Geological Fieldwork

a summary of field activities
of the geological division,
mineral resources branch

1975

THE GOVERNMENT DEPARTMENT OF
MINES AND PETROLEUM RESOURCES
PARLIAMENT BUILDINGS VICTORIA BRITISH COLUMBIA V8V 1X4

FOREWORD

This is the second year of publication of *Geological Fieldwork*, a publication designed to acquaint the interested public with the preliminary results of fieldwork of the Geological Division as soon as possible after completion. The reports are written without the benefit of extensive laboratory or office studies. To speed publication, figures have generally been draughted by the authors. A fuller account of the work of the Division will be presented in *Geology, Exploration and Mining in British Columbia, 1975.*

Technical editing of this publication was done by N. C. Carter and production editing and layout by Rosalyn J. Moir.

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SOUTHEAST BRITISH COLUMBIA

LEAD–ZINC DEPOSITS

By Trygve Höy

GEOLOGY OF THE RIONDEL AREA
(82F/15)

Reconnaissance mapping of the area between the Riondel map-area (Höy, 1974) and the Duncan Lake area (Fyles, 1964) was initiated in August 1975. This mapping indicates that:

(1) The 'Loki' and 'Powder Creek' stocks (Höy, 1974) are apophyses of the 'Fry Creek batholith.'

(2) The isoclinal 'Phase 2' folds described in the Riondel area continue northward to the southern limit of the Fry Creek batholith.

More detailed mapping, tentatively scheduled for the 1976 field season, will more closely outline structures in this area, and may allow correlation of these structures with those in the Duncan Lake area. This mapping will also outline the Badshot marble, the host rock for most of the lead-zinc mineralization in the Kootenay Arc.

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BIG LEDGE (82L/8E)

INTRODUCTION

The Big Ledge is a stratabound zinc deposit contained in the Mantling gneisses of the Thor-Odin gneiss dome. It is located 60 kilometres south of Revelstoke and approxi-

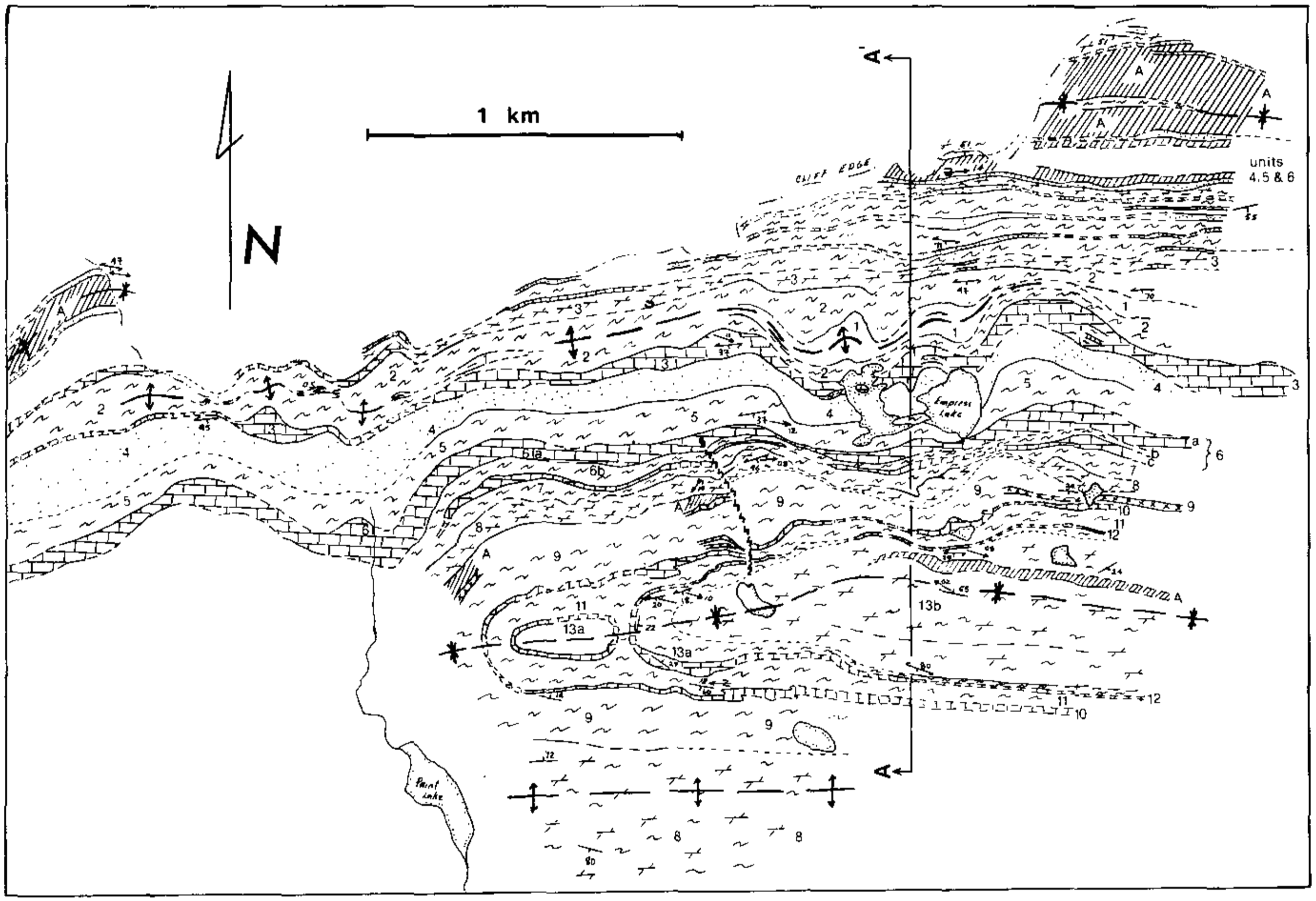
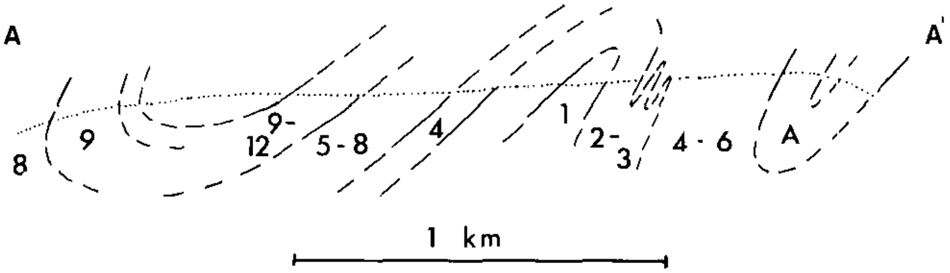


Figure 1. Geology of the Big Ledge deposit (for legend, *see* Fig. 2).



LEGEND

- ORTHOGNEISS, PEGMATITE
- AMPHIBOLITE, HORNBLENDE GNEISS; MINOR GARNET-BIOTITE GNEISS
- GARNET–BIOTITE±SILLIMANITE GNEISS; BIOTITE SCHIST
- QUARTZITE
- CALC–SILICATE GNEISS; SILICEOUS MARBLE
- MARBLE

SYMBOLS

- SCHISTOSITY, GNEISSOSITY ATTITUDE
- MINERAL LINEATION
- LAYERING ATTITUDE
- MINOR FOLD AXIS
- ANTIFORM
- SYNFORM

Figure 2. Vertical cross-section, Big Ledge area.

mately 8 kilometres west of Upper Arrow Lake, between North Forstall Creek and Ledge Creek.

The property has a history of exploration dating back to the late 1920's. Early work by The Consolidated Mining and Smelting Company of Canada, Limited consisted of trenching, some underground work, and about 1 035 metres of diamond drilling. Between 1947 and 1953, 6 100 metres of drilling was done on the property and from 1964 to 1966, approximately 3 960 metres of drilling as well as some geological mapping and geochemical and magnetometer surveying was carried out.

This report summarizes the results of five days on the western part of the property in July 1975. The assistance of Mr. James Milne while in the field is greatly appreciated.

REGIONAL GEOLOGY

The Thor-Odin gneiss dome is one of a series of gneiss domes spaced approximately 80 kilometres apart along the eastern edge of the Shuswap Complex. A central Core zone in the dome consists of gneissic and migmatitic rocks. This zone is surrounded by a heterogeneous assemblage of metasedimetary rocks of the Mantling zone and Fringe zone, the latter containing abundant pegmatite and lineated quartz monzonite (Reesor and Moore, 1971). The Big Ledge deposit is located south of the Core zone, in an east-west-trending succession of metasedimentary rocks.

LOCAL GEOLOGY

The detailed succession of metasedimentary rocks in the area of the Big Ledge deposit is apparent from the map (Fig. 1). In general the succession includes an extremely heterogeneous mixture of schist and gneiss, quartzite, calc-silicate gneiss, marble, and amphibolite. A rusty-weathering calcareous schist, mixed with calcareous quartzite and minor calc-silicate gneiss and marble, hosts the Big Ledge sulphide mineralization. It is overlain by medium to coarse-grained garnet schist and sillimanite gneiss (unit 2), a zone of interlayered marble and gneiss (unit 3), and a very prominent pure to feldspathic quartzite (unit 4).

Overlying the quartzite are interlayered biotite-garnet gneiss, marble, and calc-silicate gneiss (units 5 to 12), which in turn are overlain by calc-silicate gneiss of unit 13. A number of amphibolite layers occur throughout the stratigraphic succession, the most prominent being a massive to layered amphibolite in the core of a synform to the north of the Big Ledge horizon.

The structure of the map-area (Fig. 1) is dominated by a series of east-west-trending open to moderately tight folds. These are inclined to the south (Fig. 2) and plunge variably to the east and west. The Big Ledge 'horizon' is in the core of one of these folds, a moderately tight, southward inclined antiform.

Very pronounced north-northwest-trending air photo lineaments transect the map-area. There is little if any apparent offset associated with these structures, although layering attitudes are sometimes disrupted across them.

MINERALIZATION

Showings of pyrrhotite, pyrite, and sphalerite occur along a horizon (unit 1), known as the Ledge, for a distance of over 5 kilometres (Assessment Reports 12 and 66). The mapping of the most western part of the Ledge horizon (Fig. 1) indicates that it is in the core of an antiform. Here the Ledge is not a distinct layer, but rather a succession of rocks folded back on itself.

Sulphide mineralization in the Ledge horizon most commonly consists of massive coarse-grained pyrrhotite and sphalerite with minor pyrite, and less commonly, of finer grained disseminated sulphides.

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FX, FC, COLBY (82L/10)

INTRODUCTION

The Colby Mines Ltd.'s property is located 48 kilometres by road east of Enderby, 15 kilometres north of the Shuswap River and just east of Kingfisher Creek. The property straddles a low northeast-trending hill between Kingfisher Creek and a tributary of Kingfisher Creek to the southeast. Mineralization consists of sphalerite, pyrite, pyrrhotite, and minor galena in marble, quartzite, and calc-silicate gneiss units. These units have been traced 7 kilometres over the length of the property, with mineralization restricted to five zones: (1) the Mile 8 showing, (2) the Dakota zone, (3) the Central zone, (4) the Cominco showing, and (5) the Mile 12 showing (Fig. 3).

Since acquiring the property in 1973, Colby Mines Ltd. has carried out linecutting, trenching, and some stripping; magnetometer, electromagnetic, and geochemical surveys; geological mapping; and approximately 1 830 metres of diamond drilling.

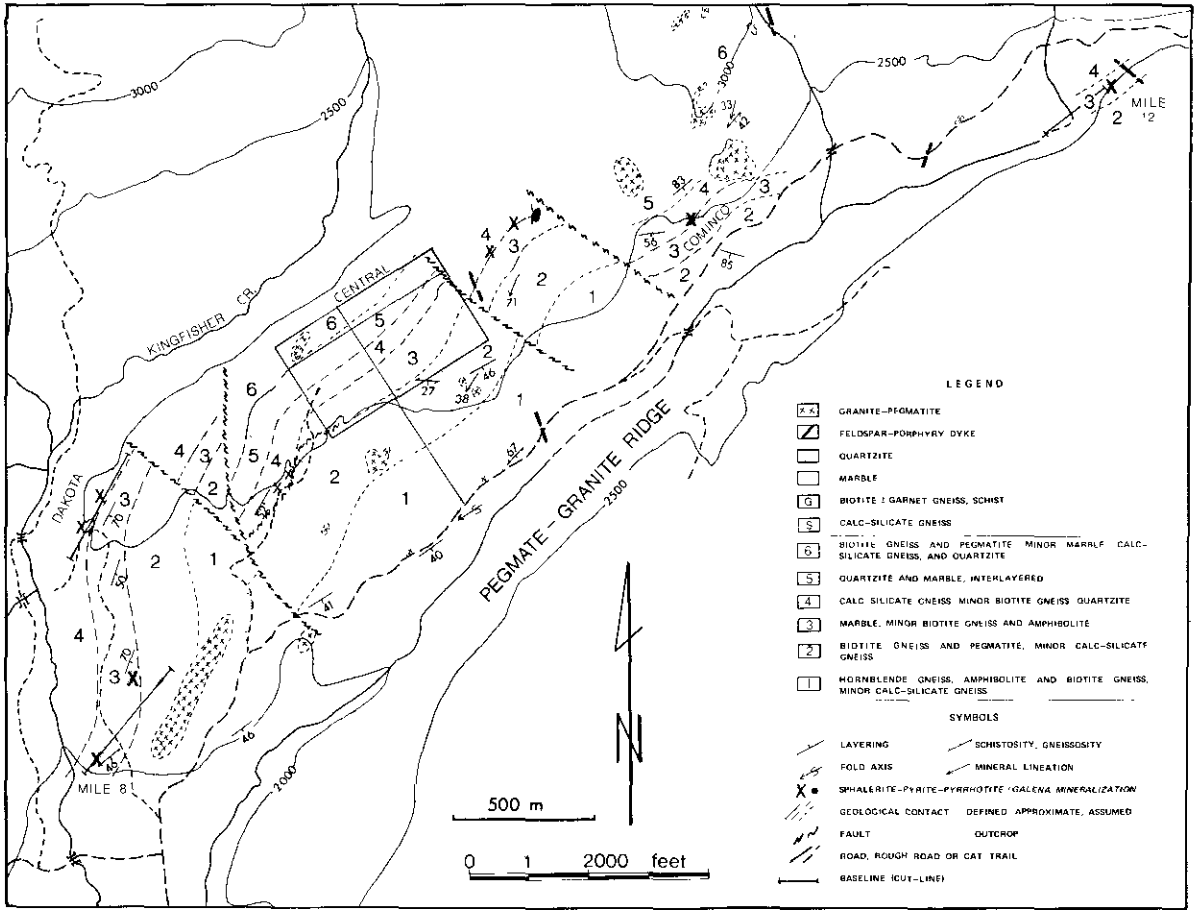

Figure 3. Geology of the Colby Mines area.

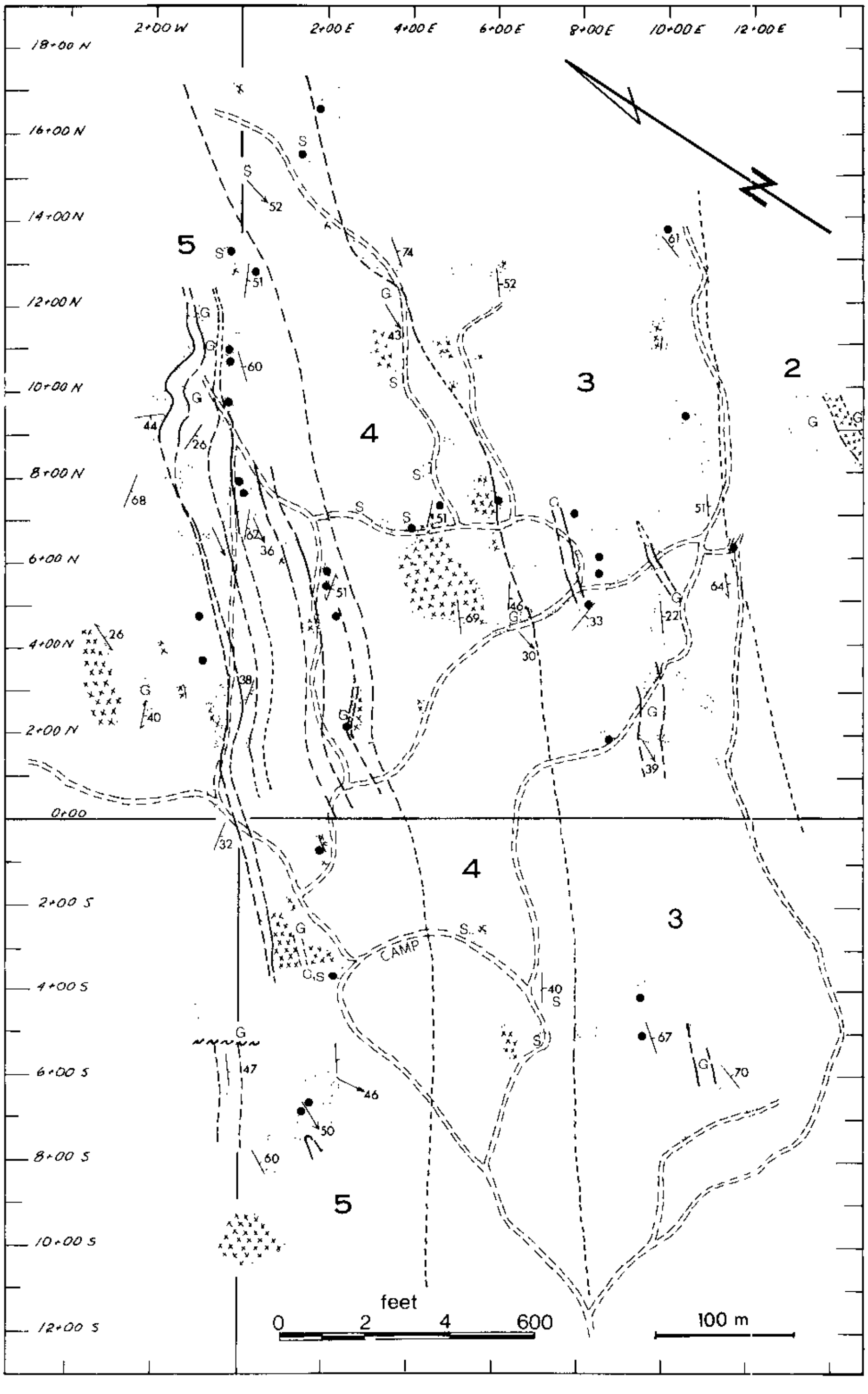

Figure 4. Geology of the Central zone, Colby Mines area (for legend, *see* Fig. 3).

GEOLOGY

Regional Setting

The property is within the Shuswap Complex, a belt of high-grade metamorphic rocks in the Columbian orogen of southeastern British Columbia. The area has been mapped on a regional scale by Jones (1959) and is on the eastern edge of a large area studied by Okulitch (1974). These authors assign rocks in the area to the Monashee Group, a heterogeneous package of probable Proterozoic and Early Paleozoic age comprising granitoid gneiss, augen gneiss, sillimanite-bearing schist, and prominent marble and quartzite layers.

Local Geology

Rocks within the map-area have been divided into six metamorphic units and two intrusive units. The sequence of metamorphic units may represent an originally conformable package of sedimentary rocks, though it is not known whether unit 1 or unit 6 is the older.

Unit 1, exposed in road cuts along the southeastern edge of the property, consists of hornblende gneiss, garnet-biotite gneiss, and some calc-silicate gneiss. The hornblende gneiss grades to amphibolite with increasing amphibole content. It consists of interbanded dark amphibole-rich layers with lighter feldspar and calc-silicate-rich layers.

Unit 2 consists of rusty weathering garnet-biotite-sillimanite gneiss and minor amounts of calc-silicate gneiss. Granite-pegmatite bodies, up to several hundred metres in diameter, commonly intrude unit 2.

Unit 2 is underlain by unit 3, a massive white marble up to several hundred metres thick. The marble consists of coarse-grained calcite with minor amounts of diopside, dolomite, tremolite, and/or quartz. Included in the marble are a number of discontinuous layers of garnet-biotite gneiss and hornblende gneiss. The most significant mineralization in the Central zone, and all the mineralization in the Mile 12 and Mile 8 showings are hosted by unit 3.

Unit 4 is a heterogeneous unit comprised predominantly of calc-silicate gneiss, but including rusty weathering to clean white marble, garnet-biotite gneiss, minor quartzite, and minor amphibolite. The calc-silicate gneiss is generally fairly coarse grained, light grey-green in colour, and composed of diopside-quartz or diopside-actinolite-quartz with varying amounts of feldspar, calcite, epidote, and/or garnet. The quartzite is commonly calcareous and contains scattered diopside grains throughout. The calc-silicate gneiss, quartzite, and marble of unit 4 host sulphide mineralization in the Central zone as well as in the Dakota and Cominco zones. This unit is not exposed at the Mile 8 or Mile 12 showings.

Unit 5 is well exposed in the Central zone (Fig. 4) and along strike southwest of this zone. It consists of fairly pure white marble interlayered with quartzite. Included in the quartzite are some garnet-biotite gneiss layers, and along the quartzite-marble contacts, coarse-grained calc-silicate gneiss. The more impure quartzite of unit 5 (those containing diopside and/or feldspar) may be mineralized with sulphides; one of the most continuously mineralized sections in the Colby area is a zone in a quartzite which follows the baseline from approximately 7 + 00 N to 11 + 00 N (Fig. 4).

Unit 6 includes all rock units west of unit 5. It is only exposed in the western part of the Central zone, due southwest of the Central zone, and north of the Cominco zone (Fig. 3). This unit consists dominantly of medium to coarse-grained garnet-biotite gneiss which is intruded by many granite-pegmatite sills and dykes. Some white quartzite, marble, and rare calc-silicate gneiss layers occur in unit 6.

Units 1 to 6 are intruded by numerous granite-pegmatite and aplite dykes, sills, and irregular stock-like bodies. These range in size from small discontinuous sills a few metres in length to almost equi-dimensional stock-like intrusions several hundred metres in diameter. The pegmatites are generally massive; only rarely do they have a conspicuous planar fabric (which is defined by a preferred orientation of micas). They are composed of feldspar and quartz with lesser amounts of biotite, muscovite, and garnet.

A number of north-trending quartz feldspar porphyry dykes also cut across the layered rocks. These dykes are generally 5 to 10 metres in width and have dark, finer grained chill margins.

Structure

The structure of the Colby Mines area is dominated by four northwest-trending faults (Fig. 3). These separate the layered rocks into five distinct blocks. The apparent movement of the faults is right lateral strike slip with displacement ranging from approximately 100 metres to 700 metres.

A fifth fault which trends northeast is inferred to cutout unit 3 southwest of the Central zone (Fig. 3). The prominent marble in the Central zone is not recognized to the southwest where biotite-garnet gneiss of unit 2 contacts calc-silicate gneiss of unit 4.

These faults cut across an earlier mineral foliation which strikes north-northeast and dips at varying angles to the southeast. This foliation is everywhere parallel or almost parallel with layering. Mineral lineations contained within the foliation plunge to the southwest.

Macroscopic folds were not recognized in the Colby area, though two types of mesoscopic folds are common. The first type is typically tight to isoclinal and plunges to the southwest, parallel to the mineral lineations. The second type is more open and has a more variable attitude, though generally also plunges to the southwest. It is not always possible to distinguish between these minor fold types.

Mineralization

Mineralization in the Colby area is restricted to five main zones. These are called the Mile 8 showing, the Dakota zone, the Central zone, the Cominco showing, and the Mile 12 showing (Fig. 3). All but the Cominco showing have a clearly marked grid cut and flagged across them.

Mineralization in marbles consists of dark, medium-grained sphalerite, with varying amounts of pyrrhotite and minor pyrite disseminated through a medium to coarse-grained white calcite matrix. Galena is also common, though much finer grained and more widely scattered.

Mineralized quartzites almost invariably contain calcareous minerals as an accessory. Dark sphalerite with pyrrhotite is generally concentrated in thin layers or defines the foliation in the quartzite. Galena is more common than in the marbles, though it is always less concentrated than sphalerite. Very commonly the mineralization in the quartzites has been concentrated in the hinge zones of minor folds, and less commonly in local brecciated zones.

Mineralization in calc-silicate gneiss shows gradational features between that in marble and that in quartzite. Sphalerite, pyrrhotite, pyrite±galena may be evenly distributed through a coarse-grained calcite-diopside rock or may tend to concentrate in layers in a more quartz-rich rock.

In general, mineralized sections in quartzites are of lower grade but are more continuous along strike with the layering than those in marbles. Discontinuous high-grade pods are common in the marbles.

Mile 8 Showing

Sulphide mineralization in marble (unit 3) is exposed intermittently for a distance of 130 metres along layering strike at the Mile 8 showing. The maximum exposed width of the mineralized zone is approximately 2 metres. Two 'grab' samples from a small pit assayed: (1) lead, .04 per cent; zinc, .34 per cent and (2) lead, .70 per cent; zinc, 7.7 per cent.

The next outcrops of marble, approximately 300 metres to the north, contain two small mineralized pods.

Dakota Zone

Mineralization in the Dakota zone is in calcareous quartzite of unit 4. A quartzite intermittently exposed over a length of approximately 400 metres contains spotty sphalerite and galena along its contacts with calc-silicate gneiss and marble. The mineralized sections are generally of low grade and are narrow with a maximum width of 1 to 2 metres.

Central Zone

Mineralization in the Central zone is in marble of unit 3 and calc-silicate gneiss and quartzite of units 4 and 5.

One of the largest mineralized sections in the marble of the Central zone occurs at approximately 6 + 00 N – 8 + 00 E (Fig. 4) where a zone up to 3 metres wide and 15 metres in length contains coarse-grained sphalerite and pyrrhotite. A .65-metre chip sample from this zone assayed: .31 per cent lead and 7.2 per cent zinc; and a 'grab' sample: .27 per cent lead and 6.3 per cent zinc. Approximately 30 metres to the north a trench exposes siliceous and very rusty marble with minor mineralization, and 15 metres to the south, mineralized blocks of marble are exposed in a blast pit.

Calcareous quartzite grading to siliceous calc-silicate rock of unit 4 is mineralized at 7 + 00 N – 4 + 00 E and 15 + 50 N – 1 + 50 E. Both occurrences appear to be fairly restricted in size.

Three of the quartzite layers of unit 5 are mineralized. Outcroppings of the central of these layers (Fig. 4) indicate that in this layer the mineralization has a strike length of at least 170 metres with widths varying from less than 1 metre to 6 metres. Drill hole data suggest that this zone may be continuous with a zone approximately 400 metres to the south where diamond-drill hole 73-3 intersected a 40-metre thick mineralized section grading approximately 3.5 per cent zinc and 1.5 per cent lead. A 20-metre section in this zone averaged 4 per cent zinc and 1.8 per cent lead.

Cominco Showing

A trenched area 1,300 metres east of the Central zone exposes three mineralized zones which have been called the Cominco showings. These zones are less than 1 to 2.5 metres in width and a maximum of 8 metres in length. Mineralization consists of dark sphalerite, pyrite, pyrrhotite, and minor galena in a diopside-rich, rusty weathering marble. This marble is believed to be within unit 4, just to the north of the contact with the marble of unit 3.

Mile 12 Showing

A small outcrop of marble of unit 3 is well mineralized through its entire exposed width (2 metres). The length of the mineralized zone is unknown. Two 'grab' samples from this zone assayed: (1) .98 per cent lead and 11.3 per cent zinc; (2) .49 per cent lead and 5.3 per cent zinc.

SUMMARY

Mineralization on the Colby property consists of sphalerite, pyrrhotite, minor pyrite, and minor galena in three distinct lithologic units. These include a massive white marble (unit 3), calc-silicate gneiss (unit 4), and calcareous quartzite (units 4 and 5). These units extend the length of the map-area, but are offset by four northwest-trending strike slip faults. Large areas underlain by units 3, 4, and 5 are covered by overburden and have not been adequately tested.

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GOLD–SILVER–COPPER MINERALIZATION IN THE BOUNDARY DISTRICT

By G. G. Addie

INTRODUCTION

A porphyry copper prospect has been found recently in the Franklin Mining Camp north of Grand Forks, near the Boundary District. It is predicted here, on the basis of this study, that a similar porphyry copper deposit will be found in or near the Wallace Creek batholith.

OBSERVATIONS

Three mining camps of the Boundary District of British Columbia seem to be related to a common ore genesis. These are: the Deadwood Camp, the Phoenix Camp, and the Summit Camp (Fig. 5). All the major deposits in these camps are skarn deposits. Figure 6 indicates that the production from the above camps plot on regression lines with a high correlation coefficient, indicating a common, single stage mineralization.

SOURCES OF ERROR

(1) Those who work with production figures know how inaccurate some of them can be.

(2) Studies of metal ratios do show variations with grade of ore. There is the very real question as to if this present study is indicating a common source or a common geochemical phenomenon only.

(3) The production figures are based on recovery and this will vary from mill to mill as well as change in time due to technology. In this study it is assumed that these variations are insignificant compared to the final product.

(4) In the statistical calculations many figures have been rounded off. This normally gives a higher correlation coefficient. However, in this case, this type of error is also considered insignificant.

(5) The 'B.C. Mine' silver production figure has been used in the silver-copper regression line, but the gold production has not been used as it would shift the whole curve and greatly lower the correlation coefficient. This is a bias.

HYPOTHESIS

While the individual orebodies have a north-south orientation, the spatial distribution is around the south edge of the Wallace Creek batholith. Indeed, both the Motherlode and Emma-Oro Denoro mines are in contact with rocks believed to be associated with, or part of, the batholith.

Assuming that the mineralization originated from the Wallace Ceeek batholith, it is postulated that there are areas within the batholith which have gold-silver-copper mineralization.

