Geological Fieldwork

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of the geological division,
mineral resources branch

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FOREWORD

This is the third year of publication of *Geological Fieldwork,* a publication designed to acquaint the interested public with the preliminary results of fieldwork of the Geological Division as soon as possible after completion. The reports are written without the benefit of extensive laboratory or office studies. To speed publication, figures have generally been draughted by the authors. A fuller account of the work of the Division will be presented in *Geology, Exploration and Mining in British Columbia, 1976.*

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SOUTHEAST BRITISH COLUMBIA

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

By B. N. Church

Detailed geological mapping in the Greenwood area during July, September, and October was carried out over a 50-square kilometre area. The study was concentrated on the Phoenix mine and adjacent Summit area several kilometres northeast of Greenwood and on the Skomac mine to the southwest. The purpose of the study was to update regional stratigraphic and structural interpretations and to gather new data from currently accessible workings.

PHOENIX MINE

The closing of the Phoenix mine pit in October marked the end of an era in the Province's mining history. The Phoenix operation of Granby Mining Corporation was one of the oldest and most important mines in British Columbia. The original mineral discovery at Phoenix was made in 1891. Development work began in 1896 and with the completion of a spurline of the Canadian Pacific Railway in 1900, the Granby smelter at Grand Forks received ore shipments of 700 tons per day. On completion of a second rail connection in 1904, by the Great Northern Railway, shipments approached 4,500 tons per day. By 1910 the Granby smelter achieved the status of the largest non-ferrous smelter in the British Empire and the second largest in the world. Depletion of the ore reserves combined with an extended strike in the Kootenay coalfields led to the suspension of smelter and mine operations in 1919.

In 1956 there was a re-appraisal of the old mine in the light of new open-pit mining technology and production began in 1959. Excavation of the old underground workings led to the discovery of additional ore resulting in an increase in mill capacity from 900 tons per day in 1957 to 1,900 tons per day in 1964, and finally to 2,750 tons per day in 1972.

Milling at the Phoenix mine site is continuing utilizing the remainder of a stockpile of low-grade ore supplemented by a small reserve transported from the Oro Denoro mine. It is planned to continue milling ore from Granby's new Lone Star development located nearby in Washington State. A 16-kilometre-long road is presently under construction.

Mineralization at Phoenix consists essentially of irregular pockets and disseminations of chalcopyrite in a chlorite-epidote skarn. The skarn is presumably the result of

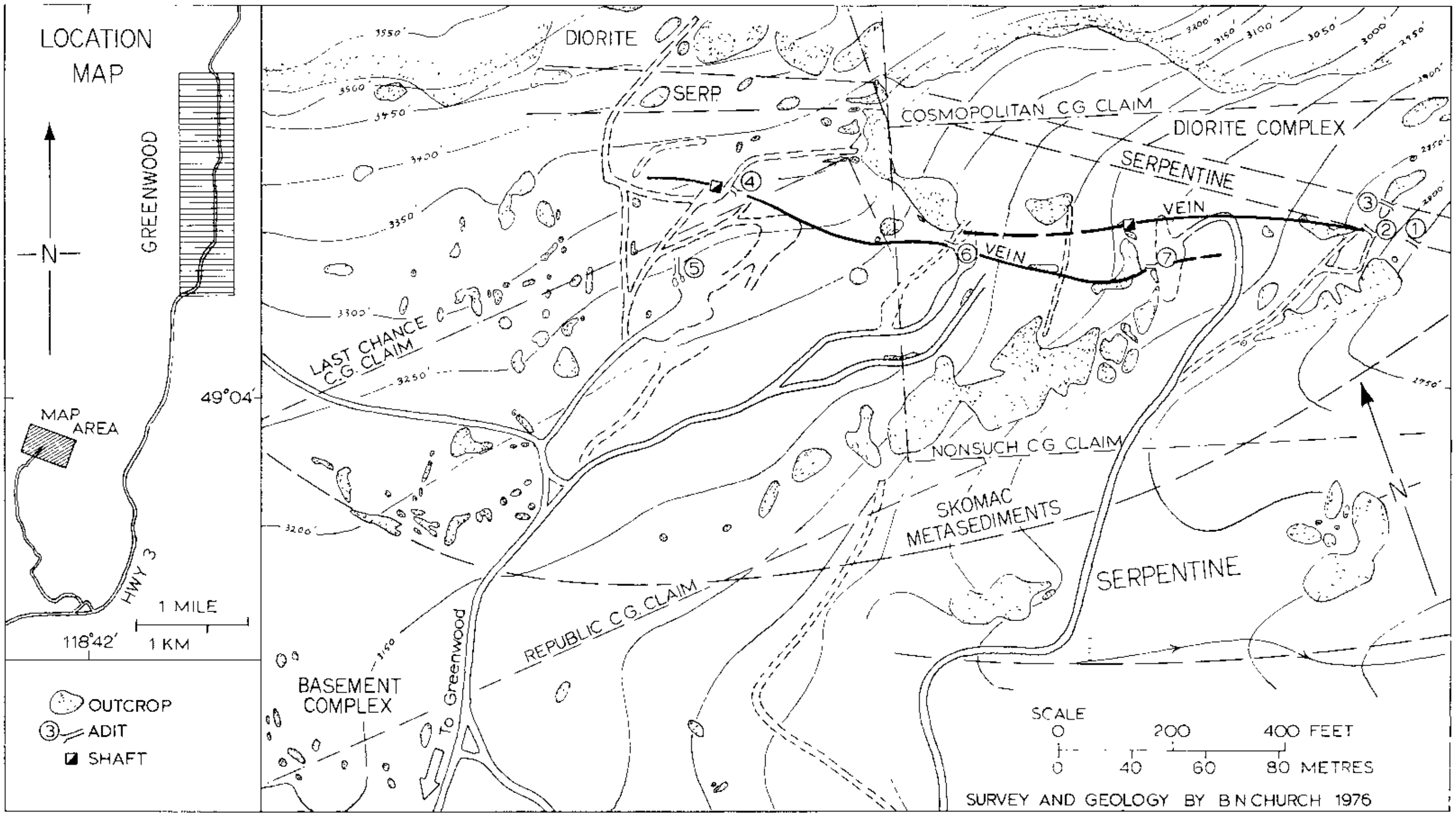

Figure 1. Geology of the Skomac Mine, Greenwood Area.

hydrothermal transformation of Triassic sharpstone conglomerate, argillite, and limestone. The main ore zone varied in thickness from about a metre to as much as 60 metres. The zone is geologically well defined, having an argillite footwall. It dips easterly under a thick wedge of Tertiary sedimentary and volcanic rocks.

Structurally, the entire Phoenix pit and the area to the north extending beyond Providence Lake is a tilted graben. In the immediate vicinity of the mine a combination of north-south and east-west-striking gravity faults mark the walls of the graben. These faults have severed the Snowshoe orebody on the east and the Monarch and War Eagle orebodies on the south from the main zone. The graben is known to be of Tertiary age and is superimposed on older faults and fold structures.

SKOMAC MINE

The Skomac mine is a recently revived small gold and silver operation located 5.5 kilometres southwest of Greenwood. The workings consist of several adits on a quartz vein system traceable on three Crown-granted claims, the Nonsuch, Republic, and Last Chance.

The first mine development began in the period 1894 to 1896 when two small adits (Nos. 1 and 2, Fig. 1) were driven on the Nonsuch claim and an inclined shaft was sunk on the Last Chance claim. The only noted production from this era, amounting to a few carloads of crude ore, was recorded by Republic Gold Mines Ltd. in 1904. Although the mine appears to have been thoroughly examined and sampled in 1922, no additional work was undertaken in the area for the next 40 years. The property was then acquired by Skomac Mines Ltd. who re-opened the old workings on the Last Chance claim. From 1962 to 1964 a total of 670 tonnes of ore grading: gold, 1.49 ppm; silver, 185.4 ppm; lead, 2.16 per cent; and zinc, 0.98 per cent, was mined from adits numbers 4 and 5 and shipped to the Trail smelter. Except for a small production by leasers in 1969, the mine remained closed for 10 years.

The current period of mining activity began in 1974 when Roberts Mines Ltd. gained control of the property. Adit number 6 on the Nonsuch claim was collared at this time. Operations during the spring and summer months of 1975 yielded a total of 434 tonnes of ore grading: gold, 4.94 ppm; silver, 694.9 ppm; lead, 3.01 per cent; and zinc, 1.94 per cent. In October 1976, number 7 adit was started to investigate the downward extension of the vein system.

The geology in the immediate vicinity of the workings is relatively straightforward. The vein system, contained mainly in black argillite, trends southeasterly subparallel to the sheared contact between Paleozoic (?) metasedimentary rocks (Skomac Formation) and a metamorphosed granodiorite-diorite intrusive complex. Numerous dykes and tongues emanating from the intrusive complex cut the metasedimentary rocks.

The age of the vein system is bracketed by concordant serpentine bodies and crosscutting pulaskite and andesite dykes. The serpentine has been injected along the contact between the Skomac argillites and older metamorphosed basement rocks, mainly quartzites and siliceous gneisses, and at the boundary of the granodiorite-diorite complex where serpentine schist is locally the host rock to the veins. Fresh andesite and pulaskite dykes, evidently feeders for nearby Tertiary lava flows, are found in several places crosscutting many of the main structures, including the veins.

For the most part the vein system dips about 55 degrees northeast, although local variations in attitude are common and dips as low as 35 degrees have been recorded. While major fault dislocations are not common, movement on minor fractures trending subparallel to the crosscutting Tertiary dykes has resulted in a number of sinistral offsets on the veins of 1.5 to 4.5 metres. Also, reactivation of larger shears trending subparallel to the vein system has resulted in significant dextral strike slip movement offsetting some of the Tertiary dykes.

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URANIUM RECONNAISSANCE PROGRAM
(82E, 82L, and 82M)

By P. A. Christopher

A federal-provincial geochemical reconnaissance program for uranium was initiated in 1976. This program involved stream and water sampling at a sample interval of approximately one sample per 5 square miles (12.5 square kilometres) in south-central British Columbia. Map areas 82E, 82L, and most of 82M were covered between mid June and mid September by a crew of 13 people under the direction of S. B. Ballantyne, Geological Survey of Canada, Ottawa, and T. Kalnins, British Columbia Department of Mines and Petroleum Resources. Silt and water samples were collected at approximately 3 600 sites. Water samples are being analysed for uranium, fluorine, and pH, and silt samples are being analysed for uranium by neutron activation at the Atomic Energy laboratory in Ottawa, and for copper, lead, zinc, silver, molybdenum, manganese, and cobalt. Analytical results should be available prior to the 1977 field season.

In conjunction with this program, brief examinations of uranium occurrences were carried out in order to evaluate their geological environments. Company exploration in the study area was directed mainly to basal type uranium deposits in unconsolidated sediments below Pliocene (K-Ar whole rock 4.7±0.2 m.y.) and Miocene (?) plateau basalts. The Lassie Lake – Cup Lake, Kallis Creek, Pearson Creek, Hydraulic Lake, Carrott Mountain, and Vidler Creek prospects were examined to evaluate this type of occurrence.

URANIUM MINERALIZATION IN THE HYDRAULIC LAKE AREA
(82E/11E, 14E)

By P. A. Christopher

Examinations of basal-type uranium prospects in the Hydraulic Lake area were conducted to establish favourable settings for uranium deposition. Figure 2 shows the general geological settings of known deposits in the Hydraulic Lake area. Uranium mineralization occurs in unconsolidated fluvial sediments that are capped by an impermeable horizon, usually Pliocene or Miocene (?) plateau basalts. The mineralized area northwest of Hydraulic Lake is partly capped by basalt and partly by clay-rich horizons of low permeability within the sedimentary sequence. The uranium-bearing fluvial sediments in the area unconformably overlie metamorphic rocks (Monashee Group), Early Tertiary sedimentary and volcanic rocks (Kettle River Formation), and Nelson, Valhalla, and

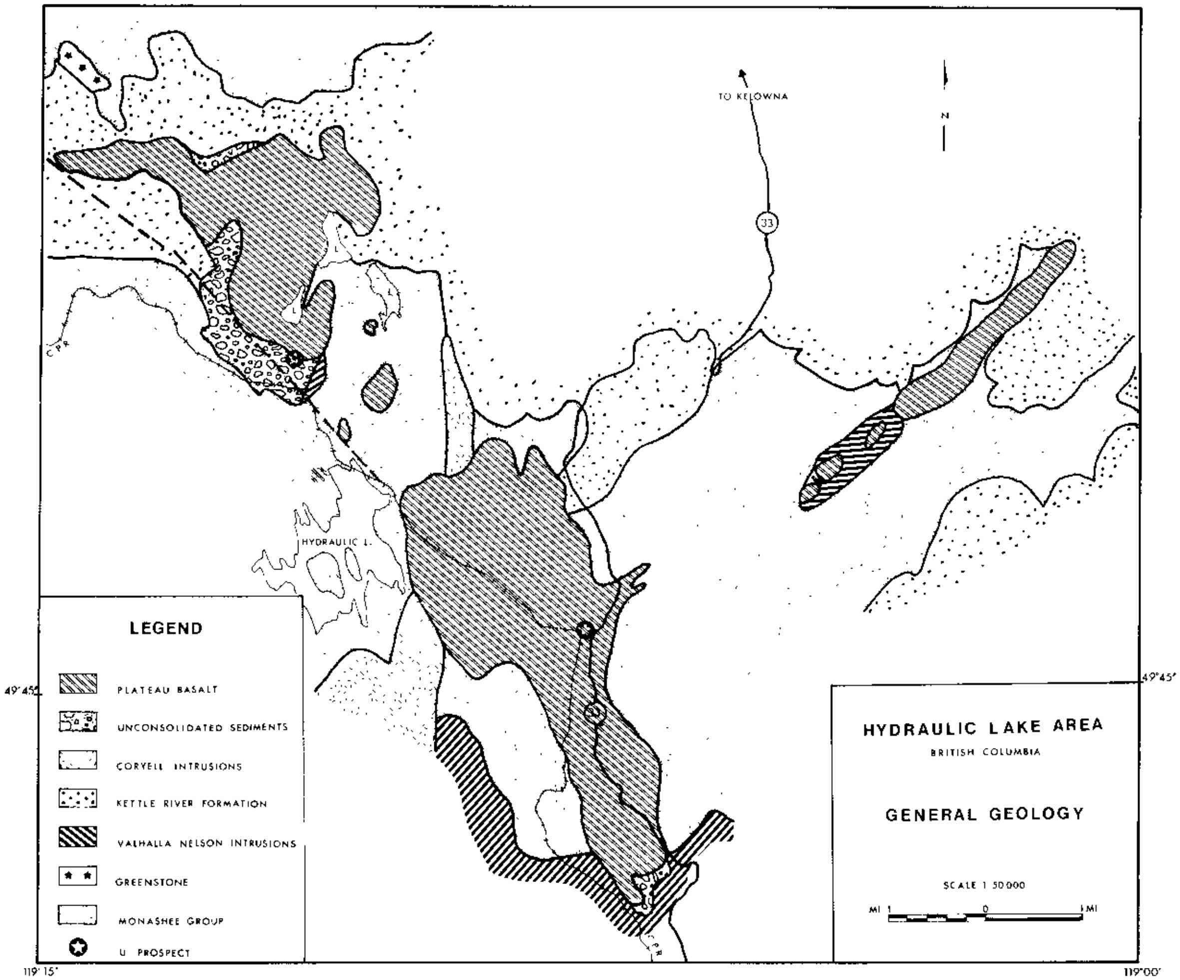

Figure 2. General geological setting of uranium deposits in the Hydraulic Lake area (modified from company reports).

Coryell intrusive rocks. Strong faults occur in the area of the mineral deposits but their relationship to the mineralization has not been determined.

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. Meta-autunite is the only uranium mineral that has been identified. Authigenic iron sulphide is common in the unconsolidated sediments and northwest of Hydraulic Lake massive iron sulphide cements uraniferous gravels just above the unconformity with basement rocks.

Figure 3 is an idealized section of basal-type uranium deposits in south-central British Columbia. Uranium mineralization occurs in groundwater traps at several horizons within the basal sediments below an impermeable capping commonly at or near an unconformity. The base of the Early Tertiary Marron and Kettle River Formations has been checked in several locations but no deposit similar to the Northwest Uranium deposit in Washington State has been found.

The following features should be considered when prospecting for basal-type uranium deposits in British Columbia:

(1) Plateau basalts provide an easily recognizable cap which may have sealed a favourable porous horizon, but impermeable sediments can also act as caps for a groundwater trap (for example, Hydraulic Lake).

(2) High background granitic rocks (for example, Coryell intrusions) are the preferred basement rocks.

(3) Organic material can stimulate reducing conditions necessary for deposition of uranium.

(4) Deposits are often associated with faults or fracture zones.

(5) Channel deposits are more likely to occur than large blanket deposits.

(6) Surface expressions of uranium are weak because of the impermeable caps. Groundwater seepage testing appears to be the best prospecting tool.

(7) In Washington State the Northwest Uranium and Big Smoke deposits are basal-type deposits in carbonaceous sediments of the mid Tertiary (Oligocene) Gerome Formation. A similar setting may occur within Eocene volcanic and sedimentary rocks in British Columbia.

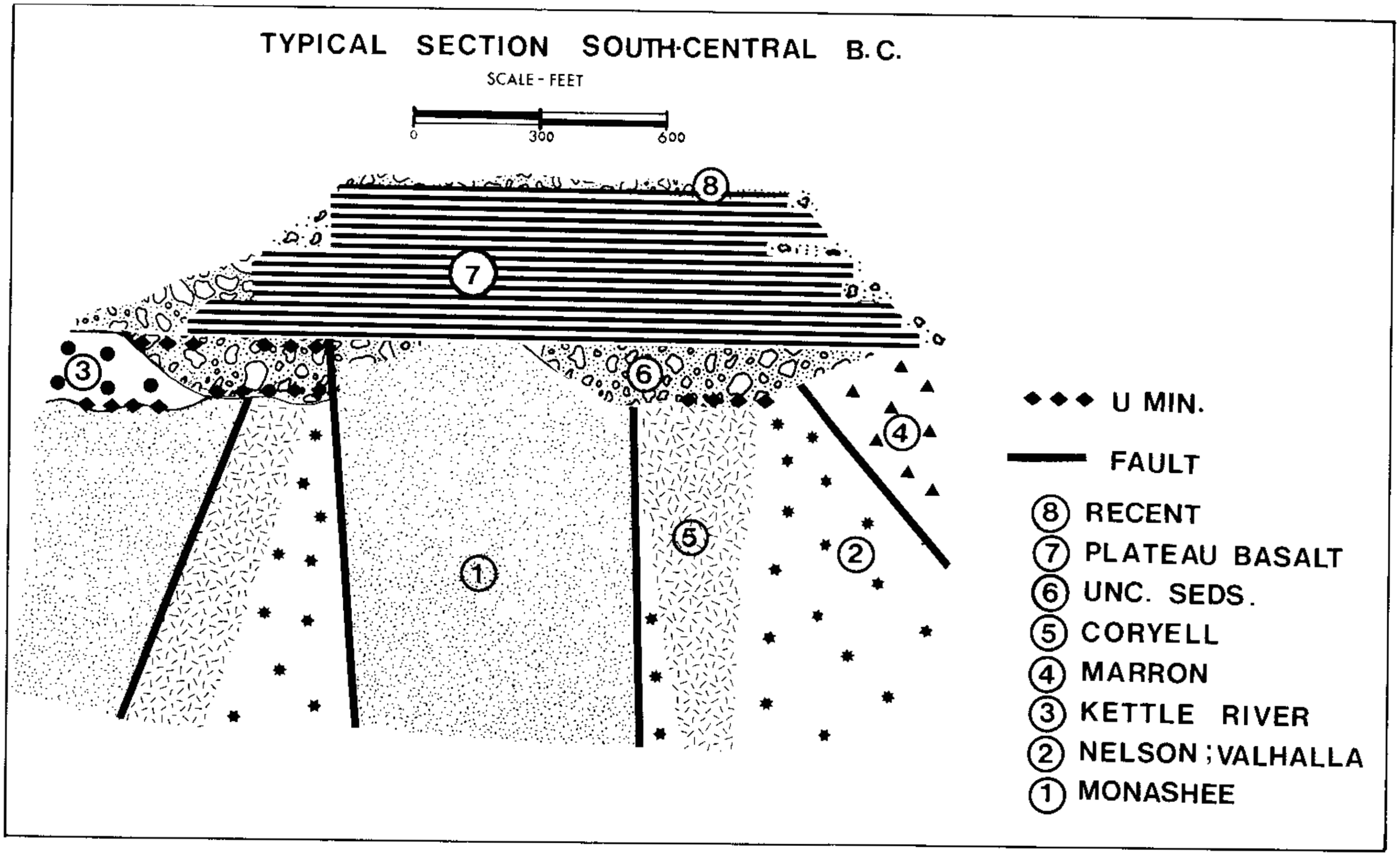

Figure 3. Typical section showing the setting of basal type uranium deposits in south-central British Columbia.

