Geology in British Columbia 1975

British Columbia Ministry of Mines and Petroleum Resources

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PREFACE

The first Minister of Mines of the Province of British Columbia was appointed in 1874. One of his responsibilities was "the duty of collecting information on the subject of the mining industries of the Province." This material, which consisted of reports by the Gold Commissioners and Mining Recorders of the Province, was published in the Annual Report of the Minister of Mines.

A Bureau of Mines was established by Parliamentary authority in 1895 and in 1896 was staffed by a Provincial Mineralogist and an assayer and chemist. Technical reports on mines and mining activities were prepared by them and published in the Annual Report, together with reports contributed by the Mining Recorders and Gold Commissioners.

Over the years with the expansion of the mining industry, the staff of the Department of Mines grew, as did the number and size of the technical reports on geology and mining that were still published in the Annual Report of the Minister of Mines. Over a period of nearly 75 years the Annual Report became known as the authoritative record of mining in the Province.

However, in 1969 because of the size to which the Annual Report had grown, it was decided to publish all geological and technical reports dealing with solid minerals in a separate volume entitled *Geology, Exploration and Mining in British Columbia.* Thus a new annual publication was initiated with chapters on exploraton and mining related to metals, placer, structural materials and industrial minerals, and coal. *Geology, Exploration and Mining in British Columbia, 1975* will introduce a revised format to allow the three main sections to be released as soon as prepared with the whole to be eventually bound together as a volume. The separate sections to be issued are: *Geology in British Columbia, 1975* — a record of the mapping and research of the Geological Division; *Exploration in British Columbia, 1975* — a record of the performance of the industry in exploration, and *Mining in British Columbia, 1975* — a record of mining in British Columbia and incorporating the Chief Inspector's report. Some parts of the latter that are of restricted interest will be omitted in the final bound volume.

ORGANIZATION

The order of sections in the bound volume is Mining, Exploration, and Geology and the reports that form the body of each section are arranged, where present, in the following order: lode metals, placer, structural materials and industrial minerals, and coal. Introductory statements precede the body of most parts of each section. These are not to be gathered together as a general review of the industry in the final bound volume.

Two maps (Figs. M-1 and M-2) showing the major producing mines are included in *Mining.* One showing the distribution of explored properties is in the pocket of *Exploration* (Fig. E-1).

All reports are arranged *sequentially* according to *National* Topographic System map designation. In the NTS designation, the whole of Canada is divided into primary quadrangles, each 4 degrees latitude by 8 degrees longitude. Each is described by a number, the last digit of which indicates latitude and the first one (or two) indicates longitude (for example, 104). British Columbia is covered by six of these primary quadrangles except for minor areas. Each primary quadrangle is subdivided into 16 map-sheets, each 1 degree latitude by 2 degrees longitude, and described by letters A to P (for example, 104G) proceeding from the southeast corner to the west in the southern panel, then east to the next panel, and so on. Each lettered quadrangle is subdivided into 16 map-sheets, each 15 minutes latitude by 30 minutes longitude and numbered 1 to 16 in an analogous manner to the lettering (for example, 104G/7). Finally each sheet is halved east and west for maps of the 1:50 000 series and each is described, for example, 104G/7E and 104G/7W.

The reports proceed by primary quadrangle from the southeastern part of the Province to the northwestern part. Within each primary quadrangle the order proceeds from A/1E to A/1W to A/2E, and sequentially to P/16E. In some instances, exceptions are made so that adjacent prospects are not widely separated.

An index to published base maps and air photographs may be obtained from the Lands Service, Department of the Environment.

SOURCES OF INFORMATION

A considerable amount of information in the following reports was supplied by mining and exploration companies. Their cooperation in completing and returning exploration questionnaires for each of the properties on which they worked is gratefully acknowledged by the Department and should be greatly appreciated by all users of this report. In some instances this information is augmented by staff geologists or mine inspectors.

Geological, geophysical, geochemical, drilling, and prospecting reports accepted for credit as assessment work contain a large amount of valuable information. The results of work presented in assessment reports that were accepted by April 1, 1976 are summarized and published herein. The last report summarized is Assessment Report 5738. Assessment reports accepted after April 1, concerning properties for which exploration questionnaires have already been submitted to the Department, are entered as references on the property write-ups until this manuscript is finalized for publication. Reports accepted in 1975 for work done in 1974 are not summarized if the work was previously reported on exploration questionnaires. Because of this policy, not all assessment reports appear as references. Assessment Reports are available for study or for duplication at cost one year after the date of their submission.

Geologists and engineers on the staff of the Mineral Resources Branch prepare reports on mineralized areas, deposits, and mines which, in particular, form the body of *Geology in British Columbia* and much of *Mining in British Columbia.*

LOCATIONS

In this report a description of the property location is given as well as the latitude and longitude and NTS designation of the 1:50 000 map-sheet in which the property lies. The latitude and longitude given is either the centre of the property or the area of major work. NTS designation is that of the main showing(s) or for the majority of the claims. In cases where claims are located in more than one NTS sheet, several NTS designations are given.

NAMES

Most often the name or names given to a property are those used for the Mineral Inventory. This is often the name by which the property was originally or formerly known (for example, Glacier Gulch, Magnum). Sometimes the name or names are those of one or more of the claims that constitute the group; occasionally a name is used which is derived from the name of the company owning the property (for example, Bralorne, Granisle). Where established to a reasonable degree of confidence, the Mineral Inventory number, which appeared after the property name in 1974, has been included with the references (for example, MI 82E/SE-1). Where practicable, all names of claims comprising a property are given under the heading 'Claims.'

OWNERSHIP

Wherever possible the owner (or owners) of the claims reported is stated. For located claims the owner is taken directly from Departmental records at the time the manuscript is being prepared. Unrecorded bills of sale and outstanding option agreements sometimes make it impossible to determine the owner at a given date. For Crown grants, unless an extensive search is made, it is sometimes impossible to be certain of their ownership.

In instances when the operator (the company or individual for whom the work was done or who paid for it) is known but the owner is uncertain, then only the operator is recorded; when the owner is also the operator, then only the owner is recorded; and when the owner is not the operator and both are known, then both are recorded.

GEOLOGY

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INTRODUCTION

Geology in British Columbia, 1975 is comprised reports on mineralized areas and mineral deposits based on fieldwork carried out by staff geologists of the Geological Division, Mineral Resources Branch. These reports are concerned either with areas and properties under active exploration, recent mineral discoveries of importance, or are part of a more general study of mineralized areas which will form the body of a subsequent bulletin. Some studies, in part financed by the Department, are carried out by graduate students in geology at various universities.

The geological reports contained in this section are arranged sequentially by National Topographic System map designation, beginning with Southeast British Columbia (NTS Division 82).

Draughting of diagrams in this section was done by J. Armitage, R. Hoenson, V. Kalina, and D. Dorrington.

PUBLICATIONS

Geology, Exploration and Mining in British Columbia, in its revised format, continues to be the main vehicle for publication of data on metal, mineral, and coal publication. *Geological Fieldwork,* an annual publication initiated in 1974, gives a summary review of field results of the Geological Division as soon as possible after the end of the field season.

No bulletins were published during the year.

The following preliminary geological maps were released in 1975:

Map No. 17: *Geology of the Allison – Messezula Lake Area* (plus descriptive notes), by V. A. Preto.

Map No. 18: *Geology of the Central Part of the Nicola Belt,* by V. A. Preto.

Map No. 19: *Geology of Germansen Lake Area,* by H. D. Meade.

The Department published 15 maps in the Mineral Deposit/Land Use map series at a scale of 1:250 000. These maps are intended to portray simply the relative mineral potential of the terrain of the Province. The maps issued total 53 and cover most of the Province west of the Rocky Mountain Trench.

During the year 23 aeromagnetic maps of the Federal-Provincial joint program were issued. These included 14 (1 inch = 1 mile) maps of the Fort Grahame map-area (NTS 94C) and 9 (1:250 000 scale) maps of Central and Northern British Columbia including the Liard Trough of the Northern Rocky Mountains.

Assessment Report Index Maps were made available in 1975. These maps show locations and numbers of assessment reports filed with the Department describing geological, geophysical, geochemical, drilling, linecutting, and some prospecting work done on mineral claims by companies and individuals as part of annual work requirements. The maps are at a scale of 1:50 000 (Highland Valley area), 1 inch = 2 miles (Southern British Columbia), and 1:250 000 (Central and Northern British Columbia). An accompanying list for each sheet shows the assessment report number, type of report, NTS, claims or property names, operator, the year the work was done, and for recent reports, the dates when the reports are removed from the one-year confidential period. The maps and lists are updated monthly.

The following papers were published outside the Department by the geological staff:

Church, B. N.: Quantitative Classification and Chemical Comparison of Common Volcanic Rocks, *Geol. Soc. America,* Bull., Vol. 86, pp. 257-263.

..........: A Tertiary Thermal Event in South-Central British Columbia: Discussion, *Can. Jour. Earth Sci.,* Vol. 12, pp. 896-899.

Kesler, Stephen E., Issigonis, Michael J., Brownlow, Arthur H., Damon, Paul E., Moore, William J., Northcote, K. E., and Preto, V. A.: Geochemistry of Biotites from Mineralized and Barren Intrusive Systems, *Econ. Geol.,* Vol. 70, No. 3, pp. 559-567.

Sutherland Brown, A: Two Meetings – Two Ways, *Geoscience Canada,* Vol. 2, No. 3, pp. 156-158.

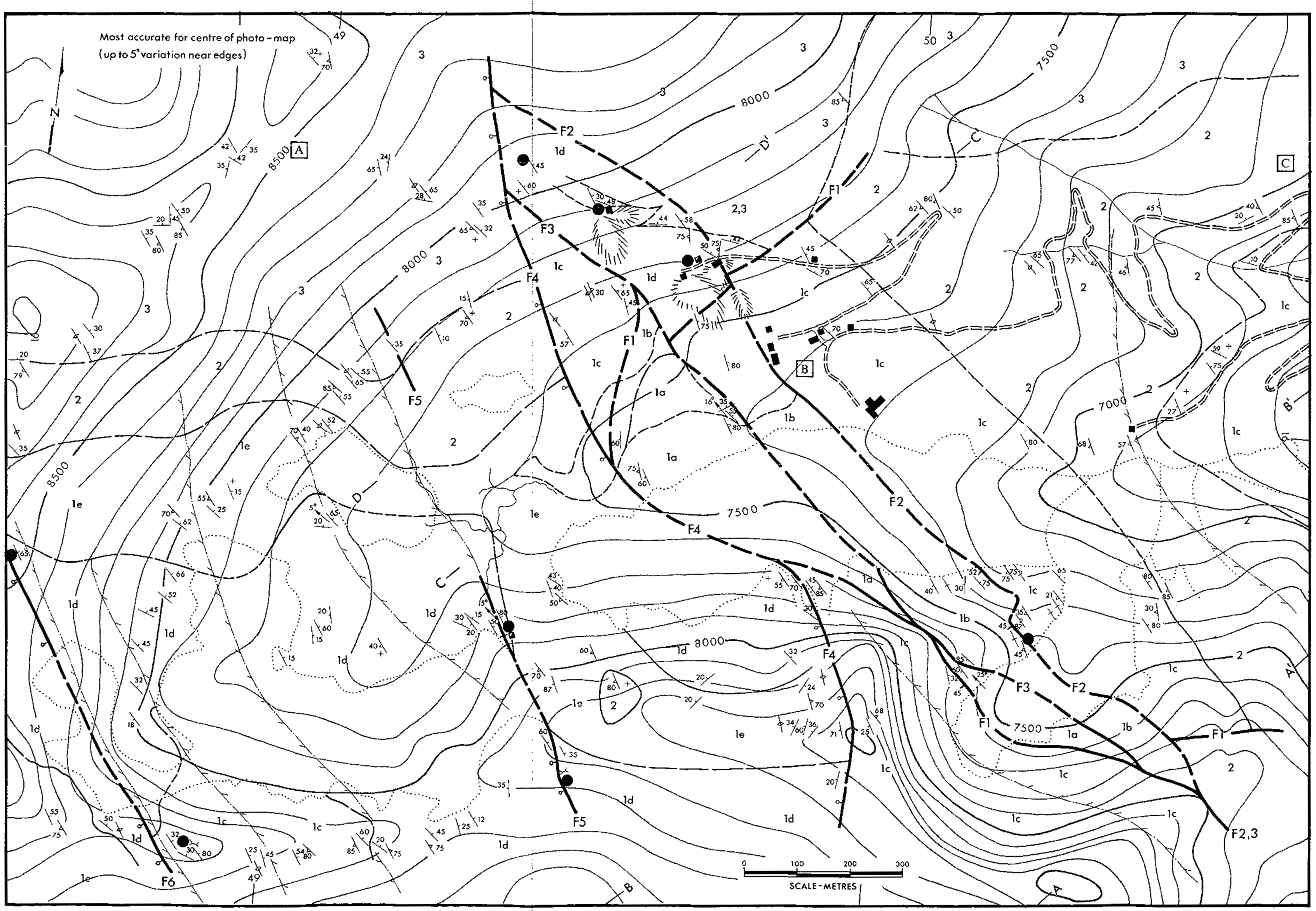


Figure G-1
PARADISE BASIN GEOLOGY ON AIR PHOTO BASE
(maximum distortion at edges)

LEGEND

HORSETHIEF CREEK GROUP — Windermere Supergroup
- 3 limestone, shale

TOBY FORMATION — Windermere Supergroup
- 2 diamictite, conglomerate

MOUNT NELSON FORMATION — Purcell Supergroup
- 1e green siltite, black shale
- 1d grey dolomite (black chert)
- 1c upper white quartzite
- 1b grey dolomite
- 1a red argillite, buff dolomite

SYMBOLS

- Geologic contact: known, approximate, assumed
- Fault: normal (symbol on downthrown side)
- Hinge trace: syncline, anticline on kink fold (barbs on side of rotated limb)
- Adit
- Ruined building
- Trench
- Mine rubble
- Coarse talus
- Passable road
- Bedding
- Cleavage
- Mineralized locality (Pb–Zn)
- Location of stratigraphic column
- Location of cross–sections

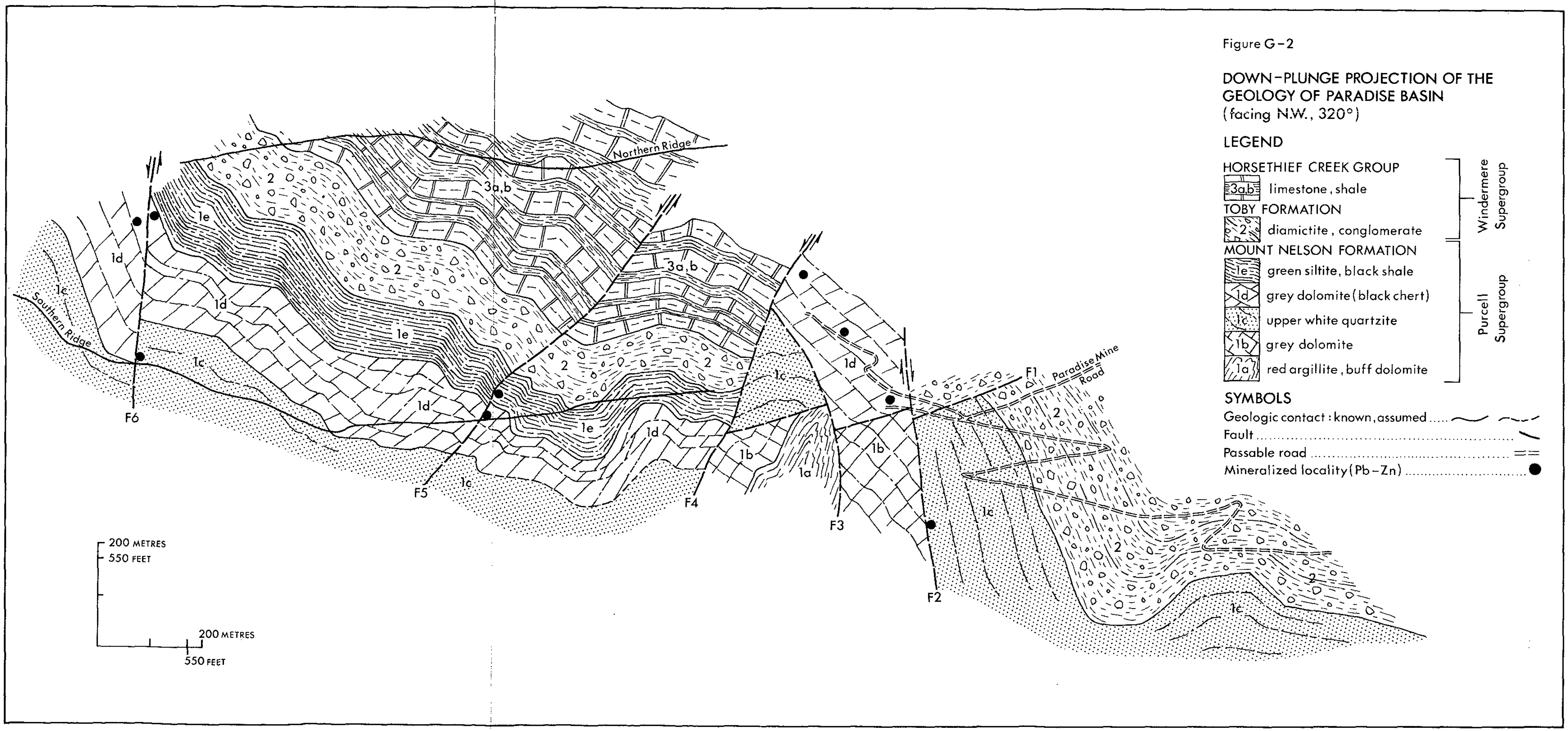


Figure G-2

DOWN-PLUNGE PROJECTION OF THE GEOLOGY OF PARADISE BASIN (facing N.W., 320°)

SURFACE GEOLOGY OF THE PARADISE BASIN
(Location of the Paradise Mine 82K/8W)

By S. J. Atkinson

LOCATION: The old Paradise mine, at an elevation of 2 250 to 2 400 metres, is situated at the head of Springs Creek, a tributary on the north side of Toby Creek. The basin can be reached by car, a total road distance of about 30 kilometres west from Invermere.

Previous geological work was done by Walker (1926) and Reesor (1957, 1973). The present work is part of a larger geologic investigation across the Mount Forster syncline from the Rocky Mountain Trench near Invermere to just east of Mount Nelson. Surface mapping in the Paradise Basin shows mineralization consists of fracture fillings in shattered dolomites of the upper Mount Nelson Formation. The extent of replacement, based on this report, is unknown. The stratigraphy and structural relations across the area show that the main Paradise orebody is related to a Winderemere-age block fault. Locally, much later Mesozoic folding and normal faulting is associated with remobilized material in the form of veins and fracture filling occurrences.

STRATIGRAPHY: Excellent exposures of the upper members of the Mount Nelson Formation (top formation of the Purcell Supergroup), the Toby Formation, and the lower part of the Horsethief Creek Group (both of the basal Windermere Supergroup) occur in the Paradise Basin and on the encircling ridges. Each of these has been subdivided into a number of distinctive members and three stratigraphic sections have been drawn within a 2-kilometre distance (east-west) across the Paradise Basin map-area (Fig. G-3). These sections are schematic and are not drawn internally, bed by bed, to an accurate scale. They serve to illustrate the nature and importance of major lithologic units at a particular level of each stratigraphic column.

MOUNT NELSON FORMATION: In the central and western part of the basin, 400 metres (of a 1 000-metre total section) of Mount Nelson Formation is exposed. With 'a' at the base of the visible section, the following members are apparent:

(a) *Red argillite, cream-coloured argillaceous dolomite:* often present are small-scale grading, ripple cross-laminations, green reduction spots; mud cracks and convolute bedding are much less common.

(b) *Grey dolomite:* finely laminated, stromatolitic (undulatory, hemispherical) and thickly bedded; laminated orange-coloured chert concretions near top of member; 1 metre of oolitic dolomite and a sedimentary breccia with rounded to subangular buff-coloured dolomite blocks in a laminated chert matrix near top of member.

(c) *White orthoquartzite:* crossbedding (0.3 to 1 metre) widespread, foreset angles up to 25 degrees; pervasive symmetrical ripples with continuous crests define a south-southeast-trending shoreline (or wind direction east-northeast); minor green argillite; Upper Mount Nelson quartzite.

(d) *Grey dolomite with black chert:* thickly bedded, light grey dolomite with very distinctive black chert bands and lenses parallel to bedding; dolomite finely

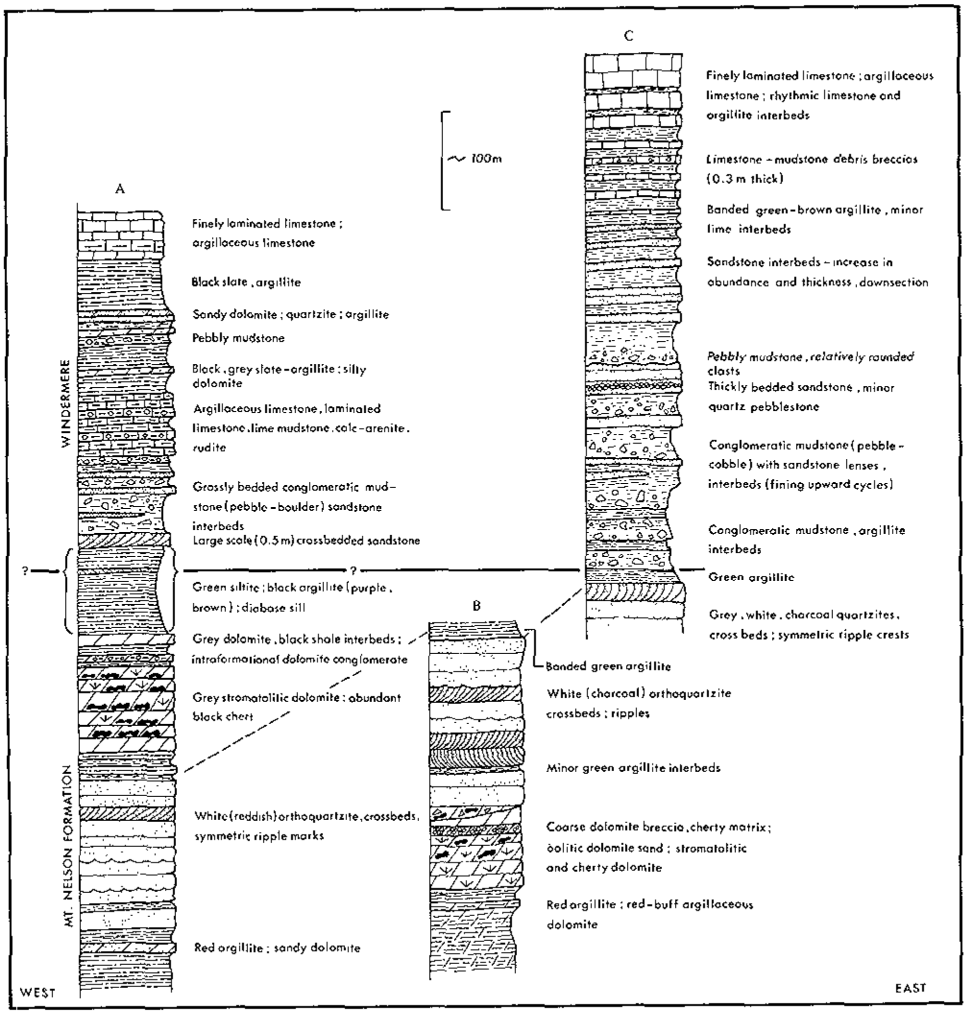


Figure G-3. Schematic stratigraphic sections across the Paradise Basin (locations in Fig. G-1).

laminated, stromatolitic (domal, cylindrical); uppermost beds have clastic textures: intraformational flat pebble conglomerate, and are interbedded with 1 to 2-metre-thick black shale units of the lower part of member 'e'; main occurrences of lead-zinc-silver mineralization occur in this member.

(e) *Green siltite, argillite:* also brown, black; near top but below first diamictite bed some coarse sandstone with crossbeds.

Of the above, members 'd' and 'e' are missing in the eastern part of the Paradise Basin. This is due to the presence of a Windermere-age block fault whose upthrow on the southeast has resulted in the erosion of the upper members of the Mount Nelson *Formation.*

A comparison of the above section with McCammon's excellent description of the Upper Mount Nelson in the Brisco Magnesite Area (*Minister of Mines, B.C.*, Ann. Rept., 1964, pp. 194-199) shows that the two are directly correlative across 40 kilometres. As future mapping uses these superb marker units in the Mount Nelson Formation, it will be a simple matter to reconstruct the all-important regional details of the pre-Windermere surface. This, and information on the Windermere section, will delineate major Precambrian block faults along which future exploration in the Purcell Mountains should be directed.

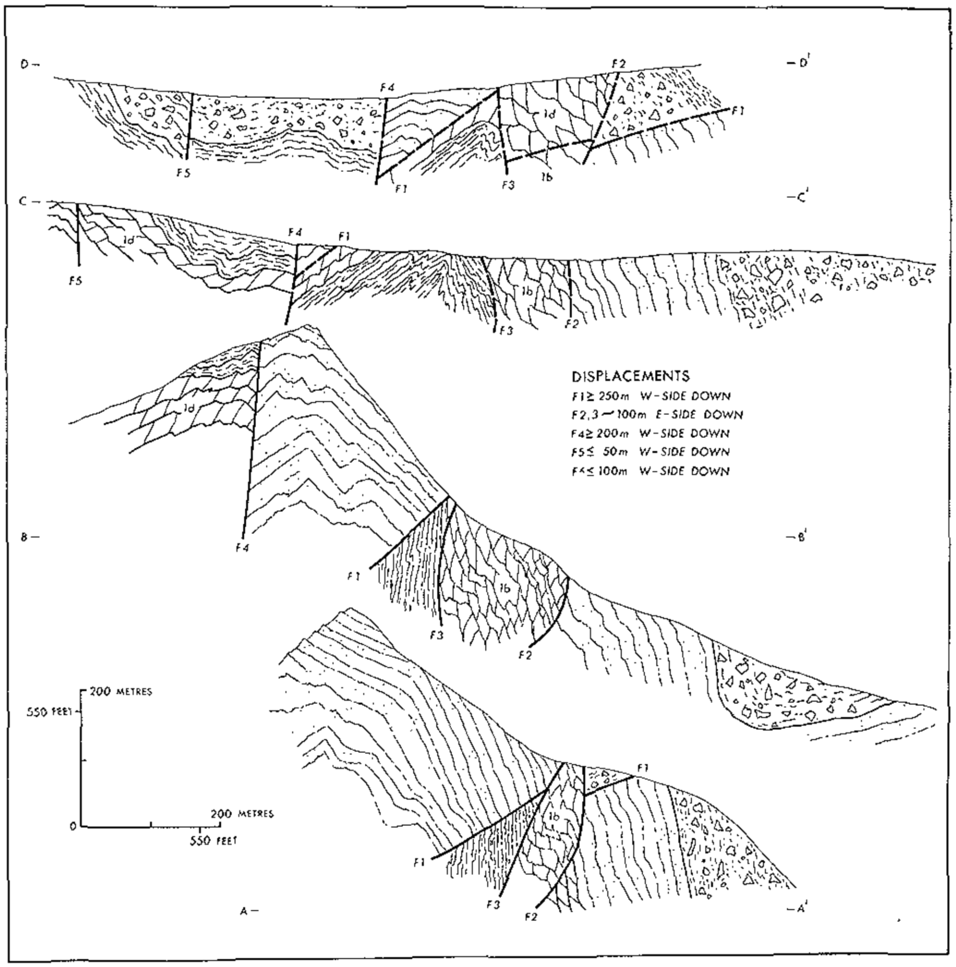


Figure G-4. Geologic cross-sections, Paradise Basin (for legend *see* Fig. G-1).

TOBY – MOUNT NELSON CONTACT: There is a general lack of large angular discordance between the basal Windermere and the members of the Mount Nelson Formation. In the western part of the basin there is even little indication of a disconformable relationship since both the Lower Toby diamictites and the Upper Mount Nelson dolomites are interbedded with a lithologically similar unit. A clear identification of the contact is only possible east of F1 (*see* Fig G-1 and Fig. G-4, section A-A') where the Upper White Quartzite is directly overlain by the conglomerate-diamictite with an obvious angular discordance of 5 degrees.

TOBY FORMATION: The total thickness of conglomerate and diamictite (pebbly mudstone) of the Toby Formation increases from 70 metres at the north and west end of the Paradise Basin (west side of Windermere-age fault, F1) to 200 metres along the upper mine road 2 kilometres further east (east side of F1).

Over much of the basin the Toby Formation is typified by 1 to 7-metre-thick beds of conglomeratic mudstone and conglomerate, with interbedded shales, argillite, and minor sandstone. Here, bedding is more often defined than in sections further east, and the relative thinness of the units suggests that this is a more distal phase of the formation. A few boulder-sized clasts of a quartz-pebble Toby conglomerate were found in the diamictite units of the western section. These are evidence that some kind of erosion and reworking of the lower Windermere is going on even during its deposition. The similarity of these conglomerate clasts with a Toby unit found further east in the map-area suggests a possible source in this direction, to the east of F1. Occasionally slump structures have been observed in the interbedded shale units, and there is much greater abundance of syngenetic pyrite in these black shales than in any equivalent facies seen to the east.

HORSETHIEF CREEK GROUP: Exposure of the Horsethief Creek Group in the Paradise Basin is confined to the northern ridge, above and to the east and west of the main workings. The lower 300 metres of the group is dominated by finely laminated limestones, rhythmically interbedded lime muds and shales (argillites, slates) and clastic carbonates. Within some of these rhythmic limestone-shale members (each individual bed 5 to 15 centimetres thick) small iron nodules (5 centimetres, long diameter) are present. In addition, a few sandstones or coarser grits are found in the western section of the lower Horsethief Creek Group. When present, they are thinly bedded, single occurrences (1 to 4 metres thick), and are not associated with quartz pebblestones such as are common to the eastern and higher parts of the section. Eastward, the volume of quartz sandstones in the lower Horsethief Creek Group increases and it is only a short distance stratigraphically from the top of the sections on Figure G-3 that the first quartz pebblestones appear.

STRUCTURAL GEOLOGY AND AGE AND OCCURRENCE OF MINERALIZATION: The major structure of the Paradise Basin is a small part of the west limb of the Mount Forster syncline. Here, about 25 per cent shortening (natural strain 0.30) is taken up by second order folds with straight limbs 100 to 300 metres long and narrow hinge zones with approximate 120-degree interlimb angles (*see* down plunge projection, Fig. G-2). These approach kink folds in geometry, most of which are formed by moderate to steeply west-dipping kink bands (the enveloping surface of the rotated limb). In all units finite strain is at its highest on the steep limbs of these second order folds – an obvious illustration found in the more ductile oolitic dolomites where axial ratios are 4:1 parallel to fold axes (near 2 235 metres, level of main buildings). In massive brittle units the density of fractures is high and their local accumulation and running together in the steep fold limbs gives rise to shatter breccias. Further multiplication of these fractures causes major surfaces of weakness which are expressed as west-side down, north to northwesterly trending normal faults (F4, F5, and F6 on Figs. G-2 and G-4). The displacement along these faults is small, in the order of 10 to 100 metres. Similar small displacements are associated with contraction faults F2 and F3 which occur at relatively low angles to bedding. Often minor amounts of mineralization are associated with these breccias adjacent to, or along, the fault planes so that, in general, there is a direct correlation between the present local distribution of lead-zinc sulphides/carbonates, quartz (minor copper), and barite veins, and the structures (veins, breccias, faults) on steep limbs of second order kink folds. These veins, breccia zones, and faults are usually at low angles to bedding and their presence can be explained in terms of area changes that occur during kink folding (rotation of steep limbs). All such material can be derived locally during Mesozoic shortening, driven to its present location under high strain gradients. Though the lead-zinc mineralization in the 1d dolomites has been remobilized over short distances during Mesozoic deformation of the Cordillera, its original age could well be Late Proterozoic (Windermere). The reasoning behind this is that the main Paradise orebody is in the immediate vicinity of a Windermere-age block fault (F1 of Figs. G-1, G-2, and G-4) whose downthrow was to the northwest and involved at least 250 metres of stratigraphic relief. This is represented by an extra two members (dolomite, 1d; siltite, 1e) between the basal Windermere diamictite and the upper Mount Nelson quartzite on the north side of F1. Both these members are absent on the southeast side of the fault where basal Windermere directly overlies the upper quartzite.

NOTE ON THE DOWN PLUNGE PROJECTION

Standard cross-sections of the geologic map where fold axes plunge at some angle off the horizontal view the structure obliquely and do not provide an accurate representation of fold geometry. The truest representation is made in a plane perpendicular to the fold axis so that the viewer of such a section is, in effect, looking directly down the plunge of the fold axis (in the Paradise Basin this is 15 degrees to 320 degrees). Where faults occur oblique to this direction, matters are complicated and one must resort to drawing a 'simple' cross-section locally. Such is the case in the area between faults F2 and F4 (Fig. G-2) where the down plunge view is only representative of structures in the centre of the Paradise Basin at the level of the main buildings.

RECOMMENDATIONS: Realization that the main Paradise orebody is probably related to a Windermere-age normal fault makes the future for exploration in the Purcells mainly dependent on tracing the details of Upper Purcell — Windermere stratigraphy. In so doing it becomes immediately possible to distinguish (1) Precambrian-age structures (major fault scarps controlling Windermere sedimentation and local occurrences of different Upper Purcell members) from (2) Mesozoic structures (large scale folding and associated normal faults). Major orebodies can be associated with the first, while it is more likely that small, less economic showings are associated with the second, though often in the immediate vicinity of the first (as at Paradise Basin).

It is of foremost importance to trace the position and details of the Windermere — Purcell contact, paying particular attention to the stratigraphy on either side. Where upper members of the Mount Nelson Formation are missing in the immediate vicinity of a more complete section, a Windermere-age block fault may be implied. It is suggested that exploration might best be directed to the Mount Nelson carbonates in such areas.

REFERENCES

Reesor, J. E. (1957): Lardeau (East Half) Map-Area, British Columbia, *Geol. Surv., Canada, Map 12-1957.*

.... (1973): Geology of the Lardeau Map-Area, East Half, British Columbia, *Geol. Surv., Canada,* Mem. 369, 129 pp.

Walker, J. F. (1926): Geology and Mineral Deposits of the Windermere Map-Area, British Columbia, *Geol. Surv., Canada,* Mem. 148.

BIG LEDGE (82L/8E)

By Trygve Höy

INTRODUCTION: 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 approximately 8 kilometres west of Upper Arrow Lake, between North Forstall Creek and Ledge Creek (Fig. G-5).

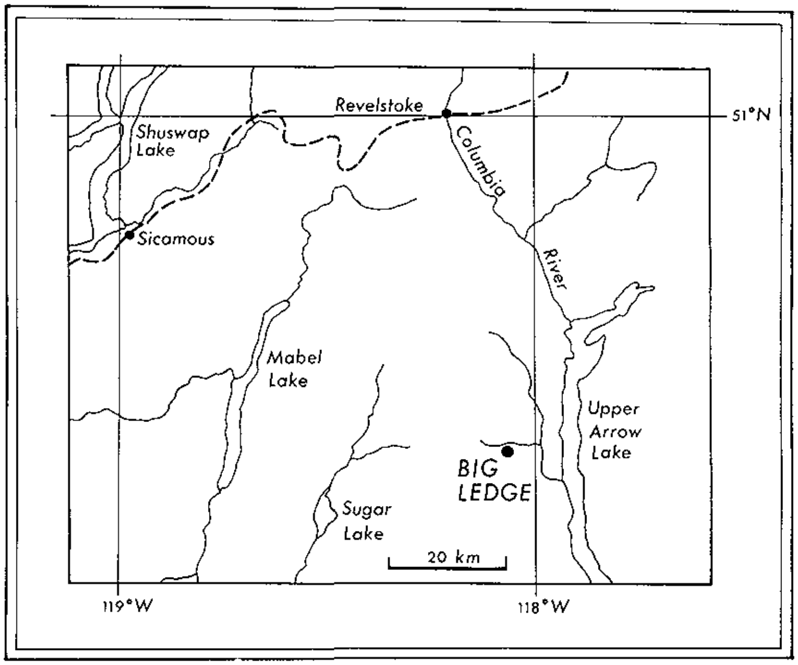


Figure G-5. Location map, Big Ledge.

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 were carried out.

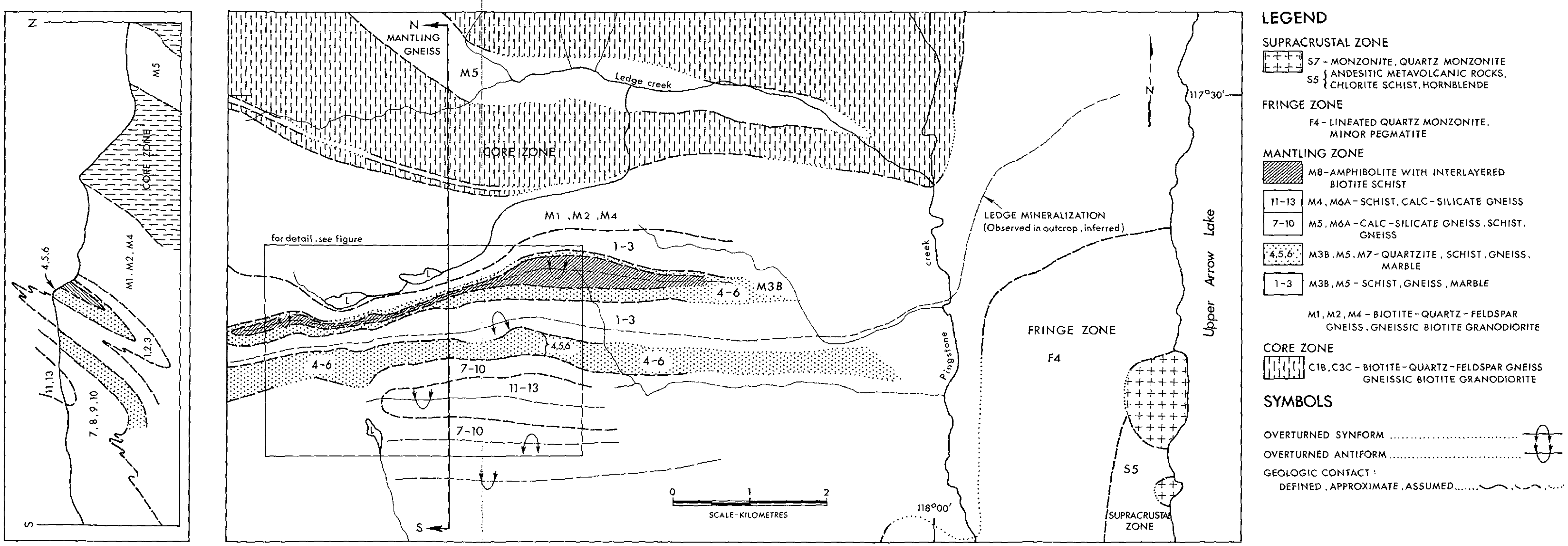
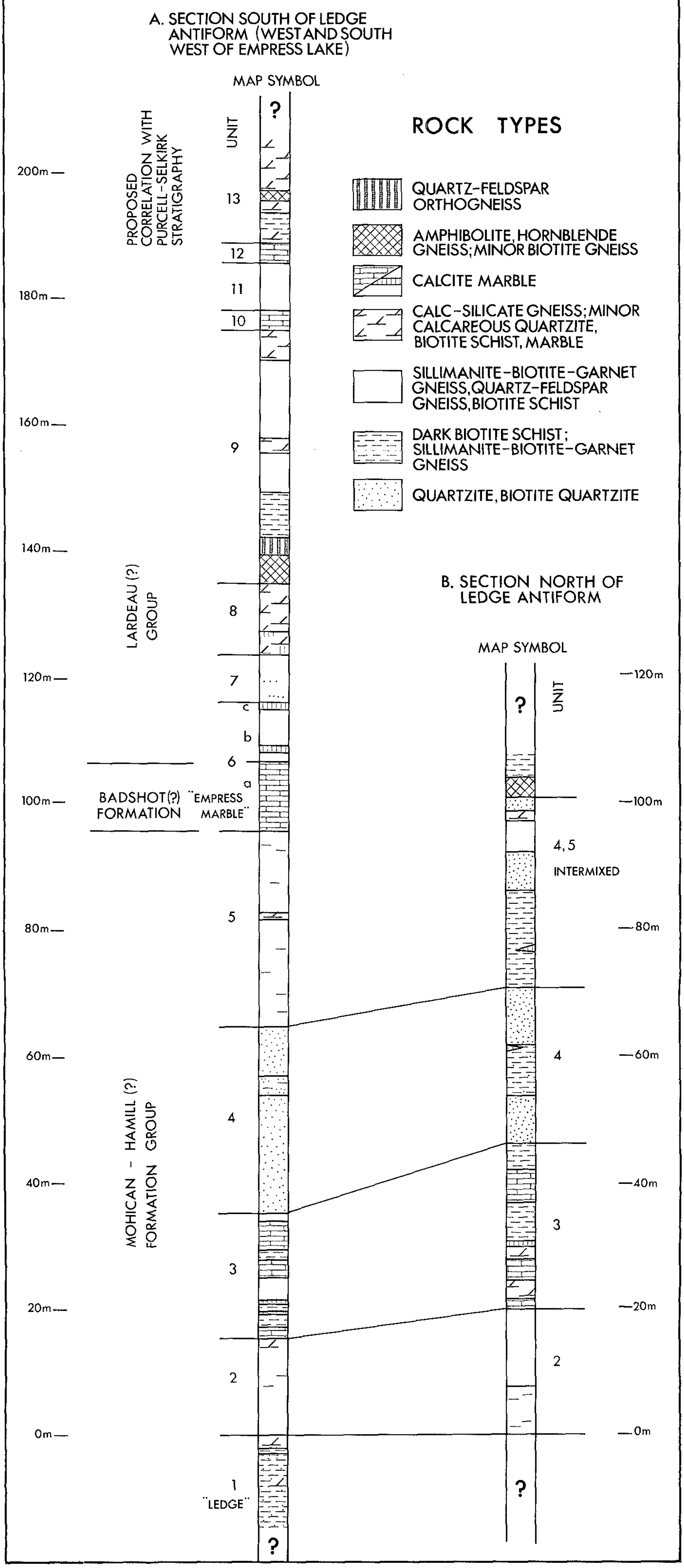


FIGURE G-6 REGIONAL GEOLOGY OF THE BIG LEDGE AREA (SLIGHTLY MODIFIED FROM REESOR AND MOORE, 1971 — LEGEND - S, F, M, C)
EASTERN EXTENSION OF LEDGE LAYER IS FROM ASSESSMENT REPORT 66

FIGURE G-7

SUCCESSION OF METASEDIMENTARY ROCKS IN THE BIG LEDGE AREA



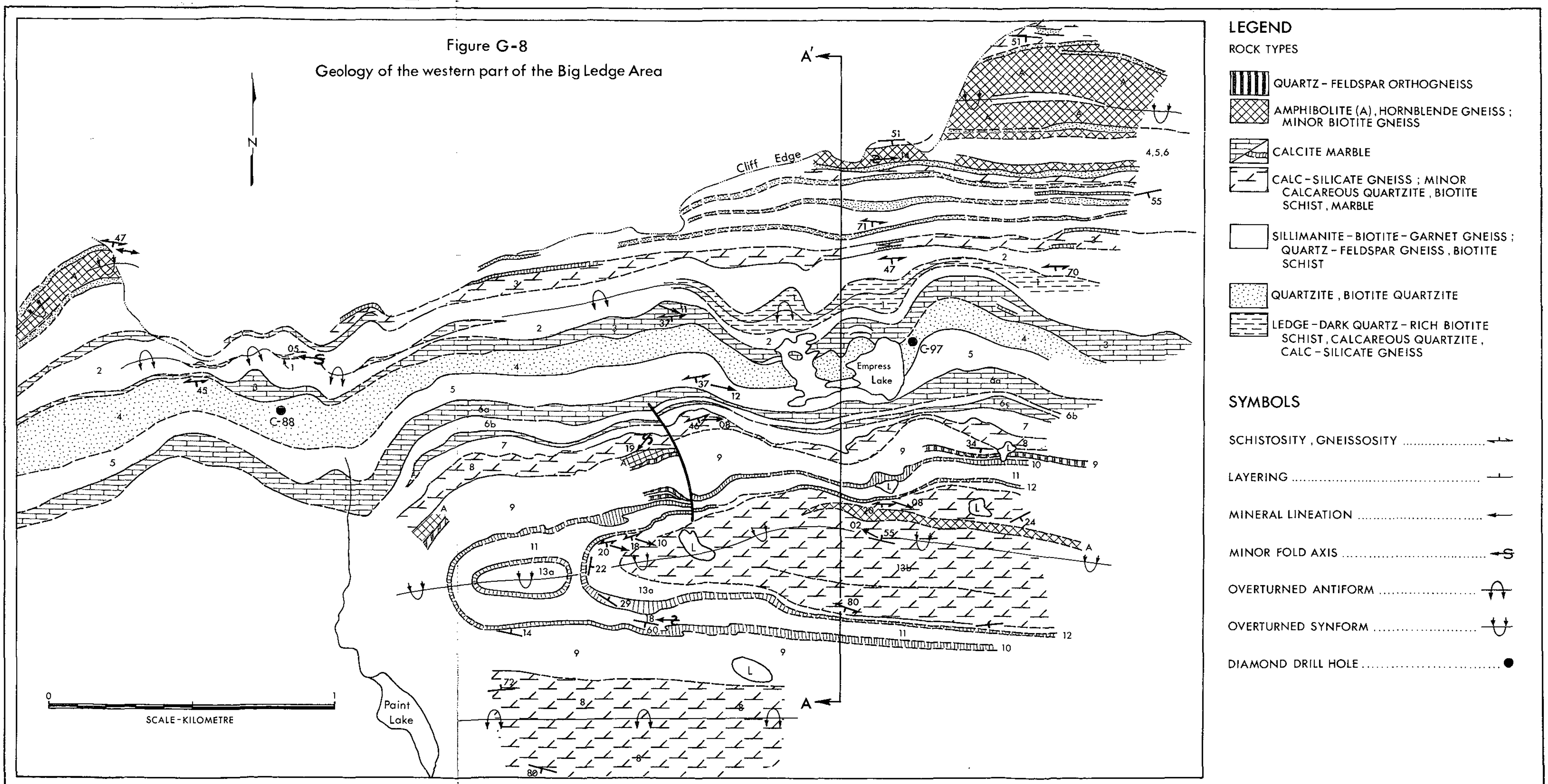


Figure G-8
Geology of the western part of the Big Ledge Area

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. (The following description of the regional geology is summarized from Reesor and Moore, 1971.) A central Core zone in the dome consists of gneissic and migmatitic rocks (Fig. G-6). This zone is surrounded by a heterogeneous assemblage of metasedimentary rocks of the Mantling zone and Fringe zone, the latter containing abundant pegmatite and lineated quartz monzonite. The Supracrustal zone, consisting of quartzite, marble, phyllite, schist, and metavolcanic rocks, forms a cover to the gneisses. The Big Ledge deposit is located south of the Core zone, in an east-west-trending succession of metasedimentary rocks of the Mantling zone.