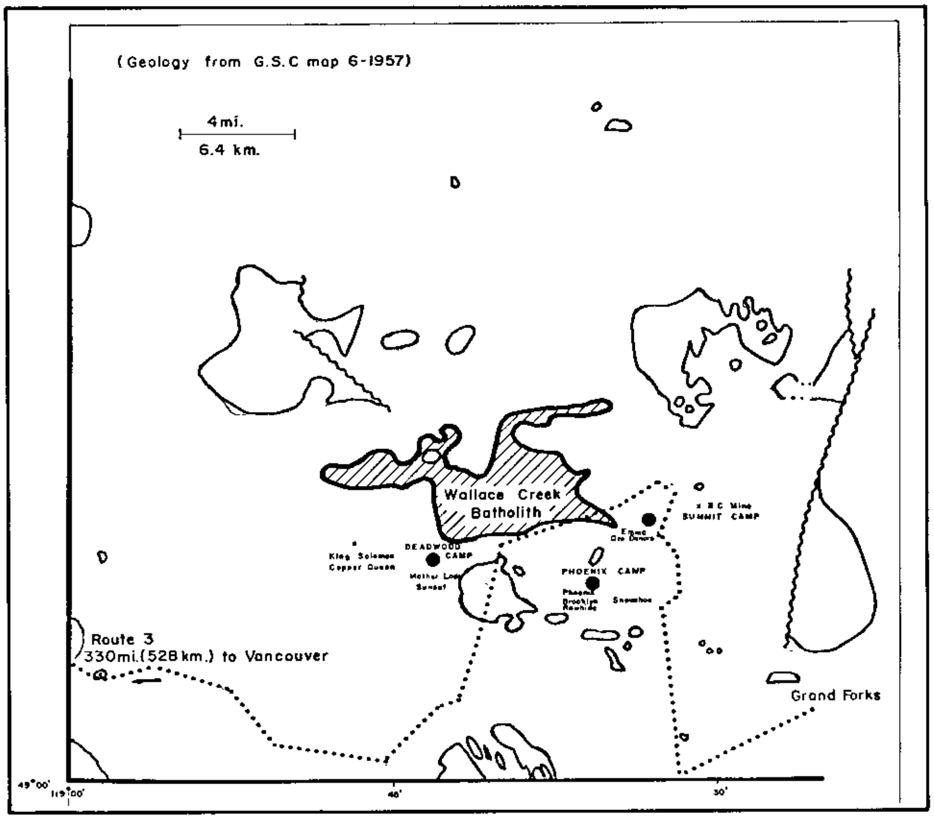
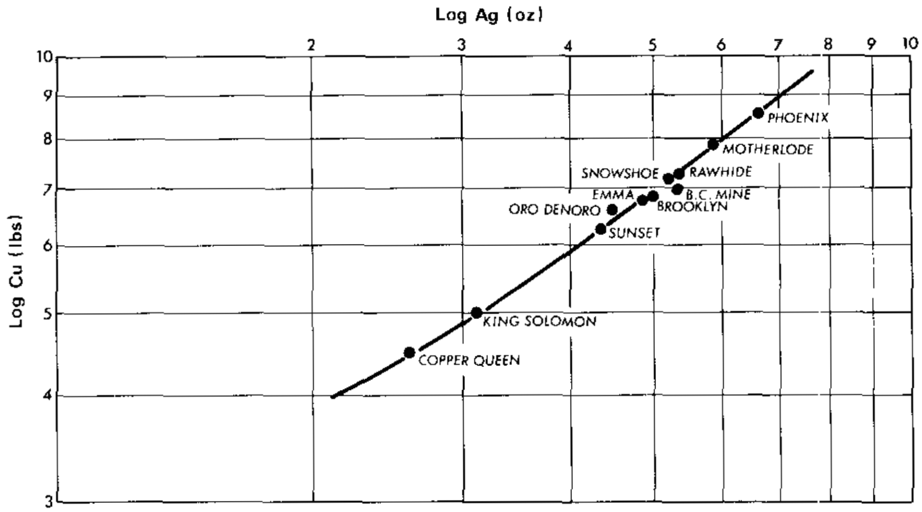
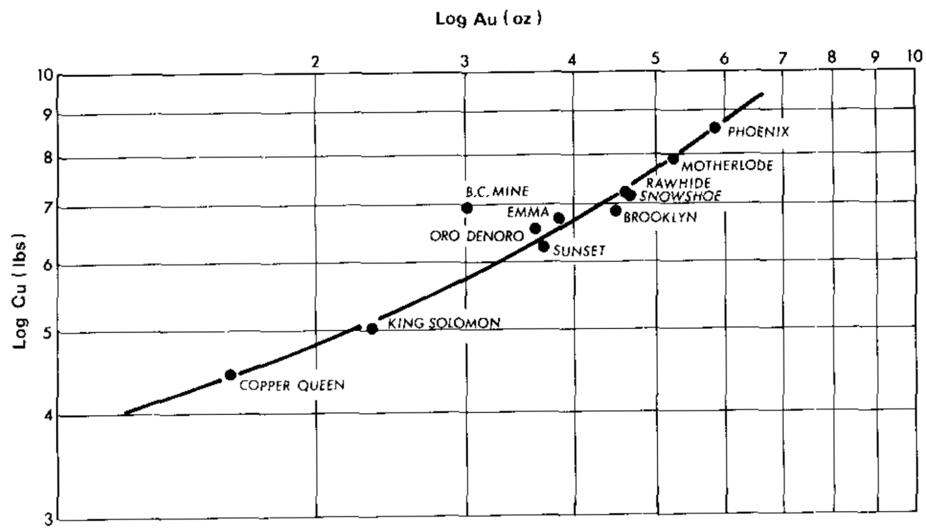


Figure 5. Location of major mining camps in the Boundary District in relation to the Wallace Creek batholith and other Nelson Intrusions.



LOG Ag (oz) = 0.984 LOG Cu (lbs) - 1.79



LOG Au (oz) = 1.033 LOG Cu (lbs) - 2.93

Figure 6. Boundary District, gold-copper and silver-copper ratios.

TABLE 1. PRODUCTION FIGURES

Mine	Years	Copper lb.	Log Copper	Gold oz.	Log Gold	Silver oz.	Log Silver
Phoenix*	1900–69	389,084,296	8.59	764,074	5.88	4,596,861	6.66
Motherlode*	1900–62	76,975,516	7.89	173,322	5.24	688,214	5.84
Brooklyn*	1900–49	7,819,517	6.89	27,404	4.44	110,028	5.04
Rawhide*	1904–16	18,610,304	7.27	33,941	4.53	222,149	5.35
Snowshoe*	1910–11	13,937,892	7.14	41,282	4.62	159,147	5.20
Sunset*	1900–18	1,910,265	6.28	4,649	3.67	24,015	4.38
Emma*	1901–21	5,132,118	6.71	6,804	3.83	78,065	4.89
Oro Denoro*	1903–17	3,727,194	6.57	3,744	3.57	30,652	4.49
King Solomon†	1901–17	101,801	5.01	214	2.33	1,299	3.11
B.C. Mine†	1900–19	9,025,707	6.96	1,002	3.0	214,275	5.33
Copper Queen**	1954–55	28,627	4.46	39	1.59	402	2.60

*Production figures used for Figure 6 from the *Western Miner,* December, 1970, page 45, in a paper titled 'The Greenwood Area' by Frederick H. Reid, P. Eng.

†Production figures from Index No. 3, *British Columbia Department of Mines and Petroleum Resources.*

**Production figures from Index 4, *British Columbia Department of Mines and Petroleum Resources.*

TABLE 2. BOUNDARY DISTRICT GOLD–COPPER REGRESSION LINE CALCULATIONS

	x Copper	y Gold	xy	x^2	y^2
Phoenix	8.59	5.88	50.51	73.79	34.57
Motherlode	7.89	5.24	41.34	62.25	27.46
Brooklyn	6.89	4.44	30.59	47.47	19.71
Rawhide	7.27	4.53	32.93	52.85	20.52
Snowshoe	7.14	4.62	32.99	50.98	21.34
Sunset	6.28	3.67	23.05	39.44	13.47
Emma	6.71	3.83	25.70	45.02	14.67
Oro Denoro	6.57	3.57	23.45	43.16	12.74
King Solomon	5.01	2.33	11.63	25.10	5.43
Copper Queen	4.46	1.59	7.09	19.89	2.53
	$\sum x = 66.81$	$\sum y = 39.70$	$\sum xy = 279.28$	$\sum x^2 = 459.95$	$\sum y^2 = 172.44$

$$b = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}} = \frac{279.28 - \frac{(66.81)(39.7)}{11}}{459.95 - \frac{(66.81)^2}{10}} = \frac{279.29 - 265.24}{459.95 - 446.36} = \frac{14.04}{13.59} = 1.033$$

$$a = \frac{1}{n}[\Sigma y - b(\Sigma x)] = \frac{1}{10}[39.7 - (1.033)(66.81)] = \frac{1}{10}(39.7 - 69.01) = -2.93$$

$$\text{Log gold (oz.)} = 1.033 \text{ log copper (lb.)} - (2.93)$$

TABLE 3. BOUNDARY DISTRICT
SILVER–COPPER REGRESSION LINE CALCULATIONS

	x Log Copper	y Log Silver	xy	x^2	y^2
Phoenix	8.59	6.66	57.21	73.79	44.36
Motherlode	7.89	5.84	46.08	62.25	34.11
Brooklyn	6.89	5.04	34.73	47.47	25.40
Rawhide	7.27	5.35	38.89	52.85	28.62
Snowshoe	7.14	5.20	37.13	50.98	27.04
Sunset	6.28	4.38	27.51	39.44	19.18
Emma	6.71	4.85	32.81	45.02	23.91
Oro Denoro	6.57	4.49	29.50	43.16	20.16
King Solomon	5.01	3.11	15.58	25.10	9.62
B.C. Mine	6.96	5.33	37.10	48.44	28.41
Copper Queen	4.46	2.60	11.60	19.89	6.76
	$\sum x = 73.77$	$\sum y = 52.89$	$\sum xy = 368.14$	$\sum x^2 = 508.39$	$\sum y^2 = 267.57$

$$b = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}} = \frac{368.14 - \frac{(73.77)(52.89)}{11}}{508.39 - \frac{(73.77)^2}{11}} = \frac{368.14 - 354.70}{508.39 - 494.73} = \frac{13.44}{13.66} = 0.984$$

$$a = \frac{1}{n}[\Sigma y - b(\Sigma x)] = \frac{1}{11}[52.89 - (0.984)(73.77)] = \frac{1}{11} = (52.89 - 72.58) = -1.79$$

Log silver (oz.) = 0.984 copper (lb.) – (1.79)

GEOLOGICAL INVESTIGATIONS IN THE GREENWOOD AREA (82E/2E)

By B. N. Church

INTRODUCTION

Detailed mapping was initiated following renewed exploration and mining in the vicinity of the old Oro Denoro workings, 9.7 kilometres northeast of Greenwood.

Early in 1975 Granby Mining Corporation began a test operation to prove an orebody estimated by previous work to contain about one million tonnes grading slightly less than 1 per cent copper. When the property was visited in June, excavation had advanced to the third bench in the open pit, and approximately 135 000 tonnes of bedrock had been removed. Subsequently mining ceased pending the results of a percussion drilling program.

The history of Oro Denoro can be traced to the original discovery of copper in the so-called 'Summit Camp' in 1891. Beginning in 1903 the property became an important local mine producing 136,447 tons of ore grading 1.37 per cent copper, 0.027 ounce per ton gold, and 0.225 ounce per ton silver. By 1910 accessible ore had been extracted from five open stopes and 1,000 feet of underground drifts.

After many years of inactivity, prospecting was revived in response to increases in the price of copper. Between 1951 to 1953, Attwood Copper Mines Ltd. carried out a number of geological, geophysical, and geochemical surveys. Later the property was drilled by Noranda Mines, Limited (1955 to 1957) and again by West Coast Resources Ltd. (1965 to 1970). The present testing by Granby Mining Corporation began in 1974.

GEOLOGY

The geology of Oro Denoro is relatively straightforward. Mineralization consists of pockets of pyrite, chalcopyrite, and magnetite in a garnetite skarn. This is mostly a replacement of limestone intruded by an apophysis of the Lion Creek granodiorite stock.

Oro Denoro is centrally located on a 2.4-kilometre-long meridianal alignment of skarn deposits, including the Emma and Jumbo on the north and the Cyclops and Lancashire Lass on the south. The host rock for all of these, and many other deposits in the Greenwood area, is the Triassic Brooklyn Formation.

In regional setting, the Mesozoic strata rest unconformably on a basement complex of Precambrian ? gneisses and schists. The sequence is as follows:

MESOZOIC BEDS (mostly Triassic ?)

Banded limestone (algal mats ?)
Massive limestone (reef breccias ?)
Laminar bedded sandstone and siltstone
Sharpstone conglomerate
Andesite and dacite volcanic rocks

BASEMENT (Precambrian ?)

Mostly fine to medium-grained amphibolites interlayered with metaquartzites and some marble

This assemblage is intruded by Jurassic or Cretaceous granodiorite stocks and dykes and an assortment of Tertiary trachyte and phonolite dykes and sills.

STRUCTURE

While structural relations are not entirely clear in this region because of limited exposure, there is some evidence of significant folding and faulting.

The Mesozoic beds, well exposed southwest of Oro Denoro, trend mostly northerly and dip to the east, the average attitude being 005° – 50° east. Minor folds appear to plunge gently to the northeast.

The fabric of the basement complex is more difficult to identify, since most of the rocks are massive amphibolites. The average bedding attitude determined on a metaquartzite unit is 064° – 50° northwest.

The main fractures trend easterly, coincident with major valley lineaments, and northerly parallel to the principal strike direction of the Mesozoic formations. The two most important fracture attitudes, determined from hundreds of measurements in the Oro Denoro workings and the surrounding area, are 110° – 85° southwest and 005° – 82° east.

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CARMI–BEAVERDELL AREA
(82E/6, 11)

By P. A. Christopher

A programme of regional mapping and property examinations was initiated to define the geological setting of mineral deposits in the Carmi-Beaverdell area. This area includes a variety of interesting silver, gold, molybdenum, copper, and uranium prospects as well as the Beaverdell (Highland Bell) silver-lead-zinc-(gold) mine of Teck Corporation Ltd. The last comprehensive study of the geology and mineral deposits was conducted by Reinecke (1915).

The map-area straddles the Westkettle River valley in south-central British Columbia and is situated within the southern part of the Interior Plateau. Access is provided by Highway 33 from Kelowna (88 kilometres) and Rock Creek (48 kilometres), and freight service is provided by the Kettle River Railway. Penticton, about 40 kilometres west of Carmi, is connected to Carmi by a rough forestry access road that is passable during summer months. Locally mining and logging roads provide excellent access to most of the area.

Mapping covered an 8 by 15-kilometre area extending from south of Tuzo Creek to Wilkinson Creek and including parts of Mount Wallace, Cranberry Ridge, and King Solomon Mountain. The area is dissected by the Wilkinson Creek, Beaverdell Creek, Tuzo Creek, and Westkettle River valleys. Elevations range from 1 733 metres at Goat Peak to 744 metres in the Westkettle River valley.

GENERAL GEOLOGY

The map-area (Fig. 7) is mainly underlain by the Westkettle batholith (Nelson granodiorite) and Beaverdell stock (Valhalla ? quartz monzonite) with contained pendants of Paleozoic or Early Mesozoic metamorphosed rocks of the Wallace Formation (Anarchist Group). Tuffaceous rocks and conglomerates of the Oligocene Curry Creek series and basic Miocene flows of the Nipple Mountain series occupy the eastern part of the map-area. A complex of dykes and sills of quartz monzonite and granite composition occur near Tuzo Creek in the southern part of the map-area and mark the position of an Eocene volcanic centre (Leary, 1967) with associated molybdenum mineralization. Hypabyssal rocks of granite to basalt composition occur throughout the area and are temporally and probably genetically related to mineralization at the Beaverdell mine, Tuzo Creek molybdenum prospect and Carmi molybdenum prospect.

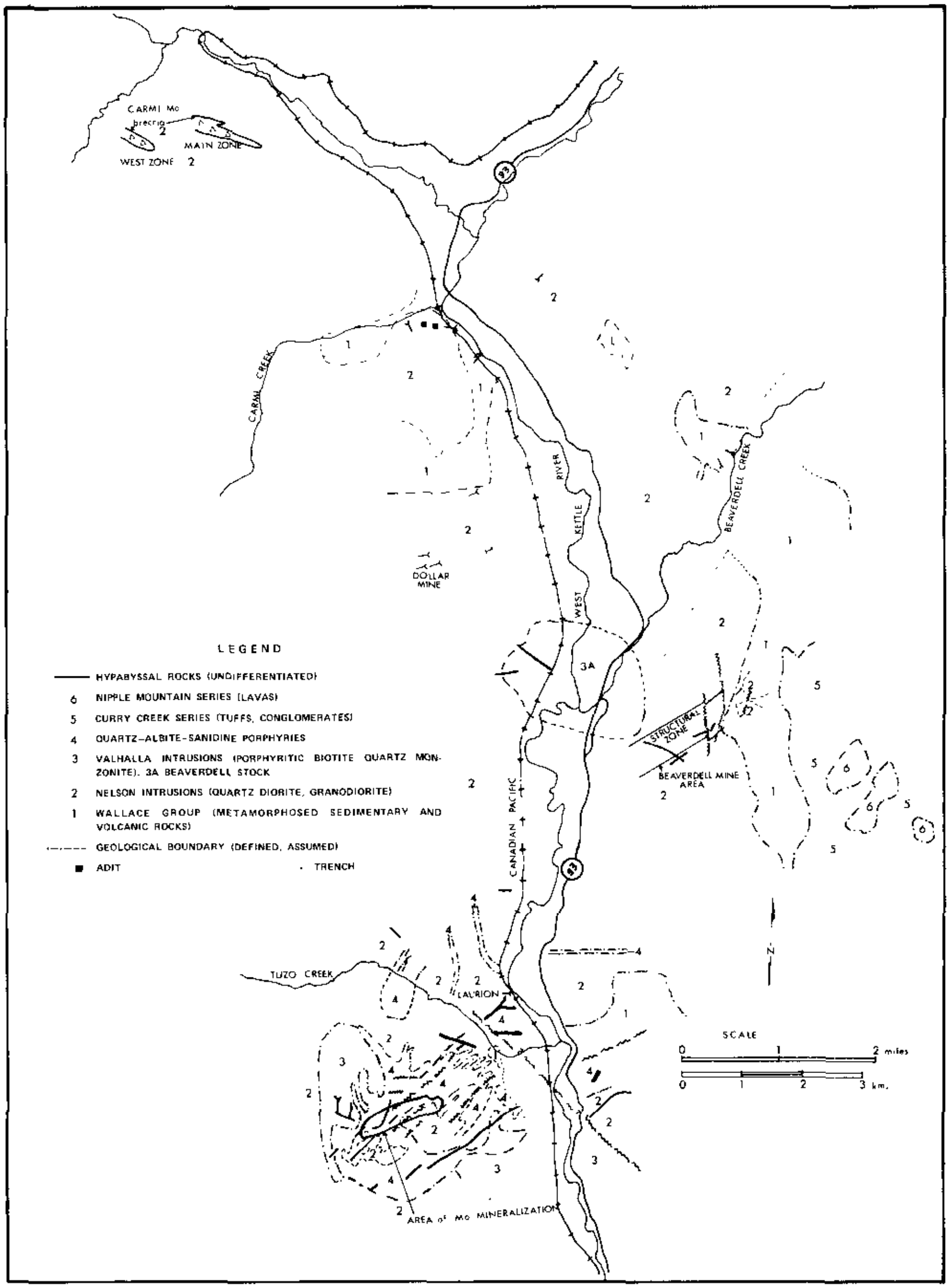

Figure 7. Carmi-Beaverdell area.

MINERAL PROPERTIES

Beaverdell (Highland Bell) Mine

Vein systems of the Beaverdell mine occur mainly within quartz diorite or granodiorite of the Westkettle batholith. Five separate vein systems are situated in a 3-kilometre, northeast-trending, complexly faulted zone on the west slope of Mount Wallace. At the eastern end of the mineralized zone, the Westkettle batholith is overlain by metamorphosed sedimentary and volcanic rocks of the Wallace Formation and at the western end of the mineralized zone, porphyritic quartz monzonite (Beaverdell stock) intruded the Westkettle batholith. Pre-mineral andesitic dykes (Wellington type) and syn or post-mineral quartz latite dykes (Idaho type) are spatially and temporally related to mineralization and often occupy the same structural zone. Veins are essentially mineralized fissures that formed along either easterly or northeasterly trending faults with mainly easterly trending veins in the western part of the mineralized zone (Wellington, Sally, and Rob Roy vein systems) and mainly northeasterly trending veins in the eastern part of the mineralized zone (Upper and Lower Lass systems). The Bell system in the central part of the mineralized zone has both easterly and northeasterly trending veins. Except for the mineralized 'black breccia' (probably a carbonaceous fault brecciated vein) that occurs in the Wallace Formation, mineralized lodes persist for only short distances into the Wallace Formation. The proximity of the Wallace Formation to mineral occurrences throughout the area suggests that the Wallace rocks acted as a dam to mineralizing solutions.

Sulphide mineralization consists mainly of pyrite, galena, and sphalerite with lesser chalcopyrite, pyrrhotite, and arsenopyrite and silver minerals including tetrahedrite, pyrargyrite, polybasite, argentite, and native silver (*see* Staples and Warren, 1946). Quartz, calcite, and rare fluorite are the main gangue minerals. Veins generally have a prophylitic alteration halo that may be recognizable up to 10 metres from the main vein and may carry low-grade silver values.

Production from the Beaverdell mine area started in 1900 and since then has totalled about 32 million ounces of silver, 24 million pounds of lead, and 28 million pounds of zinc with minor production of gold, cadmium, and copper. Gold values appear to increase in the eastern part of the Lower Lass mine but further exploration is required to outline an economic gold-silver part of the deposit. Complex faulting makes estimation of proven ore reserves tenuous and with the present economics, the main requirement for continued production is to keep mill heads above about 10 ounces of silver per ton.

Tuzo Creek Molybdenum Prospect

The main altered and mineralized zone is on the ridge immediately south of Tuzo Creek about 1 kilometre west of the Westkettle River valley. The geology of the property is generalized after Leary (1967). A stock of porphyritic quartz monzonite (Valhalla ?) and younger bodies of quartz-albite-sanidine porphyry (Late Valhalla? differentiates) intruded Nelson granodiorite. Low-grade molybdenum mineralization occurs in a northeasterly trending altered and sheared zone about 300 metres and 1 000 metres long. Two hydrothermal phases of structurally controlled mineralization have been recognized by Leary (1967):

Phase I (main phase) with a metallic mineral assemblage including hematite, magnetite, pyrite, and molybdenite and gangue of quartz (stockwork veining), hydro-mica and K-feldspar, and

Phase II with a metallic mineral assemblage including pyrite, sphalerite, galena, chalcopyrite, and molybdenite and gangue of sericite, quartz, calcite, and fluorite.

Weathering has produced a gossan over the mineralized zone with molybdenite converted to ferrimolybdenite.

East of the Tuzo Creek property, phase II mineralization becomes more intense and represents the typical lead-zinc vein systems that are found peripheral to molybdenum deposits.

Carmi Molybdenum Property

The property is situated north of the Carmi-Penticton road about 6 kilometres northwest of Carmi. Molybdenite with pyrite, minor chalcopyrite and notable uraninite, occurs chiefly in two sheared and brecciated zones in gneissic granodiorite (Nelson). The main or eastern zone was discovered in 1960 when Kennco Explorations, (Western) Limited obtained anomalous molybdenum values from stream sediments. In 1974 Vestor Explorations Ltd. used soil geochemistry to locate the western zone. Granby Mining Corporation (1974-75) and International Minerals & Chemicals Corp. (1970) have also explored the property.

Grade of molybdenum appears to vary with intensity of alteration and brecciation. Where alteration within the breccia zone is intense, a greissen zone consisting of quartz, muscovite, fluorite, and molybdenite (ferrimolybdenite near surface) is formed. Molybdenite occurs mainly as rosettes that are disseminated within breccia fragments and quartz feldspar matrix material.

Drill holes have intersected a leucocratic monzonite porphyry that does not appear to be exposed at the surface. The presence of a buried porphyry body suggests that the showing is at a high level in the hydrothermal and intrusive system.

Uraninite is widespread in Nelson rocks and shows some concentration in pegmatites at the Carmi prospect. Further leaching and concentration of similar material provides a plausible source for secondary uranium mineralization that has accumulated below Miocene plateau basalts north and northwest of Carmi.

Secondary Uranium (Fuki and Donen)

The Fuki and Donen (82E/10W) claims are situated 25 kilometres northeast of Beaverdell. Secondary uranium minerals mainly (autunite) have accumulated in unconsolidated gravel and sand deposits that are preserved below a cap of Miocene plateau lavas. Exploration in the Kallis Creek and Hydraulic Lake areas has located deposits with similar settings. Oxidation and weathering of uranium-bearing veins or pegmatities or low-grade disseminated uraninite in basement rocks (for example, Carmi molybdenum prospect) may be the source of this secondary mineralization.

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SOUTHWEST BRITISH COLUMBIA

SOUTHERN VANCOUVER ISLAND

By G.E.P. Eastwood

INTRODUCTION

In 1975 responsibility for Vancouver Island was shared with K. E. Northcote. In general Northcote took the northern part and the writer the southern, but the exigencies of scheduling made it impossible to keep to this arrangement entirely. The writer was assigned to supervise grantees under the *Prospectors Assistance Act* who indicated they would be working on the south part of the Island. Five prospectors were visited in the field. Investigation of iron and iron-copper deposits on and near Renfrew Creek was continued, and reconnaissance mapping of Carnation Creek basin was concluded. One group of new showings was examined and surveyed, and two other new showings were examined. Two creeks were briefly examined for placer potential at the request of the Mineral Titles Division. Areas and properties reported on are arranged in NTS order.

RENFREW CREEK – HARRIS CREEK AREA (92C/9)

Further information on the general geology of this area has come from several sources: field trips with W. S. Read and prospector M. Dickens, discussion with Dickens, and rock samples loaned by Read. Mr. Read conducted reconnaissance soil sampling along the logging roads in 1974, under a *Prospectors Assistance Act* grant. Rock samples were also collected at all sample points where there was outcrop. Under a further grant in 1975 he did detailed follow-up sampling on a low ridge west of Harris Creek.

The two bands of limestone noted previously (Geological Fieldwork, 1974) are now known to extend southeast down the west slope of Hemmingsen Creek, and the more northerly band to extend down to the junction with the west fork. Bedding observed on the south slope of the west fork dips gently south into the hillside. Buff-coloured bluffs farther west on the slope suggest a granitic intrusion transecting this band. A northeast-striking fault with possible left-hand displacement is inferred to underlie the pass north of Renfrew Creek.

The ridge between Hemmingsen and Harris Creeks splits toward its south end. A patch of limestone lies on the nose of the low east branch, surrounded on three sides by intrusive breccia. East of the limestone there are few diorite intrusions and the rock is virtually massive andesite. Northward this andesite is in contact with virtually massive diorite. The copper geochemical results showed a marked increase across the transition from diorite to andesite, but failed to indicate mineralization. Minor pyrite occurs in seams and as disseminations in the andesite.

REAKO EXPLORATIONS LTD. (92C/9W)

One week was spent in Vancouver logging core and gathering data relating to the property, and three weeks were spent on the property, surveying part of No. 8 zone (North Pit zone) and examining new showings.

Some of the individual magnetite occurrences in No. 8 zone are on a low ridge between the main logging road and Renfrew Creek. This ridge has been logged, and the slash was burned in 1975. Observations after the fire disclosed a jumble of small and large angular float and rounded boulders. Blocks of limestone, andesite, intrusive breccia, and magnetite are juxtaposed. Two large exposures of diorite and intrusive breccia may be projections of bedrock, but most of the ridge appears to have been transported by some form of mass movement. A glacial end moraine cannot be ruled out, but a large concavity in the hillside to the northeast is suggestive of a landslide. Recognition of the transported nature of the magnetite blocks results in a relatively minor reduction of indicated ore reserves, and on the other hand suggests that the source should be sought in the concave hillside. Of additional interest was the discovery of pyrite and bornite disseminated in one of the limestone blocks.

The new showings are on both slopes of the ridge rising west-southwest from the pass north of Renfrew Creek, and are within the northerly band of limestone. One significant and two minor magnetite showings were seen on the Renfrew Creek slope, and two significant showings were seen on the Hemmingsen Creek slope. Several smaller showings are also reported to occur on the Hemmingsen slope. The principal showing on the Renfrew slope is a body of almost pure magnetite emplaced directly in the limestone. Neither skarn nor sulphides were seen. The magnetite is exposed over an area of about 8 by 15 metres, but high positive and negative magnetic anomalies over adjacent overburden indicate that it may be more extensive.

One of the showings on the north slope is exposed intermittently for some 75 metres along a small creek. The width appears to range from 3 to 15 metres. The walls are mostly limestone, skarn is minor, and the magnetite is mostly massive. The other main showing is a long wedge of magnetite-bearing skarn between two creek gullies. The upper part has an estimated width of 45 metres, and the wedge was reported to have a slope length of 120 metres. The magnetite forms pockets and narrow bands in garnetite, and the overall grade probably does not exceed 30 per cent iron. The creek canyon on the west appears to mark the contact between the skarn and the presumed granitic intrusion. The east contact of the skarn is covered.

SOMBRIO RIVER (92C/9W)

At the request of the Mineral Titles Division the writer accompanied the Claims Inspector on an examination of the Sombrio River drainage area. Information was needed as to whether this area warranted designation as a placer area under the *Placer Mining Act*. The placer potential was found to be modest, and the volume estimates published in the 1929 and 1930 Minister of Mines Annual Reports were not confirmed.

In the first place, the general overburden is not alluvial but rather unsorted material of probable glacial origin. There has therefore been little or no concentration of heavy minerals, and the gold content could be expected to be extremely low.

Secondly, the stream gradient is generally steep, and bedrock has been stripped bare along sections of the river and its two main tributaries. The bedrock consists of slaty beds of the Leech River Formation, striking west-northwest and dipping north at about 60 degrees. It may in places have formed natural riffles, although no instance of this was seen. A small amount of heavy minerals may have collected in fracture crevices, but the total amount of gold that could be expected on the stripped sections is very small.

The main placer potential is in the river delta and in channel bars along the river and its principal tributaries. The delta was not examined, but estimates can be made from the topographic map. A width of 300 metres at the beach, as previously reported, is not unrealistic. The contour spacing would suggest that the apex is 600 to 750 metres horizontally back from the shore. The reported thicknesses of 100 and 300 feet (30 and 90 metres) appear unrealistic; 15 metres would appear to be the maximum thickness possible.

Two channel bars were found, immediately below the main road, on the river and its main east tributary. Additional bars could be expected above the main road; the upper limit on the river would appear to be close to the 800-foot (240-metre) contour, above which the channel becomes a steep canyon. The bars observed are 25 and 37 metres long, 6 and 8 metres wide, and generally less than 120 centimetres thick. Boulders are few, and the gravel should not be difficult to handle.

CARNATION CREEK (92C/14E, 15W)

An additional four days mapping was done in the Carnation Creek watershed, (*see* Geological Fieldwork, 1974). Most of the mapping was done along newly constructed logging roads in the lower part of the basin and is sufficient to elicit some patterns, which are illustrated on Figure 8.