BEAVERDELL AREA
(82E/6E)

By P. A. Christopher

Approximately six weeks during the 1976 field season were spent revising and extending geological mapping in the Beaverdell area. Work was mainly concentrated in the Tuzo Creek – Eugene Creek valleys. Previous interpretation of the quartz monzonite porphyry along Tuzo Creek as a stock (Geological Fieldwork, 1975) appears to be incorrect. A series of shallow-dipping sheeted dykes would best explain the sequence of alternating Nelson granodiorite and quartz monzonite porphyry. This environment contains minor *copper, molybdenum, gold, lead, zinc, and silver mineralization in narrow (1 metre)* pyrite and magnetite-rich zones at dyke contacts and in rare quartz-carbonate veins.

As part of a study of the age and nature of mineralization in the Beaverdell area, K-Ar whole rock ages were obtained for a Wellington-type dyke (60.4±2.2 m.y.) and for an Idaho-type dyke (49.4±1.5 m.y.).

A preliminary map of the Beaverdell area will be compiled from fieldwork completed during parts of the 1975 and 1976 field seasons.

ESTELLA – KOOTENAY KING AREAS
(82G/12E)

By Trygve Höy

A study of the structure, stratigraphy, and lead-zinc mineralization of Purcell rocks in the Wasa area was initiated during the 1976 field season. Approximately 140 square kilometres of mountainous terrain, bounded by the Wild Horse River to the south and the east, Lewis Creek to the north, and the Kootenay River to the west, was mapped at a scale of 1:25 000. This mapping, intended for release as a preliminary map, includes the Estella and Kootenay King deposits.

The study is the first phase of a project designed to determine the structural and stratigraphic controls of lead-zinc mineralization in the Aldridge Formation in southeastern British Columbia. Initially, the project will involve mapping of Purcell rocks east of the Rocky Mountain Trench. The study will emphasize detailed stratigraphic correlations in an attempt to determine the depositional environment and facies changes of the Aldridge Formation which are perhaps related to syn-depositional faulting.

The results of the 1976 field mapping are summarized below:

(1) Argillite, siltstone, and quartzite of the lower Aldridge Formation conformably overlie coarser grained quartzites and siltstones of the Fort Steel Formation.

(2) The Aldridge is largely composed of distal turbidites, thinly laminated argillites and siltstones, cross-laminated siltstone, and massive to laminated argillite and marl, divisions B, C, D, and E of the Bouma turbidite facies model (Walker, 1976). Graded quartzite layers, unit A of the Bouma model, are also fairly common.

(3) Current directions, determined from cross-laminations in the argillite layers, and a general thinning of quartzite layers to the north indicate a northerly to westerly sediment transport direction.

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STRATIGRAPHY AND STRUCTURE SOUTH OF GOLDSTREAM RIVER, SELKIRK MOUNTAINS (82M/8, 9)

By Richard L. Brown*, Trygve Höy†, and Larry Lane*

INTRODUCTION

The area described in this report is now receiving considerable attention due to the discovery in 1975 of Noranda's massive sulphide deposit just south of Goldstream River. A number of other less significant but important massive sulphide deposits as well as a number of lead-zinc occurrences have been known and explored in this area since the early 1900's. This preliminary report, based on fieldwork by the authors in July through September, focuses attention on the regional stratigraphy and structure. A preliminary map of the area is in progress and one of us (Larry Lane) will be completing an M.Sc. structural-stratigraphic thesis on the area in 1977.

Access to the western part of the area is provided by the Big Bend Highway which follows the east bank of the Columbia River north from Revelstoke. Well-maintained gravel roads extend east from the highway for limited distances along the south banks of Goldstream River and Downie Creek. The nearest permanent helicopter bases are at Mica, 40 kilometres to the north, and Revelstoke, 50 kilometres to the south.

The area is generally very rugged and exploration is difficult. Valleys are till filled, rock exposures are rare, and thick underbrush hampers traversing. Above tree-line, at 1 800 to 1 950 metre elevation, exposures are abundant, although precipitous cliffs and snow and glacier cover again hamper exploration and mapping.

STRATIGRAPHY

Strata above the Horsethief Creek Group are subdivided into a lower dominantly psammitic unit, a variable metavolcanic/clastic unit, and a dominantly calcareous and pelitic unit.

Horsethief Creek Group in this area is characterized by pelitic schists which grade laterally into black graphitic schist, white calcitic marble, thin bands of brown-weathering quartz feldspathic grit, and minor rusty weathering pelitic marbles. These rocks are considered to belong to the upper Horsethief Creek Group due to their close similarity to the upper pelitic member of the Horsethief Creek Group which underlies Lower Cambrian Hamill Group to the east.

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The psammitic unit overlying the Horsethief Creek Group is primarily a quartz-muscovite-chlorite sandstone interlayered with pelitic schist, black graphitic schist and quartzite, quartz feldspar grits with occasionally visible graded bedding, and minor well-layered dolomitic marble. The psammitic unit is interdigitated with, and locally occurs as large lenses within, the metavolcanic unit. This interlayering appears to be of primary origin, but has undoubtedly been augmented by deformation.

The metavolcanic unit consists of massive hornblende-feldspar-chlorite rock, and chloritic schist. Coarser grained equivalents may be of hypabyssal origin or are cores of thick flows. Relict primary textures occur in some of the less recrystallized specimens, and deformed pillows are preserved locally. The unit thickens and thins rapidly along strike, and is best envisaged as a series of lenses rather than one continuous stratigraphic horizon. Within the metavolcanic unit are thinly layered impure clastics with thin bands of carbonate. The clastic rocks include muscovite-chlorite-graphite schist, thinly laminated green quartzite with chlorite partings, and chlorite schist. The carbonates consist of thin grey calcitic marble interlayered with brown-weathering dolomite with phlogopite (?) or graphite partings. These metasedimentary rocks have variable thicknesses and exhibit considerable lateral variation, especially with respect to the presence of graphite and carbonate, as would be expected in an area of submarine volcanism where locally derived and transported sediments are deposited amongst flows.

Also associated with the metavolcanic rocks are brown-weathering talc-serpentine-dolomite ultramafic rocks. They are found primarily in fold closures, but one 10 to 20-metre-thick band occurs continuously for at least 2 kilometres (stratigraphically) above the massive metavolcanic unit that hosts the sulphide mineralization at Standard Peak. These ultramafic rocks may be related to one or two specific adjacent metavolcanic horizons which extend through both Standard and Keystone ridges.

Massive sulphides occur as pyrite, pyrrhotite, chalcopyrite, and sphalerite layers within metavolcanic rocks (Standard) or in metasedimentary rocks adjacent to them (Goldstream, Montgomery ?). They are often associated with very siliceous sedimentary rocks (chert ?), chlorite-phyllite (basic tuffs ?), and dark carbonaceous, calcareous phyllite (marls or calcareous shales ?).

The uppermost unit is dominantly calcareous, and is exposed only in the cores of the antiforms. It consists of interlayered grey banded calcitic marble, rusty weathering impure marble with pelitic interbeds, and massive structureless dolomitic marble. Also included in this unit is a black pyritic, calcareous graphitic schist. The marble unit has been thickened considerably in the core of the Keystone structure, and it forms a huge pod which comprises Keystone Peak.

STRUCTURE

The structure which dominates the map-area is a large, generally northeast-plunging antiformal syncline whose axial surface varies from very steeply dipping toward the east in the Downie Peak area, to recumbent in the Keystone area and moderate toward the east in the vicinity of Standard Peak where it appears to be dying out (*see* Fig. 4 for location of axial surface trace and Fig. 5 for cross-section). In the Standard Peak area the antiform is paired with a synform; this couplet forms a northeast-plunging S fold with a wavelength of approximately 1 kilometre.

Throughout the terrain of Figure 4, Phase II folds have been superimposed on previously inverted stratigraphy, and Phase I minor fabrics have been deformed by the later deformation. These relationships which continue northward across the Goldstream River imply the existence of a Phase I nappe with an inverted limb of at least 25 kilometres (compare Van der Leeden, 1976).

METAMORPHISM AND PLUTONIC ACTIVITY

Pelitic rocks are generally chlorite-muscovite bearing and the metavolcanic rocks form chlorite schist at their borders. Regional metamorphism within the map-area does not appear to exceed greenschist grade, but hornblende and biotite are developed, in metavolcanics and pelites respectively, adjacent to granitic plutons. The largest granitic pluton outcrops south of the Goldstream River and its margins are deformed by Phase II structures. Later intrusives which truncate Phase II fabrics are generally porphyritic granites, while the older intrusion is a quartz monzonite.

STRATIGRAPHIC CORRELATION

The psammitic and metavolcanic package stratigraphically overlies rocks which on the basis of lithologic similarity have been tentatively assigned to the Proterozoic Horsethief Creek Group (Figs. 4 and 5), and as such may be correlated with Lower Cambrian Hamill Group. If this correlation is correct, it implies a northwestward shaling out of cross-bedded sandstones which to the southeast typify this group (compare Wheeler, 1965).

The possibility that the metavolcanic and associated rocks are part of the Lardeau Group as originally proposed by Wheeler (1965) cannot be ruled out, but this would require extensive tectonic disruption of stratigraphy.

ACKNOWLEDGMENTS

We would like to acknowledge the co-operation of a number of geologists working in the Goldstream area this past summer. In particular, discussions with Noranda's geologists, Gordon Gibson, Brian Hughes, and Laurie Reinertson, were most helpful.

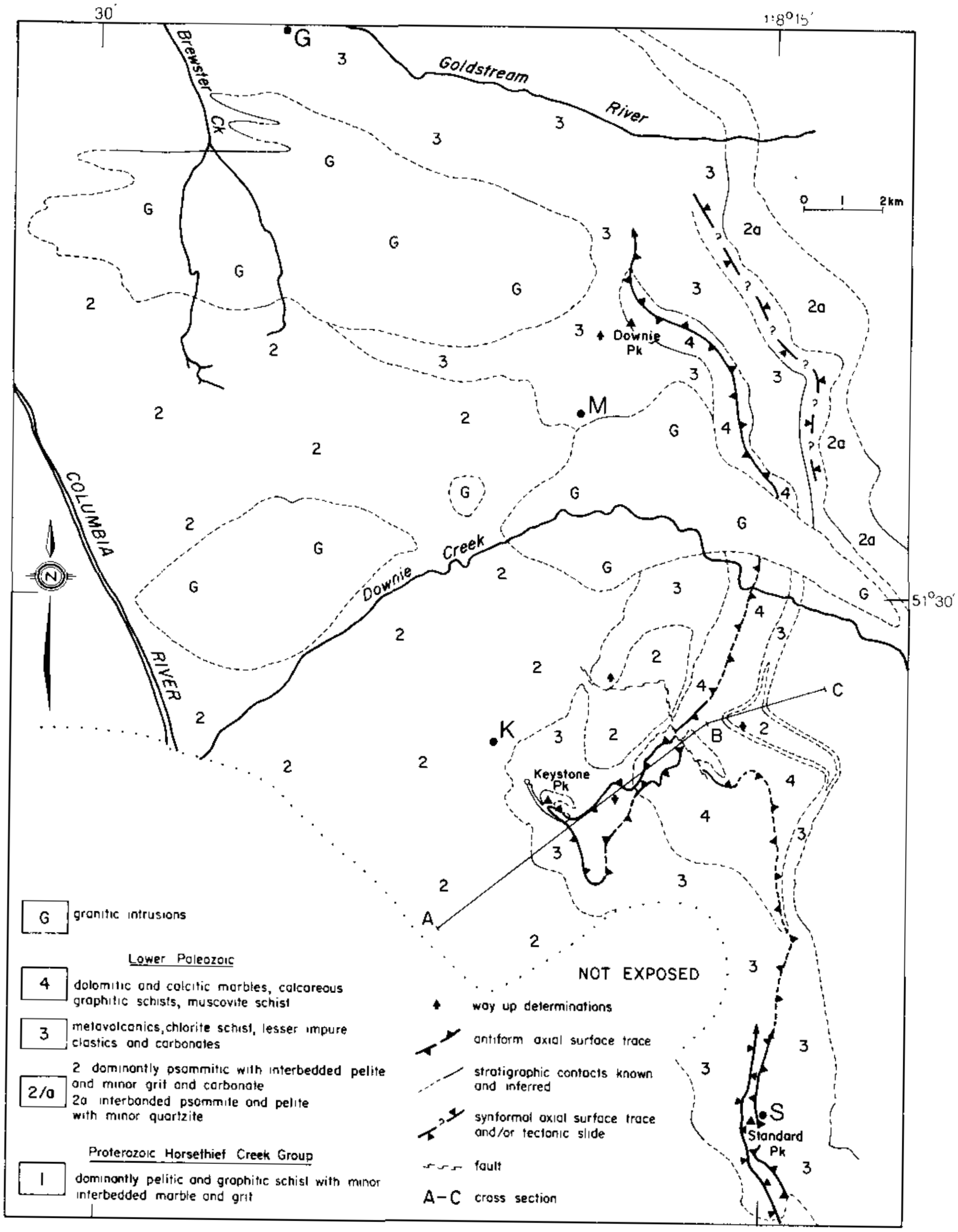

Figure 4. Regional geology of the area south of Goldstream River. Dots locate the mineral deposits referred to in text: G – Goldstream; M – Montgomery; K – Keystone; S – Standard.

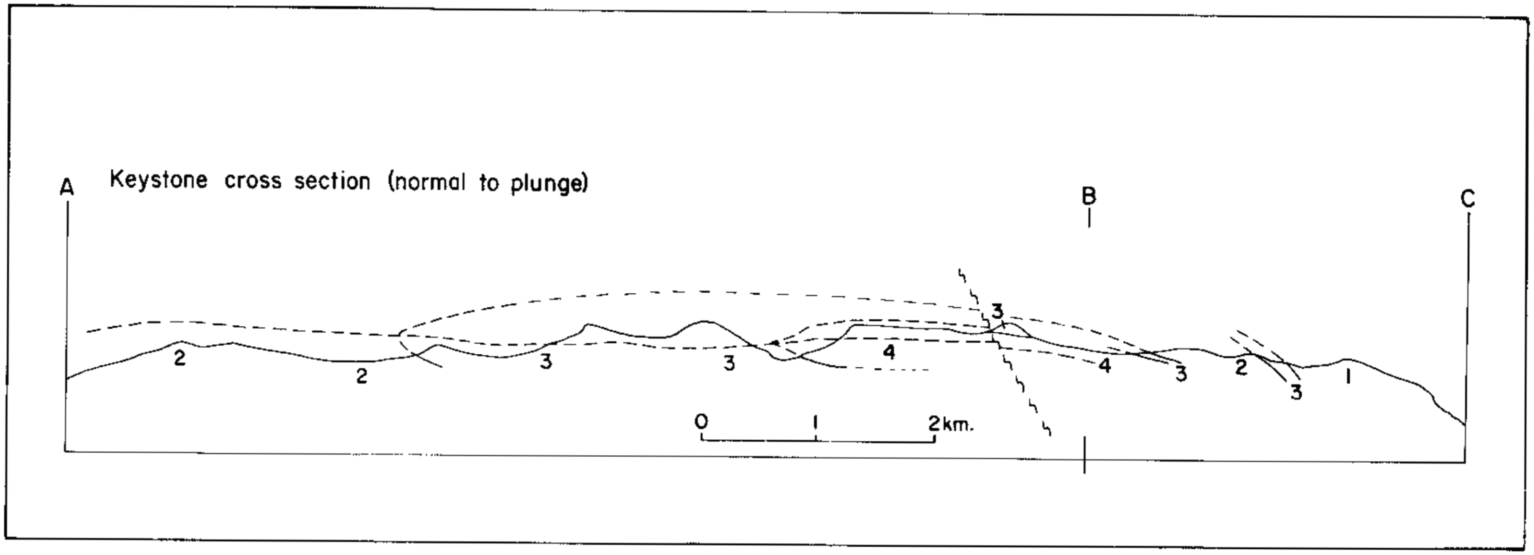

Figure 5. Cross-section through the Keystone area. For location and identification of units, refer to Figure 4.

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GOLDSTREAM MASSIVE SULPHIDE DEPOSIT
(82M/9W)

By Trygve Höy

INTRODUCTION

The Goldstream deposit is a stratiform massive sulphide deposit located in the Selkirk Mountains of southeastern British Columbia. Mineral claims were located in 1973 by Gordon and Bruce Bried and Frank E. King. Development work by these prospectors included trenching and drilling of 22 X-ray holes. Noranda Exploration Company, Limited optioned the property in December 1974 and in 1975 drilled 50 holes outlining a deposit with announced reserves of approximately 3.175 million metric tons grading 4.49 per cent copper, 3.124 per cent zinc, and 0.68 ounces silver per ton. Work during 1976 included approximately 1 200 metres of underground development and 3 500 metres of underground drilling.

The property is located 70 kilometres north of Revelstoke, on the south side of Goldstream River. It is accessible from the Big Bend Highway by a dirt road that follows the southern tributary of Goldstream River crossing Brewster Creek just west of the exploration camp.

The deposit is in an area of relatively deep glacial till overburden. The only exposures are restricted to a number of weathered pits where the south end of the deposit subcrops.

GEOLOGY

The Goldstream deposit occurs as a massive sulphide layer in metasedimentary rocks of probable Lower Cambrian age. These rocks strike east-west and dip approximately 30 degrees north. The sulphide layer averages 3 to 5 metres in thickness, has a strike length of at least 500 metres, and a trend length of at least 1 200 metres (Fig. 6). Only its western and truncated southern boundaries are defined. Its northern boundary is open, although at 30 000 N is approximately 350 metres below Goldstream River. Its eastern boundary is only restricted by the one barren hole (at 25 + 62 N, 59 + 04 E) approximately 300 metres east of the last known sulphide mineralization. Hence the eastern boundary, as shown on Figure 6, will doubtless be modified by further work.

