laminated galena, sphalerite, pyrite and siderite form the highest grade of mineralization in the Tom deposit. Assays range up to 31% Pb, 14% Zn and 11 oz/ton Ag. Sulphides occurring in minor amounts include chalcopyrite, boulangerite, jamesonite and bournonite. Overall Ag/Pb ratio is 1:2. Distinct vertical metal zoning is present. Base of the horizon consists of interlaminated pyrite and siderite, overlain, in turn, by massive galena with lesser pyrite and sphalerite and by massive sphalerite with lesser galena and pyrite. Sulfosalts and chalcopyrite primarily occur near the base of the zone as intergrowths with pyrite. Chalcopyrite also occurs in lesser amounts as exsolutions in sphalerite. Rip-up clasts of footwall rocks occur throughout this ore type. Massive sulphides grade laterally into mineralization of type B.

(B) a thin blanket of black, pyritic, cherty argillite interlaminated with pyrite, sphalerite and galena underlies most of the West Zone. Sulphide laminae are commonly monomineralic. Metal values are erratic, ranging from very low up to

20% Zn and 7% Pb. Silver and lead maintain an almost constant ratio of 1:3. Grade gradually decreases away from the massive sulphides and is accompanied by an increasing Zn/Pb ratio.

(C) interlaminated sulphides and cherty argillite of horizon C are indistinguishable from mineralization of horizon B. Metal grades average 11% Pb and 7% Zn with a Ag/Pb ratio of 1:3 and Zn/Pb ratio increases gradually upwards.

(D) unit D, which contains the bulk of the West Zone tonnage, grades laterally from unit C. Gangue consists principally of finely laminated grey barite with minor black chert and siliceous argillite interlaminae. Barite occurs as an accumulation of very fine subhedral to euhedral crystals with a sulphide matrix. Galena and honey-coloured sphalerite occur as discrete, almost monomineralic laminae between barite laminae. Pyrite is present in trace amounts, confined primarily to chert and siliceous argillite laminae where it occurs as disseminated framboids. Grade varies from 1 to 9% Pb and 3.5 to 10% Zn. Silver is present only in trace amounts. The horizon is, in general, zinc-rich with Zn/Pb ratios increasing towards the top and away from unit C. Both units C and D are capped by a 2 cm to 4 cm thick bed of pyritic grey chert.

(E) unit E consists of contorted and leached laminae of black chert,witherite, barite and sulphides. Galena, sphalerite and pyrite occur as discrete laminae as well as in veins and breccia matrix. Assay values are erratic, ranging up to 14% Zn, 4% Pb and 3.0 oz/ton Ag but averaging 8% Zn, 2% Pb and 0.1 oz/ton Ag. Silver displays no obvious correlation with lead.

(F) unit F consists of interlaminated barite, sphalerite and galena indistinguishable in appearance and grade from unit D.

(G) the West Zone is capped by thin bedded, black, pyritic chert with traces of galena and sphalerite in very thin, discontinuous laminae.

A zone of intensely silicified and pyritized silty shales, ranging in thickness from about 1 to 2 m forms the immediate footwall to the ore. Pyrite occurs as disseminations of diagenetic framboids and as bedded accumulations of finely crystalline, subhedral pyrite. Base of the pyrite and silica enrichment zone is sharply defined. A similar but more weakly enriched silica and pyrite zone occurs in hanging wall rocks. Enrichment decreases gradually away from the contact with stratiform ore.

Two areas of epigenetic mineralization occur in footwall rocks of the West Zone. A fairly large area of brecciated footwall rock, funnel-shaped in cross-section, underlies the massive sulphide ore. Breccia fragments are silicified, chloritized and carbonatized. Chalcopyrite, pyrite, galena, sphalerite and a variety of sulfosalts such as tetrahedrite, jamesonite, bournonite and boulangerite occur with quartz and siderite as breccia matrix and with cryptocrystalline quartz and chlorite as disseminated replacements of breccia fragments. Base metal values range up to 2% Cu (estimated), 6% Zn and 8% Pb. Silver occurs in amounts as high as 41 oz/ton and displays no obvious correlation with lead. Argentiferous tetrahedrite (freibergite) probably carries most of the silver values.

High temperature mineralogy of the breccia, inclusion of breccia fragments in overlying ores and metal zonation of stratiform ores away from the breccia indicates that it may have served as a channelway for mineralizing fluids that precipitated on the seafloor to form layered ores.