The predominant rock in the basin is medium to dark grey and generally porphyritic with a dense groundmass. Locally it is bleached and resembles porphyry dykes. A few narrow

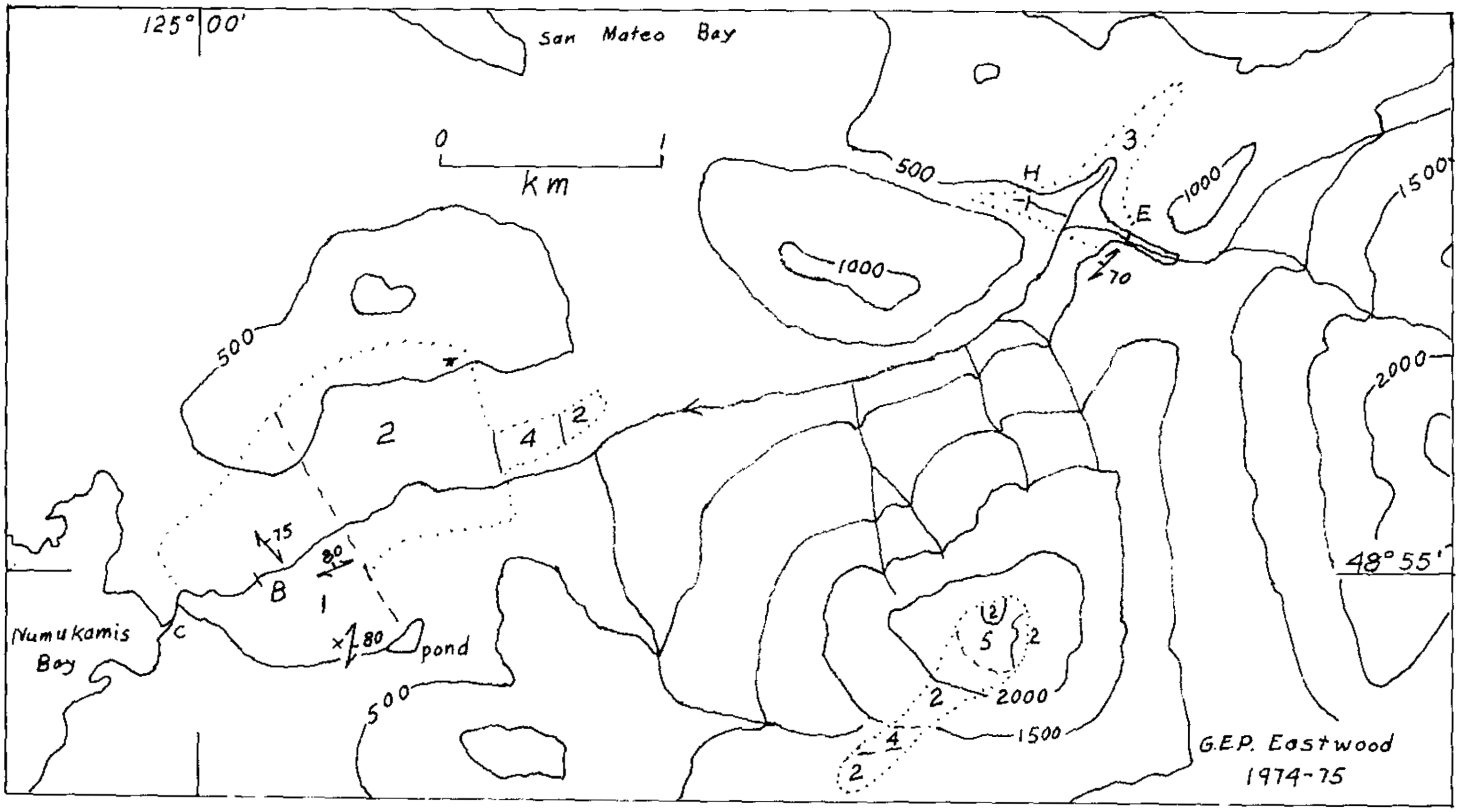
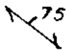
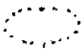


Figure 8. Reconnaissance geology, Carnation Creek Basin.

LEGEND

1	BONANZA FORMATION, WESTERN AREA
2	BONANZA FORMATION, CENTRAL AREA
3	BONANZA FORMATION, EASTERN AREA
4	DIORITE, MAFIC QUARTZ DIORITE
5	QUARTZ DIORITE
B, E, H	FLOW-MEASURING WEIRS
C	STUDY CAMP
X	SAMPLE SITE
π	PYRITE OCCURRENCE
	LOCALLY PREVAILING ATTITUDE OF SHEAR ZONES
	MAPPED AREAS

sections of a purple rock were found south of the creek in both the western and central areas; two are clearly lapilli tuff. In thin section the purple colour is seen to be caused by grains and dust of hematite. Another lapilli tuff was found near the north limit of mapping in the central area; it consists of dark lapilli in a greenish grey matrix. Amygdules are common in the western area north of the creek, but scarce elsewhere.

For the predominant type of rock that is neither lapilli-bearing nor amygdaloidal there is scant indication in outcrop or hand specimen as to whether it is lava or tuff. Two thin section specimens were taken from the western area south of the creek. One specimen was tentatively identified in the field as intrusive, but in thin section the grain size is seen to grade down to dust, with no interlocking of grains. The rock is probably an unsorted crystal tuff. The other specimen was taken, along with a sample for silicate analysis, from the site marked 'X' on Figure 8. In thin section it is evidently a bedded crystal tuff, with the grain size again ranging down to dust, but with an alternation of coarser and finer beds. These beds are bent around large plagioclase crystals, which vary from euhedral to rounded to broken. The composition of the large crystals appears to vary somewhat, from about An_8 to An_{12}, although the individual crystals are unzoned. It seems likely that *much of the apparently porphyritic rock is in fact crystal tuff. This would support* correlation with the Bonanza Formation.

The following analysis was obtained on the bedded tuff:

	Per Cent		*Per Cent*
SiO_2	71.0	TiO_2	0.27
Al_2O_3	14.6	MnO	0.06
Fe_2O_3	2.54	P_2O_5	<0.18
MgO	0.20	SO_3	<0.2
CaO	0.94	CO_2	0.05
Na_2O	4.3	H_2O	0.57
K_2O	3.7		

When taken, the sample appeared to be typical of the predominant porphyritic rock, showing an almost black groundmass, and was selected because it appeared particularly fresh and clean. It is possible that it is more silicic and potassic than the average.

Three areas have been indicated, on the bases of structure, alteration, and mineralization. The western area is replete with shear and gouge zones. Taken together, they strike randomly, although prevailing directions are apparent in any one outcrop. They range in width from a few centimetres to a metre or so, and are spaced at intervals of a few metres to about 100 metres. Alteration and mineralization are common, enough to suggest that the area should be more thoroughly prospected. The principal alteration minerals are epidote and chlorite, and on a microscopic scale sericite and carbonate. Hematite and serpentine occur sporadically along slips. Quartz is common as seams and veinlets. Pyrite is common, both in joints and as disseminations. Pyrrhotite is disseminated with pyrite in a very siliceous-looking rock near the north limit of mapping. Sporadic chalcopyrite was found in joints, in quartz veinlets, in amygdules, and as disseminations.

The central area is more coherent structurally, shows only minor epidote alteration, and generally does not contain introduced quartz or sulphides. The few shear zones are widely spaced. Quartz veins were found only on the southwest ridge of Mount Blenheim, and pyrite only at the indicated site north of Carnation Creek.

The eastern area is marked by increased shearing, by very common epidote alteration and injection, and by considerable injection of quartz and carbonate. Some slips are hematitic. Sulphides were not found.

The volcanic rocks have been intruded by three small stocks and several granitic dykes. The stocks have been only partly outlined, and their full extent is not known. The stock north of the creek is medium to coarse grained, and medium grey in colour due to the presence of considerable dark minerals. In thin section it is identified as quartz diorite. The stock on the southwest slope of Mount Blenheim is coarse grained and dark grey to black, and appears to grade from mafic quartz diorite to diorite or gabbro. The stock which forms the summit of Mount Blenheim (unit 5) is a typical quartz diorite, consisting of a framework of coarse yellowish grey (5Y 8/1) plagioclase and interstitial quartz and mafic minerals. All three stocks contain considerable magnetite; the thin section from north of the creek is estimated to contain 8 per cent combined magnetite and ilmenite. Granitic dykes intrude the volcanic rocks in all three areas, and range in width from 3 to 10 metres. The two that were examined in thin section were identified as rhyolite porphyry and rhyodacite granophyre porphyry. A few narrow aplite dykes cut the stock on the summit of Mount Blenheim.

In addition to the shear and gouge zones, the rocks are cut by gougy slips, tight slips, and joints, all with a considerable variety of attitudes and with a great range in density. The result in the road cuts is a range from large stable blocks to fine rubble with a tendency to run. The volcanic rock in the western area has developed the most fine rubble, but a small amount has also developed in broken parts of the three stocks.

At least three faults or shear zones of larger magnitude are inferred in the basin of Carnation Creek.

(1) In the central area west of the pyrite occurrence, striking northwest through the sharp bend in the 500-foot (150-metre) contour.

(2) Along the deeply incised lower course of the creek flowing off the west slope of Mount Blenheim.

(3) In the eastern area along the northeast tributary and along the course of Carnation Creek below the junction.

Some increase in the debris contributed to Carnation Creek can be anticipated from the fault and gouge zones and the fine rubble upon removal of the timber. This increase will depend greatly on the degree of disturbance of the ground surface and the consequent exposure of the soil and broken rock to stream and slope erosion.

HORNET (92C/16E)

This claim was located in 1975 by Vincent Allan to cover a newly discovered copper-bearing quartz vein on Ashburnham Creek, south of Cowichan Lake. The vein occurs at a fall in the creek about 300 metres upstream from the Honeymoon Bay water supply dam. The host rock is a grey volcanic rock of the Bonanza Formation containing common apple-green flakes and sporadic structures suggestive of volcanic fragments. It is criss-crossed by shear zones at every attitude and has evidently been crushed on a major scale. Many quartz veins have been injected, generally into the shear zones, but only one was found to contain sulphides. This vein strikes 085 degrees and dips 60 degrees south. It pinches just west of the creek, but in the east wall it widens from 10 centimetres at water level to 35 centimetres from 3 to 6 metres above. It consists of quartz, calcite, serpentine, and rock fragments, with chalcopyrite disseminated in the quartz for 4 to 10 centimetres along both walls of the vein.

From 150 to 210 metres above the fall, the creek crosses a band of mixed limestone, argillite, and calcareous argillite. It is not clear whether this is a lens within the Bonanza pyroclastic rocks or an upfolded equivalent of the Sutton limestone.

LUCKY STRIKE (92C/16W)

Ten Lucky Strike claims were located in 1974 by G. W. Horsman and partners over the west ridge and south slope of Mount Vernon to cover extensive pyrite mineralization. The rock under the west ridge is mainly white to light grey but is locally darker and appears to be an altered volcanic rock. In thin section it is seen to consist of plagioclase phenocrysts, in various stages of alteration to sericite and tremolite, set in a fine-grained felted matrix of tremolite, clinozoisite, and unaltered feldspar. Pyrite is disseminated through the rock as clots and discrete grains, generally superimposed on the other minerals. Sporadic grains of chalcopyrite accompany the pyrite in some exposures. A small body of magnetite-bearing skarn was partly exposed in the ditch of a logging road at 710 metres elevation on the south slope of the west ridge. In places chalcopyrite accompanies the magnetite. Specimens taken by the partners from farther east on this slope appear phaneritic, though altered and heavily pyritized.

The porphyritic rock probably is part of the Bonanza Formation, and the phaneritic rock may represent an intrusive phase. The alteration and especially the extensive pyritization are suggestive of a Bonanza volcanic centre, with copper mineralization possible somewhere in or adjacent to the centre.

A CLAIMS (92F/2W)

Several new showings were examined in the company of the owner, Lawrence Vezina, and were subsequently tied in to logging roads shown on aerial photographs. It is now known that the saddle in which the showings occur is between the heads of two tributaries of Cous Creek, about 1 kilometre southeast of the head of Fosseli Creek. The saddle was incorrectly identified in *Geological Fieldwork, 1974.*

A narrow band of Quatsino limestone strikes northwest under the saddle, between Karmutsen lavas on the northeast and Bonanza volcanic rocks on the southwest. In a few places Parson Bay sedimentary rocks are exposed between the Quatsino and Bonanza. The limestone pinches out to the southeast and widens on the north-facing slope. The south showing of the 1974 report now appears to be in Karmutsen lava adjacent to the limestone contact. Further stripping and blasting at this site had exposed a modest amount of additional copper mineralization. The rusty patches noted in the lava in 1974 had been blasted into and found to result mainly from weathering of ankerite; chalcopyrite appeared to be negligible.

Mr. Vezina prospected the west flank and south nose of the low ridge east of the saddle with a magnetometer and by conventional means. He found seven new showings, and had opened them up to varying degrees by rock trenching and pitting. The most northerly is a body of almost massive magnetite mid-way along the ridge flank. It contains bands and pockets of pyrrhotite with some chalcopyrite. The trench measured 3 by 5 metres, and the limits of the magnetite had not been exposed. Farther south, two pyrrhotite occurrences had been exposed, but showed only minor copper stain.

The fourth new showing is on the southeast angle of the ridge nose. A trench about 4 metres long had exposed a body of massive sulphide apparently striking southeast and dipping 43 degrees southwest. A 15-centimetre hangingwall band of massive pyrrhotite with minor chalcopyrite is underlain by at least 45 centimetres of nearly massive chalcopyrite. The hangingwall limit of the body is the local bedrock surface, and the footwall was not reached. The body has been broken and offset on small faults, and tracing of extensions would require closely spaced pits and/or drill holes.

The fifth and sixth new showings are close to the more southerly tributary of Cous Creek. One consists of pyrite and minor chalcopyrite disseminated in Karmutsen volcanic breccia, the other of pyrrhotite and less chalcopyrite and bornite blebs in a relatively coarse-grained and light-coloured rock. The seventh new showing, farther to the southeast, and three reported mineral occurrences north of the saddle were not seen by the writer.

CUP (92F/7E)

This claim was located to cover chalcopyrite mineralization found in 1975 by H. J., A. O., and D. Rodstrom while prospecting under a *Prospectors Assistance Act* grant. The showings are southwest of Parksville, at elevations of 900 to 1 000 metres on the crest and west slope of the north ridge of the hill between the heads of French and Lockwood Creeks. The host rock is a hornblende diorite which extends an unknown distance to the west, north, and east. A siliceous volcanic rock is exposed on the hill summit and part of the west slope. The contact is not exposed, but the disposition of outcrops on the west slope suggests that it may be steep.

The diorite is characterized by abundant prismatic hornblende and in part by xenoliths. The grain size ranges from fine to coarse; in some places the change is gradational, in others the fine-grained phase with its characteristic network of hornblende needles forms cognate xenoliths in a medium-grained or coarse-grained phase. Other xenoliths are clearly of volcanic origin. A few small bodies consist almost entirely of dark minerals: they are clearly not segregations *in situ* but may be xenoliths derived from the breakup of marginal segregations. In a few places the diorite texture is disordered.

The diorite is mineralized with chalcopyrite and locally pyrite and pyrrhotite. Most commonly the chalcopyrite forms discrete blebs or clots ranging from pin-head to walnut size. For the most part the blebs show no structural control, but in a few places they line up to suggest deposition along an old, healed fracture. Part of the fine-grained phase of the diorite contains finely disseminated chalcopyrite which is invisible to the unaided eye. The xenoliths are almost totally barren. The chalcopyrite is sparse overall and is irregularly distributed. One block of rock of 30-litre size may contain a dozen or more blebs and adjacent blocks of similar size may show none at all. The overall mineralization dies away down the west slope of the ridge.

The common xenoliths on the ridge would suggest a position close to the roof of the intrusion, and the chalcopyrite would appear to have been introduced into this roof zone at a relatively early stage. It is probable that the best mineralization was concentrated higher in the roof zone and has since been eroded away.

PROPERTY EXAMINATIONS
VANCOUVER ISLAND AND LOWER MAINLAND

By K. E. Northcote

During the 1975 field season several prospectors under the *Prospectors Assistance Act* were visited and a number of showings, prospects, and mining properties were examined. The most significant of these prospects and properties are briefly described below.

I, STAN, PORT HB CLAIMS (92L/8E, 9E)

The I, STAN, PORT, and HB claim groups (latitude 50° 30′, longitude 126° 06′) total 35 claims and fractions which are located on the mainland on Nelson Ridge opposite Port Neville, 14 kilometres northwesterly across Johnstone Strait from Kelsey Bay.

The claims are underlain by Karmutsen massive and amygdaloidal basalt flows which are cut by numerous basic feeder dykes. The basalts in the northern part of the claim block are intruded by bodies of quartz diorite.

Mineralization occurs in the Karmutsen flows and consists of disseminated chalcopyrite and bornite in unaltered basalt matrix, in amygdules in flow tops, and in small fractures. Better grades of mineralization are commonly accompanied by some increase in epidotization, a feature typical of mineralization in Karmutsen rocks. Slight iron staining on outcrop surfaces is the only indication of mineralization. The rock, when broken, may show malachite (rarely azurite) on former hairline fractures.

In places, copper grade is significant but to date lateral and vertical extents appear to be limited. The best assay reported to present is from an iron-stained bluff between the upper and lower adits where chip samples across 6.3 metres assayed 1.69 per cent copper.

Workings consist of two water-filled shafts, a trench, several small pits, and upper and lower adits of 21 metres and 33 metres respectively. Approximately 180 metres of diamond drilling has been done in 17 drill holes since 1970. The property has not been active since 1974.

NARVAEZ CLAIM (92F/9W)

The Narvaez claim (latitude 49° 38.2′, longitude 124° 18.5′) consists of four claim units which cover part of the former Bob and Tex groups. The claim is located 2.5 kilometres north of Mount Grant on Texada Island.

The claim is underlain by massive and amygdaloidal Karmutsen basaltic flows cut by a quartz diorite-granodiorite intrusion. Related quartz veins are concentrated in the contact zone. Although contact effects are visible in the volcanic rocks the intrusive and volcanic rocks are otherwise unaltered and unbrecciated.

Mineralization is fracture dependent with molybdenite occurring as films and small lenses in quartz veins and as films in fractures in intrusive and metavolcanic rocks. Pyrite and chalcopyrite occur in fractures and in quartz veins in metavolcanic rocks near the volcanic-intrusive contact.

OK PROPERTY (92K/2E; 92F/15E)

A brief examination of the OK property (latitude 49° 59′ to 50° 04.5′, longitude 124° 35′ to 43′) was made in company of Mr. Tom Young, an associate of the owners of the property Mr. R. Mickle and Mrs. M. V. Boylan.

A paper by W. Meyer, R. E. Gale, and A. W. Randall, for inclusion in the Charles S. Ney CIM Special Volume, gives an excellent account of the OK property. Much of the information for the following description of the property is from their paper.

The OK property consists of approximately 344 claims which are located on Bunster Hills approximately 19 kilometres by road northwest of Powell River. The property is bounded on the north by Theodosia Inlet and on the west by Okeover and Lancelot Inlets.

Mr. Mickle discovered the property in 1965 using a combination of prospecting and soil geochemistry. Since 1966, six companies have done considerable work including geological, geophysical, and geochemical surveys and approximately 14 000 metres of diamond drilling.

The area of the claims is underlain by diorite and gabbro of the Coast Plutonic Complex, cut by a composite stock 6 kilometres by 3 kilometres, which contains a dyke-like core of highly siliceous leucogranodiorite porphyry. Quartz-rich zones and quartz stockworks are associated with the younger central unit. A breccia zone was noted which consists of angular to rounded intrusive fragments in an iron-stained lithic matrix. The composite intrusive units are cut by late post-mineralization porphyritic hornblende diorite and dacite dykes ranging from a few centimetres to to several metres wide.

Strong quartz-sericite alteration in the central leucocratic porphyritic core grades outward into chlorite-epidote alteration in the granodiorite (Meyer, *et al.*).

Mineralization consists of pyrite, chalcopyrite, molybdenite, and minor magnetite in altered granodiorite peripheral to the barren leucogranodiorite porphyry (Meyer, *et al.*).

Chalcopyrite and molybdenite occur in a stockwork of quartz veins and as films in fractures. Chalcopyrite also occurs as disseminations in the rock matrix in association with mafic minerals. Reserve figures reported by Meyer, *et al.,* at a 0.20-per-cent cut-off are as follows: drill indicated 48 978 000 tonnes of 0.30 per cent copper and 0.016 per cent molybdenite; drill indicated 19 047 000 tonnes of 0.26 per cent copper and 0.02 per cent molybdenite.

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CREAM LAKE PROPERTY, STRATHCONA PARK (92F/5E)

The Cream Lake property (latitude 49° 29.25′, longitude 125° 32.25′) is located 8 kilometres south of Buttle Lake, Vancouver Island, at the headwaters of Price and Drinkwater Creeks. The main showings are on the west side of Cream Lake. Access to the property is by helicopter from Campbell River or 5 kilometres by trail from the end of a gravel road which terminates 3.2 kilometres south of Buttle Lake.

The Cream Lake property consists of approximately 180 claims of the CREAM, CROSS, PRICE, STAN, BEAR, ELK, D, E, F, H, and X groups. There are at least seven vein-shear systems known on the claims.

Massive Sulphide Zone – Upper Price Area

Numerous blocks and fragments of massive sulphide float occur on a talus slope below a cliff on Mount Septimus near the headwaters of Price Creek. The mineralization consists of massive or thin-layered extremely fine-grained pyrite and pyrrhotite (?) with some slightly coarser grained chalcopyrite. Sphalerite is also reported in similar float in the same area.

The massive sulphides occur in coarse basic fragmental volcanic rock interbedded with thin-bedded acidic tuff and cherty layers which appear to overlie Buttle Lake limestone.

Several probable sources of massive sulphides were checked by helicopter while hovering at the cliff face. One fairly local area was thought to be the most probable source.

The massive sulphide zone is not considered at this time to be as significant as the silver-gold-bearing vein-shear systems.

Vein-Shear Systems

Vein-shear systems occur west and northwest of Cream Lake in Sicker Group rocks of volcanic origin. These rocks have been cut by Karmutsen dykes and intruded by offshoots of Island Intrusions which lie at the west side of the property.

The mineralized veins or broken mineralized vein material commonly occur in *en echelon* arrangement in large shear zones or in smaller shear structures which extend for tens of metres and possibly up to 1 200 metres. It is important to note that continuity of a shear structure does not necessarily mean continuity of the vein system. Continuity of veins in this case can only be proven by assays at closely spaced intervals.

Quartz-carbonate veins were emplaced in fracture-shear systems which were loci for later shearing. Although shearing may have preceded and accompanied vein deposition, the most obvious shearing occurred after emplacement of the veins. The intensity of post-ore shearing is varied along the vein shear systems, being fairly uniform in some places and tending to pinch and swell in others. The amount of vein material and mineralization visible along the structures is also varied; commonly appearing as relatively unbroken lenses or 'horses' preserved in or adjacent to gouge. Post-vein shearing causes dilution of vein material with surrounding country rock and masks the continuity of veins except where lenses and 'horses' of vein material are visible.

The mineralogy of the veins appears to consist of pyrite, sphalerite, galena, tetrahedrite, arsenopyrite, owyheeite, and chalcopyrite in a gangue of locally intricate open space quartz vein filling associated with calcite and iron-rich carbonate.

Both gouge and vein material carry silver and gold values ranging from trace amounts to 5 100 grams per tonne silver and 18.7 grams per tonne gold for selected samples. Most of the assays listed by Cream Silver Mines Ltd. in assessment reports show significant silver and gold values. Both vein material and gouge are considered to constitute potential ore and the vein-shear systems range in thickness from a few centimetres up to 1.5 metres but are commonly between 35 to 61 centimetres wide. Assays from samples collected in September 1975 are given in the accompanying table.

ASSAYS – CREAM SILVER PROSPECT

Sample No.	Gold *ppm*	Silver *ppm*	Copper *per cent*	Lead *per cent*	Zinc *per cent*	Remarks
15955M	4.76	102	----	----	----	Cream vein Gouge and solid vein Across 1.2 metres
15956M	7.14	1706.8	0.08	1.15	1.65	Cream vein Solid vein Grab sample
15957M	7.14	7401.8	0.305	4.25	3.96	Cream vein Solid vein Grab sample
15958M	8.84	802.4	0.032	0.35	0.083	Cream vein Solid vein Grab sample
15959M	0.34	10.2	----	----	----	Cream vein Gouge and solid vein Across 30 metres
15960M	4.76	139.4	----	----	----	Cream vein Gouge and solid vein Across 1.2 metres
15961M	5.1	510	0.016	0.44	4.33	Cream vein Solid vein and gouge Across 40 centimetres
15962M	2.04	176.8	0.021	0.148	0.26	Cream vein Gouge and solid vein Across 1.2 metres
15963M	8.16	411.4	0.030	0.73	0.36	Sugar Lake vein Solid vein Grab sample
15964M	8.16	17.0	----	----	----	Hughes Elliott vein Solid vein Grab sample

KELLY CLAIM, CAYCUSE CREEK (92C/15E)

The Kelly claim (latitude 48° 48.12', longitude 124° 31.25') consists of four units staked during the 1975 field season by J. M. McNulty. The claim is located on Caycuse Creek, 13 kilometres from Nitinat Lake.

The claim is underlain by a contact zone between Island Intrusions and Karmutsen volcanic rocks and limestone. The country rocks are weakly metamorphosed and abundantly fractured and sheared with the result that bedding is obscured and the limestone appears as lenticular bodies within the volcanic rocks.

There has been massive replacement of limestone and to a lesser extent volcanic rocks by skarn which contains disseminated sulphides and randomly distributed irregular bodies of massive sulphides. The skarns are, for the most part, exposed on the north side of Caycuse River and form at least eight bodies which trend in a northeasterly direction in *en echelon* arrangement and have steep northerly dips. The bodies of skarn are commonly bounded by slip surfaces resulting in lenticular forms ranging in dimension from about a metre long and several centimetres wide to over 15 metres long and 3 metres wide.

Massive sulphide mineralization within skarn consists of pyrite, pyrrhotite (?), chalcopyrite, and minor magnetite in a gangue of garnet, epidote, ilvaite, amphibole (?), and remnant marble. A small amount of galena was seen in association with quartz and epidote in metavolcanic rocks. Assay results provided by Mr. McNulty for mineralized skarn are as follows:

No. 1 — copper,	1.38 per cent;	silver,	6.8 ppm	over 1.5+ metres
No. 2 — copper,	4.75 per cent;	silver,	6.8 ppm	over 1.2+ metres
No. 3 — copper,	4.66 per cent;	silver,	20.4 ppm	over 1.8+ metres
No. 4 — copper,	2.77 per cent;	silver,	13.6 ppm	over 1.2+ metres
No. 5 — copper,	8.61 per cent;	silver,	37.4 ppm	over 0.9+ metre
No. 6 — copper,	1.28 per cent;	silver,	6.8 ppm	over 1.5 metres
No. 7 — copper,	7.33 per cent;	silver,	30.6 ppm	over 1 metre

Additional samples have been submitted for assay.

REGIONAL SETTING OF GIANT MASCOT MINE
(92H/5W, 6E)

By Mark R. Vining
(Graduate Student, University of British Columbia)

Field mapping was carried out between American and Emory Creeks (Fig. 9) in an attempt to determine the relationship between the Spuzzum batholith and the Giant Mascot ultrabasic complex. The study will be completed as a Master of Science degree at the University of British Columbia and field costs were supported, in part, by the British Columbia Department of Mines and Petroleum Resources.

Work began in mid-June at American Creek and had been extended northward to Emory Creek by mid-September. Heavy forest cover extends to elevations of 1 430 metres, above which open areas are thickly overgrown with brush. Age relationships between the ultrabasic rocks and surrounding dioritic rocks in the Giant Mascot mine area have been the subject of study by a number of previous workers. Ultrabasic rocks and the surrounding diorites and norites in the mine area were described by Aho (1956) as being roughly contemporaneous, although they exhibit ambiguous contact relationships.

GENERAL GEOLOGY

Schist

The oldest rocks in the area are schists, which occur as xenoliths in tonalite and diorite. They are mainly pelitic schists with interbeds of calc-silicate rock and quartzite, numerous synkinematic dykes and sills of aplite, and rare ultrabasic pods. The schists contain sillimanite in contact aureoles and abundant staurolite, garnet, and kyanite away from igneous contacts. Ultrabasic pods contain directionless talc and radiating clots of acicular anthophyllite or tremolite. These rocks are tentatively correlated with the Hozameen Group by McTaggart and Thompson (1967).

Ultramafites

Aho (1956) described a suite of ultrabasic rocks on the Giant Mascot property ranging from pyroxenite at the periphery to several cores of dunite in a crudely concentrically zoned complex. All phases of the complex have varying amounts of sievy hornblende. Angular xenoliths of peridotite and pyroxenite, with sharp contacts are found in diorite, and dykes of diorite cut peridotite and pyroxenite at the perimeter of the complex. Small stocks and a sill-like mass of ultrabasic rocks intrude schists, south and east of the mine.

