4501

SHUSWAP PROJECT

for

DOME EXPLORATION (CANADA) LIMITED

by

J. R. Woodcock and D. R. Ramage

J. R. Woodcock Consultants Ltd.
North Vancouver, B. C.

January 1976

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J. R. Woodcock Consultants Ltd.

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1521 PEMBERTON AVENUE NORTH VANCOUVER, B.C., CANADA TELEPHONE: 604-988-2171

January 8, 1976

Mr. Wally Bruce,
Dome Exploration (Canada) Ltd.,
Suite 600 - 365 Bay Street,
Toronto, Ontario,
M5H 2V9

Re: Shuswap Project

Dear Wally:

Enclosed is a report on our Shuswap study. We are still accumulating data on the area as I believe that this part of British Columbia will start receiving more attention for lead-zinc deposits.

As I mentioned to you when you were in Vancouver, I would like to break the region into three project areas:

(a) The Shuswap Project of 1974, west of the Columbia River and north of latitude 51°. Depending on outcome of studies, this area could be extended further north or west.

(b) Arrow Project: Continuation of the same geology southward, bounded on the east by the Columbia River and Upper Arrow Lake.

(c) Selkirk Project: That area east of the Columbia River and north-west of Highway #1 (this highway goes northeasterly through Revelstoke). This latter area could be extended to the southeast, depending on the outcome of the compilation of data and on the size of a budget.

Also, as I mentioned to you on your trip to Vancouver, I would like to get a total budget of about $150,000, allocating approximately $50,000 to each of the proposed project areas. I have quickly made an estimate of the possible cost of a three month project and am enclosing it herein. I have incorporated an allowance for 10% increase in helicopter rates and wages over 1975 prices; however the increase may be less with the new Federal guidelines.

Fast reply needed.

Please look over the data at your earliest convenience and decide which of these project areas that you would like to pursue. There will undoubtedly be numerous questions that you would wish to ask so it would be wise for me to go to Toronto to review this and the other ideas that I have, with you as soon as possible.

Please excuse the delay in getting this report out, and my present urgency in getting my projects for 1976 lined up. We have had numerous interruptions such as working to get the Socialists out in the last December election, holiday interruptions, and various illnesses in my small staff.

Best luck in the coming exploration season. I look forward to visiting you shortly.

Yours very truly,

Dick Woodcock

J. R. Woodcock

JRW:smb
Encls.

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See GSC paper 64-32
BC Mines
Mem. G 1990-73

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SHUSWAP PROJECT

INTRODUCTION

Early in 1975 the writer proposed a preliminary study of the Shuswap terrain to include a compilation of the available published and unpublished data, and also some field observations for the purpose of selecting suitable areas and suitable techniques for a lead - zinc exploration program in 1976. The field work, supported by G3 B2 helicopter, started in late August and continued for eight days with two geologists and a prospector based in Revelstoke. This program was severely hampered by poor weather conditions and so at the end of the eight day period the helicopter and the geologists left the project, leaving Nick Wychopen to do some additional orientation sampling and prospecting from the roads.

During this period the three sulphide bands within the Shuswap project area, and the Big Ledge sulphide band south of Revelstoke were visited. Subsequent to the field work, data from published sources and from assessment work reports have been compiled and discussions with the government geologists are in progress.

While in Revelstoke the crew learned that Noranda were carrying on a very active exploration program along Goldstream River, 60 miles NNW of Revelstoke. Information gained on this new copper-bearing zone is included within this report.

GENERAL GEOLOGY

The Shuswap metamorphic complex, widespread in the eastern part of southern British Columbia, includes a thick sequence of metamorphosed rocks. In recent years mapping has indicated that this complex includes strata from most of the Paleozoic, some of the Proterozoic, and possibly even some Mesozoic.

Mapping by government geologists such as John Reesor has revealed that part of the Shuswap Complex includes a north-northwesterly trending stretch of gneiss domes extending for a distance of about 250 miles. These include, starting on the south, the Valhalla, the Thor-Odin, the Frenchman Cap, and the Malton. The domes centre on the "core zones" consisting of migmatites, biotite-quartz-feldspar gneisses, and granodiorite gneiss. A "mantling zone" surrounds the cores. It includes quartzite, pelitic schist, paragneiss, marble, and calc-silicate gneiss bands. Outside of the mantling zone is a "fringe zone", quite similar to the mantling zone but characterized by extensive pegmatitic and granitoid intrusive masses. Outside of the fringe zone lies the undifferentiated metamorphic Shuswap rocks.

The ages of the various parts of the Shuswap metamorphic complex are not fully known. Reesor has published a Proterozoic date for granodiorite in the core of one of the domes. Other

government geologists have suggested that the calc-silicate bands, with their associated marble and white quartzite bands of the Frenchman Cap dome might be equivalent to the Lower Cambrian strata of the Kootenay Arc. Also a carboniferous age has been proposed for the mineralized strata of the Adams Plateau.

MINERALIZATION

Five massive sulphide zones merit some discussion for this project. Starting from the north these include the Ruddock Creek, Cottonbelt, and King Fissure sulphide bands of the Frenchman Cap gneiss dome, the Big Ledge band at the southern end of the Thor-Odin gneiss dome, and the Wigwam deposit outside of the gneiss dome area but within phyllitic strata that have been included in the Shuswap complex.

Mapping of the gneiss domes has shown that a relatively early period of folding along an east-west axis was followed by the much later northwesterly structures such as folds, faults, and major uplifts. This early phase of folding is reflected in the attitude of some of the sulphide bands.

Ruddock Creek

The Ruddock Creek deposit, the northernmost of the massive sulphide bands, occurs in the fringing zone of metamorphic rocks. Within this fringing zone igneous rock such as petmatite and granodiorite have been mobilized and intruded into the ore area, and in places these cut off or diminish the thickness of the sulphide horizon. The sulphide horizon can be traced for about three miles along the north and south limbs of a synclinal structure which appears to plunge westerly. The ore is thickest where the sulphide layer has been squeezed into the crests or troughs of folds, especially at the eastern part of the mineralized zone. Both limbs of the sulphide layer disappear to the west under the overburden of Oliver Creek.

According to J. Fyles, several million tons of ore grading 10% combined lead and zinc have been discovered in the sampling and drilling of 1961 to 1963. Woodcock and Ramage sampled the northern limb at its westward extent. In one blasted cliff exposed, it grades 4.1% lead, 17.2% zinc and 2.3 oz per ton silver, over a thickness of 4.0 feet. About 50 feet west of this the sulphide layer was only one foot thick because of the intrusion of a pegmatite. This exposure graded 5.4% lead, 27.0% zinc and 1.9 oz per ton silver across 1.0 feet.

The Ruddock Creek deposit was discovered in 1960 by prospectors and geologists working for Falconbridge Nickel Mines Ltd. Exploration work was done from 1961 to 1963. This included geological mapping, diamond drilling, and airborne geophysical work.

The airborne geophysical work included magnetic and electromagnetic, using a helicopter with an average EM bird height of 120 feet and an air speed of 70 mph. The airborne work, done July 3 to August 28, 1973, was filed for assessment work (Assessment Report 4567) in 1973. The EM map shows a few possible and probable anomalies

and only one of these coincides with the sulphide band. The best anomaly occurs in the centre of the synclinal structure and is probably not related to the sulphide band. Magnetic maps filed with the assessment work report include a"total field map" and a "screened" magnetic map. The northern limb of the sulphide band is not reflected by the magnetic map. However the two highest magnetic anomalies on the map do correspond with a thickened trough area on the east end of the sulphide band and on a complexly folded area on the south limb of the sulphide band. It appears from the data filed for assessment work (and one cannot assume that it is all of the data that the company had) that the EM survey failed to detect the sulphide band, and that the magnetic survey picked up two places of complexity within the sulphide band but cannot be used as a criterion for eliminating potential ground

The present writers intended to visit the property, especially the eastern thickened area, in the orientation study of August and September. However they found an active drill camp and a drill was operating at the eastern end of the property. This drill program was reportedly for Cominco Ltd. Thus it appears that Cominco Ltd. has optioned the properties from Falconbridge Nickel Mines Ltd.

Cottonbelt Area

Location and Access

The Cottonbelt area is on N.T.S. map sheet 82M/7W in the vicinity of Mount Grace. A road suitable for a 4-wheel drive vehicle connects Seymour Arm and the Goldstream River area. A section of this follows Ratchford Creek to the south of Mount Grace. This road was built in 1974 and 1975 for power line construction. It is poor but passable; deterioration can be expected to be fairly rapid after the power line is completed.

History and Early Work

History of the area is taken from the B.C. Minister of Mines Report for 1927 and from assessment reports available for the area.

The original "Cottonbelt" group of crown-granted claims was staked in 1805 to cover a layer of massive sulphides exposed on the Mount Grace upland area. Numerous old trenches and adits in this area indicate that much early prospecting work was done prior to 1920, mainly on the Cottonbelt zone. The "Copper King" zone was exposed in 1913 for a length of about 2000 feet by a series of open cuts. An old wagon and pack horse trail connected the property with the north end of Seymour Arm.