LOCAL GEOLOGY

STRATIGRAPHY: The detailed succession of metasedimentary rocks in the area of the Big Ledge deposit is illustrated on Figure G-7. This figure illustrates graphically the succession of rocks exposed to the south of the Ledge horizon, from the core of the 'Ledge antiform' to the core of the synform south of Empress Lake (Fig. G-8). The apparent thicknesses are estimated from the cross section (Fig. G-9). In general, the succession includes an extremely heterogeneous mixture of schist and gneiss, quartzite, calc-silicate gneiss, marble, and amphibolite.

A rusty weathering calcareous, graphitic schist interlayered with calcareous quartzite, calc-silicate gneiss, and marble (unit 1) hosts the Big Ledge sulphide mineralization. Although this unit is the lowest structural unit within the area mapped, it is underlain by dominantly quartz-rich paragneiss (unit M1) to the north (Fig. G-6) in which are contained thin partings of sillimanite-bearing garnet-mica schists, and thinly layered feldspathic schists with minor amphibolite of unit M2 (Reesor and Moore, 1971).

The Ledge horizon is overlain by medium to coarse-grained sillimanite gneiss interlayered with finer grained, darker biotite schists (unit 2). Unit 3 is the lowermost unit that contains abundant marble. It consists of at least four distinct marble layers that are separated in the southern section (Fig. G-7, section a) by sillimanite gneiss and biotite schist and, in the northern section (Fig. G-7, section b), by calc-silicate gneiss and biotite schist.

Unit 4 is a very prominent, pure to feldspathic, biotite-quartzite. It is overlain by fairly dark, fine to medium-grained biotite schist (unit 5). Calcareous schist layers and thin quartz-rich partings are common throughout unit 5. A massive, grey-weathering calcite marble, referred to as the 'Empress Marble,' overlies the schists of unit 5. Two additional marble layers, separated by garnet-sillimanite gneiss layers, are also included in the upper part of unit 6. Units 7 to 13 include a heterogeneous mixture of calc-silicate gneiss, marble, garnet-sillimanite gneiss, fine-grained dark biotite schist, and rare thin quartzitic layers.

A number of amphibolite layers occur throughout the stratigraphic succession, the most prominent being a massive or layered amphibolite that is exposed in the core of a synform located to the north of the Big Ledge horizon.

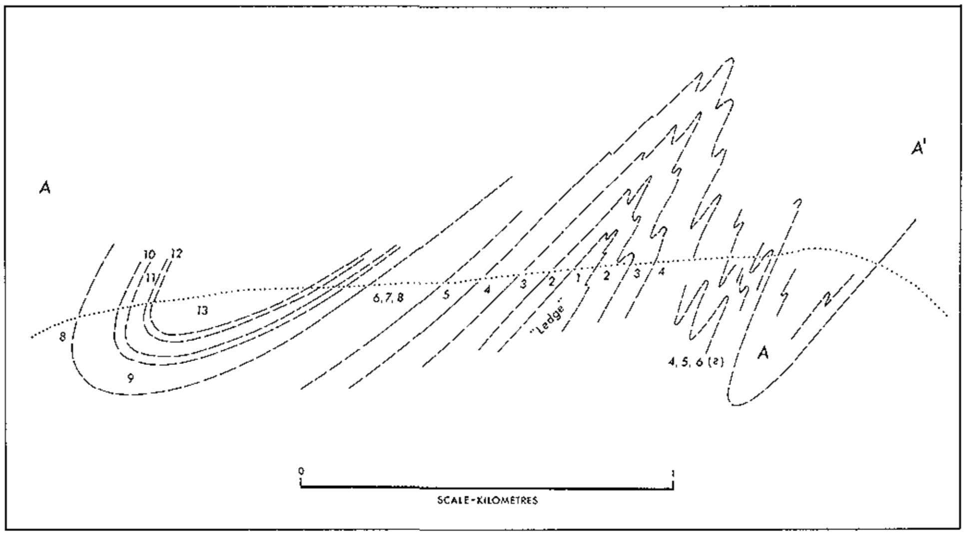


Figure G-9. Vertical cross-section, Big Ledge area.

Plate G-11. Isoclinal minor folds in gneiss northwest of Empress Lake.

Plate G-I. The Ledge antiform, northwest of Empress Lake.

Plate G-III. Minor folds in siliceous marble (unit 10) in the upper (western) limb of the synform south of Empress Lake.

Reesor and Moore (1971) tentatively correlate this stratigraphic package with the Lower Cambrian Hamill-Badshot sequence in the Selkirk and Purcell Mountains. Metasedimentary rocks of the overlying Fringe zone are correlated with Lardeau Group rocks. A more detailed correlation, proposed here, is based solely on gross lithological similarities and is more speculative. However, similarities between the succession in the Big Ledge area and the succession of metasedimemtary rocks in the area of the Bluebell mine at Riondel in the central Kootenay Arc (Höy, 1974) are apparent and are worth commenting on. The thickest marble unit in the Big Ledge area, the 'Empress Marble' (unit 6), is tentatively correlated with the Badshot marble. Prominent quartzite layers are restricted to the succession below this marble layer, being confined to unit 4 and to a lesser extent to the top of unit 5. These quartzites and the calcareous schists, marbles, pelites, and dark graphitic schist (units 1 to 5 inclusive) are probably the equivalents of the interlayered quartzites, calcareous schists, and marbles of the Mohican Formation, which directly underlies the Badshot Formation in the Riondel area (and throughout the Kootenay Arc). The Index Formation, a succession of schists, hornblende gneiss and amphibolite, calc-silicate gneiss, and biotite-quartz-feldspar gneiss overlies the Badshot marble in the Riondel area. The lithologically similar units overlying the Empress marble (units 7 to 13) are correlated with the Index Formation.

STRUCTURE: The structure of the map-area (Fig. G-8) is dominated by a series of east-west-trending open to tight folds. These are inclined to the south, overturned to the north (Fig. G-9), and plunge variably to the east and west.

The Ledge 'horizon' is in the core of one of these folds, called the 'Ledge antiform' (Plate G-I), which is a tight antiform, inclined to the south and overturned to the north. 'Interlayered' quartzites and schists north of the Ledge antiform result from tight in-folding of units 4 and 5 in the underlimb of the Ledge antiform. Minor structures related to these folds are common. The prominent mineral foliation throughout the area is axial planar to these structures and mineral lineations parallel their fold axes. Tight to isoclinal minor folds, commonly rootless and with attenuated limbs and appressed hinge zones, are common as well (Plate G-II).

The relatively open synform south of Empress Lake contains in its core the structurally highest rocks of the map-area (unit 13). Minor folds in the upper limb of the synform (Plate G-III) have the correct sense of vergence for this structure. It is uncertain whether or not this fold represents the same phase of deformation as the much tighter Ledge antiform to the north or whether it is a later structure. Interference structures such as tight to isoclinal minor folds refolded by structures related to this southern synform, which would clearly indicate two 'phases' of deformation, were not observed.

Pronounced north-northwest-trending air photo lineaments which transect the map-area show little if any apparent offset, although layering attitudes are sometimes disrupted across them.

MINERALIZATION: Showings of pyrrhotite, pyrite, and sphalerite occur along a 'layer' (unit 1), known as the 'Ledge' for a distance of over 10 kilometres (Assessment Reports 12 and 66; Fig. G-6, this report). The mapping of the western part of the Ledge (Fig. G-8) indicates that it is in the core of an antiform. Here the Ledge is not a single layer, but rather part of a succession that is repeated by folding.

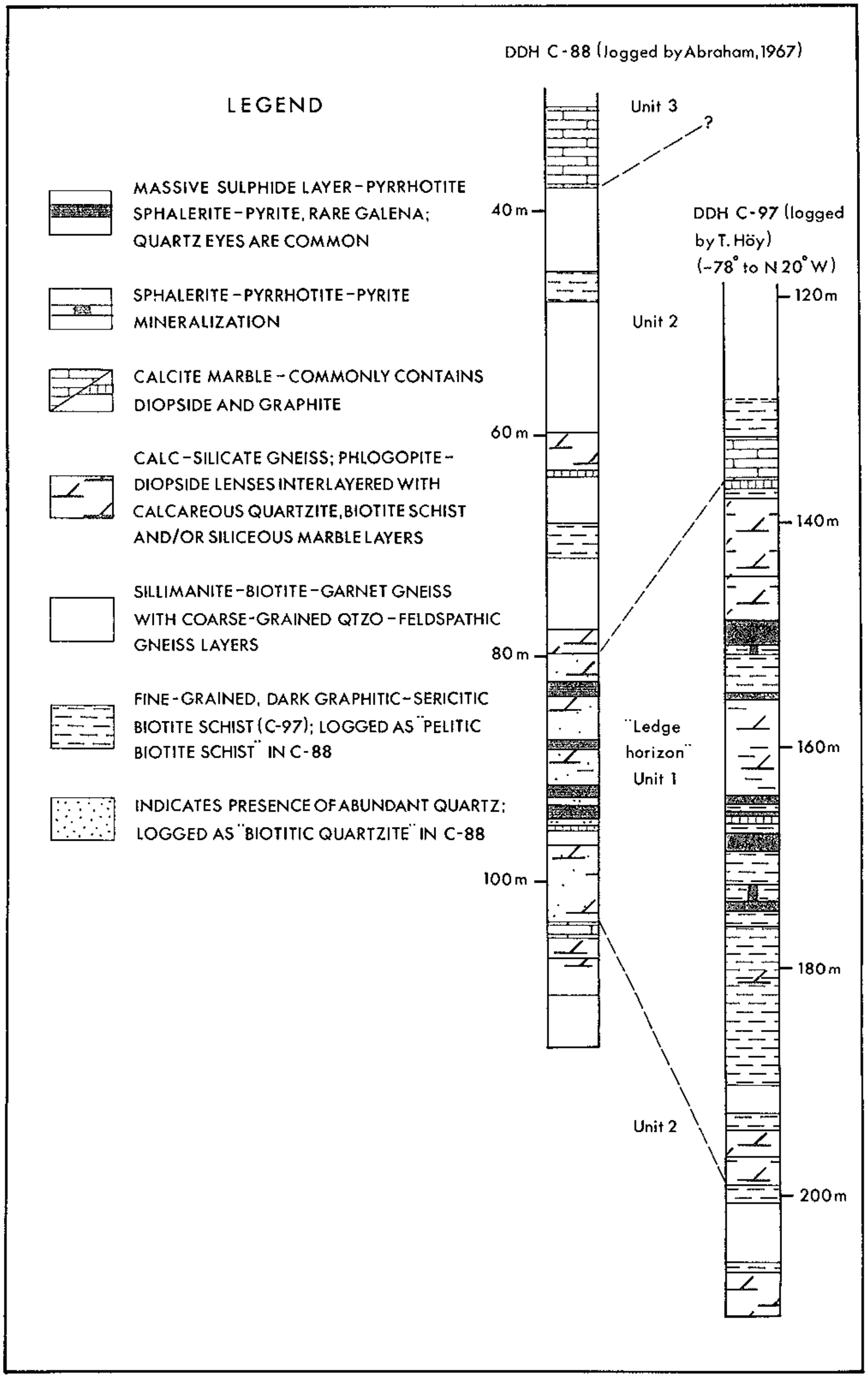


Figure G-10. Drill hole sections through the Big Ledge.

The Ledge consists of fine-grained, dark graphitic-sericitic schist, dark quartz-rich schists (grading to dark biotite quartzites), calc-silicate gneiss, and minor siliceous marble layers. Pyrite and pyrrhotite are disseminated throughout these units, resulting in the characteristic rusty weathering nature of the Ledge.

Figure G-10 illustrates two drill sections through the Ledge. C-88, logged by Abraham (1967), is located northwest of Paint Lake (Fig. G-8) and C-97 is located immediately east of Empress Lake. These sections show that there are at least four massive sulphide layers within the Ledge. It is not known if these are individual layers or fold repetitions of one or more layers. The massive sulphide layers consist of medium to coarse-grained pyrrhotite or pyrite with varying amounts of dark sphalerite. Most commonly the pyrite and pyrrhotite are segregated from each other; for example, the sulphide layer at approximately 170 metres depth (C-97) shows distinct mineral zoning, with a core of pyrite-sphalerite, and rims of pyrrhotite with only minor sphalerite. Sphalerite is commonly aligned parallel to layering in the adjacent schists. Quartz-eyes are common in the massive sulphide layers.

Sphalerite, with pyrrhotite and pyrite, also occurs as discrete blebs and as thin (1 to 2-millimetre) discontinuous layers in all other rock types within the Ledge. As well, the sulphides occur in small fractures crosscutting the layering and foliation.

The proposed correlation of rock units in the Big Ledge area with the Hamill — Mohican — Badshot — Lardeau sequence in the Kootenay Arc (*see* section on stratigraphy) implies that the Ledge is within rocks correlative with the Mohican Formation (or perhaps an upper calcareous part of the Hamill Formation). This is in contrast with deposits of lead-zinc mineralization in the Kootenay Arc which occur most commonly within the overlying Badshot marble. However, a number of occurrences within the upper Hamill or Mohican are known, such as 'Bannockburn' deposit east of Trout Lake.

REFERENCES

Abraham, B. E. (1967): Metamorphic Petrology of Big Ledge Property near Upper Arrow Lake, B.C., unpublished B.Sc. Thesis, *U.B.C.*

Höy, T. (1974): Geology of the Riondel Area, *B.C. Dept. of Mines & Pet. Res.*, Prelim. Map No. 16.

Minister of Mines, B.C., Ann. Rept., 1964, p. 130; 1965, p. 196; 1966, p. 218.

Reesor, J. E. and Moore, J. M. (1971): Petrology and Structure of the Thor-Odin Gneiss Dome, Shuswap Metamorphic Complex, British Columbia, *Geol. Surv., Canada*, Bull. 195.

KINGFISHER, BRIGHT STAR (82L/10) (FX, FC, COLBY)

By Trygve Höy

INTRODUCTION: The property of Colby Mines Ltd. is located 48 kilometres by road east of Enderby, immediately east of Kingfisher Creek (Fig. G-11). The property straddles a low northeast-trending hill between Kingfisher Creek and a southern tributary of Kingfisher Creek. Year round access is possible by a well-maintained gravel road

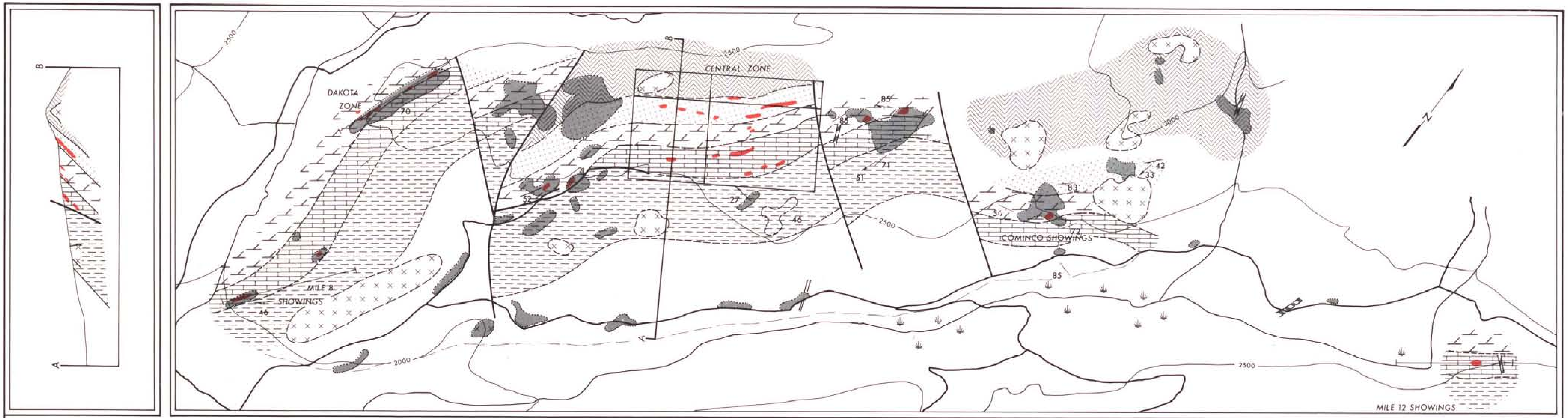


Figure G-12

GEOLOGY OF THE COLBY MINES AREA

LEGEND

- × × × Granite-pegmatite
- Feldspar-porphyry dyke
- 1 Hornblende gneiss; amphibolite and biotite gneiss; minor calc-silicate gneiss
- 2 Biotite gneiss and pegmatite; minor calc-silicate gneiss
- 3 Marble; minor biotite gneiss and amphibolite
- 4 Calc-silicate gneiss; minor biotite gneiss, quartzite
- 5 Quartzite and marble, interlayered
- 6 Biotite gneiss and pegmatite, minor marble, calc-silicate gneiss, and quartzite

SCALE-KILOMETRES 0 0.5 1.0

SCALE-MILES 0 0.5 1.0

SYMBOLS

- Sphalerite-pyrrhotite-pyrite ± galena mineralization
- Geological contact: defined, approximate, assumed
- Layering
- Schistosity, gneissosity
- Mineral lineation
- Fault
- Road
- Outcrop
- Cut baseline
- Contours 2500'

1975 pg G18A

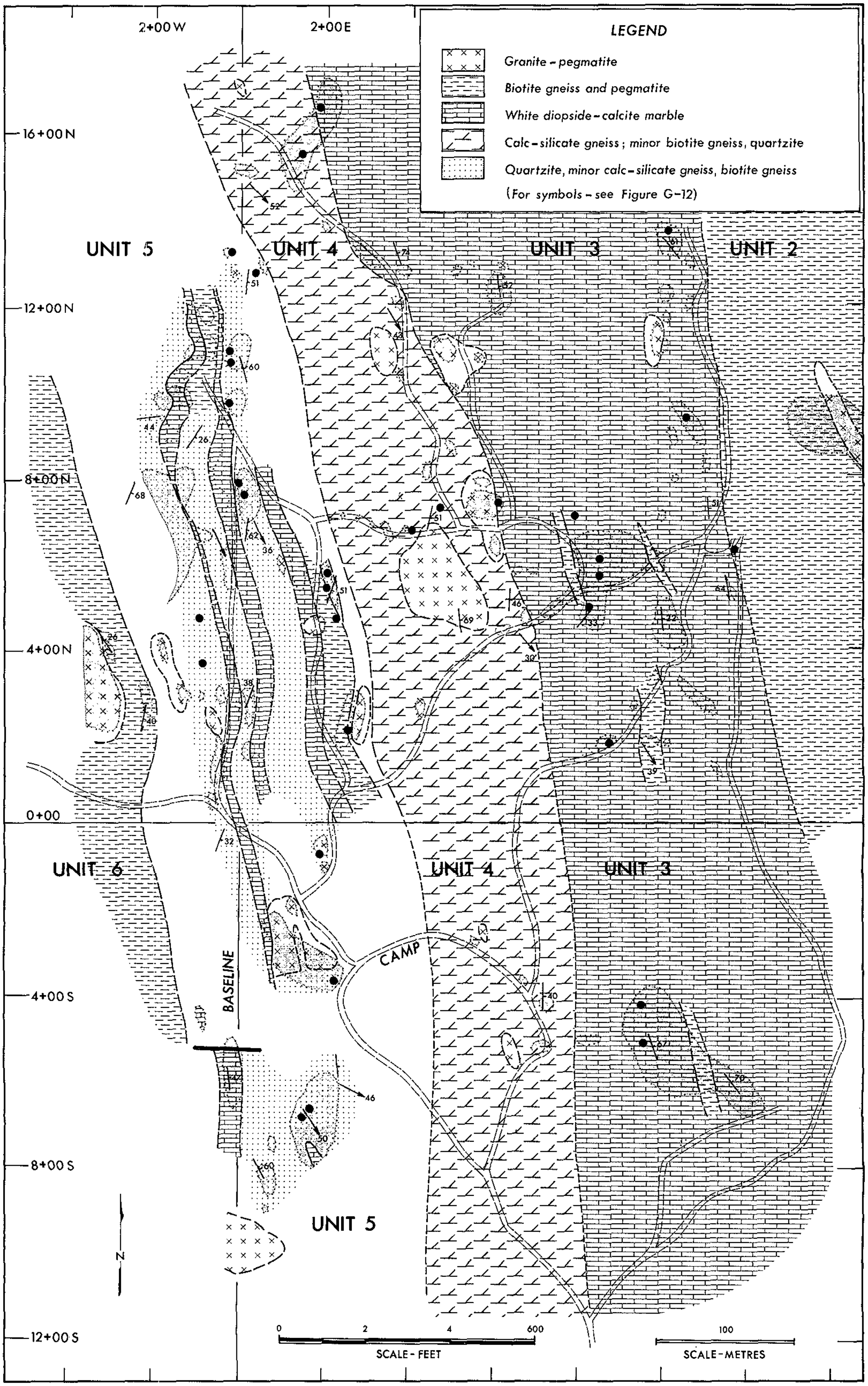


FIGURE G-13 GEOLOGY OF THE CENTRAL ZONE, COLBY MINES LTD.

extending north from the Enderby-Mable Lake road. The climate of the region is temperate, with moderate snowfall during the winter months. Vegetation is generally dense, characteristic of temperate rain forests.

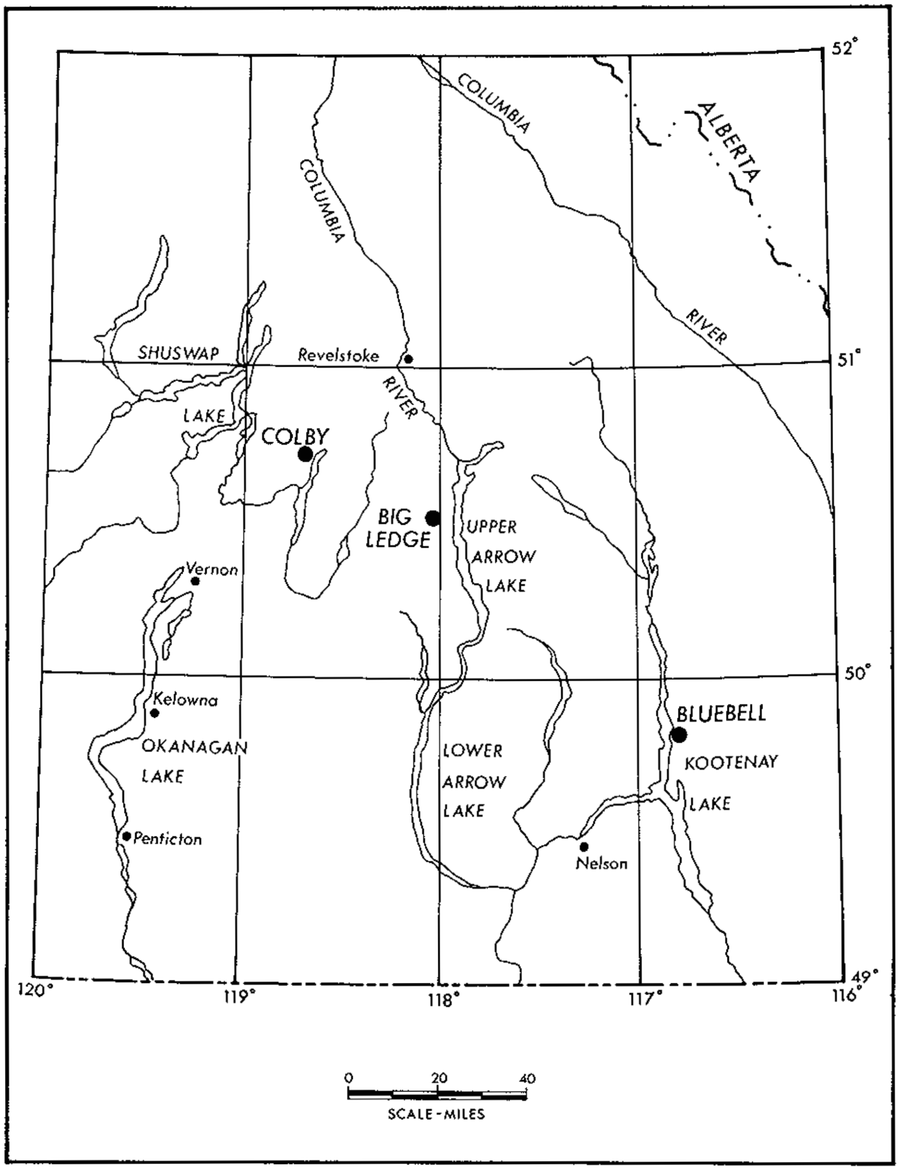


Figure G-11. Location map, Colby Mines Ltd., Big Ledge and Blue Bell mines.

The Colby property includes a stratabound zinc deposit contained in marble, quartzite, and calc-silicate gneiss units of the Monashee Group. These units have been traced 6 kilometres over the length of the property with known 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. G-12).

HISTORY: The original showings in the area of Colby's property (the 'Central zone') were discovered in 1963 by W. C. Rotar of the Bright Star Trio Syndicate, Vernon. The showings to the northeast (the 'Cominco' and 'Mile 12' zones) were located by The Consolidated Mining and Smelting Company of Canada, Limited (Cominco Ltd.).

During 1964, diamond drilling and bulldozer trenching were done on the 'Bright Star' property by Sheep Creek Mines Limited. Six diamond-drill holes, totalling 195 metres, were drilled before the option on the property was dropped. In the fall of 1964, R. G. Gifford of Cominco mapped and conducted a magnetometer survey on the Bright Star and Kingfisher claims.

In 1965 Dakota Silver Mines Ltd. located claims just west of the Bright Star claims (the 'Dakota' zone). Several trenches were blasted on this zone and two westerly inclined holes were drilled toward the trenched area.

From 1965 to 1973, work on the Bright Star-Kingfisher property consisted of trenching, some diamond drilling, and a magnetometer survey and soil sampling program conducted for Bright Star Trio Mining Ltd.

Colby Mines Ltd. located 34 claims over the original Bright Star property in 1973 (the FX and FC claims) and subsequently expanded the property to over 130 claims to include the original Kingfisher and Dakota claims as well.

Work by Colby Mines Ltd. during 1973 and the early part of 1974 was concentrated on the Bright Star showings. This work included geological mapping by E. O. Chisholm approximately 1 700 metres of diamond drilling and electromagnetic and magnetometer surveys. Further trenching in August and September of 1974 led to the discovery of lead-zinc mineralization 150 to 200 metres east and downslope of the original Bright Star showings. These new showings are in a nearly pure marble layer striking north-northeast and dipping to the east. This discovery led to the staking in October and November, 1974, of approximately 250 claims in the immediate area. Testing of the marble unit in the Central zone is restricted to a number of exploratory packsack drill holes.

GEOLOGY

REGIONAL SETTING: The property lies 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 an area studied by Okulitch (1974). These authors assign rocks in the Colby 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 probably represents an originally conformable package of sedimentary rocks, though it is not known whether unit 1 or unit 6 is the older. As unit 6 is the structurally lowest metamorphic unit in the map-area, it is described first.

Unit 6 which includes all rock units beneath unit 5 is exposed only in the western part of the Central zone and north of the Cominco showings (Fig. G-12). This unit consists dominantly of medium to coarse-grained garnet-biotite gneiss that is intruded by many granite-pegmatite sills and dykes. Some white quartzite, marble, and rare calc-silicate gneiss layers occur in unit 6.

Unit 5 is well exposed in the Central zone (Fig. G-13) and northwest of the Cominco showings. 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. G-13).

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, containing scattered diopside grains throughout. The rocks of unit 4 host sulphide mineralization in the Central zone, Dakota zone, and Cominco showings. This unit is not exposed at the Mile 8 or Mile 12 showings.

Unit 3 is a massive white marble up to several hundred metres thick, and 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 contained within unit 3.

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

Unit 1 is exposed in road cuts along the southeastern edge of the property. It 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 amphibolite-rich layers with lighter feldspar and calc-silicate-rich layers.

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 equidimensional stock-like intrusions several hundred metres in diameter. Only the largest of these are shown on the map (Fig. G-12). 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 (Plate G-IV).

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.

In summary, the succession of metasedimentary rocks in the Colby area includes biotite gneiss, interlayered quartzite and marble, and calc-silicate gneiss overlain by a thick marble layer (unit 3). These units are in turn overlain by biotite gneiss and minor associated calc-silicate gneiss, and then calcareous hornblende gneiss and amphibolite of unit 1.

COLBY AREA	BIG LEDGE AREA[1]	RIONDEL (BLUEBELL MINE) AREA[2,3]		
		L4	biotite-quartz-feldspar gneiss	Index Formation (Lardeau Group)
		L3	calc-silicate gneiss, impure rusted marble layers, one quartzite layer	Index Formation (Lardeau Group)
UNIT 1: hornblende gneiss, amphibolite, biotite gneiss, minor calc-silicate gneiss		L2	biotite-hornblende gneiss and amphibolite, minor calc-silicate and marble layers, rare schistose layers	Index Formation (Lardeau Group)
UNIT 2: biotite gneiss, pegmatite, minor calc-silicate gneiss	UNITS 7–13: schist, gneiss, calc-silicate gneiss, thin marbles, amphibolite	L1	micaceous schists	Index Formation (Lardeau Group)
UNIT 3: marble	Empress marble	B	marble	Badshot
UNIT 4: calc-silicate gneiss, minor biotite gneiss, quartzite UNIT 5: interlayered marble and quartzite	UNITS 1–5: dark schists, quartzite, calc-silicate gneiss, marble	M	schist, quartzite, impure marble	Mohican Formation
UNIT 6: biotite gneiss and quartzite		H4	dark quartzite, quartz-rich schists	Hamill Group
		H3	white quartzite	Hamill Group
		H2	schist, quartzite, siltstone, minor amphibolites	Hamill Group

[1] HØY, T., (1976): Geology of the Big Ledge Area, *British Columbia Department of Mines and Petroleum Resources*, GEM, 1975.

[2] HØY, T., (1974): Structure and Metamorphism of Kootenay Arc Rocks around Riondel, British Columbia, unpublished Ph.D. thesis, *Queen's University*, Kingston, Ontario.

[3] HØY, T., (1974): Geology of the Riondel Area, *British Columbia Department of Mines and Petroleum Resources*, Preliminary Map No. 16.

Figure G-14. Correlation of units in the Colby area with the Big Ledge and Riondel area.

Metasedimentary units in the Colby area are tentatively correlated with a lower Paleozoic succession of rocks in the Bluebell mine area, 170 kilometres to the southeast. In both areas upper amphibolite grade regional metamorphism associated with intense deformation has virtually obliterated primary structures and textures. Hence the correlation is based entirely on the similarity of rock types and sequences.

The prominent marble unit in the Colby area (unit 3) is tentatively correlated with the lower Cambrian Badshot marble in the Riondel area. Both units are relatively pure calcite marbles and both host significant lead-zinc deposits. Mohican Formation schists, quartzites, and marbles underlying the Badshot Formation in the Riondel area are the implied equivalents of the calc-silicate gneisses, schists, biotite gneisses, marbles, and quartzites of units 4 and 5 in the Colby area. Unit 6 may be a more 'argillaceous' equivalent of the upper part of the Hamill Group.

Correlation of post-Badshot rocks is more straightforward. The micaceous schists and gneisses overlying the Badshot in the Riondel area are correlated with the gneisses of unit 2. Calcareous hornblende gneiss and amphibolite overlie these units in both areas. The correlation is summarized in Figure G-14. Also included in this figure is the Big Ledge section (Höy, 1977). Confirmation (or rejection) of these proposed correlations must await more regional stratigraphic studies, particularly in the Colby area.

STRUCTURE: The structure of the Colby Mines area is dominated by four northwest-trending faults (Fig. G-12). 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. G-12). The marble in the Central zone is not recognized to the southwest where biotite-garnet gneiss of unit 2 is in contact with 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, although 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, although generally it also plunges to the southwest. Distinction between these minor fold types is not always possible.

METAMORPHISM: The rocks of the Colby area have been subjected to high-grade regional metamorphism; aluminous gneisses contain sillimanite and occasionally, kyanite.

Diopside is common in calc-silicate gneisses and marbles throughout the Colby area. The assemblage, diopside-fosterite, a higher temperature assemblage than just diopside, was observed in one marble sample from the Mile 8 showing. This assemblage is indicative of temperatures higher than 560 degrees centigrade (at pressures of 5 kb) (Höy, 1976). Chondrodite has been identified in marbles from three localities. It occurs in the assemblage calcite-phlogopite-diopside-chondrodite and, according to J. Bourne (Geological Survey of Canada, personal communication), is indicative of upper amphibolite and/or granulite facies of metamorphism and relatively high partial pressures of fluorine. Scapolite is common in calc-silicate gneisses, frequently being associated with diopside and plagioclase.

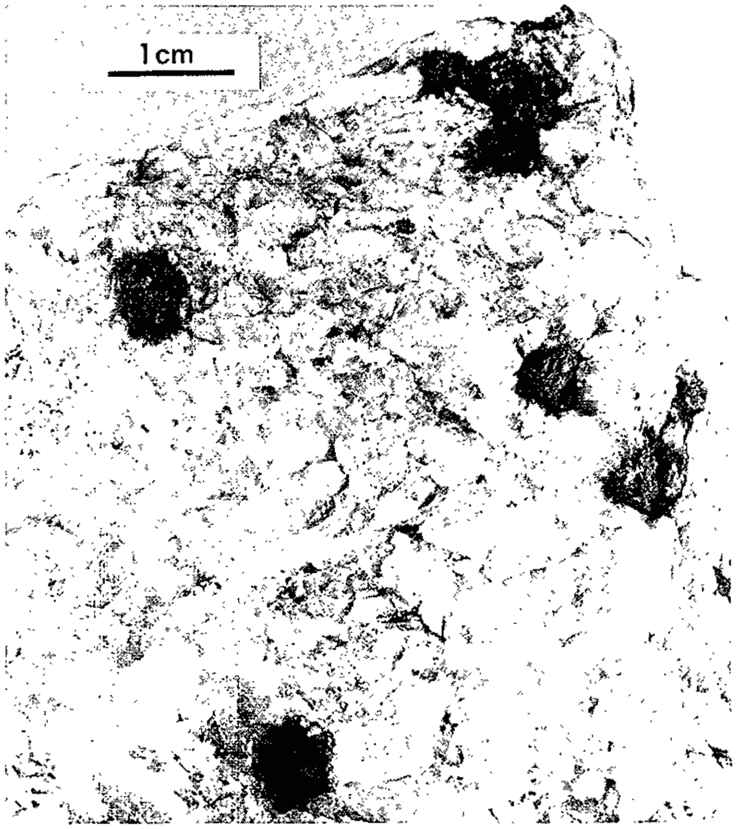


Plate G-IV. Garnet-bearing quartz feldspar pegmatite (photo, R. E. Player).

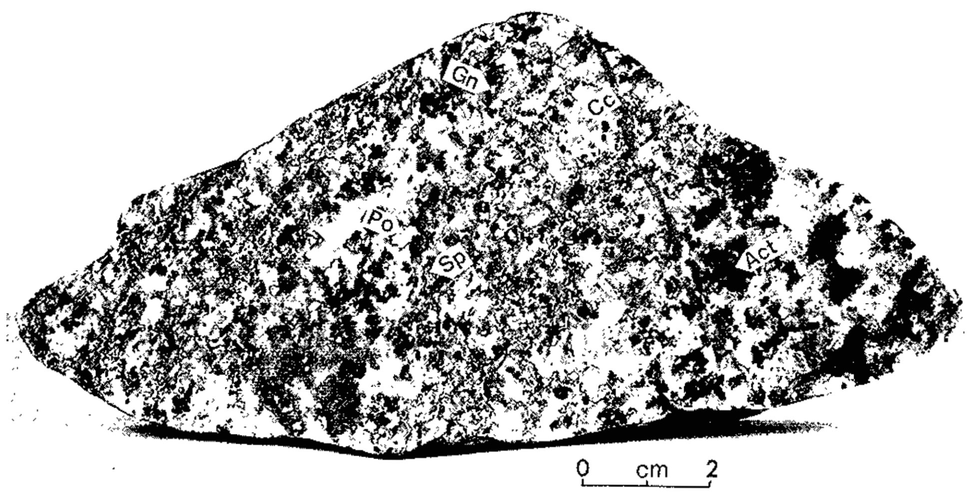


Plate G-V. Mineralized marble from the Mile 13 showing. Pyrrhotite (Po) and sphalerite (Sp) are abundant; galena (Gn) is very rare; calcite (Cc), diopside (Di), and actinolite (Act) constitute the matrix (photo, R. E. Player).

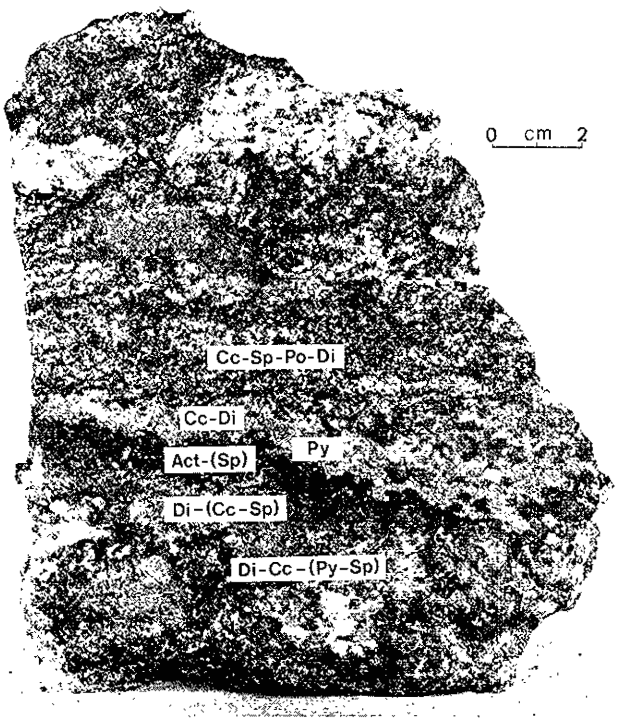


Plate G-VI. Crude layering in marble from the Mile 13 showing (photo, R. E. Player)

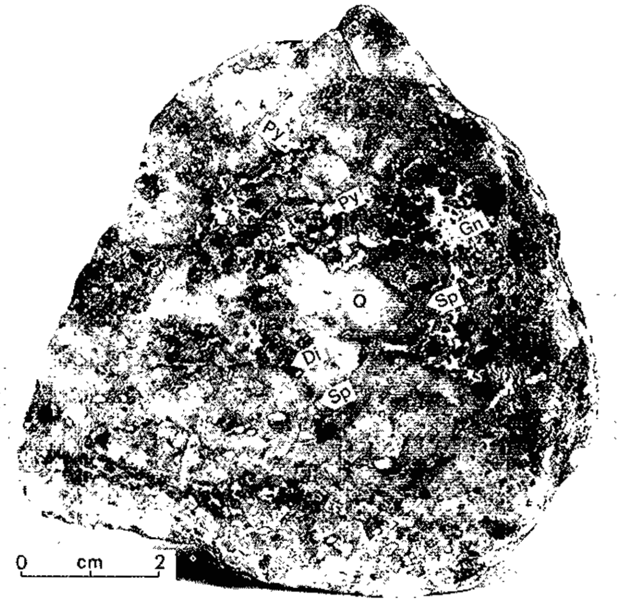


Plate G-VII. Calcareous (diopside-bearing) quartzite mineralized with galena (Gn), sphalerite (Sp), and rare pyrite (Py) (photo, R. E. Player).

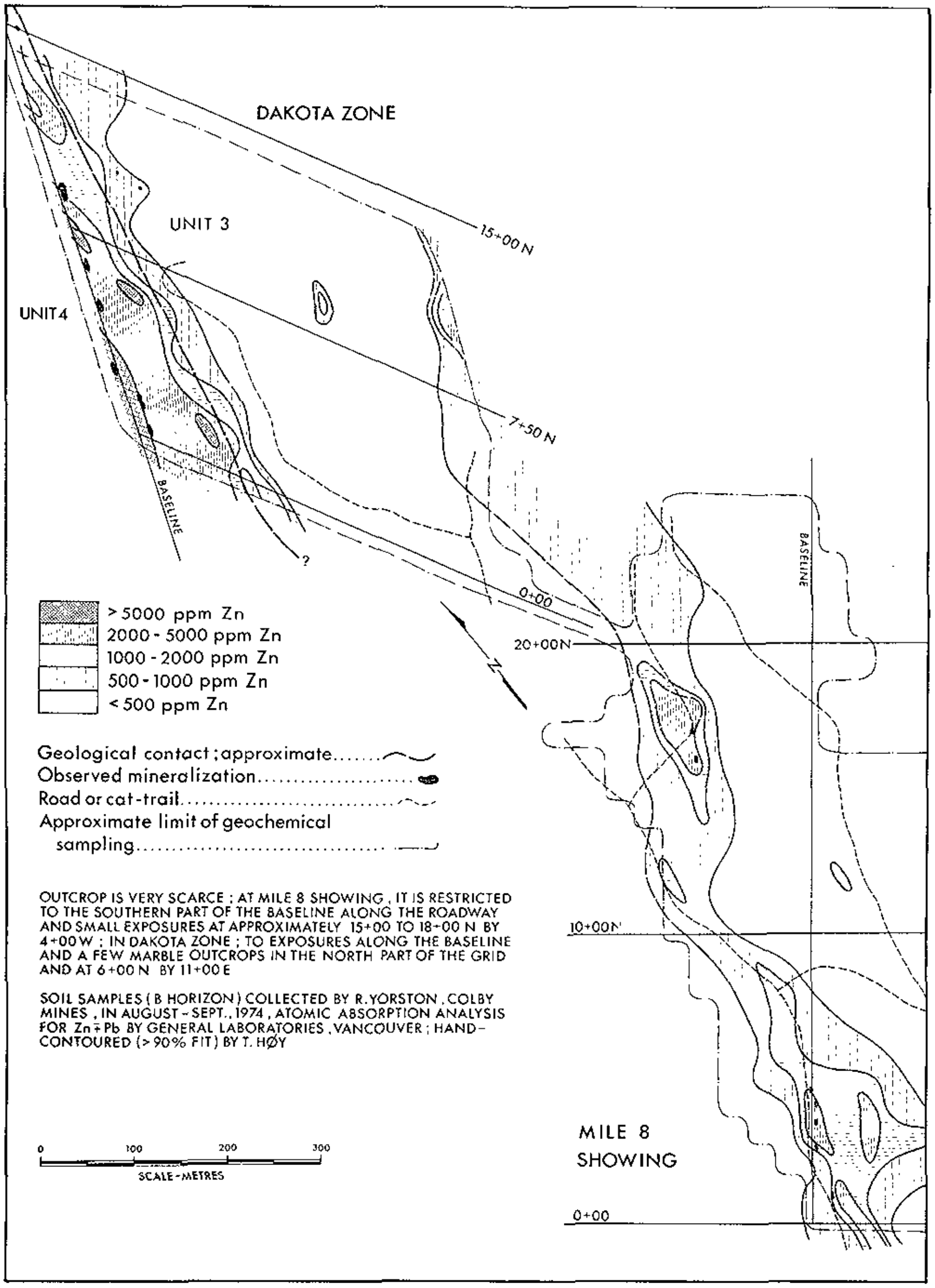


Figure G-15. Zinc soil geochemistry, Mile 8 showing and Dakota zone.