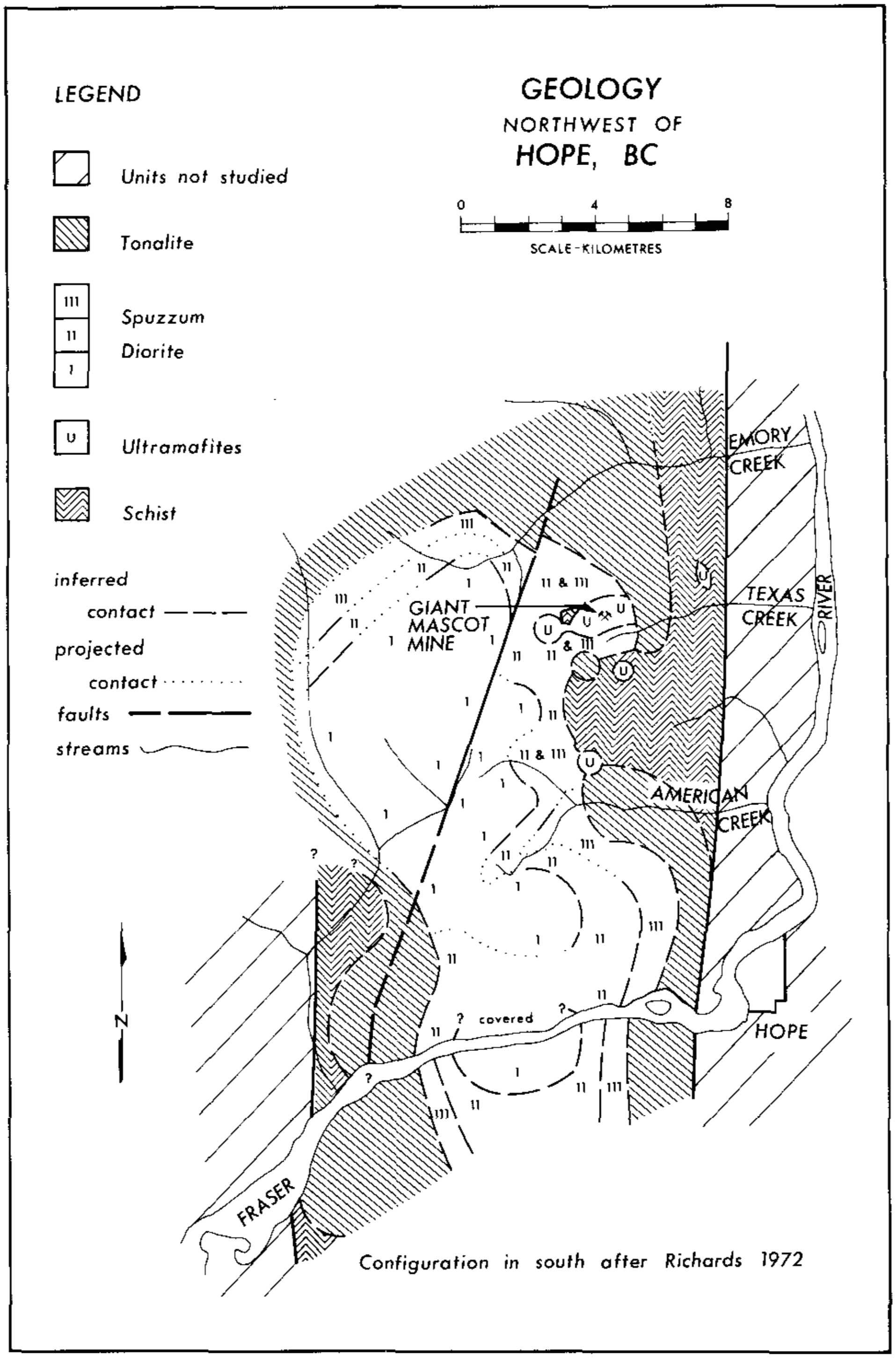

Figure 9. Geology northwest of Hope.

Hornblendite rims the complex and grades to gabbro and diorite with increasing amounts of plagioclase. Fine-grained dykes or veins of hornblendite and hornblende gabbro cut the less hydrous ultrabasic rocks. Hornblende is generally the only mafic mineral, but some dykes contain hypersthene or biotite phenocrysts. McLeod (1975) reported K-Ar ages of 95 to 119 m.y. for various ultramafites from the Giant Mascot property.

Spuzzum Diorite

A zoned suite of diorites intrudes the schists and ultramafites.

Richards (1972) described three types of diorites in the Spuzzum intrusions south of American Creek including: hypersthene-augite diorite, augite-hypersthene-hornblende diorite, and biotite-hypersthene-hornblende diorite. These three types have roughly constant proportions of hypersthene and plagioclase. Other types seen north of American Creek include: hornblende diorite, with or without biotite and with no pyroxene, hornblende diorite, with small to very large (several centimetres) euhedral crystals of hornblende in a finer grained matrix of white plagioclase which grades to a gabbro or to plagioclase-bearing hornblendite, and 'noritic' diorite in which the most common mafic mineral is hypersthene.

Foliation and lineation are common in these rocks, imparted by the alignment of plagioclase and hornblende crystals and locally by the alignment of elongate pyroxenes or biotite flakes. The structural continuity is broken near the North Fork of American Creek, and is perhaps due to a large reentrant of schist from the east.

Hornblendite Inclusions

Richards (1972) described two tpyes of ultramafic bodies, pyroxenite and hornblendite, found only in diorite. The form of these bodies is most commonly lenticular, but some hornblendite 'dykes' up to 5 feet across have sharp to gradational contacts w th diorite. The origin of both types of ultramafic bodies is attributed by Richards (1972) to metasomatic removal of SiO_2, Na_2O, and CaO by hydrothermal fluid.

Field observation during the present study suggests that their mechanism of formation is not simple. Pyroxenite bodies are of small size and occur only locally. Hornblendites in diorite are seen as irregular rounded bodies ranging in size from several centimetres to somewhat under 1 metre, in what appears to be an interconnected three dimensional net within hornblende diorite. The foliation of the diorite at a contact with hornblendite body is either truncated, somewhat contorted, or concordant, but generally rather obscure. Contacts are generally very sharp. This type of relationship may grade to another in which the hornblendite veins consist of very coarse hornblende crystals, usually with skeletal plagioclase cores, and with or without minor interstitial plagioclase. These could be termed pegmatitic hornblendite dykes or veins and are suggestive of a very volatile-rich environment. Hornblendite occurs also as narrow veins, usually under 5 centimetres, commonly associated with nearly pure plagioclase 'veins' or 'segregations.'

Tonalite

Tonalite intrudes diorite, truncating the zoning pattern in many places, and also the foliation of the diorite visibly in at least one locality (Richards, 1972). Xenoliths of granofels and hornfelsed schist occur in the tonalite. Granofels is thoroughly recrystallized, but appears more mafic than tonalite with lesser or no quartz. It is thought, therefore, to be Spuzzum diorite.

The composition of the tonalite is fairly constant and averages plagioclase, 55 to 60 per cent; quartz, 15 to 20 per cent; and hornblende plus biotite, 25 to 30 per cent. The greatest visible variation is in the ratio of hornblende to biotite, which ranges from 0.5 to 2. These rocks are quite strongly foliated and in places lineated, as expressed by the alignment of hornblende and biotite. Protoclastic textures are common. The tonalite has yielded K-Ar ages of 79, 81, 83, and 103 m.y. (Richards and White, 1970).

Late Phases

A late differentiate of the tonalite, a plagioclase-quartz-tourmaline-mica-pegmatite, fills joints in older rocks. Possibly contemporaneous with this pegmatite are quartz veins which cut most of the rock units. Lastly, a garnet-bearing, strongly foliated, leucocratic dyke-rock cuts the above-mentioned pegmatite and tonalite.

Breccias containing fragments of virtually all units older than tonalite have a fine-grained matrix of plagioclase and hornblende. The texture of the matrix appears to be metamorphic.

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IDAHO, AURUM, PIPESTEM, AND EMANCIPATION GOLD PROSPECTS

By P. A. Christopher

The Idaho, Aurum, and Pipestem gold prospect of Carolin Mines Ltd. (under option to Precambrian Shield Resources Limited and Numac Oil & Gas Ltd.) and the Emancipation gold prospect of Longbar Minerals Ltd. are situated in the Cascade Mountains of southwestern British Columbia about 17 to 20 kilometres northeast of Hope. Access is provided by a logging and mining road that heads northerly from the Coquihalla River road at about Mile 15.5 (25 kilometres from Hope). The area has rugged topography with elevations ranging from over 1 577 metres on Spider Mountain to about 364 metres in the Coquihalla River valley.

GENERAL GEOLOGY

Gold deposits occur within and ajdacent to the Coquihalla serpentine belt from Siwash Creek to just south of the Coquihalla River. The main units of interest are the Paleozoic Hozameen Group to the west, the Upper Jurassic Ladner Group to the east, and serpentinite and altered dioritic to basic bodies that occur along the Hozameen fault. The Hozameen fault is a northwesterly trending structure that appears to have a near vertical dip. The lithology of the major units in the area has been described by Monger (1970).

AURUM–IDAHO–PIPESTEM PROSPECT (92H/11W)

This prospect has recently been referred to as the Ladner Creek property of Carolin Mines Ltd. It consolidates the old Aurum, Idaho, and Pipestem gold properties with exploration directed toward large tonnage replacement deposits.

The Idaho zone, the only one of several anomalous areas explored by extensive diamond drilling (39 holes totalling about 6 700 metres), has drill indicated and geologically inferred ore reserves totalling 2,600,000 tons at better than 0.10 ounce of gold per ton (estimated by D. Cochrane for Carolin Mines Ltd. after completion of hole 33; George Cross Newsletter No. 69, 1975). The McMaster Pond zone, about 1 200 metres northwest of the Idaho zone, was located using soil geochemistry for gold and is presently undergoing further exploration.

In the Idaho zone two subparallel mineralized replacement zones strike about north 30 degrees west and dip 20 to 30 degrees northeasterly. The thickness of the zones vary but large parts of the upper zone average over 25 metres. Auriferous zones are structurally controlled replacements with albite, carbonate, pyrrhotite, arsenopyrite, pyrite, and minor chalcopyrite. The auriferous zones start about 75 to 100 metres east of faulted contact between the serpentine and Ladner Group rocks and appear to occur in coarser grained horizons.

EMANCIPATION PROSPECT (92H/6W)

Exploration of the old Emancipation prospect by Longbar Minerals Ltd. is at an early stage with surface geochemical, magnetometer, and electromagnetic surveys conducted during the past field season. Previous exploration was mainly concentrated along two north 20 degree west striking quartz veins that occur in or near the serpentinite and Ladner Group contact. The property covers several kilometres of contact between serpentinite and Ladner Group rocks that deserves further testing for auriferous replacements similar to the Idaho zones.

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GEOLOGY OF THE NICOLA GROUP SOUTH OF ALLISON LAKE (92H/10E)

By V. A. Preto

Mapping in the Nicola Belt in 1975 was continued southward from the area mapped in 1974 to the edge of the Middle Eocene Princeton Basin (Fig. 10). This part of the Nicola Group differs in many respects from areas farther north.

Structurally, the Summers Creek fault which farther north marks a sharp boundary between the Eastern and Central Belts, breaks into a number of northeasterly and northwesterly trending lesser faults in the northeastern corner of the map-area, and swings southeasterly into granitic rocks of the Okanagan Intrusions. Volcano-sedimentary rocks of the Eastern Belt are accordingly found only in the northeastern corner of the map-area, where they pinch out abruptly against faults and granitic rocks of the Okanagan Intrusions.

Similarly, the Allison fault is lost northeast of Dry Lake in an area of poor outcrop. No through-going extension of this structure can be recognized to the south along Allison Creek, though this area is characterized by a number of northwesterly trending dykes and considerable fracturing, alteration, and local faulting.

Stratigraphically, the Nicola rocks in this area exhibit more complications than farther north. South of MacKenzie Lake the basaltic and andesitic flows and associated volcano-sedimentary rocks of the Central Belt are overlain by a subaerial assemblage of rhyolitic and andesitic flows and breccias with abundant associated ash flows and laharic deposits. This succession appears to overlie unconformably both the more basic Nicola rocks and at least some phases of Allison pluton, but is in turn cut by phases of the Jurassic Okanagan Intrusions and by several other stocks. This assemblage is also locally weakly mineralized and affected by faults and alteration that do not seem to involve younger Cretaceous and Tertiary strata.

It appears therefore that this suite of acid volcanic rocks, some of which have been mapped as part of the Nicola Group and some as part of the Cretaceous Kingsvale Group (Rice, 1947) is more extensive than previously recognized and somewhat younger than the more basic Nicola strata and at least of parts of Allison pluton. This succession is provisionally considered to be of Early Jurassic age, and possibly still part of the Nicola Group, but clarification of both its age and status must await forthcoming radiometric age dates of the Allison pluton and possibly further field mapping.

The southern part of the map-area is characterized by a complex succession of basic Nicola flows, breccias, reefoid limestone, and associated volcano-sedimentary rocks that are cut by a number of small, irregular stocks of reddish granitic and syenitic rocks. Over

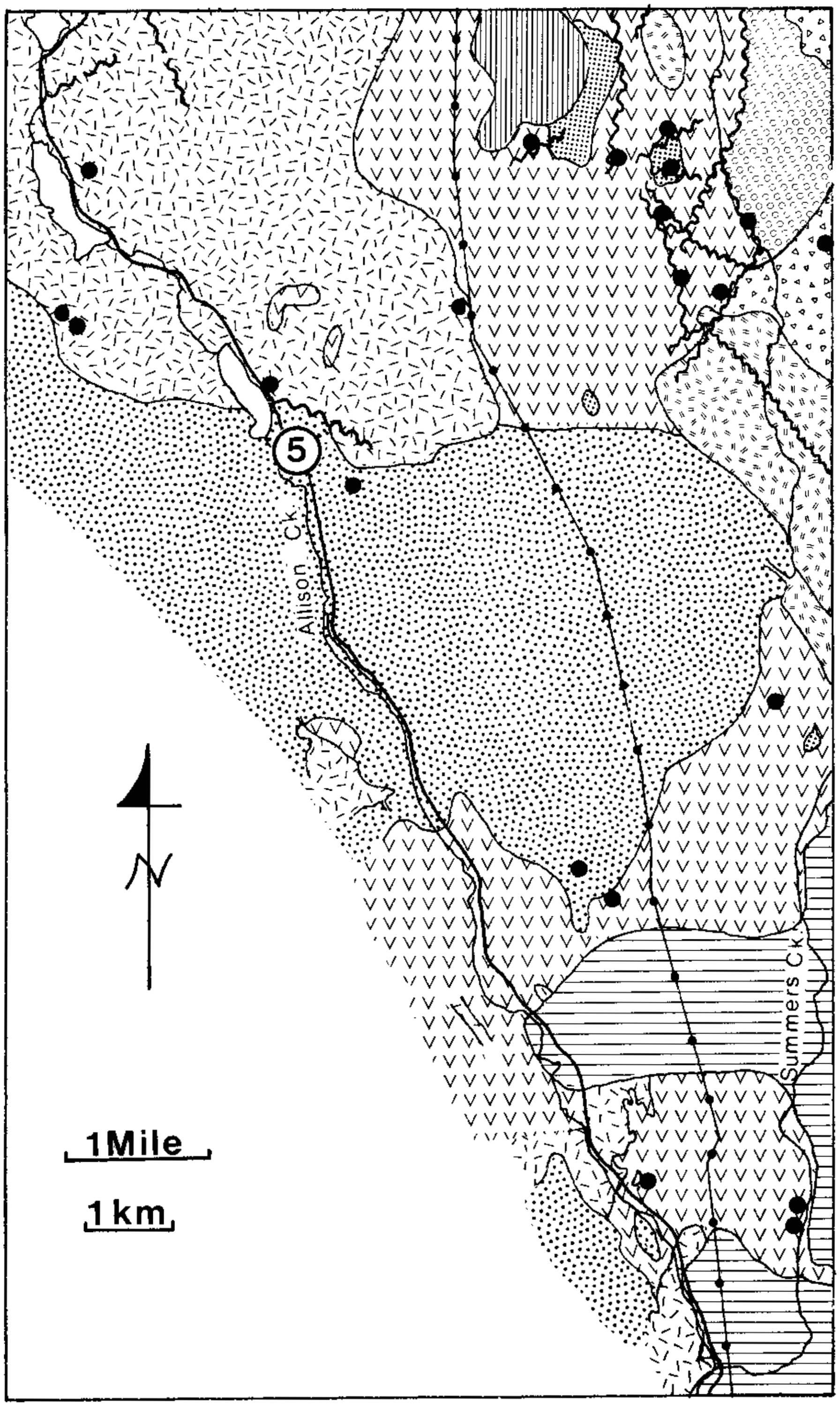

Figure 10. Generalized geology between Allison Creek and Summers Creek.

LEGEND

MIDDLE EOCENE

PRINCETON GROUP

CONGLOMERATE, SANDSTONE, SILTSTONE, AND MINOR BASALTIC FLOWS

POST–TRIASSIC

RED CONGLOMERATE, MINOR LIMESTONE

JURASSIC

OKANAGAN INTRUSIONS

GREY GRANODIORITE AND QUARTZ MONZONITE, MINOR RED AND GREY GRANITE

UPPER TRIASSIC OR LATER

ANDESITIC TO RHYOLITIC FLOWS AND BRECCIAS WITH ASSOCIATED ASH FLOWS AND LAHARIC DEPOSITS

ALLISON INTRUSIONS

GREY DIORITE, QUARTZ DIORITE, AND GRANODIORITE; RED GRANITE, QUARTZ MONZONITE, AND MINOR SYENITE

UPPER TRIASSIC

NICOLA GROUP

EASTERN BELT

VOLCANIC SANDSTONE AND SILTSTONE

AUGITE PORPHYRY FLOWS AND BRECCIAS

CENTRAL BELT

GREY DIORITE AND QUARTZ DIORITE

BASALTIC AND ANDESITIC FLOWS AND BRECCIAS WITH ASSOCIATED TUFF, VOLCANIC SEDIMENTS, AND IMPURE LIMESTONE

SYMBOLS

MINERAL SHOWINGS

FAULT

POWER TRANSMISSION LINE

most of the area, and especially near the stocks, the country rocks are strongly fractured, bleached, pyritized and silicified, and locally sheared and faulted. This fracturing and alteration are stronger along Allison Creek where most of the stocks are found, but a southern continuation of Allison fault, as indicated by previous workers (Rice, 1947), was not recognized.

Middle Eocene sedimentary and minor volcanic rocks of Princeton Basin unconformably overlie Nicola rocks to the east and south. The unconformity is well exposed in a highway cut at the junction of the Summers Creek road and Highway 5. Indication that the pre-Princeton erosion surface must have been very irregular and of considerable relief is provided by the very sinuous Princeton-Nicola contact which in three places completely straddles the high ridge between Allison Creek and Summers Creek, with no apparent evidence of post-Princeton faulting.

MINERAL DEPOSITS

Copper occurrences in the map-area are found in most rocks older than Okanagan Intrusions, but the only showings of considerable interest are those of the Axe prospect of Adonis Mines Ltd. northeast of MacKenzie Lake. The Axe showings occur on the steep west slope of Summers Creek and on the plateau to the west over an area of more than 6 square kilometres. The showings have been grouped into five zones known as the South, Main, Adit, North, and West zones, and have for the past several years been the object of extensive exploration by a number of companies. Copper and molybdenum mineralization occurs in Nicola volcanic rocks and in intrusive rocks that range in composition from mafic diorite to leucocratic quartz porphyry. All of these rocks are extensively faulted, fractured, and altered over a very large area. Rock alteration includes most assemblages that are commonly known to be associated with porphyry deposits.

Though extensive trenching and drilling have outlined several mineralized bodies of considerable proportions, exploration to date has not disclosed a body of economic size and grade.

ACKNOWLEDGMENTS

The help of P. Tremblay-Clark, M. E. Mann, and D. Calder during the 1975 field season is appreciated.

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CENTRAL AND NORTHERN BRITISH COLUMBIA

GEOLOGY OF THE MOREHEAD LAKE AREA SOUTH–CENTRAL BRITISH COLUMBIA (93A/12)

By David G. Bailey
(Graduate Student, Queen's University)

INTRODUCTION

The Morehead Lake area is situated northeast of Williams Lake in south-central British Columbia, and is accessible by road from both Williams Lake and McLeese Lake on Highway 97. The mapped area is in the central part of the Quesnel Trough at its narrowest part, and is underlain dominantly by Mesozoic volcanic rocks and their epiclastic derivatives. This research will be completed as a Ph.D. thesis at Queen's University and has been, in part, supported by the British Columbia Department of Mines and Petroleum Resources. Its aim is to define the petrochemical nature and stratigraphic relations of the volcanic and related rocks, and in particular their relationship to copper deposits in the area. This report summarizes the preliminary results of three months fieldwork carried out during the summer of 1975.

STRATIGRAPHY

On a gross scale the map-area (Fig. 11) can be divided by a northwest-trending lineament whose axis runs immediately east of Morehead and Bootjack Lakes; in general the section on each side dips and youngs toward this central lineament.

The oldest rocks, and also the most distal to the volcanic pile, are mainly calcareous argillites, sandstones, and conglomerates. This unit (Unit A) becomes more volcaniclastic in composition toward the top, and is probably of Norian age as it appears to overlie Karnian rocks to the southwest, outside the map-area. The nature of the contact with the Karnian rocks is not known, but the unit is at least as old as Early Jurassic as fossils of this age were found in stratigraphically higher formations. In the eastern part of the map-area, conglomerates of Unit A contain clasts of calcareous argillite, sandstone, chert, quartz, and minor basic volcanic rocks, and are thought to have been derived from the Upper Paleozoic Cache Creek Group.

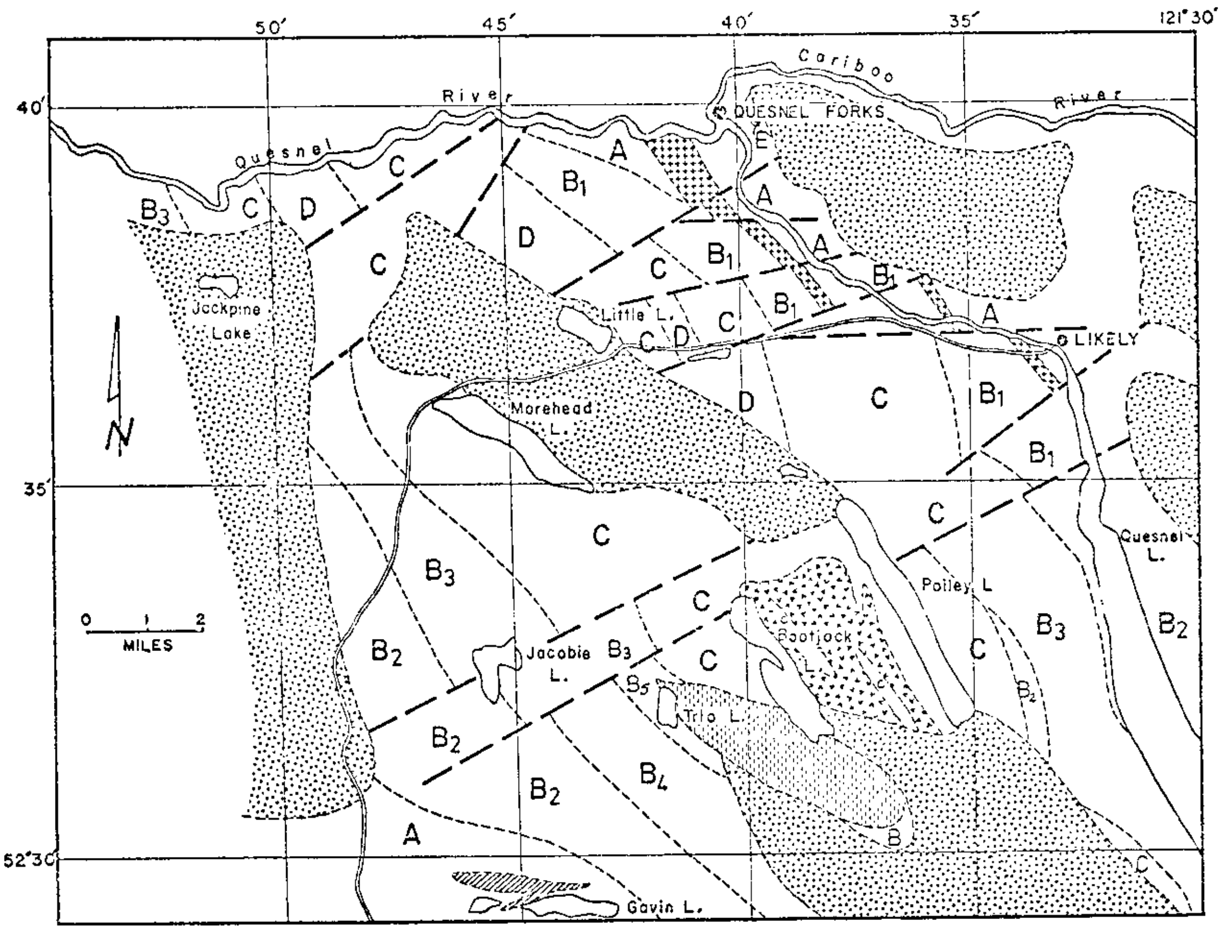

Figure 11. Generalized geology of the Morehead Lake area.

SEDIMENTARY AND VOLCANIC ROCKS

PLEISTOCENE

- GLACIAL, FLUVIOGLACIAL, AND FLUVIAL GRAVELS

CRETACEOUS (?)

- E — QUARTZOFELDSPATHIC GRITS AND SANDSTONES

MIDDLE JURASSIC (?)

LOWER JURASSIC

- D — MAROON TRACHYBASALT FLOWS AND BRECCIAS, GENERALLY ANALCITE BEARING

HETTANGIAN

- C — POLYLITHOLOGIC VOLCANIC BRECCIAS, CONGLOMERATES, SANDSTONES, MINOR LIMESTONE
- B_5 — HORNBLENDE–PYROXENE BASALT FLOWS AND BRECCIA
- B_4 — PYROXENE BASALT SLUMP BRECCIAS
- B_3 — MAROON PYROXENE BASALT FLOWS AND BRECCIA, LOCALLY ANALCITE BEARING

——— ? —— ? ——

- B_2 — GREEN AND GREY PYROXENE BASALT PILLOW LAVAS AND BRECCIAS, LOCALLY ANALCITE BEARING
- B_1 — GREEN AND GREY PYROXENE HORNBLENDE BASALT BRECCIA AND HORNBLENDE ANDESITE BRECCIA

NORIAN (?)

UPPER TRIASSIC (?)

- A — DARK GREY CALCAREOUS CONGLOMERATES, SANDSTONES, AND ARGILLITES, VOLCANICLASTIC TOWARD TOP

INTRUSIVE ROCKS

- **GAVIN LAKE STOCK** – QUARTZ MONZONITE
- **BOOTJACK STOCK** – MEDIUM TO COARSE–GRAINED LIGHT GREY NEPHELINE SYENITE
- **MOUNT POLLEY STOCK** – FINE TO MEDIUM–GRAINED SYENITE, MONZONITE, AND DIORITE
- FINE TO MEDIUM–GRAINED HORNBLENDE DIORITE AND MONZONITE

SYMBOLS

- GEOLOGICAL CONTACT
- FAULT
- MAIN ROAD

Overlying Unit A in the west are green and grey pyroxene and pyroxene-plagioclase porphyritic basalts (Unit B) which grade up into maroon amygdaloidal basalts (Unit B_3). Unit B_3 locally contains analcite-bearing basalts. The basalts of Unit B_2 are pillow lavas and pillow breccias; these overlie volcaniclastic sedimentary rocks at the top of Unit A which are similar in composition to the basal basalts of Unit B_2. The upper part of Unit A, then, represents a gradational phase from non-volcaniclastic sedimentary rocks lower in Unit A to non-reworked volcanic rocks of Unit B_2 above.

In the eastern part of the map-area hornblende and pyroxene-hornblende andesites and basalts (Unit B_1) overlie Unit A. These volcanic rocks grade into pyroxene basalts similar to those in the west.

West of Trio Lake, a sequence of polylithologic basic breccias (Unit B_4) underlies hornblende-pyroxene and pyroxene basalts (Unit B_5).

A thick sequence of polylithologic laharic breccias (Unit C) overlies the basic volcanic rocks of Units B_1 to B_5 and commonly contains clasts of syenite, monzonite, diorite, and extrusive equivalents as well as abundant clasts derived from the underlying basalts. Felsic sandstones and conglomerates, often highly calcareous, are locally intercalated within the laharic breccias and, at Morehead Lake, are associated with a massive, grey limestone lens. Although no quantitative data is available, field observations indicate that the abundance of felsic clasts in polylithologic breccias is greater in the vicinity of felsic intrusions.

Toward the top of Unit C, lenses of calcareous sandstone, mudstone, and grit contain pelecypods, brachiopods, ammonites, solitary corals, and plant debris. These rocks are thought to be Hettangian in age based on the tentative identification of the ammonite *Psiloceras canadense* (T. Poulton, 1975, personal communication), an Upper Hettangian index fossil (Frebold, 1967).

Maroon analcite-pyroxene basalts (Unit D) overlie Unit C. These flows were deposited during a late phase of basaltic eruptive activity and may possibly be Sinemurian in age.

The youngest Mesozoic rocks in the map-area are found in a small outcrop near Quesnel Forks and consist of quartzofeldspathic sandstones and grits (Unit E). The composition of this unit and the marked angular unconformity between it and the underlying rocks suggest that the rocks may be of Cretaceous or Early Tertiary age.

INTRUSIVE ROCKS

Probably the oldest intrusive rocks in the map-area are hornblende monzonites and diorites which are similar mineralogically to the hornblende andesites of Unit B, which they intrude. A large body of this rock crops out along the Quesnel River from Likely to near Quesnel Forks. It is partly sill-like, and partly exhibits crosscutting relations to the intruded rocks.

A second type of intrusion, mainly syenitic and monzonitic in composition, is represented by the Mount Polley stock. Syenitic dyke material from the Cariboo-Bell copper deposit, which lies within this stock, yielded a K-Ar age of 184±5 m.y. (Hodgson, *et al.,* in preparation). The intrusion is a dyke complex rather than a stock, and several phases of felsic intrusion can be recognized. Intrusive breccias occur locally within this complex.

Syenites similar in composition to those in the Mount Polley stock form a small dyke complex at Morehead Lake, a small stock on Morehead Creek north of Morehead Lake, and a stock to the south of Polley Lake. All these intrusions are considered to have been emplaced during an Early Jurassic magmatic event and solidified at subvolcanic levels.

Another complex of quartz monzonite dykes, called here the Gavin Lake stock, occurs in the south of the map-area next to Gavin Lake. This stock is possibly of Late Jurassic or Cretaceous age.

A relatively homogeneous body of coarse-grained nepheline syenite, in places orbicular in texture, occurs at Bootjack Lake, west of the Mount Polley stock. The age of this stock is unknown, but it is a possibility that it is younger than the alkalic rocks of the Mount Polley stock. No nepheline syenite clasts have been recognized in the younger breccias, which contain representatives of all other Lower Jurassic igneous rock types in the area, suggesting that it was at least unroofed after the deposition of all volcanic and epiclastic rocks. The stock is elongate in a northwesterly direction, in contrast to the dominantly north-trending dykes of the Mount Polley intrusive complex.

Numerous small plugs of hornblende monzonite cut all extrusive rock types and may be of Cretaceous age. These, and granite dykes throughout the map-area, probably were emplaced in a Late Mesozoic magmatic event.

STRUCTURE

The extensional tectonism of the island arc environment and the relatively mechanically homogeneous character of the volcanic rock section have resulted in block faulting rather than folding. A northwest-trending lineament along which all alkalic intrusions occur from Canim Lake in the south, through the Morehead Lake area, to Prince George in the north, is recognized regionally as a major fault system. A cover of Pleistocene gravels and a paucity of outcrop have prevented the recognition of northwest-striking faults where the lineament crosses the map-area, although a lineament can be implied from the alignment of alkalic intrusions.

Northeast-trending faults have broken the map-area into a number of small blocks which show varying degrees of uplift relative to one another. These faults may extend into the Shuswap metamorphic terrane to the east where a number of northeast-trending faults have been recognized (Campbell, 1961; Campbell, *et al.,* 1970).