Activity in the area appears to have been slight between 1930 and 1960.

A geological report by Alfred R. Allen, P.Eng., dated May 21, 1968, reviews the history and describes the geology of the area. It is referred to in some of the assessment reports of the area,

TABLE I

COTTONBELT AREA CLAIM DATA

Claim Name	Units	Tag No.	Record No.	Staking Date	Recording Date	Lapse Date	Owner	
Cottonbelt		0146664	L 2105	July 3/05		Dec. 31/75	B. I. Nesbitt	
Joe		0146663	L 2106	"		"	"	
Boyne	old	0146665	L 2107	"		"	"	Crown
Harrison	staking	0146662	L 2108	"		"	"	Grant
Victoria	system	0146666	L 2109	"		"	"	Claims
Jessie		0146668	L 2110	"		"	"	
Wellington		0146667	L 2111	"		"	"	
Vegas	9	14501	98	Sept. 7/75	Sept. 8/75	Sept. 8/76	George Adams	
Nevada	6	14502	102	Sept. 6/75	Sept. 16/75	Sept. 16/76	Les Adams	
Reno	20	08601	103	Sept. 6/75	Sept. 16/75	Sept. 16/76	Les Adams	
Ratch 1	16	07133	104	Aug. 31/75	Sept. 18/75	Sept. 18/76	Dome Exploration (Canada) Ltd.	

but is not available in Victoria. It may have been an unpublished company report.

Claims and Ownership

Valid claims in the area, their owners, and other pertinent data are summarized in Table I.

The seven crown-granted claims are being maintained by payment of taxes. The Ratch claim was staked for the Shuswap Project (Dome Exploration (Canada) Limited) on the southward extension of the Cottonbelt structure. The crew tried to return to the area several times to stake additional ground, but low clouds defeated these efforts. The Adams family have been re-staking claims to the north of the crown grants for many years. In 1975 they acquired three claims which surround the crown grants and cover the ground on strike to the north.

General Geology

Geology of the Cottonbelt area is taken from the following publications and reports:

1. G.S.C. Paper 64-32 "Big Bend Map Area, British Columbia" by J. O. Wheeler, 1965.

2. B.C. Dept. of Mines and Petroleum Resources Assessment Report Nos. 486, 958, 1768, 2637, and 4367.

The area is underlain by rocks of the mantling gneiss zone of the Shuswap Metamorphic Complex, approximately 16 miles northwest of the core zone of the Frenchman Cap gneiss dome. Attitudes in the area are fairly consistent with the original trends of the Shuswap Complex, striking 155° to 165° and dipping 25° to 40° southwest. The area can be divided into two zones with a northwest-trending gradational contact lying about 3000 feet east of Mount Grace. The western zone consists of homogeneous pink, granitic gneiss. It is non-calcareous, and contains no observed mineralization. The eastern zone consists mainly of quartz-biotite-feldspar schist and paragneiss containing garnet and sillimanite. Other rock types include amphibolite, hornblendic gneiss, quartzite, marble, calc-silicate rocks, and minor pegmatite. All sulphide layers and mineralization occur within the eastern zone.

Drift, silt and alluvium fill the valleys of Seymour River and to a lesser extent the valleys of Deep Creek and Blais Creek to the north.

Mineralization exists in three distinct northwest-trending zones. They are (from southwest to northeast): the Cottonbelt zone, the Copper King zone, and the Complex or McLeod Zone.

The Cottonbelt Zone:

The Cottonbelt zone lies 1000 feet east of the schist-gneiss/granitic gneiss contact. It lies 100 feet east of a

dictinct white marble layer from which it derives its name. The exposure of this layer extends northwest from the adit area on Mount Grace to Blais Creek, and southeast towards Ratchford Creek for almost two miles. It varies in thickness from 20 to 100 feet. The Cottonbelt sulphide layer itself consists of massive galena, sphalerite, pyrrhotite and magnetite in a gangue of quartz, skarn minerals, and carbonates. It is conformable with the surrounding metamorphic rocks. The presence of copper sulphides, tetrahedrite, and molybdenite has also been reported. Wall rock is schist and paragneiss.

The zone is exposed for a maximum length of 2000 feet over which mineralization is strong and continuous in thicknesses of 1 to 10 feet. Additional isolated exposures to the north indicate a possible length of at least 12,000 feet. Further to the northwest the zone is covered by overburden. To the southeast, it is either not exposed or not present, although the marble horizon continues. Numerous adits and trenches are exposed along the Cottonbelt zone. One tunnel follows the zone for 800 feet. Width of the sulphide zone along this length is 18 to 24 inches. Elsewhere, the zone is up to 12 feet thick.

The Complex Zone:

The Complex zone dips into the steep slopes 3000 feet northeast of the Cottonbelt zone, and is conformable with regional trends mentioned earlier. Ore mineralogy is similar to that of the Cottonbelt zone. Some copper mineralization is also reported. The footwall is white, crystalline limestone. The sulphide layer is exposed over a total length of 1800 feet, and varies from 2 to 7 feet in thickness. The associated limestone (marble ?) is 12 to 20 feet thick and is exposed for 7500 feet. The early workings include several trenches and an adit. The zone is open for extension at both ends.

The Copper King Zone:

The Copper King zone lies approximately 500 feet west of the Complex zone. It consists of disseminated chalcopyrite and minor bornite in quartzite. Magnetite or pyrrhotite may be present as indicated by a detectable magnetic response. The quartzite is interbedded with layers of limestone and schist, and lies conformable to the general geologic trend of the area. The hanging wall consists of friable schist and the foot wall is a light grey-to-black banded quartz-feldspar-biotite paragneiss interbedded with micaceous schist layers. Old reports indicate that this quartz vein system may be up to 35 to 50 feet thick, and that it is exposed for a total of 2600 feet. Copper mineralization occurs along 1000 feet of this exposed length.

Recent Work

Exploration work done in the Cottonbelt area since 1963 has been obtained from assessment reports field with the B. C. Department of Mines and Petroleum Resources and is summarized below.

In 1963, Falconbridge Nickel Mines Ltd. conducted a semi-quantitative Total Heavy Metal (THM) geochemical survey (Assessment Report No. 486) over an area approximately 5000 feet by 4000 feet, to the northwest of the known Cottonbelt and Complex zones. The area was at that time staked as the "Zan" claims. About 15 miles of sampling, at 100-foot intervals, was done on lines 400 feet apart and bearing due north, oblique to the expected mineralized trends. Irregular anomalous zones were outlined and extended along expected trends to the northwest of the known showings of both the Copper King and Cottonbelt zones. Although anomalous zones are outlined on the map, it is difficult to correlate specific trends with the known individual mineralized structures. Cold extractable analytical techniques are generally ineffective in soil geochemical surveys and so the results are not very reliable. Further northwest, the so-called "anomalies" die, possibly due to the effects of deep overburden in the valley bottoms.

In 1966, B. I. Nesbitt, a consulting geological engineer, conducted a magnetometer survey for Great Northern Petroleums and Mines Ltd. over the "Shuswap" claim group* (Assessment Report No. 958) in order to trace the known mineralized zones to the northwest. A Sharpe Model MF-1 Fluxgate magnetometer was used to make zig-zag traverses. This traced the Cottonbelt zone from the Boss Shaft to the Ken occurrence (a distance of over 4500 feet). Subsequently an area approximately 4000 feet northwest-southeast by 3000 feet northeast-southwest, extending northwest to Blais Creek was surveyed by magnetometer along lines 400 feet apart running perpendicular to the expected mineralized trends. Readings were taken every 50 feet. This later magnetometer survey outlined anomalous zones striking approximately 125° along the presumed extension of the Cottonbelt zone. Also, a well-defined zone to the northeast, striking approximately 115° was outlined. The Cottonbelt zone anomaly appeared to veer westward near the southwestern edge of the grid area. Mr. Nesbitt is the owner of the original crown-granted Cottonbelt claim group and, at the time of writing of the report, owned 150,000 free shares and 600,000 escrowed shares of the capital stock of Great Northern Petroleums and Mines Ltd.

In 1968, Jon G. Baird of Seigel Associated Ltd. conducted an induced polarization survey, using Seigel Mark VI time domain equipment, for Great Northern Petroleums and Mines Ltd. (Assessment Report No. 1768) over essentially the same area as that covered in the above magnetometer survey.

Grid orientation and line spacing for the induced polarization survey is described in Assessment Report No. 958. Station intervals and electrode spacings were generally 200 feet. A contoured plan map of chargeability reveals a large anomalous

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*The Shuswap group covered approximately the ground formerly staked as the "Zan" claims.

zone that strikes 125°, roughly parallels the known mineralized trends of the exposed zones to the southeast. It is probably a reflection of the northwest extension of the Copper King zone. Other anomalous zones are outlined along the projected extension of the Cottonbelt trend, but these are discontinuous and display less linearity.