Rock Units

The north-south section (Fig. 7) illustrates the sequence of metasedimentary rocks above and below the sulphide layer. The structurally highest rocks are described first. It is not known for certain whether or not these are the oldest or youngest rocks in the succession but, as described later, they are probably stratigraphic footwall rocks, that is, the succession may be overturned in the immediate vicinity of the deposit.

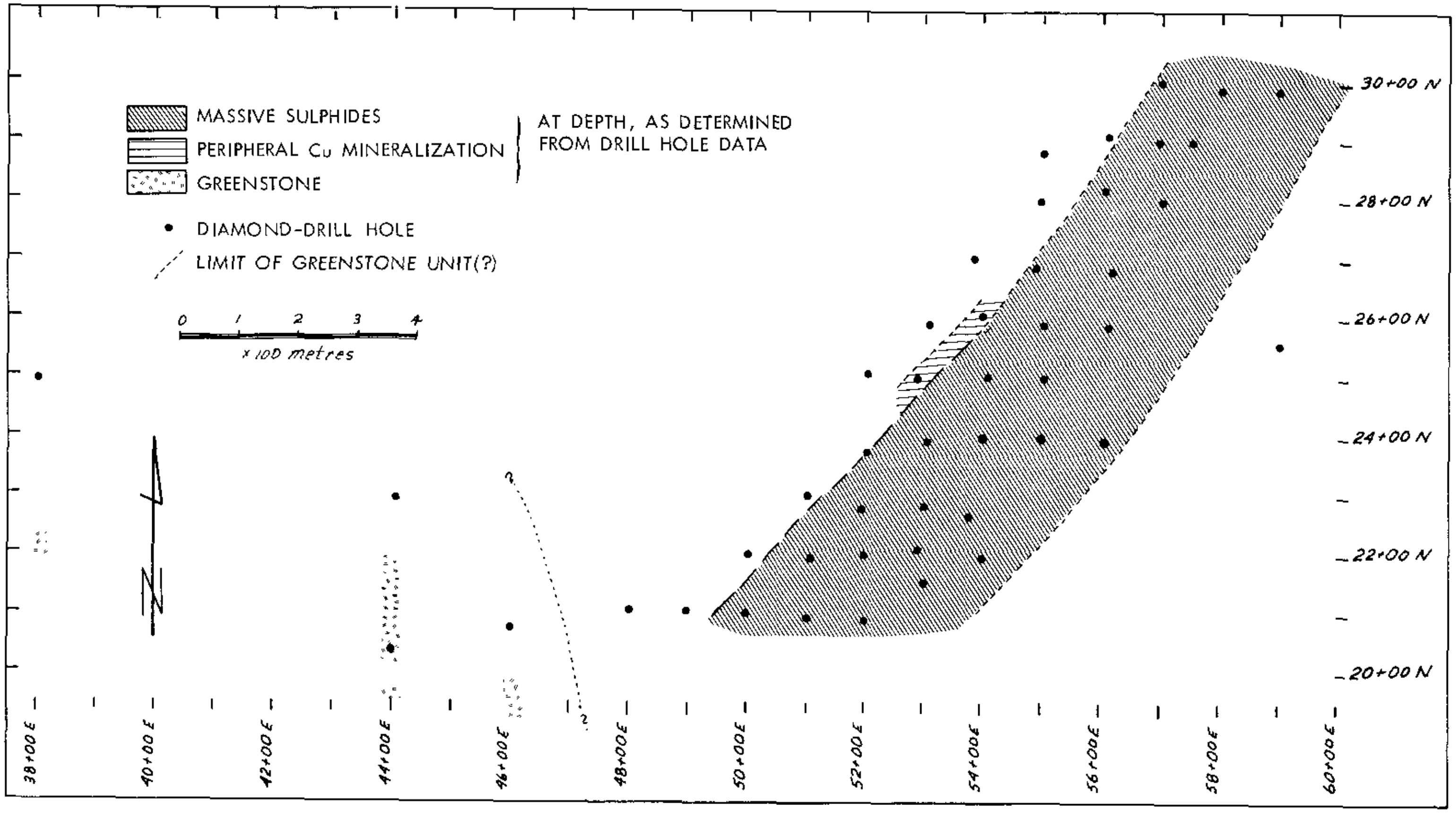

Figure 6. Plan view of Goldstream, showing drill-hole locations, outline of deposit, and greenstone drill intersections.

The structurally highest rocks, unit 1 (not shown on Fig. 7), are only intersected in the top part of the drill holes north of 28 + 00 N. They include approximately 30 metres of siliceous sericite-chlorite-biotite phyllite and phyllitic quartzite, underlain by 15 metres of dark grey calcareous graphitic phyllite, a 3-metre layer of grey-green siliceous chlorite-phyllite, and 10 metres of biotite and chlorite-phyllite that contains thin calcareous and limy layers.

Unit 2 includes approximately 220 metres of dark carbonaceous phyllite interlayered with thin grey limestone layers. Calcite and biotite are common within this unit, and pyrrhotite is ubiquitous. Quartz and carbonate augens and the abundant limy partings give this rock a distinctive layered appearance.

The 'garnet zone,' unit 3, coincides with a pronounced fault zone. It is generally medium to dark green in colour and contains abundant spessartine garnets. In part, it consists of dark banded 'cherty' layers, medium green chlorite-phyllite layers, and dark greasy lustered talc (?)-chlorite-graphite layers. Pyrrhotite may be very abundant, concentrated in layers or in discontinuous streaks.

The garnet zone is sheared and broken, and cut by numerous quartz-carbonate veins. The garnets pre-date this deformation and probably an earlier deformation which produced the prominent mineral foliation in the metasedimentary rocks. This early foliation is bent and warped around the garnet porphyroblasts.

The garnet-rich layer is a metamorphosed manganiferous iron-rich cherty horizon. It is areally restricted, dying out to the west away from the massive sulphide layer (Fig. 8).

The massive sulphide layer is enclosed within light green to brown, very siliceous chlorite and sericite-phyllite (unit 4). These grade to fine-grained quartzites. A grey limestone layer, 1 to 2 metres thick, occurs within unit 4 above the sulphide layer. Pyrrhotite, chalcopyrite, and minor sphalerite, generally uncommon within the unit, increase substantially just above the sulphide layer. Here they occur as fine disseminations, discontinuous blebs, and as layer-parallel streaks. Below the massive sulphide layer, sulphides are less common occurring primarily as discontinuous layers in a dark-layered siliceous rock.

A light grey banded limestone (unit 6), averaging 10 to 20 metres in thickness, occurs below the phyllites of unit 4. The limestone is underlain by siliceous sericite-biotite-chlorite phyllite, schist, minor quartzite, and limestone of unit 7.

The massive sulphide layer (unit 5) averages from 2 to 5 metres in thickness. It consists of pyrrhotite and chalcopyrite with varying amounts of sphalerite. Galena, although uncommon and not identified in core, was observed in a number of specimens from the adit dump. Rounded clear quartz fragments, darker 'chert' fragments, and dark chlorite-phyllite fragments are common within the massive sulphide layer. The sulphides

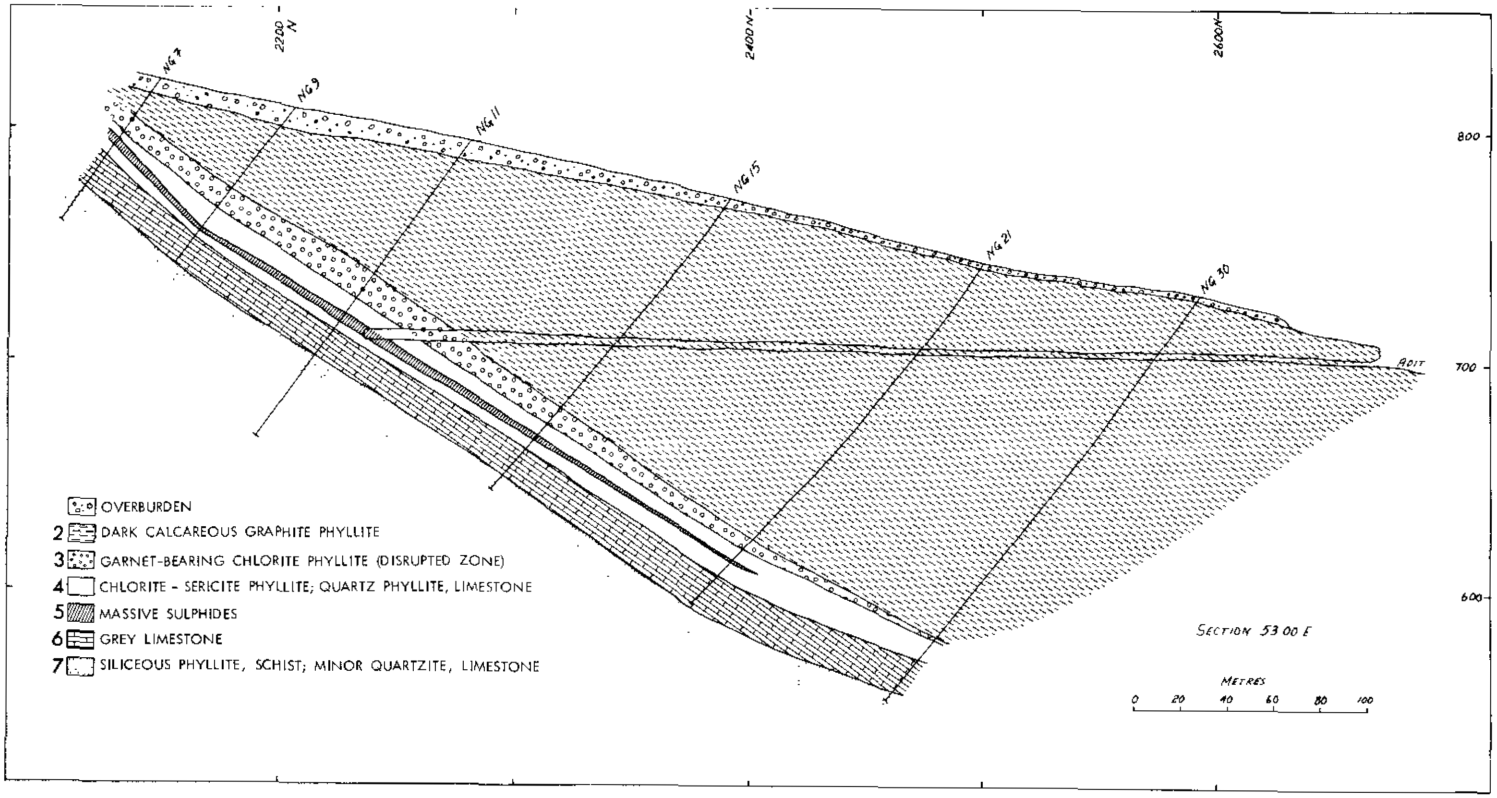

Figure 7. North-south vertical section (53 + 00 E) through Goldstream deposit.

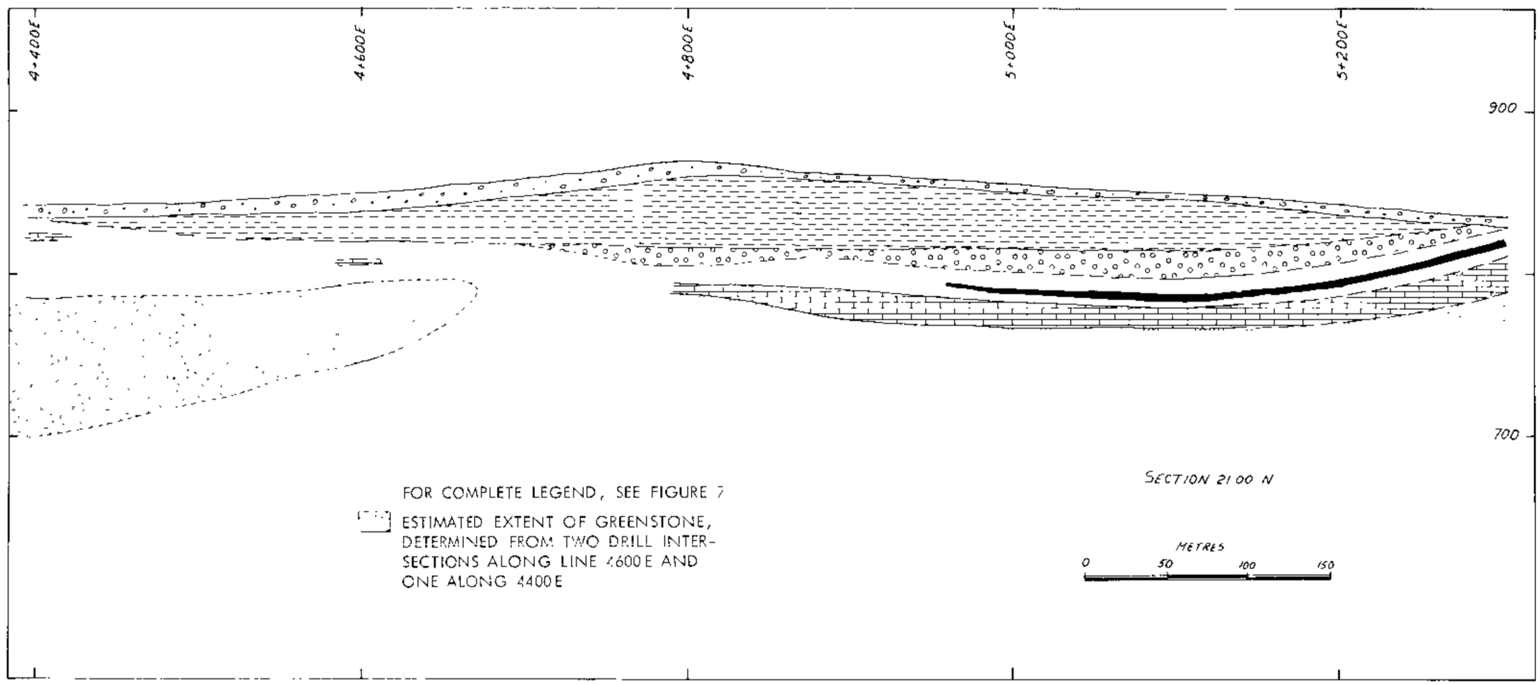

Figure 8. East-west vertical section (21 + 00 N) through Goldstream deposit.

are commonly sheared and mylonitized, particuarly toward the boundaries of the sulphide layer, and are generally coarser grained and massive toward the centre. Layering, defined by alternations of the various sulphides, is not present (or at best, very rare). In general, the lower contact is very sharp whereas the upper contact **may** be more gradational over a few feet with the disseminated sulphides in the overlying phyllitic quartzite. There is not a consistent variation in the Zn/Zn + Cu ratio within the sulphide layer or in the immediate country rock; Zn appears to be higher when the gangue is more calcareous.

CONCLUSIONS

A number of features within the massive sulphide layer and in the immediately surrounding country rocks suggest that the deposit and host rocks may be inverted. These features include the sharp lower contact as opposed to the generally more gradational upper contact, the more common disseminated nature of sulphides in the structural hangingwall contrasted with their layered nature in the footwall, and the relatively higher abundance of sulphides in the structural hangingwall metasediments (including the garnet zone). As well, the 'greasy' lustered dark talc(?)-chlorite alteration, common in units above the sulphide layer (particularly in the garnet zone), is more typical of altered footwall sediments in other massive sulphide deposits. An attempt to recognize an alteration 'pipe' may be futile due to the intense regional deformation in the Goldstream area. An alteration pipe, if it existed in the deposit, may be so attenuated as to no longer be recognized.

Consideration of regional structures in the Goldstream area (*see* preceding paper on regional geology) also suggests that the sequence of rocks in the immediate vicinity of the deposit may be inverted. At Downie Peak, 10 kilometres to the southeast, graded grit beds indicate that rocks young toward the core of the 'Downie Peak' antiform. The axial trace of this antiform swings east-west just northwest of Downie Peak and is probably located south of the deposit in the Goldstream area.

The Goldstream deposit is one of a number of massive sulphide deposits south of Goldstream River. 'Standard,' drilled by Noranda in August and September, and 'Montgomery,' on a steep southern slope of Downie Peak, are massive sulphide deposits both traceable for more than a kilometre along strike. Standard is within a thick greenstone unit, Montgomery is in 'siliceous, vitreous rocks which probably varied originally from quartzite to calcareous sediments' (Gunning, 1928A, p. 160A).

These deposits compare favourably with the 'bedded cupriferous iron sulphide' or 'Besshi' type deposits in Japan (Kanehira and Tatsumi, 1970). They are both bed-like or lenticular in form, are composed primarily of massive compact pyrite - (pyrrhotite at Goldstream) chalcopyrite ore, and occur in geosynclinal crystalline schists associated with submarine basic volcanism. In contrast, some of the typical features of Kuroko deposits are absent: the association with acid volcanism, the common metal and ore-type zoning, and the association with sulphates (barite, gypsum, and anhydrite).

ACKNOWLEDGMENTS

I wish to acknowledge the co-operation of Noranda Mines, Limited and their subsidiary, Mining Corporation of Canada (1964) Limited. Discussions with a number of geologists including W. Nelson and L. Reinertson of Noranda and D. F. Sangster of the Geological Survey of Canada, were most helpful.

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SOUTHWEST BRITISH COLUMBIA

VANCOUVER ISLAND

By G.E.P. Eastwood

UPPER RENFREW CREEK AREA (92C/9W)

The area is underlain by an intrusive complex, containing remnants of andesite and limestone which have been disrupted and engulfed by multiple intrusive activity. The two largest bodies of limestone may be roof pendants. Mafic diorite has been shattered and intricately intruded by felsic diorite. In the northwest part of the area the largest limestone body is truncated by a quartz monzonite intrusion. This intrusion was not seen in contact with the diorites, and its relative age is unknown. The limestone is intruded by numerous andesite dykes, which are older than the diorites, and by a swarm of felsite dykes in the north part of the area, which may be younger than the diorites.

The largest limestone body appears to have been contained in a syncline prior to intrusion, but any other large folds have been destroyed. This body is offset 300 metres to the left on a northeast-striking post-diorite fault. Numerous shear and gouge zones are exposed in road cuts, and some show offsets of a metre or two.

Eleven magnetite and sulphide zones have been previously described. Some are at or near limestone contacts, but others exhibit no apparent control. The No. 8 zone was planetabled: it consists of small bodies of magnetite and some attendant skarn scattered over 0.2 hectare of intrusive complex. The ridge previously thought to be a landslide appeared more solid after some of the overburden had been eroded by winter rains, and the magnetite bodies may in fact be in bedrock.

References: *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1974, p. 73; 1975, pp. 33, 34; *B.C. Dept. of Mines & Pet. Res.,* GEM, 1974, pp. 167-170; *B.C. Dept. of Mines & Pet. Res.,* Geology in British Columbia, 1975, in press.

SR (WET) (92C/15W)

This molybdenite prospect is situated near South Sarita River.

Dacite and andesite of the Bonanza Formation have been repeatedly intruded by stocks and dykes of varied composition. Pyrite is common to abundant, but molybdenite is sparse and sporadic.