Folded rocks are uncommon within most of the map-area. A sedimentary section north of Morehead Lake has been faulted and folded, but the lack of penetrative deformation, the presence of 'rip-up' textures, and small-scale stratal displacement suggest that the folding was the result of slumping of semi, or unconsolidated sediments, probably as a consequence of fault movement at the time of volcanism and sedimentation. Fold axes trend northwest, parallel to the regional strike of the rocks.

Rocks of Unit A are highly folded near Quesnel Forks and there is some development of an axial plane cleavage. This deformation extends eastward and is probably the result of tectonism affecting the Shuswap rocks as well as the eastern edge of the Mesozoic Quesnel Trough.

MINERAL OCCURRENCES

Copper is the dominant base metal found in the map-area. Five types of copper deposits have been recognized.

(1) *Alkalic Porphyry Deposits:* Two copper deposits of this type occur within the map-area, Cariboo Bell and a small showing on Morehead Creek north of Morehead Lake. Cariboo Bell comprises three copper zones on Mount Polley. The copper occurs in syenitic and monzonitic dykes, in highly potassium metasomatized extrusive felsic breccias, and in intrusive breccias. Chalcopyrite is the dominant copper sulphide. Wallrock alteration includes a zone of zeolitization closely associated with the copper mineralization, and which is partly surrounded by and partly contiguous with a pyrite zone. Secondary magnetite is ubiquitous and epidote is a common alteration mineral near the copper occurrences.

The copper occurrence on Morehead Creek is located within a monzonite plug and in felsic breccias which the plug intrudes. Epidote and calcite are common alteration minerals, but the relation of alteration to copper occurrences is not known because of the very small amount of copper observed and the limited exposure.

(2) *Stratiform Deposits:* One example of an apparent stratiform deposit is present within the map-area. Near Morehead Lake, chalcocite is found within horizons of felsic sandstone stratigraphically above a carbonate unit. Chalcopyrite and chalcocite are also present within the limestone and in rocks stratigraphically below the limestone. The deposits are non-pyritic and non-magnetic and there is little or no metasomatic alteration of the rocks. The copper may be genetically related to a number of pink syenite dykes which cut all sedimentary rock types.

(3) *Copper Associated with Amygdaloidal Basalts:* Occurring as infillings of vesicles in maroon basalt flows and breccia, copper carbonates and minor copper sulphides are found in a northwest-trending belt from south of Bootjack Lake to northwest of Morehead Lake. Copper occurrences are very small and erratic in distribution within the belt, and are probably syngenetic with the basalt.

(4) *Copper in Hornblende Diorites and Monzonites:* The diorite-monzonite complex stretching from Likely to west of Quesnel Forks contains numerous minor showings of chalcopyrite. Chloritic alteration of the intrusive and intruded rocks is common and a large pyritic zone, increasing in intensity northward, is apparent in the area.

(5) *Copper and Molybdenum in Quartz Monzonite:* The Gavin Lake stock is a calc-alkalic quartz monzonite intrusion containing minor chalcopyrite and molybdenite. The stock comprises a number of quartz monzonite dykes which intrude argillites and sandstones. A small pyritic envelope surrounds, and is partly contiguous with, the zone of quartz monzonite intrusions.

Other Mineral Occurrences: Native copper is present in small quantities in some felsic dykes such as those about 1.5 kilometres east of Little Lake.

Economic deposits of placer gold occur along the Cariboo and Quesnel Rivers.

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NORTH–CENTRAL BRITISH COLUMBIA

By T. G. Schroeter

A number of visits were made to current exploration projects throughout northern British Columbia. Following are brief descriptions of the more important exploration properties visited during 1975.

DECEPTION LAKE (93L/10E)

During March of 1975, Sumac Mines Ltd. diamond drilled four holes totalling 582 metres on the north side of Deception Lake located approximately 32 kilometres east-southeast of Smithers. There is very little outcrop in the area. An airborne geophysical survey and a subsequent follow-up ground induced polarization survey delineated an east-west anomalous zone across Deception Lake. Drilling indicated that the induced polarization response was due to graphitic and pyritic rocks of the Hazelton Group which also consist of well-bedded greywacke, fossiliferous argillite, and fragmental maroon and green volcanic rocks.

CRONIN MINE (93L/15W)

The Cronin silver-lead-zinc-gold-cadmium property is located in the Babine Range approximately 30 kilometres northeast of Smithers. Coca Metals Ltd., under an option agreement with Hallmark Resources Ltd., completed surface and underground geological mapping and surveying prior to surface diamond drilling of 10 holes totalling 1 530.5 metres. The holes were planned to test the open-pit potential of the 'Upper Showing' as well as to give some information on the vein system. A complex sequence of rhyolitic and sedimentary rocks was encountered in the drilling. There appears to be at least two main phases of rhyolite including a rhyolite porphyry with distinct quartz eyes and an aphanitic rhyolite. Mineralized sections consisting of galena and sphalerite in the rhyolitic rocks appears to be associated with quartz veining rather than occurring as disseminations, although pyrite does occur disseminated throughout the rhyolites. Sedimentary rocks include argillite pebble conglomerate and possibly silicified dust tuffs.

Metamorphism has affected both the rhyolites and the sedimentary rocks. The rhyolites have been saussuritized and pebbles in conglomerate have been strewn out.

REFERENCES

B.C. Dept. of Mines & Pet. Res., Geological Fieldwork, 1974, p. 81; GEM, 1973, pp. 347, 348.

Minister of Mines, B.C., Ann. Rept., 1949, pp. 94-98.

BIG ONION (93L/15W)

The Big Onion porphyry copper prospect is located 20 kilometres east of Smithers on Astlais Mountain. Under a continuing option agreement with Twin Peak Resources Ltd., Canadian Superior Exploration Limited completed 57 vertical percussion drill holes totalling 3 023 metres as well as three diamond-drill holes.

Old roads and access trails were cleaned up to permit access for the drills. Detailed geological mapping and rock geochemistry were carried out. An elongate, highly altered and pyritized zone along Astlais Creek exsits in and around two dyke-like masses of quartz feldspar porphyry and quartz diorite. The quartz diorite is largely enveloped by leucocratic quartz feldspar porphyry and both masses cut Hazelton Group andesitic rocks.

Copper and molybdenum mineralization appears to be intimately associated with the quartz diorite and is best developed along its sheared southeastern contact with andesite.

Leaching is locally so intense that mineralized zones may have little or no surface expression.

REFERENCES

B.C. Dept. of Mines & Pet Res., Geological Fieldwork, 1974, p. 80.

Minister of Mines, B.C., Ann. Rept., 1966, pp. 83-86.

DEN (93M/6E)

The Denison Creek porphyry copper-molybdenum prospect is located on the western flank of Mount Thoen in the Babine Range approximately 64 kilometres north of Smithers. Cities Service Minerals Corporation conducted a small diamond-drill program consisting of five holes totalling approximately 823 metres. Previous work on the property was carried out by Falconbridge Nickel Mines Limited in 1965 (including five diamond-drill holes), Highland Bell Mines in 1968, and reconnaissance by Cities Service Minerals Corporation in 1974.

The host rock is part of the large Mount Thoen stock (approximately 9 kilometres by 3 kilometres) which is composed of both biotite-hornblende granodiorite and porphyritic quartz monzonite. The stock has intruded and hornfelsed greywacke and shales which dip gently outward from the contact.

Diamond drilling was carried out to test an east-west linear zone of fracturing containing chalcopyrite mineralization. The entire area is geochemically anomalous in copper. Chalcopyrite, molybdenite, and pyrite occur in quartz veinlets while pyrite and chalcopyrite also occur as disseminations within intrusive and hornfelsed rocks.

Alteration of the host quartz monzonite includes chloritization of mafic minerals, clay alteration of feldspars, and minor sericitization and weak silicification.

REFERENCE

Assessment Report 793.

TOODOGGONE RIVER AREA

A five-day visit was made to the Chappelle and Lawyers properties in the Toodoggone River area approximately 30 kilometres northwest of the north end of Thutade Lake. Access is by fixed-wing aircraft to the Black Lake airstrip which is capable of accommodating DC-3's, and thence by helicopter from the airstrip.

Chappelle (94E/6E)

At the Chappelle gold-silver property Dupont of Canada Exploration Limited, under a continuing option agreement with Kennco Explorations, (Western) Limited, carried out extensive surface diamond drilling to further test the main vein (Vein 'A') prior to a proposed underground exploration programme.

The 1974 diamond-drill programme, consisting of 2 267 metres in 20 holes, further delineated the known quartz vein(s). Vein 'A' has been traced on surface for a length of 200 metres and has an average width of 3 metres. Surface diamond drilling during 1974 and 1975 has outlined a vein length of 330 metres with an average width of 3 metres.

During 1975, 14 diamond-drill holes (NQ and BQ size) totalling approximately 1 830 metres were drilled on Vein 'A' to test its southwestern extension as well as its character at depth.

Extensive block faulting has occurred within the vein system. Mineralization consists of pyrite, electrum, argentite, and chalcopyrite in a vuggy quartz host.

Six short (60 metres each) diamond-drill holes were put into the North Quartz vein located approximately 1.2 kilometres northeast of Vein 'A.' Mineralization consists of sphalerite, galena, chalcopyrite, and argentite in a quartz host.

Two short holes were drilled on the West Chappelle vein.

References

Assessment Reports 2581, 2819, 3171, 3198, 3343, 3367, 3417, 3418. 3419, 4066, 5268.

B.C. Dept. of Mines & Pet. Res., GEM, 1970, p. 188; 1971, pp. 65-70; 1972, p. 484; 1973, pp. 458-460; 1974, 312.

Lawyers (94D/6E)

The Lawyers gold-silver property is located approximately 7 kilometres northwest of the Chappelle property. During 1974, Kennco Explorations, (Western) Limited diamond drilled four holes totalling 610 metres to test an area containing low-grade silver-gold geochemical anomalies. Three trenches exposed a mineralized zone 180 metres by 15 metres (the Amethyst Gold Breccia Zone). Drilling confirmed the existence of fine-grained argentite, native silver, and electrum in quartz-amethyst veins within a trachyte porphyry, part of the Toodoggone volcanic rocks. During 1975, Kennco diamond drilled five holes totalling 540 metres to further test geochemical anomalies. Mercury soil analyses in the field helped define anomalies and drill targets.

The host trachyte porphyry has a reddish brown to chocolate brown fine-grained groundmass with 2 to 3-millimetre phenocrysts of orange to pink euhedral orthoclase (10 per cent by volume). Hornblende (2 per cent by volume) and biotite (trace) comprise the mafic minerals in the rock. Specularite is ubiquitous in the 'orange' variety of trachyte porphyry while magnetite is more prominent in the 'green' variety. Pyrite is almost entirely absent. Numerous narrow (2-millimetre) quartz seamlets spaced at 15 to 30-millimetre intervals traverse the porphyry. Intense silicification is seen as older cloudy quartz-amethyst open space filling in seamlets and as infilling along narrow brecciated fractures. Younger quartz-carbonate veins cut quartz-amethyst veins. Limonite is prevalent in fracture zones. A complex sequence of acid volcanic rocks was also encountered in drilling. Zeolite alteration (laumontite) is common.

One diamond-drill hole with a length of 60 metres was drilled on Kennco's Cliff Creek Breccia Zone located approximately 2 kilometres southwest of the Amethyst Gold Breccia Zone. Six trenches had previously uncovered a mineralized zone over 915 metres in length, similar to that of the Amethyst Gold Breccia Zone. In contrast, this zone contains a much greater percentage of pyrite.

References

Assessment Reports 2822, 3314, 3315, 3362, 3366, 3416, 3837, 3841, 4065, 5106, 5167.

B.C. Dept. of Mines & Pet. Res., GEM, 1970, p. 187; 1971, p. 70; 1972, p. 481; 1973, pp. 460, 461; 1974, p. 312.

WEST–CENTRAL BRITISH COLUMBIA

BABE GOLD PROSPECT
QUEEN CHARLOTTE ISLANDS
(103F/9E)

By A. Sutherland Brown and T. G. Schroeter

The Babe prospect, that now consists of approximately 102 claims and fractions including BABE, RIC, and BEE, was visited independently by the writers for brief visits. The showings are on a hill overlooking the lowlands of the Yakoun River, 17.6 kilometres south of Port Clements.

It was discovered by Efrem Specogna and Johnny Trico while prospecting along the trace of the Sandspit fault zone. They were attracted to the locality by a visible jarositic-coated bluff in which veins were visible but sulphides were sparse. Fortunately, they sampled veins and wallrocks which had some gold values. They located the property in 1971 and optioned it first to Kennco Explorations, (Western) Limited who conducted silt and soil surveys and geological mapping, and drilled two packsack diamond-drill holes totalling 55.2 metres. The geochemical surveys (Assessment Reports 2890 and 3517) reveal a considerable mercury anomaly as well as weak gold and arsenic anomalies of crudely annular shape. Since the Kennco work the property has been optioned repeatedly – to Cominco Ltd., Canex Placer Limited, Silver Standard Mines Limited, and from the latter to Quintana Minerals Corporation. In 1972 Cominco drilled nine holes shown on Figure 12, totalling 500 metres. Quintanna drilled four packsack diamond-drill holes totalling 57 metres and 16 percussion holes totalling 623 metres in 1974 (Assessment Report 5284) and also undertook a considerable program in 1975.

REGIONAL GEOLOGY

The Babe property is situated at the boundary between the Skidegate Plateau and the Charlotte Lowlands – the locus of the Sandspit fault. The precise location of the main strand of the fault is not obvious in the vicinity of the property. West of the fault is an area underlain by gently west-dipping rhyolite ash flows of the basal Masset Formation of Early Tertiary age, which unconformably overlie folded argillites of the Queen Charlotte Group of Cretaceous age. East of the main strand of the fault is a lowland largely covered by Pleistocene and Recent deposits with some exposures of poorly consolidated sands of Mio-Pliocene Skonun Formation along the Yakoun River.

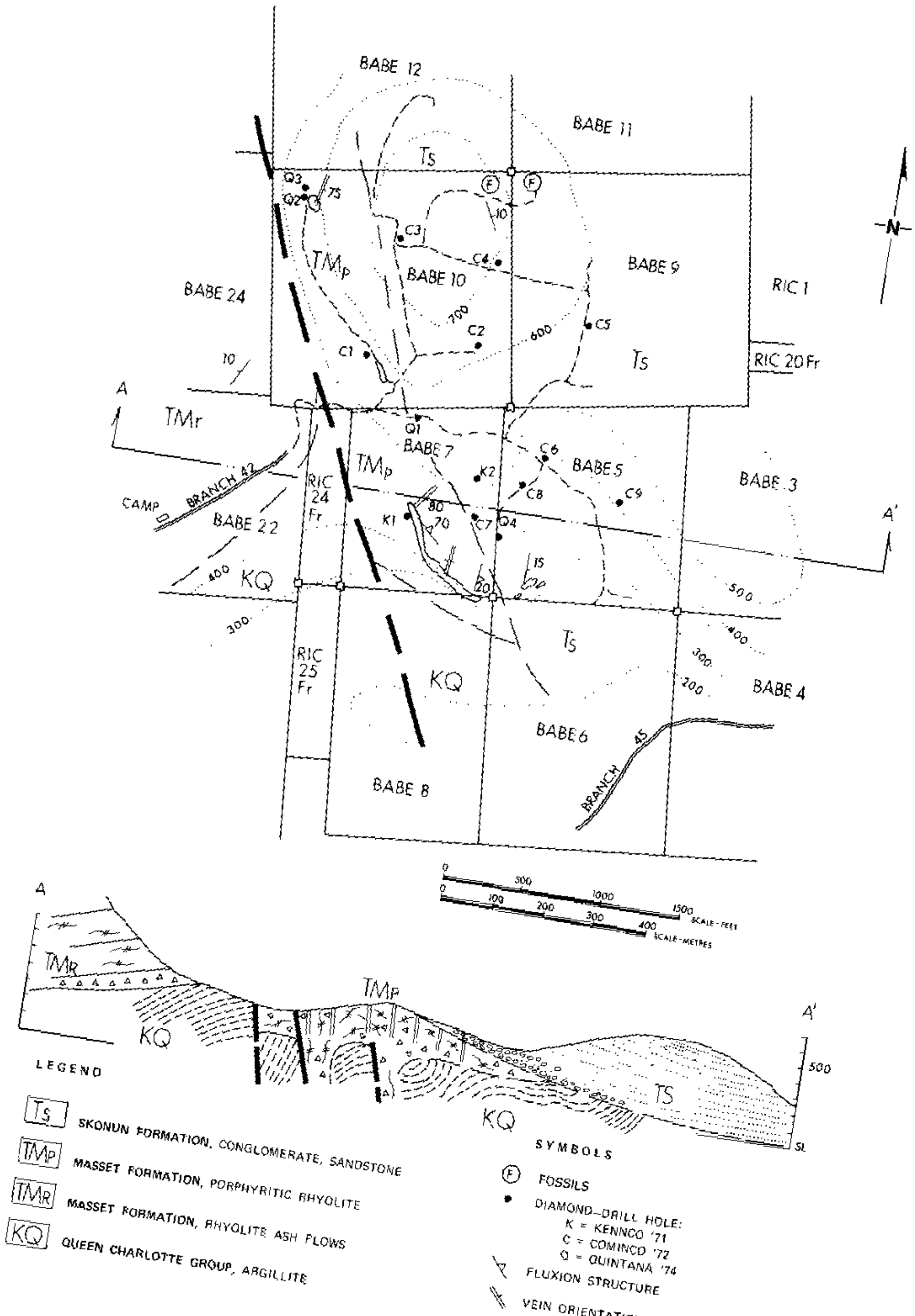

Figure 12. Geological sketch map and section, Babe gold prospect.

GEOLOGY OF THE CORE CLAIMS

The units previously described all occur within the core of the Babe claims shown on Figure 12. Outcrop is sparse in hills east of the scarp of Masset Formation, and virtually non-existent in the lowlands. Exposure on the well-forested hills is limited to the bluff along which a trench has been blasted south of Kennco DDH 1, some bulldozed trenches, and rare natural outcrops. No drill core was available for either writer to see.

The bluff outcrop is freshly exposed and is the most revealing exposure of the rhyolite porphyry body within which the deposit occurs. The exposure on the Babe 7 claim is about 210 metres long and the rhyolite here exhibits a highly varied character. The least modified rock is a very fine-grained porphyritic rhyolite which is composed of about 5 per cent phenocrysts of partly resorbed quartz up to 4 millimetres in diameter together with fewer and smaller, completely kaolinized and silicified feldspars. Primary fluxion structures are evident in some specimens which resemble the eutaxitic textures of collapsed pumice fragments in ash flows. These laminae now consist of streaks of fine mosaic quartz. Commonly the rhyolite porphyry is brecciated with fragments as large as 15 centimetres across contained in a white to black siliceous matrix. Exotic fragments of argillite or charred wood may be present and even abundant.

Along the bluff most of the rhyolite is brecciated, and exhibits both primary and secondary fluxion structures in fine breccia. In general primary fluxion structures are oriented northwestward and dip steeply, but at the southeast end of the bluff they strike northward and dip about 20 degrees eastward. In this vicinity there are abundant flattened clasts of wood that have been charred in place and infilled on dessication by cherty mosaic quartz. Throughout the length of this trench there are numerous multiple quartz veins that strike northward and dip steeply. These veins are true fissures up to 1 metre wide with outer white crystalline quartz and inner cherty quartz that exhibits cockade structure and patterned combs coated with spongy chalcedony. The lineations of the patterns in the comb structures tend to be either vertically or horizontally oriented. Relatively minor sulphides occur in the veins but adjacent silicified breccias particularly the dark matrix breccias carry fine pyrite and marcasite. In addition to the major veins a fine quartz stockwork is commonly evident that merges in places into zones of complete silicification. Gold mineralization is not visible but is present principally in the dark silicified breccias where it occurs with marcasite rather than within the veins.

To the northwest a few exposures of porphyritic rhyolite occur. The largest outcrop, called the Marino showing by Specogna, is at the northwest part of the Babe 10 claim. Here buff-coloured, rusty weathering rhyolite porphyry that is relatively unsilicified or textured is cut by a stockwork of very fine cherty quartz veinlets. The larger veinlets are commonly about 2 centimetres wide and these strike north 20 degrees east and dip about 75 degrees eastward. Smaller veinlets are randomly oriented. The main stockwork veinlets have margins of fine sugary quartz that have visible fine spongy gold in interstices. The inner part of the vein consists of fine clear quartz some of which is chalcedonic.

On the Babe 5 claim nearly 100 metres to the east of the end of the bluff trench are some other blasted outcrops that superficially resemble the rhyolite since they consist largely of clasts of rhyolite, many of which however are rounded. The rocks are crudely bedded, striking northward and dipping 15 to 20 degrees to the east. They may be compact with the clasts cemented with silica or very much less lithified. Exotic granitic clasts as well as argillite occur. Veinlets are very rare and appear to be mostly chalcedonic. No large multiple veins were observed. Cubic pyrite grains up to 2 millimetres on an edge are relatively common in the siliceous matrix and as replacements of certain clasts. The writer interprets these rocks as belonging to the Skonun Formation.

Along strike on the hilltop scattered outcrops and trenches expose siliceous sandstones identical in petrographic character to those of the Skonun Formation at the type locality although they have a siliceous matrix. In a number of localities these contain casts of clams mixed with leaf fossils that resemble alder leaves. Good specimens could not be collected but the assemblage closely resembled those typical of the Skonun Formation (Sutherland Brown, 1968, pp. 118-127). Rare small cherty veins occur in these sandstones.

TENOR OF MINERALIZATION

The mineralization observed has been described previously with the rocks. In the bluff area mineralization is contained within the brecciated wallrocks. It is highly variable in tenor, ranging from trace to 50.7 ppm gold and 245 ppm silver in selected samples by the writers. At the Marino showing where the wallrock is virtually barren, Specogna has hand-cobbed vein material and shipped it to the Tacoma smelter. One shipment this year of selected vein material weighing 0.59 tonne assayed: gold, 559.3 ppm; silver, 228.5 ppm. Another weighing 2.43 tonnes assayed: gold, 115.6 ppm; silver, 51.68 ppm.

CONCLUSION

The Babe prospect is of interest from several aspects. The structural section shown on Figure 12 is the writers' interpretation. In our view the rhyolite porphyry and breccia is part of the Masset Formation of Paleocene age that formed a flow dome at the base of the unit and which is consanguineous with the rhyolite ash flows in the scarp to the plateau to the west.

The Skonun Formation onlapped the eroded flow dome at some later date. The age of mineralization appears to predate the Skonun onlap but it is not known whether it is closely related to the rhyolitic volcanism, or is younger, perhaps related to siliceous hotsprings emerging from the regional fault. Some geologists feel that the rhyolite breccia intrudes the Skonun Formation. If this is the case the Babe prospect represents one of the youngest mineralizing events known in the Province.

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NORTHWEST BRITISH COLUMBIA

PROPERTY EXAMINATIONS AND CONTINUING STUDIES

By A. Panteleyev

BALL CREEK (ME, ROG, TARA, MENT) (104G/8W)

The Ball Creek property of Great Plains Development Company of Canada, Ltd., formerly known as MARY (1963) and GREG (1970) claims, is a low-grade polymetallic copper-gold-silver-molybdenum prospect. The area is underlain by volcanic and sedimentary rocks of probable Upper Triassic age and is intruded by numerous feldspar porphyry and felsite dykes and possibly small stocks. Sulphide minerals are associated with these subvolcanic feldspar porphyry and felsite intrusions. Disseminated and fracture-controlled pyrite is widespread and pyritic quartz stockworks are developed locally. Rare molybdenite and traces of secondary copper minerals can be seen in highly oxidized outcrops.

The Ball Creek prospect is a porphyry-type deposit and is somewhat similar in geologic setting, rock types, and style of mineralization to the WINDY, RED, SUS, CHRIS deposit near Ealue Lake (GEM, 1972, pp. 535-537; 1974, p. 340-343).

GEOCHEMISTRY AND AGE OF KAKETSA STOCK (104J/4W)

Fifty samples (mainly hornblende quartz diorite) collected from the Kaketsa stock in 1974 (*Geological Fieldwork,* 1974, pp. 63-68) are being analysed for 14 major oxide and 15 minor elements. Analytical results are being treated by various univariate and multivariate statistical procedures in cooperation with W. J. McMillan and A. F. Bowman. Comparisons of geochemical data are being made with Guichon Creek batholith as part of an ongoing study to define geochemical criteria for distinguishing potentially productive stocks from barren ones.

Radiometric dating by the potassium-argon method establishes a Middle Triassic age of intrusion for the Kaketsa stock. Hornblende from quartz diorite was dated at 218±8 million years (GEM, 1972, p. 548). Biotite from a similar rock has now been determined to be 214±6 million years in age. The stock cuts and metamorphoses volcanic rocks of the Stuhini Group. Therefore, concordant Middle Triassic radiometric dates for the stock indicate that at least part of the Stuhini Group is older than Upper Triassic.

K-Ar ANALYTICAL DATA

(J. Harakal, Analyst, University of British Columbia)

Sample number	72AP—KA—3	74—KA—4
Material analysed	Hornblende (40-60 mesh)	Biotite (40-60 mesh)
Potassium (% K)[1]	$\bar{X}$ = 0.391 σ±0.002 (4)	$\bar{X}$ = 6.88±0.035 (3)
Ar^{*40} (10^{-5} cc STP/g)	3.584×10^{-1}	6.207
Ar^{*40}/Total Ar^{40}	0.851	0.930
Ar^{*40}/K^{40}	1.354×10^{-2}	1.323×10^{-2}
Apparent age	218±8 m.y.	214±6 m.y.

NOTE: Number in parentheses refers to number of K analyses.

CONSTANTS USED:

$\lambda_{\varepsilon} = 0.585 \times 10^{-10} yr^{-1}$

$\lambda\beta = 4.72 \times 10^{-10} yr^{-1}$

$K^{40}/K = 1.181 \times 10^{-4}$

σ = standard deviation

GALORE CREEK MAP–AREA (104G/3W, 4E)

By A. Panteleyev

INTRODUCTION

Regional mapping in an area surrounding the Galore Creek copper deposits of Stikine Copper Limited was initiated in 1973 and concluded in 1975. Approximately 647 square kilometres (250 square miles) centred on a mineralized syenite complex was mapped at a scale of 1:31 680 (1 inch to ½ mile). The purpose of this mapping project is to describe the regional setting of the Galore Creek deposits, estimate resource potential in the map-area, and to assess the role and relative importance of intrusions, volcanic rocks, and structures (mainly breccias and faults) in localizing mineralized zones.

Rock specimens from 360 locations were collected and four fossil collections made. To date, 39 rocks (8 intrusive, 31 volcanic) have been analysed to determine major oxide and minor element contents. Twenty additional volcanic rocks will be analysed during 1976. Two new K-Ar ages have been determined in addition to the two reported earlier (*Geological Fieldwork,* 1974, p. 61).

GEOLOGY

Stratigraphy of Upper Triassic rocks has been mapped in detail. Bedded rocks have been divided into three major map units, all of regional extent (Fig. 13). Oldest rocks are pyroxene-bearing flows and flow breccias of basalt or basaltic andesite composition that form massive outcrops, commonly with indistinct bedding. Youngest rocks are well layered, lithic and crystal tuffs, tuffaceous sedimentary rocks, and subordinate flow rocks. Tuffs and interbedded tuffaceous sedimentary rocks have highly variable clast sizes ranging from boulder breccia to dust tuff with lapilli tuffs most prevalent. Tuffaceous rocks range in composition from pyroxene basalt to orthoclase crystal trachyte. Intercalated flows are basalt and, locally, pseudoleucite phonolites. The third map unit is discontinuous and is locally present between the two main map units. Rocks in this map unit are feldspar porphyry flows, flow breccias, and lenses of fine-grained sedimentary rocks and epiclastic rocks containing feldspar porphyry clasts.

Strata are folded into large, open structures that form a series of linked anticlines and synclines with east-west or northwesterly trending axes. A second generation of smaller upright isoclinal to box-like folds with north-northwesterly trending axes transect the larger structures. At least two zones up to 200 metres wide of sheared cataclastic rocks have been mapped for distances of 3 kilometres. Northwesterly and north-south-trending

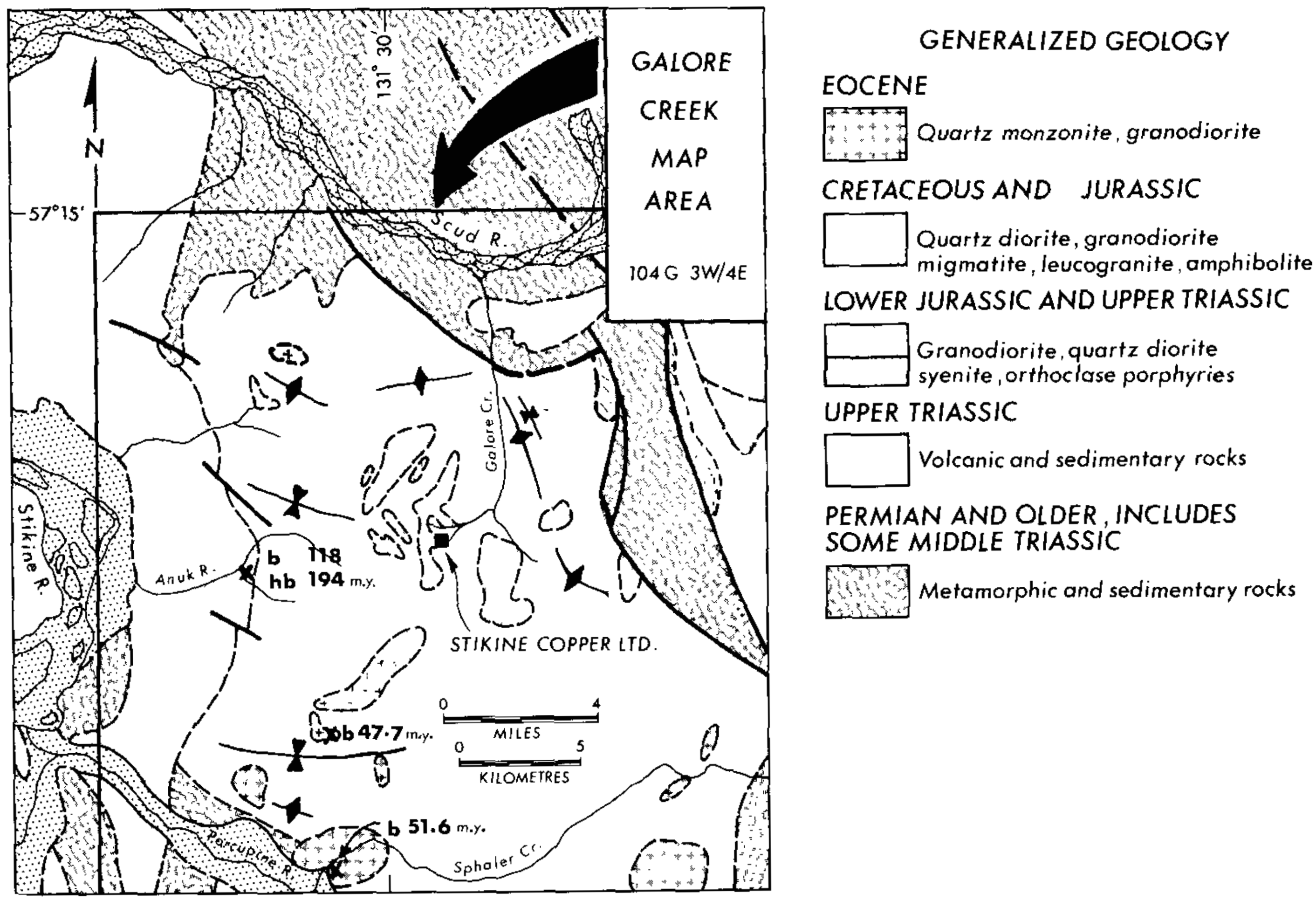

Figure 13. Generalized geology, Galore Creek map-area.

normal faults in the northern part of Galore Creek map-area and reverse faults in the east, define boundaries between Upper Triassic rocks and Middle Triassic sedimentary rocks and Paleozoic sedimentary and metamorphic rocks.