MINERALIZATION: Mineralization in the Colby area is restricted to five main areas. These are referred to as the Mile 8 showing, the Dakota zone, the Central zone, the Cominco showing, and the Mile 12 showing (Fig. G-12). 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 (Plate G-V). Galena is also common, though much finer grained and more widely scattered. In polished section, the sulphides appear as angular, equidimensional to elongate intergrowths of dominantly sphalerite and pyrrhotite entirely enclosed in the calcite matrix. The sulphide concentration varies considerably across a mineralized zone, commonly producing a crude layering. (Plate G-VI). Poorly defined folds with tight hinge zones may be defined by this sulphide layering.

Mineralized quartzites almost invariably contain calcareous minerals in accessory amounts (Plate G-VII). Dark sphalerite with pyrrhotite is concentrated generally in thin layers, or is seen to define the foliation in the quartzite. Galena is more common in quartzites than in the marbles, although it is always subsidiary to sphalerite. The sulphide concentration varies from widely scattered individual sphalerite and pyrrhotite grains entirely enclosed in quartz to almost massive, sphalerite-pyrrhotite (± galena, pyrite) intergrowths with *only interstitial subrounded to subangular quartz and diopside grains.*

Mineralization in calc-silicate gneisses 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)	Pb – 0.04%	Zn – 11.3%
(2)	Pb – 0.70%	Zn – 7.7%

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

The zinc geochemistry map (Fig. G-15) indicates that these two mineralized areas may be continuous and may extend northward to the southern part of the Dakota zone.

The Mile 8 showing has not been drilled.

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.

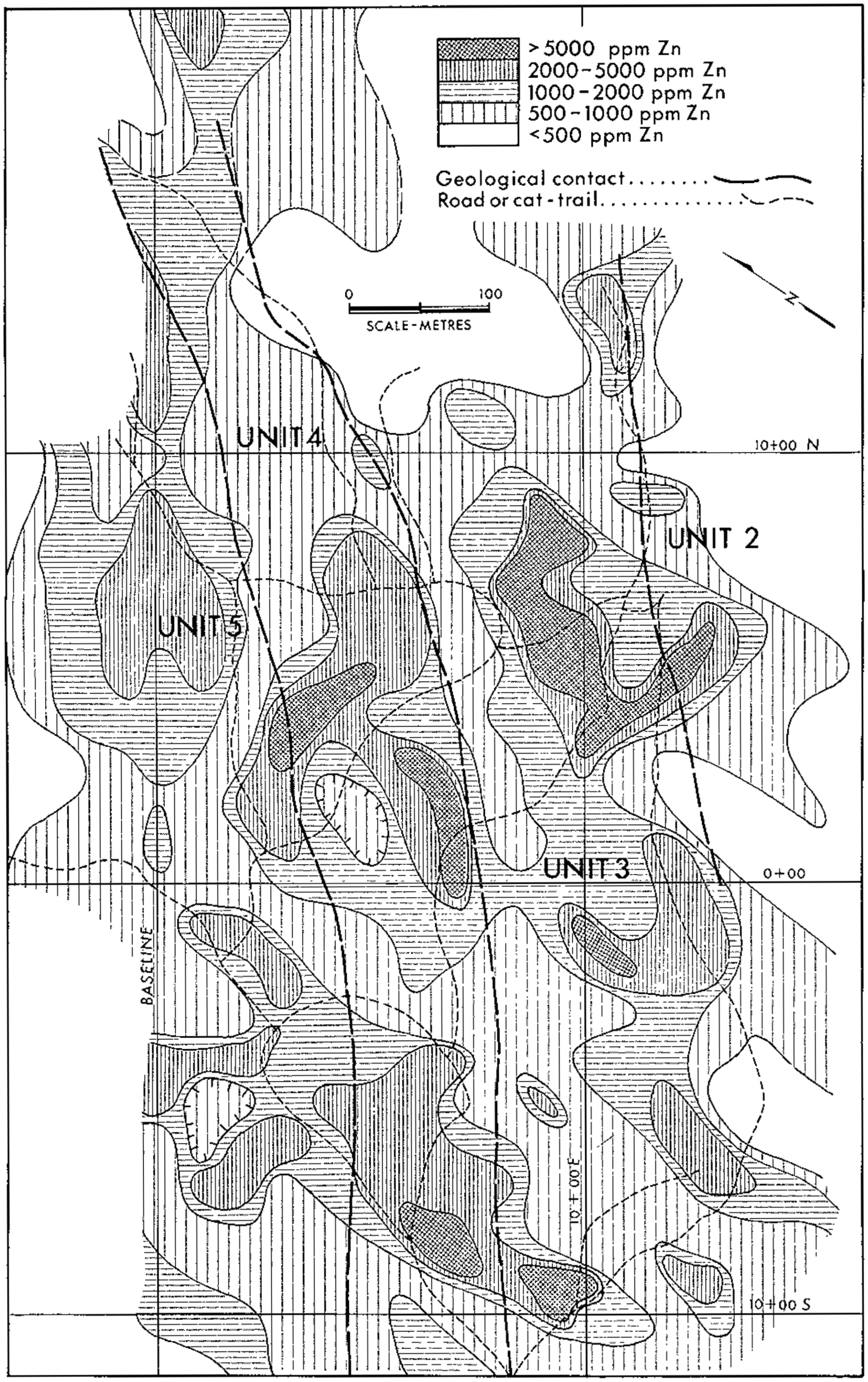


Figure G-16. Zinc soil geochemistry, Central zone.

The soil geochemistry map (Fig. G-15) outlines the mineralized section. More extensive sampling is required to determine the width of this anomalous zone and to outline its southward extension.

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. G-13) where a zone up to 3 metres wide and 15 metres in length contains coarse-grained sphalerite and pyrrhotite. A 0.65-metre chip sample from this zone assayed: 0.31 per cent lead and 7.2 per cent zinc and a grab sample: 0.27 per cent lead and 6.3 per cent zinc. Approximately 30 metres to the north a trench exposes siliceous and 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. These quartzites have been tested from approximately 9 + 50 N – 7 + 00 S by 18 drill holes spaced an average of 30 metres apart. Outcroppings of the central of these quartzite layers (Fig. G-13) 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.

The soil geochemistry map (Fig. G-16) crudely defines the northeasterly trend of the mineralization in the different units. Deeper overburden immediately to the southwest may mask this geochemical pattern.

COMINCO SHOWINGS: 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. This showing has not been drilled by Colby Mines Ltd.

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 the zone assayed:

(1)	Pb – 0.98%	Zn – 11.3%
(2)	Pb – 0.49%	Zn – 5.3%

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.

REFERENCES

Assessment Reports 578, 579, 2169, 4933, 4934, 4945.

B.C. Dept. of Mines & Pet. Res., GEM, 1969, p. 298.

Höy, T. (1975): Lead-Zinc Deposits, *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1975, pp. 11-18.

.... (1976): Calc-silicate Isograds in the Riondel Area, Southeastern British Columbia, *Cdn. Jour. Earth Sci.,* Vol. 13, No. 8, pp. 1093-1104.

.... (1977): Big Ledge, *B.C. Dept. of Mines & Pet. Res.,* Geology in B.C., this volume,

Jones, A. G. (1959): Vernon Map-Area, British Columbia, *Geol. Surv., Canada,* Mem. 296.

Minister of Mines , B.C., Ann. Rept., 1964, p. 105; 1965, p. 165; 1968, p. 222.

Okulitch, A. V. (1974): Stratigraphy and Structure of the Mount Ida Group, Vernon (82L), Seymour Arm (82M), Bonaparte Lake (92P) and Kettle River (82E) Map-Areas, British Columbia, *Geol. Surv., Canada,* Paper 74-1, Pt. A, pp. 25-30.

HIGHLAND BELL (BEAVERDELL) MINE (82E/6E)

By P. A. Christopher

LOCATION: The Highland Bell mine is situated in the Greenwood Mining Division, approximately 1.6 kilometres east of the village of Beaverdell, on the west slope of Mount Wallace. The mine is accessible by 96 kilometres of road from Kelowna via Highway 33 and is serviced by several private mining roads from Beaverdell.

HISTORY: Records indicate that prospecting and exploration in the Beaverdell mine area was in progress in the year 1889. Production of silver has been continuous since 1913, with intermittent production between 1900 and 1913.

Several companies commenced production when the Kettle Valley Railway reached the village of Beaverdell in 1913. In 1936, the Bell and Highland Lass mines amalgamated to form the Highland Bell mine which in 1938 obtained control of the Beaver mine. In 1946 Leitch Gold Mines, Limited obtained control of Highland Bell, Limited, and the Sally mine property. In 1950 a 50-ton-per-day mill was constructed and the first concentrate shipments were made. Discovery of the faulted extension of the Lass vein system (Lower Lass) in 1954 led to the expansion of the mill capacity to the present rate of 108 tonnes per day.

In 1970 Teck Corporation Ltd. acquired the Highland Bell mine and conducted an extensive exploration program with limited success. Faulted segments of known vein systems were outlined but no significant new reserves were located. At present the mining operation consists of reworking old stopes to recover remnants of low-grade sections.

Production from the Beaverdell mine area since 1900 has totalled about 32 million ounces of silver, 24 million pounds of lead, 28 million pounds of zinc, with minor production of gold, cadmium, and copper. Gold values appear to increase in the eastern

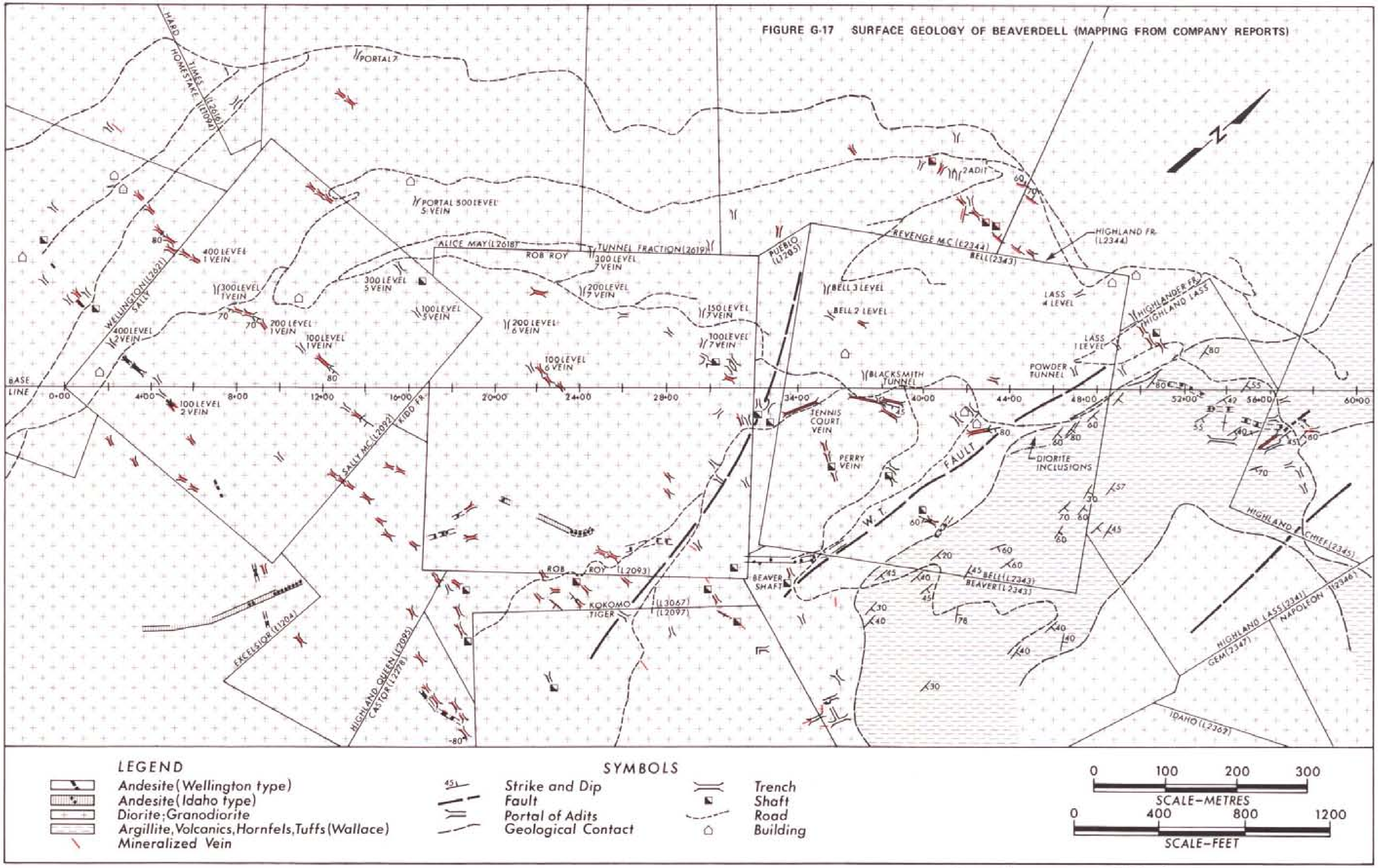


FIGURE G-17 SURFACE GEOLOGY OF BEAVERDELL (MAPPING FROM COMPANY REPORTS)

1975 Pg 30 A

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 day economics, the main requirement for continued production depends on maintaining mill heads above about 10 ounces of silver per ton.

GEOLOGICAL SETTING: Detailed geology of the Highland Bell mine property has been reported by Reinecke (1915), White (1949), Kidd and Perry (1957), and Verzosa and Goetting (1972). The mine area is mainly underlain by the Westkettle batholith (Nelson) and Beaverdell stock (Valhalla)? with contained pendants of Paleozoic or Early Mesozoic metamorphosed rocks of the Wallace Formation (Anarchist Group) (Fig. G-17). Hypabyssal rocks occur in east-west and northeast fracture zones that are also occupied by the mineralized vein systems.

Vein systems of the Beaverdell mine occur mainly within quartz diorite or granodiorite of the Westkettle batholith. Five separate vein systems (Fig. G-18) 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 while at the western end of the mineralized zone, porphyritic quartz monzonite (Beaverdell stock) has 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, often occupying the same structural zone. The table gives chemical analyses for the four main intrusive rock types.

Chemical Analyses of the Main Intrusive Rock Types in the Beaverdell Mine Area

	1	2	3	4
SiO_2	72.93	64.90	56.75	58.86
TiO_2	0.286	0.441	0.861	0.554
Al_2O_3	14.11	15.60	15.24	17.96
Fe_2O_3	1.00	2.17	2.58	2.56
FeO	0.85	2.62	3.97	2.93
MnO	0.035	0.102	0.172	0.139
MgO	0.53	1.78	3.30	1.55
CaO	1.77	4.24	4.26	4.41
Na_2O	4.274	3.52	3.82	3.37
K_2O	3.40	2.55	4.37	3.73
H_2O+	0.35	1.27	2.03	1.67
H_2O-	0.26	0.42	0.39	0.53
CO_2	1.6	2.25	1.8	1.6
P_2O_5	0.15	0.16	0.25	0.25
S	0.01	0.02	0.08	0.07
TOTAL	101.5	101.8	99.42	99.87

1 — Beaverdell stock from railroad cut near Beaverdell mine mill.

2 — Westkettle batholith from road to 3800 portal at mine grid point 1850 E — 4600 N.

3 — Idaho dyke sample from 827 stope at station 3600 E — 200 N.

4 — Wellington dyke sample from Sally No. 2 vein portal at station 408 or 150 N — 650 W on mine grid.

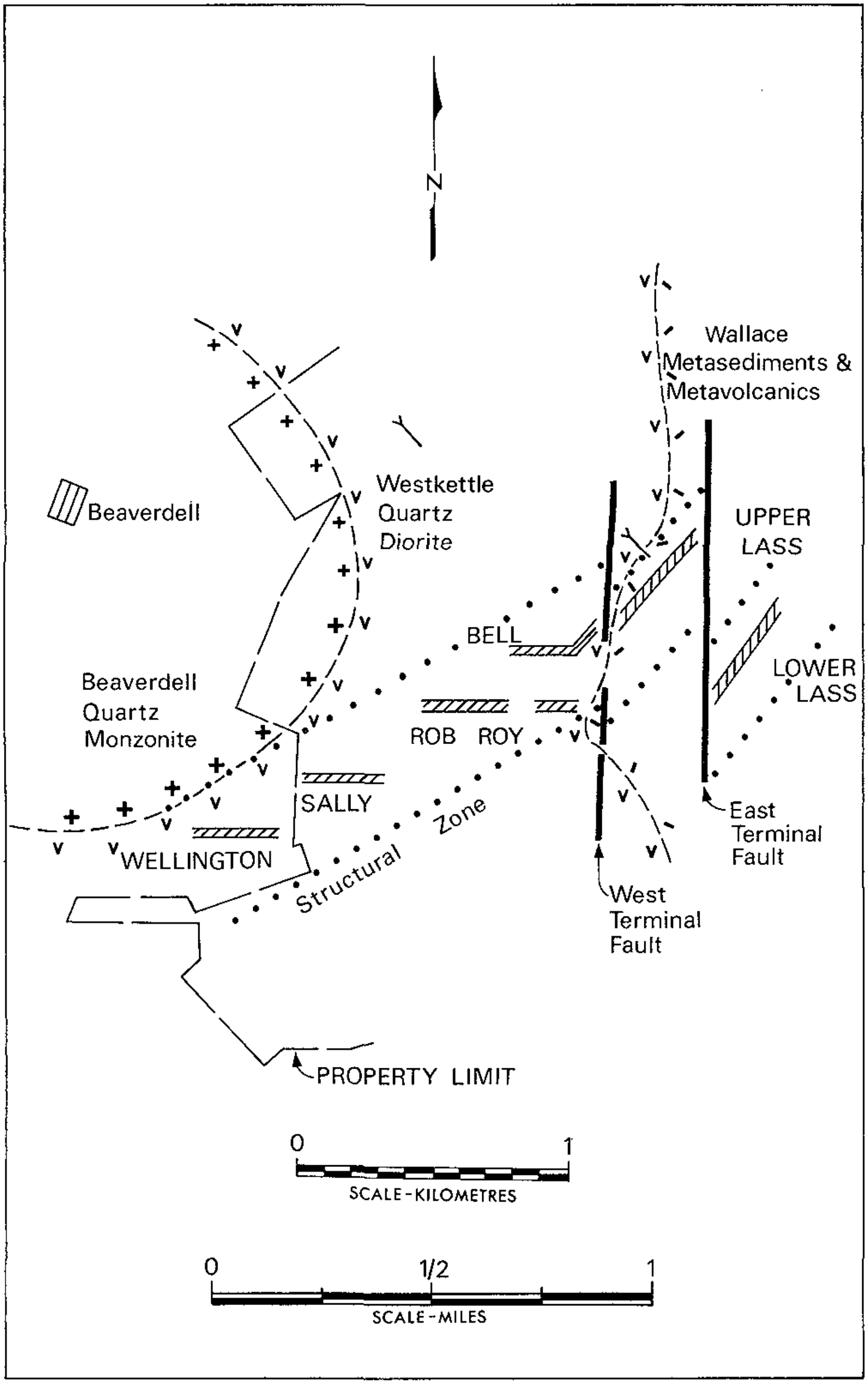


Figure G-18. Generalized geology and schematic diagram of vein systems (from Verzosa and Goetting, 1972).

Veins are essentially mineralized fissures that formed along either easterly or northeasterly trending faults. Mainly easterly trending veins occur in the western part of the mineralized zone (Wellington, Sally, and Rob Roy vein systems) while in the eastern part of the mineralized zone (Upper and Lower Lass systems), veins trend northeasterly. The Bell system in the central part of the mineralized zone has both easterly and northeasterly trending veins (Fig. G-18). Except for the mineralized 'black breccia' (probably a carbonaceous fault brecciated vein) 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.

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

Zoning is suggested by a change in the silver and gold content of the veins in the Lass system. Gold values increase and silver values decrease in the eastern part of the Lower Lass mine. Chalcopyrite and pyrrhotite are found in the Wellington and in the eastern part of the Lower Lass but are not generally found in other parts of the mine. Pyrargyrite is especially common in the Bell and Lass mines (Verzosa and Goetting, 1972).

STRUCTURAL SETTING: Faulting dominates the structural pattern at the Beaverdell mine and predicates mining and exploration procedures. Vein systems appear to have been continuous features that have been disrupted by at least five main fault systems (White, 1949; Kidd and Perry, 1954) including northerly striking, steeply east-dipping normal faults (Terminal faults) and northeasterly striking, moderately west-dipping normal faults causing the main disruptions. The East Terminal fault has been shown to have displaced the Lass vein by 210 metres (Kidd and Perry, 1954) but the extent of movement on the West Terminal fault has not been determined.

REFERENCES:

Kidd, D. F. and Perry, O. (1957): Beaverdell Camp, B.C., *in* Structural Geology of Canadian Ore Deposits, *C.I.M. Congress Vol. II*, pp. 136-141.

Reinecke, L. (1915): Ore Deposits of the Beaverdell Map-Area, *Geol. Surv., Canada*, Mem. 79.

Staples, A. B. and Warren, H. V. (1946): Minerals from the Highland Bell Silver Mine, British Columbia, *Western Miner*, May and June.

Verzosa, R. S. and Goetting, B. (1972): Geology and History of the Highland Bell Mine, Beaverdell, B.C., *C.I.M.*, paper presented at fall meeting in Prince George.

White, W. H. (1949): The Beaverdell Silver Camp, *Minister of Mines, B.C.*, Ann. Rept., 1949, pp. 138-148.

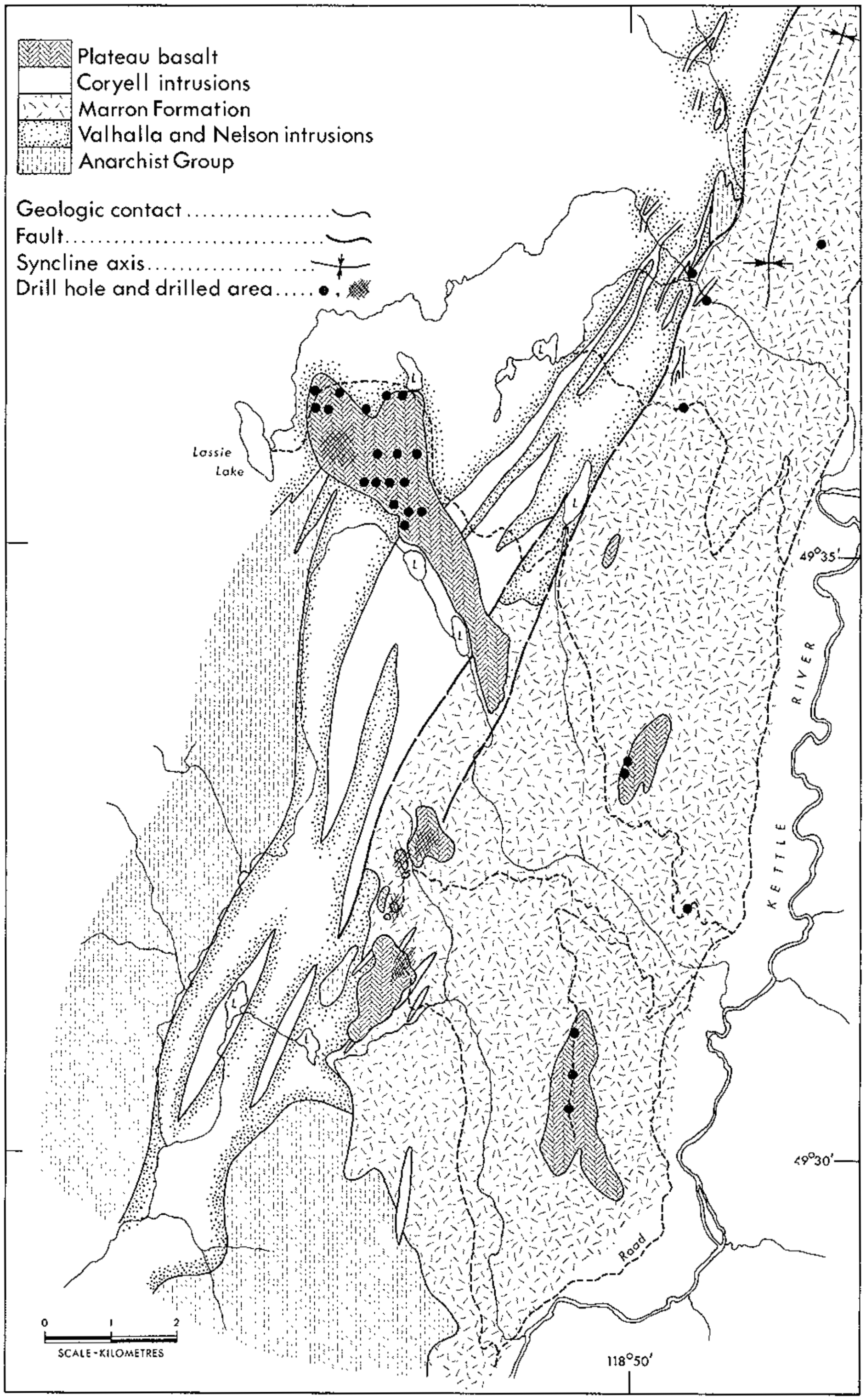


Figure G-19. Geology of the Fuki, Donen property.

FUKI, DONEN (92E/10W)

By P. A. Christopher

LOCATION: The property is situated between the Kettle River and Beaverdell Creek valleys about 53 air kilometres east of Penticton. Access from Beaverdell is via Highway 33 and Beaverdell Creek forestry road with the mineralized Fuki outcrop situated along Dear Creek at about Mile 14.3 (22.8 kilometres) on the Beaverdell Creek road. Elevations vary from 762 metres in the Kettle River valley up to about 1 403 metres.

HISTORY: The Fuki showing (GEM, 1969, pp. 302, 303) was discovered during the 1968 field season during a car-borne scintillometer survey. The Fuki 1 to 40 and Donen 1 to 280 mineral claims were located to cover the initial discovery and targets were located by follow-up geological, radiometric, and geochemical surveys. Water geochemistry for uranium proved to be the most useful method and provided indications of the buried deposit north of Cup Lake. Diamond drilling has totalled approximately 4 500 metres and has been concentrated on the plateau basalts along Dear Creek and north of Cup Lake with limited drilling used to test the potential of the Marron Formation.

REGIONAL SETTING: Secondary uranium minerals are situated in unconsolidated or loosely consolidated sand and gravel deposits that are preserved below a cap of Miocene plateau basalt. Mineralized deposits occur in fluvial sedimentary rocks that unconformably overlie Anarchist Group rocks, Early Tertiary volcanic and sedimentary rocks (Marron Formation or Kettle River Formation), and Nelson, Valhalla, and Coryell intrusive rocks. Strong north 20 degree east faults occur in the area of the mineral deposits but their relationship to the mineralization has not been determined.

LOCAL GEOLOGY: Property geology shown in Figure G-19 is generalized from company maps (Assessment Reports 2013, 2484, 3135, 3775, and 4630). Five main units are shown: metamorphic rocks of the Paleozoic Anarchist Group, Nelson and Valhalla intrusions of Jurassic and Cretaceous age, Marron Formation volcanic and sedimentary rocks of Eocene age, Coryell intrusions of Eocene age, and Miocene plateau basalts. Intrusive rocks range in composition from mainly foliated granodiorite (Nelson) to mainly quartz monzonite (Valhalla) to granitic and syenitic bodies (Coryell). The Anarchist Group consists principally of metamorphosed shale, sandstone, and limestone, and occurs mainly near the southern and western borders of the area. The Marron Formation occurs in the eastern part of the area and consists of andesite, andesitic tuff, and volcanoclastic and sedimentary rocks. The plateau basalt formation has an average thickness of about 65 metres and is a flat-lying sequence of olivine basalt with minor interbedded sedimentary rocks and fluvial deposits of conglomerate, sandstone, and shale as a basal member. The fluvial deposits are the main host for uranium mineralization.

Intrusive rocks in the map-area have a pronounced elongation in a north-south to north 20 degree east direction. A major north 20 degree east fault zone passes through the Fuki showing, extends through the Slate Lake area, and probably continues southerly through the valley occupied by the Triple Lakes. Structures in the Marron Formation are not well defined but the main fold axes also appear to have a north 20 degree east trend.

URANIUM MINERALIZATION: Secondary uranium minerals occur as films on pebbles and in the matrix of unconsolidated or loosely consolidated conglomerate and carbonaceous sediments that were deposited in paleo-stream channels. Autunite is the only uranium mineral that has been identified.

Three possible sources from which uranium could be leached are: (1) Coryell intrusions which have high background uranium content, (2) the Marron Formation, parts of which have high background uranium and a readily leachable tuffaceous content, and (3) uranium-bearing veins and pegmatites in Nelson and Valhalla intrusive rocks (for example, Carmi molybdenum property).

Exploraton in the Kallis Creek and Hydraulic Lake areas about 35 kilometres north of this property has located uranium mineralization with a similar setting.

REFERENCES: *B.C. Dept. of Mines & Pet. Res.,* GEM, 1969, pp. 302, 303; 1970, p. 409; 1971, p. 396; 1972, p. 43; 1973, pp. 49, 50; Assessment Reports 2013, 2484, 3135, 3775, 4630.

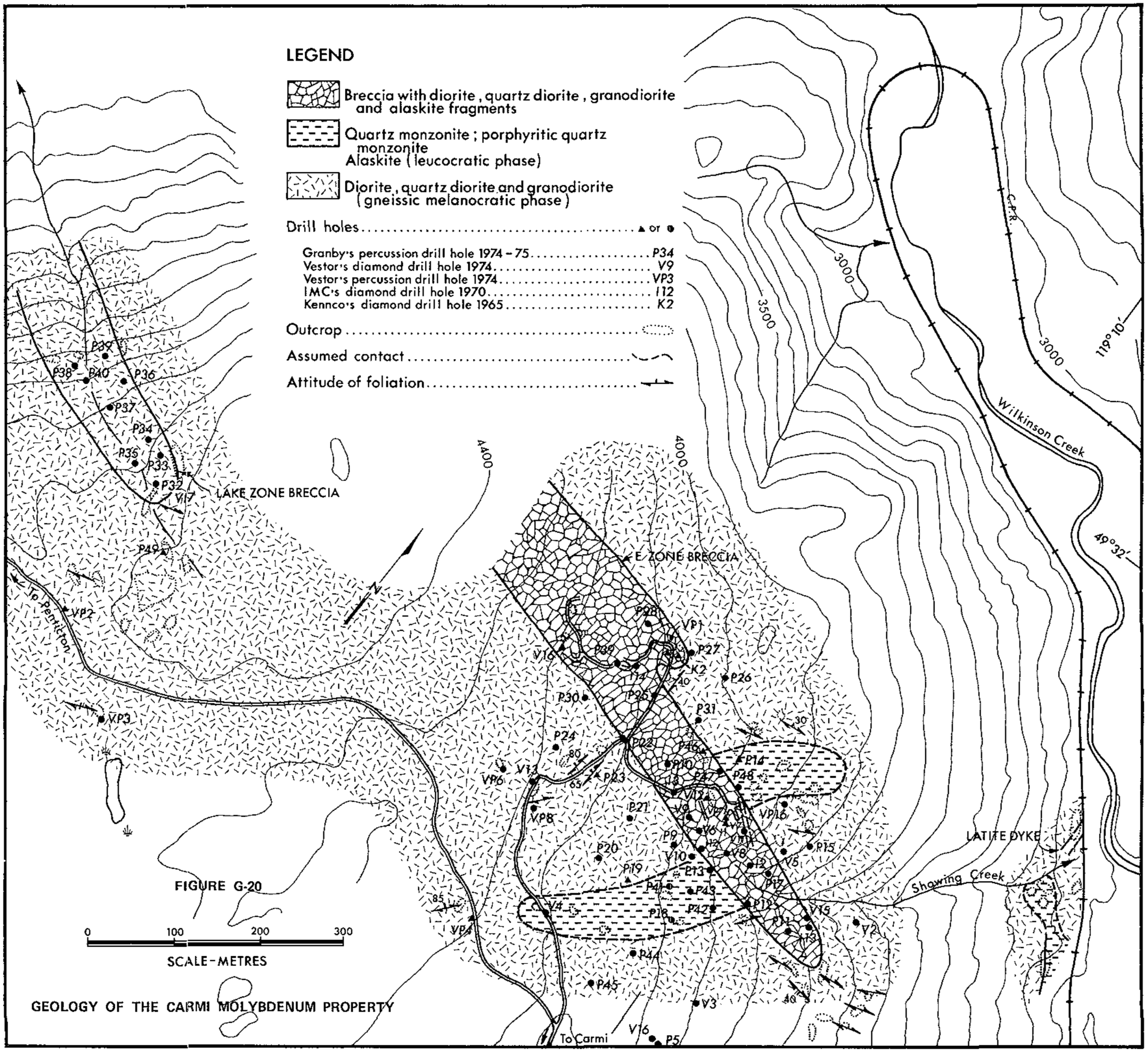
CARMI MOLYBDENUM PROPERTY (CARMI MOLY) (82E/11E)

By P. A. Christopher

LOCATION: The property is situated in the Greenwood Mining Division, about 29 kilometres east of Penticton and about 3.2 kilometres northwest of Carmi. Access is via the Carmi-Penticton forestry road about 6.2 kilometres from Carmi.

HISTORY: The Main or E zone was discovered in 1960 when Kennco Explorations, (Western) Limited obtained anomalous molybdenum values from stream sediment samples. In 1974 Vestor Exploration Ltd. used soil geochemistry to locate the Lake (Western) zone. Granby Mining Corporation (1974-1975), Husky Oil Limited (1971), and International Minerals & Chemical Corporation (1970) have also explored the property. Thirty-one diamond drill holes totalling approximately 3 250 metres and over 4 800 metres of percussion drilling have been completed on the property. Drill hole locations are shown on Figure G-20 with drill results reported by Vestor in George Cross Newsletter No. 75 (1976). Drill indicated reserves for the E zone and Lake zone were reported by the company as being approximately 40 million tons of 0.15 per cent molybdenum.

GEOLOGY: The property is mainly underlain by Nelson and Valhalla plutonic rocks of Mesozoic age (Little, 1961). Monashee Group rocks have been mapped along Wilkinson Creek but appear to be outside the mineralized area. Molybdenite, with pyrite, magnetite, chalcopyrite, minor bornite, and notable uraninite, occurs chiefly in two sheared and brecciated zones in gneissic granodiorite, quartz diorite, and diorite (Nelson). A leucocratic body of granodiorite, quartz monzonite, and alaskite occurs near the E zone. Hypabyssal rocks encountered in diamond-drill holes include quartz feldspar porphyry, mafic-rich dykes, and leucocratic monzonite porphyry. The presence of breccia zones and buried porphyry bodies suggests that the showings are at a high level in the hydrothermal and intrusive system.


LEGEND
Breccia with diorite, quartz diorite, granodiorite and alaskite fragments
Quartz monzonite; porphyritic quartz monzonite
Alaskite (leucocratic phase)
Diorite, quartz diorite and granodiorite (gneissic melanocratic phase)
Drill holes .... ▲ or ●
Granby's percussion drill hole 1974-75 .... P34
Vestor's diamond drill hole 1974 .... V9
Vestor's percussion drill hole 1974 .... VP3
IMC's diamond drill hole 1970 .... I12
Kennco's diamond drill hole 1965 .... K2
Outcrop
Assumed contact
Attitude of foliation
LAKE ZONE BRECCIA
E. ZONE BRECCIA
LATITE DYKE
Showing Creek
Wilkinson Creek
C.P.R.
To Penticton
To Carmi
119°10′
49°32′
N
SCALE-METRES
0
100
200
300
FIGURE G-20
GEOLOGY OF THE CARMI MOLYBDENUM PROPERTY

The two breccia zones trend north 70 degrees west, have quartz or quartz and feldspar as the main matrix, and display greisen development and gneissic diorite fragments, and show gradations from tectonic breccias to fault-controlled chemical and intrusive breccia. The E zone breccia is more complex with fragments of granodiorite, quartz diorite, and porphyritic granodiorite as well as gneissic diorite.

MINERALIZATION: The grade of molybdenum appears to vary with intensity of alteration and brecciation. Where alteration within the breccia zones is intense, a greisen zone consisting of quartz, muscovite, fluorite, and molybdenite (ferrimolybdite near surface) is formed. Molybdenite occurs mainly as rosettes that are disseminated within breccia fragments and quartz feldspar matrix material. Pyrite, magnetite, chalcopyrite, minor bornite, and rare sphalerite also occur with the mineralized zone. Pyrite and magnetite occur as fracture fillings, blebs, and disseminations. Copper grades are generally below 0.1 per cent.

Uranium is widespread in Nelson rocks and shows some concentration in granodiorite and breccia in diamond-drill hole V8 (92.5 to 103 metres of 0.045 U_3O_8). Uraninite has been identified and is generally associated with purple fluorite.

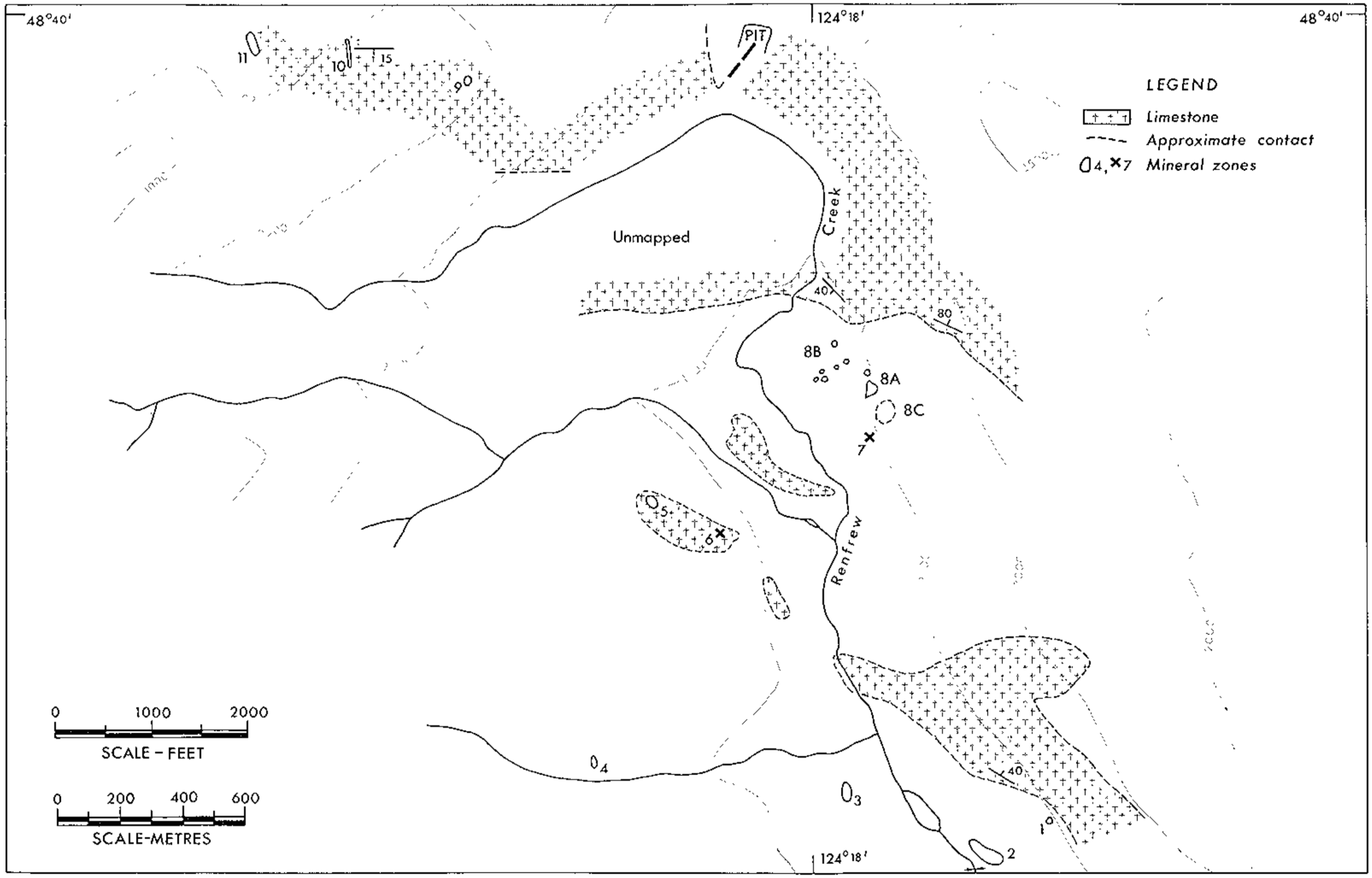
REFERENCES:

Assessment Reports 3562, 3740, 5203, 5204, 5430, 5519.

George Cross Newsletter No. 75 (1976).

Little, H. W. (1961): Geology of the Kettle River Area (West Half), B.C., *Geol. Surv., Canada,* Preliminary Map 15-1961.

Needoba, J. C. (1971): Petrology of a Molybdenite Occurrence near Carmi, South Central British Columbia, B.Sc. Thesis, *U.B.C.*



G-21 Geological diagram of the Reko-Kestral area

REKO, KESTREL (92C/9W)

By G.E.P. Eastwood

LOCATION: The Reko 1 to 66 claims cover the upper part of Renfrew Creek valley, and the adjoining Kestrel 1 to 15 claims extend over the ridge onto the steep slope of the west tributary of Hemmingsen Creek. Access to the Reko and Kestrel claims, owned by Reako Explorations Ltd., is provided by Granite Main Line of British Columbia Forest Products and several branch logging roads. The creek is crossed by two bridges, of which the lower and more useful is at 365 metres elevation as shown on Figure G-21.

DESCRIPTION: An outline of exploration from 1970 through 1974 is given in the 1974 report. Prospecting of the Kestrel claims early in 1975 led to the discovery of three significant new showings and several minor ones. The writer spent a week in Vancouver, logging mineralized drill core at its place of storage, and three weeks on the property, surveying part of No. 8 zone and examining the new showings.

Figure G-21 is a composite, prepared by enlarging the NTS manuscript map to 1:12 000 and modifying it with details reduced from the company's 1:4800 map. Geological contacts south of the reverse bend of Renfrew Creek are taken from detailed mapping by R. L. Roscoe, the company's consultant, modified in places by the writer's observations. Mineral zones 1 to 7 are shown as outlined by 1974. The individual showings of zones 8A and 8B were tied in to Roscoe's map by compass-tape and compass triangulation survey. Zone 8C was not mapped, and the position and outline shown are diagrammatic only. North of the creek the writer made observations along the logging road and along traverses to and around zones 9 to 11.

The north part of the area thus mapped is underlain by grey to white crystalline limestone, and the central and south part is underlain mainly by intrusive breccia. Several bodies of limestone occur in the central and south part, and show differing relationships to the breccia. The primary fragments are fine grained and dark greyish green in colour, resembling andesite, and some contain amygdules. This andesitic rock was successively intruded by mafic-rich and mafic-poor diorite. The breccia grades to massive, mesocratic diorite southwest of a line through zones 3 and 5, and to massive andesite about the 2,000-foot contour on the west side of the east ridge. A set of long, narrow, fine-grained grey dykes strikes 020 degrees, transects all other rocks, and probably follows late fractures; one such dyke is well displayed at the lower bridge. A small body of feldspar porphyry just east of the upper bridge, 200 metres south-southwest of zone 7, is intruded by leucodiorite.

The limestone bodies cannot be shown conclusively to belong to the same formation, but proximity, similar lithology and metamorphic response, and in part similar relations to the intrusions, render this conclusion likely. Most limestone bodies have been successively intruded by dykes of andesite and leucodiorite, but the dykes are not co-extensive in distribution. The andesite dykes are widespread and form in effect a characteristic part of the limestone lithology. They occur adjacent to zone 10, where diorite dykes are absent, recrystallization of the limestone is incipient, and bedding is well preserved. Nearer to the

Zone No.	Magnetite	Pyrite and Pyrrhotite	Chalcopyrite	Skarn	Limestone Host	Breccia Host	Diorite Host	Remarks
1	abundant to massive	abundant to massive	minor	locally abundant	X	---	---	Mineralization probably localized adjacent to andesite dykes
2, 3	patchy locally massive thick to thin disseminations	abundant to localized	sporadic	abundant to massive	---	X	---	
4	veins, pockets and masses	none	none	minor	---	---	X	
5	locally abundant	locally abundant	moderate	abundant	---	?	---	near limestone
6	common	none	none	abundant	---	?	---	near limestone
7	none	massive	networks	none	---	X	---	
8	pockets	minor	none	common	---	X	---	
9	massive	none	none	none	X	---	---	
10	mostly massive	none	none	minor	X	---	---	near andesite dykes
11	pockets and narrow bands	none	none	massive	---	---	---	host not determined

intrusive complex many of the andesite dykes are more or less altered to skarn and some are intruded by dykes of leucodiorite. Southeast of the gravel pit a large diorite dyke, dipping a little more steeply than the hillslope, may intrude the limestone directly. Two of the limestone bodies west of Renfrew Creek contain no diorite dykes and their outer contacts are not exposed. The body containing zones 5 and 6, however, appears to be extensively cut by diorite. The larger body to the southeast appears in part to rest on the intrusive breccia without being disrupted by it. The southwest contact is well exposed at Granite Main Line, where fingers and tongues of leucodiorite penetrating the andesitic rock terminate abruptly at a 20-centimetre rind of massive garnetite lying against the limestone. On a branch road above, a small dragfold in the limestone near the southwest contact indicates that the limestone overlies the breccia. Farther north on Granite Main Line, andesite dykes in the limestone are in part altered to skarn and intruded by dykes of leucodiorite. Drilling through and around zone 1 found a small body of limestone which is not exposed at surface; its origins are not completely understood.