A different form of epigenetic mineralization occurs to the northwest, underlying ore horizon E. It is characterized by leaching and brecciation of stratiform sulphides to produce boxworks after pyrite, sphalerite and galena. Barite crystals are commonly etched and chalcopyrite, pyrite, sphalerite, galena and minor tetrahedrite occur as veins and disseminations.

This leached zone probably served as a channelway for mineralizing solutions for ore units E, F and G.

Mineralization in the East Zone is similar in style and grade to zones A, B and C of the West Zone.

(III) Genesis

Succession and morphology of ore types, their relationship to epigenetic mineralization, and metal distribution suggests the following sequence of events leading to formation of the Tom West Zone:

(i) deposition of chert pebble conglomerate debris flows and turbidites on a flat or gently sloping seafloor following uplift and erosion of Road River cherts to the southwest.

(ii) rapid differential subsidence and concurrent deposition of silty shales and siltstones.

(iii) brecciation, as a result of differential subsidence and/or explosive release of boiling fluids ascending along a fracture system.

(iv) ascent of iron and silica-rich brines causing pyritization, silicification, chloritization, and sideritization of brecciated rock, and silicification and pyritization of bottom muds by pooling of exhalatives.

(v) ascent of brines enriched in silica, iron, copper, lead, silver and zinc, resulting in enrichment of the breccia as well as precipitation of massive sulphides near the vent and interlaminated sulphides and silicified sediments away from the vent. Galena precipitated closer to the exhalative centre than spahlerite because of the relative instability of lead-chloride complexes with respect to zinc-chloride complexes. Copper minerals such as chalcopyrite and tetrahedrite precipitated in the breccias near the vent because of the even lower stability of copper-chloride complexes.

(vi) continued exhalation of cooler fluids containing barium, lead, zinc, iron and silica in solution. The lower temperature of these fluids contributed to the generally weak metal zonation of ore horizons C and D as well as the low content of silver incorporated into the galena lattice. Copper probably precipitated out of the relatively cool solutions before reaching the sea-floor. In an area approximately 100 m northwest of the breccia zone in the cross-section shown in Figure 40, gentle subsidence of the seafloor was co-incident with precipitation of horizons C and D from the pooled brine.

(vii) succeeding stages of exhalation were probably reduced in volume and temperature by clogging of the geothermal system by precipitation of epigenetic minerals in the breccia pipe. Exhalative fluids at this stage were enriched in silica and iron species because of their low temperature with respect to the stab-ilities of base metal-chloride complexes. The precipitation of the 2 to 4 cm thick, grey, pyritic chert bed probably represents the last significant con-tribution from this hydrothermal system.

(viii) differential subsidence locally continued in the area northwest of the now dormant vent. Fluids under very high pressure in the now-sealed geothermal system broke through to the seafloor along a zone of weakness coinciding with the axis of greatest subsidence. These hot and probably acidic solutions leached and brecciated footwall rocks and weakly consolidated sulphide and barite muds of ore horizons B and D.

(ix) local subsidence continued during deposition of ore horizons E and F. The high proportion of witherite and silica in unit E reflects a higher partial pressure of CO_2 near the vent, probably as dissolved CO_2 in exhalative fluids.

(x) unit G precipitated from pooled brines in the continually subsiding local basin. The presence of a high proportion of iron- and silica-rich chemical sediments in this unit reflects the waning stages of the geothermal system, probably through self sealing.

(xi) deposition of pelagic black shales followed precipitation of chemical sediments. Continued very weak exhalation formed the hanging wall pyrite and silica enrichment zone.

SUMMARY

Important characteristics of the McArthur, Sullivan, Meggen, Rammelsberg and Tom deposits are summarized in Table 6. Examination and comparison of the similarities between these deposits serves to outline a model for their genesis.

The syngenetic nature of this type of sedimentary lead-zinc mineralization is almost universally accepted. Recent studies of these deposits have independently suggested an "exhalative" source for mineralization in each case. Conduits for mineralizing fluids are theorized to have been located along deep-seated faults or fracture zones associated with the initiation of active tectonism expressed as rifting or differential subsidence.