In Galore Creek basin, regional northwesterly stratigraphic and structural trends are disrupted by north-northeasterly trending breccia zones, syenite (orthoclase porphyry) intrusions, and tightly folded strata cut by numerous faults. Five major types of syenite intrusions are now recognized. The intrusions form a series of dykes, sheets, and at least two stocks, the smaller of which might be a volcanic neck. Breccias of many types are present; the most widespread is associated with dyke swarms and contains porphyritic syenite fragments in an andesite matrix mineralized with magnetite and rare sulphide minerals.

Two new K-Ar age determinations have been made. A 194 million year date was obtained from a hornblende collected from a quartz diorite phase of the Coast Plutonic Complex. This date provides a discordant pair of ages for this part of the Coast Plutonic Complex (hornblende 194±5 m.y., biotite 118±5 m.y., *Geological Fieldwork,* 1974, p. 61). A 47.7±1.7 million year date from fine-grained biotite associated with pyritic mineralization in a granodiorite stock at Split Creek indicates that mineralization as well as intrusion of small barren quartz monzonite stocks (52.6±1.6 m.y., *Geological Fieldwork,* 1974, p. 61) took place during Eocene time.

A simplified geological map of Galore Creek map-area is shown on Figure 13.

SPATSIZI PLATEAU

By N. C. Carter

The Spatsizi Plateau area of northwestern British Columbia was proposed as a wilderness conservancy by various government agencies in late 1974. An integrated resource study of the area was initiated by the Environment and Land Use Committee Secretariat which involved the major Provincial resource agencies including the Department of Mines and Petroleum Resources.

The study area (Fig. 14) was bounded on the north, east, and south by the Stikine River and its upper reaches, and on the west by the Klappan and Little Klappan Rivers. The Spatsizi River courses the central part of the area. Included in the wilderness conservancy was an ecological reserve proposal to include the Gladys Lake drainage southwest of Cold Fish Lake.

Oldest rocks in the area are Triassic and Jurassic clastic volcanic and sedimentary rocks which occur in a northwest-trending belt in the central part of the area and border it on the north and east (Fig. 14). These are partly in fault contact with siltstones, greywackes, and conglomerates of the Upper Jurassic—Lower Cretaceous Bowser assemblage which occupy the western part of the area shown on Figure 14. Intruding both the Triassic—Jurassic and Bowser rocks are small stocks of porphyritic granodiorite, quartz monzonite, and syenite. Underlying nearly half the study area are Late Cretaceous and Early Tertiary sandstones, conglomerates, and shales of the Sustut Group. These overlie older rocks unconformably or are in fault contact with them.

Sustut Group rocks are not known to contain significant mineral deposits. Several airborne scintillometer and ground geochemical surveys conducted by mining exploration companies have not indicated radioactive mineralization. Bowser assemblage sedimentary rocks are known to contain potential reserves of coal in the Groundhog Range to the south, but no coal seams of importance are known in the study area.

In a relative sense, the Triassic and Jurassic volcanic and sedimentary rocks and the granitic stocks intruding them were considered to have the highest mineral potential although no mineral occurrences were known. A field examination of these rocks, combined with a geochemical sampling program, was undertaken in 1975. A significant amount of regional geochemical information was also provided by a number of exploration companies which had worked in the area.

Rock samples were collected from four granitic stocks, indicated as A, B, C, and D on Figure 14. Several silt samples were also collected from creeks draining into Gladys Lake, shown as area E. Sample results are as follows:

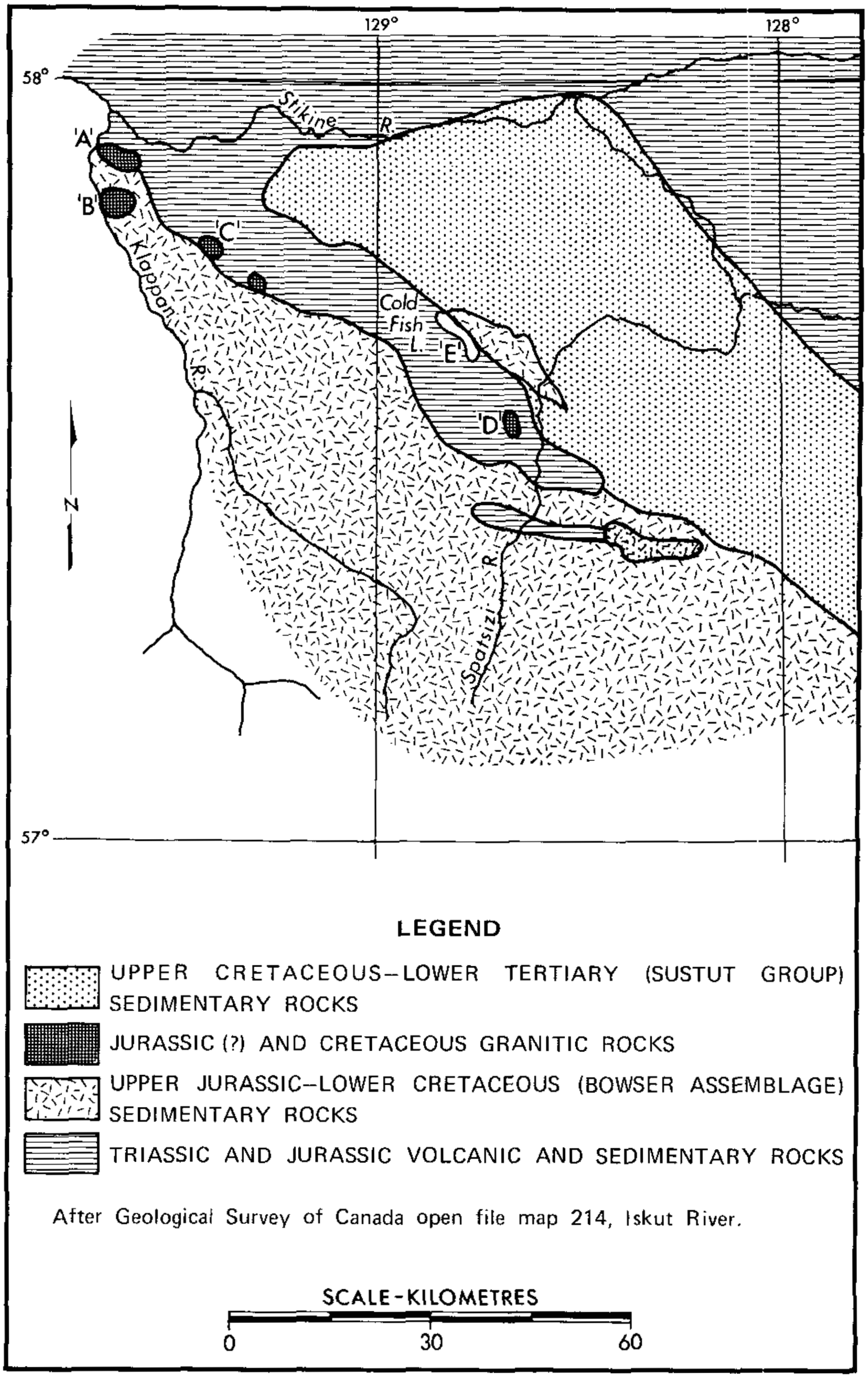

Figure 14. Spatsizi Plateau.

	Ag ppm	Cu ppm	Mo ppm	Pb ppm	Zn ppm
Location A					
SP–75–1–1	1.3	221	1	26	75
SP–75–1–2	0.8	126	1	20	75
SP–75–1–3	1.4	45	1	27	123
SP–75–1–4	1.1	69	1	141	60
SP–75–1–5	0.9	59	1	20	59
SP–75–1–6	1.0	104	1	17	52
SP–75–1–7	1.2	106	1	24	75
SP–75–1–8	0.9	68	1	19	51
SP–75–1–9	0.5	127	1	17	45
Location B					
SP–75–2–1	0.5	6	1	10	34
SP–75–2–2	0.3	15	1	17	36
SP–75–2–3	0.2	13	1	13	51
SP–75–2–4	0.2	3	1	18	20
SP–75–2–5	0.1	3	1	14	15
SP–75–2–6	0.1	3	1	11	28
SP–75–2–7	0.1	3	1	12	26
Location C					
SP–75–3–1	0.1	2	1	10	20
SP–75–3–2	0.1	1	1	3	4
SP–75–3–3	0.1	2	1	12	35
SP–75–3–4	0.1	3	1	13	30
Location D					
SP–75–4–1	0.1	33	1	12	141
SP–75–4–2	0.1	2	1	7	27
SP–75–4–3	0.1	5	1	17	11
Location E					
SP–75–5–1	0.6	17	0.1	43	67
SP–75–5–2	0.4	27	0.3	42	98
SP–75–5–3	0.2	6	0.2	33	82
SP–75–5–4	0.7	39	0.8	48	221
SP–75–5–5	0.9	17	0.1	52	69
SP–75–5–6	0.8	17	0.1	53	68
SP–75–5–7	0.5	36	0.6	50	141
SP–75–5–8	0.4	6	0.1	37	75

Based on these results, and on information made available by exploration companies, a recommendation was made to exclude areas A and B from a mineral reserve.

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CUPRIFEROUS IRON SULPHIDE DEPOSITS KUTCHO CREEK MAP–AREA (104I/1W)

By David E. Pearson and A. Panteleyev

INTRODUCTION

The area mapped is situated between Tucho River and Kutcho Creek, 12 kilometres north of Pitman River, a major tributary of the Stikine River. Mapping of about 135 square kilometres was completed during a two-week period in July. Orthophotos at a scale of 1:12 500 were used as base maps for fieldwork. The map accompanying this report (Fig. 15) represents a preliminary synthesis of field data.

According to a recent Geological Survey of Canada 1:1 000 000 compilation map (Iskut River, Open File Report 214, 1974), rocks of this area are of Carboniferous and Permian age. They are located at the southeastern extremity of the Atlin terrane and sit in a series of southwesterly directed thrust sheets that juxtapose them with Upper Triassic Stuhini Group and Lower to Middle Jurassic Laberge Group rocks. Plutonic rocks of the Cassiar batholith occur to the north and east of Kutcho Creek map-area.

One of us (A. Panteleyev) made a preliminary study of the Kutcho Creek area in 1974 (Panteleyev, GEM, 1974, pp. 343-348), and recognized that mineralization in this area was stratabound and concordant within a schistose sequence of rocks, and that repetition of the succession by suspected recumbent folds was possible.

This report describes briefly the geological setting of what we believe to be a bedded cupriferous iron sulphide deposit that possesses several characteristics common to other stratabound copper deposits in the world; notably, the 'Kieslager' of European geologists and 'Besshi-type' deposits of Japan (Kanehira and Tatsumi, 1970).

LITHOLOGIES

Because of severe deformation an axial planar foliation, which in most areas has obliterated original textures, has been imposed on all rocks. It is only in hinge areas of major folds that primary textures have been identified. The following is a brief description of major mapped units on Figure 15.

Unit 1: Unit 1 is a sequence of green-coloured, chloritic and actinolitic conglomerates, grits, greywackes, and graded sedimentary rocks together with epidotized, vesicular basalts containing carbonate pods that constitutes the oldest exposed rocks of the area. In

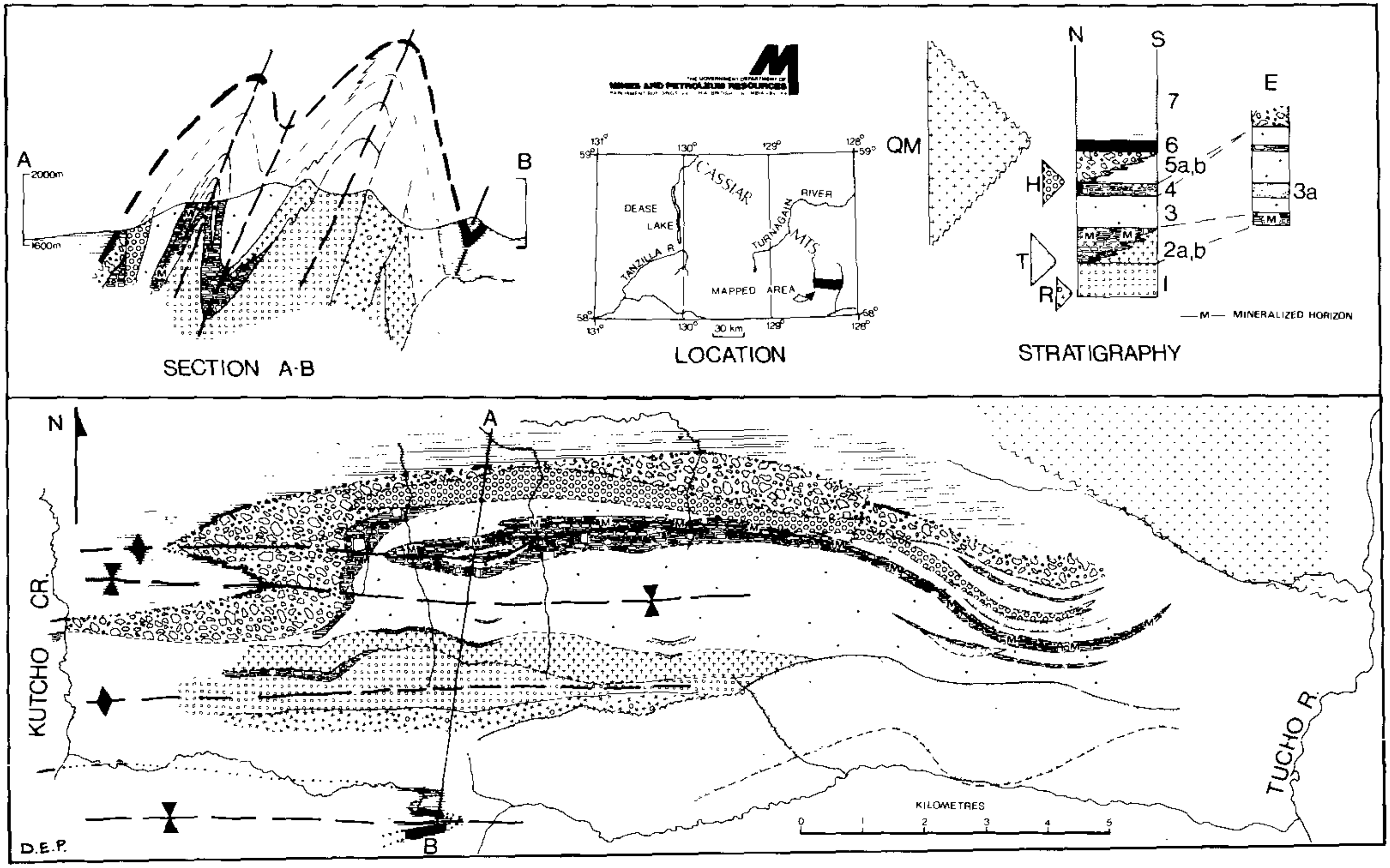

Figure 15. Simplified geological map, Kutcho Creek map-area.

the western part of the area these rocks are intruded by feldspar porphyry dykes and a small metagabbro body, but these features are not illustrated on Figure 15. The rocks form the observed core of the major anticlinal fold in the southern part of the mapped area. The southern margin of the unit we believe to be intruded by a rhyolite dyke (R). The rhyolite is a sodic quartz feldspar porphyry that is foliated in places.

Units 2a and 2b: Unit 2a, which is a white, lustrous quartz-eye sericite schist, includes a sulphide-bearing horizon (M) in a unit of siliceous pelite that contains rare lenses of dolomite on the north limb of the northern anticline (Fig. 15). In the hinge of this fold on the ridge that is taken as a line of section (A–B, Fig. 15), a green quartz-eye feldspathic chlorite schist is intercalated with quartzose sericite schist.

Unit 2b is a mixed sequence of rocks that includes siltstones, cherts, quartz feldspar crystal tuffs, and graded tuffaceous sedimentary rocks, the original textures of which were best studied in folds exposed along the ridge of the line of section (*see* Section A–B, Fig. 15). West of this section, thin bands of sericite schist are found above and below this unit.

The structural interpretation presented in the map and on section line A–B shows unit 2a to be the lateral equivalent of unit 2b. This accepted, a northward provenance and coarsening of sedimentation is implied. The sulphide-bearing bed has not been found in the southern unit, 2b.

Unit 3: Unit 3 is a feldspathic quartz-eye chlorite schist or pelite, and is the most widespread rock type in the central portion of the map-area. The rocks are classified as metamorphosed grits. They are composed predominantly of quartz grains up to 1 centimetre in size and epidotized feldspar grains in a fine-grained chloritic matrix. Proportions and quantities of quartz and feldspar vary so that quartz-eye grits, quartz feldspar grits, and feldspathic grits with little quartz are all present.

Grits in the hangingwall of the main mineralized zone contain rounded cobbles and boulders up to 50 centimetres in size. The rock is an oligomictic conglomerate in which boulders of a coarse-grained quartz-bearing plutonic rock (? trondhjemite) constitute up to 35 per cent of the rock. Such a plutonic rock appears to be the main source of coarse quartz eyes in the grit unit.

The large area of grits in the south is caused by the presence of a synclinal fold trace. At one locality, prefolding intermediate dykes up to 1 metre wide can be seen cutting fold hinges; elsewhere similar rocks are presumed to be dykes rotated into parallelism with the foliation.

Unit 3a: Unit 3a is a pale grey claystone or pelite and occurs at the east end of the mapped area. It forms a marker horizon within a succession of grits along the south side of the foliated hornblendite dyke (H).

Unit 4: Unit 4 is a quartz-eye sericite schist that is exposed in a stream bed on the west side of the mineralized zone. It may not be present at the east end of the mineralized zone (*see* stratigraphic section E, Fig. 15), or it might be represented by the intercalated quartz-eye sericite schist of that section.

Unit 5a and 5b: Unit 5a is a thick sequence of foliated polymictic conglomerate that occurs along the northern margin of the mapped area where it is intruded by the hornblendite dyke (H). In the western part of the area these rocks are considerably thickened in hinge zones of the complimentary northern fold pair.

Unit 5b is a grey-black argillite. It is exposed beneath recrystallized carbonate (marble) in the hinge of the southern syncline. Section A–B (Fig. 15) indicates that this marble is that which overlies polymictic conglomerate in the north. If this is correct, northerly provenance is implied with a southward decrease in grain size of clastic rocks. A similar facies change has been invoked to explain relationships between units 2a and 2b.

Unit 6: Unit 6 is a grey crystalline marble, which outlines the northern fold-pair, and outcrops sporadically across the northern part of the mapped area. A similar (probably the same) marble band can be traced westward across Kutcho Creek and is exposed south of the southern anticline. Traced eastward this marble band defines the southern syncline at locality B in section A–B (Fig. 15).

Unit 7: Unit 7 is slaty siltstone, graphitic shale, sandstone, and thin limestone members that overlie the marble band in the northern part of the map-area, and outcrop in the core of the southern syncline.

Plutonic Rocks

Unit T is a trondhjemite that occupies a broad tract of ground across the southern part of the map-area. It has foliated and locally brecciated margins. Overall it is a medium-grained rock composed primarily of quartz, plagioclase, and chloritized mafic minerals. Locally it is coarse grained and porphyritic with quartz grains up to 1 centimetre in size.

Unit QM is a quartz monzonite stock that occurs across the creek in the northeastern corner of the area. The stock is in fault contact with bedded rocks of the map-area.

STRUCTURE

The dominant planar feature across the entire map-area is a foliation, displayed by all schistose rocks. Many of the more massive intrusive rocks possess a parallel feature at their margins. The steep northerly dip of this foliation can be deduced from the sterogram of measured structural elements (Fig. 16). In the hinge zone of large folds, this foliation is axial plane parallel, and at high angles to bedding. In the limbs of these folds, bedding and axial planar foliation are so close that virtually no sedimentary features, including bedding, can be distinguished, and the folds become tight or isoclinal (Fig. 16).

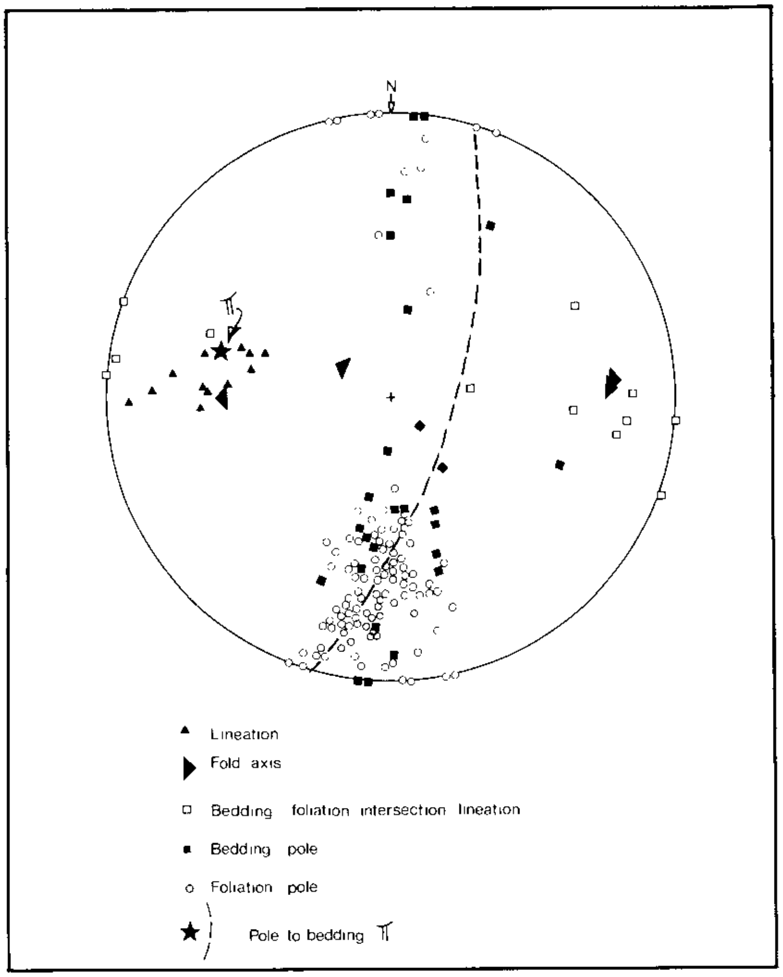

Figure 16. Wulff net structural elements, Kutcho Creek map-area.

Minor folds are not common. They have been recognized only near hinge zones, where their asymmetry indicates the position of the major fold axial plane trace. Fold axes are therefore uncommon, and of the four measured minor fold axes, they show a wide scatter (Fig. 16). Bedding/cleavage intersection lineations lie in an east-west plane and show low stability because of the generally shallow angle between these planes. Lineations measured in conglomerates in the hinges of the northern fold pair are more stable and lie close to the computed Pi point at 285 degrees/25 degrees.

The measured plunge of the northern synclinal hinge is steep at 65 degrees westerly. However, this cannot persist very far because of the observed shape of the folds in map plan. Overall plunge of these structures must approximate horizontal or the trace of major mapped lithological units would not be as observed in map plan.

Late kinking is apparent in many places throughout the area, otherwise there is no evidence of major fold superposition.

Small-scale faults or bedding plane discontinuities have been observed, but their magnitude at this time is not known.

ECONOMIC GEOLOGY

The zone of mineralization, as indicated on the accompanying map by a series of M's, can be traced for approximately 13 kilometres along strike. It is defined on surface by limonite staining of schists. The main zone of interest is about 2 kilometres in length and is located near the western end of the mineralized horizon.

Mineralization is commonly pyrite with lesser chalcopyrite and minor sphalerite disseminated in quartz-sericite schists, with occasional bands rich in chalcopyrite and bornite. Tetrahedrite and pyrrhotite are rare; galena has not been seen. Pyrite content of any specimen from the mineralized bed rarely exceeds 50 per cent. However, the presence of massive sulphide layers or lenses is indicated by float fragments, one large boulder that assayed: copper, 13.7 per cent; zinc, 4.7 per cent; lead, 0.25 per cent; gold, 0.035 ounce per ton; silver, 3.4 ounces per ton (GEM, 1973, pp. 510, 511), and an indigenous gossan derived from a massive sulphide lens measuring 0.5 by 10 metres.

Origin of this deposit is of particular interest in that it might provide a Cordilleran example of what Japanese geologists call bedded cupriferous pyrite deposits. As this type of deposit contrasts with the more familiar Kuroko-type deposit, some of the more salient features of copper-pyrite deposits are summarized below and compared with main features of Kuroko-type deposits.

Comformable copper-pyrite deposits of Japan have the following main characteristics:

(1) They are massive, compact ores of principally pyrite with some chalcopyrite.

(2) Orebodies are lenticular or bed-like and are concordant with planar and linear structures in specific members within sequences of crystalline schists.

(3) The mineralized horizons are persistent along strike; distances of several kilometres are common.

(4) Most, but not all, deposits are associated with products of *basic* volcanism. Less than 10 per cent of these deposits are found in rocks of dominantly pelitic lithology.

The relevant features of the Kutcho Creek deposit are as follows:

(a) Mineralization at Kutcho Creek is of two types: disseminated sulphides with copper sulphide-rich bands and massive sulphide lenses or layers. Both types are intimately associated.

(b) Mineralization can be followed in the same stratigraphic horizon for about 13 kilometres, and is believed to be stratabound. Sulphide minerals are concordant within a sequence of schists of lower greenschist facies. Minor folds outlined by sulphide bands can be seen in at least one outcrop.

(c) In Kutcho Creek map-area, the mineralized horizon is not contained in 'basic schists,' that is, metamorphosed equivalents of basic lavas and pyroclastic rocks. Instead, mineralization is contained within a unit of siliceous sericite schists (pelitic schist in Japanese terminology). Footwall and hangingwall rocks are quartz-eye sericite schists and quartz-eye chlorite schists derived from grits.

In this latter regard the deposit is not identical with most Besshi-type deposits, though we believe it to be a bedded cupriferous pyrite deposit. The main contrasts with Kuroko deposits are: the absence of *acid* volcanic rocks, simple mineralogy (notably absence of galena, barite, gypsum, and anhydrite), and persistence of mineralization in a particular stratigraphic horizon over a great distance.

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COAL INVESTIGATIONS

STUDIES IN THE EAST KOOTENAY COALFIELDS

By David E. Pearson and P. McL. D. Duff*

INTRODUCTION

During the early part of the 1975 field season, a geological survey was conducted over the Upper Elk Valley to the north of Cadorna Creek. The purpose of this program was to understand the geology in order to determine the mining potential of the northern portion of the Elk Valley Coalfield. Problems encountered in correlating individual coal seams prompted the second study; the search for a paleontologically based method of seam correlation similar to that used throughout the paralic coalfields of Western Europe. The following account describes the results of the mapping, and indicates the progress made in correlation.

A. UPPER ELK VALLEY

Coal-bearing rocks of the Kootenay Formation occupy a narrow tract of ground generally less than 3 kilometres wide in the Upper Elk Valley (Fig. 17). Exposure is not good, and the basal contact of the formation on the east side of the valley is nowhere exposed. Paleozoic carbonates riding on the Borgeaux thrust hide the western boundary of the coal measures, and form a mountain barrier on the west side of the valley.

A basal sandstone, the Moose Mountain member, is exposed on the east flank of Tobermory Hill, where it is at least 200 metres thick. West of Tobermory Hill, the thickness of the coal-bearing member is increased by the presence of a large, regional, northwesterly trending syncline. This structure, the Alexander Creek syncline (known elsewhere as the Fording syncline), dominates the geology of the Elk Valley Coalfield south to beyond Crowsnest Pass, a distance of about 100 kilometres. Large asymmetric folds in the limbs of the syncline are seen to repeat some seams (section E–F, Fig. 17).

Individual seams cannot be traced for great distances along strike, and therefore correlation of stratigraphic sections not continuously exposed is virtually impossible. Three fossiliferous localities yielded lamellibranchs (bivalves) and ostracods, but at the present state of our knowledge, these cannot be used in correlation.