A CLAIMS (92F/2W)

A segment of the Quatsino limestone was planetabled, and eight chalcopyrite and magnetite showings were tied in. The limestone is offset to the right by a subparallel fault, and does not pinch out to the southeast. Two showings are adjacent to the fault, but the others are distant from it in Karmutsen lavas.

References: *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1975, p. 41; *B.C. Dept. of Mines & Pet. Res.,* Geology in British Columbia, 1975, in press.

MORNING (92F/6W)

The main adit on this property is driven into a steep rocky slope overlooking the Taylor River 4.8 kilometres west of Taylor Arm of Sproat Lake. Access is by 3.9 kilometres of rough road, designated Branch 500, and a short steep tractor road.

A contractor enlarged the old adit, extended it 41 metres, and drove a 12-metre crosscut. At the time of the visit he was diamond-drilling three holes from the crosscut to test the vein below adit level. The writer mapped the adit and crosscut by chain and Brunton compass.

The adit follows a persistent shear zone in massive Karmutsen volcanic rocks, which strikes 057 degrees in the first 90 metres of adit and 069 degrees over the remaining 56 metres, and dips generally northwest at 75 to 80 degrees. Along the hangingwall a discontinuous quartz vein, 30 to 90 centimetres wide, carries disseminated chalcopyrite and malachite. A footwall quartz vein, 90 centimetres wide and well mineralized with disseminated chalcopyrite, is exposed in the crosscut 3 metres from the centre of the shear zone.

GREY JAY (92F/7E)

The property straddles the upper part of French Creek, and is reached by a road which leaves the Parksville–Port Alberni Highway 3.7 kilometres west of Coombs. The upper part of this road is interrupted by a bulldozer trench which extends for about 100 metres between the 2,000 and 2,100-foot contours on the ridge north of the creek.

The country rock is grey chert intruded by small granitic dykes. In the trench it has been largely altered to skarn, and patches of skarn occur in it up along the angle of the ridge. The skarn in the trench contains a gently north-dipping band of generally massive magnetite which carries disseminated pyrite and chalcopyrite. The shape and extent of this zone have not been determined. Some magnetite and pyrite occur in the skarn along the angle of the ridge.

FORBIDDEN PLATEAU AREA (92F/11W)

In 1968 a tract of land including Forbidden Plateau and the mountainous area to the west was added to Strathcona Park. H. C. Gunning had in 1930 described the Three Musketeers and New Bronsville copper-bearing shear zones and the Gem Lake copper zone. In his 1968 report D.J.T. Carson referred also to gold and copper occurrences at Faith Lake. None of the zones had been examined by the Department of Mines and Petroleum Resources prior to 1976. The shear zone occurrences did not appear to represent a significant mineral resource, and were given a secondary priority. The Gem Lake and Faith Lake copper deposits offered the possibility of substantial tonnages; they were examined in August and are described separately.

References: Carson, D.J.T., in *Geol. Surv., Canada,* Paper 68-50; Gunning, H. C., in *Geol. Surv., Canada,* Summ. Rept., 1930, Pt. A, pp. 74, 75; *Minister of Mines, B.C.,* Ann. Rept., 1930, p. 302.

FAITH LAKE (RIM) (92F/11W)

Faith Lake is a tarn at 1 200 metres elevation between Mount George V and an unnamed peak southeast of Mount Albert Edward. It is drained by Eric Creek, which descends very steeply to the end of an old road at 600 metres elevation. Access was made to the west end of the lake by helicopter from Campbell River. At this time (August 5) the north slope of Mount George V was still largely snow-covered, and large patches of snow remained in the bottom of the valley west of the lake, but south-facing slopes were largely clear.

Falconbridge Nickel Mines Limited had explored the area in 1961-64 and 1969 and located 12 RIM claims covering Faith Lake and the valley slopes to the north, west, and south. J. J. McDougall did preliminary geological mapping, self-potential surveys were made, and several holes were diamond drilled. Company reports on this work were made available to the writer after the property was visited.

The country rock is massive andesite or basalt of the Karmutsen Formation. Immediately west of Faith Lake it is intruded by a small stock and associated dykes of hornblende monzonite. J. E. Muller obtained a Tertiary radiometric age, and D.J.T. Carson suggested that it might constitute a porphyry copper deposit similar to Catface. Three traverses were made over the length of the stock, and no chalcopyrite and only very minor, sporadic pyrite was found. Off the west end of the stock the Karmutsen volcanic rocks are cut locally by numerous narrow feldspar veins and contain sporadic disseminated pyrite and rare grains of chalcopyrite. A band of skarn, 25 centimetres wide, is well mineralized with chalcopyrite. Southwest of this occurrence Falconbridge obtained anomalous self-potential readings, but no mineralization was found. Most of this anomalous area is covered with overburden which would appear to be frozen or waterlogged for most of the year. The south contact of the stock was covered by the toe of the George V snowslide, but had been intersected by Falconbridge's diamond drill hole AX-5. Some magnetite, a little pyrite, and some rusty sections were noted in the core.

Falconbridge had found several gold-bearing quartz veins scattered around Faith Lake, but none were seen because the small-scale sketch map available at the time of the visit was inaccurate.

References: Muller, J. E. and Carson, D.J.T., *Geol. Surv., Canada,* Paper 68-50.

GEM LAKE (MEG) (92F/11W)

Gem Lake lies at 1 020 metres elevation in a deep valley between Mounts Regan and Albert Edward on the southwest and Jutland Mountain on the north. At the time of the visit (August 4) snow still filled the valley bottom between the lake and headwall cliffs, but the steep rocky walls were largely bare. Access was made by helicopter from Campbell River to a point on the snowslide about 75 metres above the lake.

Falconbridge Nickel Mines Limited had explored the area in 1960-61, and a summary report was placed in the Department's files.

The country rock is massive andesite or basalt of the Karmutsen Formation. It is intruded on the east side of the valley by a small diatreme and by associated dykes of felsite and hornblende quartz diorite. The diatreme consists of fragments of the felsite and quartz diorite in a dark green matrix which is presumably reconsolidated Karmutsen. It contains considerable disseminated magnetite and rather sparse disseminations and fracture coatings of pyrite and chalcopyrite. It is transected by a shear zone striking 300 degrees and dipping 80 degrees north. The south side of the shear zone has been eroded, leaving a vertical to overhanging wall about 60 metres high which is spectacularly stained with malachite. No sulphides were found in outcrops of the quartz diorite, but a talus block contained veinlets of massive chalcopyrite. A felsite dyke near the diatreme appeared to be barren, but another extending south along the juncture of the snow surface with the rock wall contained modest chalcopyrite with pyrite or pyrrhotite as disseminations or fracture veinlets. Fracture seams of pyrite and chalcopyrite occur in the Karmutsen near this dyke.

MOUNT WASHINGTON AREA (92F/11W, 14W)

A brief visit was made to the property while Imperial Oil Ltd. were carrying out a drill program.

Karmutsen andesite or basalt and Comox sandstone were faulted, intruded by Tertiary quartz diorite stocks and dykes and dacite porphyry sills, brecciated in part and altered and mineralized. The Murray and Washington breccias constitute much of the north face of the peak. In addition to quartz diorite and sandstone fragments, the Washington breccia also contains fragments of Karmutsen and Murray breccia. Beside Murex Creek to the east, the Murex breccia shows both simple and fluidized phases. The simple breccias consist of angular fragments of Comox sandstone in a matrix of more finely crushed sandstone, or angular fragments of Karmutsen basalt in more finely crushed basalt, with very little mixing at the formational contact. The fluidized breccia contains mixed fragments and shows a streaming pattern and locally, fluidization channels.

Chalcopyrite is widespread, but is marginal to submarginal outside the open pit on the northwest ridge. This ore was in a quartz stockwork developed in Comox sandstone between two sills.

WESTERN MINES (92F/12E)

Ten days were spent on preliminary studies. The ore control is both structural and stratigraphic, and future detailed studies should assist the search for additional ore. A new crosscut in the Price mine had intersected a fault-slice of argillite of unknown origin.

DONNER, HEBER (92F/12W)

These claims extend across the lower south slope of White Ridge from Strathcona Park boundary to Kunlin Lake. The southern claims are reached by the Ucona logging road. Branch 140 formerly provided access to the northern claims, but bad washouts had rendered it impassable by 1976.

A tongue of the Bedwell batholith extends obliquely across the south face of White Ridge between tongues of the Karmutsen Formation. An infold of Quatsino limestone was found by Bacon and Muller on the crest and upper face of White Ridge, but was not reached by the writer. The tongue of the batholith is variable in grain size, colour, and mineral composition, and there is evidence of multiple intrusion. The contacts with Karmutsen rocks are zones of dykes and intruisve breccia. Sporadic alteration in both rock units consists of epidotization, silicification, and incipient development of garnet.

Pyrite is sparsely widespread, and locally is fairly thickly disseminated in and near silicified rock and shear zones, where it is accompanied by minor chalcopyrite. One of the better occurrences is on the lower part of Branch 145. The only magnetite found in place occurs as an accessory mineral in phases of the intrusive tongue.

Abundant alluvial magnetite and limestone are present along the lower course of the creek that enters the Ucona River 300 metres below the bridge over the falls. Part of this surficial deposit has been used to surface logging roads above this point, but it might be profitable to recover magnetite from the remaining material. The source is clearly the magnetite associated with limestone reported from the east end of the upper south face of White Ridge, on the adjoining TRIM claim.

References: Assessment Reports 560, 4972; *Geol. Surv., Canada,* Map 17-1968.

CEDAR HILL (92F/13E)

The mineral occurrences are on the southwest slope of the hill west of Gentian Lake, and are reached by a dirt road which leaves the main logging road about 2 kilometres north of the Iron Hill mine, or 15.2 kilometres from the Campbell River-Gold River Highway. The country rock is diorite of the Quinsam Intrusions. The owner, R. B. Hopton, had excavated some 13 small open cuts, exposing some small shear zones and some disseminated sulphides. The first seven cuts contained pyrite and minor chalcopyrite, one cut contained moderate chalcopyrite, and the last three, low on the west slope of the hill, contained moderate pyrite, chalcopyrite, malachite, and sphalerite. The mineralization appears to be sporadic.

HEATHER HILL, KALGOORLY (92F/14W)

The mineral occurrences are on the south brow of the ridge east of Gentian Lake, 700 metres north of the east tip of the triangular lake. They are reached by a dirt road which leaves the main logging road within sight of the Iron Hill mine and passes along the south side of this lake. The country rock is andesite of the Bonanza Formation. A vertical shear zone striking 070 degrees is exposed on the southeast corner of the ridge and can be followed westward for some 30 or 40 metres. Chalcopyrite and arsenopyrite are disseminated in and adjacent to the shear zone. The mineralized zone continues westward along the strike of the zone, although the shear zone is not discernible and cross-fractures appear to provide local control. Pyrite and galena are present in this westerly extension. Farther west, bedrock is covered in a shallow draw, but pyrite and galena are present on the HEATHER HILL claim, approximately on the strike of the zone. The width of the zone is of the order of 1 to 3 metres.

MOUNT HOY AREA (92L/7W)

A traverse was made with Hans Knapp up the creek that flows northeast off the 1 336-metre summit north of Mount Hoy and into the north end of Bonanza Lake. Mr. Knapp had obtained encouraging copper and zinc geochemical results from sediments collected from this and nearby creeks. The creek exposes a nearly continuous section of gently west-dipping beds of the upper part of the Quatsino Formation and the lower part of the Parson Bay Formation. Abundant fossils were found on the surfaces of some shale beds. Both limestone and shale are intruded by thick and thin medium-grained sills and connecting dykes. Beds and sills are displaced a metre or two on more or less perpendicular faults. These intrusions appear substantially different from the Karmutsen-type intrusions common in the Quatsino at other localities, and could be offshoots of the Mount Hoy stock. They contain considerable disseminated pyrite and sporadic grains of chalcopyrite, and could be indicative of copper mineralization higher on the mountain.

ISLAND COPPER (92L/11W)

A brief visit was made to the Island Copper open pit. Now that the upper north and west walls have been pushed back, away from ore and alteration, the Bonanza stratigraphy is becoming apparent. The ore was splitting into north and south zones at the pit floor, as predicted from diamond drilling.

NORTH TEXADA ISLAND

By G.E.P. Eastwood

E. T. Johanson of Vananda prospected two areas with a self-potential instrument and discovered several new mineral occurrences. The country rock is the Marble Bay limestone, which is described in some detail by Mathews and McCammon. It is intruded by several diorite and gabbro stocks and by many mafic dykes.

References: *B.C. Dept. of Mines & Pet. Res.,* Bull. 40, pp. 52-58.

SANDY (92F/10E)

This 2-unit claim is northwest of Paxton Lake, and is reached by a dirt road which branches off the highway to Gillies Bay on Crown Grant Lot 79. The main mineralized zone is blind, and is exposed by three large test pits over a length of 40 metres, on a trend of 014 degrees. It is a zone of bleached limestone, 20 to 75 centimetres wide, containing braided veins of pyrite, sphalerite, and galena. A second zone is also blind and is exposed in a large test pit 140 metres south of the main zone. Bleached limestone, 120 centimetres wide, carries abundant pyrite and less sphalerite. It strikes 020 degrees, but appears to terminate at the north end of the pit. Northeast of the main zone, sulphides are finely disseminated in a mafic dyke.

STURT BAY AREA (92F/15E)

On the north shore of the Lagoon, on the IRISH FR. claim, galena and chalcopyrite are sparsely disseminated in a resistant limestone bed, and galena veinlets feather out from it at 350 degrees. Nearby, blebs of massive chalcopyrite occur in a mafic dyke at about the mid-tide line. Farther east on the IRISH FR. the limestone is bleached for 30 centimetres across an open fracture lying 005 degrees 80 degrees east and contains veinlets and pockets of sphalerite and less pyrite.

An open cut had been made on the JENNY FR. claim near the southwest boundary of the former Lot 161. The limestone is bleached white in and around the cut. Sphalerite and pyrite were fairly abundant in the bottom of the cut but died out upward; no trend could be determined.

At the head of Francis Cove an old adit had been driven 18 metres at 065 degrees into the base of a small bluff of white limestone. The complex OKE showing occurs in a slight recess in this bluff, southeast and east of the portal. One or more mafic dykes have been sheared, altered, mineralized, and cross-faulted. Chalcopyrite and sphalerite occur in quartz veinlets in dyke rock, and with pyrite and a little galena in chlorite schist and adjacent limestone.

On the shore a short distance east of Francis Cove, just inside Lot 156, an irregular mafic dyke runs 14 metres at 340 degrees, then either turns abruptly or is cut off by another dyke striking 080 degrees. The first segment and flanking limestone are mineralized with chalcopyrite, and the second segment with chalcopyrite, sphalerite, and tetrahedrite.

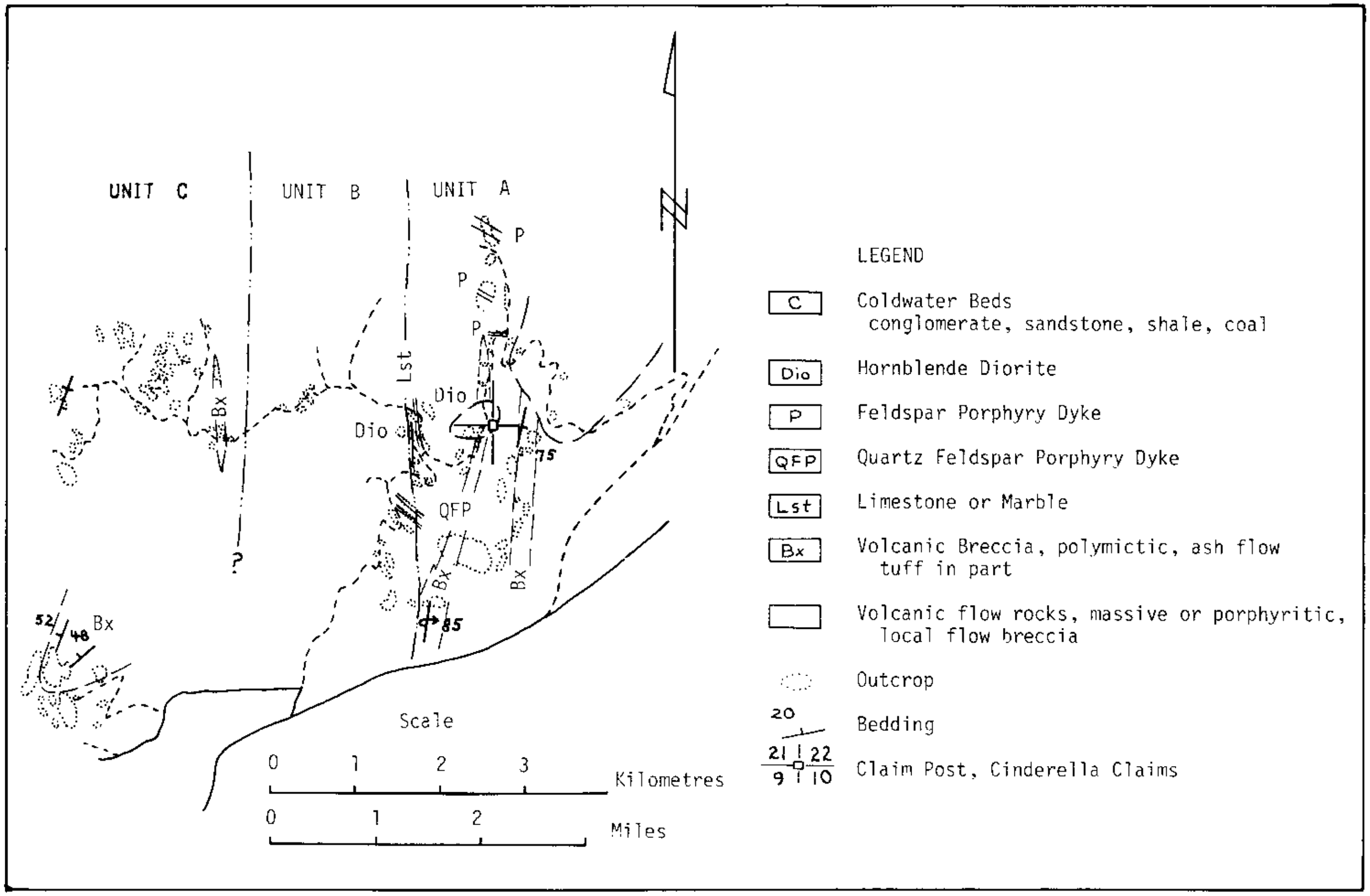

Figure 9. Nicola volcanic rocks north of Merritt.

MERRITT AREA
(92I/2)

By W. J. McMillan

Several days were spent north of Merritt to get a preliminary impression of the nature of the Triassic Nicola Group in this area. Volcanic flows and fragmental units predominate but volcanic argillites and limestone pods occur locally. The succession is cut by small hornblende diorite bodies and west to northwest-striking porphyritic dykes; most of the dykes appear to have been feeders for the nearby flows. Two quartz plagioclase porphyry dykes are associated with copper-iron mineralization.

Contacts between flows and clastic rocks, elongated fragments in the clastics, and bedding almost invariably strike between 350 degrees and 010 degrees. Dips are steeply east or west. 'Way up' was determined at only one locality where grading and scour zones suggest younging toward the west.