At the same time, Seigel and Associates extended the magnetometer surveys to follow Nesbitt's magnetometer anomalies westerly (Assessment Report No. 958). However the Nesbitt anomalies did not continue into the new grid area.

The only geological study submitted for assessment purposes (Report No. 2637) in the Cottonbelt area was done in 1970 by R. S. Boyle, a third year geology student. Boyle was working under supervision of Harold A. Quinn, P. Eng., consultant for Great Northern Petroleums and Mines Ltd. This covered the Shuswap group, the GN group (adjoining the Shuswap group to the southwest) and the Snow claims (adjoining the Shuswap group to the north). Orientation for this survey is based on the geological report by Alfred R. Allen.

The area, mapped on a scale of 1" = 500' is bounded on the north by Blais Creek, on the east by Deep Creek, on the south by Mt. Grace, and it extends 3000' west of the Cottonbelt zone. The geology described in this report is reviewed under "General Geology". At the same time, the Copper King adit was re-opened and sampled. Assay values obtained from the Copper King "vein" are over vein thicknesses of 3 to 9 feet. The best values over a 3-foot thickness range from 0.08 to 3.55 per cent copper and trace to 0.20 oz/ton silver. Trench sampling was also undertaken, but no assays are given. No details of sampling or assay results are given for any work which may have been done on the Cottonbelt or Complex zones. A diamond drill hole 100 feet south of the Copper King adit portal is indicated on a map of the adit, but no details are given.

In May of 1973, a combined airborne magnetic and VLF-EM survey was done by Howard A. Larson, P.Eng., of Geotronics Surveys Ltd. This survey, for Great Northern Petroleums and Mines Ltd., was conducted over the Shuswap and GN claim groups. Weather did not permit extensive coverage of the Cottonbelt property.

For the survey, a Sabre Electronic VLF-EM instrument was mounted on a boom protruding from the front of a Jet Ranger helicopter. This unit provides a continuous plot of the induced current, but is extremely sensitive to air turbulence, ground clearance, and terrain variations. However, Larson states: "Only VLF-EM anomalous zones that could be separated from the effects of turbulence and terrain were plotted." At the same time an Elsec proton precession magnetometer,mounted in a bird, was towed on a 30-foot cable. Readings were taken at 50 to 200 foot intervals. Readings were generally near 58,000 gammas, and had a range of 110 gammas. Unfortunately, average flying height is not given.

A linear VLF-EM high is evident along and near the Cottonbelt zone and its projected extension to the northwest. These anomalous VLF-EM lines become widespread and inconsistent to the southeast, over the known Cottonbelt trend showings.

Anomalous magnetic highs of the airborne survey occur in a linear pattern apparently between the Cottonbelt and Copper King zones, but closer to the Copper King. Magnetic highs are conspicuously absent over known Cottonbelt mineralization.

Observations From Present Survey:

One day was spent by J. R. Woodcock and D. R. Ramage examining the Cottonbelt zone. Their observations are noted as follows:

1. Gneiss and calc-silicate rocks lie between the marble bed and the sulphide layer.

2. A pure, white quartzite layer about 15 feet thick was noted approximately 300 feet east of the marble bed. A similar quartzite layer was noted by the writers below the sulphide layer at the King Fissure property. Dr. Peter Read, working for the G.S.C., suggests the possibility of using the white quartz to make correlation with the Lower Cambrian strata of the Kootenay Arc.

3. J. R. Woodcock noted a pinching and swelling of the Cottonbelt sulphide zone down-dip, suggesting horizontal lens-like pipes.

4. Samples of the Cottonbelt sulphide layer collected by J. R. Woodcock and D. Ramage gave the following assays:

Sample No.	Location	Pb	Zn	Cu	Ag
W75-306R	Upper Adit	2.290%	2.90%	0.002%	19.2 ppm
R75-73R	Lower Adit	3.930%	4.50%	0.003%	22.2 ppm

Sample W75-306R is an underground sample across 3.7 feet thickness. Sample R75-73R is a grab sample from the massive sulphides piled at the portal.

King Fissure (Jordan River)

The best publication on the geology and mineralization of the Frenchman Cap gneiss dome and surrounding Shuswap Metamorphic Complex is the British Columbia Department of Mines Bulletin 57 by Dr. James Fyles, titled "The Jordan River Area". Fyles took some of his data on the King Fissure sulphide layer from a report on the "Jordan River lead-zinc deposit" by Dr. C. Riley (C.I.M. Bull. June 1966, pp 437-441).

Copies of the bulletin were submitted to Dome Exploration (Canada) Limited early in 1975 and parts of his report were quoted in the project proposal of May 17, 1975. In the orientation study, one day was spent on the property making geological observations, and taking chip samples while Nick Wychopen took some silt samples:

Several observations merit mention:

(a) Fyles has shown a sulphide layer with canoe-like shape and with the best thicknesses on the south limb of the synclinal structure. The present writers learned that the northern limb, where they searched, was practically non-existent.

(b) Fyles quotes Riley in stating that the ore reserves were 2,873,000 tons grading 1.1 oz silver, 5.1% lead and 5.6% zinc with average width ranging from 3 to 7 feet and that subsequent drilling has extended the depth of mineralization. Woodcock is skeptical that the limited amount of drilling and surface sampling would allow ore reserves to be stated in such detail.

(c) Assuming for stratigraphic reference that the structure is a syncline (and not overturned) the vein is zoned with almost massive fine-grained sulphide (Fyles, Plate XV) underlying a silica-rich sulphide zone. The quartzose layer has sulphide disseminations and concentrations. In the exposure examined, the grade appeared to vary greatly over short distances of strike.

(d) The strata, for several hundred feet above and for a short interval below the ore horizon, contain many rusty-weathering pyrite-rich beds.

(e) A white quartzite bed occurs a short stratigraphic distance above the ore horizon.

While the exploration activity was proceeding in the area of Mount Copeland, mainly for the King Resources and Stampede Oils, and mainly instigated by the molybdenite deposit on Mount Copeland, geological mapping was being done by Dr. James Fyles of the British Columbia Department of Mines. Also, Mr. L. W. Vigrass of Regina was mapping the geology of the Nora and John claim groups (196 claims) of the Frisby Ridge area. These claims lie across the valley of Upper Jordan River near the mouth of Copeland Creek. The prime objective of the work by Vigrass and his assistants was to map and appraise the economic potential of the carbonate or lime silicate horizon on Frisby Ridge with a view to finding sulphide layers similar to those of the King Fissure zone on Mount Copeland.

The report by Vigrass mentions widespread sulphide mineralization, mainly pyrrhotite, occurring on Frisby Ridge, and scattered areas containing small amounts of sphalerite and galena. The best showing that he found has been called the Big Slide deposit. This is in a calc-silicate layer and contains fine-grained pyrrhotite with minor pyrite, black sphalerite, and traces of galena, chalcopyrite and bornite. The layer, although less than 0.6 feet thick is remarkably continuous for 2000 feet along the trace of the lime unit, and then gives way to a spotty

mineralization. The best values in grab samples assayed 0.26% lead, 7.91% zinc, 0.2% copper, and 0.6 oz/ton silver. The report by Vigrass appears to be quite professional and could be of value in further work in the area. He has recommended additional prospecting in places where minor mineralization was noted. The Big Slide showing is on the west slope of Frisby Ridge and its location will be marked on the geological map (Assessment Report No. 1788).

Mount Copeland Molybdenite Deposit

The molybdenite deposit on Mount Copeland constituted the main interest of King Resources Ltd. This deposit, with its costly access road, went into production. However it did not operate profitably and soon closed. The mill and mine equipment have been sold and removed.

The molybdenite occurs as coarse flakes and rosettes in disseminations and concentrations within a syenite gneiss. Considerable geological mapping has been done by Robinson, Wilson, etc. The geology and petrographic work done by George Wilson, consultant from Calgary, was filed for assessment work. Some geological data is also included in Bulletin 57.

Goldstream River Area

Two prospectors from Vernon, British Columbia, discovered copper mineralization along the valley sides of the Goldstream River, and in 1975 Noranda Mines Ltd. optioned the property and staked a very large group of claims covering the potential strata. An outline of the Pat claim group was obtained from the Mining Recorder's office in Revelstoke, in late August. Probably additional staking has been done by Noranda since that time. Noranda geologists immediately started an extensive exploration project and by the end of the season had done geophysical work (ground induced polarization and magnetometer work) and considerable diamond drilling. It is rumoured that by the end of August, Noranda had completed 17,000 feet of diamond drilling with one drill and then moved in a second drill to accelerate the program.

The geological map shows that the claim area is underlain by the Lardeau Series and the Horsethief Group. Both of these groups have a large amount of sericitic and phyllitic schists and so the contact as outlined on the G.S.C. map may not be accurate in detail. Therefore the host strata for the copper mineralization is uncertain. There have been suggestions that the mineralization is similar to that which Noranda Mines Ltd. and Cartier Mining have at Harper Creek where the chalcopyrite is disseminated throughout sericitic schists, mapped as Shuswap strata but probably part of the Lardeau Group. There are also rumours that the copper mineralization of Goldstream is of much better grade than at Harper Creek. The Harper Creek deposit is rumoured to grade between .3% and .4% copper, although this has not been confirmed. Another rumour states that the mineralization at Goldstream River does carry significant silver values. The few stream geochemical results do not confirm this rumour.