Deposit	Age	Size (standard tons)	Grade	Tectonic Control on Ore Deposition	Evidence for Regional Tectonism	Associated Volcanic Rocks	Exhalative "feeder pipe" Recognized (?)	Relative Temperature of Ore Fluids	Relative Strength of Metal Zonation
McArthur, Australia	Middle Proterozoic	200 million tons	10% Zn 4% Pb 0.2% Cu 1.5 oz/ton Ag	differential subsidence adjacent to active fault of regional extent	turbidites, slump deposits, rapid thickness changes in enclosing sediments	tuffs and tuffaceous shales	no	low (less than 150° C)	unzoned
Sullivan, British Columbia	Middle Proterozoic	170 million tons	6.2% Pb 6.0% Zn 1.66 oz/ton Ag	intersection of tensional fracture zones and normal faults along rift (?) margin	slumped sediments coinciding with breccia zones. Geophysical evidence for Middle Proterozoic rift	none recognized	yes	high	strongly zoned
Meggen West Germany	Middle Devonian	65 million tons 16.5 million tons	10% Zn 1.3% Pb 0.2% Cu 96% $BaSO_4$	differential subsidence adjacent to active fault zones	rapid thickness changes in enclosing sediments, sedimentary "dikes"	tuffs and tuffaceous shales	no	low	weakly zoned
Rammelsberg, West Germany	Middle Devonian	33 million tons	19% Zn 9% Pb 1% Cu 3.0 oz/ton Ag 0.05 oz/ton Au 22% $BaSO_4$	differential subsidence adjacent to linear "hinge zone"	rapid thickness changes in enclosing sediments, flysch deposition	tuffs and tuffaceous shales	yes	high	strongly zoned
Tom, Yukon Territory	Upper Devonian to Mississippian	9 million tons with 8% Pb & Zn cutoff additional 10 million tons	8.6% Pb 8.4% Zn 2.6 oz/ton Ag 25–30% $BaSO_4$ 2.6% Zn 0.9% Pb 1.5 oz/ton Ag 60–70% $BaSO_4$	differential subsidence adjacent to linear "hinge zone"	rapid thickness changes in enclosing sediments, flysch deposition, slump deposits below ore mineralization	none recognized	yes	moderate	moderately zoned

Table 6 Summary of important characteristics of McArthur, Sullivan, Meggen, Rammelsberg and Tom deposits.

A recent publication by Hodgson and Lydon (1977) has outlined a model for exhalative systems associated with block faulting by comparison with active geothermal systems on land. Hydrothermal systems of this type form when and where an impermeable cap rock overlies a permeable aquifer and when discharge channels develop through the cap following movement on the bounding faults of tilted fault blocks. A heat source for the driving process could be related to the tapping of heated groundwaters by deep-seated faults or by the intrusion of magma bodies at depth along these fault zones (Figure 42).

This model can be applied to the formation of the Tom deposit and, by analogy, to the formation of other similar deposits in the following way:

(i) an aquifer is necessary for the movement of large quantities of seawater. Composition of discharge fluids in exhalative systems is determined by fluid-mineral equilibria in the aquifer. Aquifer rocks should be altered and depleted with respect to seawater in elements enriched in ores. The aquifer should be an oxidized zone, because if the sulphur of the ores, as the isotopic evidence suggests, comes at least in part from seawater sulphate, its reduction in the aquifer would require the oxidation of ferrous to ferric iron in the aquifer rocks. The silty shales and siltstones which underlie the comglomerate at the Tom deposit satisfy the requirements of an aquifer for mineralizing fluids. These rocks are extremely porous and permeable and are extensively altered and oxidized.

(ii) the accumulation of heat energy in a hydrothermal system is favoured where an impermeable, insulating cap rock is present below the zone of surface discharge. Many active hydrothermal systems contain "self-sealed" caps which form by rapid precipitation of constituents of boiling discharge fluids. The massive