Apparently, the section can be divided into three units (Fig. 9). Unit A is a volcanic assemblage with both massive and porphyritic phases; it has intercalations of volcaniclastic rock, limestone, and argillite. Unit B is a volcanic assemblage dominated by massive and porphyritic lavas with local breccia zones. Characteristically rocks in it are a purplish colour either on the weathered or fresh face or both. Unit C consists largely of very dark grey massive to porphyritic lavas with occasional thin lenses of volcanic breccia. Throughout the section, especially in units A and B, porphyritic rocks predominate. Plagioclase with lesser amounts of augite comprise the phenocrysts.

Magnetite is common as fracture coatings and veins, particularly in Unit C. Pyrite is an accessory mineral in some of the flows and occurs in the volcanic sediments. Pods of magnetite-specularite-chalcopyrite with minor amounts of sphalerite formed in epidote-calcite skarns adjacent to layers of clean white marble. Adjacent to the quartz plagioclase porphyry dykes, minor magnetite-chalcopyrite mineralization occurs in fractures with quartz, epidote, and some tourmaline.

Epidote with associated quartz is ubiquitous as fracture and vein fillings and less common as replacements of phenocrysts, matrices, or volcanic clasts. Chlorite and actinolite were noted coating fractures in several outcrops.

Some time was also devoted to examining drill core west of Craigmont mine. An attempt is being made to define Nicola stratigraphy there. Toward this end, detailed mapping was employed to determine the structural geometry of the area. Results of the study require further office analysis and will be presented in *Geology in British Columbia, 1976.*

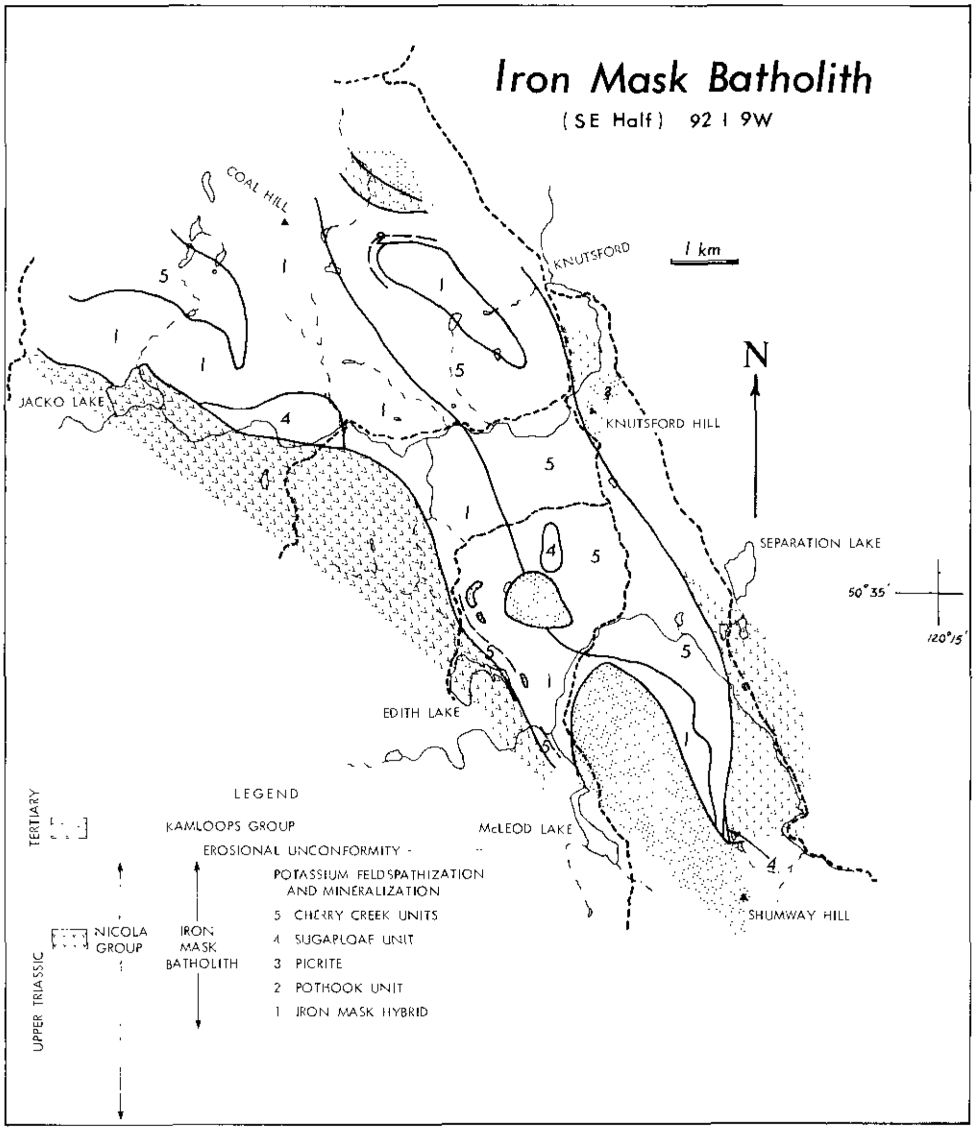

Figure 10. Sketch of southeast part of the Iron Mask Batholith.

GEOLOGY OF THE SOUTHEAST HALF OF IRON MASK BATHOLITH (92I/9)

By K. E. Northcote

Regional mapping of the Iron Mask batholith was resumed during the 1976 field season. Mapping has virtually been completed on the batholith (scale – 1:1320) and the next phase of the program will be to refine contacts, descriptions of rock units, and their relationships to one another. This will be done by carrying out detailed work on some of the mining properties.

REGIONAL SETTING

The Iron Mask batholith is a multiphase intrusion comprised of Iron Mask Hybrid, Pothook, Sugarloaf, and Cherry Creek units, each of which has several varieties. The rocks *are fine grained and fine porphyritic to coarse grained and are silica-poor ranging from* gabbro to syenite composition with diorite predominating.

Major systems of northwesterly, northerly, and northeasterly trending recurring fractures or faults controlled emplacement of various units of the Iron Mask batholith. The batholith was emplaced in a high level volcanic to subvolcanic environment, comagmatic with Nicola volcanic rocks and coeval with part of the upper Nicola succession. The batholith intruded volcanic and sedimentary rocks of the lower Nicola but the Cherry Creek unit occurs both as fragments within, and is in intrusive contact with, uppermost Nicola rocks.

The Nicola and Iron Mask rocks are unconformably overlain by Tertiary sedimentary and volcanic rocks of the Kamloops Group. In many places on and along the flanks of the batholith the pre-Tertiary erosion surface appears nearly to coincide with the present day erosion surface. Erosional remnants of Tertiary volcanic rocks cap the higher hills and occur in places along their flanks. This pre-Tertiary erosional surface appears to have been very irregular although post-Tertiary faulting may have accentuated this apparent irregularity and resulted in local preservation of post-batholith rocks within the batholith.

GEOLOGY

Rock descriptions are based on field observations of texture, composition, and type and intensity of alteration. These descriptions are subject to revision when petrographic studies are completed. Major rock units are shown on Figure 10.

Nicola Group

The southeast half of the batholith is flanked on both sides by Nicola volcanic and volcaniclastic sedimentary rocks which are lithologically quite dissimilar to overlying Tertiary volcanic and volcaniclastic rocks.

Nicola rocks on the southwestern flank consist predominantly of well-indurated, weakly metamorphosed, massive and bedded tuffs, breccias which are possibly lahars, and interbedded flows and monomictic flow breccias. Most of these rocks are a fairly uniform green-grey colour.

Nicola rocks on the northeast flank are mainly tuff and tuff breccia which are generally less well indurated than those on the southwest flank. They contain fragments of many different colours and in some places are abundantly hematitic. A well-indurated exposure of bedded tuff and breccia similar to those on the southwestern flank crops out between Knutsford and Knutsford Hill.

The Nicola rocks on both flanks of the batholith contain augite porphyry and augite porphyry breccia which, on the north side of Jacko Lake, has been metamorphosed along the intrusive contact. Nicola rocks along the southwestern flank and at the southeast tip of the batholith contain distinctive augite-hornblende porphyries which are identical to varieties of the Sugarloaf unit which also occurs predominantly along the southwest flank of the batholith.

Intrusive Rocks of the Iron Mask Batholith

All intrusive units with the exception of 'picrite' are thought to be genetically related. Most units everywhere show some degree of alteration and/or contamination which may be intense in some places. In most cases, however, original textures are still visible and are used as the main criteria for distinguishing among units and varieties.

Iron Mask Hybrid Unit

The Iron Mask Hybrid unit forms a margin about 1.2 kilometres wide along the southwest side of the southeast half of the batholith. An elongate pendant or screen of Iron Mask Hybrid rocks approximately 3.2 kilometres long occurs in Cherry Creek rocks and extends from east of Coal Hill southeasterly toward Knutsford Hill.

Most outcrops of the Iron Mask unit can best be described as a melange of intrusive rock varieties. The rocks range from fine to coarse melanocratic and mesocratic diorite, fine to coarse-grained hornblendite, coarse-grained magnetite-rich gabbro, and xenoliths of recrystallized Nicola. All of the rock varieties contain magnetite and are commonly cut by irregular, criss-crossing, fine to coarse-grained leucocratic dioritic dyke-like bodies and dykelets. Some of the dyke-like bodies are recognizable as Cherry Creek varieties, particularly in the vicinity of Iron Mask Hybrid and Cherry Creek contacts.

Mineralization is fairly ubiquitous in Iron Mask rocks with noteable concentrations of magnetite and copper. The Iron Mask mine is located in this rock unit.

Pothook Unit

The Pothook unit is not as prevalent in the southeast half of the batholith as it is in the northwest half. It appears as narrow, mafic-rich, gradational zones between Iron Mask Hybrid and Cherry Creek units. The rock is more uniform in texture and composition than Iron Mask Hybrid rocks. It is fairly coarse grained, generally dioritic but has varied K-feldspar content, is mafic-rich, and lacks the characteristic speckled appearance of Cherry Creek varieties.

At the northwest end of the batholith the Pothook unit is more extensive than to the southeast, is of dioritic composition except near Cherry Creek contacts, is medium to coarse grained, and is mafic-rich. Commonly coarse interstitial masses of biotite 2 to 3 centimetres across are visible in this unit.

There appears to be a gradation from the melange of Iron Mask varieties through Pothook diorite to the Cherry Creek unit showing an increasing degree of differentiation to more K-spar rich varieties. Intrusive contacts between these units are also evident.

Mineralization is prevalent in many places in the Pothook unit with noteable magnetite occurring in uniformly dipping veins south and southeast of the Afton deposit.

Picrite Units

The problem of the origin and age of the Picrite unit remains unresolved. The picrite is of basaltic composition with serpentinized olivine reported by Carr (1956), Preto (1967), and Carr and Reed (1976). Picrite bodies appear to be associated with recurring, northwesterly trending fracture systems and are found in many parts of the batholith commonly in association with mineralization (Carr, 1956; Carr and Reed, 1976). The unit is cut by clean fine-grained rocks akin to the Cherry Creek unit. Inclusions of picrite are reported in the Iron Mask unit (C. Godwin, personal communication).

Cherry Creek Unit

The name Cherry Creek is retained for the unit of rocks which extends along the north margin of the batholith (Preto, 1967) and is applied to equivalent rocks underlying Iron Mask Hill and brecciated, ankeritic rocks east of Galaxy. Mapping during the 1976 field season has shown that this same unit of Cherry Creek rocks forms the eastern half of the southeastern part of the batholith. A pendant or screen of Iron Mask Hybrid unit occurs within it extending from east of Coal Hill and projecting southeasterly toward Knutsford Hill. A body of Sugarloaf-like rocks extends up the north side of the Knutsford ski hill and heals brecciated fragments of Cherry Creek rocks.

There are a wide variety of Cherry Creek rocks which retain a characteristic speckled texture resulting from a clustering of fine-grained mafic minerals with indistinct outline. The rocks are commonly weakly porphyritic to porphyritic, fine grained, and range in composition from diorite to syenite. They include varieties which can be termed macrodiorite, microdiorite, micromonzonite, microsyenite, and Cherry Creek porphyry (Carr, 1956; Preto, 1967 and 1972). The wide variety of Cherry Creek rock types may be the result of tapping of magma of different stages of differentiation, and emplacement and crystallization under varied pressure-temperature-volatile content conditions existing in an intermittently venting subvolcanic to volcanic environment.

Copper and lesser iron mineralization is prevalent in the Cherry Creek unit particularly in zones of intense brecciation and K-feldspathization. Preto (1967) points out the significance of the brecciation and K-feldspathization. Similar brecciation to that reported by Preto (1967) and Northcote (1974) in Cherry Creek rocks along the north side of the batholith occurs in Cherry Creek rocks at the Kimberley copper property northwest of Knutsford (Preto, 1967). A breccia consisting largely of Cherry Creek fragments also occurs on the extreme southeast tip of the batholith.

Sugarloaf Unit

The Sugarloaf unit occurs mainly along the southwest flank of the batholith and as small bodies within the batholith including the north flank of Knutsford ski hill and at the southeast tip of the batholith. Several varieties were noted which are mainly the result of differences in grain size. Almost everywhere the unit is of fairly uniform andesitic composition and is medium green in colour. The distinguishing characteristic of this unit *is the persistent presence of hornblende and/or augite phenocrysts. Identical rocks were* observed in the Nicola although their relationship to Nicola rocks was not determined but they probably occur as dykes or sills.

Conflicting age relationships were observed where Cherry Creek rocks appeared to be cutting rocks of the Sugarloaf unit and breccia fragments of Cherry Creek rocks were healed by a matrix of Sugarloaf-like rocks.

Copper mineralization occurs within Sugarloaf rocks in several localities, including the Ajax property east of Jacko Lake where Sugarloaf rocks are brecciated and albitized (Preto, 1967).

Kamloops Volcanic and Sedimentary Rocks

Tertiary volcanic and sedimentary rocks unconformably overlie the batholith and Nicola rocks. The Kamloops volcanic rocks in the Iron Mask area are mainly of basaltic composition and occur as vesicular flows, flow breccias, and vent breccias. The present erosion surface closely approximates the pre-Tertiary erosion surface so that erosional remnants of Tertiary rocks are prevalent capping the tops of some of the higher hills on the batholith, in former depressions on the pre-Tertiary erosion surface, and in downfaulted blocks both within and flanking the batholith.

DISCUSSION OF THE ENVIRONMENT OF EMPLACEMENT, ALTERATION, AND AGE OF THE BATHOLITH

Alteration

Most of the batholithic rocks show some degree of saussuritization which locally may be very intense. Some K-feldspathization is evident locally in most rock units but is most abundant in Cherry Creek rocks where the relatively high K-feldspar content is the result of magmatic differentiation. The K-feldspar was introduced into the rocks through processes of normal crystallization of potassium-rich magma and by alteration of previously crystallized dioritic to monzonitic rocks by introduction of potassium-rich solutions.

Environment of Emplacement

An increasing amount of evidence suggests a shallow volcanic to subvolcanic environment of emplacement especially for the Cherry Creek varieties and a comagmatic and partly coeval relationship between Nicola volcanic rocks and units of the Iron Mask batholith.

Cherry Creek rocks at the north end of the batholith occur as criss-crossing dyke-like bodies of varied grain size and composition. Their fine-grained texture suggests near surface conditions and, as noted by Carr (1957), the Cherry Creek unit had previously been mapped as volcanic rocks. Intrusive brecciation associated with K-feldspathization is prevalent in many places particularly in a narrow zone extending westerly from a point near Iron Mask Lake to the Afton orebody. This brecciation appears to involve mainly varieties of Cherry Creek although fragments of Iron Mask Hybrid or Pothook are also visible in core. The brecciation may have been the result of venting at a slightly higher level. Fragments of Cherry Creek rocks and other Cherry Creek-like rocks occur in tuff breccia of the Nicola which indicates that some of the Cherry Creek rocks are older than some of the Nicola. However, intrusive contacts between these same Nicola volcanic rocks and Cherry Creek rocks indicates the opposite relationship; that is, some Cherry Creek rocks are younger than some of the Nicola rocks they intrude. Intense epidotization of Nicola rocks which contained Cherry Creek fragments and some mineralization was noted in Nicola rocks at the north edge of the batholith, suggesting that volcanic-plutonic processes were going on simultaneously.

It is unnecessary to postulate three separate magmatic events: one for Nicola volcanism, a second to emplace the Iron Mask batholith, and a third for later volcanism to explain Cherry Creek fragments in volcanic rock described as being identical to Nicola (Cockfield, 1948). The observed geologic features and relationships would be consistent with a single but pulsating comagmatic and partly coeval volcanic-plutonic system operating in a subvolcanic to shallow volcanic environment.

Iron Mask Age Determinations

Sample No.	Age	Rock Type	Location
VP72KA–3	197±6 m.y.	Cherry Creek Micromonzonite Porphyry	Near east end of Iron Mask Lake
VP72KA–5	190±6 m.y.	Pothook	Afton
VP72KA–4	205±6 m.y.	Cherry Creek Micromonzonite Porphyry	Near Iron Mask Lake
VP72KA–1	201±6 m.y.	Iron Mask Hybrid	Gas pipeline north of Ajax property
VP72KA–2	198±6 m.y.	Hydrothermal Biotite Cherry Creek Microdiorite	Near Iron Mask Lake

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TASEKO LAKES AREA
(92O)

By W. J. McMillan

GRANITE CREEK PROPERTY (92O/3W)

The Granite Creek property was studied and diamond drilled by Quintana Minerals Corporation in 1976. Work was directed by K. W. Livingstone and W. A. Howell.

Diamond drilling, predominantly in the vicinity of the Empress showing, was conducted as a follow-up to earlier percussion drilling, both by Quintana and other companies. The general geology and locations of the mineral deposits described are shown on Figure 11.

Granite Creek is a tributary of Taseko River east of the south end of Taseko Lakes. Copper and minor molybdenum mineralization occurs in both volcanic and plutonic host rocks on the property. The northern contact of a large body of granodiorite runs approximately eastward across the property. Volcanic rocks near the contact are variably altered; the more intensely altered areas form colourful brown, red, and yellow gossans. It is not certain whether the alteration zones relate to granitic emplacement or are volcanic phenomena. Mineralization occurs in sericitized and silicified zones in both the volcanic and plutonic rocks. In the granodiorite mineralization is either disseminated or in shattered and brecciated zones and is generally close to its borders.

Hydrothermal alteration of the volcanic rocks is obviously fracture controlled. Altered zones are typically rusty weathering due to pyrite which was added to the country rock while it was being variably sericitized, bleached, and silicified. Chlorite and epidote alteration and specularite, chalcopyrite, magnetite mineralization accompanied the alteration. Some alunite (Livingstone, personal communication) was deposited. The altered zone affects roughly 150 metres of section. Where they are recognizable, rocks in this zone are massive to porphyritic andesitic flows and fine to coarse volcaniclastic rocks.

DEPOSITS IN THE GRANODIORITE

(A) Buzzer Showing

Mineralization at Buzzer forms a subequant zone in variably altered porphyritic granodiorite. The country rock is vuggy and sulphides, quartz, flaky sericite, and rarely tremolite line the vugs. The country rock is distinctly porphyritic at the main open cut but gradually gives way northward to grey, slightly porphyritic granodiorite. The size and percentage of phenocrysts in the rock varies. Consequently, unless there is an appropriate weathered face, the porphyritic nature of the rock is not always obvious.