Rexspar Property

North of the Barriere Pluton and accessible through the little town of Birch Island, is the Rexspar property which has been investigated over a number of years, especially for its uranium. This appears to be a carbonatite centre; the uranium prospect has a number of rare earth minerals. In addition, celestite deposits and zones of fine-grained purple fluorite have been investigated. The mineralization is centred on Foghorn Creek about four miles south of Birch Island.

Miscellaneous Stratiform Deposits

The Big Ledge

The Big Ledge sulphide band occurs at the south end of the Thor-Odin gneiss dome in the mantling zone of metamorphic rocks. It runs along Sunshine Creek in a due east direction for about three miles and then swings northeasterly for another four miles, and then easterly to Upper Arrow Lake for an additional two miles. The "ledge" averages about 100 feet in thickness. The dips vary from 25° to 50° southerly. Interspersed with the metamorphosed sediments are a number of granite and pegmatite bodies. It is a series of impure marbles and quartzites that contain sulphides within an area of biotite gneisses.

Pyrrhotite is the most abundant sulphide, with pyrite occurring in local small nodular masses. Sphalerite, the only mineral of consequence, is erratically distributed within the pyrrhotite; galena is occasionally present in small amounts. Graphite flakes are scattered within the sulphide zone over much of its length.

This zone has been known for many years and some very old adits and trenches are present. In the late 1940's, Cominco Ltd. owned the deposit and did additional exploration work including some diamond drilling. Apparently the best sphalerite occurs in the western part of the zone and therefore the northeast two-thirds of the zone was dropped by this company and staked by other smaller organizations.

A magnetometer survey with some geological description was filed for assessment work in 1947 (Assessment Report #12) and a brief geochemical survey was filed for assessment work in 1951 (Assessment Report #66).

Barriere Lake Sulphide Zones

North of Birk Creek and north of Barriere Lake are some zones of stratiform sulphide and base metal mineralization. These include some pyrite bands adjacent to Birk Creek (mainly barren), some pyrrhotite bands (generally under one foot thick) that contain some copper, and some sphalerite; and some smaller disseminated sulphide zones.

These zones have been investigated for many years. The first major work recorded is that done by Kennco Explorations (Western) Ltd. on the massive pyrite beds north of Birk Creek. In subsequent years Ducanex Limited acquired ground north of Birk Creek and west of Harper Creek and did a fairly detailed investigation with geological mapping, induced polarization, magnetometer work, geochemical work, followed by diamond drilling. Nothing of economic importance has been found.

Harper Creek Copper Property

About 1969, Norands Mines Ltd. and Cartier Quebec Exploration Ltd. discovered disseminated copper mineralization in schists at the head of Harper Creek, about three miles southeast of the Rexspar property and about two miles north of the Barriere Pluton. Considerable drilling has been done on this mineralization by both companies and reportedly they have consolidated their properties.

Mineralization is largely disseminated chalcopyrite within muscovite schists, and the grade is reported to be in the order of .3% copper. However this report cannot be confirmed. The mineralization appears to be stratiform in gently-dipping beds and these beds, although belonging to the Shuswap Metamorphic Complex, are possibly part of the Lardeau Series.

Similar mineralization has also been investigated by Royal Canadian Ventures and other companies, between North Barriere and East Barriere Lakes at the south side of the Barriere Pluton.

Adams Plateau

Lead - zinc mineralization carrying some silver values has been investigated for a number of years on the Adams Plateau. The most important deposit is near the middle of the Plateau. It is known as the Mosquito King and is owned by Giant Metallic Mines Ltd.

In addition there are other massive sulphide bands of pyrrhotite - chalcopyrite, and zones that contain mainly disseminated sphalerite.

Strata in this area are flat-lying to very gently dipping, and so existence of similar mineralized sulphide zones at depth and without known exposures could be expected. Some investigation has been done; however this is largely by short diamond drill holes.

The schists are included within the Shuswap Metamorphic Complex. There have been some suggestions that the age is Upper Paleozoic, possibly Pennsylvanian.

Colby Mines Ltd.

A deposit, quite similar to the massive sulphide bands of the gneiss dome is being explored by Colby Mines Ltd. on Kingfisher

Creek, about 30 miles southwest of Revelstoke. This deposit is within the Shuswap metamorphic strata and has been described by the British Columbia Department of Mines and Petroleum Resources as follows: "The area is underlain by garnet - biorite - quartz - feldspar gneiss, tremolite - calcite marble, calcareous quartzite, and occasional amphibolite units. Quartz - feldspar - garnet pegmatite dykes are common throughout the area and quartzeye porphyry dykes are less common. Sulphide mineralization consists of sphalerite and pyrrhotite with minor galena and pyrite in quartz-rich biotite gneiss, biotite, quartzite and calc-silicate gneiss. Sphalerite, pyrrhotite and galena are also concentrated in quartzite breccia zones, and sphalerite and pyrrhotite are disseminated in tremolite - calcite marble. The marble is at least 300 metres thick and appears continuous over a strike length of at least six kilometres. Sulphide mineralization within the marble unit is restricted as distinct zones near the centre of the claim group and at both the northern and southern extensions of the marble unit."

Rio Tinto Prospect

A massive sulphide zone is also being explored by Rio Tinto Canadian Exploration Ltd., about six miles from the Wells Grey Provincial Park, and about 30 miles northwest of the Ruddock Creek massive sulphide deposit. The property is called the CK property; however very little information has been released on the geology or the extent of the mineralization.

Deposits within the Lower Cambrian Strata

Numerous lead - zinc deposits occur within strata of the Badshot or equivalent formations (Lower Cambrian). These extend from the Salmo area on the south to the area northeast of Revelstoke. Some are of a stratiform type and some are vein type. Some are within metamorphic terrain.

The more important deposits are shown on Figure 2 and a summary of the geology by Del Ramage is appended.

GEOCHEMISTRY

Bondar-Clegg Geochemical Survey

In 1968, Bondar-Clegg conducted a detailed reconnaissance geochemical silt survey in the Jordan River drainage basin, extending southward from Jordan River to the Highway and including Hiren Creek, Kirkup Creek, and the upper part of Craig Creek. The area is outlined on Figure 1. The survey covered part of the 2000 claims owned by King Resources Company and Stampede Oils Limited. The survey was requested by Dr. M. C. Robinson, consultant geologist for King Resources Company and Stampede Oils Limited. Bondar-Clegg did the analytical work and F. E. Fergeron of Bondar-Clegg acted as the consultant. MCR Explorations Limited and Versatile Mining Services Limited supplied the field personnel, and K. L. Daughtry directed the program.

Daughtry's report is dated November, 1968 and is filed as Report #1792 for assessment work. Forgeron's report, which makes reference to Daughtry's report, is dated November, 1968, and is filed as Assessment Work Report #1793.

According to Daughtry's report, Forgeron and Daughtry made a brief orientation survey to determine the feasibility of a geochemical survey in the area. The subsequent reconnaissance survey was done by a crew of six to twelve men based in a tent camp at the mouth of Hiren Creek. Five areas within the project region were designated as first priority anomalies and three others were designated as second priority anomalies. Follow-up sampling was completed on four of the first priority anomalies.

Threshold values and anomalous classifications used are as follows:

Range:	Cu ppm	Zn ppm	Mo ppm
average background	18	50	1
threshold	35	100	2
possibly anomalous	36 to 55	101 to 145	2.1 to 4
probably anomalous	56 to 75	146 to 175	4.1 to 6
definitely anomalous	>75	>175	>6

The best anomaly was a zinc anomaly (235, 500, 240, and 160 ppm) at the head of Victor Creek. A two-man crew (geologist and prospector) spent two days on the follow-up work. They took additional samples, and suggested that the fault underlying Victor Creek might be the source of the anomaly.

Anomaly #2 included an area of scattered copper, zinc, and molybdenum anomalies at the head of Crazy Creek. Additional samples were taken but the results were not available when Daughtry wrote his report. This area of widespread high copper values is near the contact between the nepheline syenite and a band of calc-silicate rocks and Daughtry suggested that the source might be along such a contact zone. The geochemical maps show that the so-called anomalous copper values are about 50 ppm with one value at 82 ppm and one value at 100 ppm. The zinc values are not anomalous.

Anomaly #3 is an area of scattered copper, zinc, and molybdenum values at the divide between Crazy Creek and the south fork of Hiren Creek. A look at the geochemical map shows that these so-called anomalous copper values are in the order of 40 ppm and that there are a few zinc values up to 200 ppm. Although some follow-up work was done and additional samples taken, the source is suggested as possibly along one of the contact zones.