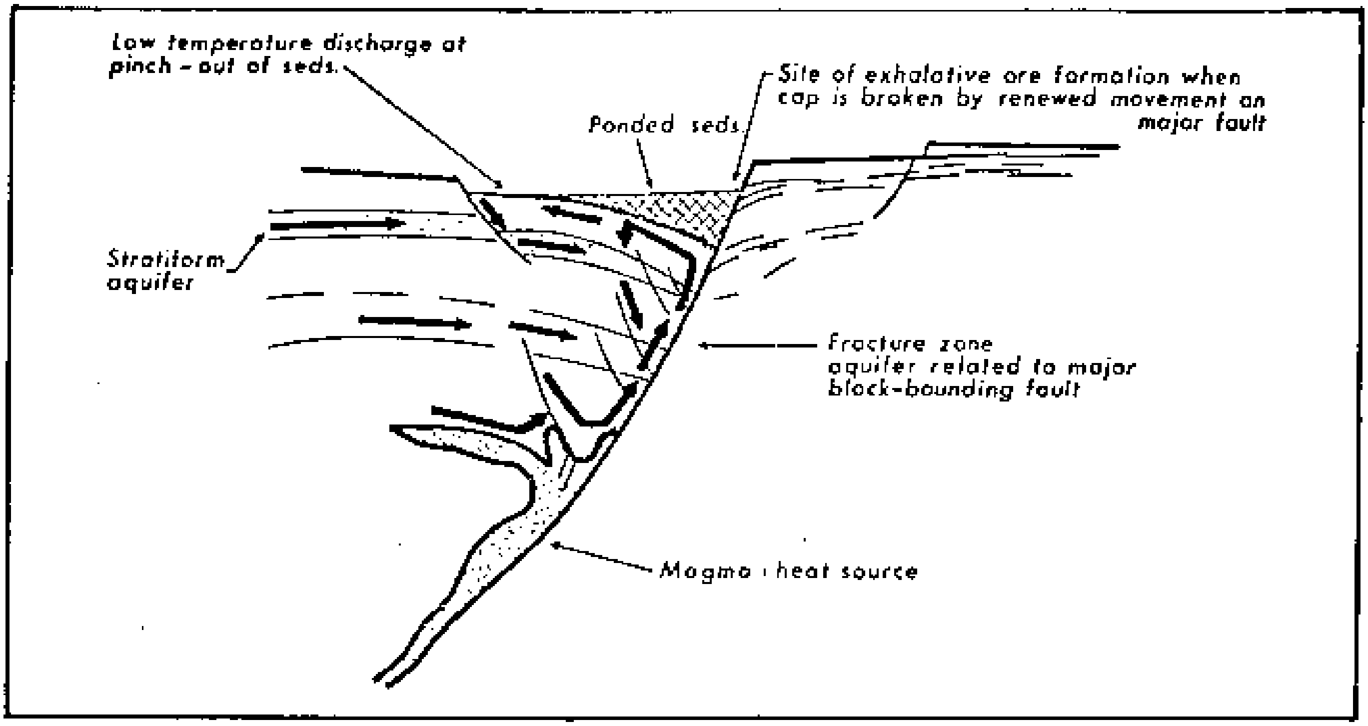


Figure 42 Diagrammatic representation of a hydrothermal system developed in a fracture zone adjacent to the boundary fault of a tilted faultblock (from Hodgson and Lydon, 1977).

chert pebble conglomerate which overlies the aquifer siltstones and shales and underlies the stratiform mineralization, is extremely impermeable due to the almost complete destruction of porosity and replacement of matrix by cryptocrystalline silica cement. In fact, the selective pervasive silicification of the conglomerate is very difficult to explain without invoking some sort of secondary hydrothermal process.

(iii) if boiling is a requirement for self-sealing, then a massive ore zone lying above a self-sealed cap should have an associated zone of alteration and stringer mineralization and there should be steam-blast eruption products. Epigenetic breccia mineralization occurring below massive sulphides at the Tom fit these requirements. Angular clasts of footwall rock which are incorporated into the massive ore probably result from steam-blast eruption caused by boiling of depressurizing ascending fluids.

Ore composition is directly dependent on temperature and salinity of fluids in the aquifer. For example, ores rich in Zn and Pb and low in Cu would be expected to form in relatively low temperature, highly saline fluid brine systems because of the relatively low stability of copper chloride complexes with respect to those of Pb and Zn. Furthermore, the relatively unstable nature of lead chloride complexes should favour high Zn/Pb ratios in these systems. Higher temperatures and lower salinity brines will favour an increase of Pb and Cu with respect to zinc over lower temperature brines.

Behavior of exhalative ore-forming solutions in seawater has been predicted by Sato (1972 and 1976) on the basis of their physical characteristics. Based on the assumptions that behavior of these fluids in seawater can be approximated by physical characteristics of the $NaCl-H_2O$ system and that modification of their behavior by contributions of heat conduction, reaction heat and heat of dilution are negigibly small compared with behavior predicted by heat capacity, morphology of the deposits summarized in Table 9 can be explained by the behavior of two type of brines in seawater (Figure 43).