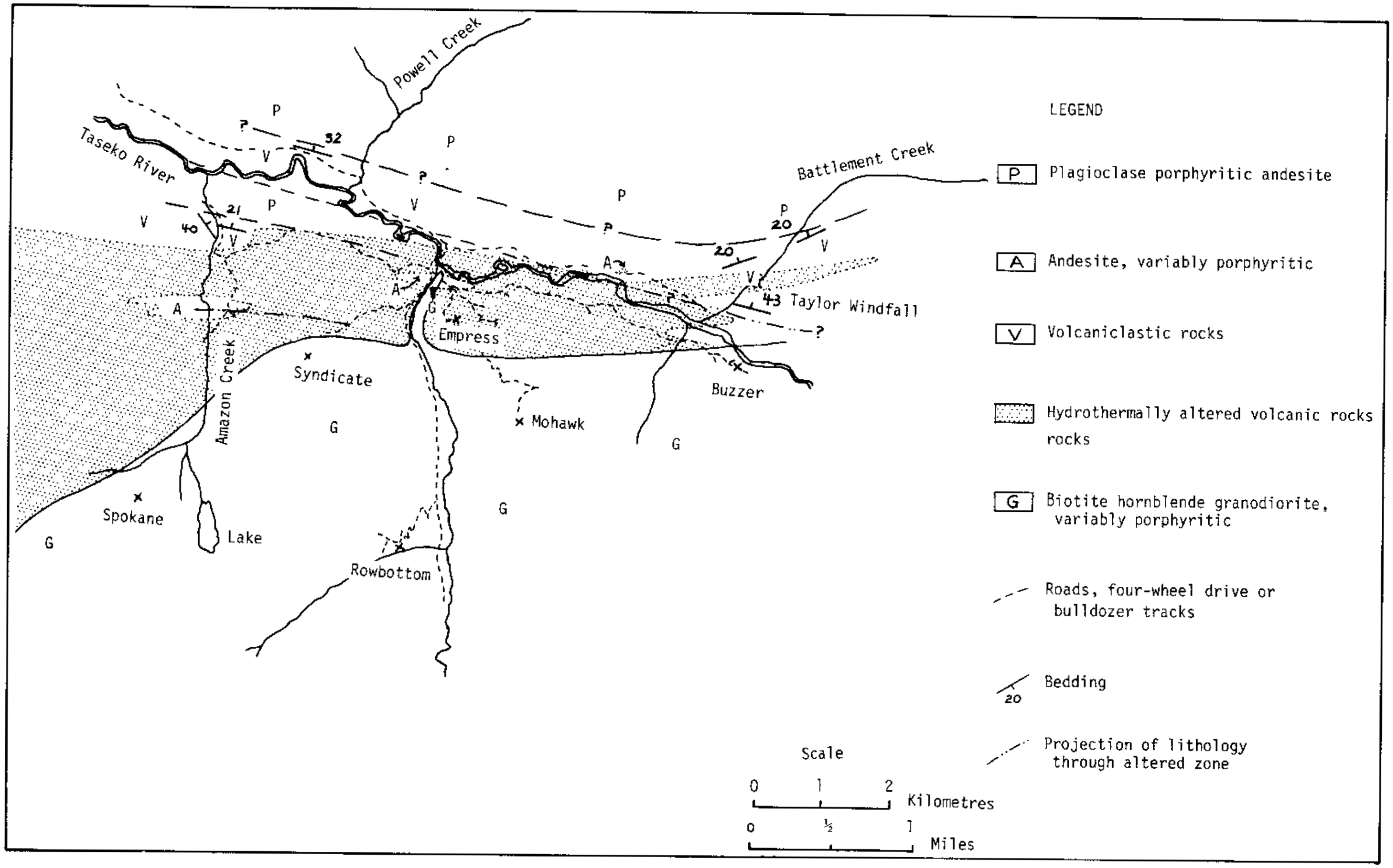

Figure 11. Generalized geology of Granite Creek property.

In mineralized areas the country rocks may be relatively fresh or altered. Relatively fresh rocks look grey whereas the altered rocks are pink. Mafic minerals in both types are pervasively chloritized. Mineralization occurs in vugs in the country rock and the size and percentage of vugs increase in more altered zones. However, grade is not necessarily better in more altered zones because chalcopyrite is the predominant mineral in vugs in 'fresh' zones but flaky sericite and quartz are more abundant than chalcopyrite in vugs in 'altered' zones. Molybdenite occurs locally. The pink altered zones trend 060 to 070 degrees and are probably fracture controlled. Oxidation is minor but some malachite occurs. The overall control which localizes mineralization is obscure. It appears, however, that the granitic rocks were high level intrusions and that mineralization occurred in gas cavities in volatile-rich areas.

Tonnage potential for the deposit can be roughly estimated. The deposit is circular, 200 metres in diameter, and has been drilled to about 100 metres in depth (Woodsworth, Pearson, and Sinclair, 1976). Thus tonnage potential is about 10 million tonnes but, judging from surface exposures, grades are subeconomic.

(B) Rowbottom Showing

Mineralization in the Rowbottom showing (Fig. 11) closely resembles that at the Buzzer showing with the exception that pyrrhotite is a minor accessory. Mineralization is in vugs and replaces chloritized mafic minerals in variably altered porphyritic granodiorite. At Rowbottom it is more obvious that copper abundance is not correlated closely with alteration intensity. In more altered zones at Rowbottom the rock is pinker, fractures are rusty, vugs range to 10 per cent by volume, and the vugs are rusty weathering. Vugs are rounded to elliptical in outline and range to 1.25 centimetres by 2.5 centimetres. Generally in the mineralized zone feldspar is mildly sericitized and pink to yellow-green in colour and mafics are completely chloritized. Local epidote alteration was noted in drill core. In this deposit plagioclase phenocrysts are medium to coarse grained, mafic phenocrysts are coarse grained and range from 15 to 20 per cent, and there are a few per cent medium-grained quartz phenocrysts. The matrix is a finely crystalline mixture of quartz, mafics, and feldspar.

Away from the main showing, the rock is less obviously porphyritic and alteration decreases. Mafics are seen to be biotite and hornblende in roughly equal abundance. Sulphides continue to be present but pyrite rather than chalcopyrite predominates.

In drill core, the country rock granodiorite is cut by barren, locally epidotized, porphyritic dykes. The dykes have hornblende (8 per cent) and plagioclase (15 per cent) phenocrysts in a finely crystalline grey matrix. These dykes are probably of post-mineral age.

No estimate of tonnage potential is possible with available data but the zone is apparently smaller than the Buzzer showing with roughly the same grades.

(C) Mohawk Showing

Mineralization at Mohawk is largely confined to a zone of almost monomictic breccia. Breccia fragments consist predominantly of hematite-speckled, finely crystalline leucocratic 'aplite,' although rare granodiorite clasts occur (Wolfhard, personal communication). Most fragments are from fist to boulder sized and many are rounded. The fragments are not strongly altered but the breccia matrix is veined by and infilled with quartz, flaky sericite, and sulphides. Although the breccia body is irregular in detail, it can be traced northeasterly across the hillside. An adit, which is now caved, was driven by Cominco in 1928 and extended by Motherlode Gold Mines Ltd. between 1933 and 1935 (*Minister of Mines, B.C.,* Ann. Rept., 1935). It intersected the breccia and confirmed the impression that the body dips steeply southeastward. Along strike to the northeast, the breccia zone narrows rapidly, while to the southwest there is no exposure. At its maximum, the zone is roughly 25 metres wide. In the underground working, where the footwall is reported to be marked by a 1-metre-wide gouge zone, mineralization is weak and confined to a 10-metre-wide zone adjacent to it (*Minister of Mines, B.C.,* Ann. Rept., 1935, p. F24).

Mineralization occurs as disseminations in the sericitic matrix of the breccia and with quartz in veinlets. Chalcopyrite is the predominant sulphide and is reported to carry significant gold and weak silver values. Lesser molybdenite and minor galena and sphalerite occur. Small amounts of tourmaline and rutile have been reported and calcite-fluorapatite veinlets were found in the adit dump.

Quartz veins occur throughout the breccia but are most abundant adjacent to the hangingwall. They tend to be vuggy, locally have crystals to 3 centimetres in length, and may carry chalcopyrite, pyrite, disseminated or rosettes of molybdenite, galena, or sphalerite. Molybdenite and galena appear to be more abundant near the hangingwall. Some quartz veins have coarse-grained sericite envelopes, some have flaky sericite in vugs. Molybdenite rosettes are usually rimmed by pale brown micaceous-looking powellite. Chalcopyrite also occurs as disseminations in the quartz-flaky sericite-rich breccia matrix. In outcrop, weathering has produced local malachite staining.

Country Rock

The country rock of the Mohawk showing changes from even grained to porphyritic and from biotite granodiorite to biotite quartz monzonite. The textural variations apparently reflect local conditions of crystallization rather than multiple intrusions because porphyritic and even grained varieties have gradational boundaries.

Furthermore, biotite and plagiolcase which are phenocrysts in the porphyritic rocks are also early formed components in those which are even grained. K-feldspar and quartz are late, interstitial components.

East of the showing the granitic country rock is cut by medium to dark grey, fine-grained to porphyritic dykes. Phenocrysts, where present, are biotite and plagioclase. One finely crystalline dyke had calcite amygdules.

Adjacent to the mineralized zone, the footwall country rock displays a narrow zone with weak argillic alteration of plagioclase and chloritization of biotite. The hangingwall alteration halo is also narrow but is more intense. In it, plagioclase is altered to a pink-coloured mixture of sericite + carbonate + hematite ? and biotite is sericitized. Pink rims occur locally on altered plagioclase crystals along the footwall within a metre or so of the zone (Wolfhard, personal communication).

Reserve Potential

Insufficient data is available to estimate reserves for the showing. Assay results from *the 1935 Annual Report of the Minister of Mines (p. F24) suggest that grades at* surface will average about 4.68 grams per tonne (0.15 ounce per ton) gold over 20 metres with copper near 0.75 per cent. Grades worsen and the zone narrows with depth. Reserve potential of the known zone to a depth of 30 metres is roughly 150 000 tonnes; grades would likely be well below the above figures.

(D) Spokane Showing

Mineralization at Spokane is in veins, in shear zones, and along altered fractures in biotite hornblende granodiorite. In the area of the workings, the country rock is cut by pre-mineral aplite and alaskite dykes. Often the dykes are altered and locally they are heavily pyritized. Basaltic post-mineral dykes have glassy quartz amygdules set in a finely crystalline matrix shot through with plagioclase microlites. Xenoliths are fairly common in the granodiorite. Most are medium grained, grey, and partly assimilated and some are amphibolites. Almost all the xenoliths are less than 15 centimetres across.

Sulphides occur both as disseminations in altered country rock and pre-mineral dykes and in veins. Most of the disseminated sulphide is pyrite but chalcopyrite is a prominent vein mineral. Usually hematized plagioclase causes granodiorite adjacent to veins to be pink coloured and mafic minerals are pervasively chloritized. Vein walls are lined with quartz crystals and sulphides fill vein cores. Apatite occurs locally as a vein accessory. Chalcopyrite and pyrite predominate in the veins and rare scheelite occurs. Chalcopyrite and pyrite also occur in pockets of quartz-sericite alteration along pink-altered fractures. The best mineralized veins on the property strike northeast or southeast and are steeply inclined. In weathered surface exposures, primary sulphides have been partially altered to malachite and chrysocolla. Pyrite-rich areas are rusty weathering and country rock in them tends to be bleached to a pale grey colour.

It is not possible to accurately assess the reserve potential of this deposit from surface exposures and available data. According to early assay reports, gold is present along with the copper but best values were in leached, oxidized granodiorite rather than with chalcopyrite. Potential appears to be only a few million tonnes with values in copper and gold.

DEPOSITS IN THE VOLCANIC ROCKS

(A) Empress

Rocks at the Empress showing are pervasively altered. Judging from regional relationships the country rocks are a mixed assemblage of massive to porphyritic andesitic flows, and variably fine to coarse-grained thick-bedded fragmental volcanic rocks. At Empress, bleaching, pervasive silicification, and sericitic alteration were accompanied by formation of pyrite, chalcopyrite, and magnetite. Alteration intensity and type vary as do amounts and proportions of magnetite and sulphides. Both in trenches and in drill core variations in magnetite content impart lighter and darker colour banding and a foliation to the rock. The foliation typically dips 40 to 50 degrees and may represent relict bedding.

Silicification is more intense at Empress than elsewhere in the hydrothermally altered area adjacent to the granodiorite contact (Fig. 11) along Taseko River. In places the rock now consists primarily of granular quartz with disseminated magnetite and sulphides. Sericitic alteration is expressed as pale pink or green alteration of feldspars and as disseminated pockets and veinlets of flaky sericite. Where the flaky sericite is disseminated it generally accompanies magnetite, quartz, sulphides, and often feldspar. Specularite rather than magnetite and chlorite is locally present and occurs in pockets and veinlets where it is often joined by quartz and sulphides.

Magnetite is predominantly disseminated but at the original Empress showing it forms irregular patches and massive zones in a strongly silicified outcrop. Sulphides are predominantly pyrite and chalcopyrite but there are minor amounts of molybdenite and pyrrhotite. Sulphides occur as disseminations, in fractures, and in veins. Gangue minerals in fractures and veins include calcite, quartz, and chlorite.

Gypsum-coated fractures occur locally and are associated with soft green montmorillonite alteration zones. Some fractures are coated with white kaolinite.

Reserve potential at the Empress showing is uncertain.

(B) Taylor – Windfall

The Taylor – Windfall workings are in altered volcaniclastic rocks where pockets and veins of quartz, tourmaline, and pyrite occur. Taylor – Windfall was not mapped but is well described in the Annual Report of the Minister of Mines for 1935. Apparently very fine to sponge gold was recovered in quartz, tourmaline, *rutile, pyrite gangue in fracture-controlled pockets. Other fine gold occurred in* shoots with pyrite, tennantite, chalcopyrite, and some sphalerite, galena, and barite in sericite, chlorite gangue. Much of the gold was apparently disseminated in the chloritic gangue.

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FISH LAKE DEPOSIT (92O/5E)

Results of work done on the Fish Lake deposit will be presented in *Geology in British Columbia, 1976.* Drill holes along east-west and north-south sections through the deposit were logged and core from each hole was checked at the 4600 level (or as close to that as possible) for overall geological data.

POISON MOUNTAIN (92O/2E)

Several days were spent examining outcrops and drill core at the Poison Mountain copper deposit. An attempt will be made to radiometrically date the intrusive rocks on the property by K-Ar analysis.

ELDORADO MOUNTAIN (92O/2W)

An attempt will also be made to date intrusive rocks from the Eldorado Mountain gold prospect which is being explored by Chevron Standard Limited. Two small vein deposits south of Eldorado Mountain were examined. In the dump from Lucky Strike adit, vein material consisted of arsenopyrite, sphalerite, jamesonite, some pyrite, and minor amounts of chalcopyrite. Quartz, calcite, and siderite (?) comprise the gangue. The country rock is variably serpentinite, porphyry dyke (?), or altered volcanic rock. Mineralization at Lucky Jem is similar but country rock appears to be bleached, altered argillites and sandstones. Both showings are described in the Annual Report of the Minister of Mines for 1933.

CENTRAL AND WEST CENTRAL BRITISH COLUMBIA

TOOPVILLE PLACERS
(93G/1E)

By G. E Klein

This placer area, actively worked by Terrence M. Toop of Quesnel since 1973, lies approximately 30 kilometres east-northeast of Quesnel, on Mary Creek. The main site of operations is Placer Lease No. 7141, at the confluence of Norton and Mary Creeks. Long known to placer miners, the area had been worked sporadically over the years. Recent discoveries by Mr. Toop has rekindled interest in the area.

GENERAL GEOLOGY

The area is one of gentle relief and lies within the Fraser Basin. Rocks underlying the area are of Mesozoic age (H. W. Tipper, *Geol. Surv., Canada,* Map 19-1960) and where exposed by mining comprise a highly fractured and weathered argillite. The pay gravels which vary from a few centimetres to a few metres in thickness are sandwiched between what is known locally as 'blue clay' but what may be a basal till, and the argillite. Glacial till of up to 40 metres thick covers the pay gravels.

It is evident that the pre-glacial Norton Creek had a wider channel than at present and that the gold now being recovered comes from the wider channel. The gold varies from very well worn to only slightly worn suggesting differing distances of travel from origin. Several nuggets in the 28-gram range have been recovered.

MINERAL PROPERTY EXAMINATIONS

By T. G. Schroeter

SAM GOOSLY (93L/1E)

The Sam Goosly copper-silver-gold property is located approximately 40 kilometres southeast of Houston. The property is at an advanced stage of development, following drilling of more than 28 336 metres on both the Main and Southern Tail Zones and 177 metres of underground bulk sampling on the Main Zone. In addition, pilot plant concentrate production from both the Main and Southern Tail Zones and pilot plant operation of an antimony leaching and recovery circuit were carried out.

The reserves as defined by 2.0 ounces silver equivalent cutoff are estimated at:

	Tonnes	Copper *per cent*	Silver *ppm*	Gold *ppm*	Antimony *per cent*	Stripping Ratio
MAIN ZONE	29 934 878	.30	87.5	0.719	0.084	2.1:1
SOUTHERN TAIL	9 538 301	.42	84.38	1.094	0.087	2.3:1
TOTAL RESERVE	39 473 179	.33	86.88	0.813	0.085	2.1:1

These are open pit reserves and the potential for expanding reserves at depth as well as in other parts of the property remain excellent.

Exploration on the property in 1976 was confined to the Southern Tail Zone where four test pits averaging 75 square metres in length and depths of 4 metres were excavated for the purpose of supplying an 18-tonne per day pilot mill. The pits were dug on a north-south line with the more spectacular ore coming from the most southerly pits. The host rock is a highly fractured and veined cream-coloured tuff with varying amounts of coarse-grained pyrite, tetrahedrite, and chalcopyrite. Stripping has shown that overburden depths are very shallow (for example, 1 metre) and that oxidation has been intense for a depth of about 3 metres. A grab sample of high-grade ore from the southernmost pit assayed:

	Gold *ppm*	Silver *ppm*	Copper *per cent*	Zinc *per cent*	Lead *per cent*	Antimony *per cent*
SG–10	6.25	5646.88	11.12	1.37	.25	7.65

Approximately 900 tonnes of ore was put through a crusher and pilot mill yielding a silver-copper concentrate of about 27 tonnes, of which approximately 18 tonnes was shipped to several smelters for test processing.

Clearing of land for plantsite location was completed and a new road from Houston to the property along Dungate Creek was initiated.

References: *B.C. Dept. of Mines & Pet. Res.,* GEM, 1969, pp. 142-148; 1970, pp. 126-129; 1973, pp. 333-338; *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1974, p. 79.

POPLAR (93L/2W; 93E/15W)

The Poplar property, situated on the north side of Tagetochlain Lake approximately 50 kilometres southwest of Houston, consists of approximately 389 claims located by F. Onucki, C. Critchlow, and M. Callaghan (optioners) and Utah Mines Ltd. (operator) between 1971 and 1974.