Anomaly #4 is 1-1/2 miles east of the lake at the head of the south fork of Hiren Creek. The geochemical maps show copper values from 40 to 53 ppm in three samples. The follow-up work indicated a contact between granite gneiss and metasediments and areas of limonitic staining.

Woodcock's observations on the Bondar-Clegg Project

The authors based their recommendations for a geochemical survey on some brief orientation studies. In his conclusions Forgeron states that the Mount Copeland (the King Fissure property) lead - zinc zone is indicated by the geochemical sampling. However the geochemical data shown on the maps does not confirm this. The creeks draining the mineralized zone are not anomalous in zinc. The main exposures of mineralization (according to Ryles' map) occur in a cirque at the head of the largest stream entering Copeland Creek from the south. Zinc value at the mouth of this creek is 85 ppm. Another stream flowing westerly into Copeland Creek also drains some of this mineralization; its silts had only 145 ppm zinc. Thus it appears from the survey of Bondar-Clegg that the King Fissure zone has not been detected by silt geochemistry.

The anomalies discussed in the reports are very low in magnitude and most geologists working in geochemistry throughout British Columbia would not consider them particularly attractive.

However the geochemical maps do show other areas with higher zinc values than the ones designated as anomalies. In particular, a large stream flowing southward into Copeland Creek has anomalous zinc values near its head, including values of 670, 150, 235, 225, 1230, 850, 1000, and 1020 ppm. Also, some of the smaller streams entering Copeland Creek from the north (due north of Mount Copeland) have values of 900, 300, 350, 141, 2400, ppm zinc. These are the outstanding zinc anomalies of the assessment report. No significantly anomalous copper values are presented.

Orientation Sampling - 1975

Areas Sampled

In order to establish background and test the feasibility of silt sampling to detect the King Fissure type mineralization, some sampling was done by Nick Wychopen along Kirkup Creek and Copeland Creek. The results of this sampling compare favourably with those of the Bondar-Clegg report. In particular, a sample taken near the mouth of the main stream draining the eastern part of the King Fissure zone contained 72 ppm zinc. The sample from the Bondar-Clegg survey contained 85 ppm zinc.

In addition to the sampling done along Copeland Creek and Kirkup Creek to check the background for the area and the geochemical response to lead - zinc at the King Fissure deposit, Nick Wychopen silt sampled using a four-wheel drive vehicle after the helicopter and geologists had left the area. He spent one day checking the area of Noranda's claim on the Goldstream River and two days sampling in the vicinity of the Big Ledge deposits on the south end of the Valhalla gneiss dome for orientation work. In addition, he sampled from roads along Perry River and Crazy Creek near the southwest part of the Frenchman Cap gneiss dome, and he sampled north of Seymour Arm and along the power line access road south of Ratchford Creek.

In addition to the above sampling, Wychopen and Ramage spent one day, when the weather was too poor for helicopter work, sampling

streams along the road towards Mabel Lake (southwest of Revelstoke). This is part of a separate area called the "Arrow Project".

In addition to the sampling by Wychopen, Woodcock took one silt sample from a stream draining the north end of Ruddock Creek, two samples from streams draining southward from the area of the Cottonbelt crown grant, and a short line of soil samples north of the Cottonbelt adits.

Analytical Work

This project was an orientation study as a base for a more extensive program in 1976. All silt samples were analyzed for a number of elements, including those one might expect to find within a stratiform sulphide deposit, and those that one could expect within a stratiform copper deposit. Lead, zinc, and silver could be expected within the massive sulphide beds, whereas copper, molybdenum and cobalt might be found in stratiform copper deposits.

Arsenic was also obtained for these silt samples as it is sometimes associated with massive sulphide deposits. This element also has a different reaction to pH conditions and might be quite effective in areas of calcium-rich soils such as in the dry belt. Previous work done by Woodcock on the Adams Plateau indicated that arsenic might be of particular value.

Much literature has been published on the importance of manganese and iron in concentrating certain elements, especially zinc, within stream sediments, and on the techniques of making corrections to eliminate the bias contributed by these concentrating oxides. The easiest and probably most significant calculation involves the metal/manganese ratio. This ratio is reported to be especially significant in appraising the zinc values of stream sediments. The ratio of cobalt/nickel and of cobalt/manganese has, in places, proven effective.

Many of the lead - zinc deposits within the Lower Cambrian strata have associated minor amounts of scheelite and some companies have actually used panning of the scheelite in the streams to lead them to veins or small stratiform deposits of lead - zinc within the Lower Cambrian carbonates. Seventeen samples of this survey were tested for tungsten. The samples were from Copeland Creek and Kirkup Creek drainages, Reddock Creek and Cottonbelt, and all results were low background ($\leq$ 10 ppm). One sample from a creek draining the southern part of the Cottonbelt crown grants had 30 ppm.

Threshold Values

Simple histograms were drawn for the various metals and the metal ratios for the samples taken in the region of the Shuswap project. Background values, threshold ranges, and anomalous ranges were estimated by quick visual examination of these resulting distribution curves or histograms without the aid of exact mathematical determinations based on standard deviations, etc. These results, based on about 150 silt samples taken in all of the places sampled, are shown in Table II.

GEOCHEMICAL THRESHOLD VALUES

TABLE II

Metals	Background	Threshold Range	Anomalous
Cu	0 - 30	31 - 50	> 50
Zn	0 - 70	70 - 130	> 130
Pb	0 - 25	25 - 40	> 40
As	0 - 5	6 - 10	> 10
Mo	0 - 3	4 - 6	> 6
Mn	0 - 500	500 - 800	> 800
Ag	0 - .8	.8 - 1.0 (?)	
Co	0 - 20	20 - 30 (?)	> 30
Cu/Mn	0 - .10		> .10
Zn/Mn	0 - .25	.25 - .4	> .4
Pb/Mn	0 - .10		> .10
Co/Ni	.10 - .9	.9 - 1.0	>1.00

Anomalous Streams

The samples were taken from a number of places scattered throughout the Shuswap project area and also from places east of the Kootenay River (Goldstream River) and south of latitude 51° (outside of the Shuswap project area). Presentation of all of the results on separate maps is not warranted. Instead, a review of the samples that are anomalous and some that are probably in the threshold range will be presented.

The one sample taken from the Ruddock Creek deposit has the highest anomalous values of all the samples. This would be expected since the sample is from a relatively small creek below the exposures discussed. With reference to Table II, this sample is anomalous in Zn (317 ppm), Pb (84 ppm), Pb/Mn (.17 ppm), Zn/Mn (.63 ppm). Cu, As, Mn, were in the background range.

One gully sample (W75-301G) was taken along the soil line north of the Cottonbelt adits, and two silt samples were taken from a creek draining the southern part of the Cottonbelt crown-granted claims. The gully sample is anomalous in Pb (104 ppm), Zn (195 ppm), Mn (2300 ppm) and Mo (8 ppm). The ratios of Pb/Mn and Zn/Mn were not anomalous because of the extremely high manganese value. This gully sample, essentially a soil sample out of the gully near the mineralized zone, should not be used as a basis for any comparison. The two samples from streams draining the southern part of the crown grants were not anomalous in any metals or in any metal ratios.

Copeland Creek receives the drainage from the King Fissure lead-zinc sulphide band. The 1975 sampling included only seven samples along this creek, four of them from the main creek itself and three from smaller drainages of the rugged mountains to the south. Two of these smaller drainages receive part of their waters from the King Fissure zone. The zinc values are comparable to those reported in Bondar-Clegg's survey; however they are only in the threshold range and quite distressing in view of the much higher values (up to 1000 ppm) in drainages from the northern slopes of Copeland Creek. The Zn/Mn ratios are also not outstanding. Three of the ratios are within the threshold range (.26, .27, and .31), two of which are from the small drainages coming partly from the King Fissure zone.

Lead results are more encouraging. Of the seven samples taken along Copeland Creek, four have anomalous values (52, 52, 53, 65 ppm) and three have threshold values (35 ppm). The Pb/Mn ratios (.12 to .14) are even more definitive. Of the seven samples, only two are background, while the remainder are anomalous. The two background ones are from Copeland Creek above any drainage from the King Fissure zone and from a small side stream also lacking drainage from the King Fissure zone. The only other anomalous Pb/Mn value (0.168) was from the creek at the west end of the Ruddock Creek deposit. The other metals tested (Cu, As, Mn, Ag) for the Copeland Creek samples were in the background range. The Co, Ni and the Co/Ni ratios (.52 to .67) were also in the background range.