Type I: Type I brines are low temperature brines of high salinity that will theoretically produce deposits with high Zn, low Pb and very low Cu content. These brines, will always be heavier than seawater during their cooling history and will be sulphur deficient because of their poor leaching capacity. Consequently, distribution of stratiform mineralization formed by these brines will be controlled by basin topography. Sulphide laminae will be finely alternated with sediments. Boundaries of the deposit with enclosing metalliferrous sediments will be diffuse as stagnant brines crystallize slowly. Homogenization of the brine pools will produce very little metal zonation within the deposits. Since very little mixing with seawater occurs during the cooling history of the brines, barite (if present at all) will be largely separated from sulphides at the margins of the deposit. Alteration zones of "stockworks" in footwall sediments will be poorly developed or not present. Examples of deposits that probably formed from Type I brines include McArthur River and Meggen.

Type II: Type II brines are moderate to high temperature brines of moderate salinity that will theoretically produce deposits with high Zn and Pb and low Cu content. Because of their high temperatures, the brines have increased leaching capacity and are sulphur excess. Upon exhalation on the seafloor, the density of these brines will initially be less than seawater but will eventually exceed seawater as mixing causes

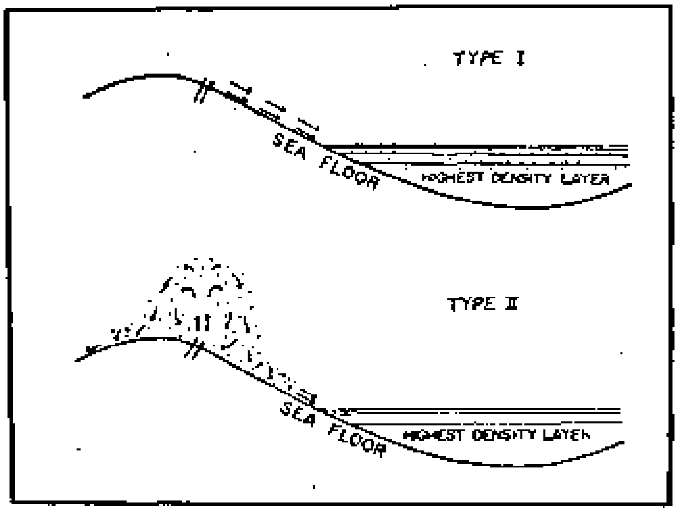


Figure 43 Probable behaviors of ascending ore-forming solutions welling up and into the seafloor. Dotted areas are the sites of mineral precipitation, assuming that metals are precipitated at early stages of mixing.

cooling. Consequently, distribution of stratiform mineralization formed by Type II brines will not be controlled by basin topography to the same extent as those formed from Type I brines. Boundaries of deposits formed by Type II brines will be sharp and enclosing sediments will usually contain anomalous amounts of metal. Rapid precipitation of ore constituents will occur, forming high grade, and commonly cupriferous, massive sulphide deposits near the vent. Degree of metal zonation away from the exhalative vent, both vertically and laterally, will be dependent on temperature of the exhaled brines. Since mixing with seawater occurs immediately after exhalation, barite (if present at all) will be intimately associated with layered sulphides. Alteration pipes or "stockworks" in footwall sediments along brine conduits will be well developed. Examples of deposits that probably formed from Type II brines include Sullivan and Rammelsberg. Tom deposit may also be an example of Type II although its characteristics suggest that it may be imtermediate between Type I and Type II endmembers.

Barite is an important volumetric component of many "sedimentary-exhalative" deposits. The distribution of barite within deposits can be explained satisfactorily by physico-chemical models of ore deposition from exhalative brines but the presence of barium in these brines initially is not well understood. The model proposed for genesis of sedimentary exhalative base metal deposits does not satisfactorily explain the presence or absence of barite. Examination of Table 6 shows that barite is an important component of three of five deposits summarized and that these share a common age of Middle Devonian to Mississippian. Moreover, the Tom deposit is located in the same stratigraphic position as literally hundreds of sulphide-deficient bedded barite deposits occurring in the Selwyn Basin and Kechika Trough of Yukon Territory and northeast British Columbia. Since bedded barite occurs in the same stratigraphic position and is morphologically similar to barite associated with the Tom deposit, barite and barite-lead-zinc deposits must share a similar depositional history. When barite is present, it tends to occur peripheral or above the central sulphide zone, although mixing always occurs. Barite is absent from deposits of Precambrian age, which may reflect some sort of geochemical evolution of barite from Precambrian to Phanerozoic times.

Barite and barite-lead-zinc mineralization in the Gataga area are markedly similar to occurrences of bedded barite and barite-lead-zinc mineralization in the MacMillan Pass area (Tom-Jason).

Some of the main similarities are:

(i) same apparent ages (Upper Devonian to Lower Mississippian).