During 1976, Utah continued to explore claims not examined previously and diamond drilled the Main Zone and a highly altered zone to the southeast of the Main Zone. An access road and limited trenching were completed on a zone approximately 3 kilometres to the east of the Main Zone.

The area is underlain by volcanic and sedimentary rocks of the Hazelton Group which have been intruded by several stocks and dykes of granodiorite and biotite feldspar porphyry. A late barren rhyolitic porphyry dyke system intrudes all rocks.

The Hazelton Group with a general attitude of 060 degrees/75 degrees southeast can be divided into three units:

(1) **Lower Volcanic Unit** consisting of andesitic tuff and lapilli tuff, aggomerates, and andesite-dacite flows located in the northwestern part of the property.

(2) **Middle Sedimentary Unit** consisting of well-banded, hornfelsed argillites, with occasional interbeds of sandstone located in the south-central part of the property.

(3) **Upper Volcanic Unit** consisting of purple porphyritic andesite and minor agglomerate in the southeast part of the property.

Intrusive rocks include varieties of granodiorite and feldspar porphyry as well as younger andesitic and basaltic dykes. The main mineralized body is contained in a biotite feldspar porphyry body which is up to 150 metres wide locally and has been emplaced along a major north-northwest structure now occupied by Canyon Creek. It is in this area that most of the 1976 diamond drilling was concentrated over 750 square metres straddling Canyon Creek.

Block faulting is common with dominant fault and shear directions trending north-northwest, northeast, northwest, and east-west. Canyon Creek has apparently controlled the emplacement of quartz feldspar porphyry and rhyodacite dykes.

Intrusive rocks have been moderately to intensely sericitized and silicified. Quartz-sericite-pyrite is the typical assemblage. Outward from this zone there is a rapid alteration gradient from moderately argillized (feldspars altered to clay) to propylitized rock which is widespread. Gypsum is also a common vein mineral.

Roughly coincident with alteration zoning is a pyrite distribution of 2 to 4 per cent with local concentrations greater than 10 per cent, especially adjacent to shear zones. Pyrite occurs as disseminations and in veinlets in most rock types. Chalcopyrite and molybdenite are locally concentrated and are associated with veinlets and disseminations of pyrite and veinlets of quartz. Trace amounts of tetrahedrite, covellite, bornite, sphalerite, and galena were observed. Secondary copper minerals include malachite, azurite, and tenorite.

References: *B.C. Dept. of Mines & Pet. Res.,* GEM, 1972, p. 373; 1974, pp. 256, 257; Assessment Reports 5360, 5586, 5679.

MORICE MOUNTAIN (93L/7E)

Morice Mountain is located 18 kilometres south of Houston. Two styles of mineralization are known to occur:

(1) Chalcopyrite and molybdenite in fractures and as disseminations in quartz porphyry and granodiorite.

(2) Chalcopyrite, tetrahedrite, and pyrite in epidote-rich zones with folded and fractured volcanic rocks, especially grey-green dacite horizons.

Amax Exploration Inc. explored the porphyry potential of the property between 1963 and 1967 and Falconbridge Nickel Mines Limited investigated the 'massive sulphide' potential in 1970. In 1976 the area was staked by John Bot and several new occurrences of copper and silver were located, mainly within the volcanic rocks. The porphyry potential and 'massive sulphide' potential were again tested by a number of major companies using geochemical and geophysical techniques.

References: *B.C. Dept. of Mines and Pet. Res.,* GEM, 1970, pp. 155, 156; Assessment Reports 797, 2844.

UTE (FRENCH PEAK) (93M/7E)

Aalenian Resources Ltd.'s French Peak high-grade vein silver-lead-zinc-copper-gold property is located on the southeast flank of French Peak, approximately 65 kilometres north-northeast of Smithers. In 1956 Rio Tinto Canadian Exploration Limited diamond drilled 530 metres and trenched narrow silver-lead mineralized structures in bedded volcanic rocks over a length of 365.8 metres. In 1964, approximately 2.5 tonnes of selected ore was shipped from surface cuts by S. Homenuke and 25.5 tonnes of hand-sorted ore was shipped in 1974.

The main mineralized vein containing coarse-grained galena and tetrahedrite occurs in shear zones in bedded volcanic rocks of the Hazelton Group. It is variable in width having a maximum mineable width of 35 centimetres. The mineralized vein has been traced for 36 metres along strike.

During Phase I of the 1976 program by Aalenian, approximately 215 metres was diamond drilled in 11 holes to test the continuity of known exposures at depth and along strike. Massive tetrahedrite and/or galena and/or chalcopyrite with disseminated pyrite was confirmed at depth along the vein structure which appears to lie in a volcanic sequence of rhyolitic and andesitic flows and tuffs. Mineralized vein sections vary in width from less than 2 centimetres to zones of 1 metre.

Phase II of the 1976 program consisted of diamond drilling of eight short holes on the newly discovered South Zone located 122 metres to the south of the Main Zone, and three more holes on the main mineralized structure. The South Zone consisting of massive banded vein mineralization of chalcopyrite, tetrahedrite, and pyrite within a bedded rhyolite unit has been traced along a length of about 5 metres and an apparent width of 0.5 metre.

The road to the property has been upgraded and an all-weather camp was constructed during 1976. The proposed underground program of drifting along the main vein has been postponed.

References: *Minister of Mines, B.C.,* Ann. Rept., 1956, p. 29; 1964, p. 50; *B.C. Dept. of Mines and Pet. Res.,* GEM, 1974, p. 272; *B.C. Dept. of Mines & Pet. Res.,* Geological Fieldwork, 1974, p. 82.

BELL MOLYBDENUM (103P/6W)

The Bell Molybdenum property is located 10 kilometres southeast of Alice Arm. During the past year Climax Molybdenum Corporation of British Columbia Limited optioned the property and this summer diamond drilled eight holes totalling approximately 2 728 metres. One hole (DDH 76-8) was drilled on the northeast part of the Main Zone and the other seven were drilled on a newly discovered zone located approximately 1 370 metres to the southwest of the Main Zone in an area of hornfelsed sedimentary rocks overlain by a capping of flat-lying Quaternary basalts. The lava appears to be underlain by a thin (approximately 15 metres) layer of angular breccia and unconsolidated silty material (up to 30 metres thick). Drill holes collared in basalt went through this sequence and into mineralized hornfels and intrusive at depth. The intrusive is a leucocratic quartz monzonite but its geometry is not known. Post-mineral basic dykes cut both the sedimentary and plutonic rocks. Molybdenite mineralization in the form of selvages in quartz veinlets occurs in both the quartz monzonite and biotite hornfels similar to that in the Main Zone. Significant amounts of pyrrhotite and pyrite occur as disseminations and as fracture fillings.

References: *B.C. Dept. of Mines & Pet. Res.,* Ann. Rept., 1967, pp. 44-47.

GRAVITY AND SEISMIC REFLECTION PROFILES OVER THE SANDSPIT FAULT QUEEN CHARLOTTE ISLANDS (103G/1E)

By I. F. Young and R. L. Chase

(Institute of Oceanography and

Department of Geological Sciences, University of British Columbia)

INTRODUCTION

Fieldwork on northeastern Moresby Island and eastern Graham Island was conducted in order to obtain more precise information on the timing, magnitude, and sense of displacement on the Sandspit fault (Sutherland Brown, 1968). On land, the fault and parallel subsidiary splays form the western edge of the Queen Charlotte Basin, separating Neogene nonmarine and marine sediments on the east from Mesozoic and Paleogene volcanic and plutonic rocks exposed to the west on the Queen Charlotte Islands.

In addition to the geophysical work reported here, limited geological mapping was done in order to supplement previously published (Sutherland Brown, 1968; 1975) and open access data (Grinsfelder, 1959; Sproule, 1967). A revised geological and structural map of the landward portion of the Queen Charlotte Basin is presently being prepared. Volcanic and granitic rocks, the distribution of which may have been controlled by the Sandspit fault, will be dated using K-Ar and Rb-Sr techniques (with R. L. Armstrong, University of British Columbia).

The study forms part of an M.Sc. thesis to be submitted by one of the authors (I. F. Young) to the University of British Columbia. Financial support came from the British Columbia Ministry of Mines and Petroleum Resources, Department of Energy, Mines and Resources, Shell Canada Limited, National Research Council, and the University of British Columbia.

DISCUSSION OF GEOPHYSICAL RESULTS

The major part of the study consisted of gravity and magnetic measurements across the fault zone and seismic reflection and magnetic profiling in Skidegate Inlet (Fig. 12). The offshore work, carried out aboard *C.F.A.V. Endeavour,* was part of a more extensive survey that investigated a possible submarine continuation of the Sandspit fault in southwestern Hecate Strait and northwestern Queen Charlotte Sound. Unequivocal evidence that the fault does extend southeast from Cumshewa Head was not obtained though gentle folds, rarely faulted, with axes parallel to the Sandspit fault, were seen in seismic profiles in a zone west of the presumed submarine fault trace. Preliminary results of this work will be published elsewhere (Young and Chase, in press).

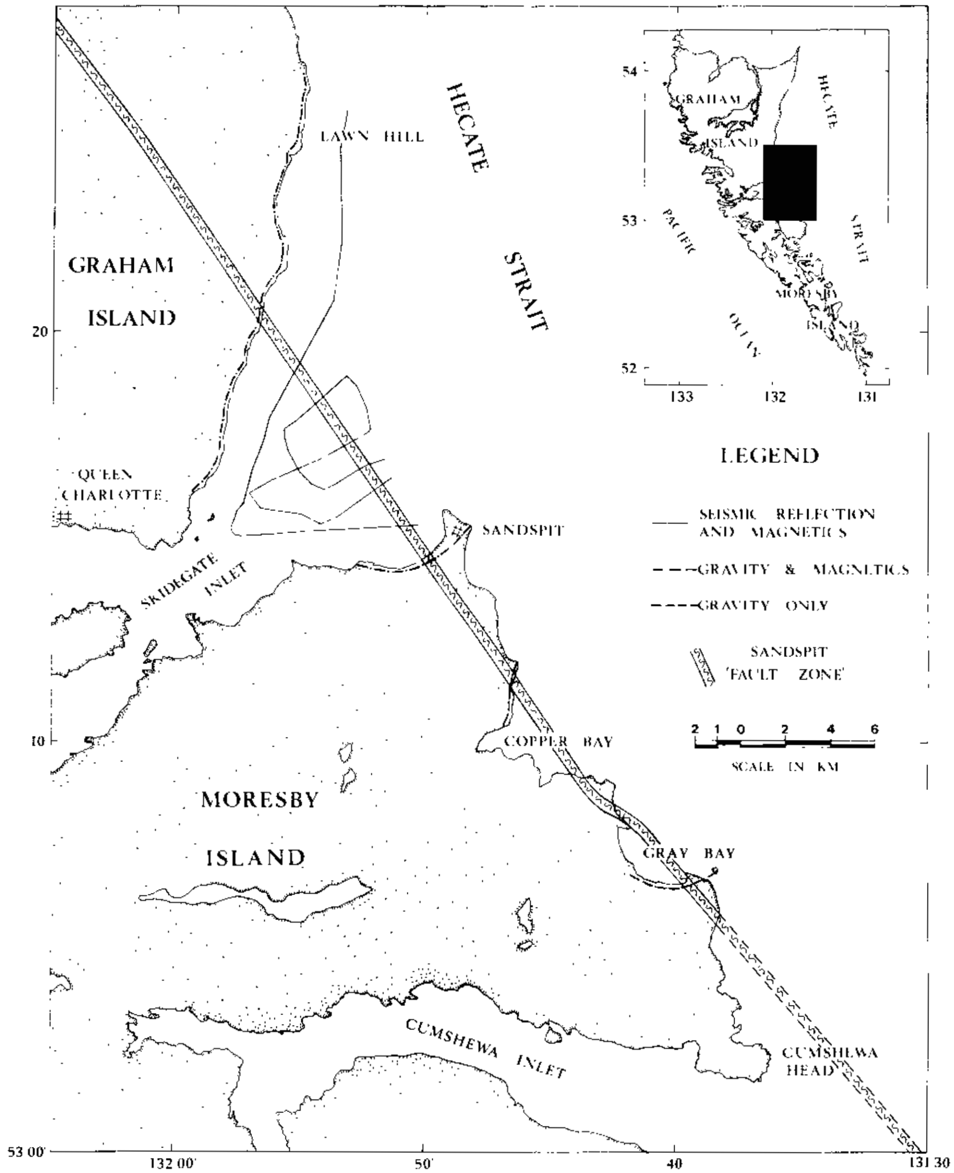

Figure 12. Sandspit fault study area.

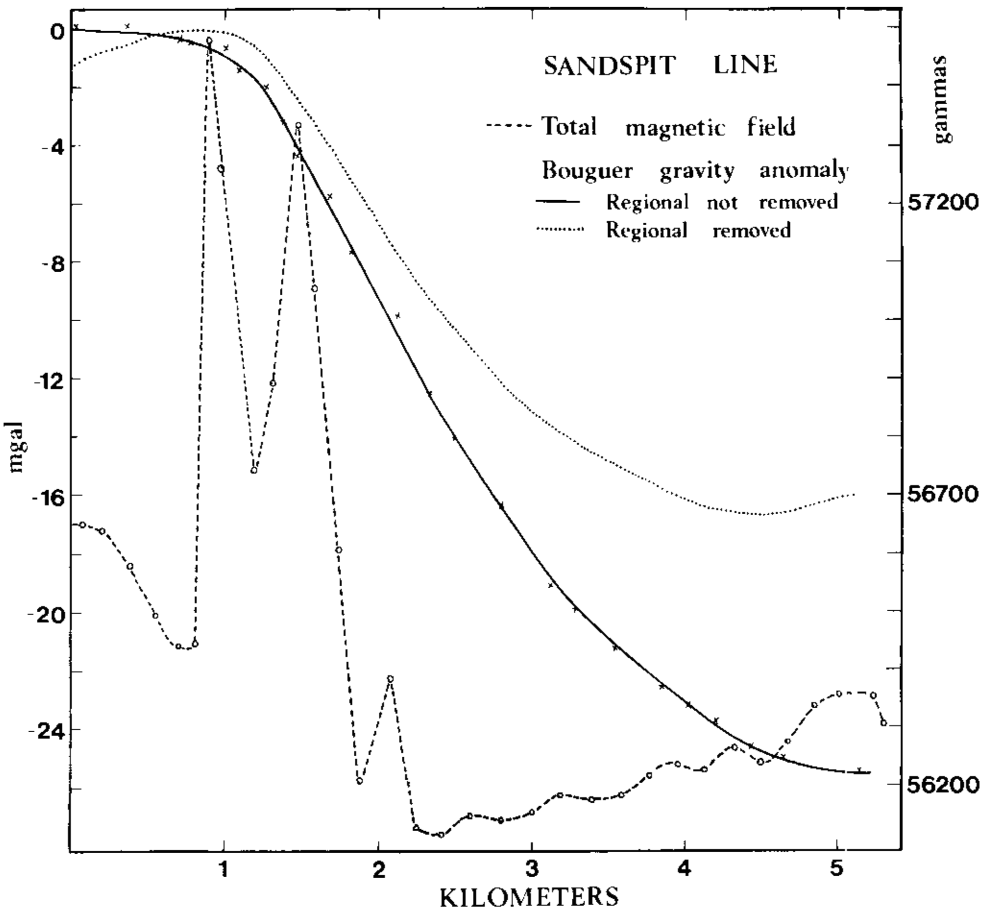

Figure 13. Gravity and magnetic intensity profiles — Sandspit line.

Gravity Measurements

A total of 70 gravity stations at spacings of 0.2 to 2.5 kilometres were occupied along four lines across the Sandspit fault zone. Gravity measurements, using a Worden gravimeter, have been corrected to mean sea level assuming a vertical gravity gradient equal to 0.09406 mgal/ft. and a crustal density of 2.67 g/cm^3. Reduced gravity values are estimated to be accurate within ±0.5 mgal. The detailed gravity survey supplements earlier work of the Earth Physics Branch which defined regional gravity gradients for the west coast (Stacey and Stephens, 1969).

An example of one of these profiles, the 'Sandspit line,' is shown on Figure 13. The observed Bouguer anomaly curve shows a 'mass deficit' below the east block of −25 mgal and a gradient of 12 mgal/km across the fault zone. The more relevant residual Bouguer curve, obtained by subtracting a linear regional gradient of +2 mgal westward (Stacey and Stephens, 1969), shows a deficit of −17 mgal and a gradient of 8.0 mgal/km. Analysis of the latter profile, using characteristic curves (Grant and West, 1965, pp. 283-286) gives a dip for the Sandspit fault of 50 degrees to 70 degrees east and a vertical displacement of approximately 1 500 metres (east block down). A uniform density contrast of -0.4 g/cm^3 for sediments infilling the Queen Charlotte Basin (compared to granitic and volcanic rocks of the western block) has been assumed in the above calculation. The total magnetic intensity profile over the Sandspit fault (Fig. 13) distinguishes clearly between buried magnetic source rocks and sediments.

Two-dimensional multidensity computer modelling of the gravity curves will be used to provide possible geological representations of the crustal structure in the vicinity of the fault zone. Inflection points, or mean values between gravity 'lows' and gravity 'highs,' are coincident on all lines with the surface trace of the fault indicated by topography and continuous seismic profiles obtained in Skidegate Inlet in our survey and by Grinsfelder (1959).

Continuous Seismic Profiles

Fifty-six kilometres of continuous seismic reflection, bathymetric, and magnetic profiles were run in Skidegate Inlet across the presumed submarine trace of the Sandspit fault between Graham and Moresby Islands. Discussion of the equipment and means of data collection are given in Young and Chase (in press).

Line drawings of selected portions of the seismic profiles (Fig. 14) show possible evidence of Quaternary (Pleistocene ?) faulting along subsidiary splays parallel with the main fault trace. An acoustically opaque unit terminates abruptly against poorly to well-stratified sediments, interpreted to be of Pleistocene and Holocene age respectively. The presumed fault surface is steeply dipping to near vertical. On three of the four profiles (Nos. 2, 3, and 4) the vertical component of movement appears to be east block up.