A few samples were taken from the road along the east side of the Jordan River between Kirkup and Hiren Creeks. Some of the

Table III

GOLDSTREAM RIVER

Sample No. (N75)	490L	491	492	493	494	495	496	499
Metals (ppm)								
Mo	2	1	1	1	3	1	1	1
Cu	9	8	16	13	168	25	24	10
Pb	14	9	19	12	26	16	14	11
Zn	36	17	50	20	220	50	29	28
As	1	2	5	2	3	3	1	4
Ag	0.5	0.3	0.6	0.3	0.8	0.6	0.5	0.6
Mn	320	210	420	200	1050	300	370	400
Co	20	15	22	17	20	16	17	17
Ni	22	18	33	23	35	26	25	20
Metal Ratio								
Zn/Mn	.11	.08	.12	.10	.21	.10	.08	.07
Ag/Mn	.0016	.0014	.0014	.0015	.0008	.0012	.0014	.0015
Cu/Mn	.028	.038	.038	.065	.160	.050	.065	.025
Pb/Mn	.044	.043	.045	.060	.025	.032	.038	.028
Co/Ni	.91	.83	.67	.74	.57	.61	.68	.85
Co/Mn	.062	.071	.052	.085	.019	.032	.046	.042
Pb/Zn	.39	.53	.38	.60	.12	.32	.48	.39

zinc and some of the copper values were within the threshold range, and two of the Cu/Mn ratios were anomalous. The Pb, As, Ag, and Mn values were in the background range.

About eleven samples were taken from the Kirkup Creek basin. None of these samples was anomalous. However one sample (N75-350L) did have threshold values in Cu(32 ppm), Pb (25 ppm), Zn (120 ppm).

Fifty samples were taken from the roads along Perry River and Crazy Creek. These were tested for Cu, Pb, Zn, As, Mn, Co, and Ni, and a few were tested for Ag. Most of the values were in the background range. Sample N75-444S was a soil sample taken beside a rusty zone along the Crazy Creek road. This had anomalous or threshold values in most of the metals and in most of the metal ratios.

About ten samples were taken at the north end of Seymour Lake and along the Seymour River, and these were tested for all of the metals. All values were within the background range.

Sampling along Ratchford Creek was mainly from the creeks draining into it from the south. Twenty-two samples were taken and tested for Cu, Pb, Zn, Mo, Mn, Co, Ni. None of the values is anomalous.

Because the mineralization along the Goldstream River is unique in that it consists of disseminated stratiform copper mineralization within schists, possibly of the Lardeau Series, the results of all the sampling from eight streams are presented in Table III.

According to unconfirmed reports, the mineralization at Goldstream River, although widespread, is not readily detected by silt sampling unless the silt sampling is done in great detail. The results of Table III appear to confirm this, as only one sample is anomalous. Wychopen has stated that the sample was taken in a stream above the drill sites. Possibly many of the samples were uphill from the copper zone.

AREAS EXCLUDED FROM CLAIM STAKING

Parks

In the general region of interest for stratiform base metal deposits west of the Rocky Mountain Trench, several provincial and national parks exist (Figure I). These include:

(a) Monashees Provincial Park at the south end of the Thor-Odin gneiss dome.

(b) Wells Gray Provincial Park also underlain by rocks of the Shuswap Complex.

(c) Glacier National Park underlain by strata of Proterozoic and Lower Paleozoic ages, including some beds of Lower Cambrian limestone.

(d) Mount Revelstoke National Park, also with the Proterozoic and Lower Paleozoic strata.

Anstey Arm Recreation Study Area

On July 31, 1975 the Provincial Government made a reserve of a large area lying between Perry River (to the east) and Seymour Arm of Shuswap Lake (to the west), on map sheet 82M. This reserve now eliminates any staking until December 31, 1977. According to discussions Woodcock had with geologists in Victoria, this is a preliminary reserve made in order to study the area for its potential as a recreational reserve, and according to this same geologist there was a very slim chance that the reserve would remain after 1977. However, at present claim staking is eliminated and although some preliminary investigations could be made if convenient and cheaply done, any great expenses on exploring this potential area at this time are not warranted.

The Power Line Reserve

A new power line is being constructed from the Mica Dam site at the head of the Columbia River, down the Columbia River to Downie Creek, and then southwesterly across the pass, down Ratchford Creek, and down the west side of Seymour Arm. A reserve of one-half mile on either side of this power line has been reserved from mineral and placer staking.

In addition to the power line reserve down the east side of Columbia River, there is a mineral and placer reserve along this river to protect any possible future flooding of the valley for hydro power. The outer limits of the reserve are based at the 2200 ft. contour at latitude 52°, and at the 1900 ft. contour downstream to the south. However, the claim maps show that, in general, the reserve is less than one mile wide.

CONCLUSIONS & RECOMMENDATIONS

1. The lead-zinc belt of British Columbia lies largely west of the Rocky Mountain Trench in a major geological subdivision known as the Omineca Geanticline. Many of the deposits within this zone are strata-bound and some of these are also stratiform. In the region presently under consideration the stratiform deposits can be classified into three main types:

(a) The massive sulphide (abundant iron sulphide) layers which occur within calc-silicate bands of the Shuswap Metamorphic Complex. The best examples of this include the Ruddock Creek, the Cottonbelt, the King Fissure and the Big Ledge deposits, all within the zone of gneiss domes. The Sullivan deposit differs in that it is not within calc-silicate layers and it is associated with an underlying breccia pipe.

(b) Disseminated chalcopyrite in muscovite schists of the Shuswap Metamorphic Complex. Examples of these include the one on Harper Creek and the new one on Goldstream Creek.

(c) The lead-zinc deposits within carbonate strata of the Lower Cambrian. These are stratiform or crosscutting, such as veins.

The first type appears to be genuinely a syngenetic type. The disseminated copper type appears to be syngenetic. However the known copper occurrences are near small batholithic plutons; there could be some concentration by remobilization. The deposits within or near the Lower Cambrian limestone generally have some sort of structural control and could have been mobilized or changed by some tectonic or metamorphic forces. This latter type are generally not as extensive or continuous as the first two types; however they have been the only ones that have been mined in southern British Columbia.

2. The initial proposal for the Shuswap project included mainly search for the massive sulphide bands within the calc-silicate layers. These appear to be associated with marine sediments and so some knowledge of their genesis may prove important. There could be some relationship to ancient rift zones such as those which control the mineralization within the Red Sea; this might account for the apparent alignment of the better known deposits.

The fact that some of these deposits do vary along strike in grade; that they have been explored by major companies (e.g. the Ruddock Creek deposit); and that they can increase in thickness along the crests and troughs of sharp folds, indicate that search for them is warranted. One always hopes that a thicker deposit with continuity of high grade zones will be found. The discovery of additional deposits such as the Rio Tinto one and the Colby Mines one, several miles to the west of the gneiss domes, indicates that the forested area along the western flanks of the Monashee Mountains merits exploration.

3. The westernmost exposure of the north limb on the Ruddock Creek sulphide band was examined by the writers. Whether the bands extend westward from the claim group underneath the adjacent valley cannot be determined from the data filed for assessment work. Some geological mapping, possibly aided by some geochemical or magnetometer lines should be done to determine the possibility of these zones extending westward.

Who owns Ruddock?

4. The Cottonbelt zone appears to be the most straightforward one geologically. However data indicate that, where sampled, it has the lowest grade.

The data has been reviewed and summarized by Del Ramage, and is included within this report. Most of the exploration effort has been expended towards finding the northwestern extension of the mineralized zones. However there is no work

recorded on exploration for the possible southeastern extension of the zones. The geochemical survey was an analytical procedure that is generally inadequate for soil sampling, and so the results are not too reliable. The ground magnetometer survey showed linear anomalous zones but these do not, in general, follow the mineralized trends defined by Boyle's geological mapping. There is some correlation of the induced polarization anomalies with the parallel Copper King zone, possibly reflecting the more disseminated and possibly wider mineralized area of this zone compared to the Cottonbelt and the Complex zones. The airborne work did give anomalies but there is not good correlation with the Cottonbelt zone.

The Cottonbelt deposit is covered by crown granted claims. The Ratch claim staked for Dome Mines Ltd. is on the southeast extension of this deposit, and three claims staked by local people (the Adams brothers) surround the crown granted claims and extend to the northwest.

This area should be mapped geologically on air photos with a scale of 20 chains, for the purpose of sorting out and tracing the three sulphide layers, and the three or more marble bands. Such geological mapping should give information on the stratigraphic sequence to compare with other deposits in the area, and with the Lower Cambrian deposits of the Kootenay Arc further to the southeast, and it should also indicate the possibility of whether these marble bands include several or just one isoclinely folded bed. The geotechnical surveys done so far have been under the direction of a promotional consultant; the geological mapping was done by an undergraduate student; and the geochemical survey was done with the aid of a cold extractable laboratory technique. The reliability of any of this work is not known. It is necessary to bring it all to the same base scale and to correlate it with the proposed geological map. After this work has been done it would then be possible to appraise the merits of the ground presently held under claims and plan acquisition of claims if warranted.

5. The rumors and information indicate that Noranda geologists must be quite impressed with the stratiform copper deposits on the Goldstream River. The amount of diamond drilling done in the first season is very large. In addition to this diamond drilling, preparations have been made for the 1976 reconnaissance program. Presumably a helicopter was chartered last fall, merely to find landing sites along creeks, with a view to using a Hughes 500 helicopter in the regional geochemical survey in 1976. The Hughes 500 will land in a smaller space and in higher brush than the Bell helicopters.