It is likely that, prior to diorite intrusion, andesite underlay the limestone and also intruded it:

(1) The andesite in the breccia is too abundant to be accounted for by small, scattered dykes, even should efficient mechanisms be postulated for removal of the limestone.

(2) Near the 2,000-foot contour andesite is exposed for 250 metres along a road south from the main body of limestone, an areal extent much larger than a possible dyke.

(3) The south body of limestone is not nonconformable on the breccia, but it appears to rest on it, indicating that it must have rested on the andesite before it was intruded and broken up.

The contact of the main body of limestone with the expansive andesite was excavated, but with inconclusive results. A narrow cave separates the limestone from 20 centimetres of skarnified andesite and a further 15 centimetres of sheared, rusty andesite. Not only are the contact relationships indeterminate, but it seems likely that the contact has been faulted to some extent.

The geological structure is unclear, though there are indications of folding and faulting. Metamorphic recrystallization has obliterated most of the bedding in the limestone over most of the area, leaving only sporadic thin sandy beds and rare layers of andesite chips. Sandy beds were used to outline a small northwest-plunging dragfold near the southwest contact of the south body of limestone, indicating that the limestone occupies a northwest-plunging syncline. The lobe to the northeast may indicate a second, distorted syncline. This limestone terminates at the creek, and the patches to the northwest may be fragments of the synclines disrupted and carried up by the force of intrusion. The northwest trend is discordant to the westerly trend of the main body of limestone. Discordant attitudes in the main body near its south contact suggest at least local intense deformation. Near zone 10 the limestone is well bedded, with an easterly strike and gentle south dip. The overall structure of this main body appears to be a highly asymmetric syncline.

The strongest indication of faulting is provided by the gravel pit in the saddle north of Renfrew Creek (size exaggerated on Fig. G-21). The gravel is flanked on the west and underlain by rubbly intrusive breccia which has been closely fractured and healed with thin white veinlets. Limestone is exposed in the southeast corner of the pit and on the ridge to the east. The lowest part of the pit (that is, deepest gravel) lines up with a deep draw trending 215 degrees toward Renfrew Creek. The relation of the intrusive breccia to the limestone farther west has not been determined, and the amount and direction of movement on the fault are unknown. Indications of movement along the south contact of the main body of limestone have been noted previously. Numerous gouge and shear zones appear in drill core, but they probably do not represent significant amounts of movement.

The age of the rocks is unknown. Lithologically the limestone closely resembles Quatsino limestone, which also has ubiquitous andesite dykes, and the andesite resembles rocks characteristic of the Karmutsen Formation. The intrusive breccia is probably the gently dipping roof zone of a batholith or large stock. It appears to resemble the Westcoast diorites, which have been assigned a Jurassic age (Muller and Carson, 1969; Northcote, 1972).

Eleven mineral zones have been identified for descriptive purposes. Two additional magnetite occurrences were briefly examined and judged too small to be significant. Other occurrences are reported to be small, and were not seen. The main characteristics of the eleven zones are summarized in the table.

Where substantial sulphides are present, pyrrhotite generally predominates over pyrite, except in zone 2.

Sub-zones A, B, and C of zone 8 correspond to the company's designation A, B, and C of the North Pit zone. Sub-zone A comprises massive to thickly disseminated magnetite in skarn, as exposed in a road cut and small quarry. Sub-zone B comprises small magnetite showings on a bedrock knoll and a low ridge to the northeast of it. The three showings on the knoll comprise veins and pockets of massive magnetite in patches of skarn in intrusive breccia; the largest is 4.5 by 6 metres. Considerable local magnetic attraction was found in the saddle between this knoll and the ridge. A fire in 1975 exposed a jumble of small and large angular float and rounded boulders around the rim and sides of the ridge and a slightly dished central area floored by fine overburden. Blocks of limestone, andesite, intrusive breccia, and the two blocks of magnetite indicated on Figure G-21 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 suggests a landslide. The occurrence shown on the north nose of this ridge consists of pyrite and bornite disseminated in a transported block of limestone. Sub-zone C consists of several poorly exposed magnetite showings in the logged-off hillside.

Zone 9 is a body of almost pure magnetite emplaced directly into the limestone. It is exposed over an area of about 8 by 15 metres, but high positive and negative magnetic anomalies over adjacent overburden areas indicate that it may be more extensive. Magnetite pebbles and float continue uphill almost to the crest of the ridge. About 60 metres northeast of zone 9 a vein of massive magnetite 50 centimetres wide dips 70 degrees southwest in the limestone; the exposed length is a few metres. Southwest of zone 9 a 120-centimetre lens of massive magnetite dips 70 degrees east-northeast.

Zone 10 is a narrow zone of outcrops of mostly massive magnetite trending at a small angle to a creek gully tributary to West Hemmingsen Creek. Downslope it appears to finger out among andesite dykes, but mostly the walls appear to be limestone. The width

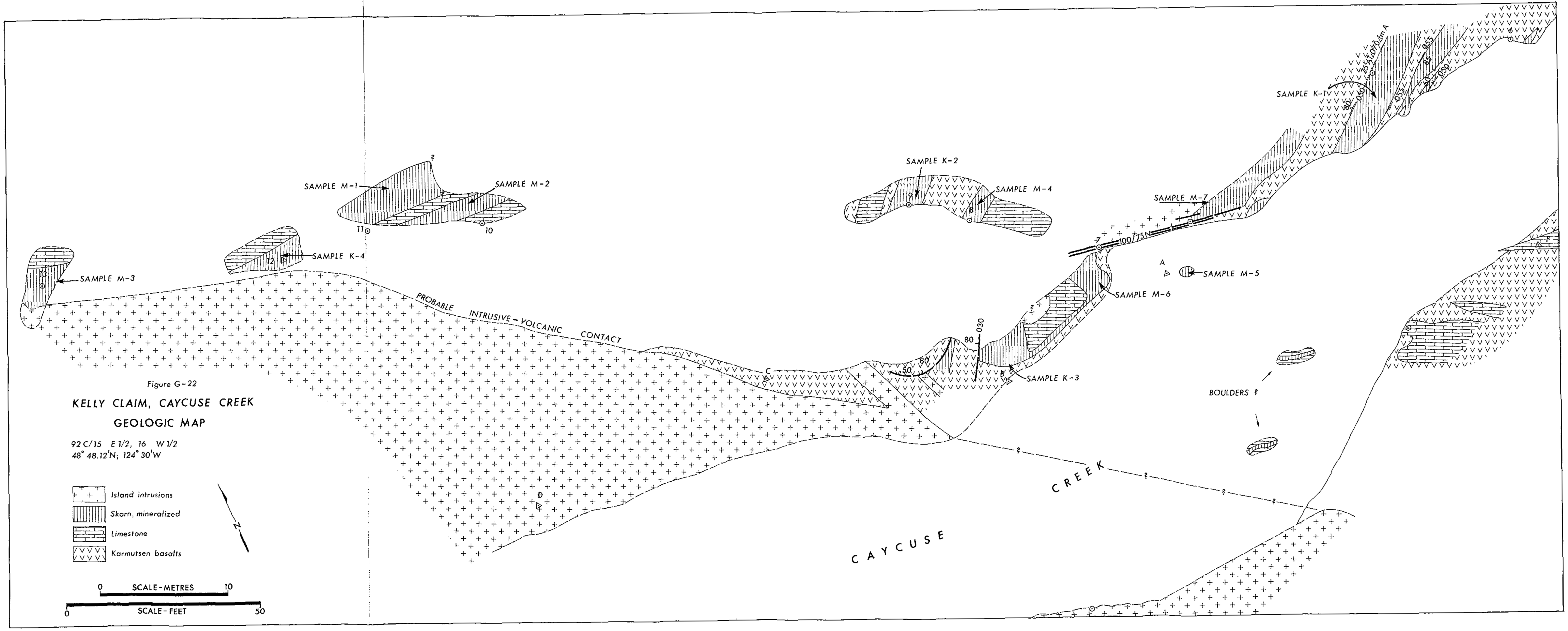


Figure G-22

KELLY CLAIM, CAYCUSE CREEK

GEOLOGIC MAP

92 C/15 E 1/2, 16 W 1/2
48° 48.12′N; 124° 30′W

appears to range from 3 to 15 metres, over a length of inferred continuity of 75 metres. Upslope the ground is mostly covered, but a small magnetite showing occurs 200 metres above.

Zone 11 occupies a long wedge-shaped ridge between a creek canyon on the west and a shallow creek gully on the east. It consists largely of garnetite, which contains pockets and narrow bands of magnetite. The upper part has an estimated width of 45 metres, and the wedge was reported to have a slope length of 120 metres.

REFERENCES

B.C. Dept. of Mines & Pet. Res., GEM, 1974, pp. 166-170; Geological Fieldwork, 1975, p. 34.

Muller, J. E. and Carson, D.J.T. (1969): Geology and Mineral Deposits of Alberni Map-Area, British Columbia, *Geol. Surv., Canada,* Paper 68-50, p. 19.

Northcote, K. E. (1972): *B.C. Dept. of Mines & Pet. Res.,* GEM, 1972, pp. 243, 244.

KELLY (92C/15E, 16W)

By K. E. Northcote

LOCATION: The Kelly claim consisting of two units is owned by J. M. McNulty and is situated on Caycuse Creek, 13 kilometres from Nitinat Lake.

DESCRIPTION: 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 vertical to steep 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 (Fig. G-22).

Massive sulphide mineralization within skarns consists of pyrite, pyrrhotite (?), chalcopyrite, and minor magnetite, in a gangue of garnet, epidote, ilvaite, pyroxene (diopside), amphibole (tremolite-actinolite), 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:

Sample	Copper *per cent*	Silver *ppm*	Width *metres*
McN 1	1.38	6.8	1.5+
McN 2	4.75	6.8	1.2+
McN 3	4.66	20.4	1.8+
McN 4	2.77	13.6	1.2+
McN 5	8.61	37.4	0.9+
McN 6	1.28	6.8	1.5
McN 7	7.33	30.6	1

Samples collected during mapping of the property are as follows:

Sample	Copper *per cent*	Lead *per cent*	Zinc *per cent*	Gold *ppm*	Silver *ppm*	Width *metres*
K1	2.35	<0.005	0.04	trace	17.0	0.9
K2	0.10	<0.005	0.01	trace	trace	1.5
K3	4.57	<0.005	0.13	trace	17.0	1.5
K4	0.68	<0.005	0.34	trace	trace	1.8

A (92F/2W)

By G.E.P. Eastwood

LOCATION: The A 5-8 claims, owned by Lawrence Vezina, are located in the Alberni Mining Division, about 1 kilometre southeast of the head of Fosseli Creek. Prospecting, hand trenching, and blasting were carried out during the year.

DESCRIPTION: The showings occur in a broad saddle between the heads of two tributaries of Cous Creek and on a low ridge to the east. The two swamps shown on Figure G-23 constitute the heads of these two drainages. Vehicles may be driven to showings 1 and 2 via MacMillan Bloedel Ltd.'s Summit Road and branches. The other showings are readily accessible on foot from No. 2. Much of the area was logged more than 20 years ago, but a strip of timber covering most of the showings was logged only in recent years, after the aerial photographs were taken.

The first two showings were found by the owner and partially explored early in 1974. Further prospecting, by a magnetometer and conventional means, late in 1974 and early in 1975 led to the discovery of additional showings. These were opened up to varying degrees by trenching and blasting. After an initial examination, the writer returned in August to map the showings and the geology. Mapping on the airphotos had to be augmented by a combination of compass-tape and compass triangulation. The resulting Figure G-23 is thus of variable accuracy and probably contains distortions of both scale and orientation.

Much of the area is underlain by Karmutsen rocks, mostly amygdaloidal lavas. They are flanked on the west by grey to white crystalline limestone of the Quatsino Formation. Three outcrops of dark grey to black argillite and calcareous argillite to the west of the limestone are assigned to the Parson Bay Formation. The contacts are not exposed, thus actual width is not known, and continuity is not certain. Exposures to the west are mainly grey pyroclastic rocks common to the Bonanza Formation. Just off the northwest corner of the area shown, carbonaceous limestone with disturbed bedding is flanked on the west by thin-bedded white quartzite interbedded with pale green chert and possibly cherty tuff. The quartzite beds strike 355 degrees and dip 68 degrees west. They are probably basal Bonanza.

From No. 2 showing south to the swamp the Karmutsen-Quatsino contact is marked by a shallow draw which may be a fault. South of the swamp the strike is apparently northeast and the limestone appears to pinch out; no further exposures of it were found to the south of the area of the sketch, although Karmutsen and Bonanza rocks were not seen in

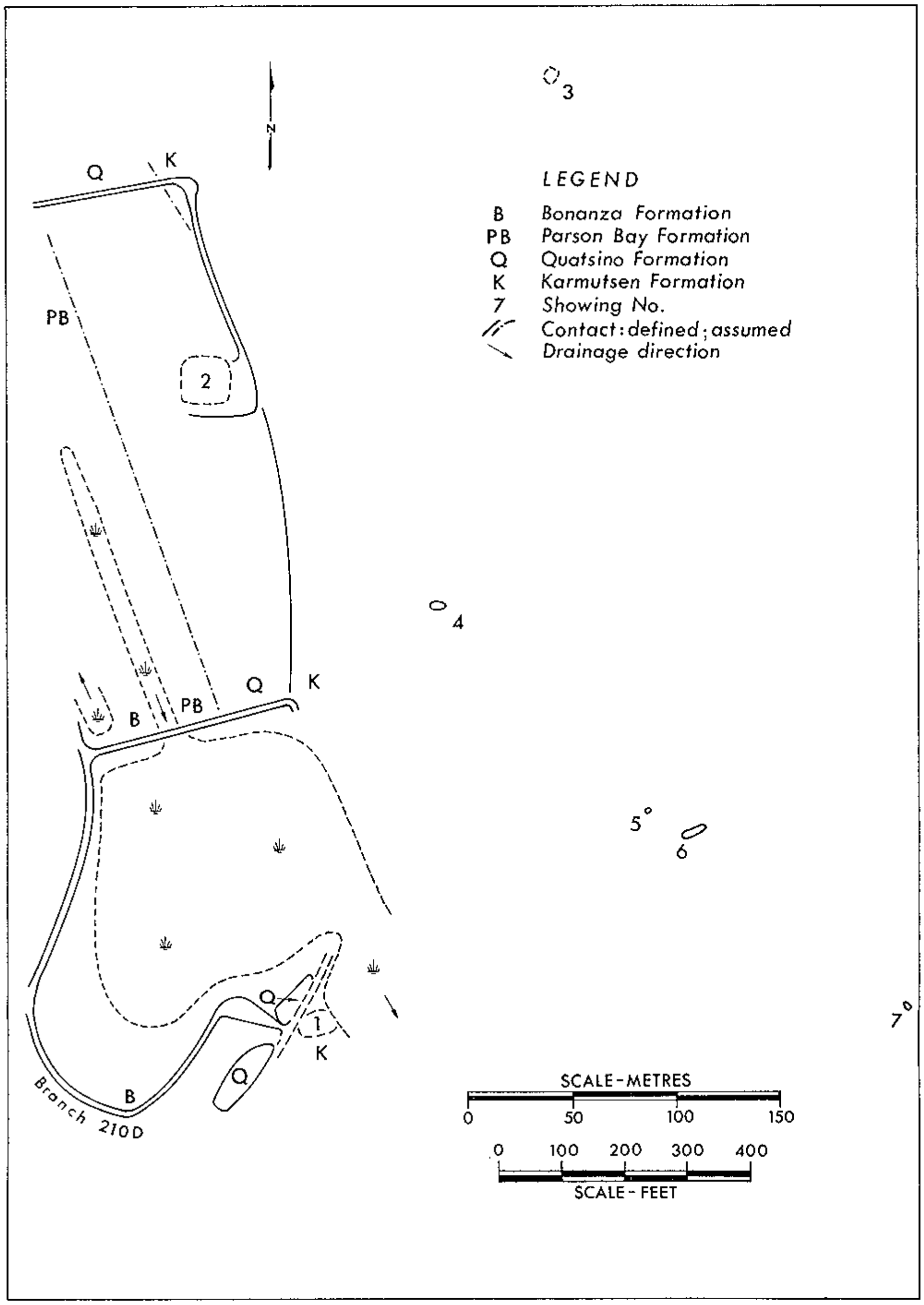


Figure G-23. Geological sketch of the A showings.

contact. This rapid pinch-out would appear to be structurally controlled, but it is not clear whether folding, faulting, or a combination of the two is responsible.

The No. 1 showing is now known to be in Karmutsen diabase adjacent to the limestone contact. Irregular alteration to skarn and irregular mineralization with chalcopyrite, less bornite, and superficial malachite and azurite are probably fracture-controlled. Further stripping and blasting at this site had exposed a modest amount of additional copper mineralization.

The No. 2 showing is centred on an irregular, branching body of andesite intrusive into the limestone. The andesite has been partly altered to skarn, and pockets and disseminations of chalcopyrite and bornite occur in both skarn and limestone near their mutual contact. Some additional mineralization had been exposed, but the greater part of the area outlined on the sketch is essentially barren.

One of the rusty patches noted in the 1974 report had been blasted into, and is designated No. 3 on the sketch. It was however found to result mainly from weathering of ankerite, and chalcopyrite appeared negligible.

No. 4 showing 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.

Pyrrhotite occurrences designated No. 5 and No. 6 showed only traces of malachite.

No. 7 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 was 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.

Two additional showings lie south of No. 7, 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.

REFERENCE: *B.C. Dept. of Mines & Pet. Res.,* GEM, 1974, p. 173.

CREAM, BEAR (92F/5E)

By K. E. Northcote

LOCATION: The principal showings of the Cream Lake property, owned by Cream Silver Mines Ltd., are covered by approximately 31 claims of the Cream and Bear groups. Additional claims are presently held by the company in the Drinkwater Creek — Buttle Lake area. The property lies about 8 kilometres south of Buttle Lake, at the headwaters of Price and Drinkwater Creeks. The main showings are on the west side of Cream Lake.

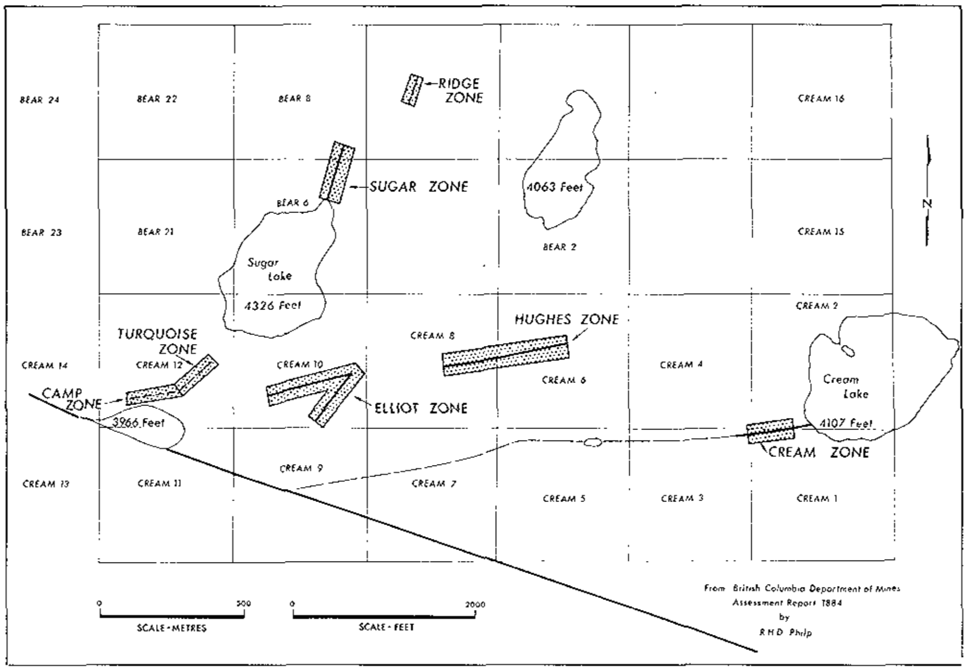


Figure G-24. Cream Silver property, location of silver showings.

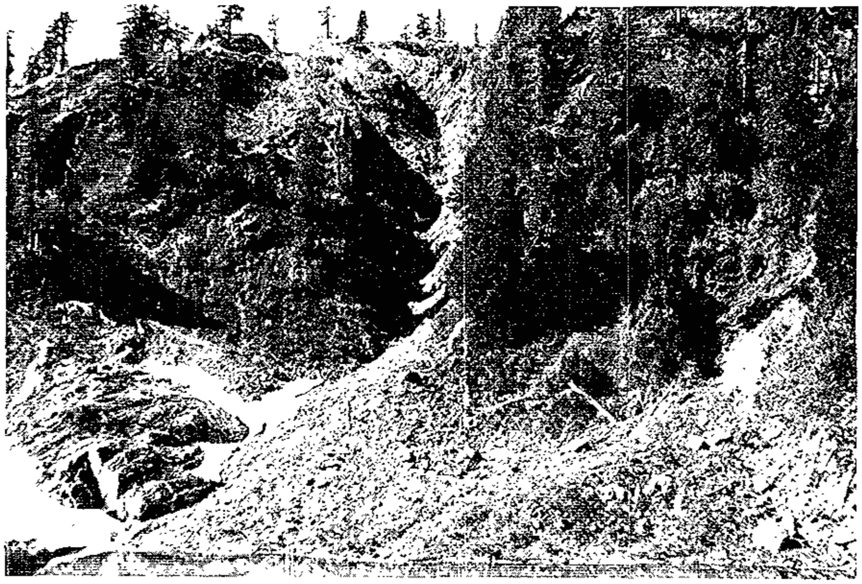


Plate G-VIII. The Cream zone is located in the gully in the centre of the photograph. Cream Lake is in the foreground.

Plate G-IX. Cream vein showing the intensely sheared and pinching and swelling nature of the vein-shear system.

Plate G-X. Cream vein showing sheared nature of the vein-shear system.

DESCRIPTION

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 within a sequence of volcanosedimentary clastic rocks interbedded with tuff and siliceous beds 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.

VEIN–SHEAR SYSTEMS: *Vein-shear systems occur* west and northwest of Cream Lake in Sicker Group rocks of volcanic origin (Plate VIII). 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 locations of the most prominent vein-shear systems are shown on Figure G-24.

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 (Plates IX and X). 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-shear systems range in thickness from a few centimetres up to 1.5 metres but are commonly between 35 to 61 centimetres wide (Plates IX and X). 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 centimetres
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

REFERENCES: Assessment Reports 3911, 3912.

CUP (92F/7E)

By G.E.P. Eastwood

LOCATION: The Cup claim consisting of 12 units is owned by A. Rodstrom and is situated in the Alberni Mining Division on the northwest slope of the hill between the heads of French and Lockwood Creeks, from 900 to 990 metres elevation. Conventional prospecting, under the Prospectors' Assistance Program, was carried out.

DESCRIPTION: Exposures of solid bedrock are largely restricted to the road cuts of the logging roads. Loose blocks derived from mechanical weathering of the bedrock litter the summit and north ridge and probably are essentially in place. Soil and transported rock fragments form a thin cover over and between the loose blocks on the summit and north ridge.

The long north ridge of the hill is underlain by hornblende diorite, and a siliceous volcanic rock is exposed on the summit and south part of the west slope. The contact is not exposed, but the disposition of occurrences on the west slope suggests that it may be steep.

The diorite is characterized by abundant prismatic hornblende and in part by the presence of 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, and a discontinuous vein and veinlet of chalcopyrite were found. Part of the fine-grained phase of the diorite contains very finely disseminated chalcopyrite. The xenoliths are almost totally barren. The chalcopyrite is sparse overall and is irregularly distributed. One block of rock of cubic-foot 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.

NARVAEZ (92F/9W)

By K. E. Northcote

LOCATION: The Narvaez claim, consisting of four units which cover part of the former Bob and Tex claims, is located 2.5 kilometres north of Mount Grant on Texada Island.

DESCRIPTION: 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.

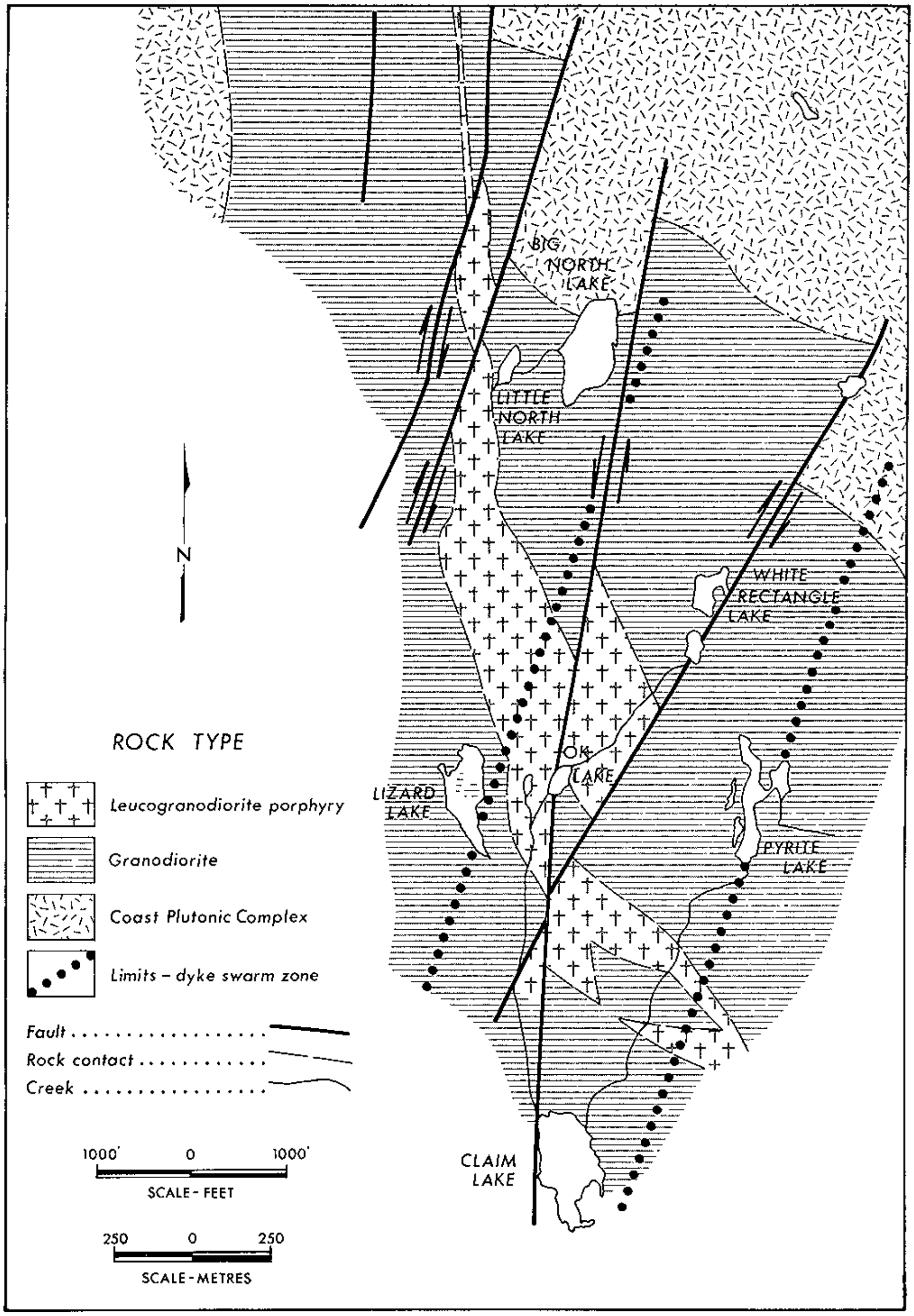


Figure G-25. Geology of the OK deposit (from Meyer, Gale, and Randall).

OK, DEE, IN, MBM (92K/2E; 92F/15E)

By K. E. Northcote

LOCATION: The OK, DEE, IN, and MBM claims, totalling approximately 144, are owned by Mr. R. Mickle and Mrs. M. V. Boylan and are situated 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.

DESCRIPTION: 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 0000 metres of diamond drilling.

A paper by W. Meyer, R. E. Gale, and A. W. Randall, for inclusion in the Charles S. Ney Volume (*C.I.M.,* Special Volume 15) gives an excellent account of the OK property. Much of the information for the following description of the property is from this paper.

The area of the claims is underlain by diorite and gabbro of the Coast Plutonic Complex, cut by a composite stock of granodiorite, measuring 6 kilometres by 3 kilometres, which contains a dyke-like core of highly siliceous leucogranodiorite porphyry (Fig. G-25). 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 matrix. The composite intrusive units are cut by a swarm of late post-mineralization porphyritic hornblende diorite and dacite dykes ranging from a few centimetres to several metres wide (Fig. G-25).

Strong quartz and sericite alteration in the central leucocratic porphyritic core grades outward into chlorite and 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 on 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 cutoff are as follows: drill indicated 48 978 000 tonnes of 0.30 per cent copper and 0.016 per cent molybdenite; drill inferred 19 047 000 tonnes of 0.26 per cent copper and 0.02 per cent molybdenite.

REFERENCE: Meyer, W., Gale, R. E., Randall, A. W., OK Property, *C.I.M.,* The Charles S. Ney Volume, Special Volume 15, pp. 311-316.

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

By K. E. Northcote

LOCATION: The I, Stan, Port, and HB claims, totalling 35, are owned by Stanley Weston and are situated on the mainland on Nelson Ridge, opposite Port Neville, 14 kilometres northwesterly across Johnstone Strait from Kelsey Bay.

DESCRIPTION: 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.

AXE (92H/10E)

By V. A. Preto

LOCATION: The AXE, BUD, BOL, LOX, and RUM claims, totalling approximately 200, are owned by Adonis Mines Ltd. and are situated on the west side of Summers Creek, approximately 19 kilometres north of Princeton. Access is by dirt road branching eastward from Highway 5 at the north end of MacKenzie Lake, or by dirt road branching westward from the Summers Creek road, approximately 13 kilometres north of the junction of this road with Highway 5.

DESCRIPTION

HISTORY: Copper mineralization at the Axe showings is exposed in natural outcrops on the Adit zone and on steep east-facing cliffs of augite porphyry on the South zone. These showings must have been known for some time, as indicated by an old 28.8-metre adit driven at the Adit zone. The sequence of events which in recent years led to the property's present status can be summarized as follows:

> The claims were staked by J. A. Stinson in 1967 and 1968, and later acquired by Adonis Mines Ltd., with Mr. Stinson becoming a major shareholder and officer of the company.
>
> Soon after the claims were first staked, the Summers Creek access road to the South zone was built and eight trenches totalling 295.5 metres were excavated.
>
> In 1967 Meridian Mines Ltd. optioned the property, cut 3 910 metres of lines, and performed various geophysical and geochemical surveys. This company also did some bulldozing and drilled seven BQ wireline holes (M1 to M7) totalling 641.7 metres.

FIGURE G-26

GENERALIZED OUTCROP GEOLOGY OF THE SUMMERS CREEK PROSPECT (AXE) ADONIS MINES LTD.

LEGEND

CRETACEOUS

7

- 7a – GREY BIOTITE–HORNBLENDE GRANODIORITE, PINKISH GREY BIOTITE QUARTZ MONZONITE, AND MINOR PINK GRANITE
- 7b – HORNBLENDE DIORITE, QUARTZ DIORITE, AND GRANODIORITE

AGE UNKNOWN

6 VOLCANIC CONGLOMERATE AND LIMESTONE

- 6a – RED VOLCANIC BOULDER CONGLOMERATE
- 6b – GREY, LOCALLY BEDDED, IMPURE LIMESTONE AND CALCAREOUS GRIT

UPPER TRIASSIC TO LOWER JURASSIC

5 ALLISON PLUTON

- 5a – REDDISH TO REDDISH GREY BIOTITE–HORNBLENDE GRANITE AND QUARTZ MONZONITE
- 5b – GREY HORNBLENDE GRANODIORITE
- 5c – GREY TO DARK GREY HORNBLENDE DIORITE, GABBRO, AND QUARTZ DIORITE
- 5d – METAVOLCANIC ROCKS WITHIN OR NEAR THE PLUTON

4 DIORITE INTRUSIONS

- 4a – DIORITE, QUARTZ DIORITE, MONZONITE, AND DIORITE BRECCIA
- 4b – PORPHYRY DYKES

3 SHEARED AND MYLONITIZED, LEUCOCRATIC QUARTZ PORPHYRY

UPPER TRIASSIC

NICOLA GROUP

EASTERN BELT

2 BASALTIC FLOWS AND BRECCIA, SILTSTONE, GREYWACKE, AND LAHARIC DEPOSITS

- 2a – PURPLISH GREEN PYROXENE–PLAGIOCLASE BASALT PORPHYRY FLOWS, FLOW BRECCIA, AND MINOR TUFF BRECCIA, LOCALLY INTENSELY RECRYSTALLIZED
- 2b – GREY–GREEN, MASSIVE TO BEDDED VOLCANIC SILTSTONE AND GREYWACKE, LOCALLY TUFFACEOUS
- 2c – MASSIVE TO CRUDELY BEDDED GREY–GREEN LAHARIC DEPOSITS

CENTRAL BELT

1 MASSIVE FLOWS, BRECCIA, TUFF, AND LIMESTONE

- 1a – MASSIVE DARK GREEN BASALTIC AND ANDESITIC FLOWS WITH PLAGIOCLASE AND/OR PYROXENE PHENOCRYSTS
- 1b – AUTOBRECCIATED EQUIVALENTS OF 1a
- 1c – MASSIVE TO THINLY BEDDED GREEN CRYSTAL AND LITHIC TUFF LOCALLY RICH IN FELSIC FRAGMENTS; MINOR VOLCANIC SANDSTONE AND SILTSTONE
- 1d – BEDDED TO MASSIVE, GREY, FOSSILIFEROUS, IMPURE LIMESTONE AND LIMESTONE BRECCIA

cp = CHALCOPYRITE
cc = CHALCOCITE
mal = MALACHITE
az – AZURITE
py – PYRITE
mt – MAGNETITE

SYMBOLS

AREA OF PREDOMINANT OUTCROP
FAULT
JOINT, FRACTURE SET: VERTICAL, INCLINED
PRIMARY FOLIATION VERTICAL, INCLINED
BEDDING: VERTICAL, INCLINED, RIGHT SIDE UP
PROSPECT: TRENCH, ADIT
POWER TRANSMISSION LINE
GEOLOGICAL CONTACT: DEFINED, ASSUMED
NATURAL GAS PIPELINE
SAMPLE LOCATION, MINERAL USED, AND APPARENT AGE IN M.Y. .... VP-75-KA-2 B 98.2±2.6 my HB 96.8±2.6 my

0 — 1

SCALE-KILOMETRES

In 1968 the property was optioned by Quintana Minerals Corporation. This company excavated more trenches, and sampled and mapped the claims. It also drilled four large-diameter rotary holes (R1 to R4) totalling 990.9 metres.

In 1969 Mr. Stinson excavated more trenches and drilled two diamond holes (A1 and A3) totalling 269.4 metres.

In 1969, 1970, and 1971 the property was under option to Amax Exploration, Inc. This company did further linecutting and performed more geochemical, geophysical, and geological surveys. It also drilled 51 percussion holes totalling 3 350.7 metres and 15 diamond holes totalling 2 730.3 metres.

In 1972 and 1973 Adonis Mines Ltd. did further work including more trenching, 22 NQ wireline holes totalling 3 134.1 metres, and 70 percussion holes totalling 2 551.2 metres.

No further significant work has been done on the property.

The work done to date has contributed in outlining a large porphyry system involving an area nearly 3.2 kilometres in diameter and containing at least three zones of appreciable but scattered copper and some molybdenum mineralization. In spite of the persistent and considerable efforts outlined above, the sizes and grades of the mineralized zones are only poorly known, because of the complicated geology, erratic nature of mineralization, and generally poor recovery obtained in drilling due to intense faulting and fracturing and in places deep weathering of the bedrock.

GEOLOGY

GENERAL: The Axe property belongs to a large group of copper showings including several porphyry-type deposits that are found in a narrow, northerly trending belt between Copper Mountain and Nicola Lake. All of these deposits occur within an assemblage of high-energy proximal volcanic and genetically related intrusive rocks which form a narrow, largely fault-bounded Central Belt (Preto, 1974, 1975) in the Upper Triassic Nicola Group.

Figure G-26 is a generalized outcrop map of the area surrounding the showings. Copper mineralization occurs in Upper Triassic Nicola volcanic rocks that are cut by a variety of intrusive rocks ranging from mafic diorite to syenite and from quartz diorite to felsic quartz porphyry. Structurally the mineralization occurs in an area where two major branches of the northerly trending Summers Creek fault come together, break up into a series of lesser east-west, northeast, and northwest-trending structures, and finally continue southeastward apparently as a single fault of seemingly lesser magnitutde.

The oldest rocks within the area of Figure G-26 are massive flows and breccias of augite basalt porphyry. Interlayered with these are massive to thinly bedded crystal and lithic tuffs and some volcanic sandstone and siltstone. A few small lenses of massive, locally fossiliferous, impure limestone and limestone breccia are also found interlayered with the volcanic sediments. All these rocks are part of the high-energy volcanic assemblage of the Central Belt which is well displayed for several kilometres to the north (Preto, 1974, 1975).

On the east side of Summers Creek, and across the Summers Creek fault is a succession of grey-green volcanic siltstone, greywacke, and some tuffs which are underlain by massive, purplish green pyroxene-plagioclase basalt porphyry flows and breccias. The sedimentary rocks of this succession are part of the Eastern Belt assemblage (Preto, 1974, 1975) and are the distal, fine-grained equivalent of extensive laharic deposits that form the eastern slopes of Summers Creek a short distance to the north. The underlying flows and breccias of unit 2a are identical to and possibly equivalent with some of the Central Belt rocks. If this correlation could be proven, it would support the interpretation that the Central Belt rocks have been uplifted with respect to those of the Eastern Belt.

In the areas of copper mineralization, and especially on the Adit and Western zones, the Nicola rocks are cut by a complex assemblage of generally fine-grained diorite and monzonite which appear to form small stocks and dyke-like bodies and locally contain small bodies of high-level intrusive breccia. At least two, and probably more, phases of these quartz-poor intrusive rocks exist on the Adit and Western zones, but their number and relationships are difficult to understand because of intense faulting and extensive alteration. By comparison with better known and similar porphyry deposits such as those of Copper Mountain or of Iron Mask batholith, these intrusive rocks are interpreted to belong to an older high-level suite which is part of the Nicola magmatic suite. In fact the two areas of unit 4a rocks on the Adit and Western zones may well represent the deeper parts of Nicola volcanoes in this area.

Volcanic and intrusive rocks in the vicinity of the mineralized zones are intensely fractured and cut by numerous faults, only the largest of which are shown on Figure G-26. Rock alteration of the volcanic and intrusive rocks appears to be variable and, probably because of later faulting, highly irregular. *Potassic alteration* includes the development of secondary biotite and of potash feldspar in volcanic and intrusive rocks. *Propylitic alteration* is represented by chloritization of mafic minerals and breakdown of plagioclase to epidote, sericite, and carbonate. *Argillic alteration* is best developed along the numerous shear and fault zones and commonly reduces the rocks to an unrecognizable conglomeration of altered fragments or to a clay-like paste.

Copper mineralization includes widespread chalcopyrite, accompanied by variable amounts of pyrite, and abundant azurite, malachite, and some chalcocite. The formation of the copper deposits is considered to be closely related in age and origin to the magmatism which produced the volcanic rocks of unit 1 and the intrusive rocks of unit 4. The mineralization represents the latter stages of a series of Upper Triassic events which started with the accumulation of a volcanic pile, continued with the high-level intrusion or rocks of unit 4, and culminated with hydrothermal rock alteration and sulphide deposition. This period of mineralization is considered to be separate from and older than molybdenum mineralization which followed at a much later time and was probably associated with intrusive rocks of unit 7.

The western part of the area of Figure G-26 is underlain by granitic rocks of the Allison Pluton which range from red biotite-hornblende granite to granodiorite, mafic diorite, and gabbro. Extensive alteration and minor mineralization along the contact with Nicola rocks, and numerous inclusions of metavolcanic rocks clearly show that Allison Pluton intrudes Nicola strata. Recent isotopic age dating (Preto, in press) indicates that at least some phases of this complex pluton were emplaced about 200 m.y. ago, or in Latest Triassic-Earliest Jurassic time.

North of the Western zone, Nicola rocks are overlain, probably unconformably, by an outlier of red to maroon volcanic conglomerate and minor interbedded impure limestone and calcareous grit of map unit 6. Bedding in the conglomerate dips gently to steeply to the southwest. The age of this conglomerate is unknown, but it must be considerably younger than that of Nicola rocks since it is not affected by strong faults and considerable alteration which cut Nicola strata. Clasts in the conglomerate include green basic Nicola volcanic and grey intrusive rocks, abundant grey limestone, some acid volcanic rocks, and locally some vein quartz, but very few, if any, granitic clasts.

Granitic rocks of the Okanagan intrusions cut Nicola rocks south of the South zone and north of the Adit zone. These rocks include grey biotite-hornblende granodiorite, biotite quartz monzonite, and some pink granite. Co-existing biotite and hornblende from grey granodiorite 1.2 kilometres south of the South zone yield an average K-Ar age of 97.5±2.6 m.y. Biotite from quartz monzonite 2.8 kilometres to the southeast yields an age of 96.7±2.1 m.y. Northeast-trending quartz feldspar porphyry dykes at the Adit zone, numerous quartz veins, and some silicification and minor molybdenum mineralization in the volcanic rocks are probably related to these Cretaceous intrusive rocks and thus are much younger than the main period of copper mineralization.

EXTENT OF MINERALIZATION: Though a good deal of effort and money has been spent in trying to outline one or more copper orebodies on this property, the results to date have been inconclusive and difficult to interpret. Core recovery in most diamond holes, even in those drilled with the greatest care, has been only fair to poor because of the intensely fractured and locally deeply weathered state of the rocks. Different adjustment factors have been employed by various workers in evaluating assays from diamond, percussion, and rotary holes, and the figures obtained from these highly variable and often problematic data should only be considered to be a very crude estimate. The latest figures released by the company (George Cross Newsletter, September 11, 1973) are as follows:

South zone	—	41	million tons at 0.48 per cent copper
West zone	—	6.4	million tons at 0.47 per cent copper
Adit zone	—	16	million tons at 0.56 per cent copper

REFERENCES

Preto, V. A. (1974): Geology of the Aspen Grove Area, B.C., *B.C. Dept. of Mines & Pet. Res.,* Preliminary Map No. 15.

.... (1975): Geology of the Allison Lake-Missezula Lake Area, *B.C. Dept. of Mines & Pet. Res.,* Preliminary Map No. 17.

MINERALIZATION IN THE BRIDGE RIVER CAMP (92J/10W, 11E, 14E, 15W)

By D. E. Pearson

The history of placer and mineral deposit exploration in the Bridge River area dates back to the 1880's. During this interval, vein mineralization has been found in many widely scattered localities and defines what is known as the Bridge River Mining Camp. The camp is located along the Cadwallader Creek valley on the south side of Bendor Pluton, along Hurley River Canyon, on both sides of Bridge River at the west end of Carpenter

Lake, and in the valleys of Tyaughton Creek and its tributaries to the north of Bridge River.

Principal interest has been in precious metals, but antimony, tungsten, and mercury deposits have all been found and worked to varying degrees. The only significant production has come from the Bralorne-Pioneer and the Minto mines, which together have mined 8 224 520 tonnes of ore grading 3 ppm silver and 16 ppm gold.

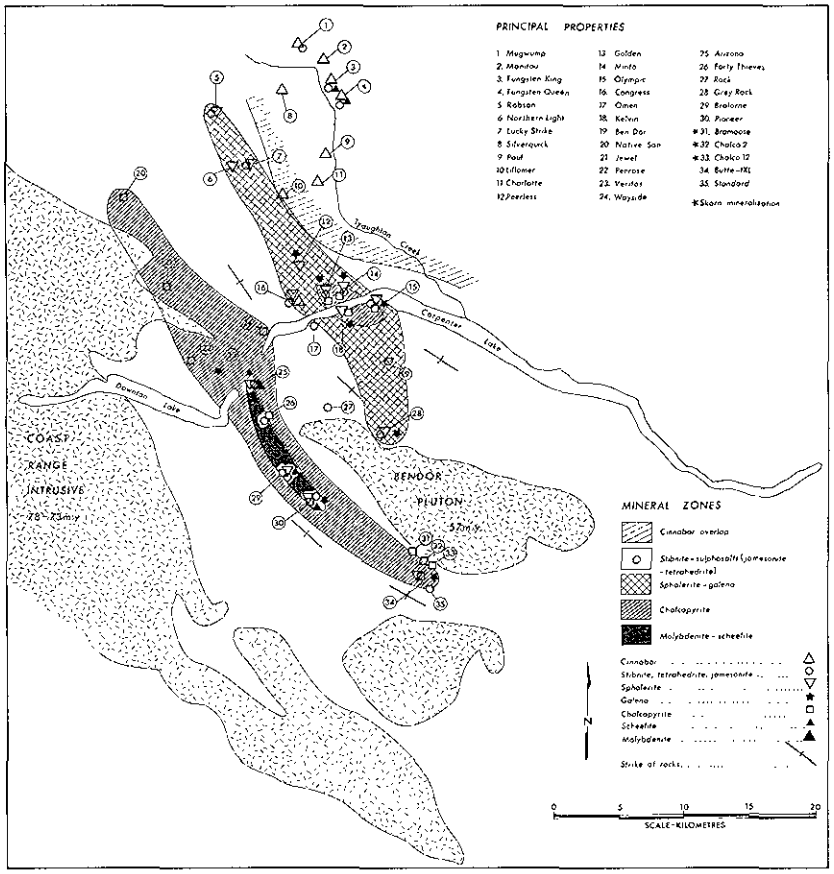


Figure G-27. Regional mineral zoning pattern, Bridge River mining camp.