The coal seams west of Elk Valley road are both thin (less than 2 metres), and structurally disturbed by faulting and minor folding related to the Alexander Creek

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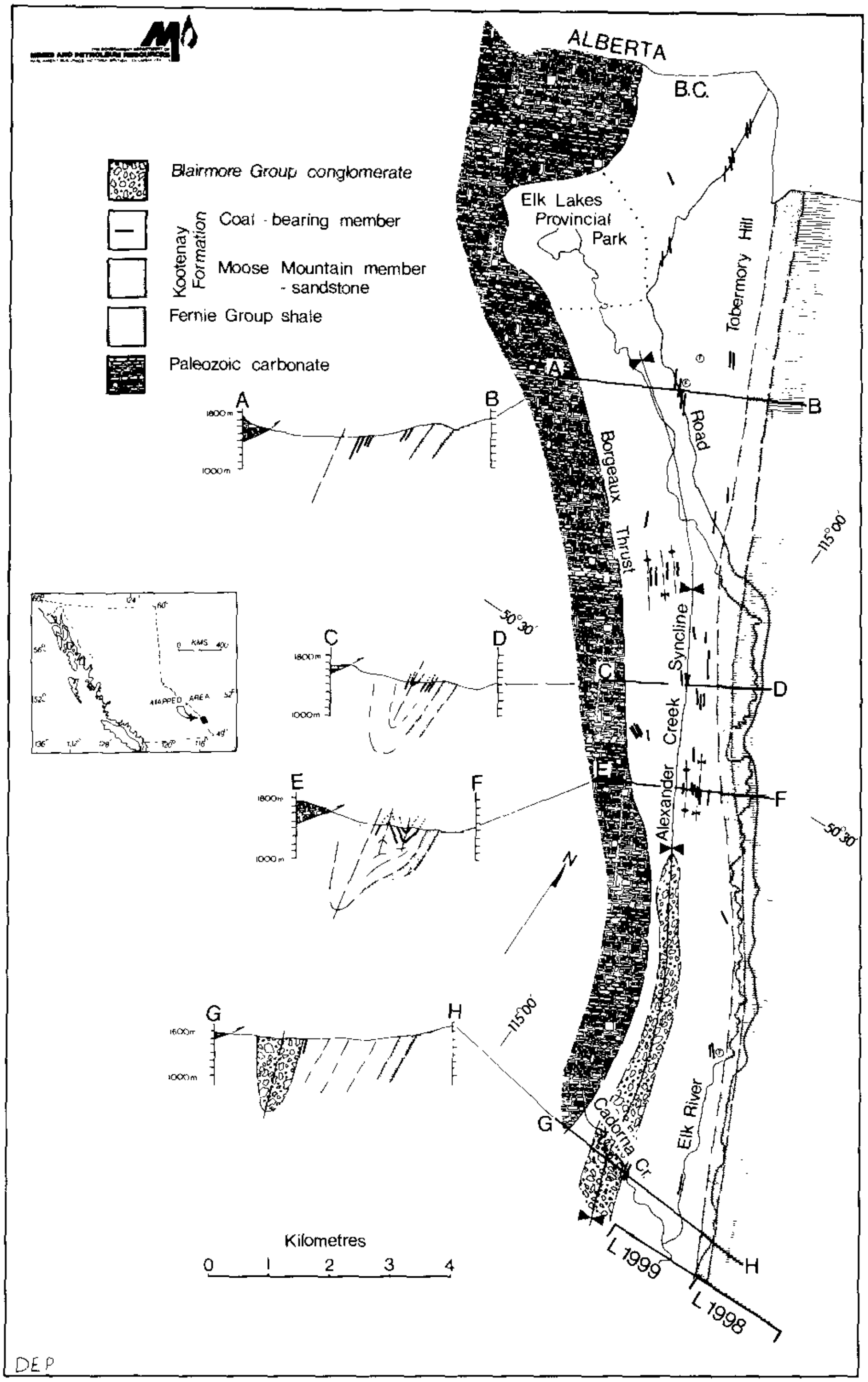

Figure 17. Generalized geology, Upper Elk Valley.

syncline, and consequently they do not offer an attractive open-pit mining situation. East of Elk Valley road on Tobermory Hill, at least seven seams are present, and two of these (on the east side of the hill, immediately north of section line A—B) have an aggregate thickness of 7 metres. Although these seams occupy a dip-slope situation, albeit at 40 degrees to 50 degrees, nowhere can a complete succession be observed, and total coal thickness is unknown. Moreover, Tobermory Hill is close to the Elk Lakes Provincial Park. That notwithstanding, the potential of Tobermory Hill can only be evaluated by several cored drill holes designed to test the total thickness of coal above the basal sandstone.

B. CORRELATION OF COAL SEAMS

Correlation of coal seams by paleontological methods has not been undertaken by workers in the Kootenay Formation, despite the fact such correlations, between and within similar paralic coalfields in Europe are entirely dependant on these methods. In the South Wales Coalfield (Woodland and Evans, 1964) and the East Pennine Coalfield (Smith, Rhys, and Eden, 1967) of Great Britain, for example, approximately 1 000 metres of coal-bearing succession can be correlated by reference to *marine bands* which occur at 11 different stratigraphic horizons. These marine bands are recognized by their contained marine fossil fauna, and are generally found in the shale roofs to coal seams. The marine bands vary in thickness from as little as 10 centimetres to more than several metres.

The coal measures of Great Britain have also been 'zoned' using non-marine lamellibranchs or 'mussels' that also occur in shales above coal seams. Zoning offers to the experienced eye a method of determining the approximate position in a sequence, that is, lower, middle, or upper coal measures, but cannot be used to establish time-lines.

Present methods of correlation in the East Kootenay Coalfield rely heavily on the interpretation of geophysical logs and comparison of proximate analyses for individual seams. Between closely spaced drill holes in structurally uncomplicated areas these methods are successful. However, correlations through thrust panels or across distances of more than 2 kilometres cannot be relied upon.

The usefulness of fossils in correlating coal seams is no less important at strip-mining operations, but has potentially greater economic value in planning underground operations. The knowledge that coal mining in the East Kootenays would increasingly be using underground methods, particularly in the Fernie basin, encouraged us to attempt such a method of correlation.

RESULTS

At outcrop, shale roofs to coal seams crumble rapidly upon exposure to the elements, and provide a poor place for collecting fossils. Far more successful is an integrated approach

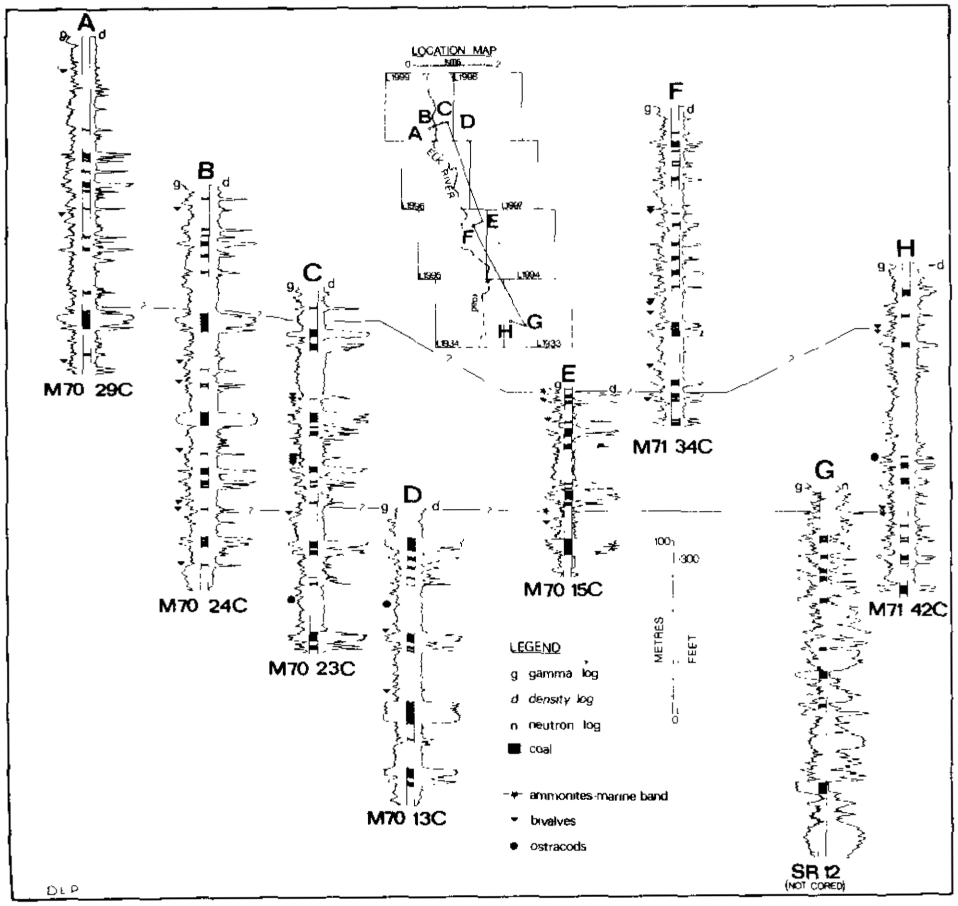

Figure 18. Correlation of coal seams and marine bands, Upper Elk Valley.

of fossil collecting and diamond-drill core logging, where at least the exact stratigraphic position of a fauna is known.

The Elco property immediately south of Cadorna Creek (*see* Lot 1999 and Lot 1998 on Figs. 17 and 18 for location) was extensively drilled by the Emkay-Scurry partnership in 1970 and 1971, and we were given access to the stored core. Two long holes on Kaiser Resources' ground south of the Northern Dominion Coal Block were also examined.

At Elco we located 99 separate faunal horizons in 3 978 metres of drill core examined. This implies that, statistically at least animal remains occur every 40 metres.

On Kaiser's ground 13 faunal horizons were located in 1 440 metres, or every 110 metres.

Some of the faunal horizons are represented by one fossil, whereas several other horizons are spread over 2 metres. Within the fauna there is considerable variety; lame libranchs ('mussels') are dominant, and ostracods are almost as common; gastropods are not infrequent; ammonites are rare. A selection of the fauna is currently being examined by paleontologists of the Geological Survey of Canada in Ottawa.

Figure 18 indicates the positions of the two recognized marine bands that we have located to date. Hole M70–15C was not examined until late September, and we have not been able to check the calculated positions of these marine bands in holes M70–23C and M70–24C, at the north end of the Elco property.

The lower marine band occurs approximately 300 metres above the top of the Moose Mountain member, that at Coal Creek, Fernie, is of Upper Jurassic (Portlandian) age. Since the base of the Kootenay Formation is probably diachronous, becoming younger northward, the five ammonites found on the Elco property are probably Early Cretaceous in age.

Marine forms were not found in the fauna obtained from the Kaiser Resources' drill holes.

In view of the fact that marine embayments do not generally occur over small areas, we are hopeful that the marine bands described above can be traced south to Fording's property, and beyond. However, if the Kootenay Formation is as diachronous as we believe, it is conceivable that the upper part of the formation in the Fernie Basin may actually occur beneath the level of the two recognized marine bands.

Finally, mention should be made of the oil shales that are not uncommon in the roofs of some coal seams. Unlike ordinary shales that give a pale yellow streak, oil shales characteristically possess a greasy brown streak. Oil assays (petrol ether extraction) to date have been disappointing; no sample possessed less than 0.10 per cent oil, but none assayed greater than 0.20 per cent oil.

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PRINCETON BASIN
(92H/7E, 8W, 9W, 10E)

By R. D. McMechan

INTRODUCTION

Remapping of the Princeton basin, south-central British Columbia, was undertaken during the summer of 1975 in order to:

(1) produce an up-to-date, detailed geological map of the basin and the immediate surroundings.

(2) determine the structural and stratigraphic setting of coal-bearing strata, if possible.

(3) develop a geological framework under which coal exploration could adequately be assessed.

The project is being carried out under contract with the British Columbia Department of Mines and Petroleum Resources.

FIELDWORK

The Princeton basin, which covers an area of 170 square kilometres, was mapped at a scale of 1:15 840. The project commenced in mid-May and fieldwork was completed by late September.

Fieldwork involved detailed examination of outcrops, including section measurement where appropriate. Outcrop was found to occupy significantly less than 1 per cent of the overall basin by area and as much as one-third of this showed definite signs of slumping or other disturbance. The best exposures were found immediately adjacent to the Tulameen and Similkameen Rivers and along Summers Creek (Fig. 19). Remaining exposures were mainly restricted to small creeks or road cuts, although resistant arkosic sandstone/granule conglomerate ridges were locally prominent.

While there are numerous coal workings in the Princeton basin which operated from the turn of the century until the mid-1950's, only the surface operations were visited and described as the underground ones are presently inaccessible due to caving or slumping. Data on the underground operations are available in the Annual Reports of the Minister of Mines and in Geological Survey of Canada Paper 52-12 (Shaw, 1952). Borehole data are reported by Rice (1947); Granby Mining Corporation drilled two holes (Shaw, 1952) and Bethlehem Copper Corporation drilled 12 holes in 1971 (unpublished report, B.C. Dept. of Mines & Pet. Res).

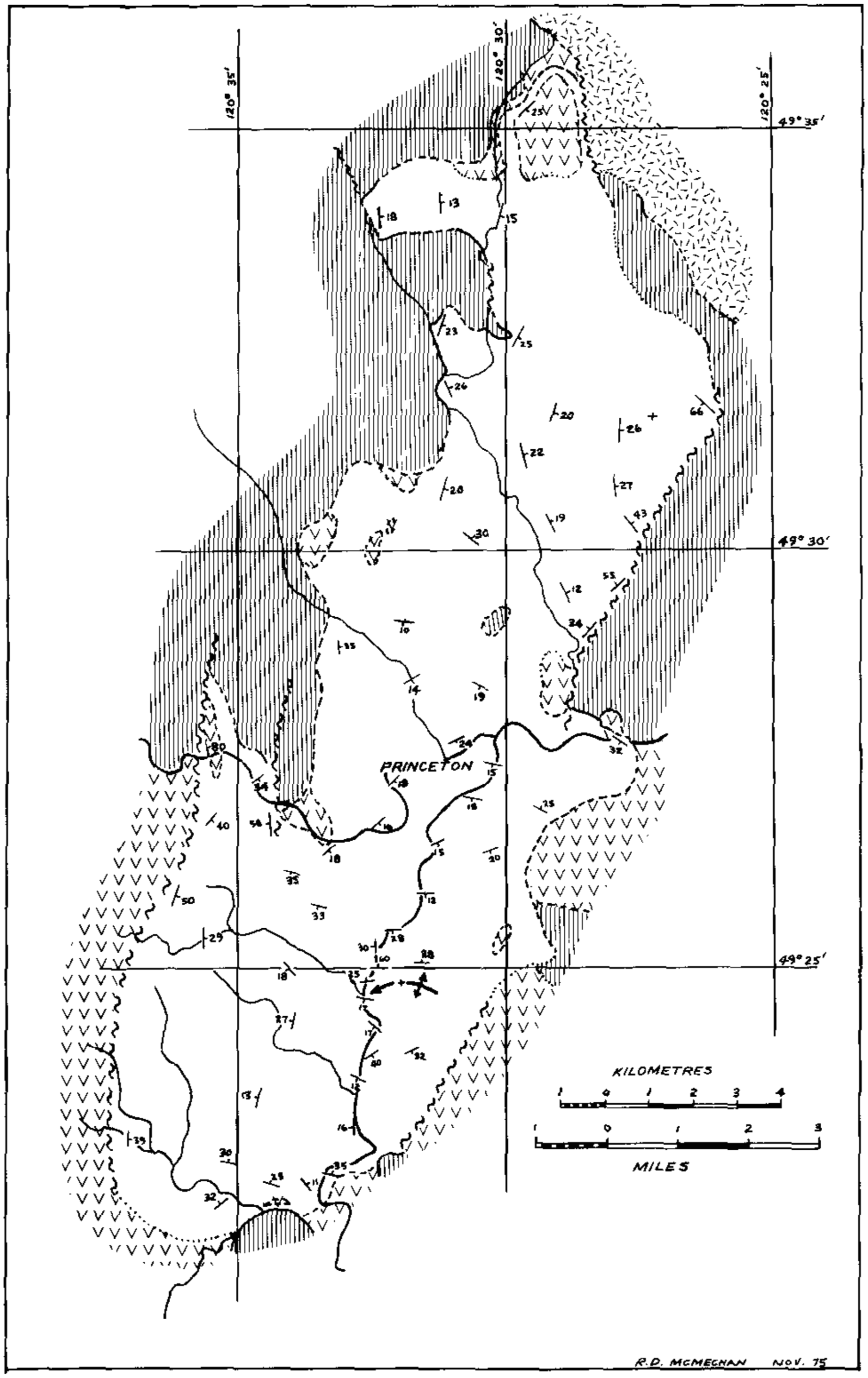

Figure 19. Preliminary geological map of Princeton basin.

LEGEND

TERTIARY

EOCENE

ALLENBY FORMATION: MAINLY SHALE, MUDSTONE, ARKOSIC WACKE, TUFFACEOUS SANDSTONE, ARKOSIC CONGLOMERATE, BENTONITE, COAL

PRINCETON VOLCANICS: UNDIFFERENTIATED FLOWS OF DACITIC (?) TO BASALTIC COMPOSITION, RED LAHARS, AND BRECCIAS (IN PART INTERBEDDED WITH BASAL ALLENBY FORMATION)

JURASSIC OR LATER (?)

OSPREY LAKE INTRUSIVE BODY: PINK TO GREY GRANITE/ QUARTZ MONZONITE AND ASSOCIATED PORPHYRIES

TRIASSIC

UPPER TRIASSIC AND LATER (?)

NICOLA GROUP: UNDIFFERENTAITED VARICOLOURED FLOWS, TUFFS, AND BRECCIAS, MINOR LIMY SEDIMENTARY ROCKS; ALSO INCLUDES INTRUSIVES AND VOLCANIC BRECCIAS OF APPARENTLY YOUNGER AGE

FAULT (INFERRED)

GEOLOGICAL CONTACT (KNOWN, APPROXIMATE, ASSUMED)

ANTICLINE (PLUNGING)

PRELIMINARY INTERPRETATION

On the basis of palynological study, K-Ar dating and mammal-tooth dating, Hills (1965b) assigned an age of mid–Eocene to the sedimentary and associated volcanic rocks of the Allenby Formation of the Princeton basin.

Early sedimentation appears to have alternated with local vulcanism in a structurally controlled, north-northeast-trending Tertiary basin in which the sedimentary and volcanic rocks were deposited unconformably on Upper Triassic (?) Nicola Group rocks. This early phase may have deposited a pile of sedimentary and volcanic rocks as much as 800 metres thick. Deposition of coal-bearing strata occurred during later stages. Four major coal zones [Princeton – Black, Pleasant Valley – Jackson, Gem – Bromley Vale and Golden Glow in ascending order after Shaw (1952)], together with intervening strata, occupy the next 500 metres. A further 600+ metres of sedimentary rocks, including other coal zones, may make the total column as much as 1 900 metres thick. Present information indicates that the dominant current direction on a basin-wide scale was south to southwesterly, in agreement with Hills (1965a).

Sedimentation appears to have occurred in an alluvial floodplain environment within a Tertiary basin having at least 300 metres of relief. Lateral lithological changes observed in outcrop scale suggest the existence of larger scale facies changes in such an environment. Field correlation was thus made difficult by anticipated lateral discontinuity, by lack of areally extensive marker beds, and by poor exposures. Therefore, it does not appear possible, nor meaningful, to construct a single stratigraphic column applicable to the whole basin. Nevertheless it was possible to correlate on scales of a few kilometres by tracing resistant units and to construct a 'piece-by-piece' section through much of the coal-bearing zone along the Similkameen River. The general succession of environments portrayed in this section should be a useful correlation tool for local exploration in the southern half of the basin. Hills (1965b) identified a palynological succession within the Tertiary which can be used as a laboratory check on tentative field correlations.

STRUCTURE

The northern half of the basin appears to be a 'block' that has been folded into a very gentle open syncline about a gently plunging, easterly trending fold axis. The 'limbs' of the syncline dip inward about 15 to 25 degrees.

A 'knob' of Nicola Group rocks surfaces approximately 2.5 kilometres north of Princeton (Fig. 19). From this point, sedimentary rocks generally dip gently (10 to 20 degrees) to the south through the village area. On the extreme west, sedimentary rocks dip approximately 50 degrees to the east while volcanic rocks in the Tulameen River dip as steeply as 80 degrees east.

The southern part of the basin is, in a broad sense, a structural depression having its greatest apparent depth west of the Similkameen River, 7 kilometres southwest of Princeton. Numerous meso-scale undulations occur south along the Similkameen River from Princeton, and a major east-west, asymmetric anticlinal structure is encountered near Allenby [Shaw's (1952) Allenby anticline]. A gentle to moderate southerly dip continues to the south. Dip direction swings around to the west and north at the extreme southern end of the basin. Little information is available in the southwest corner of the basin, but an easterly or northeasterly dip is postulated.

Margins of the basin are well defined in many places, either by visible contacts as in the extreme northern parts, or by strong topographic boundaries as on the western side.

Numerous normal faults of small displacement (a few metres to tens of metres) are visible along the Similkameen River section although extensive covered intervals along the higher reaches of the Similkameen frustrate detailed structural interpretation. Significant disturbance (dip steepening and/or reversal and local inconsistency of attitudes) and topographic breaks along some present basin margins suggest post-depositional vertical movement along regional basin-boundary fracture systems.

SUMMARY

While the present geological study combined with those done previously should yield enough structural and stratigraphic information to initially guide coal exploration, it should be borne in mind that extensive Quaternary and Recent cover, as well as surface disturbances such as landslides, leave large gaps in the present understanding and interpretation of the Princeton basin. A carefully planned drilling program, using the expected succession of sedimentary environments rather than single coal seams as a correlation tool (perhaps backed up by a palynological study), should fill in many of these gaps.

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GEOLOGY OF THE HAT CREEK BASIN

By B. N. Church

INTRODUCTION

Coal deposits in the Hat Creek basin, located about 22 kilometres west of the village of Cache Creek, are currently being investigated by the British Columbia Hydro and Power Authority. A reserve of several hundreds of millions of tonnes of sub-bituminous coal is indicated by recent drilling (Fig. 20).

This report is intended as a brief outline of the Hat Creek area preliminary to a more detailed report to be published in *Geology, Exploration and Mining in British Columbia, 1975.* The descriptions and interpretations offered are based mainly on direct field observations by the writer during June and July, 1975.

PHYSIOGRAPHY AND GLACIAL HISTORY

The valley formed by the upper reaches of Hat Creek, site of the coal deposits, is a northerly trending topographic and structural depression 22 kilometres long and 3 to 5 kilometres wide. It is an open basin bounded by the rugged Clear Range on the west and Cornwall Hills on the east. Relative relief is marked by slopes rising from Hat Creek, near Marble Canyon at the north end of the valley, at elevation approximately 810 metres, to the encircling ridges and peaks with elevations in excess of 1 950 metres.

It is evident that the valley was overridden by at least two and possibly several Pleistocene ice sheets. The most recent advance originated in the Coast Mountains and moved easterly at 117 degrees, according to striae measurements, and deposited much gravel and clay. Except for the coal beds now exposed at the north end of the valley, bedrock is rarely seen on the valley floor. Reconnaissance drilling shows that the average till cover is 51 metres thick.

The soils of Hat Creek valley are characteristically clay-rich. In many areas the clays have unusual swelling properties when water saturated suggesting the presence of bentonite — a type of clay formed by the decomposition of volcanic ash. In several places bands of volcanic ash are clearly visible intercalated in the glacial deposits.

The consequence of this clay-rich mantle is evident in the area immediately north of the proposed No. 1 pit, where two large active landslides have been identified. A second active landslide area is located farther south in the vicinity of White Rock Creek.

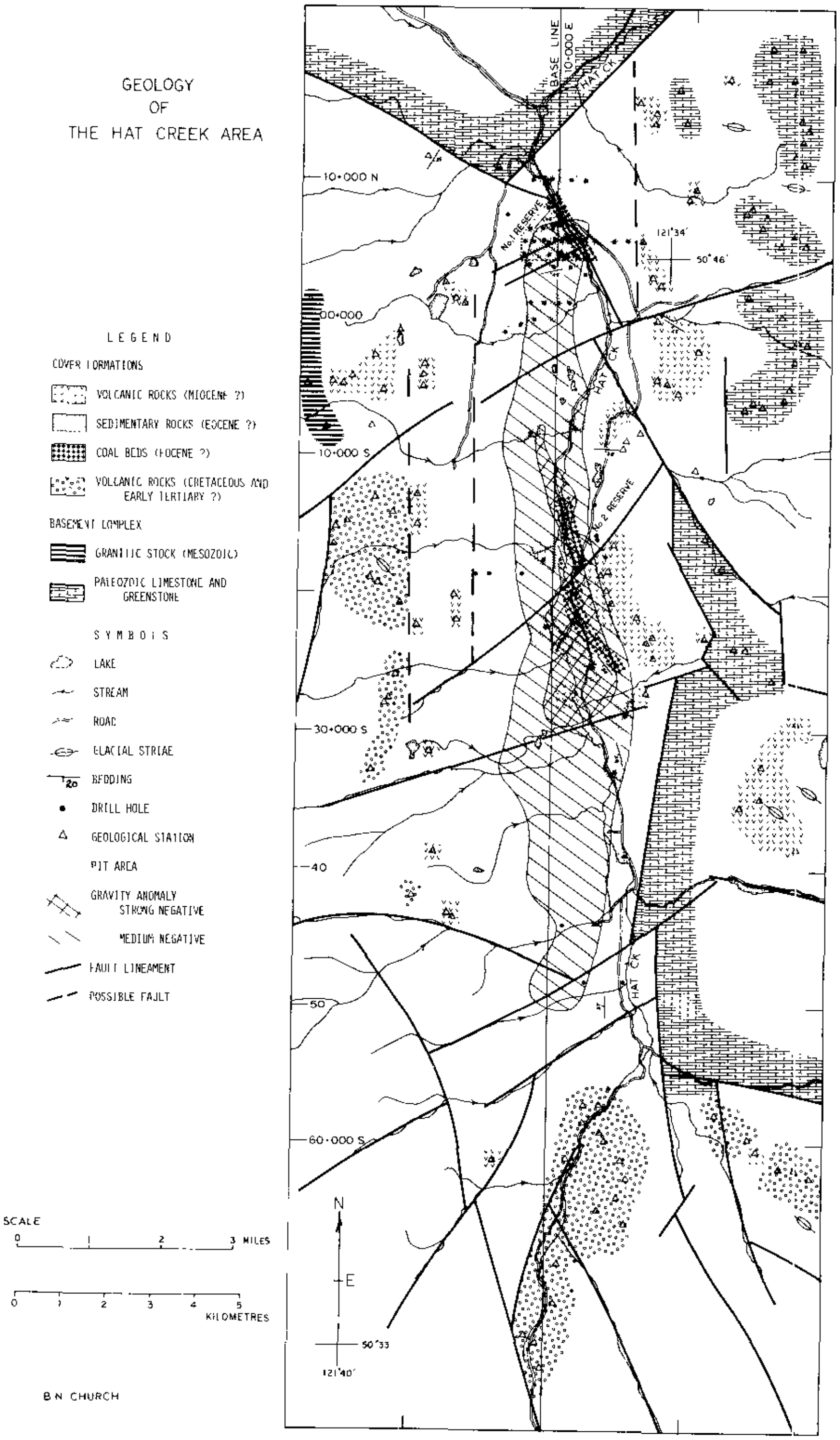

Figure 20. Geology of the Hat Creek area.

The bright yellow and reddish soils, conspicuous at several points in the valley, are residual and not glacial in origin. These are often found near coal seams and appear to be the cindery residue of burnt coal. There is evidence that much, if not all, of the exposed coal in the Hat Creek valley has been superficially burnt in prehistoric times.

GENERAL GEOLOGY AND STRUCTURE

The general geology of the Hat Creek area is shown on Figure 20.

Cover rocks of Tertiary and Cretaceous age, consisting of coal and sedimentary and volcanic formations, rest with marked unconformity on a Paleozoic basement of metamorphosed carbonate rocks and greenstones.

The soft, easily eroded coal and shaly formations occur mainly on the floor of the valley whereas the resistant volcanic rocks and basement formations are found on the valley slopes and ridge crests.

Although extensive glacial deposits have hampered geological investigation to date, much stratigraphic information has been obtained from drilling the 'cover rocks.' The most important relations revealed by this work show that the coal is almost everywhere overlain by a thick claystone sequence which in turn is overlain unconformably by a variety of volcanic rocks including lahars and dacite, basalt, rhyolite, and trachyte lavas.

Owing to the great thickness of the claystone and coal, often in excess of 750 metres, few drill holes have penetrated below the main coal horizon. A thick succession of intermixed sandstones, conglomerate, and shales found lateral to the coal formation are thought to underlie the coal. Andesitic volcanic rocks of the Kamloops Group (Eocene) and Spences Bridge Group (Cretaceous), exposed peripherally in the valley, appear to form the base of the 'cover rock' succession.

The general structure of the Hat Creek basin is simple. The central zone of the valley, underlain mainly by coal and sedimentary formations, has been down-dropped forming a graben. This has been achieved principally by downward movement on a series of north-south tension faults trending subparallel to the direction of regional maximum stress. Locally the walls of the graben have been offset somewhat by a series of northwest and northeast-striking conjugate shear faults. An important system of easterly trending gravity faults cutting across the basin appears to be of recent origin, and superimposed on the main graben structures.

COAL RESERVES

No. 1 Reserve

The proposed No. 1 open pit is adjacent to the original discovery on Hat Creek near the north end of the valley. Here the main near surface coal reserve covers approximately 117 hectares. The area has been thoroughly drilled yielding intersections of coal formation ranging from 150 to nearly 500 metres. Calculations based on data obtained from 21 holes indicates slightly more than 220 million tonnes determined to base elevation of 760 metres. Additional calculations, on fewer drill penetrations, suggest that about twice this tonnage can be realized by extending mining downward to base elevation of 600 metres.

Further investigation of the coal formation in this area is made difficult by the displacement of beds by major faults and the down dip burial of coal under the claystone formations.

No. 2 Reserve

A second major near surface coal occurrence was recently discovered south of the No. 1 reserve near the mid-point in the valley. This is a sinuous 3 600-metre long band of coal paralleling the axis of a large negative gravity anomaly. Initial drilling has indicated a thickness of about 510 metres of coal, the beds dipping 20 to 30 degrees westerly under the claystone formation. The band has been cut and displaced near the centre point by a fault.

The calculation of tonnage in this deposit awaits further drill results to establish the extent of the zone. There seems to be general consensus, however, that the volume of coal here well surpasses the No. 1 deposit. The quality also appears to be superior with only 15 to 25 per cent clay admixture.

OTHER POTENTIAL

The ultimate coal potential of Hat Creek basin is well delineated by the negative gravity contours. However much of the coal is deeply buried.

Figure 20 shows the position of diamond-drill holes to July 20. The positions of more recently completed holes have not been recorded and the core not yet examined. Much of this new drilling has been in the vicinity of No. 2 deposit.

Many additional holes are required to complete the testing of the gravity anomaly zone.

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GEOLOGY OF A TERTIARY SEDIMENTARY BASIN NORTHEAST OF HAT CREEK (92I/NW)

By Trygve Höy

INTRODUCTION

This report summarizes the results of three weeks of fieldwork in a Tertiary sedimentary basin northeast of the Hat Creek area. The study was initiated in July 1974 and continued in June 1975. The area investigated includes approximately 100 square kilometres of hilly terrain, 10 to 20 kilometres west and northwest of Cache Creek. The area is underlain by a north-south-trending belt of dominantly coarse clastic rocks (conglomerate and sandstone, with minor siltstone and shale) of the Coldwater Group. These rocks appear to be bounded on all sides by greenstone, argillite, chert, and marble of the Cache Creek Group.