From this activity it appears that search in the schistose rocks for the stratiform copper is warranted. The information obtained thus far indicates that these are probably in the Lardeau

Series and that it is not easy to distinguish the Lardeau schists from the schists of the adjacent Wolverine Complex, in places. Therefore it is necessary to acquire additional data on the distribution of schistose rock units of the Proterozoic and the Paleozoic east of the Columbia River.

Also in this area east of the Columbia River are the more abundant scattered lead-zinc prospects associated with the Lower Cambrian limestones. Any exploration program based on regional geochemistry should integrate the search for both types of deposits.

6. Geochemical work done has shown that the massive sulphide layers within the calc-silicate band and also the Goldstream copper deposit, do not throw outstanding stream geochemical anomalies. The work indicates that sampling must be done in detail and that the lead, zinc and copper values individually may be significant but that the ratios of these metals to manganese may be even more definitive in selecting targets for follow-up work. In particular, the lead/manganese ratio seems to be the best chemical result indicating the King Fissure zone. Panning of streams and following scheelite trains can lead to some of the old exploration pits and adits. However the few samples of the survey tested for tungsten indicated that tungsten geochemically would not be a good exploration technique for the massive sulfide bands.

poor geochem

7. The air observations and ground observations made along the Monashee Mountains showed that, within the vicinity of these massive sulfide layers, are many bands rich enough in iron sulphides to form outstanding gossan bands. The known sulphide bands with base metals do not occur alone but are accompanied, both above and below, by other layers containing abundant disseminated iron sulphides.

Thus, in areas of good exposure, it would be wise to outline gossan bands possibly classifying the mountainous regions into (a) areas completely devoid of limonite, (b) areas with moderate amounts or bands of limonite, and (c) areas with abundant conspicuous bands of limonite. Any extremely rusty zones in the high, exposed areas would undoubtedly have been prospected. However, those adjacent to overburden areas might indicate that these overburden areas warrant extra attention.

One such zone occurs on the upper parts of Myoff Creek, about ten miles southeast of the Cottonbelt property. These rusty bands occur in some basins east of the creek, but also occur on the ridge west of the creek, extending under the glaciers on top of this ridge. The complete area between Myoff Creek and the upper basin of Ansty River merits some investigation. Unfortunately the Ansty River drainage basin is covered by the Ansty Arm recreation study area, and within this restricted area only some very preliminary investigations are warranted.

8. One who explores for stratiform copper deposits east of the Columbia River, within the Selkirk Mountains (near the Goldstream River property) will probably be faced with some exploration competition from other companies. Therefore any technique that will accelerate the output of the analytical data should be investigated. Since the anomalies are quite subtle, the usual field technique of using the cold extractable Helman copper test may not be too effective. Last October at the S. E. G. convention in Salt Lake City, a paper was presented by Mr. Schuller, et al, describing a technique for using a cold extractable buffer solution, and a specific copper ion electrode for field analysis. The information presented indicated that these results, if done on sifted samples, might be quite comparable to the results that one would obtain from a hot digestion and atomic absorption determination. Whether this technique, which is applicable in the eastern States, would be applicable to the rugged areas of British Columbia where chemical weathering is not as relatively important is not known. However the technique merits some investigation. The cost of setting up such a technique would be in the order of $2,000.00

J. R. Woodcock
January 8, 1976

NOTES ON LOWER CAMBRIAN CARBONATE STRATA AND ASSOCIATED LEAD-ZINC DEPOSITS IN BRITISH COLUMBIA (to accompany 1:1,000,000 scale maps)

INTRODUCTION

Strata considered in this study are delimited and correlated on the basis of general lithologic similarities and age as determined by fossil assemblages, noting especially the presence of the pleosponge, Archaeocyathus, common in the ore-bearing limestones of southern B.C. These sponges may outline narrow areas of relatively shallow water paralleling Lower Cambrian paleoshorelines (Okulitch, 1955), and thus may prove valuable guides in exploration for reef- or facies-controlled mineralization.

In southern B.C., only major lead-zinc deposits are considered. North of Prince George, smaller showings and deposits are noted because of,(1) the lack of larger deposits to outline areas of mineralization and (2) factors of location which have prevented exploration and development of comparable intensity to that in southern B.C.

SALMO AREA (ref. Fyles and Hewlett, 1959)

The Reeves member of the Laib Formation represents the Lower Cambrian carbonate strata in this area, and contains all the major lead-zinc deposits of the district. It is characteristically a grey and white or black and white banded fine to medium-grained limestone, locally dolomitized, and varies in thickness from 130 to 450 feet. The area has undergone low-grade regional metamorphism.

Major lead-zinc deposits are the Reeves-MacDonald, Jersey, and H-B Mines, and the Aspen and Jackpot properties. All these deposits occur in the Reeves limestone, and are generally lenticular in form. Tungsten deposits, the largest of which is the Emerald Mine, are also present in the area, generally as skarns in metamorphic rocks and limestones, and are peripheral to intrusive stocks.

The Reeves MacDonald property was first staked in 1910. It consists of six orebodies which occur as replacement deposits in dolomotized envelopes of Reeves limestone. Ore minerals are pyrite, honey sphalerite, and galena which forms in lenses and bands. Barren lamprophyre dykes cut the orebodies.

Showings in the Jersey mine area were known in the early 1900's. The mine is comprised of six orebodies, all of which occur within dolomitized Reeves limestone. The dolomite is epigenetic and is closely associated with the development of sulfides. The ore has been cut by intrusive stocks. Mineralization consists of banded and disseminated fine to medium-grained sphalerite, galena, pyrite, and pyrrhotite, and is localized along secondary folds and bedding faults.

The H.B. mine was found prior to 1910. The orebodies lie within a large, lenticular mass of dolomite within the Reeves limestone and are irregular in form. Mineralization consists of fine-grained pyrite, sphalerite, minor galena, and rare pyrrhotite in bands or lenses, or disseminated.

First underground work on the Aspen property was done in 1912. The two mineralized zones are replacement bodies in dolomitized Reeves limestone. Mineralization consists of banded and disseminated sphalerite, galena, argentiferous tetrahedrite, pyrite, and pyrrhotite. Mineralization and dolomotization generally follow banding in the limestone. The dolomite is occasionally siliceous. The area is intruded by granitic masses and lamprophyre dykes.

Old workings suggest that showings on the Jackpot property were known since about 1900. Mineralization is restricted to dolomitized zones that seem to follow banding in the Reeves limestone, and consists of banded, disseminated pyrite and sphalerite with some galena, pyrrhotite, and minor tetrahedrite.

NELSON - KASLO AREA (ref. Rice, 1941; Little, 1960; Fyles, 1967)

The Badshot Formation is the probable extension northward of the Reeves limestone. It is Lower Cambrian in age and is a grey-to-cream colour, locally siliceous or magnesian limestone. It varies in thickness from fifty to several hundred feet. Like the Reeves limestone, the Badshot Formation seems important in the localization of lead-zinc deposits.

The Bluebell mine at Riondel was prospected in the early 1900's. It occurs within the Badshot Formation, which is here 100 to 150 feet thick, as open-space fillings and replacement related to these fillings. The area has undergone sillimanite grade of regional metamorphism. Dolomite is present, but does not form ore envelopes as is the case in many Salmo deposits. Gentle flexures in the limestone produced axial plane fracturing

extending down dip in the formation. Mineralization is localized along these fractures and consists of sphalerite, argentiferous galena, and pyrrhotite with minor pyrite, arsenopyrite, and chalcopyrite. Gangue rock is limestone, with some quartz and pegmatite.

The Ainsworth camp contains more than fifty lead-zinc-silver properties, which have produced a total of 763,858 tons of ore since 1889. Deposits are both fissure-filling and replacement types, although the former is more common and significant. All deposits display some transgressive features. The three largest producers in the area are the Kootenay Florence, Highlander, and No. 1 properties.

The Kootenay Florence and Highlander deposits are on two separate fracture systems. Mineralization is found in hornblende schist, micaceous quartzite, dolomite, and limestone, all of various ages, and does not follow the limestone horizon. Mineralization is transgressive, and replacement is minor and localized. Sulfides include galena, sphalerite, pyrite, pyrrhotite, and minor chalcopyrite in fissure veins of quartz and calcite with lesser amounts of siderite and fluorite.

The No. 1 property is an example of replacement mineralization, although it is subordinate to fissure-filling in this instance. Replacement occurs in limestone of probable Precambrian age adjacent to quartz-siderite-calcite veins. Sulfides consist of sphalerite, galena, pyrite, and pyrrhotite.

Similarities in mineralogy and styles of mineralization between the Ainsworth deposits and the Bluebell mine are apparent, and exploration on this basis has been extensive in the Ainsworth area.