A study of mineral content of the various known deposits indicates the presence of a distinctive asymmetric metal and mineral zoning pattern in the Bridge River Camp (Fig. G-27) (Pearson, 1975; Woodsworth, Pearson, and Sinclair, 1977). Two mineralized centres are apparent. One is located in the vicinity of the Bralorne-Pioneer mine, and the other in the area of the Minto mine. The Minto centre is defined by vein-type mineral occurrences that characteristically contain chalcopyrite in addition to sphalerite and galena. This centre is surrounded by an envelope of sphalerite and galena-bearing veins. The centre differs from the Bralorne centre in that it contains veins that carry abundant mixed sulphides, and gold occurs with one or more of them, chiefly with arsenopyrite. The Bralorne centre is defined by vein-type mineral deposits that contain scheelite or

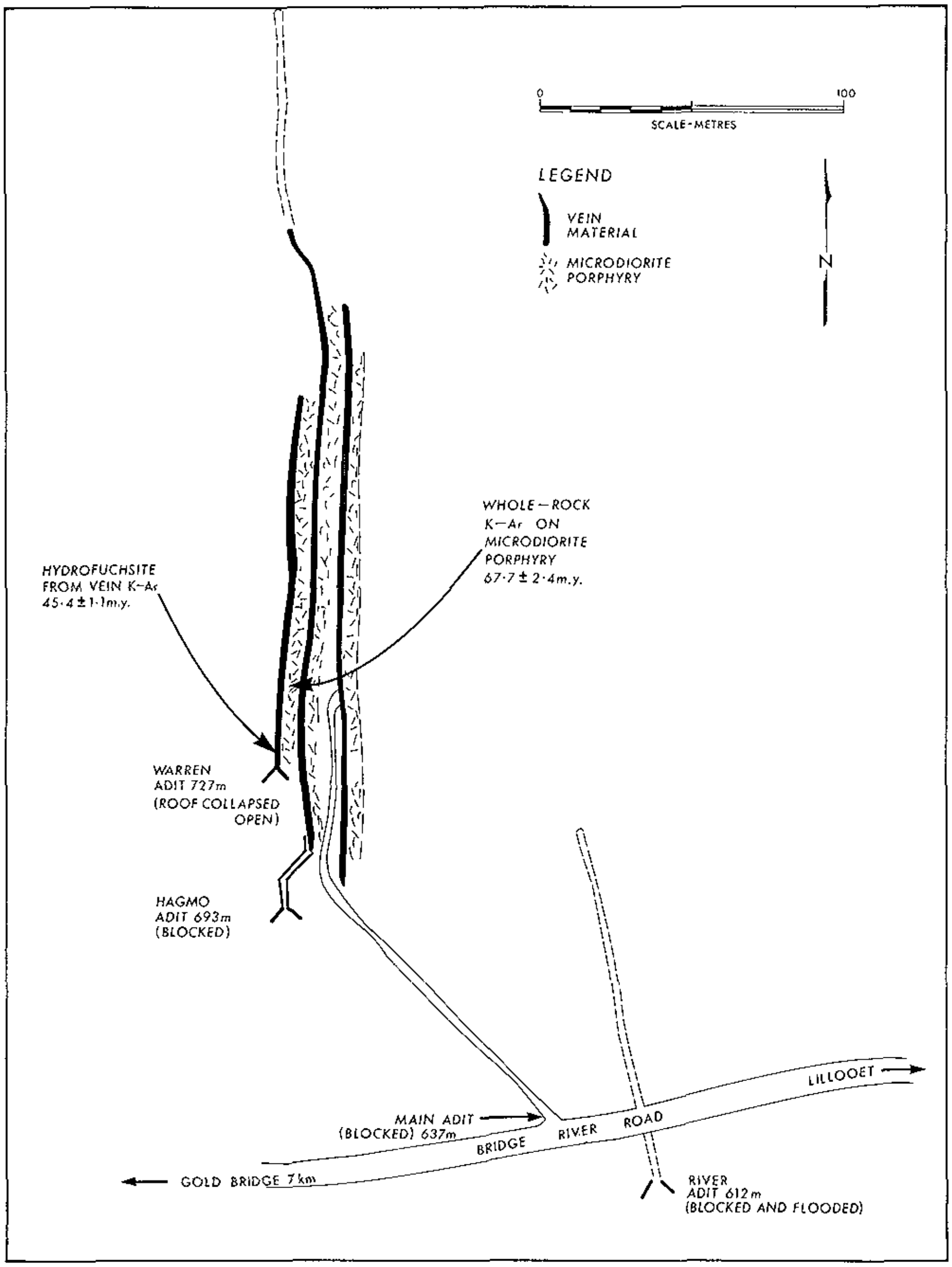


Figure G-28. Location of analysed samples, Minto mine.

molybdenite or both. A number of chalcopyrite-bearing vein-type deposits surround this core area and define an envelope. Of the two centres, Bralorne was principally a gold producer whereas Minto was primarily a silver producer. Both centres lie within an area characterized by deposits containing the antimony-bearing minerals tetrahedrite, jamesonite, and stibnite. To the northeast of the camp, in the right angle of Tyaughton Creek, the area of antimony mineralization is overlapped by an area of mercury that is devoid of gold-bearing deposits.

The elongation of the zonal pattern is coincident with regional strike of bedding, faulting, and dykes. Mineralization at the Minto centre is related to the emplacement of diorite feldspar porphyry dykes (McCann, 1922; Pearson, 1975) whereas mineralization in the core of the Bralorne centre is restricted to the dykes of trondhjemite (the so-called Bralorne soda-granite).

AGE OF MINERALIZATION

MINTO CENTRE: Samples of the Minto porphyry dykes were collected for chemical and petrographic analysis. Analyses revealed the rock to be a microdiorite porphyry (Table 1) that has unfortunately undergone some alteration, so that much of the hornblende is chloritized. In spite of this a whole-rock K-Ar age of 67.7±2.4 m.y. was obtained from the Minto microdiorite porphyry dyke.

Because of the assertion that the Minto centre mineralization is related to the emplacement of the porphyry dykes, a 30-kilogram sample of vein material was collected from the collapsed roof of the Warren adit of the Minto mine (Fig. G-28). From this sample was separated 0.6 gram of green mineral thought to be the chromian phengite, mariposite. Analysis revealed that the mineral was hydrofuchsite (Table 2), the high H_2O and low K_2O values of which are common to hydromicas (Brown and Norrish, 1952). The hydrofuchsite yielded a radiometric K-Ar age of 45.4±1.1 m.y.

BRALORNE CENTRE: Samples of the Bralorne soda-granite were collected from 250 metres above the old workings on the Arizona property (Fig. G-29). Chemical and petrographic analysis revealed that the rock is a trondhjemite (Table 3). White mica separated from this rock is phengite (Table 4), and has a K-Ar age of 62.5± m.y.

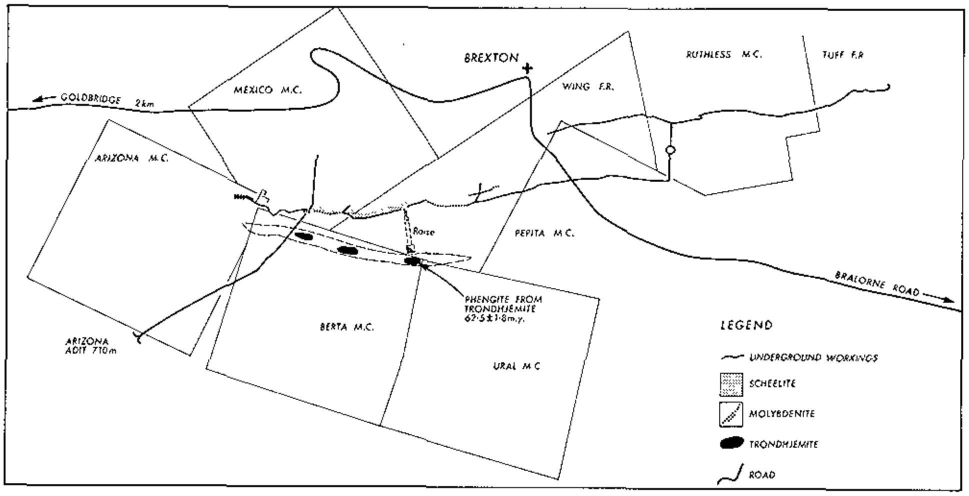


Figure G-29. Location of analysed samples, Arizona property.

Table 1.
Analysis of Minto Microdiorite Porphyry

SiO_2	59.26	58.84
Al_2O_3	17.47	17.06
Fe_2O_3	0.91	(4.86)
FeO	3.63	3.54
MgO	2.89	2.89
CaO	5.16	5.07
Na_2O	4.43	4.29
K_2O	1.13	1.13
TiO_2	0.74	0.74
MnO	0.08	0.08
H_2O+	1.90	1.86
H_2O-	0.27	0.27
CO_2	1.43	1.40
P_2O_5	0.21	0.21
S	0.04	0.04
BaO	----	0.04
TOTAL	99.55	98.4

Analyst, M. Chaudhry, British Columbia Ministry of Mines and Petroleum Resources.

Table 2. Analysis of Hydrofuchsite from Minto Vein

Analysis		**Structural Formula****			
SiO_2	57.37	Si	7.83		8.00 (Si + Al 0.17)
Al_2O_3	17.98	Al	{0.17 / 2.71}		
Cr_2O_3	4.52	Cr	0.25		3.65 (Al 2.71 + Cr + Fe^{3+} + Mg)
Fe_2O_3 (total)	0.35	Fe^{3+}	0.03		
MgO	3.12	Mg	0.66		
TiO_2	0.03	K	0.74		2.01 (K + Ca + Na + H_3O^+)
K_2O	4.05	Ca	0.16		
CaO	1.29	Na	----		
Na_2O	0.03	H	{3.33 / 4.00}	1.11 (H_3O^+) / 4.00	OH
H_2O*	12.00	O = 25.13 – (H_3O + OH) = 20 (O)			
TOTAL	100.74				

*H_2O by ignition loss
**water assumed to be: 8.00% H_2O+; 3.91% H_2O-

Analyst, P. Ralph, British Columbia Ministry of Mines and Petroleum Resources.

Table 3. Analysis of Trondhjemites

	1	2	3	4
SiO_2	74.40	75.87	74.36	67.67 – 72.11
Al_2O_3	14.27	12.42	12.87	15.25 – 16.87
Fe_2O_3	0.97	0.66	0.61	0.28 – 2.22
FeO	0.22	2.03	1.96	0.03 – 2.37
MgO	0.17	0.11	1.27	0.31 – 1.09
CaO	0.78	1.59	1.12	1.65 – 4.42
Na_2O	5.22	5.06	5.27	4.18 – 6.63
K_2O	1.46	0.46	0.36	0.57 – 2.22
TiO_2	0.13	0.31	0.14	0.08 – 0.35
MnO	0.01	----	----	0.00 – 0.06
H_2O+	0.88	0.31	1.21	0.20 – 0.66
H_2O-	0.11	0.10	0.10	trace – 0.03
P_2O_5	0.20	0.28	0.07	0.03 – 0.15
S	0.02	0.26	0.61	0.03 – 0.06
TOTAL	98.84	98.99	99.87	

1 – Arizona property; analyst, M. Chaudry, British Columbia Ministry of Mines and Petroleum Resources.

2 – Reported by C. E. Cairns from Bralorne mine.

3 – Reported by C. E. Cairns from Pioneer mine.

4 – Ranges of five trondhjemites from Norway by Goldschmidt; reported by A. Johannsen.

Table 4. Analysis of Phengitic White Mica from Arizona Trondhjemite

Analysis		Structural Formula		
SiO_2	46.88	Si	6.50	8.00
Al_2O_3	32.48	Al	1.50	
			3.81	
TiO_2	0.70	Ti	0.07	
Fe_2O_3 (total)	2.80	Fe	0.29	4.45
MgO	1.24	Mg	0.26	
MnO	0.02	Mn	----	
K_2O	9.85	K	1.75	
CaO	0.28	Ca	0.08	2.03
Na_2O	0.91	Na	0.24	
H_2O	4.84			

Analyst, P. Ralph, British Columbia Ministry of Mines and Petroleum Resources.

DISCUSSION: Notwithstanding the anomalous apparent age of the Minto hydrofuchsite, the radiometric evidence obtained from the Minto dyke and the Arizona trondhjemite indicates that both centres are essentially of the same age, and that both were emplaced in Late Cretaceous or Early Tertiary time. The difference between the ages of these dykes and that of biotite from Bendor Pluton (57±2 m.y.) is not large enough to deny that they are unrelated.

REFERENCES

Brown, G. and Norrish, K. (1952): Hydrous Micas, *Mining Magazine,* Vol. 29, pp. 929-932.

Cairns, C. E. (1937): Geology and Mineral Deposits of Bridge River Mining Camp, British Columbia, *Geol. Surv., Canada,* Mem. 213, 140 pp.

McCann, W. S. (1922): Geology and Mineral Deposits of the Bridge River Map-Area, British Columbia, *Geol. Surv., Canada,* Mem. 130, 115 pp.

Johannsen, A. (1932): A Descriptive Petrography of the Igneous Rocks, Vol. II, The Quartz-bearing Rocks, *Univ. of Chicago Press,* 428 pp.

Pearson, D. E. (1975): Bridge River Map-Area, *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1974, pp. 35-39.

Woodsworth, G. J., Pearson, D. E., and Sinclair, A. J. (1977): Metal Distribution Patterns Across the Eastern Flank of the Coast Plutonic Complex, South-Central British Columbia, *Econ. Geol.,* in press.

TOPLEY RICHFIELD (93L/9E)

By T. G. Schroeter

LOCATION: The Redtop, Richfield, and TR claims, owned by Canadian Superior Exploration Limited, are situated approximately 11 kilometres north of Topley.

DESCRIPTION: During the 1920's three levels of underground workings were developed by the Richfield Mining Company. The property was inactive until 1955 when Silver Standard Mines Limited dewatered and sampled the underground workings and also conducted a limited surface diamond drilling program. In 1967 Seemar Mines Limited carried out an electromagnetic survey on the property.

In 1975 Canadian Superior optioned the property and concentrated their exploration work on a 45-metre-wide quartz-carbonate alteration zone ('topleyite') developed along a north-trending fault zone in Mesozoic volcanic rocks. Weakly disseminated pyrite, chalcopyrite, galena, sphalerite, tetrahedrite, and arsenopyrite occur within this altered zone which dips 45 to 50 degrees to the west. Four diamond-drill holes were put down to test this zone.

REFERENCES: *Minister of Mines, B.C.,* Ann. Rept., 1926, pp. 138-143; 1927, pp. 140-148; 1928, pp. 173, 174; 1929, p. 179; 1935, p. C39; 1946, p. 89; 1951, p. 117; 1952, p. 95; *see also* Exploration in British Columbia, 1975.

SERB CREEK (93L/12)

By T. G. Schroeter

LOCATION: The SC 1 (9 units), SC 2 (6 units) (Fig. G-30), New Katie, and New Petra claims are situated approximately 40 air-kilometres west-southwest of Smithers.

DESCRIPTION: Diamond drilling by Craigmont Mines Limited, conducted in the overburden-filled valley bottom north of the previous drilling by Amax Exploration, Inc. in 1965 and 1966, encountered a sequence of intrusive rocks similar to those described in the Annual Report of the Minister of Mines and Petroleum Resources for 1965 (pp. 76-80) (Fig. G-30). Low-grade molybdenum mineralization is contained in quartz veins (up to 2 centimetres in width) and quartz stockworks and in dry fractures. The veins and veinlets are composed of varying amounts of quartz±pyrite±molybdenite±epidote. Pyrite also occurs as disseminations in the rock (1 to 3 per cent). Gypsum occurs on some fractures. Two main types of alteration related to the period of mineralization include: sericite-orthoclase-carbonate alteration, or epidote-chlorite-orthoclase alteration, accompanied in some cases by pyritization and silicification.

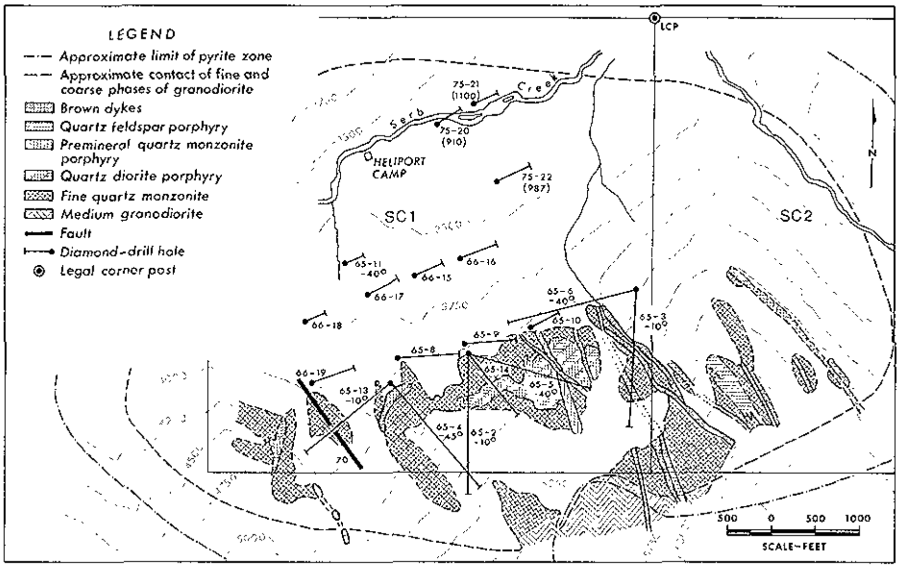


Figure G-30. Geology of SC 1 and 2 claims, Serb Creek area (after company plans).

REFERENCES: *Minister of Mines, B.C.,* Ann. Rept., 1965, pp. 76-80; 1966, p. 91; *see also* Exploration in British Columbia, 1975.

BIG ONION (93L/15W)

By T. G. Schroeter

LOCATION: The JA (9 units), JB (8 units), JC (10 units), JD (20 units), JE (12 units), JF (8 units), JG (8 units), and JH (12 units), owned by Canadian Superior Exploration Limited, are 16 kilometres by road due east of Smithers.

DESCRIPTION: A large percussion drilling program was carried out to better define areas of known widely distributed copper and molybdenum mineralization within the highly altered Big Onion pluton and to explore areas previously untested by drilling (*see* Fig. G-31 for locations). Previous locations of diamond drill holes are also indicated on Figure G-31.

An elongate, highly altered and pyritized zone along Astlais Creek exists 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.

Two main elongate mineralized zones with northeasterly trends parallel to Astlais Creek have been recognized: the South zone (approximately 1 200 metres by 300 metres) and the North zone (approximately 840 metres by 120 metres). The division of zones appears to correspond with the geologic division of the quartz diorite porphyry.

Leaching has been very intense and may have lead to zones of secondary enrichment.

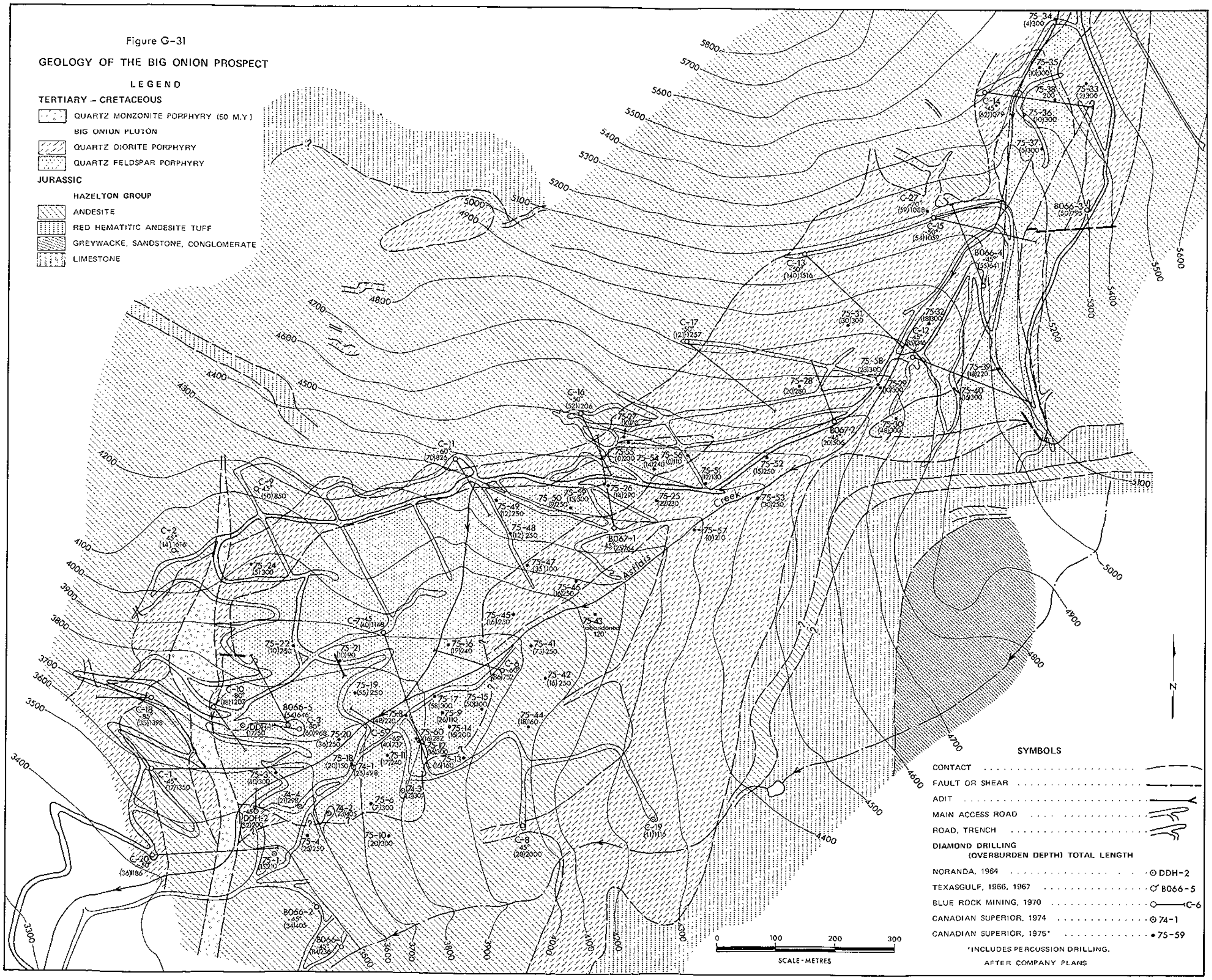


Figure G-31
GEOLOGY OF THE BIG ONION PROSPECT

REFERENCES: *Minister of Mines, B.C.,* Ann. Rept., 1966, pp. 83-86; *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1974, p. 80; 1975, p. 67; *see also* Exploration in British Columbia, 1975.[

CRONIN MINE (93L/15W)

By T. G. Schroeter

LOCATION: The Sunflower, Homestake, Bonanza, Eureka, Lucky Strike, Babine Chief, Bulkley Pioneer, etc., claims, owned by Hallmark Resources Ltd., are situated on the east slope of Mount Cronin, near Cronin Creek, at approximately 1 560 metres elevation.

DESCRIPTION: Results of surface mapping and sampling, carried out on the upper showing by the writer in 1974, are illustrated on Figure G-32 together with the present mine workings. Interesting lead, silver, and zinc mineralization contained in veins and quartz stockworks within a complex zone of intrusive rhyolite, sericite schist, and intensely folded black argillite were mapped and assay results obtained (*see* accompanying table). The geology appears to be complex in the vicinity of the contact between rhyolite and sedimentary rocks. Three major rock types host the mineralized structures: a sedimentary unit of Hazelton age and two rhyolite intrusions of indeterminate age.

Sample No.	Sample Interval *metres*	Gold *ppm*	Silver *ppm*	Lead *per cent*	Zinc *per cent*	Sample Description
C– 2	9	0.31	43.75	0.25	0.01	Rhyolite
C– 3	grab	0.31	12.5	0.23	0.10	Rhyolite
C– 4	18	0.31	87.5	0.23	0.35	Rhyolite
C– 5	9	0.31	78.12	0.35	0.013	Rhyolite-phyllite contact
C– 6	grab	trace	21.87	0.05	0.40	Rhyolite
C– 7	30	1.56	1450	11.5	2.25	Along Wardell vein
C– 8	24	trace	12.5	0.01	0.038	Rhyolite
C– 9	7.5	1.56	68.75	1.06	0.05	Rhyolite-quartz stockwork
C–10	1	trace	21.87	0.35	0.01	Quartz vein
C–11	grab	trace	trace	0.01	0.01	Sericite schist
C–12	4.5	0.94	646.87	6.81	0.138	Quartz vein in rhyolite
C–13	18	0.94	625	13.1	0.10	Quartz stockwork in rhyolite
C–14	30	trace	trace	0.06	0.05	Quartz stockwork in rhyolite
C–15	15	0.31	56.25	1.00	0.938	Quartz stockwork in rhyolite
C–16	1	3.43	221.87	7.31	0.05	Quartz vein in rhyolite
C–17	52.5	trace	trace	0.01	0.063	Rhyolite
C–18	.3	trace	trace	11.9	0.813	Quartz vein in argillite
C–19	1	trace	68.75	0.01	0.015	Microdiorite dyke
C–20	1.3	trace	trace	0.01	0.01	Microdiorite dyke and argillite
C–21	10 cm	3.12	1009.37	17.5	0.213	Quartz vein in sericite schist
C–22	grab	1.25	125	1.75	1.15	Quartz vein in sericite schist
C–23	1	0.62	1518.75	33.1	0.625	Quartz vein in sericite schist
C–24	1.3	2.81	10075	18.8	8.88	Across Wardell vein

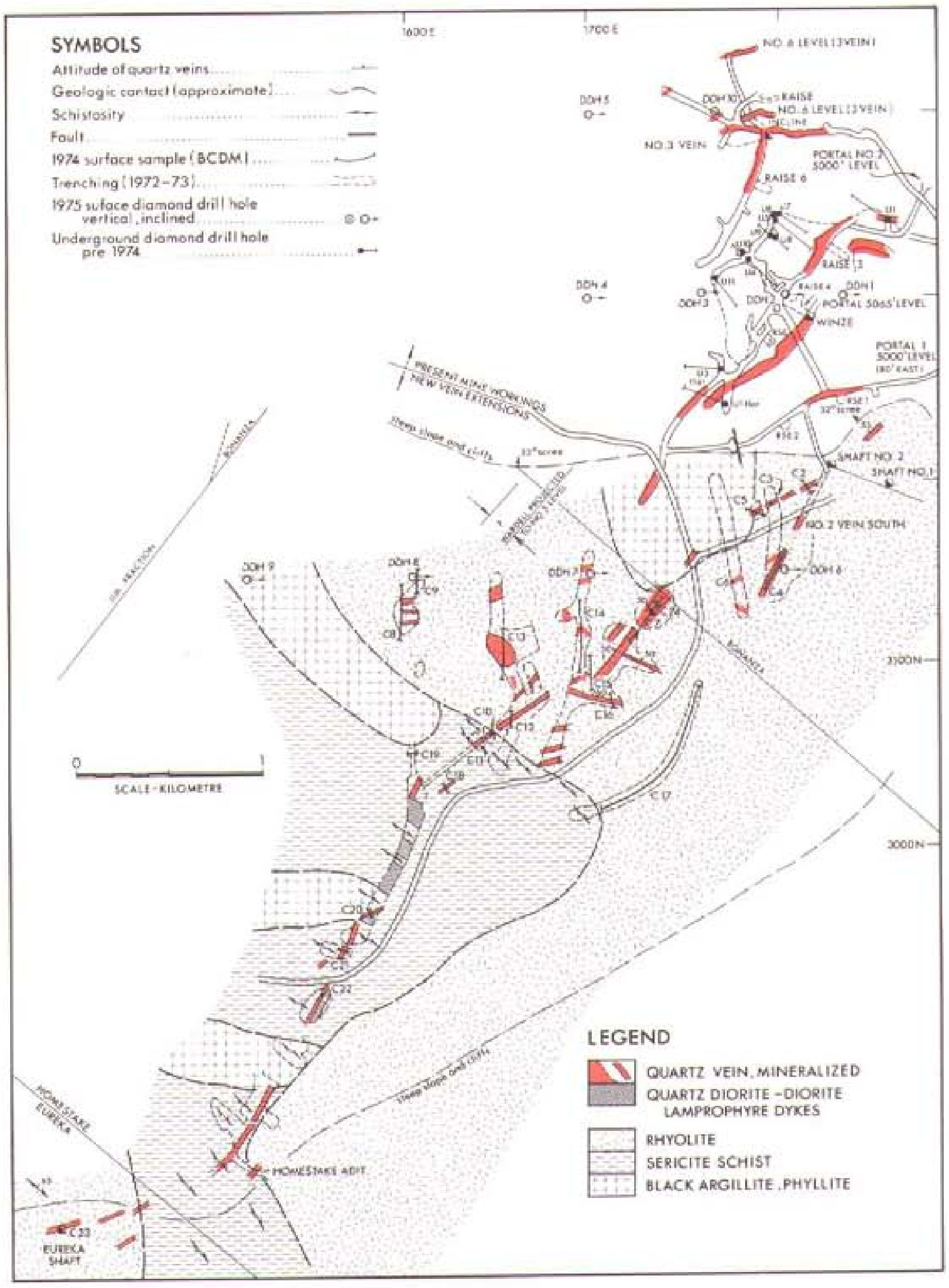


Figure G-32. Cronin mine, composite plan (mine and surface) (after company plans).

ROCK TYPES

SEDIMENTARY UNIT: The sedimentary unit is a bedded clastic sequence consisting of argillite, grits, and minor pebble conglomerate. Sericite schist has developed at the contact with rhyolite. Clasts are for the most part derived from volcanic rocks. Sedimentary structures observed include graded bedding, cross-bedding, and slump structures. Tight folds with refolded axial planes were seen in the argillites. Overturned beds observed in diamond-drill holes indicate that large-scale folding is intense. The argillite is locally graphitic. Moderate to intense quartz veining (1 to 4 millimetres in width) with minor galena exists within the argillite.

Interbedded mudstone, sandstone, intraformational pebble conglomerate, and ash tuffs also exist within the sedimentary unit.

RHYOLITE PORPHYRY: Rhyolite porphyry is the most prominent part of the intrusive complex. It is a grey, massive, medium to fine-grained porphyry with 20 to 40 per cent 1 by 3-millimetre albite laths in an aphanitic groundmass of quartz, calcite, 'sericite,' zoisite, and chloritoid.

There is no appreciable chilled margin where this unit is in contact with the sedimentary unit. A quartz stockwork exists within the rhyolite porphyry and this has been intruded by another rhyolite porphyry which has in turn been cut by a second phase of quartz veining. Quartz veinlets average 4 to 20 millimetres in width and carry variable amounts of sphalerite and galena.

Silicification adjacent to quartz veins is the only significant alteration of this unit.

RHYOLITE: This strongly altered white to pale yellow unit intrudes the rhyolite porphyry. This unit is aphanitic for the most part, but may contain up to 15 per cent 1 to 2-millimetre quartz phenocrysts. Micro-sized quartz, 'sericite,' and calcite make up the bulk of the rock. Pyrite, sphalerite, and galena occur on dry fractures rather than in a quartz stockwork.

Both rhyolite units have undergone low-grade regional metamorphism.

A set of dykes of mixed composition (probably andesitic), variably porphyritic, comprise the final intrusive event. They are post-stockwork and post-mineral.

Faults and vein structures are well developed in the rhyolites and are traceable over considerable distances.

MINERALIZATION: Sulphide mineralization occurs as dilation veins associated with quartz, in quartz stockworks, as coatings on dry fractures in the rhyolite and rhyolite porphyry, and as trace disseminations in the rhyolite. The most common minerals, in order of abundance, are: pyrite, sphalerite, galena, chalcopyrite, boulangerite, and tetrahedrite. Widths of mineralization vary dramatically over relatively short distances.

Leaching was observed throughout all drill holes extending to as much as 175 metres below surface.

Diamond drilling confirmed that significant mineralization is restricted to the immediate vicinity of the vein structures. The possibility of a buried mineralized intrusive body still exists.

REFERENCES: *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1974, p. 81; 1975, p. 66; *see also* Exploration in British Columbia, 1975.

KING (93M/6E)

By T. G. Schroeter

LOCATION: The Den 1 to 36 claims, owned by Cities Service Minerals Corporation, are situated approximately 38 kilometres northeast of Hazelton, 6.4 kilometres west of Thoen Mountain.

HISTORY: In 1964 Falconbridge Nickel Mines Limited put down four short diamond-drill holes on the property known as TEE (*see* Fig. G-33 for locations) and in 1965 they completed geological mapping. During 1967 and 1968 Mastodon-Highland Bell Mines Limited conducted a program consisting of geological mapping, geochemical sampling, and a ground magnetometer survey. In 1974, Cities Service Minerals Corporation did reconnaissance work on the property and completed an induced polarization resistivity survey consisting of 13.28 line-kilometres. In 1975 five diamond-drill holes totalling approximately 817 metres were drilled.

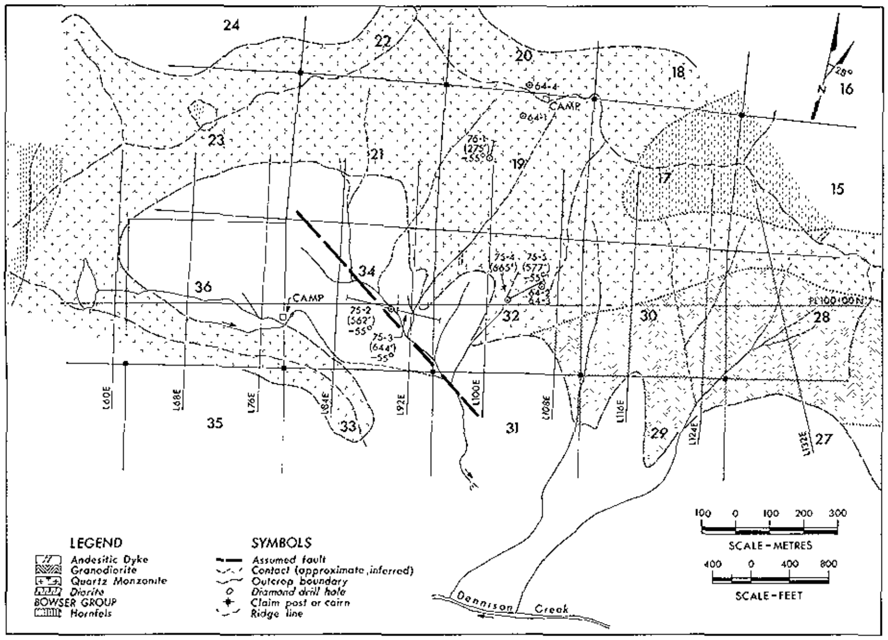


Figure G-33. Geology of the Den copper prospect (after company plans).

DESCRIPTION: The property is predominantly underlain by greyish pink, medium to coarse-grained quartz monzonite. Diorite and granodiorite are also present (Fig. G-33).

The typical composition of the quartz monzonite is:

Per Cent	Mineral
12	Plagioclase phenocrysts — subhedral with discernible lamellar twinning and concentric zoning
5	Quartz phenocrysts — anhedral to subhedral
8	Orthoclase phenocrysts (up to 2 centimetres by 1 centimetre) — subhedral
75	Finer grained (<1 millimetre) groundmass containing: 25 per cent quartz, 20 per cent plagioclase, 20 per cent orthoclase, 5 to 8 per cent biotite, 2 per cent opaques, 1 per cent apatite, and minor sphene, white mica, and chlorite

Plagioclase is moderately to strongly altered to very fine-grained sericite and to a lesser extent calcite. Biotite has been partly altered to chlorite. Some opaque minerals replace biotite and chlorite. Quartz crystals are relatively clear, whereas orthoclase is clouded with very fine-grained inclusions.

At least four dyke rocks injected during the last stages of crystallization have been recognized:

(1) Monzonite — light brown, fine grained with sericite and secondary biotite alteration

(2) Felsite — in part porphyritic (feldspar), quartz rich, less than 3 per cent mafic minerals

(3) Feldspar porphyry — dark grey, aphanitic matrix with phenocrysts of plagioclase and minor orthoclase

(4) Andesite

Hornfelsed greywacke and shale occur as xenoliths and are also found at the contact between intrusive rocks and well-bedded argillites of the Bowser Group. The hornfels is an unaltered, recrystallized, fine-grained, equigranular rock.

Small secondary fresh biotite flakes make up nearly 40 per cent of the rock by volume. Quartz phenocrysts comprise about 2 per cent of the rock and the remainder is made up of a fine-grained groundmass of quartz and feldspar.

The area is intensely fractured with the more pronounced sets striking northwesterly and dipping steeply to the east. Apart from local disruptions immediately adjacent to the intrusive rocks, the sedimentary strata have not been greatly affected except for a slight dip outward.

Chalcopyrite, pyrite, and molybdenite are widely distributed as hairline stringers within orthoclase veinlets, in quartz veins, and as fine disseminations in argillite and the intrusive rocks. Malachite and pyrite appear to be intimately associated with patches of felted sericite and/or chloritized biotite, patches of silicification, and areas of potassic feldspar alteration. Mineralized quartz veins average 3.2 to 6.4 millimetres in width and may reach 2.54 centimetres. Shear zones tend to contain greater amounts of sulphides.

REFERENCES: *Minister of Mines, B.C.,* Ann. Rept., 1968, pp. 112, 113; *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1975, pp. 67, 68; Assessment Reports 793, 1590, 5278, 5626; *see also* Exploration in British Columbia, 1975.

NAT (HIGGINS) (93M/7W)

By T. G. Schroeter

LOCATION: The Nat A (2 units), NAT B (6 units), and Nat C (6 units), owned by Ronald Gilbert and Robert Williams of Smithers, are situated on the northwest flank of Netalzul Mountain, approximately 56 air-kilometres north of Smithers. Access is by helicopter from Smithers or by skidder trail from Suskwa Pass.

DESCRIPTION: Galena, sphalerite, and tetrahedrite were first discovered in 1917 in a vein in hornfelsed rocks adjacent to an intrusive body. In 1965 Noranda Exploration Company, Limited examined the granodiorite for its 'porphyry' potential. Mineralization within the biotite-granodiorite to quartz monzonite body consists of tetrahedrite, pyrite, chalcopyrite, molybdenite, galena, sphalerite, and scheelite in quartz veins 1.2 to 1.8 metres in width, disseminated chalcopyrite and pyrite, and ribbon molybdenite in quartz gangue. Quartz veins with attitudes of 030°/55° southeast and 075°/60° southeast have been traced over lengths of up to 600 metres. Mineralized veinlets have envelopes of orthoclase. The intrusive rocks are generally fresh but locally show intense argillic alteration. Aplite and minor pegmatitic dykes exist.

WORK DONE: Ronald Gilbert and Robert Williams did 45 square metres of trenching and 45 square metres of test pitting and also took some soil samples.

REFERENCES: *Minister of Mines, B.C.,* Ann. Rept., 1917, p. 106; MI 93M-17.

BABE GOLD PROSPECT (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. The showings are on a hill overlooking the lowlands of the Yakoun River, 17.6 kilometres south of Port Clements, Queen Charlotte Islands.

It was discovered by Efrem Specogna and Johnny Trinco while prospecting along the trace of the Sandspit fault zone. They were attracted to the locality by a visible jarosite-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 G-34, totalling 500 metres. Quintana 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 including two drill holes each 180 metres deep. The following description has been modified from that of *Geological Fieldwork 1975* in the light of information made available by Quintana (Richard, Christie, and Wolfhard, 1976).

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 but is east of the showing. 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. Between the Masset rhyolites and the Sandspit fault is a faulted area exposing quartz feldspar porphyry of uncertain age and variably silicified Skonun Formation of Mio-Pliocene age. East of the main strand of the Sandspit 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.

GEOLOGY OF THE CORE CLAIMS: The units previously described all occur within the core of the Babe claims shown on Figure G-34. 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 at the time of our visits.

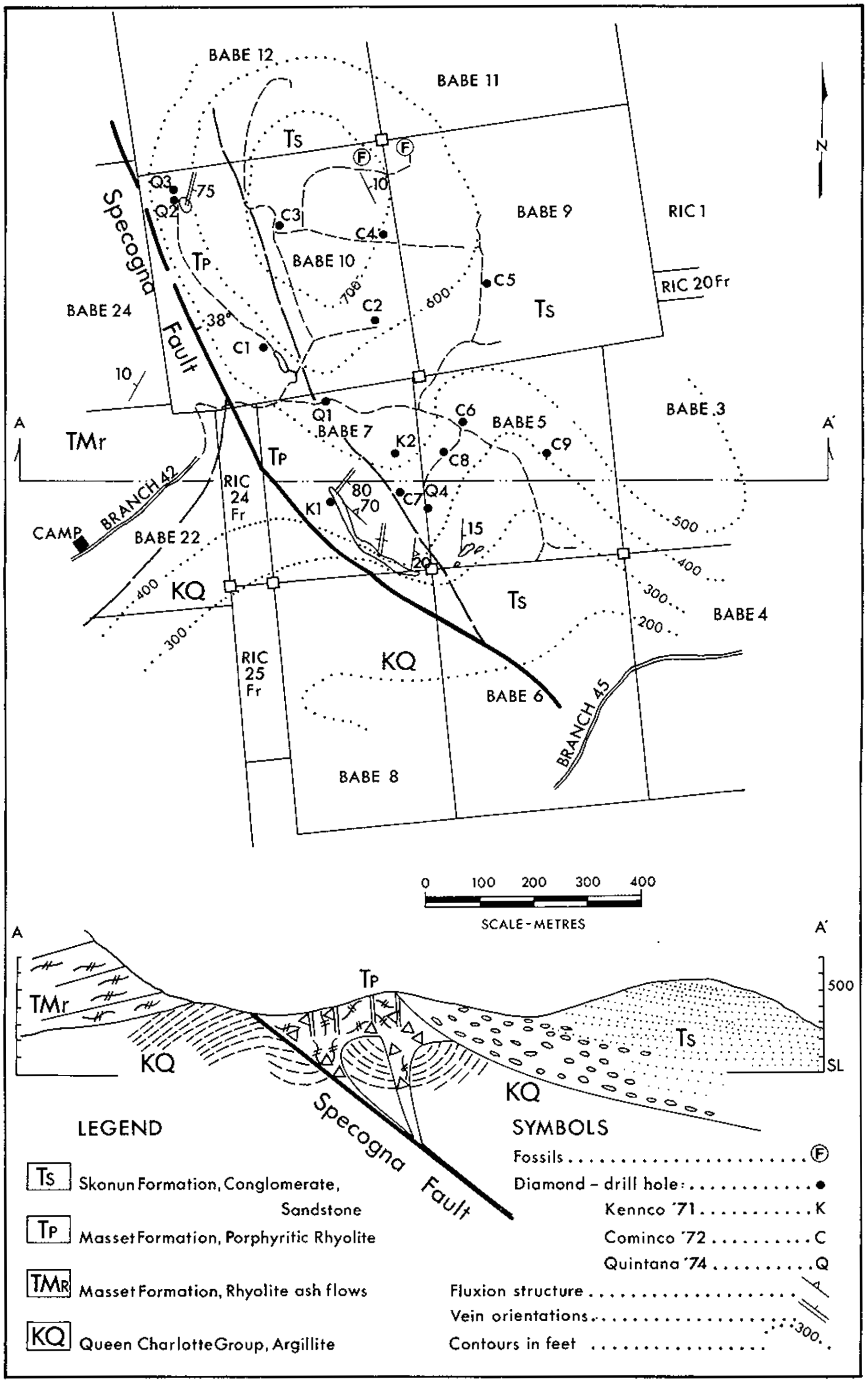


Figure G-34. Geological sketch map and section, Babe gold prospect.

The bluff outcrop is freshly exposed and is the most revealing exposure of the rhyolite porphyry body of uncertain age with which the deposit is associated. The exposure on the Babe 7 claim is about 210 metres long and exposes silicified rocks of 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 sericitized 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. The interface with onlapping silicified Skonun Formation is not readily evident if exposed in this trench.