STRUCTURE

Exposed near the centre of the area are a number of outcroppings of Cache Creek rocks (argillite, slate, and 'greenstone') which define three aligned north-northwest - south-southeast-trending areas of outcrops (Fig. 21). Immediately to the west of these belts, the overlying Coldwater sedimentary rocks dip west at approximately 20 to 40 degrees; to the east, they dip east at 30 to 40 degrees. These exposures of Cache Creek rocks are interpreted to be within the core of an open, upright south-southeast-trending anticline (Fig. 22) with a horizontal to south-plunging fold axis (based on an equal area stereoplot of poles to layering within the central part of the basin). Coldwater beds in the eastern part of the area define the east limb of the anticline, and those in the west, the west limb.

Within the core of the anticline (the area mapped as 'Cache Creek' in Fig. 21), there are a number of small exposures of conglomerate and sandstone which appear to be members of the Coldwater Group. These may represent down-dropped fault slices suggesting the axial region of the anticline is more complex than illustrated on Figure 22.

The eastern contact of the Coldwater Group with the Cache Creek is fault controlled; the western contact is also partially fault controlled but may also be depositional since in the very western part of the basin Coldwater beds dip east (J. Irvine, *Geological Survey of Canada,* personal communication) suggesting the presence of a syncline immediately to the east of the Cache Creek contact (Fig. 22). The basin therefore probably represents a 'half-graben,' down-dropped along its eastern margin.

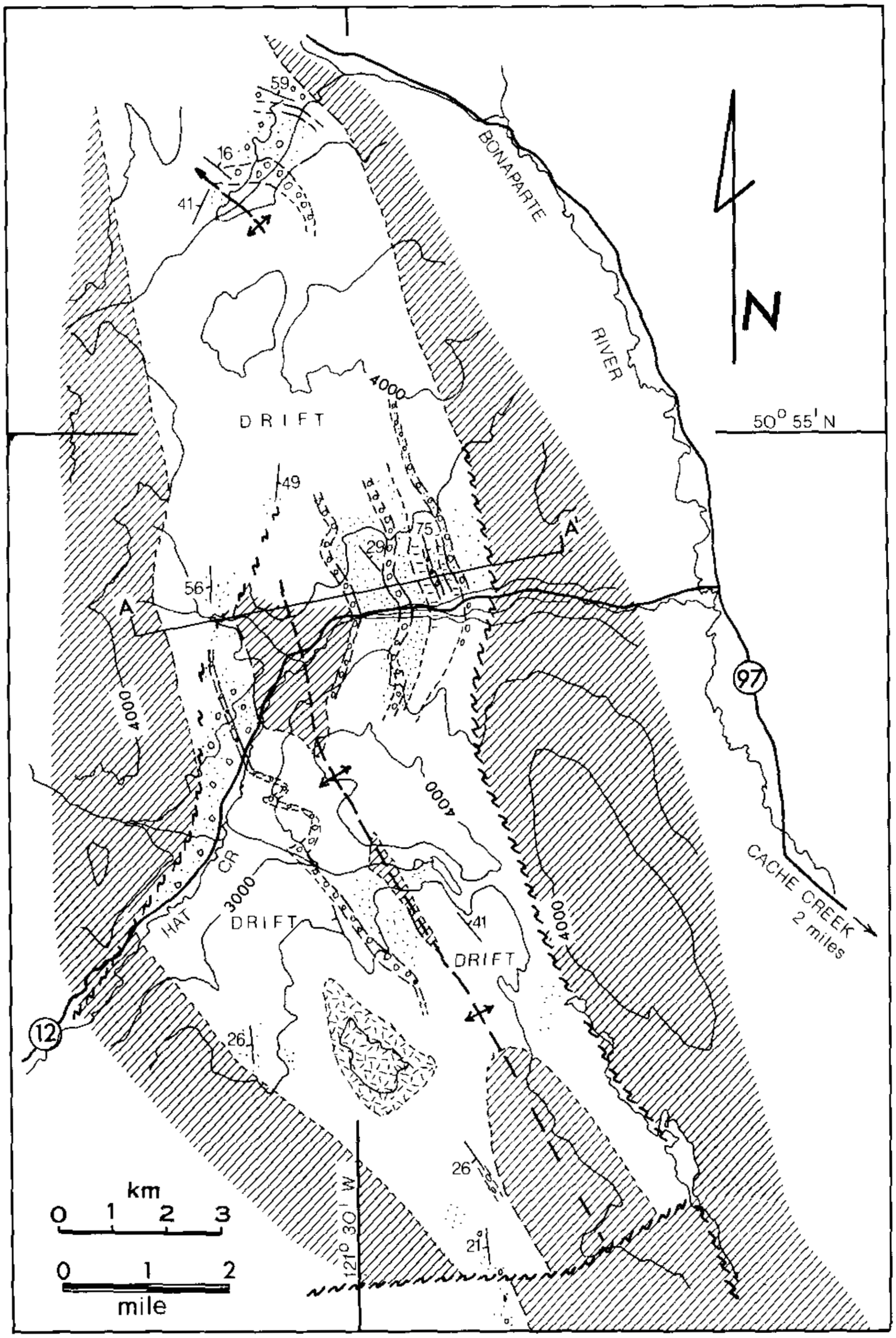

Figure 21. Geology of a Tertiary sedimentary basin northeast of Hat Creek.

LEGEND

TERTIARY

KAMLOOPS GROUP

BASALT, ANDESITE, RHYOLITE (DEFINED BY DUFFEL AND McTAGGART, 1952)

COLDWATER GROUP

SILTSTONE–SHALE; MINOR SANDSTONE AND CONGLOMERATE

SANDSTONE; RARE CONGLOMERATE

SANDSTONE; INTERLAYERED CONGLOMERATE

CONGLOMERATE; MINOR SANDSTONE

PRE–TERTIARY

CACHE CREEK GROUP – ARGILLITE, SHALE, LIMESTONE, 'GREENSTONE', ULTRAMAFICS

SYMBOLS

GEOLOGICAL CONTACT: DEFINED, APPROXIMATE, ASSUMED

BEDDING

AXIAL SURFACE TRACE OF ANTICLINE

FAULT

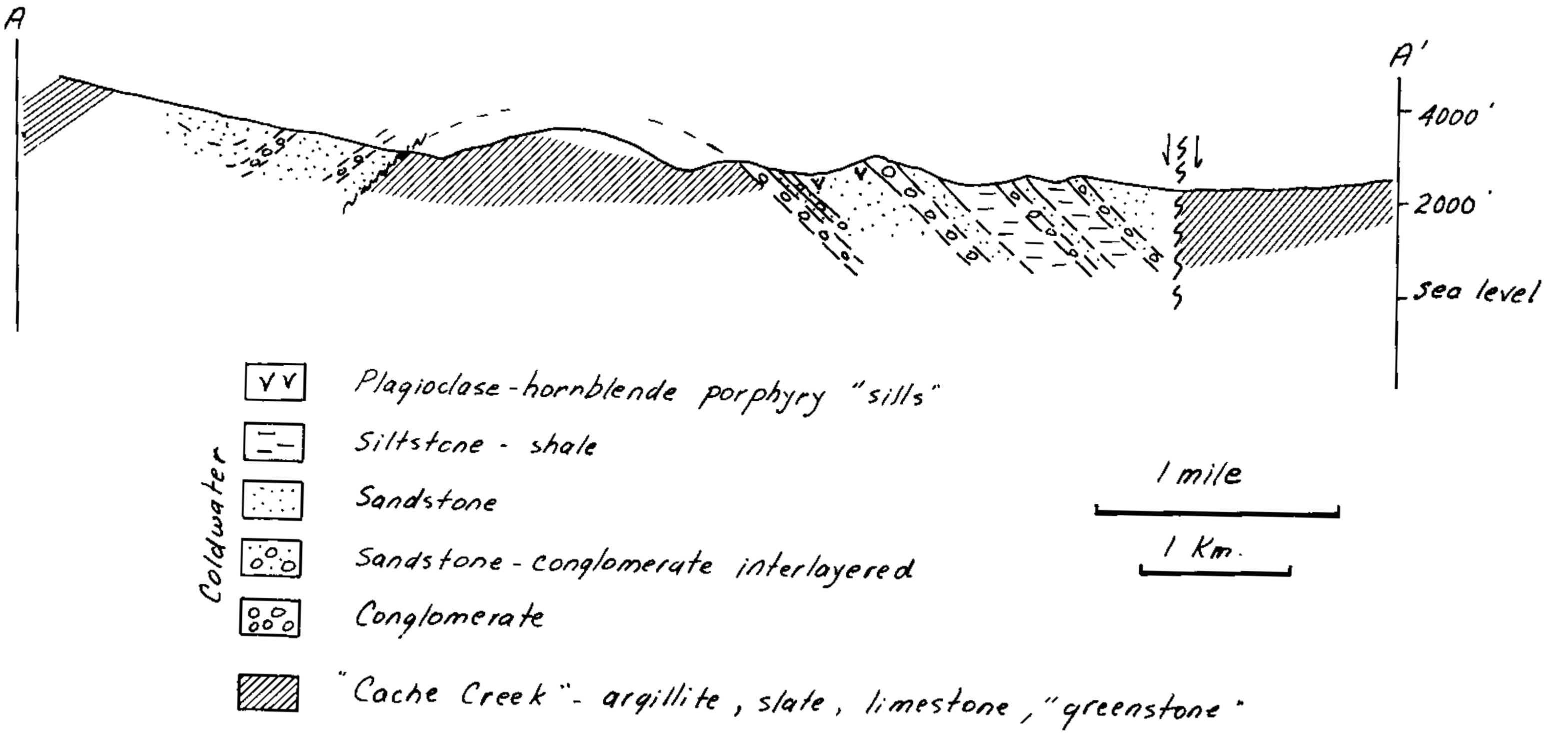

Figure 22. Vertical cross-section, Hat Creek area.

STRATIGRAPHY

Coldwater beds within the basin are composed dominantly of coarse clastic members, pebble conglomerate, and coarse to medium-grained sandstone with lesser amounts of siltstone and shale.

Conglomerates generally display a wide range of particle size, ranging from fine sand to large pebbles within a single sample. The matrix commonly forms the bulk of a sample with separated rounded to subrounded pebbles suspended in a coarse sand to granule-sized matrix. The pebbles are composed of rock fragments, similar to rocks of the underlying Cache Creek Group and hence are assumed to be derived from the Cache Creek rocks.

Sandstone members are generally better sorted, though coarse-grained layers and layers containing widely spaced pebbles are common. Sedimentary structures, such as crossbeds and less commonly, graded beds, provide sufficient data to determine stratigraphic tops throughout the area. Sandstones commonly have a green tinge, though in the western part of the area they are reddish brown. They are fairly compact, usually cemented by silica rather than carbonate.

The coarse-grained members, particularly the conglomerates, form prominent ridge exposures. The siltstones and shales are recessive weathering and are therefore poorly exposed. Hence the greater portion of the area mapped as 'siltstone-shale' on Figure 21 is interpreted from a few exposures, soil profiles, and low topographic relief.

DETAILED DESCRIPTION OF THE COLDWATER SECTION EXPOSED ALONG HIGHWAY 12

Coldwater beds exposed along Highway 12 eastward from the Cache Creek exposures (Fig. 21) are believed to represent a normal stratigraphic sequence. Numerous crossbeds within the sandstone members and some graded beds indicate that these beds become progressively younger toward the east. Structural repetitions or omissions, due to faulting, were not recognized in this sequence of rocks, although they may have been missed as a large part of the section is not well exposed. The section, illustrated on Figure 23, may therefore represent the lower 1 360 metres of the Coldwater sequence within this basin.

In general, the lower half of the exposed section is coarser grained than the upper half. The lowermost 600 metres include a thick basal conglomerate overlain by medium-grained sandstone with occasional conglomeratic lenses and two volcanic (amphibole-plagioclase porphyry) sills. Overlying the sandstone are two conglomerate-sandstone-shale sequences, each with an aggregate thickness of 300 to 450 metres.

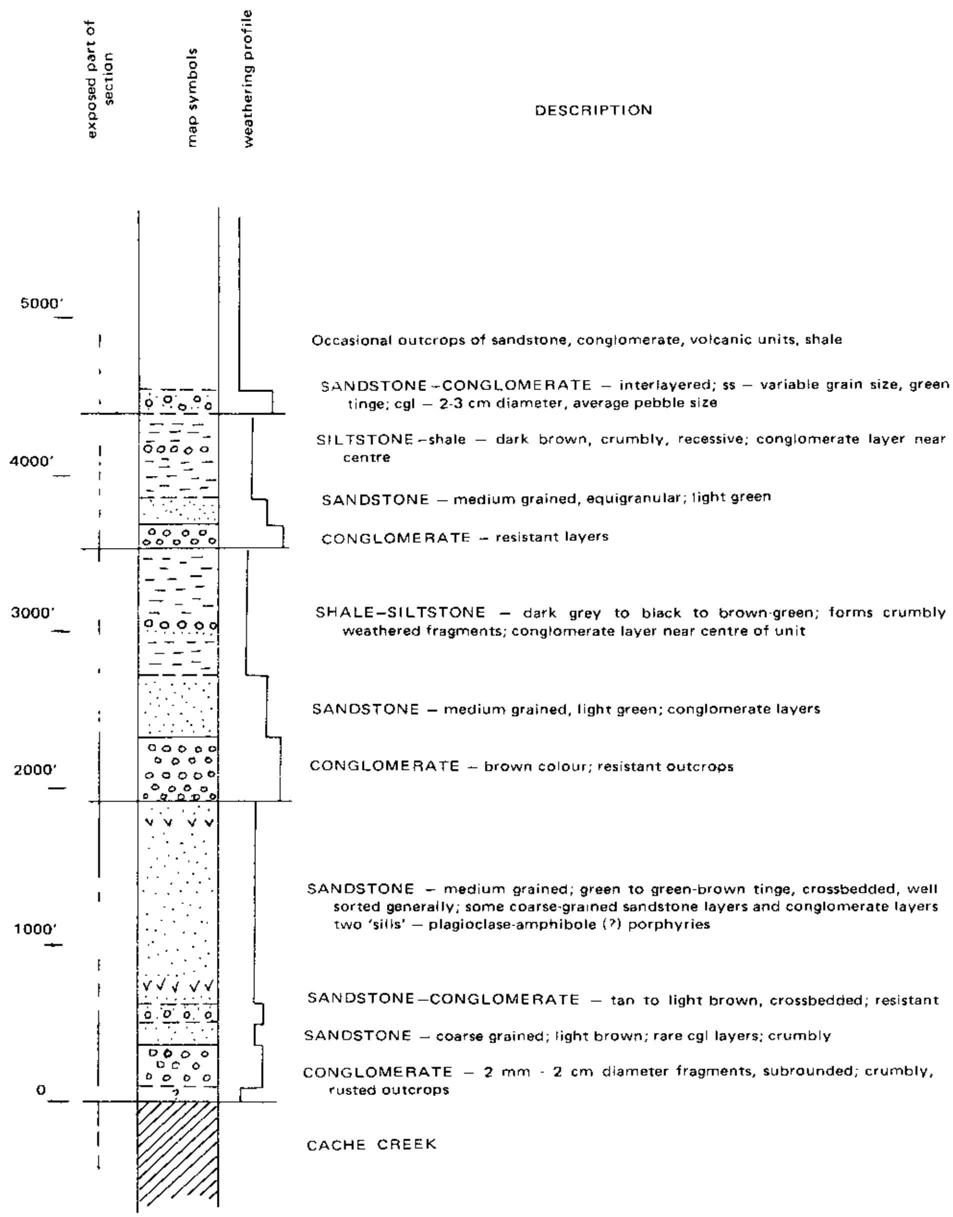

Figure 23. Sequence of rocks exposed along Highway 12, eastward (up-section) from Cache Creek exposures.

The section is thus a cyclical repetition of upward fining clastic sedimentary rocks. Three of these cyclical sequences and perhaps a part of a fourth (the lowermost, coarser grained part of it) are exposed along Highway 12. In each cycle, poorly sorted conglomerate is conformably overlain by medium to coarse-grained sandstone which, in the upper two, is overlain by dark, massive shale containing interbeds of conglomerate, grit, and sandstone. A similar sequence, conglomerate overlain by sandstone and then shale, is exposed in the northern part of the area (Fig. 21). However, it is difficult to correlate this sequence with one of the specific cycles exposed along Highway 12, even though they are roughly on strike. The various members within a cycle do not appear to be megascopically distinctive to that cycle. Hence, it has also not been possible to correlate individual units in the western part of the area, west of the anticline, with those on the east.

The pebbles and cobbles of the conglomerates are predominantly rock fragments; in decreasing order of abundance they include dark grey to black chert, quartzite, argillite, limestone, and rare volcanic fragments. The volcanic roundstones, pale grey to tan feldspar porphyries, are more abundant in the southern part of the area. The sandstones are composed primarily of quartz, dark chert, and argillite (?) grains. Altered feldspar (?) grains are less common.

SUMMARY

Coldwater beds northwest of the town of Cache Creek were deposited in an eastward-tilted non-marine basin. Sedimentation was cyclical and rapid with detritus derived from Cache Creek chert, argillite, and volcanic units.

Open flexure folding subsequent to sediment deposition produced the north-south-trending anticline and syncline. Faulting (?) in the core zone of the anticline may be related to the development of the anticline. Marginal faults cut the Coldwater beds and were hence active after sediment deposition.

STRUCTURAL MATERIALS

SAND AND GRAVEL

By J. W. McCammon

The reconnaissance survey of the surficial geology of the Sunshine Coast between Port Mellon and Powell River (92F/9, 16; 92G/5, 12), begun in 1974, was completed. No new sand or gravel deposits were discovered.

A similar survey was carried out in the vicinity of Campbell River (92K/3). The major source of gravel in this region is the 3.2-kilometre-long front of a raised delta that extends from north to south about 1 kilometre east of McIvor Lake (the east arm of Campbell Lake). A small raised delta west of the city arena provides small amounts of gravel. Small local supplies of gravel have been obtained from a flat-lying lag veneer surface layer 1 to 2 metres thick that covers sand and other materials in areas at the west end of John Hart Lake, just east of the Forestry Department nursery on the north boundary of Elk Falls park, and in Menzies Creek valley.

Large amounts of gravel are present in Campbell River and in the spit and delta at its mouth but it is most unlikely that any exploitation of these areas would now be permitted.

APPENDIX

SUMMARY OF MAPPING PROJECT
TOBY CREEK AREA, NORTHEAST SECTION
LARDEAU DISTRICT, BRITISH COLUMBIA

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This manuscript was delayed by recent mail difficulties.

Eighty-five square kilometres along the north side of Toby Creek have been mapped at a scale of 1:5 840 (Fig. 24). The map-area extends from 11 to 27 kilometres west of Invermere and covers a section through the Mount Forster syncline (Reesor, 1973, Map 1326A). A more extensive account of structural, stratigraphic, and sedimentologic relations within the map-area and their regional implications is to be published in a forthcoming report. As well, a detailed, large-scale map of the surface geology in the Paradise Basin is in preparation (GEM, 1975).

Previous coverage of this area has been by Walker (1971). This study constitutes the first detailed mapping of the area including the type section of the Toby Formation. It reveals a structural and stratigraphic section hitherto unrealized or erroneously interpreted. As well, the geometry and age relations between folding, faulting, and zinc-lead-silver mineralization in and around the Paradise Basin have been recognized.

STRATIGRAPHY

The main lithologic units in the Toby Creek map-area are shown on Figure 25. The oldest rocks exposed are the upper 300 metres of the Dutch Creek Formation — uniform sequence of well-bedded, multi-layered, green and black argillites, slates, and greywackes. Thick units of argillite without visible sedimentary structures are common, as are thinner, coarser grained units with small-scale ripple-cross- stratification, distinctive graded beds and other finely laminated units. The whole sequence is interpreted as basin distal-intermediate turbidites.

This predominantly fine-grained off-shelf argillaceous clastic sequence provides the foundation for an apparently westward (and southward ?) facing shallow water dolomite shelf which, in the Toby Creek area, is about 700 metres thick. The basal member of these shallow water sedimentary rocks is a 70-metre-thick white to apple green crossbedded orthoquartzite (the lower quartzite of the Mount Nelson Formation). It is immediately overlain by cyclicly interbedded, finely laminated and graded sandstones, argillites, fine siltstones, and argillaceous dolomites. Up section these grade into more massively bedded, stromatolitic and oolitic dolomites and cherty dolomites near the top of the sequence. Red mudstones occur at intervals within the dolomite phase and finely laminated red siltstones and fine quartzites in the eastern part of the area cap the dolomite phase (almost approaching iron-formation in appearance).

These thick red clastic rocks are not present over the western portion of the map-area but are replaced by a white crossbedded orthoquartzite up to 170 metres in thickness (upper quartzite of the Mount Nelson Formation).

The basal Windermere Toby Formation overlies a variety of lithologies in the Mount Nelson Formation: (1) a mottled grey dolomite in the east; (2) the upper quartzite (of variable thickness) over much of the central and western parts; (3) a green argillite locally within the Paradise Basin; and, (4) a grey cherty dolomite and green siltite (themselves above the upper quartzite) on the western end of the Paradise Ridge. The contact is well exposed in many places and the lack of an angular unconformity over much of the area is a significant feature.

Across the type section and much of the map-area the Toby Formation is a 500-metre-thick*† chaotic jumble of boulder to pebble-sized clasts which are supported by a fine argillaceous and dolomitic matrix. Clasts (dolomite, quartzite, argillite) are coarsest and most abundant near the base of the formation. Upward the basal conglomerate grades quickly into the pebbly mudstone so typical of the Toby Formation in this section. Deposition of the formation has probably taken place by shallow-water debris flows and mud-flows related to Windermere age fault scarps.

The Toby Formation is overlain by slates, limestones, and quartz (feldspar) pebblestones of the Horsethief Creek Group. Much of the upper part of the section mapped is dominated by upward fining fluvial cycles (1 to 5 metres thick) showing great variations in grain size, from coarse pebbles at the base to fine clay-sized material at the top. Scours and small channels trend 150 degrees indicating a local line of transport (probable *direction* is to the northwest).

STRUCTURE

The eastern and central part of the Purcell structure in the Lardeau district is dominated by the Mount Forster syncline (first-order fold) which parallels the Rocky Mountain Trench for 45 kilometres. The syncline is developed in rocks with a low to sub-greenschist grade of metamorphism. These rocks possess a single penetrative fabric — the result of one period of deformation during Cretaceous time. The Toby Creek map-area covers a

*The 1 000-metre thickness report by Aalto (1971) results from an incorrect interpretation of the structure and stratigraphy. The quartzite, dolomite, and argillite at the west side of his Figure 3 are actually part of the Mount Nelson Formation and not, as he reports, part of the Horsethief Creek Group.

†On the ridge northwest of the Paradise Basin little more than 70 metres of Toby Formation is present.

16-kilometre-wide section across this structure and its origin and regional significance will be more thoroughly dealt with in a Ph.D. thesis.

The eastern part of the map-area consists of broad, open flexures (second order) in the massive dolomites of the Mount Nelson Formation. Faults in the eastern part of the area (and elsewhere) are believed to be Cretaceous-Tertiary in age (rather than Proterozoic or otherwise) because: (1) they are associated with the formation of folds that are part of the regional deformation; or (2) they cut and brecciate Cretaceous-Tertiary structures. Second-order kink folds to the west are tighter and take up much greater shortening than those to the east. They have a very distinctive 'stair-step' profile so that a syncline will show a gently almost flat-lying east limb and a steep to overturned west limb. North to northwest-trending normal faults postdate folding and almost invariably occur in these steep to overturned fold limbs where finite strain is at its highest. The movement of faults is west side down with displacements in the order of 10 to 100 metres. Along the fault planes it is common to find: (1) narrow breccia zones involving dolomite or quartzite country rock; and (2) quartz-carbonate veins.

MINERALIZATION

Lead-zinc-silver mineralization in the Paradise Basin occurs along the late normal faults, commonly on the steep limbs of second order folds. It is primarily a fracture-filling occurrence, associated with zones of brecciated dolomite or quartzite found along and adjacent to the fault plane. Although the present local distribution of the sulphides is structurally controlled by Mesozoic folding and late(r) normal faulting it is not yet certain whether stratigraphic controls may originally have come into play. (A distinctive Late Proterozoic sedimentary breccia consisting of large rounded blocks of dolomite imbedded in chert is apparently restricted to the vicinity of the main Paradise ore zone.)

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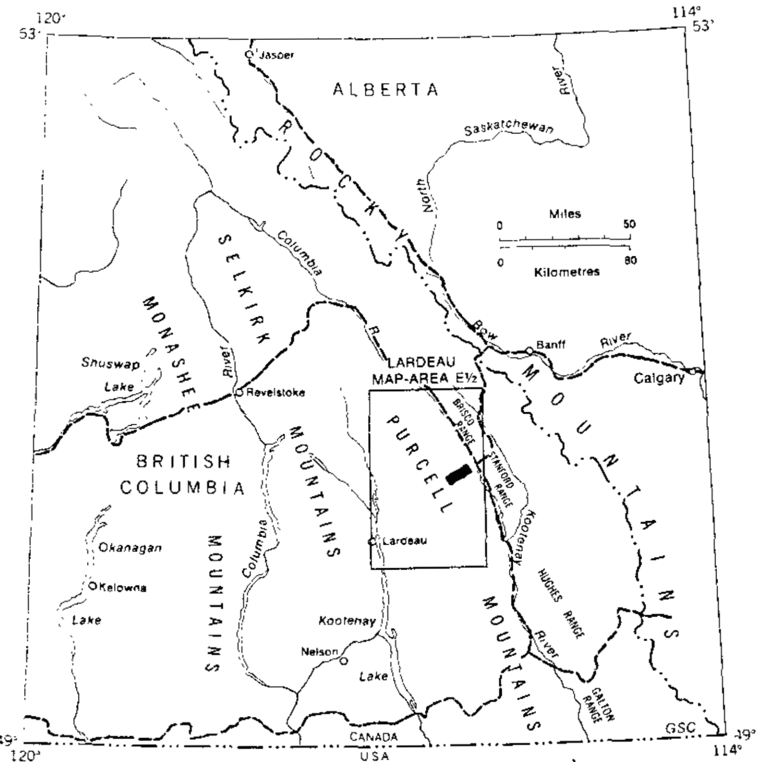

FIGURE 24 Location of Toby Creek,(North-East) map-area shown by small black rectangle within the Lardeau area. Main highways in black dash.

▲ top unknown

				thickness(m)	
PROTEROZOIC	WINDERMERE	HORSETHIEF CREEK GRP.	Limy shale, ls, argill, slst.	>1100	4c
			Qtz(feld) peb-stone, ss, sh.		4b
			Black slate, argill, slst, qtzite, dol.		4a
		TOBY FM.	Pebble cobble boulder – mudstone (diamictite) conglomerate, limy congl.	70 – 500	3
	PURCELL	MT. NELSON FM.	White quartzite	~1100	2c
			Dolomite phases, red sh, slst.		2b,d
			White, green; quartzite		2a
		DUTCH CREEK FM.	Black, green; argillite, slate, siltstone, greywacke	> 300	1

▼ bottom unknown

FIGURE 25 Legend for Toby Creek(NE)

⚒ Paradise Mine site

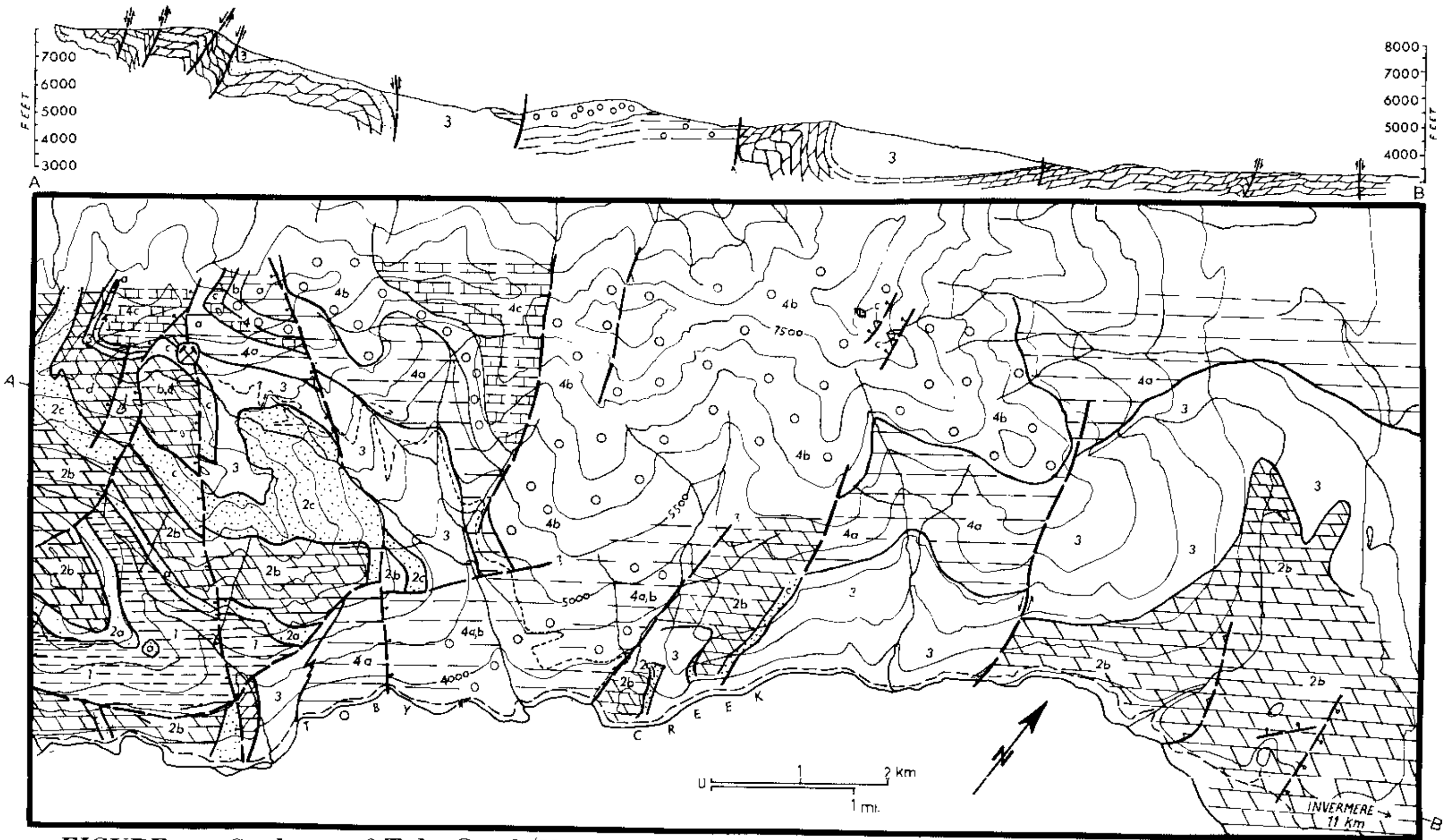

FIGURE 25 - Geology of Toby Creek (NE); generalized map outlining main units.