Although not associated with Lower Cambrian carbonate strata, lead-zinc-silver-gold properties of the New Denver - Slocan area are worthy of note because of their number and total output, especially of lead and silver. Most of the properties were found or prospected in the 1890's or early 1900's. Most deposits occur in Mesozoic sediments of the Slocan Group as fissure-fillings and vein deposits, often peripheral to intrusions, in particular the Nelson batholith. Mineralization is rarely disseminated in the wall rock. Gangue minerals are commonly quartz, siderite, and calcite. On a regional scale, deposits seem to display increases in the zinc to lead ratio proceeding outwards from the main belts of mineralization.

DUNCAN LAKE AREA (ref. Fyles, 1964)

The Badshot Formation is here repeated several times by extensive folding and faulting. It contains several small lead-zinc deposits, occurring as both fissure-fillings and replacements in limestone and dolomitized limestone, some of the former being of fairly high grade. Siliceous layers in the dolomite often have sulfide mineralization concentrated on their borders. Two of the more important properties are the Sal, a replacement deposit, and the Moonshine, a high grade fracture-filled deposit with some replacement. Pyrite, sphalerite, and galena are the common ore minerals.

The Duncan mine (ref. Muraro, 1966) is the largest known deposit in the region, and was staked in 1925. Muraro suggests it is similar to the Salmo deposits. It occurs in the Badshot Formation in dolomite and, to a lesser extent, limestone. Many ore shoots parallel fold axes. Dolomite-chert contacts also bear ore concentrations. Mineralization consists of pyrite, sphalerite, and galena, with some pyrrhotite.

LARDEAU AREA, WEST HALF (ref. Fyles, 1962, 1964, 1966)

The Badshot Formation in this area reaches thicknesses of over 1000 feet and continues relatively unbroken through the map-area. Far fewer showings are associated with the formation than is the case to the south. The area has been prospected intermittently since the 1880's.

The Bannockburn property (ref. Reed, 1961) is located on a disseminated galena deposit called the "Shelagh vein". Mineralization consists of bands of galena with minor pyrite, sphalerite, and tetrahedrite localized in a porous horizon of quartzite in the Marsh Adams Formation of the Precambrian Hamill Series. This horizon lies close to the base of the Badshot limestone. Origin of the deposit and its relation to the Badshot limestone are uncertain.

The Silver Cup property is a vein deposit in carboniferous shales and argillites of the Broadview Formation, at a considerable stratigraphic and real distance from the Badshot Formation.

The Wigwam deposit (Muraro, 1966; Fyles, 1970) occurs at limestone-chert and dolomite-chert contacts in the Badshot Formation in probable

upper garnet zone metamorphic terrain. Pyrrhotite and dark sphalerite occur with calc-silicates as laminations in the chert.

The Big Ledge property lies almost twenty miles southwest of the nearest Badshot outcrops, but is mentioned here because of its similarities to other deposits in the Shuswap Metamorphic Complex, especially those of the Jordan River area. It occurs in a sequence of mica schists, quartz-mica schists, marbles, and gneisses comprising the Thor-Odin gneiss dome (ref. Reesor and Moore, 1971). Pyrrhotite, pyrite, and sphalerite occur sporadically in a layer traceable for several miles. No detailed stratigraphic correlation can be made with similar deposits to the north.

ROGERS PASS and BIG BEND AREAS (ref. Fyles, 1970; Wheeler, 1962, 1964)

The Rogers Pass area has several exposures of Badshot limestone. However, they are widespread and discontinuous due to extensive faulting and folding. Some showings are known but most are insignificant. National Park boundaries may have affected this pattern.

The Columbia Lead and Zinc mine and Snowflake mine are parts of the same vein system. Ore minerals include galena, sphalerite, stannite, pyrite, and scheelite. Wall rocks are slates and limestones of the Lardeau Group.

The adjacent Big Bend area, by contrast, has several significant deposits in the widely scattered Badshot limestone and in Shuswap metamorphic terrain.

The lead-zinc showings in the Badshot limestone are numerous. Most of the significant deposits occur as replacement bodies in limestone or dolomite, but all deposits show some fissure filling.

The Mastodon mine occurs as sphalerite replacement of limestone along a zone of intense fracturing near the contact with a phyllite succession. Fyles (1960) considers structural factors to be more important than chemical character of the rock in localization of mineralization here.

The Shuswap Metamorphic Complex lies to the west of the Columbia River north of Revelstoke. It does not contain numerous showings but three lead-zinc deposits of significant size have been located:

King Fissure (= Jordan River), Cottonbelt, and Ruddock Creek. They have the following characteristics in common (the Big Ledge property could be included here):

1. Unlike most deposits discussed thus far, mineralization in these bodies is concordant.

2. They occur in schists and gneisses of the Shuswap Metamorphic Complex, and are commonly associated with calcareous schists and gneisses, and marbles.

3. All deposits contain sphalerite and pyrrhotite (replacing pyrite due to metamorphism).

4. All deposits are demonstrably pre-metamorphic.

5. Although ore-bearing layers may be traceable for as much as several miles, no correlation can be made thus far between deposits. Fyles (1970) suggests they are probably not in the same time-stratigraphic unit.

The King Fissure deposit was found in the 1890's. Mineralization occurs as replacement of limestone within a synform succession of gneiss, schist, quartzite, and marble. Ore minerals are galena, sphalerite, pyrite, pyrrhotite, and minor chalcopyrite in a quartz-calcite-(barite) gangue. Discontinuous mineralization occurs over a length of 3500 feet and averages five feet wide. 10 % to continued

The Cottonbelt property has been relatively dormant since the 1920's. Mineralization consists of galena, sphalerite, pyrrhotite, and magnetite, with some molybdenite and grey copper reported. It can be traced for more than 2000 feet.

The Ruddock Creek property was uncovered in 1960. Mineralized layers several feet thick and traceable for several thousand feet, consist of sphalerite, pyrrhotite, and galena in calcareous horizons in gneisses and schists.

CENTRAL and NORTHERN B.C.

The Lower Cambrian strata seem to abut against the Shuswap Metamorphic Complex south of the Big Bend. Limestones continue in a NNW trend north of the Complex, but they differ substantially from the Badshot Formation. The closest equivalent in age and lithology is

the Mural Formation, consisting of limestone with some shale, sandstone, and quartzose sandstone. It locally contains Archaeocyathids. Towards the south, it is frequently metamorphosed to marble. Thickness varies from 500 to over 2000 feet. It is traceable somewhat incontinuously to about 30 miles north of Prince George. Some minor lead-zinc occurrences are present in the Black Stuart Mountain area and also near Dome Creek, but these are insignificant.

North of Prince George, Lower Cambrian carbonates are present in the Ingenika Group and, farther north, in the Atan Group. Both locally contain Archaeocyathids.

The Ingenika Group limestone range from pure calcite in composition to rock having up to 30% quartz + feldspar, and sometimes grading into calcareous argillites and slates. Limestone beds are commonly ten to fifteen feet thick and are often intercalated with coarse clastic sediments. Dolomite is rare. The unit attains a maximum thickness of 4000 feet.

Limestones and dolomites of the Atan Group are thick-bedded and vary widely in colour. Beds are generally massive and may be intercalated with minor shale horizons. The calcareous strata reach a thickness of 1500 feet and thin northward, becoming increasingly shaly in character. These facts, coupled with the presence of Archaeocyathids, may indicate the western limit of the Lower Cambrian geosyncline.

The Beverley prospect (ref. G.E.M., 1973) was staked in 1946. Galena, sphalerite, and barite with some pyrite replace dolomitized and occasionally silicified limestone of the Ingenika Group. Mineralization is post-dolomitization and bears a direct relation to the degree of dolomitization.

The Ferguson Group (or Ingenika Mine, ref. Roots, 1954) is a lead-zinc property located in 1917. Host rock is a contorted limestone of the Ingenika Group which has been silicified and invaded by iron solutions resulting in a distinct banding. Mineralization is found in this banded rock and consists of galena, sphalerite, and pyrite with minor copper and silver sulfides.

Other minor lead-zinc showings within Lower Cambrian strata, occur near Manson Creek and in limestone strata northward, especially

in the McDame area, but none are of significant size.

SUMMARY

Lower Cambrian carbonate strata can be traced in an arcuate north to northwest pattern throughout British Columbia, interrupted by plutonism and obscured by regional metamorphism. Most lead-zinc deposits in these strata are concentrated in southern B.C., and are generally open space fillings and/or replacement bodies in dolomitized limestone. Mineralization in all deposits of the belt, excluding those in the Shuswap Metamorphic Complex, display some transgressive features.

Ore deposits in the adjacent Metaline district of Washington are strikingly different from those in southern British Columbia and are characterized by locally banded ore. The most important controls of mineralization here seem to be facies changes and original sedimentary features, i.e. primary lithologic and structural features rather than secondary structural controls.

Concordant lead-zinc deposits of the Shuswap Metamorphic Complex are not numerous but are of important dimensions.

The Cariboo district is notably barren of significant lead-zinc deposits in these strata.

Lower Cambrian limestone strata near Manson Creek and northward bear several lead-zinc prospects, especially in the McDame area, but none have proven to be of major dimensions thus far. Information is too incomplete to discern meaningful patterns of mineralization in Lower Cambrian strata of the area.

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