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 nearly vertically oriented in the west and nearly horizontal in the east. Relatively minor sulphides occur in the veins but adjacent silicified breccias particularly the dark matrix breccias carry fine pyrite and marcasite. Significant coarse pyrite and marcasite occur at depth (Richards, et al., 1976). 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 (carbonaceous) 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 writers interpret these rocks as belonging to the Skonun Formation. The relationship of these rocks to silicified breccias, etc., in the trench to the west is obscure on the surface but some of the silicified rocks are definitely Skonun Formation according to evidence in drill holes (Richards, et al., 1976).

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.

STRUCTURE: The Sandspit fault marks the approximate edge of the Hecate Basin but the fault dislocates the onlap of the Skonun Formation that fills that basin. The Specogna fault, west of the Sandspit fault, strikes parallel to it and dips eastward toward it at 38 degrees. It was shown as a steep fault previously (Sutherland Brown and Schroeter, 1975) but the deeper drilling of Quintana shows its attitude, that it forms the footwall to mineralization but is the locus of younger movement, and that it may have controlled the site of the porphyritic rhyolite 'dome.'

TENOR OF MINERALIZATION: Mineralization is largely restricted to a subcircular zone of silicification adjacent to the Specogna fault. In detail the tenor is highly variable, 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 in 1975 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. On a broad scale mineralization is quite uniform. Quintana have outlined by drilling a mineral reserve of 45 million tonnes of 2.1 ppm (0.06 ounce per short ton) gold and 3.5 ppm (0.1 ounce per short ton) silver (Richards, Christie, and Wolfhard, 1976).

CONCLUSION: Studies by Quintana have clarified the relationships at this property. The present writers interpreted the porphyritic rhyolite to be part of the basal Masset Formation which it resembles. On Quintana evidence these rocks appear to post-date Masset deposition and be very slightly older or possibly equivalent in age to some part of the Skonun Formation. The mineralization is thus shown by them to be younger than the porphyritic rhyolite and in the upper part of the Skonun Formation and therefore Miocene or younger — surely one of the youngest exposed areas of significant mineralization.

The Babe prospect has clear similarities with the Carlin deposit of Nevada or the Pueblo Viejo mine of the Dominican Republic for it is spatially associated with young acid volcanic rocks along a major fault and is contained in an area of intense silicification carrying minor sulphides and very fine-grained native previous metals reminiscent of hotspring deposits.

REFERENCES

Assessment Reports 2890, 3517, 5284.

Richards, G. G., Christie, J. S., and Wolfhard, M. R. (1976): Specogna: A Carlin Type Gold Deposit, Q.C.I., *C.I.M.*, Bull., Vol. 69, No. 773, p. 64 (abst.) and preprint.

Sutherland Brown, A. (1968): Geology of the Queen Charlotte Islands, British Columbia, *B.C. Dept. of Mines & Pet. Res.*, Bull. 54.

Sutherland Brown, A. and Schroeter, T. G. (1975): Babe Gold Prospect, *B.C. Dept. of Mines & Pet. Res.*, Geological Fieldwork 1975, pp. 71-75.

ANTI (103P/1E)

By T. G. Schroeter

LOCATION: The Anti 1 to 4 claims, owned by Edwin E. Utterstrom of Coquitlam, are situated 3.2 kilometres northwest of Kitwanga on the east bank of Mill Creek. Access is by four-wheel-drive road from Kitwanaga.

DESCRIPITION: In the late 1920's two short adits (3 metres) were put into the east bank of Mill Creek to follow a vein of stibnite. The showing was staked in 1966 and examined by L. J. Manning and Associates in 1968.

A vein of massive stibnite up to 20 centimetres in width and open at both ends over an exposed length of 18 metres transects a bedded sequence of quartz-rich sandstone and shale. Bedding in the sedimentary rocks is 035°/60° west. Wallrock immediately adjacent of the vein is brecciated with a siliceous matrix containing minor amounts of stibnite in the form of veinlets and minor disseminations. Quartz veins up to 10 centimetres in width intrude the sedimentary sequence but are barren of mineralization. Structurally, there are abundant minor slips. A complete spectrographic analysis of high-grade stibnite ore indicated that there were no significant metal values other than antimony which assayed 17.66 per cent. An average high-grade vein sample assayed 12.9 per cent antimony and wallrock immediately adjacent to the main vein with brecciation assayed 3.35 per cent antimony over a total width of 35 centimetres.

WORK DONE: Edwin E. Utterstrom reconstructed 3.2 kilometres of road and dug five trenches totalling 120 metres.

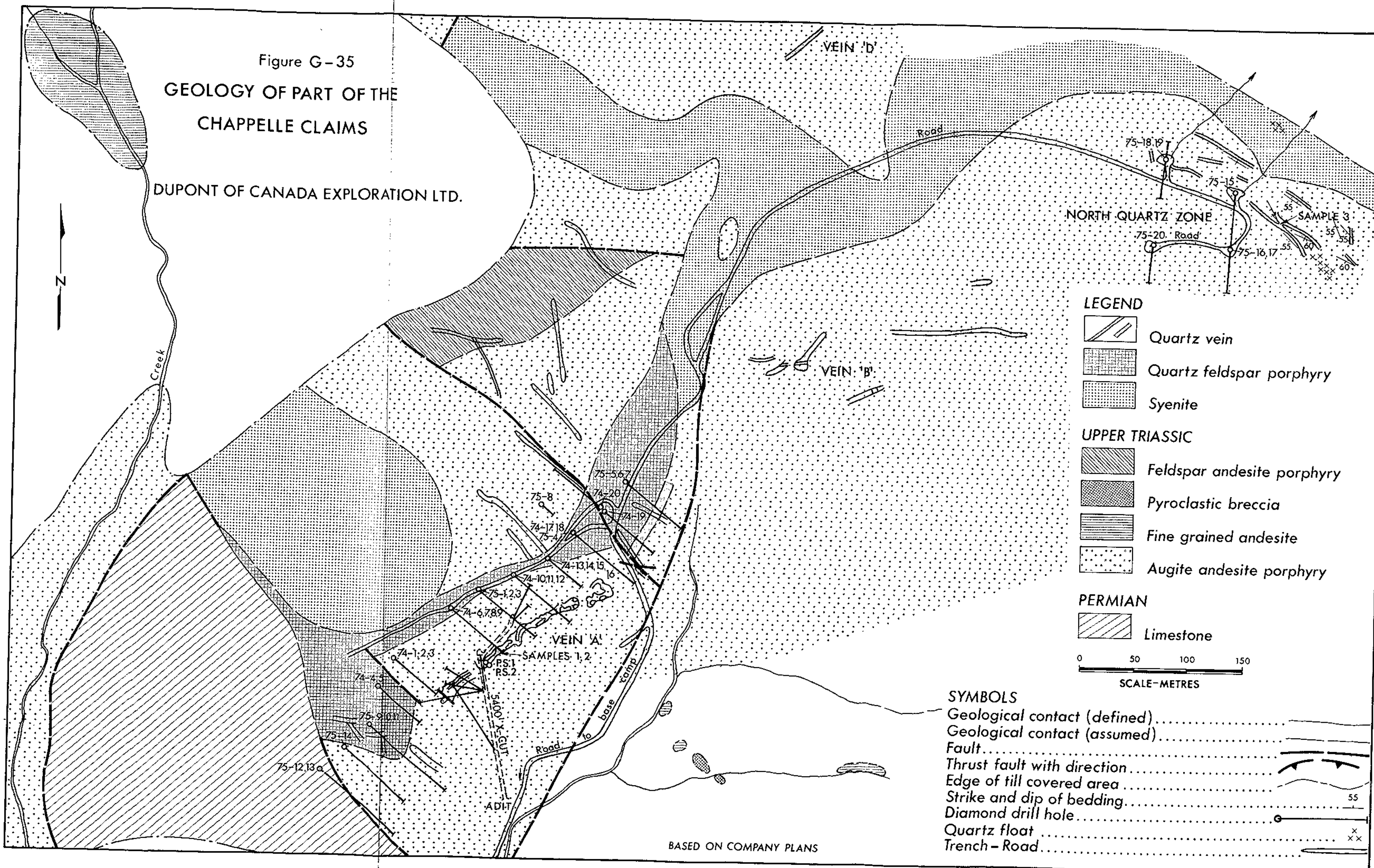


Figure G-35
GEOLOGY OF PART OF THE CHAPPELLE CLAIMS

CHAPPELLE (94E/6E)

By T. G. Schroeter

LOCATION: The 168 Chappelle claims are owned by Kennco Explorations, (Western) Limited and operated by DuPont of Canada Exploration Limited. They are situated 30 kilometres northwest of Thutade Lake and 8 kilometres northwest of the Black Lake airstrip.

DESCRIPTION: Two high-grade grab samples taken from a surface exposure of vein 'A' assayed (*see* Fig. G-35 for locations):

Sample 1: gold, 153.12 ppm; silver, 6172 ppm; copper, 0.6 per cent

Sample 2: gold, 2077 ppm; silver, 17 346 ppm; copper, 9.75 per cent

One mineralized grab sample taken from the North Quartz zone assayed (*see* Fig. G-35 for location):

Sample 3: gold, 95.62 ppm; silver, 37.5 ppm; copper, 1.5 per cent

REFERENCES: Assessment Reports 2581, 2819, 3171, 3198, 3343, 3367, 3417, 3418, 3419, 4066, 5268, 5667; *B.C. Dept. of Mines & Pet. Res.,* GEM, 1970, p. 188; 1971, pp. 65-70; 1972, p. 484; 1973, pp. 458-460; 1974, p. 312; *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1974, p. 84; 1975, pp. 68, 69; *see also* Exploration in British Columbia, 1975.

SAUNDERS (LAWYERS) (94E/6E)

By T. G. Schroeter

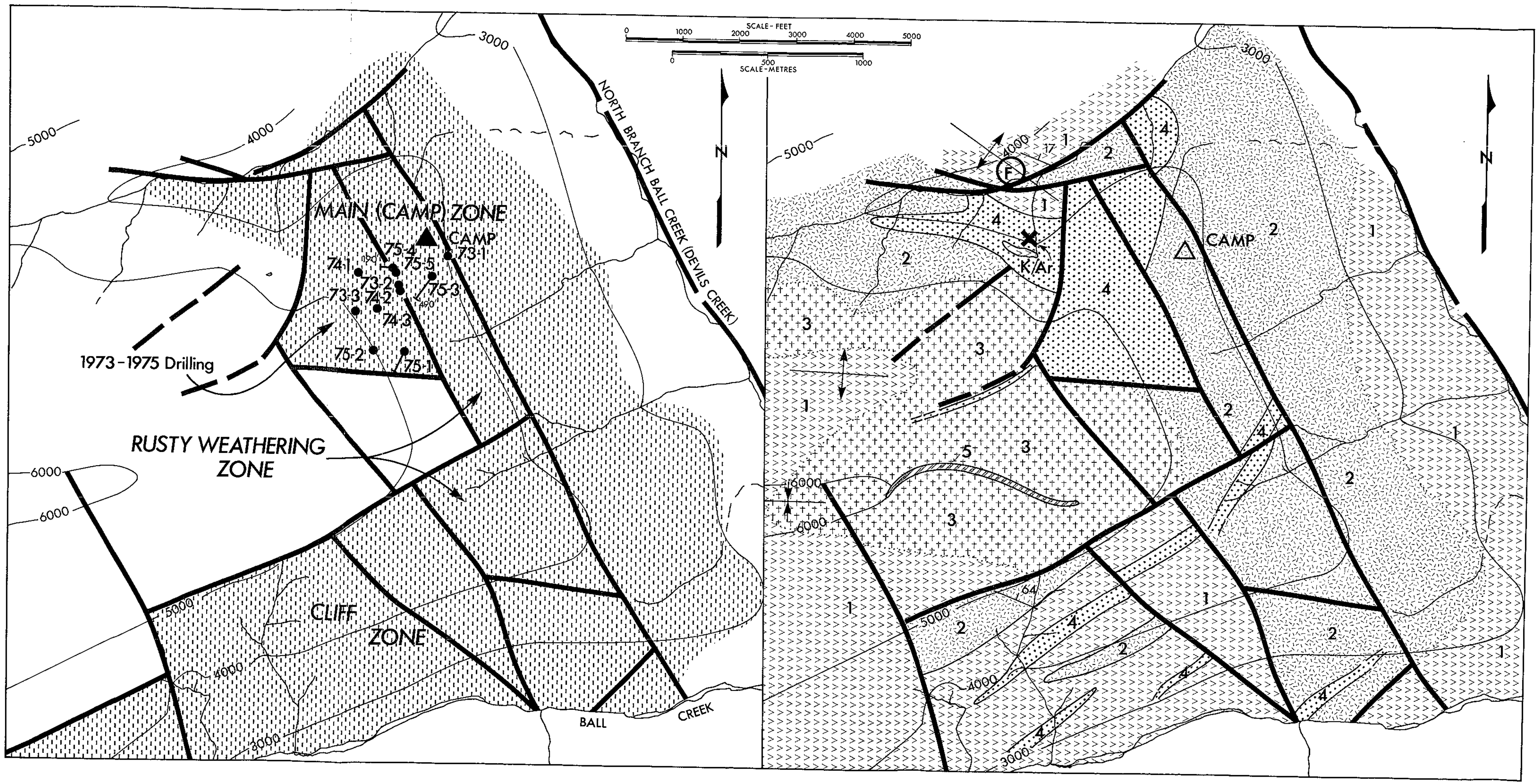
LOCATION: The Lawyers and New Lawyers claims, owned by Kennco Explorations, (Western) Limited, are situated 40 kilometres northwest of Thutade Lake and 9 kilometres southwest of Toodoggone Lake.

DESCRIPTION: Two main zones of gold mineralization were investigated: the Amethyst Gold Breccia zone and the Cliff Creek Breccia zone. The most prominent host rock on the property is a trachyte porphyry, a quartz-potash feldspar porphyry; or crystal and lithic tuffs and aggomerates. The mineralized Amethyst Gold Breccia zone is exposed over a length of 180 metres and a width of 15 metres by three trenches. Mineralization consists of fine-grained argentite, native silver, and electrum in quartz-amethyst veins within the trachyte porphyry unit. The zone strikes north 30 degrees west and has an assumed near vertical dip. Intense silica veining is directly proportional to the best mineralized specimens.

The Cliff Creek Breccia zone is exposed over a length of 915 metres by six trenches and is located approximately 2 kilometres southwest of the Amethyst Gold Breccia zone. One sample taken from the north end of the zone assayed: gold, 1.25 ppm; silver, 121.87 ppm. Another sample taken from the south end of the zone assayed: gold, 0.94 ppm; silver, 218.75 ppm. zone assayed: gold, 0.03 ounce per ton; silver, 7.0 ounces per ton.

The testing of soil samples for mercury content appears to be a useful aid in locating anomalies.

REFERENCES: Assessment Reports 2822, 3314, 3315, 3362, 3366, 3416, 3837, 3841, 4065, 5106, 5167; *B.C. Dept. of Mines & Pet. Res.,* GEM, 1970, p. 198; 1971, p. 70; 1972, p. 481; 1973, pp. 460, 461; 1974, p. 312; *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1974, p. 84; 1975, p. 69; *see also* Exploration in British Columbia, 1975.



GENERALIZED GEOLOGICAL MAP
BALL CREEK DEPOSIT (104G/8W)

LEGEND

INTRUSIVE ROCKS (LATE TRIASSIC)

HORNBLENDE PLAGIOCLASE PORPHYRY – SILL

FELDSPAR PORPHYRY (MONZONITE), (BIOTITE HORNBLENDE MONZONITE PORPHYRY, FELSITE – DYKES, SILLS, SMALL IRREGULAR INTRUSIONS

BEDDED ROCKS [UPPER TRIASSIC (NORIAN)]

VOLCANIC – TRACHYANDESITE AGGLOMERATE, FLOW BRECCIA, LAHAR; SOME PILLOWED BASALT AND MINOR TUFFACEOUS SEDIMENTS

VOLCANIC – FINE GRAINED TO PORPHYRITIC ANDESITE AND TRACHYANDESITE FLOWS, FLOW BRECCIA

SEDIMENTARY – SILTSTONE, SANDSTONE, SHALE; SOME CHERTY AND CALCAREOUS BEDS. INCLUDES ORTHOCLASE CRYSTAL AND LITHIC TUFFS, GREYWACKE, AND LAHAR NEAR BOUNDARY WITH MAP UNIT 2.

SYMBOLS

RUSTY WEATHERING PYRITIC ROCKS

DIAMOND-DRILL HOLE LOCATION

FOSSILS

K-Ar DATING SAMPLE SITE

FOLD AXIS

BEDDING

SOURCES OF INFORMATION

BASE MAP: UNCORRECTED FROM BRITISH COLUMBIA GOVERNMENT AIR PHOTOGRAPHS B.C. 1212:39 AND 40

TOPOGRAPHY: ASSESSMENT REPORT 4657

GEOLOGY: A. PANTELEYEV, 1975; G.W. MANNARD, 1963; ASSESSMENT REPORT 3186

Figure G-36

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

By A. Panteleyev

INTRODUCTION: This geological report is a summary of a 2½-day examination of the Ball Creek property in 1975. The writer was generously given access to all relevant data and information in the field by Great Plains Development Company of Canada, Ltd. Amax Exploration, Inc. made available a 1963 report on the Ball Creek Molybdenite Prospect by G. W. Mannard which reaffirmed the geological interpretation presented here.

The Ball Creek property of Great Plains Development Company of Canada, Ltd. is a porphyry-type, low-grade polymetallic copper-gold-silver-molybdenum prospect. Sulphide-bearing rocks are found in an extensive fault dissected, rusty weathering pyritic zone that is associated with a number of small monzonitic feldspar porphyry and felsite intrusions. Small amounts of chalcopyrite, secondary copper minerals, and traces of molybdenite are widespread as fracture-controlled and rarely disseminated minerals in volcanic rocks and feldspar porphyry intrusions. Also rare grains of chalcopyrite, molybdenite, sphalerite, and galena are present in quartz veinlets within small areas of quartz stockworking.

The area was first examined as a molybdenum prospect in 1963 when Southwest Potash Corporation staked the Mary claims. New claims were relocated in 1970 by Newmont Mining Corporation of Canada Limited (Greg group) and in the same year by Great Plains Development Company of Canada, Ltd. as the Me and Rog claims. Great Plains added the Tara and Ment claims in 1971, the MDM claims in 1972, and the Bare, BR, and VKR claims in 1973. Initial exploration interest was focused on the rusty coloured slopes overlooking Ball Creek in what is now known as the Cliff zone (including the Gulley, West, Goat, and South showings). Later the most promising area was assessed to be to the north of the Cliff zone along the boundary of the Rog and Tara claim groups in what is now called the Main zone (including the Camp, North, and DM showings).

In addition to examination of outcrops and extensive geochemical sampling of surface showings, the Main zone has been tested by some diamond drilling (Fig. G-36). Six diamond-drill holes, three of which were drilled in 1973, and three of which were completed in 1974, together total 1 202 metres. An additional five diamond-drill holes totalling 780 metres were completed during 1975. Drilling was difficult and costly due to blocky ground in the highly fractured and oxidized rocks.

GEOLOGY: A number of arcuate feldspar porphyry and felsite dykes, irregular intrusions, and a small composite stock intrude volcanic and sedimentary strata.

Stratified rocks in the area can be subdivided into three map units. Host rocks are thinly bedded siltstone, chert, shale, sandstone, and calcareous beds near the top of the succession. In one locality such calcareous siltstone beds contain abundant pelecypod and gastropod shells that indicate a Late Triassic (Norian) age for the beds. The top of the sedimentary succession is marked by volcaniclastic rocks such as in the gully northwest of camp where crystal-lithic tuffs containing abundant orthoclase crystals are interbedded with sandstone and siltstone, and in the cliff zone where beds containing coarse clasts of lahar or agglomeratic origin were noted. The middle bedded map unit is a series of volcanic flows and flow breccias. The rocks are fine-grained to porphyritic andesite to trachyandesite with a mottled buff to grey appearance and characterized by abundant small grains of chloritized hornblende in a fine-grained feldspathic matrix. The youngest bedded map unit consists mainly of agglomerate containing trachyandesite feldspar porphyry clasts. On the ridge along the western boundary of the mapped area pillowed basalt flows and tuffaceous siltstone are interbedded with agglomerate, greywacke, and coarse-grained tuff.

Intrusive rocks are present as at least three genetically related phases – chloritized hornblende-bearing feldspar porphyry (monzonite), biotite hornblende porphyry, (monzonite or quartz monzonite), and felsite. In addition, narrow diabase dykes intrude bedded and porphyritic intrusions and a hornblende plagioclase porphyry sill intrudes volcanic rocks along the crest of the ridge northwest of the Cliff zone.

Feldspar porphyry is a fine to medium-grained porphyritic rock with 60 per cent crowded phenocrysts ranging in size from 1 to 4 millimetres in a matrix of mainly very fine-grained K-feldspar and plagioclase. The average modal composition of feldspar porphyry is:

	Per Cent
Plagioclase ($An_{10\text{-}20}$)	45
K-feldspar	3
Hornblende (chloritized)	16
Magnetite	1-2
Accessory and alteration minerals	4
Matrix	30

Feldspar porphyry forms dykes and sets of closely spaced or adjoining dykes which have a similar appearance to porphyritic trachyandesitic volcanic rocks and may not be distinguishable from them in altered and weathered outcrop.

Biotite hornblende monzonite porphyry is a pale grey medium-grained porphyry that contains biotite in addition to hornblende. It is coarser grained with a less crowded porphyritic texture than feldspar porphyry and has more prominent K-feldspar phenocrysts and less chloritized mafic minerals. Average modal composition is:

	Per Cent
Plagioclase ($An_{15\text{-}26}$)	35
K-feldspar	7
Hornblende and biotite (chloritized)	9
Magnetite	2
Apatite and sphene	1-2
Alteration minerals	5
Matrix	40

Plagioclase is zoned, commonly $An_{15\text{-}20}$ although the cores of some larger crystals are as calcic as An_{26}. Alteration minerals are pyrite, magnetite, chlorite, calcite, and epidote. Euhedral apatite and sphene are relatively abundant as is fine-grained magnetite. The matrix contains fine-grained quartz estimated to range between 5 and 10 per cent. Hexagonal biotite crystals are almost completely replaced by chlorite whereas coarser grained hornblende crystals are less altered and replaced by chlorite only along grain edges and fractures. A hornblende concentrate was prepared from biotite hornblende monozonite porphyry for a K-Ar age determination and contained hornblende crystals replaced about 15 per cent by chlorite. Biotite hornblende monzonite porphyry forms discrete jointed dykes commonly 40 feet or less in thickness but locally up to 120 feet wide and intrudes feldspar porphyry as well as bedded rocks.

Felsites are aphanitic to very fine granular pale buff to cream-coloured rocks that form dykes and small intrusions intimately associated with porphyritic intrusions. They are pyritic and rarely mineralized with molybdenite-bearing quartz veinlets and may, therefore, predate biotite hornblende monzonite porphyry which lacks quartz veins.

Chemical analyses of three intrusive rocks are listed below and show the rocks to approximate monzonite in composition although biotite hornblende porphyry contains modal quartz and with 11.1 per cent normative quartz may be classed as quartz monzonite. Felsite has a relatively low SiO_2 content, high K_2O content, and may be classed as a mafic-poor microsyenite.

	Feldspar Porphyry 75AP–68	Biotite Hornblende Monzonite Porphyry 75AP–70	Felsite 75AP–78
SiO_2	60.4	60.4	62.4
Al_2O_3	18.1	17.8	20.3
FeO	2.8	1.9	0.14
Fe_2O_3	3.8	2.7	0.48
MgO	1.6	1.2	0.65
CaO	1.4	3.7	0.20
Na_2O	5.6	5.0	2.0
K_2O	3.6	3.7	10.7
TiO_2	0.45	0.38	1.01
MnO	0.04	0.16	0.01
P_2O_5	0.18	< 0.18	0.18
H_2O-	0.44	0.36	0.34
H_2O+	1.17	1.16	0.90
CO_2	0.3	1.3	0.3
S	0.10	0.17	0.01
Total	100.00	100.1	99.6

	75AP–68	75AP–70	75AP–78
Q	9.3	11.1	9.0
Or	21.9	22.2	62.9
Ab	48.3	42.1	17.0
An	----	8.9	----
Cor	3.6	2.3	5.5
Orthopx	5.3	3.9	1.6
Mag	5.6	3.9	----
Il	0.9	0.7	0.3
Hem	----	---	0.5
Rutile	----	----	0.8
Ap	0.4	0.4	0.4
Calc	0.7	3.0	0.7
H_2O+	----	1.2	0.9
H_2O-	----	0.4	0.3

Chemical analyses and calculated C.I.P.W. norms, P. Ralph, analyst, British Columbia Department of Mines and Petroleum Resources.

A K-Ar age of hornblende from biotite hornblende monzonite porphyry (sample 75AP-70) was determined to be 218±24 m.y. (J. Harakal, analyst, University of British Columbia). The large uncertainty in the date is due to low potassium content in the sample and consequently reduced precision in the K_2O analysis.

The major structure evident in the map-area is a gently eastward-plunging anticlinal fold that was first described by G. W. Mannard (1963). The most obvious expression of this structure is provided by rusty weathering rocks which outline the distribution of mainly pyritic rocks of the middle volcanic map unit (map unit 2). In detail small folds on the north limb of the major anticline show that fold axes strike east-westerly and plunge eastward to east-southeasterly at 10 to 15 degrees. Faults can be traced where fault-related breccia zones crop out or where lithology changes abruptly and faults can be deduced from abrupt boundaries between rusty weathered and darker rocks. Two main sets of steeply dipping northwesterly and east-northeasterly trending faults have dissected the area into fault-bounded blocks.

MINERALIZATION: A large zone has been weakly pyritized. The distribution of pyrite is accentuated by the oxidized and rusty weathered appearance of mineralized outcrops (Fig. G-36). Within this zone chalcopyrite, molybdenite, sphalerite, galena, and traces of pyrrhotite and bornite have been noted although most copper appears to be present in malachite, azurite, chrysocolla, copper oxides, and cupriferous limonite. Traces of native copper and pyrite tarnished with chalcocite are seen in drill core. Oxidation is deep and thorough in strongly fractured rocks and fractures coated with goethite are found to depths of 400 feet and greater. However, away from fractures pervasive leaching effects are slight and primary disseminated pyrite remains. Overall supergene sulphide enrichment is negligible in the area tested and fracture-controlled secondary copper minerals are deposited as copper oxide and limonite.

Diamond drilling to date has been largely in oxidized rocks. Estimates of metal content in diamond-drill cores from the Main zone are as follows:

Copper	— approximately 0.1 per cent, rarely $\geqslant$0.2 per cent copper
Gold	— widespread, from 0.01 to 0.02 ounce per ton
Silver	— average content, 0.05 to 0.10 ounce per ton
Molybdenum	— insignificant $>$0.02 per cent MoS_2

Whether these metals can be effectively extracted from their oxidized host rocks has not been determined. Drilling below the oxidized zone is too limited to assess potential of hypogene mineralization and depth potential.

GEOLOGIC INTERPRETATION: A generalized geological map and somewhat diagrammatic interpretation is shown on Figure G-36. The three main intrusive phases recognized have not been distinguished. More than three intrusive phases are likely to be present.

Porphyritic rocks whose origin is uncertain as to intrusive or volcanic origin are mapped as part of the volcanic assemblage (map unit 2). Therefore detailing geologic mapping might well reveal that more dykes and sills are present than shown.

The geological environment can be interpreted to be a high-level extrusive-intrusive centre during Late Triassic time. Orthoclase crystal tuffs at the top of the sedimentary succession are overlain by trachyandesitic volcanic rocks and abundant agglomerate and suggest that monzonitic magma was extruded as well as emplaced as small intrusions. The small stock on which the Main zone is centred might be the intrusive core from which biotite hornblende monzonite porphyry dykes radiate and the arcuate feldspar porphyry dykes merge into at depth.

REFERENCE: Mannard, G.W. (1963), Ball Creek Molybdenite Prospect, Northern British Columbia, *Amax Exploration, Inc.*, private report, 19 pp.

CHRIS, RED, SUS, WINDY (104H/12W)

By A. Panteleyev

INTRODUCTION: In 1975 an aggressive drilling program was undertaken by Texasgulf, Inc. to test the economic potential of mineral showings that were discovered and explored in 1969, 1970, and 1972 on the Chris claim group by Great Plains Development Company of Canada, Ltd. and between 1970 to 1972 on the Red and Sus groups by Silver Standard Mines Limited. Drilling during 1973 and 1974 indicated that a large hydrothermally altered pyritic zone contains economically interesting quantities of copper and gold. In 1975 two small zones with better grade material were located about 0.8 kilometre apart and much of the intervening and surrounding rock was found to contain significant copper-gold mineralization. Geology of the area has been briefly described in *Geology, Exploraton and Mining in British Columbia,* 1972 and 1974. A detailed study and report of the style of mineralization and hydrothermal alteration will be started during the 1976 field season.

GEOLOGY AND MINERALIZATION: Successful exploration activity has been focused along the north side of a major east-northeasterly trending fault zone where quartz stockworks are developed in a composite feldspar porphyry intrusion. The intrusion consists mainly of a leucocratic feldspar porphyry of monzonitic composition, dykes of chloritized hornblende feldspar porphyry, and minor quartz feldspar porphyry. At surface the intrusion is up to 1 350 metres wide and has been traced along the northern side of the major east-northeasterly fault zone for more than 4 kilometres. The age and detailed geometry of the intrusion are not known. The western contact is severely disrupted and offset by a number of faults and the intrusive body in this area, at least, may be a relatively flat-lying sheet-like body. The southeast boundary of the intrusion is in fault contact with well-bedded, fossiliferous siltstone, sandstone, and shale of Middle to Late Jurassic age. To the north of the fault, the intrusion is emplaced in Middle Jurassic or older volcanic and sedimentary rocks.

Pyrite is widespread in rocks north of the major fault zone whereas rocks mineralized with copper and gold are confined to a quartz stockwork and fracture system containing chalcopyrite, pyrite, and traces of bornite. The mineralized quartz stockwork is an east to east-northeasterly trending zone or series of zones at least 3.2 kilometres in length and is contained mainly within the feldspar porphyry intrusion. It is uncertain whether faulting along the major fault zone that forms the southern boundary of the feldspar porphyry intrusion entirely post-dates mineralization so that screens or panels of the Middle to Late Jurassic sedimentary rocks might also be altered and mineralized.

Mineralogical zoning is evident over the 3.2-kilometre strike length of the known mineralized zone. At the western end of the quartz stockwork system where the mineralized zone is as much as 900 metres from the main fault zone, quartz veinlets are pyritic, weakly mineralized with chalcopyrite, and are locally cut by gypsum-bearing veinlets. In such areas of gypsum veining, brecciation might have been more prevalent than elsewhere. In the central, main mineralized area where most of the drilling has been done, the mineralized stockwork lies adjacent to faulted rocks and is no more than 450 metres from the major east-northeasterly trending fault zone. At the eastern end of the known mineralized zone the quartz stockwork appears to coalesce with the major fault zone and may be terminated by it. However, this area has not yet been adequately tested. Hydrothermal alteration minerals in the western part of the mineralized zone (*see* CHRIS, *Geology, Exploration and Mining in British Columbia,* 1972, pp. 535-537) are mainly ankerite, clay minerals, reddish (albitized) feldspar, chlorite, and hematite. Where such alteration is pervasive the rocks exhibit an argillic or carbonatized type of propylitic alteration. Rare carbonate gash veins with galena and sphalerite are also present. In the central area and further east pervasive alteration results in a sericitic (phyllic) assemblage. The most intensely mineralized rocks are highly siliceous and locally have a layered or sheeted appearance.

Average grades in well-mineralized intercepts from the two small better grade zones within the quartz stockwork zone have been reported (R. H. Seraphim, 1975). They contain:

MAIN ZONE (3,693 feet of drill intercepts in four drill holes)
0.63 per cent copper 0.013 ounce per ton gold

EAST ZONE (1,261 feet of drill intercepts in five drill holes)
1.10 per cent copper 0.025 ounce per ton gold

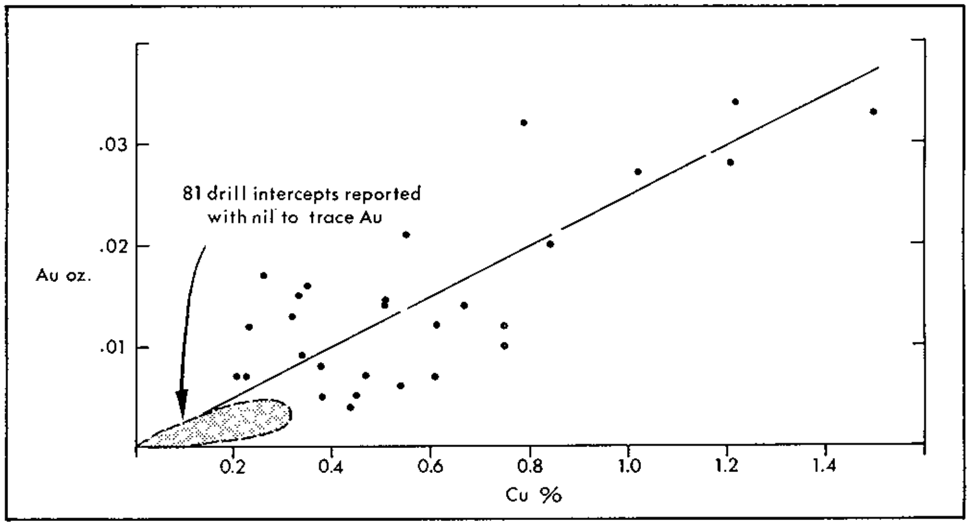
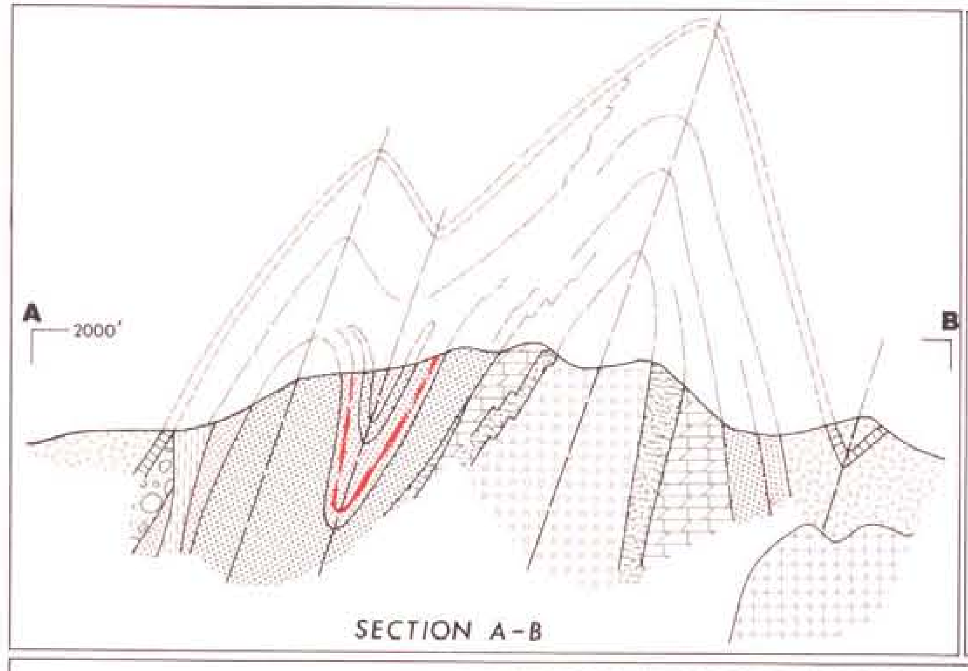
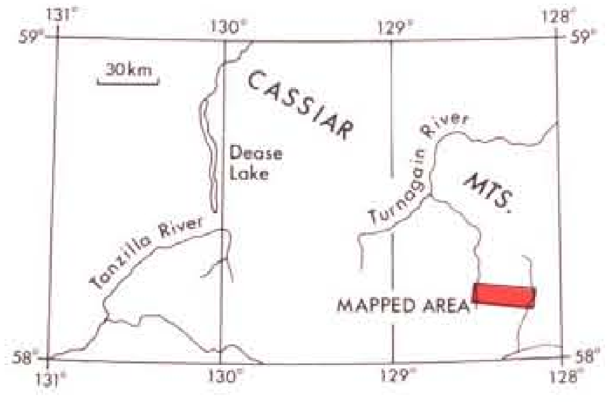


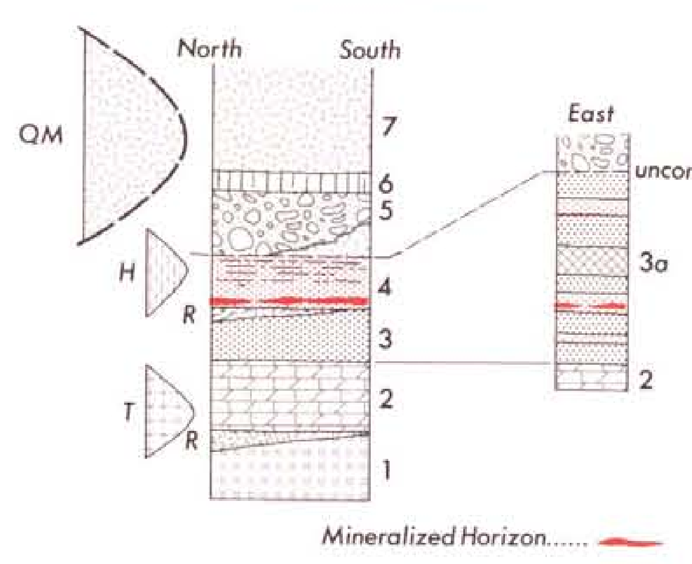
Figure G-37. Relationship of gold and copper in diamond-drill cores (Chris, Red, Sus, Windy) (plot of 109 drill intercepts from 49 core and 24 percussion-drill holes).

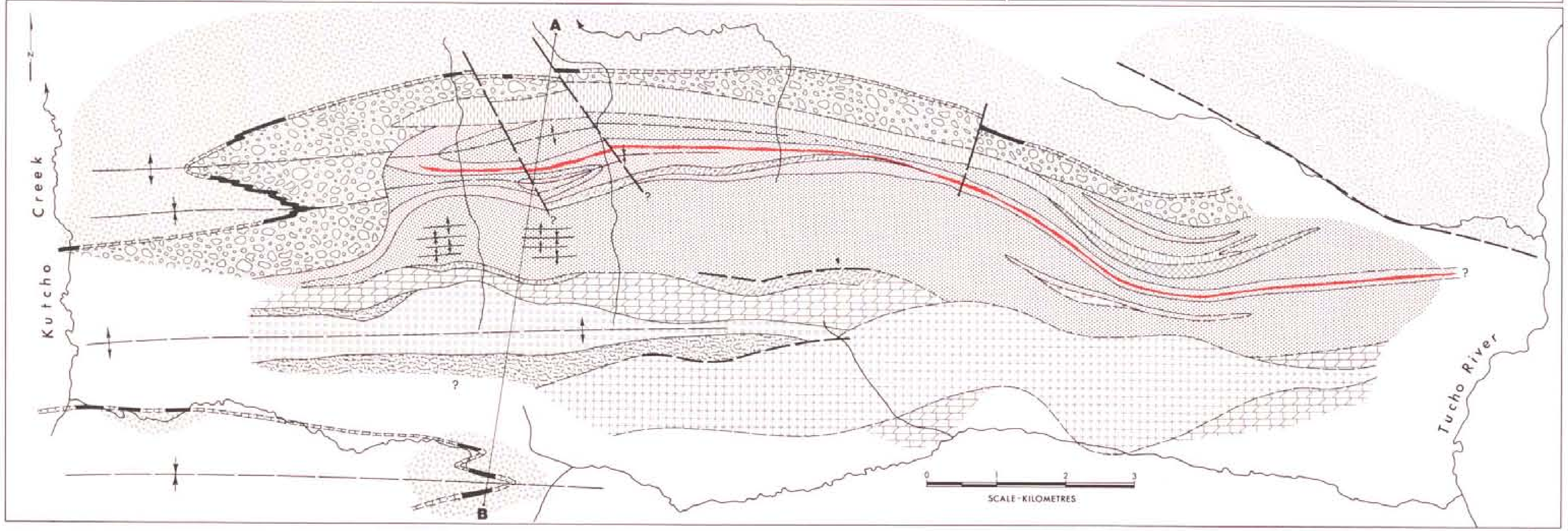
Figure G-38

KUTCHO CREEK MAP-AREA









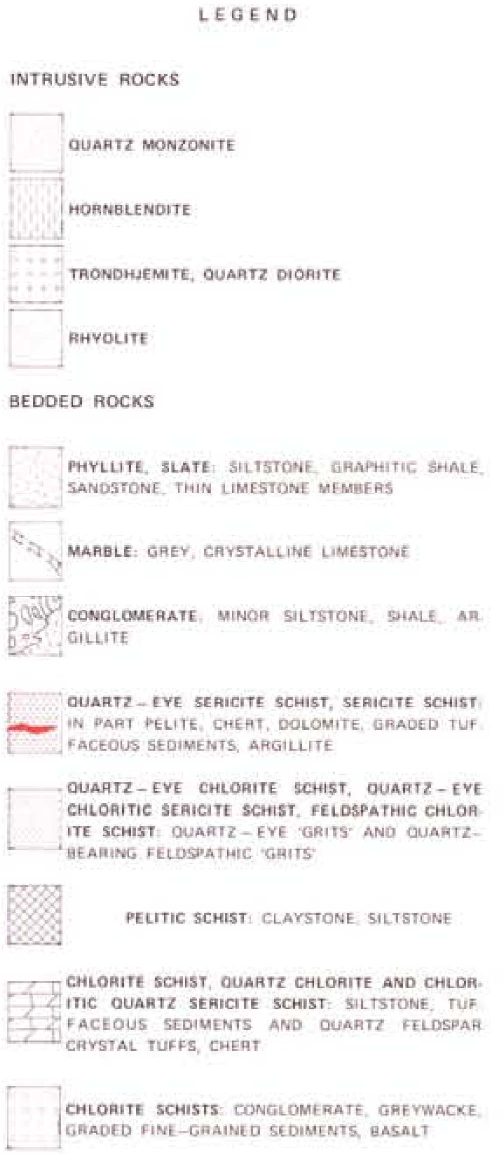


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Figure G-37 illustrates the relationship between quantity of gold and copper grade in 49 diamond and 24 percussion drill holes.

REFERENCES: Assessment Reports 5297, 5741; Seraphim, R. H., Report on Red-Chris Group, Liard Mining Division, Nov. 1975, unpublished Statement of Material Facts, *British Columbia Securities Commission.*

KUTCHO CREEK MAP-AREA (104I/1W)

By A. Panteleyev and D. E. Pearson

INTRODUCTION: This report describes the geological setting of cupriferous iron sulphide deposits situated between Kutcho Creek and Tucho River approximately 100 kilometres east-southeast of the community of Dease Lake. Mineral claims were first located in 1972 by Sumac Mines Ltd. and during 1973 by Imperial Oil Limited. The discovery has led to staking of a large number of mineral claims centred on Sumac's SMRB claim group and the adjoining JEFF claims of Imperial Oil Limited.

This report is similar to that published first in *Geological Fieldwork, 1975* by David E. Pearson and A. Panteleyev. It is based on geologic mapping of about 135 square kilometres during a two-week period in July 1975. The delayed publication of this report has permitted some late revisions to the original map and text. However, in essence this report reflects our understanding of the Kutcho Creek deposits to the end of the 1975 field season.

Preliminary statements about the deposit have been published in *Geology, Exploration and Mining in British Columbia* (1973, pp. 510, 511; 1974, pp. 343-348). In these early reports schists were interpreted to be derived from volcanic or epiclastic volcanic rocks. A number of schists were analysed chemically (GEM, 1974, p. 346). Quartz-bearing sericite schists were reported to be similar to dacite, rhyodacite, or rhyolite and chloritic schists were similar to basalt in composition. All these volcanic rocks have sodic compositions.

During 1975 the presence of thin dolomite members and abundant water-lain clastic rocks interbedded with quartz and quartz feldspar crystal-bearing rocks was recognized and the presence of pyroclastic components in some map units became suspect. Thus, in *Geological Fieldwork, 1975* the field term 'grit' was applied to schistose rocks containing coarse quartz and feldspar crystals. At least in part 'grits' were recognized to be crystal tuffs (Fig. G-38, units 2 and 3); elsewhere they were considered to be largely epiclastic rocks (Fig. G-38, unit 3). Locally fine-grained quartz-bearing sericite schists are derived from rhyolite dykes or sills (Fig. G-38, unit R and possibly part of unit 4).

The age of the rocks in the map-area remains unresolved. According to the Geological Survey of Canada 1:1 000 000 compilation map (Iskut River, Open File Report 214, 1974), the rocks are of Carboniferous to Permian age. Because of the presence of acidic volcanic units they may be equivalent to rocks of the Asitka Group. However rare granitic clasts in conglomerate (Fig. G-38, unit 5) suggest that the conglomerate and overlying limestone and shale (Fig. G-38, units 6 and 7) might be younger, possibly Late Triassic to Early Jurassic in age. The presence of an unconformity in the map-area is being investigated.

Additional fieldwork will be done during 1976 in order to describe the deposits and geological environment in more detail.

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 G-38.