(ii) coarse south-westerly derived chert pebble turbidites and debris flows produced in an active tectonic environment of deposition underlying the mineralization.

(iii) fine grained pyritic and siliceous shales overlying the mineralization.

(iv) similar tenor and mode of occurrence between mineralization exposed in trenches at Driftpile Creek and lower grade portions of the Tom deposit.

Because of these similarities, it is logical to assume that the Tom-Jason and Driftpile barite-lead-zinc mineralization were deposited under similar conditions in nearly identical tectonic environments. There is no reason to believe that they should differ significantly in size and grade since all controls on their genesis and deposition appear to be identical. The combined tonnage of the Tom and Jason deposits now apparently exceeds 20 millions tons of about 10% combined lead and zinc with the potential for much more. Both Tom and Jason deposits contain massive sulphide zones, in addition to sulphides finely interlaminated with barite. A massive sulphide deposit should, by inference, be associated with low grade barite-lead-zinc mineralization at Driftpile Creek, if it has not been eroded.

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V6B 1L8

CERTIFICATE

I, Robert J. Cathro, with business addresses in Whitehorse, Yukon Territory, and Vancouver, British Columbia, and residential address in West Vancouver, British Columbia, do hereby declare

1. I am a consulting engineer.
2. I am a 1959 graduate of the University of British Columbia in geological engineering.
3. From 1959 to 1965 I was engaged in mining and exploration geology with United Keno Hill Mines Ltd., Giant Yellowknife Mines Ltd., and Eldorado Mining and Refining Ltd. I entered private practice in January, 1966.
4. I am a registered professional engineer in British Columbia and Yukon Territory.
5. I have supervised the work described in this report.

Respectfully submitted,

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA R.J. CATHRO

R.J. Cathro, B.A.Sc., P. Eng.

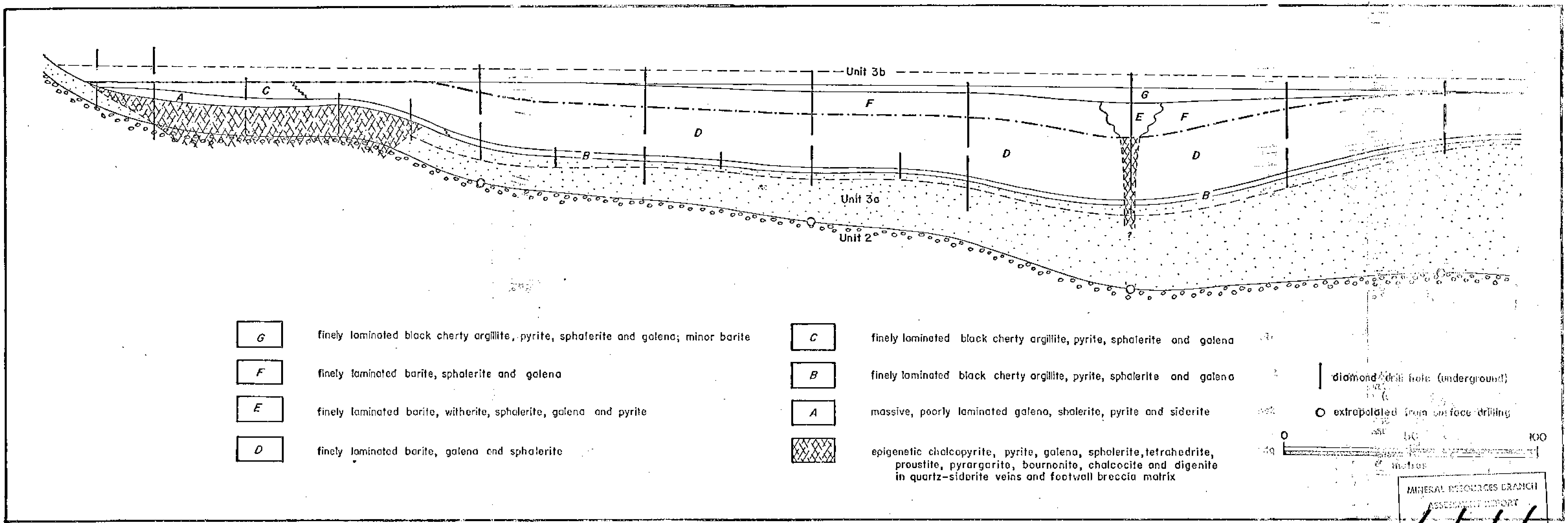

Figure 41 Restored cross-section through the Tom West Zone.

part 1 of 2