Unit 1: Unit 1 is a sequence of green-coloured, chloritic and actinolitic conglomerates, greywackes, and graded sedimentary rocks together with epidotized and rare vesicular or amygdaloidal basalts containing carbonate pods that constitutes the oldest exposed rocks of the area. In 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 G-38. 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 believed to be intruded by a number of rhyolite sills or dykes (R). The rhyolite is a sodic quartz feldspar porphyry that is foliated in places and is metamorphosed and folded along with the enclosing rocks.

Unit 2: Unit 2 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. G-38). West of this section, thin bands of sericite schist are found above and below this unit.

Unit 3: Unit 3 is a feldspathic quartz-eye sericitic chlorite schist and is the most widespread rock type in the central portion of the map-area. The rocks were classified in the field as metamorphosed 'grits' on the basis of their appearance. 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. In the north near the mineralized zone where quartz eyes are abundant, they are commonly faintly blue coloured. In the large area of 'grits' to the south of the mineralized zone along the north limb of the major anticlinal fold, the 'grits' are feldspathic and contain little quartz. There they form quartz-bearing chlorite schists and feldspathic chlorite schists.

Immediately north of the main mineralized zone 'grits' contain cobbles and blocks up to 50 centimetres in size. The rock is a polylithologic breccia in which the majority of fragments are derived from an acidic porphyry containing coarse quartz phenocrysts in an aphanitic feldspathic matrix. This porphyritic rock, from which the coarse fragments and possibly discrete quartz eyes in the main mass of 'grit' are derived, appears to be genetically related to the trondhjemites that were mapped to the south.

Therefore the origin of 'grits' is still unresolved. It is generally accepted that the quartz eyes in the schists are magmatic rather than metamorphic in origin and that the 'grits' were deposited in a subaqueous environment. However, whether the coarse quartz eye and feldspar crystal-bearing 'grits' are clastic or pyroclastic in origin is uncertain.

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 pyritic sericite schist, siliceous sericite schist, and quartz-eye sericite schist that is exposed in a stream bed on the west side of the mineralized zone and appears to extend to the east end of the mineralized zone. In the east it might be represented by a number of sericite schist units intercalated in the grit unit (Fig. G-38, unit 3). The upper part of unit 4 consists of thinly bedded graded tuffaceous sediments, argillite, and siltstone.

Units 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 the 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. G-38) 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.

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. G-38).

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.

INTRUSIVE ROCKS

Unit R is a porphyritic rock with fine-grained quartz eyes and feldspar crystals in an aphanitic matrix. The rock is a pale blue-grey colour where it is least metamorphosed and pearly grey to white in schistose zones where it forms fine-grained quartz sericite schist. A number of rhyolite bodies are present in the bedded succession and appear to be folded sills.

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.

Unit H is a dark grey-green hornblendite dyke in which hornblende crystals are locally present. Most commonly the rock is a dark green actinolite-bearing chlorite schist. The rock is shown on Figure G-38 as a single map unit but at least locally forms a number of parallel dykes separated by screens of schist.

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 T is a trondhjemite that occupies a broad tract of ground across the southern and southeastern parts of the map-area. It has foliated and locally brecciated margins. In the west, trondhjemite is a medium-grained rock composed primarily of quartz, plagioclase, and chloritized mafic minerals. In the southeast it is coarse grained and porphyritic with quartz grains up to 1 centimetre in size and has a more calcic composition akin to quartz diorite. Chemical analyses, one each from medium-grained trondhjemite (74AP-190) and coarse-grained porphyritic trondhjemite/quartz diorite (75AP-67) are given in the accompanying table.

	74AP–190	75AP–67
SiO_2	73.64	75.70
TiO_2	0.56	0.25
Al_2O_3	13.33	12.05
Fe_2O_3	0.60	2.01
FeO	2.39	0.87
MnO	0.06	0.04
MgO	1.23	0.83
CaO	0.52	4.59
Na_2O	5.79	3.26
K_2O	0.21	0.39
H_2O+	1.41	0.69
H_2O-	0.17	0.13
CO_2	0.19	0.40
P_2O_5	0.25	<0.18
S	0.18	0.01
Total	100.53	101.40

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. G-39). 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. G-38).

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. G-39). 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 in conglomerate 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.

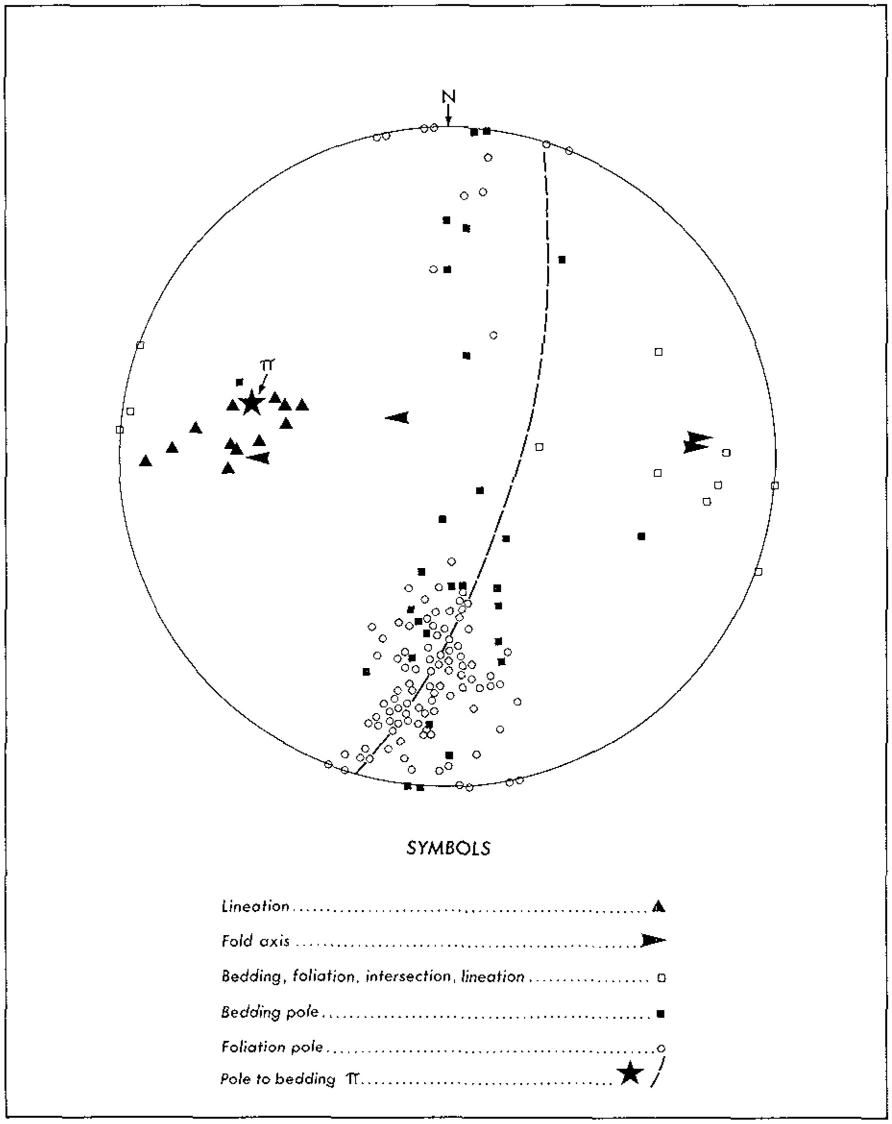

Figure G-39. Wulff net structural elements, Kutcho Creek map-area.

ECONOMIC GEOLOGY: The zone of mineralization can be traced for approximately 15 kilometres along strike. It is defined on surface by limonite staining of sericite – and quartz sericite schists, a few indigenous boxwork gossans one of which measures 0.5 by 10 metres, and limonite-cemented sands and rubble (ferricrete) in the many small drainage areas along the trace of the mineralized zone. The main zone of exploration interest is about 2 kilometres in length and is found near the western end of the mineralized zone.

Mineralized rocks contain abundant pyrite along with some chalcopyrite and sphalerite as disseminations and/or layers in a specific unit of sericite schist. Within the pyritic zone is a lens of massive sulphides consisting of compact fine-grained pyrite with some chalcopyrite, sphalerite, and locally abundant fine-grained bornite. Overall sulphide content of the mineralized beds rarely exceeds 50 per cent except in the massive sulphide lens. The aggregate thickness of pyritic beds, however, can be considerable – up to a few tens of metres. One large float boulder from an exceptionally well-mineralized part of the massive sulphide zone assayed: copper, 13.7 per cent; zinc, 4.7 per cent; lead, 0.25 per cent; gold, 0.035 ounces per ton; silver, 3.4 ounces per ton (GEM 1973, pp. 510, 511). However, average grade can be expected to be considerably less than that in the float boulder and is more comparable to a grab sample containing 2.4 per cent copper (GEM 1974, p. 347).

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

(a) The most widespread and presistent sulphide mineral is pyrite although some fine-grained chalcopyrite, sphalerite, and bornite are also present in the pyritic sericite schist. Contained within the pyritic zone is a lens of massive sulphides that appears to be restricted to the western part of the pyritic zone.

(b) Pyritic mineralization can be followed in the same stratigraphic horizon for about 15 kilometres. Sulphide-bearing schist is concordant with a sequence of dolomitic sericite schist, quartz sericite schist, and sericitic chlorite schist. All rocks are metamorphosed to lower greenschist facies and are tightly to isoclinally folded. Minor folds outlined by sulphide bands have been noted in outcrop.

(c) Ore mineralogy is simple and consists of mainly pyrite, chalcopyrite, sphalerite, and bornite in a quartz sericite matrix. Galena is rare; pyrrhotite is common in tuffaceous sedimentary rocks that overlie the pyritic beds. No barite, gypsum, anhydrite, nor any abundance of hematite or magnetite has been noted.

(d) Sulphide-bearing rocks are contained in a unit of dolomitic siliceous sericite schist (pelitic schist in Japanese terminology). Footwall rocks are compact sericitic chlorite schists and quartz-bearing chlorite schists derived from 'grit' whose origin is partially or totally volcanic. Hangingwall rocks are thinly bedded pelites, tuffaceous sediments, and argillite.

In terms of size, shape, and mineralogy the deposit closely resembles what Japanese geologists call bedded cupriferous pyrite deposits (Besshi-type deposits). However, the Kutcho Creek deposits are not contained in 'basic schists,' that is, metamorphosed equivalents of basic lavas and basic pyroclastic rocks. Instead the presence of acidic volcanic host rocks makes the environment and geologic setting more compatible with Kuroko-type deposits.

GEOCHEMICAL CONSIDERATIONS: Because pyrite is the most abundant and widespread sulphide mineral in the mineralized beds within and outside cupriferous zones, an attempt was made to characterize pyrite geochemically and to determine if any elements derived from pyrite might be useful indicators in addition to copper and zinc of this type of mineral occurrence. The results were largely negative.

The following are average values of minor elements from 10 pyrite concentrates from the mineralized beds (spectrochemical analyses, all in ppm):

As	50	Ag	7
Sb	<3	Co	217
Pb	12	Ni	52
Zn	250	Cu	66
Bi	4	Mn	53
Cd	7	V	35
		Mo	19

Ga, Sn, and In were not detected. Hg was not determined. Of the elements detected the only element contained in pyrite that might be useful as a pathfinder is silver.

Two analyses of minor elements in chalcopyrite indicate that except for zinc (1100 ppm), and possibly arsenic, other minor element concentrations are similar to those in pyrite. One chalcopyrite specimen was found to contain 5400 ppm As, the other specimen contained only 25 ppm. Therefore the presence of As in chalcopyrite, regardless of whether it is in the chalcopyrite structure or present in a discrete arsenic-bearing mineral might be useful to outline chalcopyrite-bearing zones in pyritic beds.

REFERENCES

Assessment Report 5778.

Kase, K. (1972): Metamorphism and Mineral Assemblages of Ores from Cupriferous Iron Sulfide Deposit of the Besshi Mine, Central Shikoku, Japan, Jour. of the Faculty of Science, *University of Tokyo*, Sec. II, Vol. 18, No. 2, pp. 301-323.

Kenehira, K. and Tatsumi, T. (1970): Bedded Cupriferous Iron Sulphide Deposits in Japan, A Review: *in* Volcanism and Ore Genesis, T. Tatsumi, editor, *University of Tokyo Press*, pp. 51-76.

Panteleyev, A. (1975): JEFF, *B.C. Dept. of Mines & Pet. Res.*, GEM, 1974, pp. 343-348.

Pearson, D. E. and Panteleyev, A. (1975): Cupriferous Iron Sulphide Deposits, Kutcho Creek Map-Area (104I/1W), *B.C. Dept. of Mines & Pet. Res.*, Geological Fieldwork, 1975, pp. 86-92.

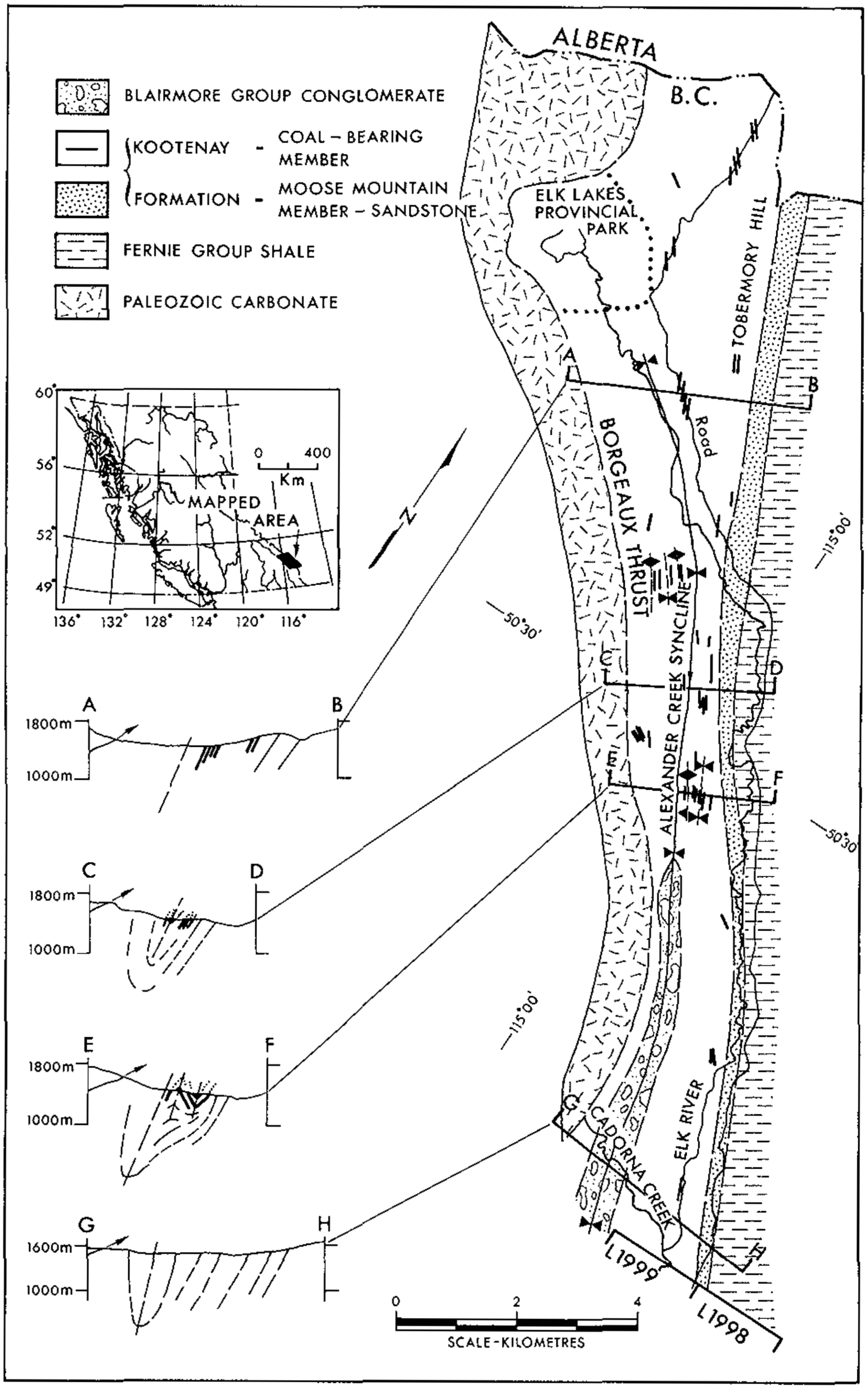

Figure G-40. Generalized geology, Upper Elk Valley.

STUDIES IN THE EAST KOOTENAY COALFIELDS (82J; 82G)

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.

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. G-40). Exposure is not good, and the basal contact of the formation on the east side of the valley is nowhere exposed. Paleozoic carbonate rocks 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 apparently 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 synclines are seen to repeat some seams (section E-F, Fig. G-40).

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 lamellibrachs (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 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, 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.

CORRELATION OF COAL SEAMS: Correlation of coal seams by paleontologically based methods has not been undertaken by workers in the Kootenay Formation,

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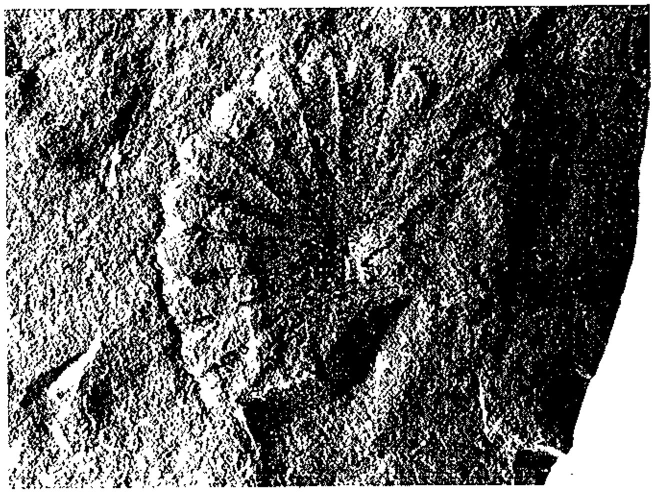

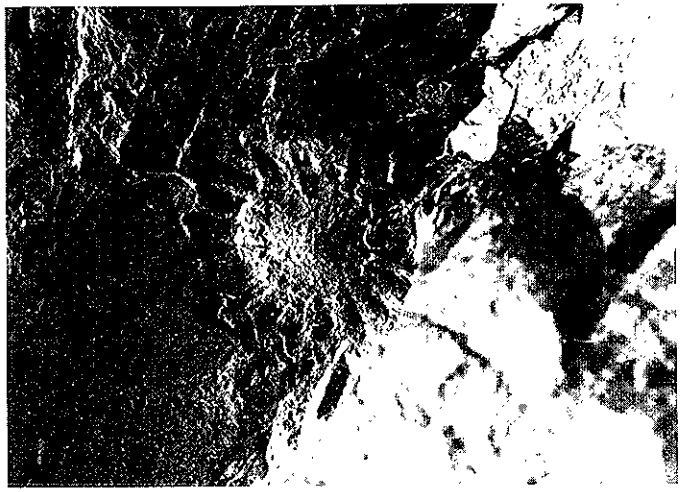

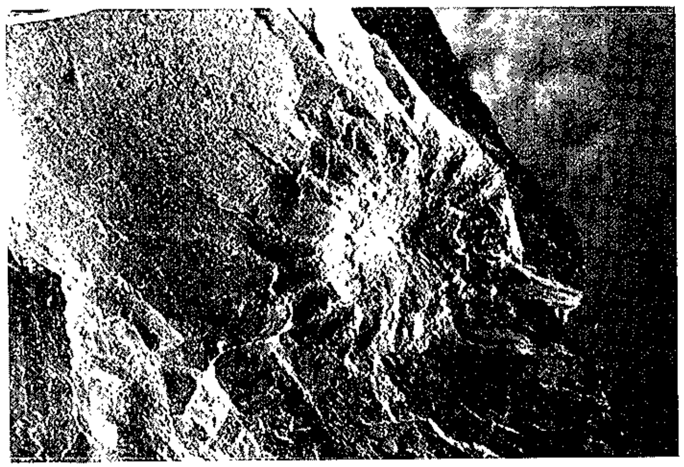

Plate G-XI. Three plant fossils similar to *Equisetites lyelli* (Mantell) Unger. Although superficially similar to ammonites, they are clearly radially symmetrical, and do not possess the typical cephalopod sutures (X4).

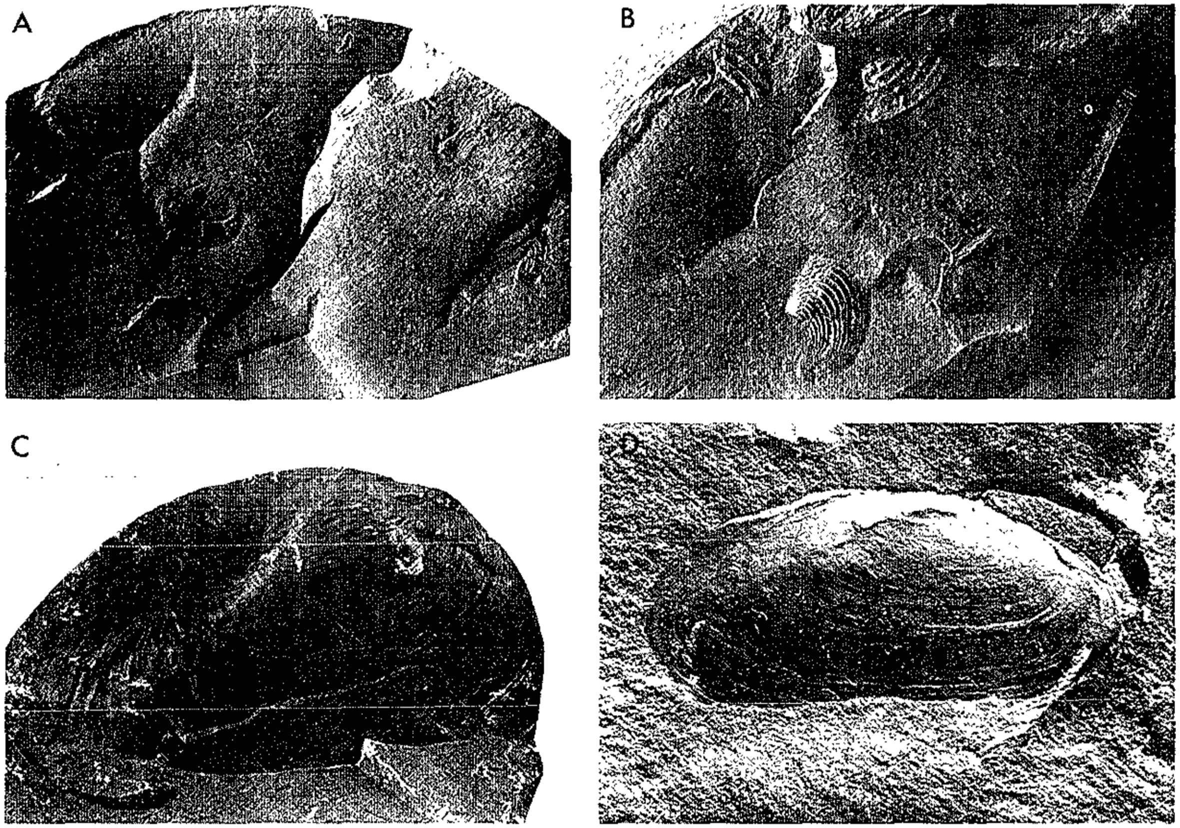

Plate G-XII. Typical animal fossils from the East Kootenay Coalfields. A and B, *'Estheria'* — these fossils are similar to lamellibranchs, but possess a stronger concentric growth line, and radial ribs (X3) (*see* text). C and D — examples of non-marine lamellibranchs or 'mussels' (C - X2; D -X5).

although such correlations between and within similar coalfields in Europe are entirely dependent 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 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.

Other fossils used in correlation of the British coal measures include the brackish water branchiopod crustaceans or conchostracans, known colloquially as *Estheria. Estheria*-bands have been recognized at 13 different stratigraphic horizons, and in some instances are as useful and as reliable as marine-bands.

Present methods of correlation in the East Kootenay coalfields rely heavily on the interpretation of geophysical logs and comparison of proximate analysis 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 maynot be reliable.

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: It was reported earlier in *Geological Fieldwork, 1975* that marine bands had been located in the Elk Valley coalfield. This was based on the discovery of fossils that resembled ammonites. In fact the fossils were not even invertebrates, but plant fragments similar to *Equisetites lyelli* (Mantell) Unger (Plate G-XI). This fossil has been described by Bell (1956) from the Kootenay Formation.

Other fossils that are potentially useful as time-plane markers are the Estherids (Plate G-XII), of which to date four discrete bands have been recognized. A selection of the fauna is being examined by the Geological Survey of Canada and other bands may be found. The positions of these bands are as follows:

CROWSNEST COALFIELD:	Above No. 1 seam in the Hosmer-Wheeler section
ELK VALLEY COALFIELD:	Above No. 4 seam on the Elco property; two other bands high in the sequence, Elco's ground

It is hoped that these *Estheria*-bands can be used to establish time-planes and correlate seams across the East Kootenay coalfields. Work is continuing to this end.

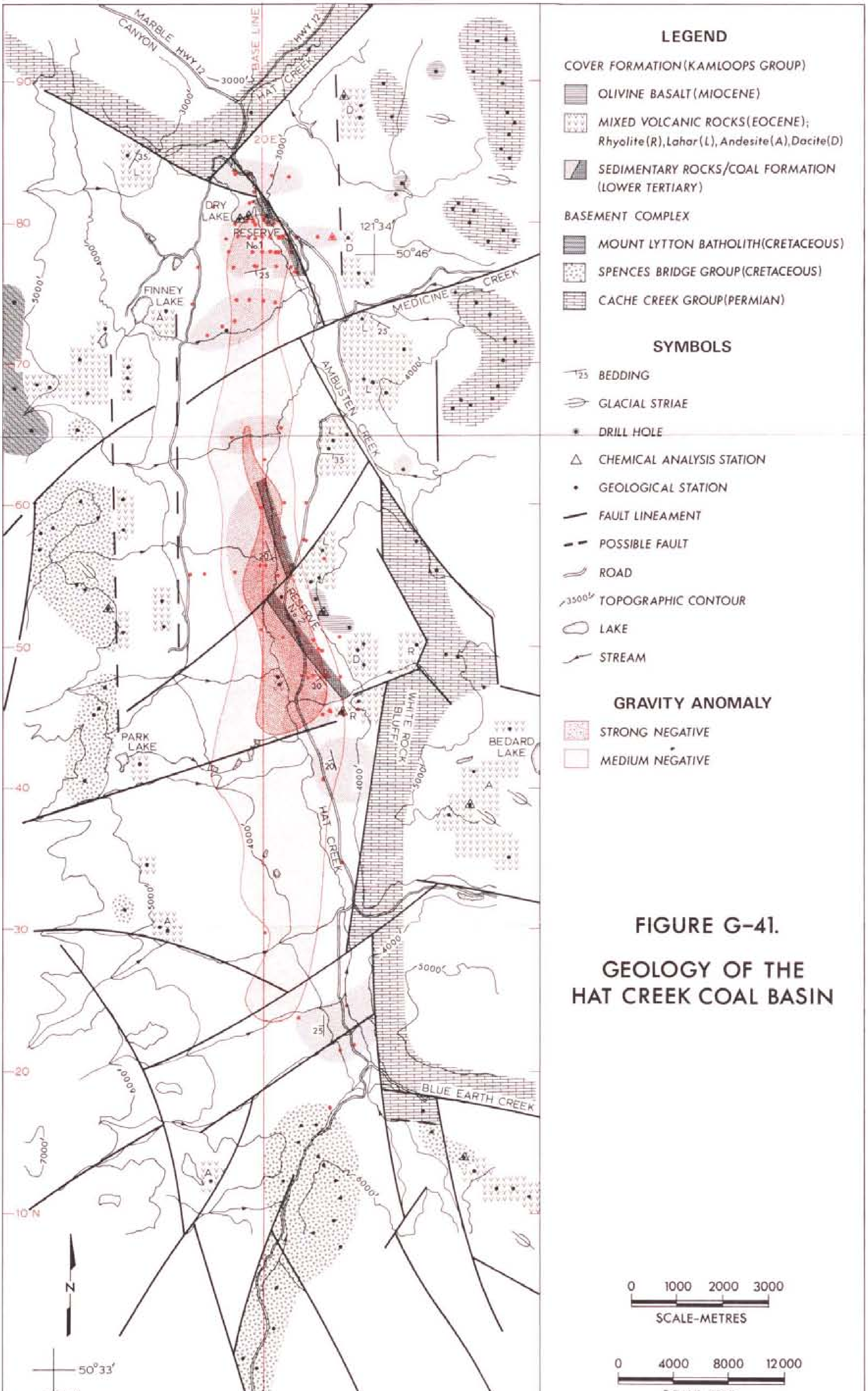

FIGURE G-41.

GEOLOGY OF THE HAT CREEK COAL BASIN

1975 pg 98A

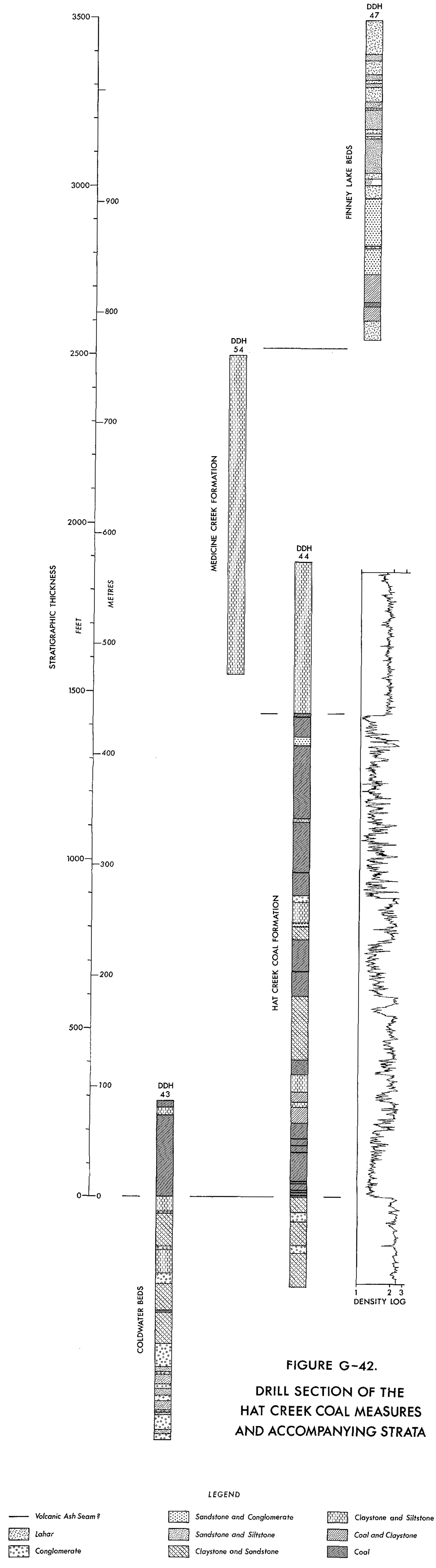

FIGURE G-42.

DRILL SECTION OF THE HAT CREEK COAL MEASURES AND ACCOMPANYING STRATA

REFERENCES

Bell, W. A. (1956): Lower Cretaceous Floras of Western Canada, *Geol. Surv., Canada,* Mem. 285.

Smith, E. G., Rhys, G. H., and Eden, R. A. (1967): Geology of the Country around Chesterfield, Matlock, and Mansfield, *Geol. Surv., Great Britain,* Mem. 112.

Woodland, A. W. and Evans, W. B. (1964): The Geology of the South Wales Coalfield, Pt. IV, The Country around Pontypridd and Maesteg, 3rd edition, *Geol. Surv., Great Britain,* Mem. 248.

GEOLOGY OF THE HAT CREEK COAL BASIN (92I/13E)

By B. N. Church

INTRODUCTION: Several hundred millions of tonnes of sub-bituminous coal have been outlined by recent drilling in the upper section of Hat Creek valley, 22 kilometres west of the village of Cache Creek (Fig. G-41). Recent exploration, conducted by the British Columbia Hydro and Power Authority has been directed toward defining these reserves with a view to the possible installation of a thermal power plant.

This report is intended as an outline of the geology of the Hat Creek basin, based mainly on field observations during June and July 1975.

PHYSIOGRAPHY AND GLACIATION: The valley formed by the headwaters of Hat Creek 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 ranges from an approximate elevation of 820 metres near Marble Canyon at the north end of the Hat Creek valley, to the encircling ridges and peaks which are in excess of 2 000 metres above sea level.

It appears that the valley was overridden by two and possibly several Pleistocene ice sheets (Plate G-XIII). The most recent advance originated in the Coast Mountains and, according to average striae measurements, moved easterly at 117 degrees, depositing 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 and glacial outwash ranges from 10 to 100 metres thick, averaging about 50 metres.

The soils of Hat Creek valley are characteristically clay-rich and have unusual swelling properties when water saturated. This swelling tendency suggests the presence of montmorillonite, a clay formed by the decomposition of glassy volcanic rocks.

The consequence of this clay-rich mantle is evident throughout the valley resulting in poor groundwater drainage and a number of significant landslides.

HISTORY: The presence of an important coal deposit on Hat Creek has been known for many years. It was first reported by G. M. Dawson of the Geological Survey of Canada in 1877 and again in 1894.

The first attempt to work the deposit was in 1893 when a rancher, George Finney, supplied coal to local residences and the village of Ashcroft. During the period 1895 to

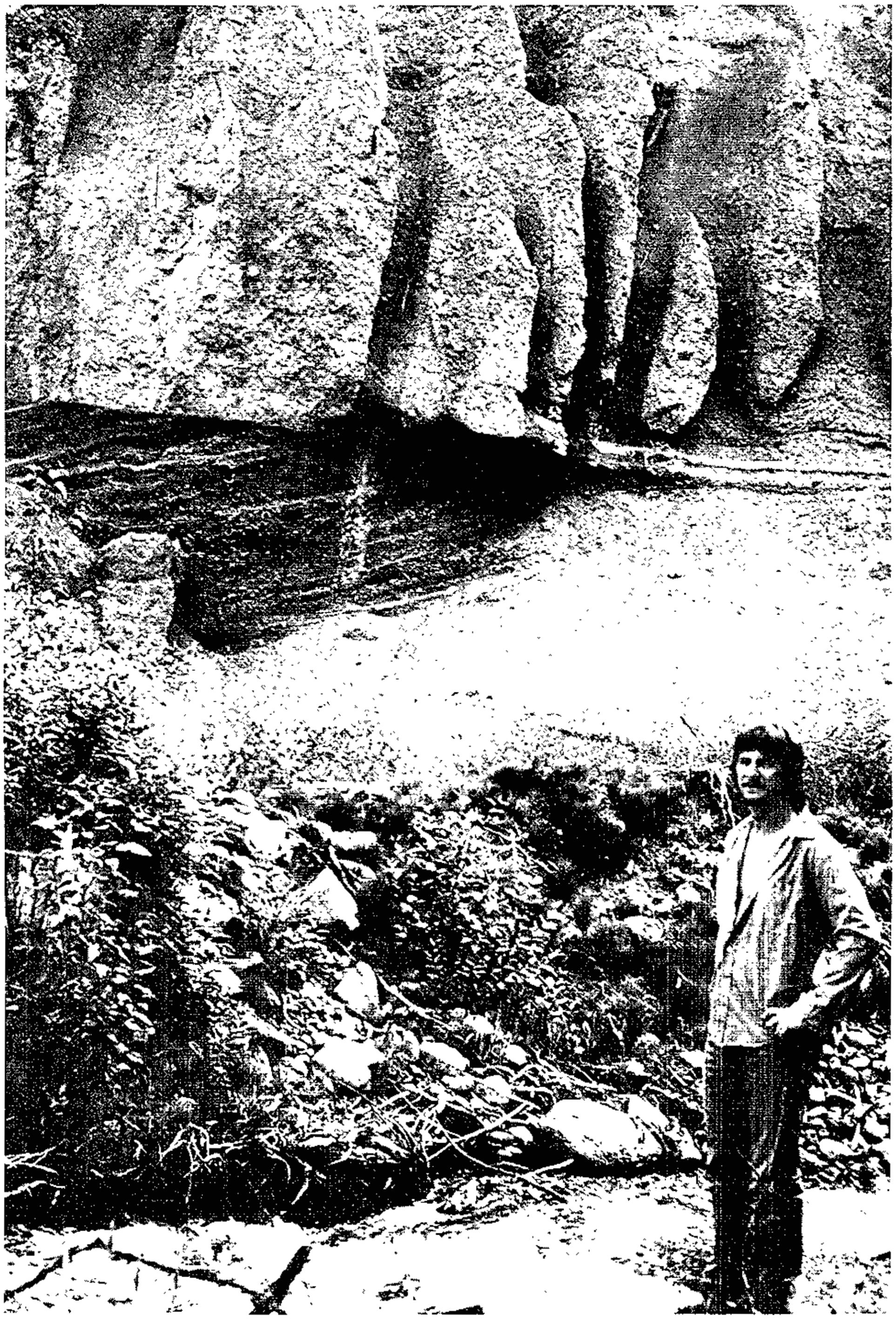

Plate G-XIII. Pleistocene deposits eroded along Hat Creek.

1925 the property was operated by a number of companies including the Hat Creek Coal Company although production was small and intermittent. The total development to 1925 included three shallow exploration shafts, two tunnels driven 35 and 50 metres from the west side of Hat Creek, and seven drill holes which tested an area of about 45 hectares located approximately 1.5 kilometres south of Marble Canyon.

The property lay dormant until 1933 when it was secured by L. D. Leonard. In the period 1933 to 1942 a production of a few hundred tonnes a year supplied local needs. No further work was done until 1957.

In 1957 the British Columbia Electric Company Limited, through a subsidiary, gained control of the property. Eight holes were drilled at this time. The investigation continued in 1959 when some trenching and six additional holes were completed west of Hat Creek near the old workings.

Acquisition of British Columbia Electric by the Province ended further exploration until mid-1974 when British Columbia Hydro and Power Authority, a Crown-owned company, began the current program of systematic drilling. Twenty-five diamond-drill holes and two rotary holes totalling 11 418 metres were completed in 1974 and 76 diamond-drill holes totalling 22 556 metres were drilled in 1975. In addition, ground level magnetometer and gravity studies were undertaken covering the entire length of the valley.

GENERAL GEOLOGY: The geology of the Hat Creek area was described originally by Dawson (1877 and 1894), and amplified later by MacKay (1925), and Duffell and McTaggart (1952). Recent studies include a number of private investigations by Dolmage, Campbell and Associates for the British Columbia Hydro and Power Authority and work by Hoy (Geological Fieldwork, 1975, pp. 109-115). The results of reconnaissance mapping by the writer in 1975 are shown on Figure G-41.

MacKay provides a good geological summary (pp. 166A, 167A):

> 'The oldest rock formation exposed near upper Hat creek and the one which apparently underlies all of the coal basin is a thick series of compact, grey limestones and argillites of Carboniferous age. These beds, termed by Dawson the Cache Creek group, have been folded and faulted and 3 miles west of upper Hat creek are intruded by several large stocks of granite, granodiorite, and diorite, so that much of the limestone has been converted into marble, hence the name Marble canyon. The age of the intrusives is not definitely known, but they are thought to be late Jurassic, the period of the Coast Range batholith intrusion.
>
> 'Lying unconformably upon the limestone is a series of early Tertiary deposits, several thousand feet thick, consisting of a basal conglomerate overlain by brown to purplish-weathering, semi-indurated sandstones, shales, and clay, which in the upper part of the series carry thick seams of lignite. The outcrops of these sediments, which have been designated by Dawson the Coldwater group, are confined to the lower slopes of Hat Creek valley, and it may be that the coal basin is very limited in extent. From the divergence of dip observed in the tunnel sections and the volcanic outcrop 1,000 feet distant the Tertiary sediments appear to be unconformably overlain by Miocene volcanics consisting of basalt, breccias, and tuffs, the latter being in places fine-grained and showing distinct stratification, as if laid down under

water. These have been subjected to folding and faulting parallel to the general axis of the valley, so that they now dip at angles up to 45 degrees. The volcanics have their greatest development to the west of Hat creek, covering all of Clear Mountain range, where the events were apparently located. Late Tertiary erosion has largely removed the volcanics from the valley area, but remnants of the extensive flows still occur on the east slope of the valley, and on the west of Hat creek close to the coal outcrop.'

The volcanic rocks, considered by Dawson to be entirely of Tertiary age, are now known to comprise a broader assemblage consisting of both Cretaceous and Tertiary lavas and breccias referred to as the Spences Bridge Group and Kamloops Group, respectively (Duffell and McTaggart, pp. 54 and 66).

SEDIMENTARY ROCKS: The sedimentary assemblage is known mainly from drilling because of sparse bedrock exposure.

Examination of the drill core shows that the coal formation is indeed many hundreds of metres thick as suspected from previous studies. Almost everywhere it appears to be overlain by a thick deposit of claystones and siltstones. Owing to the great combined thickness of the coal measures and covering rocks, often in excess of 600 metres, no drill holes have completely penetrated the sedimentary sequence. The few deep holes that have gone below the coal have intercepted siltstone, sandstone, and conglomerate beds. The thickness and lateral extent of this basal unit in the map-area remains uncertain.

The names Coldwater Beds, Hat Creek Coal Formation, and Medicine Creek Formation are applied to the lowest, middle, and upper sedimentary units, respectively, for informal use pending more detailed description.

COLDWATER BEDS: The use of the name 'Coldwater Beds' in this report is consistent with Dawson's original reference to the basal Tertiary sandstones and conglomerate but differs inasmuch as the coal formation and younger sedimentary rocks are here assigned to separate formations.

Typically the Coldwater beds consist of firmly indurated brown sandstones and conglomerates, about 1 372 metres thick, as exposed along the lower section of Hat Creek northeast of the map-area. The clasts are commonly well sized and rounded and have a mixed provenence. A thin-section study of 10 representative sandstone samples gives an average of chert and quartzite, 45 per cent (from the Cache Creek Group); quartz and feldspar, 35 per cent (from a granite source); and accessory greenstone, mica schist, and carbonate fragments.

The presence of Coldwater beds in the map-area is indicated by blocks of conglomerate in the glacial deposits near Hat Creek south of Marble Canyon and one small outcrop of conglomerate near Ambusten Creek 3 kilometres above the confluence of this stream with Hat Creek. From the results of drilling, hole No. 43 penetrated what is believed to be some of the uppermost Coldwater beds. This is a thickness of about 90 metres of sandstone and conglomerate followed upward by 130 metres of claystone and sandstone to the base of the coal formation (Fig. G-42)

According to Dawson, the Coldwater beds are fluvial accumulations deposited prior to the main phase of Early Tertiary volcanism. Volcanic clasts in these rocks were probably derived from the basement formations, mainly the Cache Creek Group, and the fresher Cretaceous volcanic units which underlie much of the area.

Plate G-XIV. Coal exposure on Hat Creek near the north end of the valley.

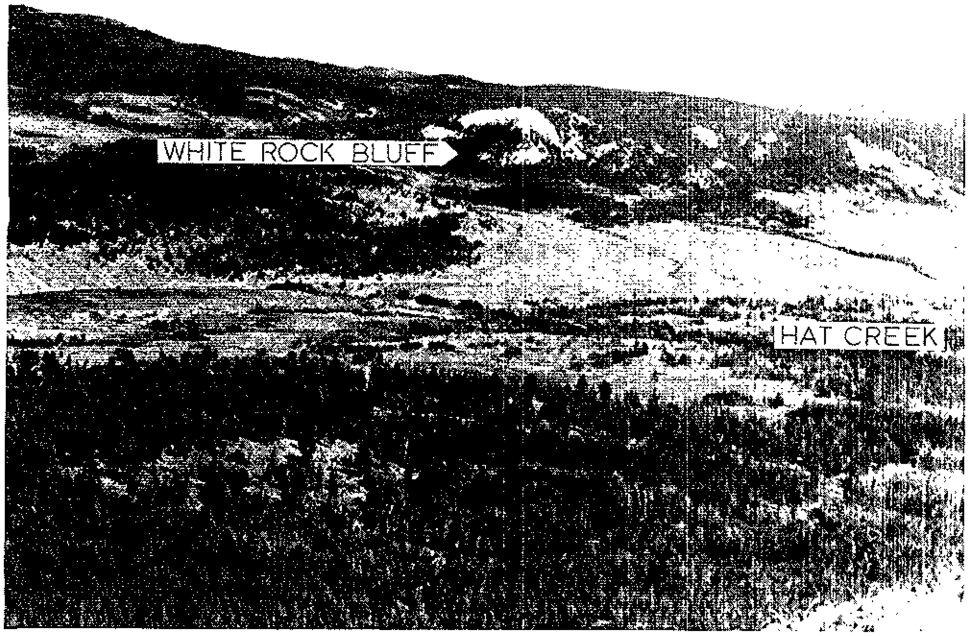

Plate G-XV. View looking easterly across Hat Creek valley to the No. 2 Coal Reserve below White Rock Bluff.

HAT CREEK COAL FORMATION: The name Hat Creek Coal Formation is applied to the coal measures. The principal exposures are along a 400-metre section of Hat Creek about 1.5 kilometres south of Marble Canyon (Plate G-XIV). This area, which includes the original coal discovery, is referred to as the No. 1 Reserve. A second coal deposit, the No. 2 Reserve, discovered by recent drilling, is centred about 8 kilometres south near the mid-point in the valley (Plate G-XV).

The general stratigraphy of the coal formation, especially in the area of No. 1 Reserve, is known from detailed studies of drill core. This formation, comprising somewhat more than 425 metres of strata, consists of three principal seams. These are well displayed in hole No. 44 which is approximately perpendicular to bedding and represents what is thought to be a complete section.

The uppermost seam, about 160 metres thick, constitutes more than one-third of the total formation. It is a relatively impure sequence of alternating coal, seat earth, and siltstone and sandstone lenses. Calculations based on density measurements indicate that total impurities amount to about 28 per cent by weight of the seam.

The middle and lower seams are comparatively thin, 50 metres and 70 metres thick respectively, and are separated by zones of sandy siltstone, conglomeratic sandstone, and a few thin coaly bands. These seams are relatively clean having an estimated 23 per cent impurities.

The lower half of the lowest seam has the largest apparent volume of clean coal, a thickness of about 30 metres with only about 14 per cent impurities.

The character of the coal has been the subject of much research. MacKay provides a good general description (p. 175A):

> 'Hat Creek coal has a dark brown to black colour and a dull, resinous lustre. Hand specimens of the clean coal show alternating layers and lenses of bright and dark material, which range in thickness from microscopic size to several inches. The bright layers represent that part of the coal derived from wood, and the dull portions the parts made up of debris. On drying, the coal breaks with a conchoidal fracture into small, irregular blocks, which on exposure to the weather further disintegrate, yielding very little lump. The coal does not soil the fingers on handling. On firing, it steams and sweats until the excess moisture is driven off, after which it burns with a bright yellow flame. Parts of the coal are characterized by small lenses, globules, and irregular-shaped masses of light yellow, semi-transparent, fossilized amber or retinite. Much of the coal shows highly polished, slickensided surfaces, whereas other parts are made up of small, angular fragments of amorphous coal partly or completely surrounded by a calcareous mud. Much of the coal is thus rendered valueless. Carbonated tree trunks occur in several horizons, and these in some instances have been converted into ironstone.'

The rank of the coal according to the ASTM system is sub-bituminous 'B.' It has a gross rating of about 6 000 Btu per pound at the 20-per-cent moisture level. A British Columbia Hydro and Power Authority investigation of the 1974-75 drilling (McCullough, 1975, p. 7) reports the mean composition of coal as follows (20 per cent moisture; 25 per cent ash): carbon, 37.72 per cent; oxygen, 12.93 per cent; hydrogen, 2.94 per cent; nitrogen, 0.92 per cent; sulphur, 0.41 per cent; chlorine, 0.02 per cent. The composition of the ash is given in the accompanying table of chemical analyses.

The sedimentary rocks intercalated with the coal vary in grain size from claystones to pebble conglomerates. Of the few thin sections of this material examined by the writer, there is a surprisingly large proportion of fresh volcanic clasts and only a few quartz and feldspar grains derived from pre-Tertiary granitic rocks.

Thin cream-coloured bands, conspicuous at a number of horizons in the coal seams, are thought to be altered ash layers from contemporaneous volcanism. Chemical analyses of a sample of this material (No. 1, Table 1) gives oxide values similar to 'tonsteins' of volcanic origin (Price and Duff, 1969). A peculiar yellow tonstein exposed above the coal measures on the south side of Dry Lake Gulch (No. 3, Table 1) was found to consist of approximately 60 per cent (molecular) kaolinite and 40 per cent montmorillonite.

The origin of the Hat Creek coal remains mostly a matter of speculation. However, the inland isolation of the deposit and a general absence of marine or brackish water fossils suggests a limnic (continental) as opposed to a paralic (coastal) environment. This conclusion is strengthened by other evidence such as the astonishing thickness of the seams. Also, the coal beds appear to terminate laterally by lithification rather than digitation or splitting. The formation maintains more or less a constant thickness although the 'height' of clean coal varies markedly over short distances passing into shaly coal then coaly shale.

The general dull lustre and massive character of the coal combined with some banding and conspicuous woody matter and resin suggests a mixed open moor, forest moor, and lacustrine facies. The lower and middle seams record a cycle of emergent moor through to submergent lacustrine and renewed emergent conditions. The larger upper seam displays a history of what appears to be repeated destruction of vegetation by flooding accompanied by influx of clay and silt.

MEDICINE CREEK FORMATION: The name Medicine Creek Formation is applied to a monotonous siltstone/claystone sequence overlying the coal. It is a remarkably homogeneous cream-coloured unit having more or less a uniform density of 1.8 grams per cubic centimetre. Except for a few zones of laminated carbonaceous argillite, the rock is almost massive with only occasional vague expression of bedding planes.

Petrographically the rock consists of small angular quartz fragments, shredded mica, and clay. Chemical analysis of the rock (No. 4, Table 1) differs slightly from average Mississippi River silt (Clarke, 1924, p. 509). Calculations give a molecular composition of: quartz, 55 per cent; feldspar, 18 per cent; the remainder being equal proportions clay, mica, and water.

The total thickness of the formation is unknown because of erosion of the upper beds, however, it is certainly in excess of 600 metres, the true bedding intersection observed in hole No. 54 (Fig. G-42).

The abrupt contact with coal beds at the base of the formation indicates a sudden change in depositional conditions from moor facies to lacustrine. The sharp contact is a marker horizon recognizable throughout the coal measures.

VOLCANIC ROCKS: The sedimentary formations are confined geographically and stratigraphically by major volcanic units. The easily eroded coal and shales occurring mainly on the floor of the valley are virtually surrounded by resistant volcanic rocks on

TABLE 1. CHEMICAL ANALYSIS

	1	2	3	4	5	6	7	8	9	10	11	12
Oxides Recalculated to 100:												
SiO_2	57.07	57.92	55.97	76.07	66.14	51.16	67.96	57.74	75.58	75.41	50.66	46.98
TiO_2	0.19	0.98	0.86	0.69	0.59	1.29	0.54	1.01	0.04	0.06	1.58	0.86
Al_2O_3	37.14	34.42	29.67	14.60	17.13	20.35	16.55	18.59	14.34	14.31	14.88	25.86
Fe_2O_3	0.37	2.45 }	7.62	2.00	3.29	5.02	2.73	4.12	0.33	0.38	1.44	14.06
FeO	0.67	0.11 }		2.80	0.79	4.04	0.55	2.57	0.34	0.28	9.26	0.36
MnO	----	0.02	----	0.12	0.07	0.19	0.01	0.09	0.04	0.04	0.16	0.19
MgO	1.36	0.89	1.44	0.94	1.38	3.74	0.49	3.10	0.52	0.14	9.84	1.97
CaO	2.21	1.04	2.74	0.83	4.09	9.72	3.08	6.09	1.05	1.05	8.33	8.70
Na_2O	0.62	0.84	1.15	0.93	4.65	3.72	4.60	4.55	3.34	4.19	2.95	0.50
K_2O	0.37	1.33	0.55	1.02	1.87	0.77	3.49	2.14	4.42	4.14	0.90	0.52
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Oxides as Determined:												
H_2O+	9.60	0.00	----	4.43	0.68	0.69	0.50	0.30	0.74	0.36	0.48	0.50
H_2O-	6.15	8.60	----	5.48	1.16	1.42	0.71	0.59	2.01	0.27	0.34	0.29
CO_2	5.44	0.07	----	3.61	0.16	0.30	0.16	0.14	0.07	0.30	0.16	0.30
P_2O_5	4.99	0.55	0.24	0.34	0.32	0.53	0.25	0.30	0.18	0.18	0.37	0.39
S	0.04	0.04	0.75	0.08	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.02
SrO	1.015	0.065	----	0.011	0.075	0.097	0.077	0.099	0.034	0.019	0.054	0.021
BaO	1.220	0.046	----	0.040	0.069	0.024	0.107	0.079	0.123	0.089	0.016	0.048
R.I.	----	----	----	----	1.518	1.578	1.507	1.545	1.488	1.486	1.604	----

1 — Hat Creek Coal Formation, tonstein band in coal, Hole 74, 1,413 feet
2 — Hat Creek Coal Formation (?), tonstein from Dry Lake area
3 — Hat Creek Coal Formation, average coal ash, McCullough, page 7
4 — Medicine Creek Formation, mudstone, Hole 34, 356 feet
5 — Spences Bridge Group, dacite from ridge 3.6 kilometres north of Park Lake
6 — Spences Bridge Group, feldspathic basalt, south of Blue Earth Creek
7 — Kamloops Group, dacite, 2.5 kilometres east of south end of Marble Canyon
8 — Kamloops Group, andesite, west of Bedard Lake
9 — Kamloops Group, rhyolite, below and immediately west of White Rock Bluff
10 — Kamloops Group, rhyolite from Trachyte Hills
11 — Kamloops Group (?), olivine basalt, 2.5 kilometres northwest of White Rock Bluff
12 — *Cinders from burnt coal (pseudo scoria deposit), south side of Dry Lake Gulch*

the valley slopes and ridge crests. The older Spences Bridge Group underlies a broad region to the west and south of the sedimentary rocks, and younger volcanic rocks of the Kamloops Group fringe the basin mainly on the east and northwest.

THE SPENCES BRIDGE GROUP: The Spences Bridge Group, where examined by the writer along the western boundary of the map-area, conforms to the descriptions of Duffell and McTaggart (1952). This is a thick sequence of gently dipping lavas and pyroclastic rocks of mainly dacitic and andesitic composition.

The rocks are mostly massive, brittle, and grey or light greenish grey. In thin section they are characterized by rectangular phenocrysts of plagioclase mixed with a few subhedral pyroxene grains, 1 to 2 millimetres in diameter, and set in a matrix of very small aligned feldspar microlites and fine magnetite dust. The normative composition of an analysed dacite sample shows: quartz, 15 per cent; feldspar, 80 per cent; and combined pyroxene and magnetite, 80 per cent (No. 5, Table 1).

The age of these rocks is considered to be Lower Cretaceous (Aptian) based on plant fossils (Duffell and McTaggart, 1952, p. 55).

Somewhat younger volcanic rocks, also mapped as part of the Spences Bridge Group by Duffell and McTaggart (1952), are exposed near the south boundary of the map-area. These are mostly basaltic lavas dated as Late Cretaceous (whole rock K-Ar analysis, 88.3±3 m.y.).

The rocks are petrographically distinctive being charged with feldspar crystals 1 to 4 millimetres in diameter. In thin section fresh labradorite phenocrysts are embedded in a groundmass of randomly arranged plagioclase microlites and interstitial magnetite, pyroxene, and a small amount of what appears to be serpentinized olivine. The normative mineralogy based on chemical analysis of a typical sample gives: quartz, 1 per cent; feldspar, 75 per cent; pyroxene, 20 per cent; and magnetite, 4 per cent (No. 6, Table 1).

KAMLOOPS GROUP: The volcanic rocks of the Kamloops Group defined as Miocene and earlier Tertiary (Duffell and McTaggart, 1952, p. 64) are considered partly coeval but mostly younger than the sedimentary formations. Tuff bands intercalated with the coal represent the oldest Tertiary volcanism in the area. These were followed by eruption of rhyolite locally and emplacement of a thick deposit of andesite and dacite lava, breccia, and lahar referred to here as the Finney Lake Beds. The youngest episode of volcanism is represented by a few small outliers of olivine basalt lava.

RHYOLITE FORMATION: Duffell and McTaggart (p. 67) note the occurrence of porphyritic rhyolite near the town of Ashcroft as:

> 'one of the earliest phases of Tertiary volcanism in the district.'

The rhyolite rests directly on Jurassic shales and is overlain locally by basalt.

In the Hat Creek area rhyolite is found on hillocks below and immediately to the west and north of White Rock Bluff. These exposures are lava and bedded pyroclastic rocks. The age of the formation determined from K-Ar analysis of biotite is 49.9±1.4 m.y., Middle Eocene.

Thin section studies indicate that much of the lava is holocrystalline. Phenocrysts of quartz, sanidine, plagioclase, and biotite, 1 to 3 centimetres in diameter, constitute about

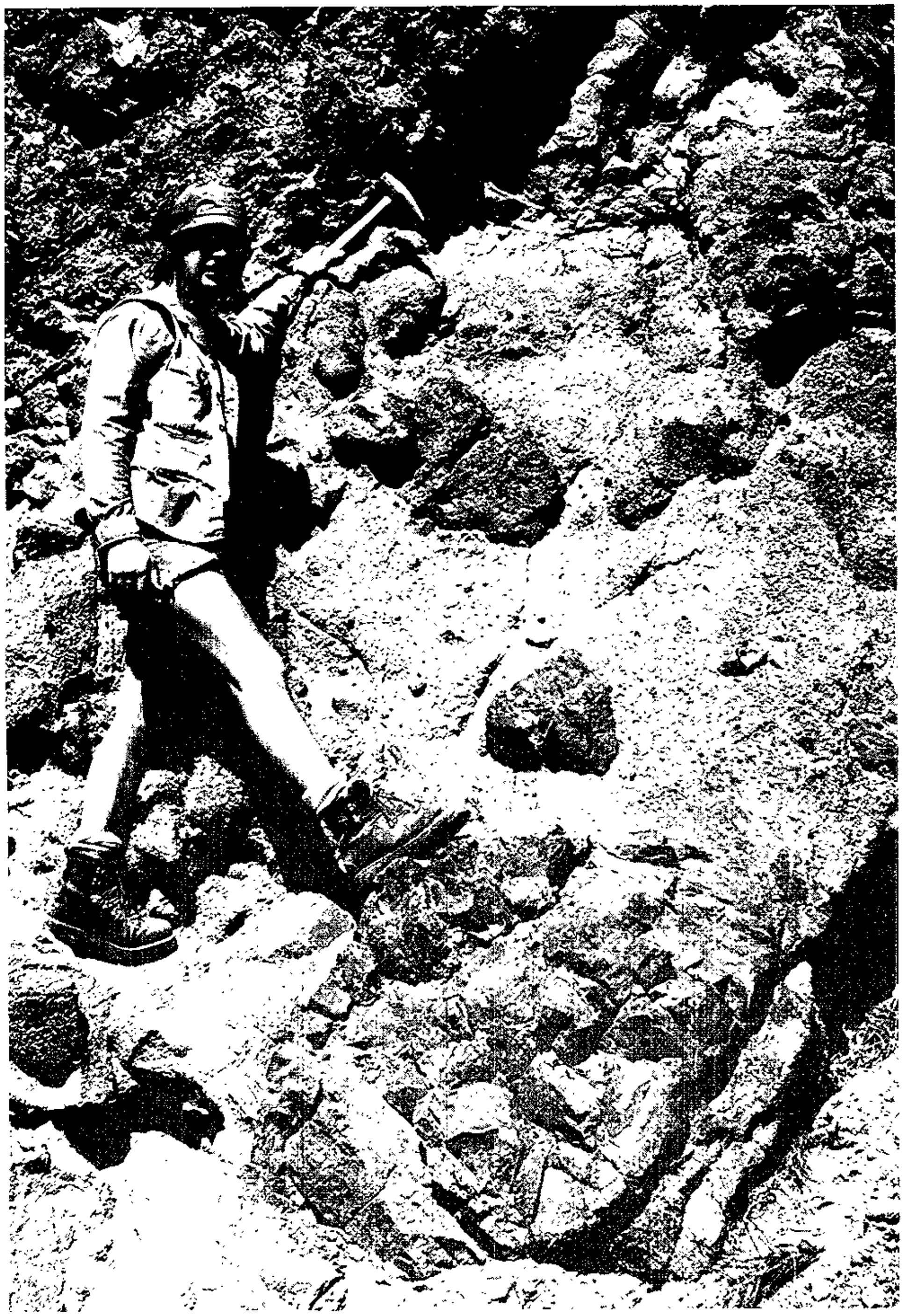

Plate G-XVI. Lahar facies in Finney Lake beds, south of Medicine Creek.

1 per cent of the rock. Except for quartz which is commonly corroded these crystals are euhedral in outline and dispersed throughout a microcrystalline groundmass which, according to norm calculations, is composed of: quartz, 35 per cent; sanidine, 20 per cent; oligoclase, 40 per cent; ferromagnesian minerals (biotite and magnetite), 5 per cent.

A larger outlier of rhyolite is centred in the Trachyte Hills immediately east of the northeast extremity of the map-area. This is a massive non-porphyritic, cream-coloured lava, undoubtedly the remnant of a lava dome, similar chemically to the White Rock Bluff rhyolite occurrence (Nos. 9 and 10, Table 1). The dome, which forms a topographic high at the north end of the Cornwall Range, rests unconformably on inclined Coldwater Beds.

FINNEY LAKE BEDS: The Finney Lake Beds comprise by far the greatest part of the Kamloops Group in this area. The formation consists of andesite and dacite lava flows and coarsely bedded volcaniclastic deposits.

The maximum development of the formation appears to be just east of Finney Lake where a thickness of approximately 290 metres of mainly volcaniclastic rocks have been intersected in hole No. 47 (Fig. G-42). Similar beds composed of lahar with admixtures of sandstone and conglomerate are well exposed along the lower section of Medicine Creek just above the main road and in the area to the south along the east side of the valley almost to White Rock Bluff. Outcrops of the same rock can also be found scattered along the west side of the valley from the region south of Marble Canyon to beyond Park Lake.

Lahar beds predominate in the volcaniclastic pile. They consist of rounded and subangular blocks ranging to several feet in diameter suspended in a mud matrix -- the manifestation of chaotic rubble flows (Plate G-XVI). The fragments are an assortment of light grey dacite, dark andesite, and dark grey to light cream-coloured obsidian and perlite clasts.

The interbedded sandstones and conglomerates are compositionally similar to the lahars appearing to be the washed and sorted, stream-worked equivalent. In thin sections, the sandstones consist almost entirely of volcanic clasts; fragments usually charged with feldspar microlites, accompanied by a small amount of chert and quartz.

The main lava deposits, source of much of the volcanic rubble, flank the valley on the east and west sides.

Dacite flows are best exposed on the low cliffs that extend south to Medicine Creek, from a point about 1 mile east of the entry of Hat Creek into Marble Canyon. Typically this is a fine-grained, non-porphyritic, light grey and brittle rock that tends to cleave into thin subparallel plates. A whole rock K-Ar determination gives an age of 43.6±1.8 m.y., Middle Eocene -- only slightly younger than the rhyolite formation.

The andesitic volcanic rocks are stratigraphically and compositionally gradational with the dacites. Commonly andesites are dark grey, and like the dacites, they are fine-grained, brittle rocks. Arc fusion analysis of eight amples of aphanitic lava show a range in refractive index of artifically prepared glass from 1.507 to 1.555, the average 1.535 marking an even division in the frequency of andesite and dacite samples.

Chemical analyses of representative samples of lava are given in Table 1 (Nos. 7 and 8). Significant differences are noted in the normative mineralogy comparing the results for andesite and dacite, respectively: quartz, 2 per cent and 20 per cent; potassium feldspar, 10 per cent and 20 per cent; plagioclase, 75 per cent and 55 per cent; and ferromagnesian minerals, 13 per cent and 5 per cent.

The contact relationships of the Finney Lake Beds are generally obscured because of poor exposure, however, the available evidence suggests the presence of an important unconformity at the base of the formation. The nature of the contact with older Tertiary rocks is revealed 10 kilometres north of the northeast part of the map-area where dacite lavas are found resting on Coldwater Beds, and in the area west of White Rock Bluff where volcaniclastic rocks are unconformable on inclined Medicine Creek mudstones and the coal formation. The contact relations with pre-Tertiary rocks are viewed in the area immediately west of Bedard Lake where andesite lavas directly overlie Cache Creek limestone, and south of Blue Earth Creek where dacite lavas are unconformable on feldspathic basalt flows of the Spences Bridge Group.

The occurrence of a thin zone of coal and carbonaceous shale in the Finney Lake Beds near the bottom of hole No. 47 (Fig. G-42) is in keeping with the discovery of logs and wood splinters in the lahar deposits. It is believed that the area had developed a rolling terrain with marshy lowlands and wooded slopes at the time of volcanic eruption. Destruction of vegetation was apparently consequent of the partial infilling of the low areas with volcanic debris — mostly mudslides.

The volume and lateral extent of the coaly member in this formation is not thought to be great.

OLIVINE BASALT: Olivine basalt lava, the youngest formation in the Kamloops Group, occurs in three small areas. The largest exposure is on the crest of a low ridge immediately east of the No. 2 Coal Reserve. Two smaller outliers are in the northeast part of the map-area centred about 2.5 and 5 kilometres north of Medicine Creek.

The rocks are fresh, dark grey or black, and speckled with small olivine crystals. In thin section the olivine forms both diamond-shaped and partially rounded grains, 0.25 to 2 millimetres in diameter, scattered throughout a matrix composed of tight ophitic growths of pyroxene and plagioclase, accessory magnetite, and a small amount of interstitial glass. The normative mineralogy, calculated from analysis of a typical sample of lava shows: plagioclase, 57 per cent; pyroxene, 26 per cent; olivine, 15 per cent; and magnetite, 2 per cent (Table 1, No. 11). Whole rock K-Ar analysis of this sample gives a Middle Miocene age of 13.8 ± 0.5 m.y.

Younger volcanic rocks are not observed in the region, except perhaps for a few ash bands in the Pleistocene tills. Bands of reddish soil, conspicuous at several points in the valley near coal seams, appear to be ash layers from burnt coal. A breccia exposed on the south embankment overlooking Dry Lake, described by MacKay (1925) as a volcanic dyke, is probably only pseudo scoria, an example of the cindery residue of burnt coal. Analysis of this rock indicates it is unlike any other volcanic rock, having a composition unusually enriched in alumina, iron oxide, and lime (Table 1, No. 12). There is evidence suggesting that much, if not all of the exposed coal in the Hat Creek valley has been superficially burnt in prehistoric time.

STRUCTURE: The Hat Creek basin is similar to a number of Tertiary grabens and half-graben structures scattered across central and southern British Columbia. As a narrow intermontane depression bounded by steep faults, it resembles the Bowron River basin near Prince George. In thickness of volcaniclastic, lacustrine, and fluvial beds, the Hat Creek section is comparable to the White Lake deposits near Penticton. It is only in thickness and volume of coal that the Hat Creek basin is unique.

The general structure of the basin is simple. The central zone of the valley, underlain mainly by coal and sedimentary formations, has been downdropped 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, the walls of this graben having been offset locally by northwest and northeast-striking conjugate shear faults (Fig. G-43). An important system of easterly trending gravity faults cutting across the basin appears to be of more recent origin being superimposed on the main graben structures.

A study of minor fractures throughout the map-area shows a general concurrence in orientation with important faults (Fig. G-44). The strongest joint development striking about 035 degrees and a weaker system striking 165 degrees, both dipping steeply, coincide roughly with the shear directions. Other fractures striking about 080 degrees and weaker sets at 125 degrees are subparallel to cleating in the coal and cross faults.

The detailed structure of the coal measures is known only from the drill holes and a few outcrops and old tunnels. The available information is mostly on No. 1 Reserve, reconnaissance drilling in the area of No. 2 Reserve being incomplete.

According to drill results, using the base of the Medicine Creek Fromation as a marker, the average bedding in the area of No. 1 Reserve is believed to dip southerly at about 25 degrees. Some divergence of bedding noted locally is probably due to faulting accompanied by minor folds. For example strata exposed on Hat Creek and the outlet of Dry Lake dip southeasterly, having attitudes of $040^{\circ}/45^{\circ}$ southeast and $075^{\circ}/47^{\circ}$ southeast respectively, whereas farther south on the west bank, dips to the southwest are most commonly recorded. MacKay (p. 168A) has described the local disruption of beds viewed in one of the old tunnels in this area (now collapsed):

> '...the beds are folded into two synclines which are separated by a compressed and faulted anticline. The axis of these folds strike north 170 degrees east astronomical and plunge 10 degrees south.'

Figure G-45A is a conceptual model of the No. 1 Reserve area. A central panel, bounded on the east and west by major north-south gravity faults, is segmented internally by a series of minor east-west reverse faults. The pattern of movement within the panel, of slices on the north moving down relative to adjacent slices on the south, has resulted in a net decrease in the southerly dip of the coal formation. The overall result of faulting on the coal formation is a gently southerly plunging trough or syncline-like structure.

The structure of No. 2 Reserve is thought to be relatively straightforward. The deposit is a sinuous 3.5-kilometre-long band of coal paralleling the valley and the axis of a large gravity anomaly (Fig. G-41). Drilling shows that the coal formation is inclined 20 to 30 degrees dipping westerly under the Medicine Creek mudstones, the strike of the beds paralleling major north-south gravity faults. The repetitive effect of the north-south faults across the graben is a trap-door-like downward rotation of beds on the west and a net increase in the westerly dip of the coal measures (Fig. G-45B). The repetitive faulting and resulting steep dip of the coal also explains the coincidence of the large negative gravity anomaly with the No. 2 Reserve.

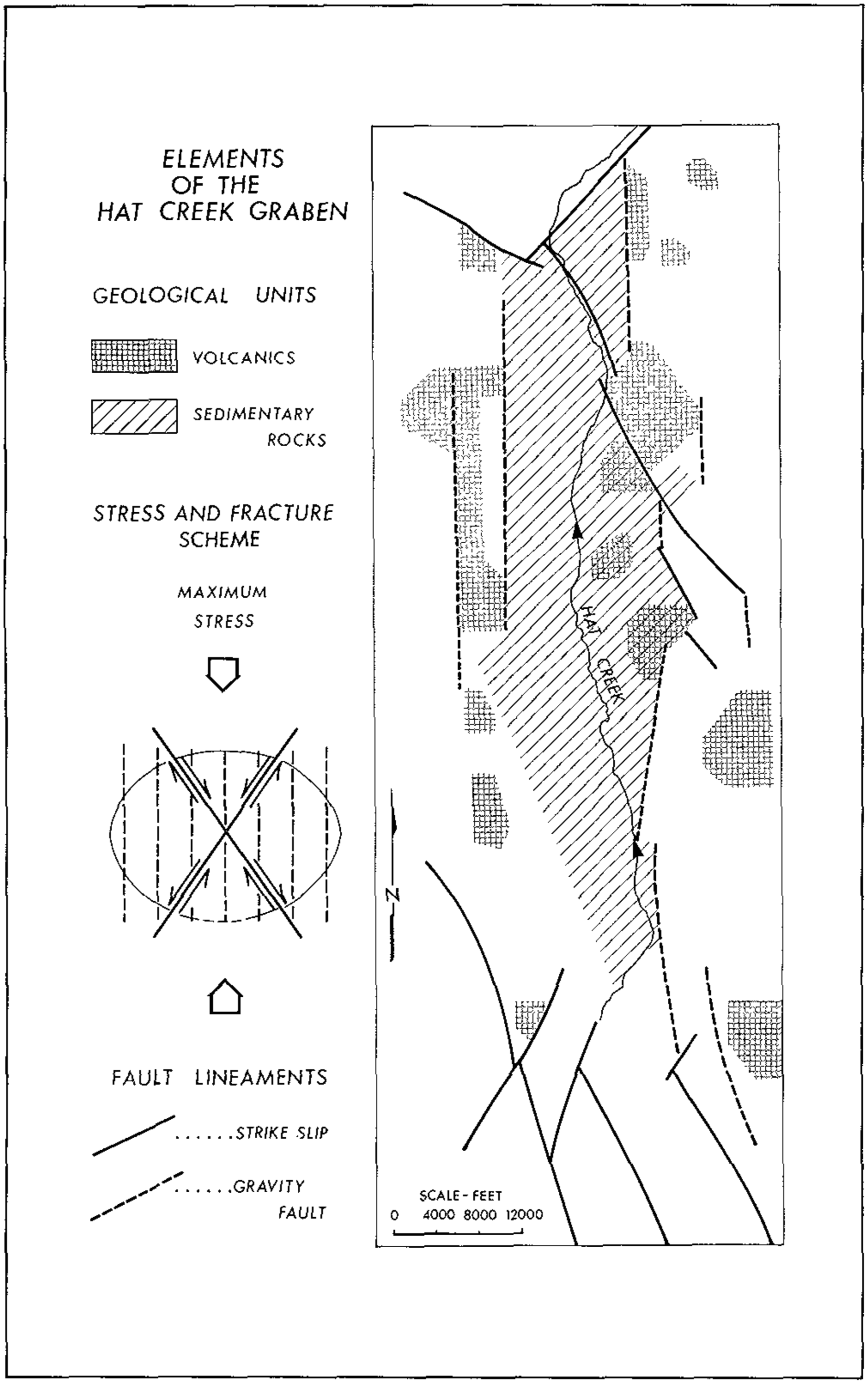

Figure G-43. Possible stress scheme relating faulting to graben development in the Hat Creek area.

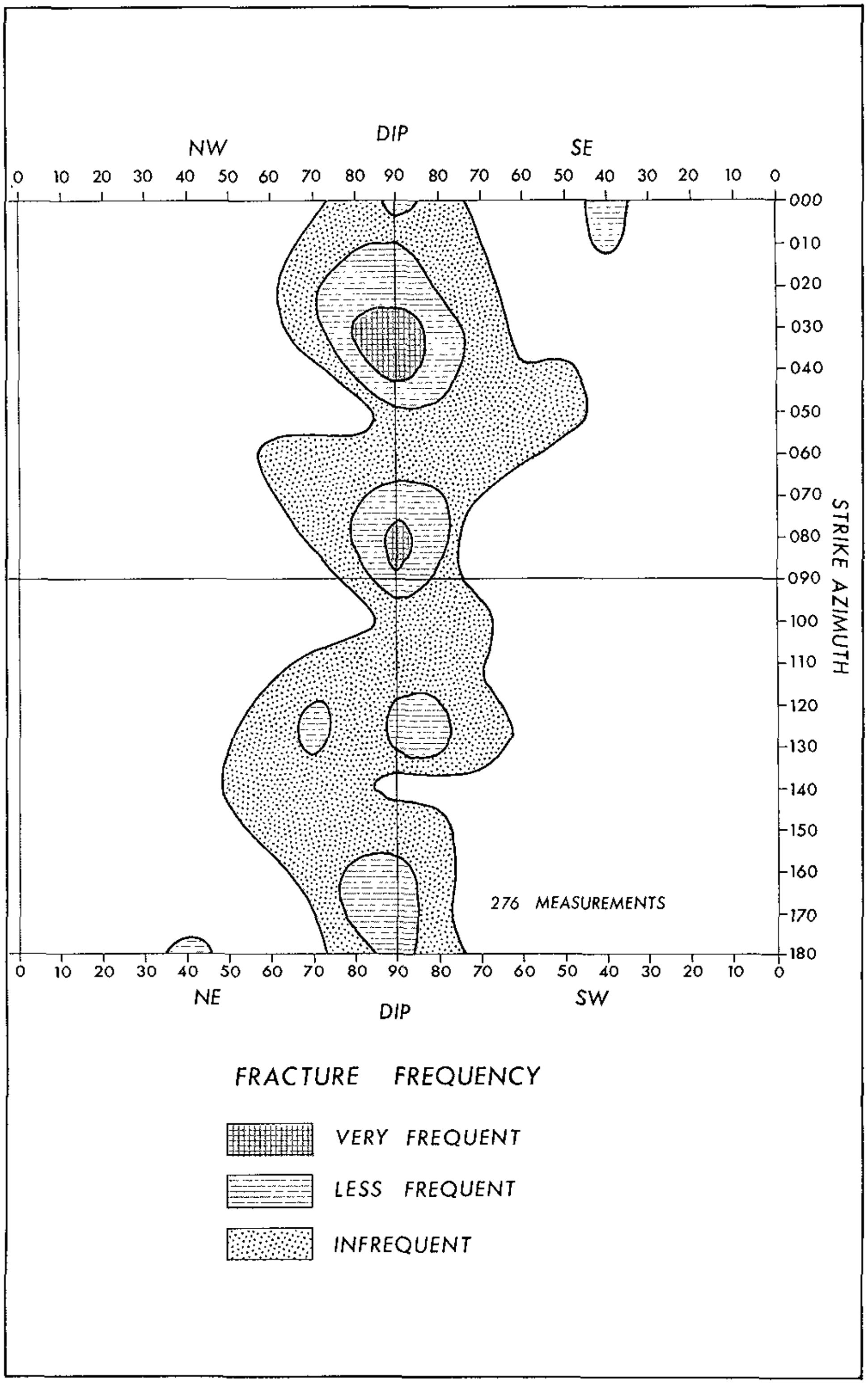

Figure G-44. Fracture frequency plot for the Hat Creek area.

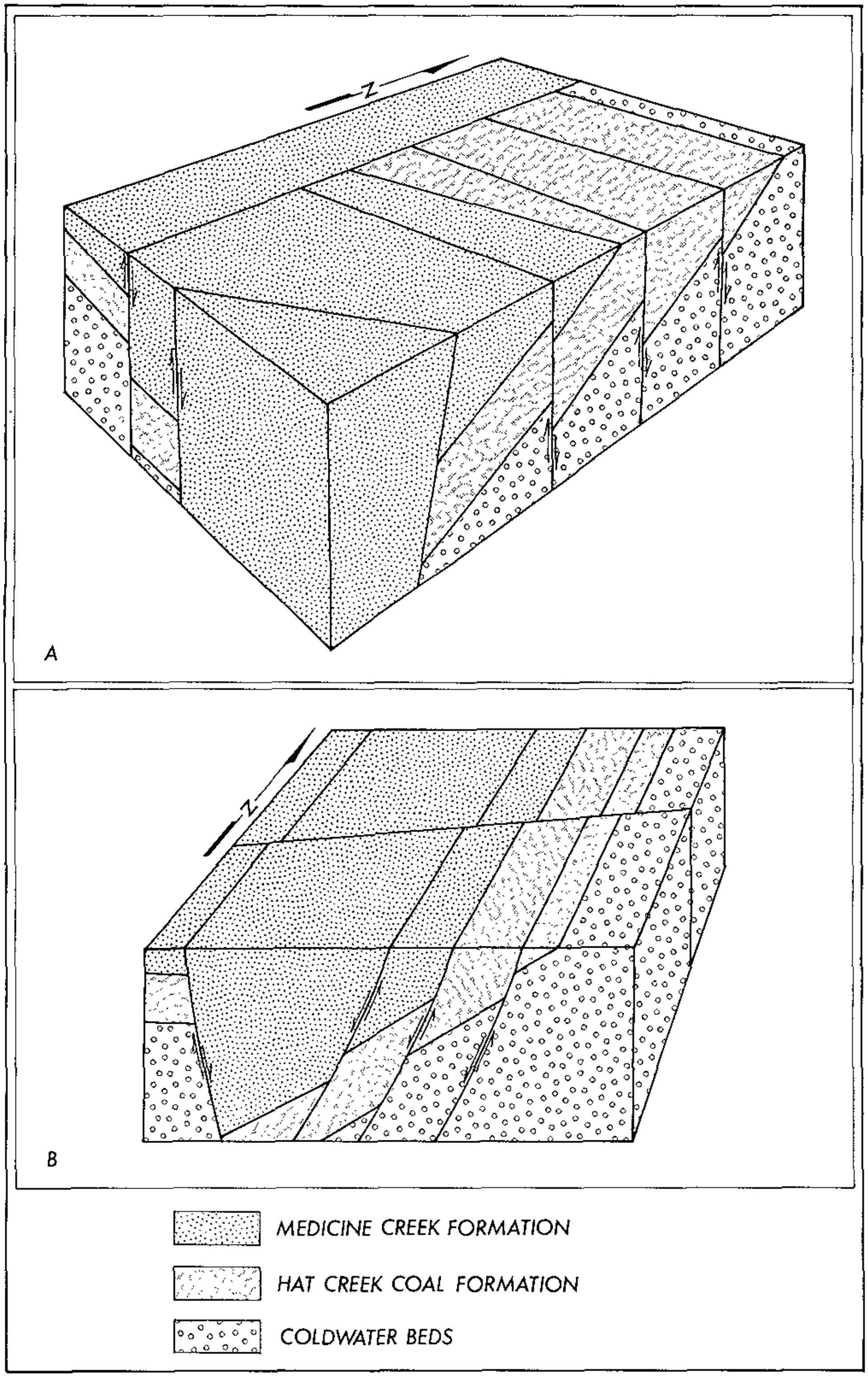

Figure G-45. A – Structural model of No. 1 Coal Reserve.
B – Structural model of No. 2 Coal Reserve.

In general, the history of the Hat Creek basin is one of downfaulting. The evidence suggests that elements of the graben structure probably prevailed from the time of the Coldwater stream deposits, to the formation of the coal measures, lake sediments, and the final period of volcanic eruption. The controlling factors in the development of the thick coal accumulations were unlike sea-level coastal conditions, and required maintenance of a high water table and a marshy environment over a long time interval. The water level in the basin was probably maintained by a spillway which, in turn, may have been controlled by the Fraser River fault system, known to have been active in the Tertiary, or possibly volcanic eruption affecting drainage.

COAL POTENTIAL: The investigation of the coal measures is difficult because of down-dip burial of the coal under younger formations and the displacement of beds by faulting. Nevertheless it is estimated that No. 1 Reserve alone consists of approximately 117 hectares of potentially extractable near-surface coal, the coal formation ranging from 150 to 300 metres thick. Calculations based on data from 21 drill holes indicates slightly more than 200 million tonnes 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.

The calculation of tonnage for No. 2 Reserve awaits further drilling 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.

Perhaps the closest analogy to the Hat Creek deposit are the Tertiary coals of the Latrobe Valley, Victoria State of Australia, described by Gloe in a series of recent papers, and the Triassic Leigh Creek coalfield of South Australia outlined by Johns (1975). These coal measures range from several hundred to 1 000 metres thick with proved accessible reserves, in the case of Latrobe, in the order of 29 000 million tonnes.

The subsurface extent of the Hat Creek coal measures can be roughly judged from the gravity contours on Figure G-41. Almost the entire central floor of the valley, an area of about 3 000 hectares, appears to be underlain at varying depth by coal. The total coal reserve is certainly of high magnitude.

A tabulation of the results of drilling at Hat Creek to July 20, 1975, accompanies this report (Table 2).

REFERENCES

Clarke, F. W. (1924): The Data of Geochemistry, *U.S.G.S.,* Bull. 77.

Dawson, G. M. (*in* Dowling, D. B.) (1915): Coalfields of British Columbia, *Geol. Surv., Canada,* Mem. 69, pp. 243-245 and 289-294.

Dolmage, Campbell and Associates (1975): The Thermal Coal Resources of British Columbia, Hat Creek No. 1 Open Pit Deposit, summary report to British Columbia Hydro and Power Authority.

.... (1975): Coal Resources of British Columbia, report to British Columbia Hydro and Power Authority, pp. 5-2 to 5-27.

Duffell, S. and McTaggart, K. C. (1952): Ashcroft Map-Area, British Columbia, *Geol. Surv., Canada,* Mem. 262, pp. 108-110.

TABLE 2. RESULTS OF DRILLING, 1974 AND 1975

Hole No.	Grid Coordinates North	East	Overburden *feet*	Total Length *feet*	Beds to Core Axis *degrees*	Remarks
74–23	79125	17425	231	1355	55	Mostly Hat Creek Coal Formation
74–24	76950	21000	212	386	15	Medicine Creek Formation
74–25	77900	19975	102	2072	90	Complete section of Hat Creek Coal Formation and some Coldwater beds
74–26	79200	21700	59	1513	30	Hat Creek Coal Formation, faulted
74–27	79000	22400	431	1501	15	Medicine Creek Formation
74–28	79000	24000	375	1469	75	Medicine Creek Formation and Coldwater Beds (?), faulted
74–29	83350	20675	283	1359	70	Medicine Creek Formation (?)
74–30	83500	19150	160	1092	?	Finney Lake beds overlying Medicine Creek Formation
74–31	83700	18000	222	664	45	Finney Lake beds
74–32	81175	16475	304	1750	45	Mostly Coldwater Beds, some Medicine Creek Formation, faulted
74–33	74400	20925	227	1370	45	Medicine Creek Formation
74–34	76500	22350	109	998	60	Medicine Creek Formation
74–35	83275	21900	395	932	55	Medicine Creek Formation
74–36	79000	25000	302	967	45	Finney Lake beds
74–37A	76950	19450	166	2186	60	Medicine Creek Formation on faulted Hat Creek Coal Formation
74–38	79925	19500	64	2085	60	Hat Creek Coal Formation
74–39	81525	19400	33	1441	45	Hat Creek Coal Formation and Coldwater beds, faulted
74–40	81500	20075	91	1318	35	Medicine Creek Formation
74–41	77950	20950	170	357	60	Hat Creek Coal Formation
74–42	72700	17100	46	532	35	Coldwater beds and Hat Creek Coal Formation (?), faulted
74–43	78950	17425	90	1526	45	Base of Hat Creek Coal Formation on Coldwater beds
74–44	76950	19450	164	2318	86	Complete section through Hat Creek Coal Formation, upper and lower contacts
74–45	73075	18075	91	1151	45	Medicine Creek Formation and Hat Creek Coal Formation, faulted
74–46	79125	17425	41	1813	50	Section through Hat Creek Coal Formation and some Medicine Creek Formation, faulted
74–47	72075	16000	53	1001	75	Finney Lake beds
74–48	74550	19100	200	1747	60	Medicine Creek Formation on Hat Creek Formation, faulted (?)

TABLE 2. RESULTS OF DRILLING, 1974 AND 1975 *(Continued)*

Hole No.	Grid Coordinates North	East	Overburden *feet*	Total Length *feet*	Beds to Core Axis *degrees*	Remarks
75-49	74500	20050	130	1277	65	Medicine Creek Formation
75–50	79950	18100	76	1002	75	Lower part of Hat Creek Coal Formation, faulted against Medicine Creek Formation
75–51	76950	18000	162	1616	50	Almost complete section of Hat Creek Coal Formation and top of Coldwater beds
75–52	74600	18150	102	1004	65	Faulted section of Hat Creek Coal Formation above Coldwater beds (?)
75–53	78050	17600	102	999	60	Lower section of Hat Creek Coal Formation above Coldwater beds (?)
75–54	65489	21266	53	1000	80	Medicine Creek Formation
75–55	64825	17750	104	1000	60	Medicine Creek Formation
75–56	34800	25700	146	590	60	Faulted Medicine Creek Formation and Hat Creek Coal Formation
75–57	24650	25900	369	1548	75	Hat Creek Coal Formation
75–58	17500	24750	161	643	20	Faulted Finney Lake beds
75–59	23800	22500	42	1488	45 – 60	Medicine Creek Formation above faulted section of Hat Creek Coal Formation
75–60	48000	22750	258	1948	65	Medicine Creek Formation above Hat Creek Coal Formation
75–61	40700	24450	161	1320	70	Medicine Creek Formation above Hat Creek Coal Formation
75–62	55250	21750	150	1678	70	Hat Creek Coal Formation
75–63	60155	23054	270	1000	45	Medicine Creek Formation
75–64	57527	22979	200	490	30	Medicine Creek Formation
75–65	56297	24335	240	790	25	Medicine Creek Formation above fault zone
75–66	55087	14655	111	135	?	Fault zone
75–67	55197	15736	78	715	?	Finney Lake beds
75–68	53350	21550	140	1843	30	Fault repetition of Hat Creek Coal Formation with Medicine Creek Formation above
75–69	55770	19738	110	1337	50	Medicine Creek Formation
75–70	51254	19788	141	1280	65	Medicine Creek Formation
75–71	55295	17911	268	1001	85	Medicine Creek Formation
75–72	29750	20100	181	886	85	Medicine Creek Formation
75–73	50850	22525	125	1940	30	*Hat Creek Coal Formation*
75–74	48025	24500	282	2232	60	Hat Creek Coal Formation with possible fault repetition
75–75	21850	26425	260	398	75	Medicine Creek Formation
75–76	21500	25500	92	1300	80	Medicine Creek Formation
75–77	59714	20655	106	1846	55	Hat Creek Coal Formation

Gloe, C. S. (1971): The Fuel and Power Resources of the West Gippsland Region, *Proc. Roy. Soc. Vict.,* Vol. 84, Pt. 1, pp. 61-70.

.... (1975): Latrobe Valley Coal-Fields, Victoria, *in* Economic Geology of Australia and Papua, New Guinea: 2 Coal, *Australasian Institute of Mining and Metallurgy,* pp. 345-352.

Gloe, C. S., et al. (1976): Brown Coal, *in* Geology of Victoria, *Geol. Soc. Australia,* Sp. Pub. No. 5, pp. 378-389.

Johns, R. K. (1975): Leigh Creek Coal-Field, Baolcunda Basin and Springfield Basin, South Australia, *in* Economic Geology of Australia and Papua, New Guinea,: 2 Coal, *Australasian Institute of Mining and Metallurgy,* pp. 301-305.

MacKay, B. R. (1926): Hat Creek Coal Deposit, Kamloops District, British Columbia, *Geol. Surv., Canada,* Sum. Rept., Pt. A, pp. 164-181.

McCullough, P. T. (1975): Memorandum on Hat Creek Exploration Program, progress report, *British Columbia Hydro and Power Authority.*

Price, N. B. and Duff, P. McL. (1969): Mineralogy and Chemistry of Tonsteins from Carboniferous sequences in Great Britain, *Sedimentology,* Vol. 13, pp. 45-69.