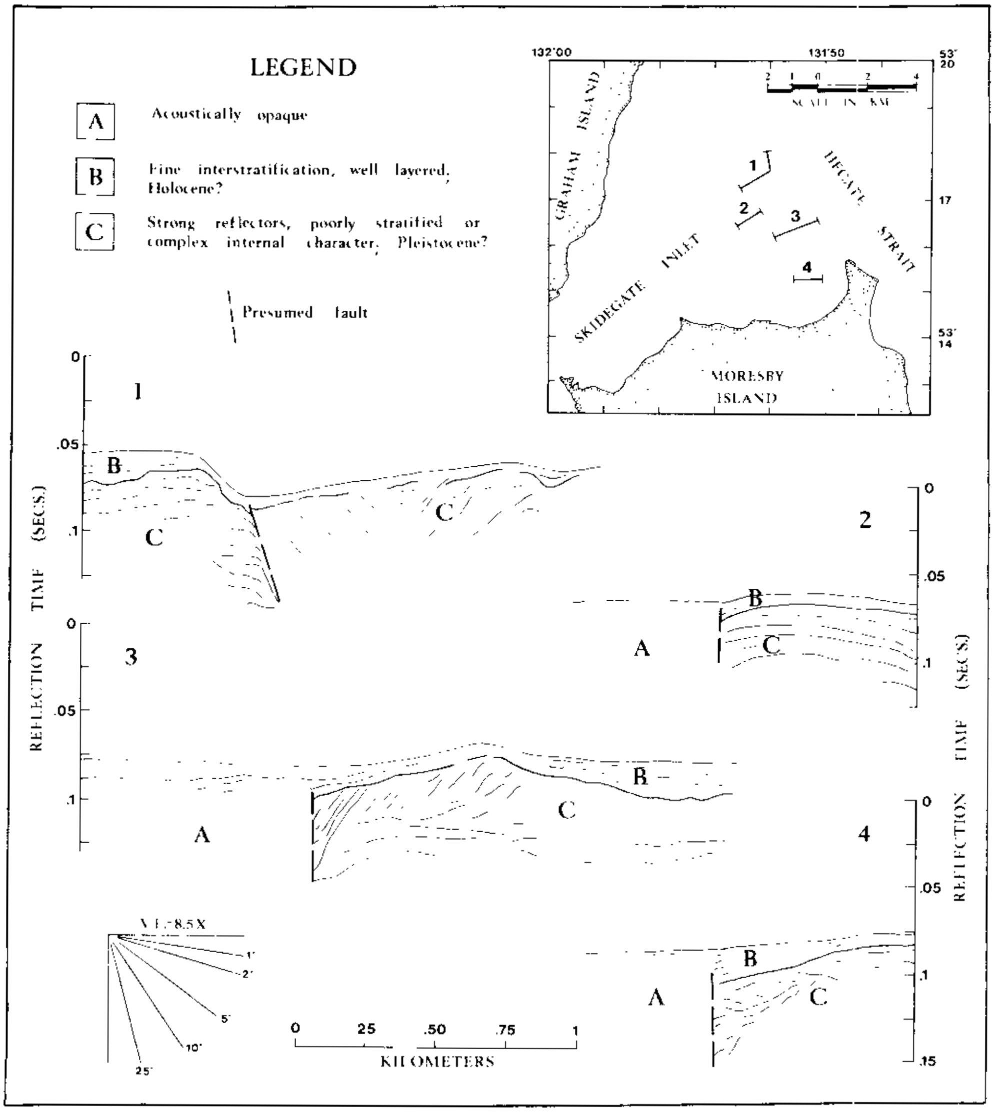

Figure 14. Seismic profiles – Sandspit fault.

Low magnetic intensity on profiles run in Skidegate Inlet suggests that sedimentary rocks (possibly the Cretaceous Haida Formation exposed on both north and south sides of the Inlet) underlie the Quaternary cover.

CONCLUSIONS

Analysis of gravity profiles suggests that in northeastern Moresby Island and southern Graham Island a major down-to-basin dislocation of up to 1 500 metres has occurred on the Sandspit fault. South of Cumshewa Head, below the waters of Hecate Strait, the western edge of the Queen Charlotte Basin does not appear to be fault controlled but is probably represented by an onlap of Neogene sediments on Mesozoic-Paleogene basement rock. Seismic profiles from Skidegate Inlet provide evidence for movement on subsidiary splay faults after the Pleistocene. The possibility exists however that such movement may only be related to local isostatic adjustments in the area.

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NORTHEAST BRITISH COLUMBIA

MINERAL PROPERTY EXAMINATIONS

By T. G. Schroeter

RED (94D/3E)

The Red copper prospect owned by Canadian Superior Exploration Limited is situated 20 kilometres west-northwest from the north end of Bear Lake and 160 kilometres north of Smithers.

Work during 1972, 1973, and 1975 by Canadian Superior included geochemical and geophysical surveying, geologic mapping, and diamond drilling of nine holes totalling 906 metres. During 1976, three diamond-drill holes totalling 352.6 metres were completed.

The property is underlain mainly by volcaniclastic rocks including light green intermediate tuffs, maroon (hematitic) tuffs and flows of the Hazelton Group. A lens of intercalated, impure, bioclastic, reefoid limestone mineralized with disseminations and minor fracture fillings of chalcopyrite is contained within the volcaniclastic sequence. A gabbro sill and small microdiorite stock intrude the rocks east of this lens. Minor amounts of bornite and chalcocite have been noted in the limestone. Traces of barite also exist.

References: *B.C. Dept. of Mines & Pet. Res.*, GEM, 1973, p. 404; Assessment Reports 4562, 5552.

IN (94D/3W, 6W)

The IN porphyry copper prospect owned by Canadian Superior Exploration Limited is located 30 kilometres west-northwest from the north end of Bear Lake, approximately 160 kilometres north of Smithers.

Previous work on the property during 1972 and 1973 included geochemical and geophysical surveys, geologic mapping, trenching, and 900 metres of diamond drilling. During 1976 Canadian Superior undertook a diamond drilling program consisting of two holes totalling 305 metres.

A prominent rust-stained mountain signifies an elongated, fractured, northerly trending pyritized zone developed within a Jura-Cretaceous sedimentary and volcanic sequence which has been intruded by essentially two types of Tertiary feldspar porphyry. The intrusives appear to be dyke-like with irregular contacts suggesting a subvolcanic level. An earlier altered quartz feldspar porphyry belonging to the Kastberg Intrusions is cut by varieties of biotite feldspar porphyry (BFP) which closely resemble the porphyries of the Babine Lake area and as such represent the most northerly known such porphyries of this type. A hornfels zone with secondary biotite and abundant disseminated and fracture-filling pyrite and minor chalcopyrite envelopes the intrusive masses.

Pyrite is ubiquitous and abundant in all rock types and occurs as disseminations and in fracture and vein fillings. Chalcopyrite also occurs as disseminations and in fracture and vein fillings within both types of porphyries. Trace amounts of molybdenite also exist associated with the quartz veining. Several phases of veining exist including quartz + pyrite ± chalcopyrite ± calcite ± fluorite. Magnetite and hematite occurring as blebs and as veinlets are also locally abundant.

Minor veinlets carrying sphalerite and galena were also noted.

Oxidation extends to depths of at least 45 metres.

References: *Minister of Mines, B.C.,* Ann. Rept., 1966, p. 81; *B.C. Dept. of Mines & Pet. Res.,* GEM, 1972, p. 479; 1973, p. 405; Assessment Reports 3868, 4563.

KEMESS (94E/2W)

The Kemess copper property is located approximately 280 kilometres north of Smithers and 9 kilometres east of Thutade Lake. Kennco Explorations, (Western) Limited diamond drilled nine holes during 1968, 1969, and 1971. In 1975, under an option agreement with Kennco, Getty Mines, Limited diamond drilled over 600 metres of BQ core in six holes and during 1976, a further 1 475.8 metres of both BQ and NQ core in seven holes.

A northwest-trending belt of Takla Group volcanic rocks have been intruded by stocks of diorite, quartz monzonite porphyry, syenite porphyry, and a quartz feldspar porphyry, all presumably related to the same Omineca intrusion. The volcanic rocks, which consist of a massive chloritic andesite and a porphyritic chloritic andesite, have been subjected to intense structural disturbances including numerous faults, shears, and fractures. The intrusive rocks show less structural disturbance. Major faulting exists in an east-west direction with numerous transverse faults.

Mineralization is almost entirely confined to the volcanic rocks and in particular the porphyritic variety and its altered equivalents. Disseminated and fracture-filling pyrite is ubiquitous in amounts averaging 5 per cent. Chalcopyrite also occurs as disseminations and in fracture fillings within the andesite. Abundant anhydrite ± quartz veins also carry varying amounts of disseminated and fracture-filling pyrite and chalcopyrite. Minor amounts of molybdenite were also noted in the veins. Magnetite is locally abundant as veinlets or blebs associated with pyrite. Pyrite is the only sulphide observed in the syenite porphyry. Coatings of chalcocite and covellite were observed in oxidized speciments.

Alteration and veining are common, particularly in the volcanic rocks. Silicification is widespread and locally the andesite takes on a white colour. Epidote is also widespread and occurs in fractures as well as being pervasive. Pink laumontite is common along fractures. Hematite is present on some fractures. Most of the feldspars have been sericitized. The most significant veining is that of purple anhydrite with or without quartz. Chalcopyrite and pyrite and minor molybdenite appear to be always associated with this veining.

References: *Minister of Mines, B.C.,* Ann. Rept., 1968, p. 149; *B.C. Dept. of Mines & Pet. Res.,* GEM, 1969, p. 104; 1971, p. 64; Assessment Reports 1705, 5748.

CHAPPELLE (94E/6E)

DuPont of Canada Exploration Limited conducted an exploration program in 1976 to test the mineralized quartz vein which has a drill-outlined length of 330 metres and an average width of 3 metres. The program consisted of 56.02 metres of drifting, 140.8 metres of raising, 59.43 metres of underground drilling in seven holes, and 760.7 metres of surface diamond drilling in 13 holes. Mineralization consists of pyrite, electrum, argentite, polybasite, and chalcopyrite in a vuggy quartz host which has undergone extensive block faulting and fracturing.

DuPont continued the drift completed by Conwest Exploration Company Limited in 1973, picked up the mineralized vein, followed it, and then made an 86.25-metre raise with three fingers at the end termed the 5454 raise. A crosscut was extended 7.9 metres to the southwest at a point approximately 39.62 metres in on the main drift from where a 54.55-metre-high taise (5450) was made which broke through to surface on the vein. Minor faulting of the vein (up to 8 metres displacement) was common.

The workings were surveyed and sampled, and a 9-tonne bulk sample from underground rounds was taken for testing.

References: *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; Assessment Reports 2581, 2819, 3171, 3198, 3343, 3367, 3417, 3418, 3419, 4066, 5268, 5667.

NORTHWEST BRITISH COLUMBIA

MINERAL PROPERTY EXAMINATIONS

By T. G. Schroeter

LETAIN – PROVENCHER LAKES JADE AREA (104I/7)

Several small operators have been working placer jade leases in an area centred around Letain Lake located approximately 80 kilometres east of Dease Lake. The jade boulders have weathered out from large masses of serpentine and are yielding some good quality material. A small airstrip with a camp, complete with large saws, is located in the valley between Wolverine Lake and Letain Lake to service companies exploring for jade. During the previous winter large boulders were trucked out to Dease Lake on Nodwells and during the summer of 1976 much of the cut jade was flown out to Dease Lake via helicopter and fixed-wing aircraft.

EAGLE (104I/6E, 11E)

The Eagle copper-molybdenum property is located approximately 50 kilometres east of Dease Lake. Imperial Oil Limited (under a joint venture agreement with Nuspar Resources Limited) diamond drilled five holes totalling 1 045 metres to test areas of coincident geochemical and geophysical anomalies. The work done was in three zones (Camp, Pass, and Bornite) along a linear zone over 3 000 metres long and 800 metres wide. The main host rock is an altered biotite-hornblende granodiorite and hornblende-biotite granodiorite in sheared contact with Lower Jurassic sedimentary rocks. Alteration includes strong saussuritization of feldspar, ± feldspathization, ± chloritization. Mineralization appears to be concentrated in steeply dipping shear zones, especially those containing chlorite and consists of chalcopyrite, bornite, molybdenite, and pyrite. Minor amounts of sulphides occur in quartz veins. Mineralization also appears to be related to K-feldspar flooding.

References: *Minister of Mines, B.C.,* Ann. Rept., 1963, p. 6; 1965, p. 16; *B.C. Dept. of Mines & Pet. Res.,* GEM, 1971, pp. 45, 46; 1972, pp. 540-543; 1973, p. 511; 1974, p. 349; Assessment Reports 585, 3476, 4256.

KEN, TOM (SNOWDRIFT) (104I/5E)

Utah Mines Ltd.'s Tom, Ken property is located some 30 kilometres southeast of Dease Lake. Approximately 275 metres in three holes was diamond drilled in a steeply dipping northwest-trending zone of shearing and alteration in a diorite-granodiorite which has intruded andesitic flows and pyroclastics. The quartz-sericite 'greisen' zone varies from a width of 300 metres in the southeast to a width of 1 000 metres in the northwest. Outcrops are leached, but locally pyrite is present in amounts up to 5 per cent. No copper mineralization was observed in the altered area, although minor malachite, chalcopyrite, and chalcocite are present in shears and quartz-carbonate stringers in unaltered volcanic rocks. Lazulite appears disseminated in parts of the altered zone. Significant concentrations of ferricrete fill the valley bottoms and presumably have been concentrated from the gossaniferous volcanic rocks.

References: *B.C. Dept. of Mines & Pet. Res.,* GEM, 1973, p. 511; Assessment Reports 4464, 5769.

ATLIN AREA (104N/11W)

(1) The Atlin Silver (Ruffner) mine is located approximately 25 air-kilometres northeast of Atlin on Vaughan Mountain. Construction of a 45 to 54-tonne per day crusher and mill was completed. The main ore block consisting of vein-type galena (with good silver values), sphalerite, and chalcopyrite in a mafic quartz monzonite exists between the 4100 and 4300 levels. Exploration work was also done on the 5700 level.

References: *Minister of Mines, B.C.,* Ann. Rept., 1923, pp. 89-91; *B.C. Dept. of Mines & Pet. Res.,* GEM, 1969, p. 28.

(2) The Adanac molybdenum deposit, located approximately 40 kilometres northeast of Atlin, was under option to Noranda Mines, Limited. During the summer underground sampling and mapping and surface mapping of alteration zones were done to further define ore potential.

References: *B.C. Dept. of Mines & Pet. Res.,* GEM, 1969, pp. 29-35; 1970, p. 28; 1971, pp. 53, 54; 1972, p. 557; 1973, p. 515; 1974, p. 351; Assessment Report 5071.

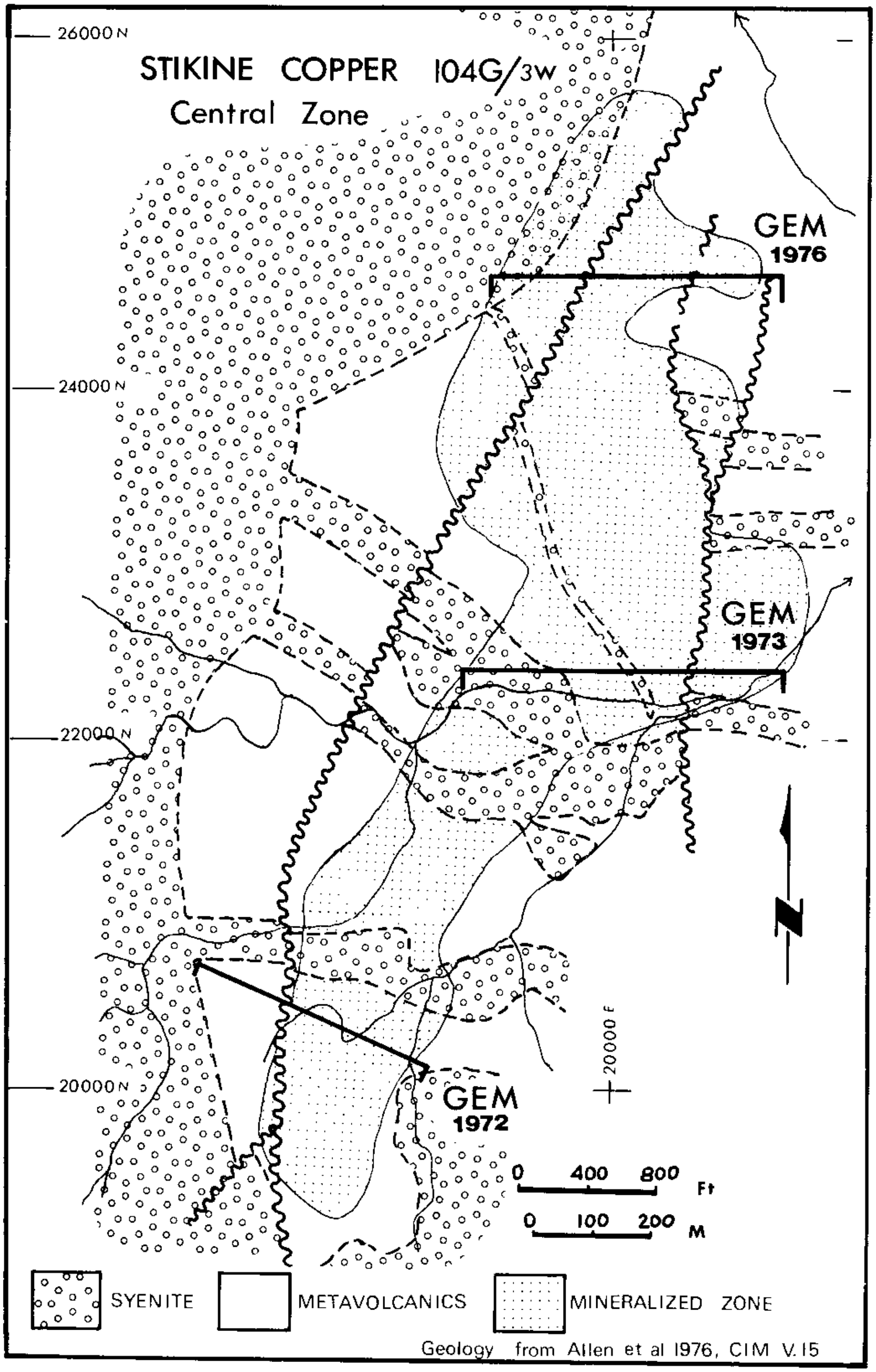

Figure 15. Locations of described geologic sections, Central Zone.

GALORE CREEK
(STIKINE COPPER LIMITED)
(103G/3W, 4E)

By A. Panteleyev

Exploration resumed at the Galore Creek deposit after a two-year interruption. A systematic fill-in diamond-drill program that was started in 1972 in the Central Zone by Hudson's Bay Mining & Smelting Co., Limited was concluded during the 1976 field season. Approximately 5 232 metres was drilled in 24 diamond-drill holes, mainly in the northern part of the Central Zone. No further drilling is planned for 1977.

Renewed exploration at the Galore Creek property facilitated completion of a study of the Central Zone that was initiated by this writer in 1972. The study is being done in conjunction with a 650-square-kilometre regional mapping project (Galore Creek Map-Area, Geological Fieldwork, 1974, pp. 59-62; 1975, pp. 79-81).

During 1976, about 2 250 metres of diamond-drill core from nine drill holes from the north Central Zone was examined. A detailed description of this drill section will be presented in *Geology, Exploration and Mining in British Columbia, 1976.* The northern part of the Central Zone is underlain by a well-mineralized bedded succession of highly altered metavolcanic rocks. This contrasts with the main parts of the Central Zone where syenite porphyries and breccia zones are abundant and very little can be determined about the original lithology, composition, and texture of the bedded host rocks.

Figure 15 shows locations of described drill sections.

RED – CHRIS DEPOSIT
(104H/12W)

By A. Panteleyev

During 1976 Texasgulf, Inc. continued to explore the Red–Chris porphyry copper deposit. Nineteen new diamond-drill holes were completed and two holes were extended, together amounting to 3 045 metres of diamond drilling.

The mineralized zone is associated with a large quartz stockwork system in an elongate monzonitic feldspar porphyry stock. Two new K-Ar determinations from samples provided by E. A. Schink, Texasgulf, Inc., indicate a Late Triassic – Early Jurassic age for the stock. The stock has intruded Upper Triassic sedimentary and volcanic rocks and is in fault contact with Middle to Late Jurassic sedimentary rocks of the Bowser Lake Group.

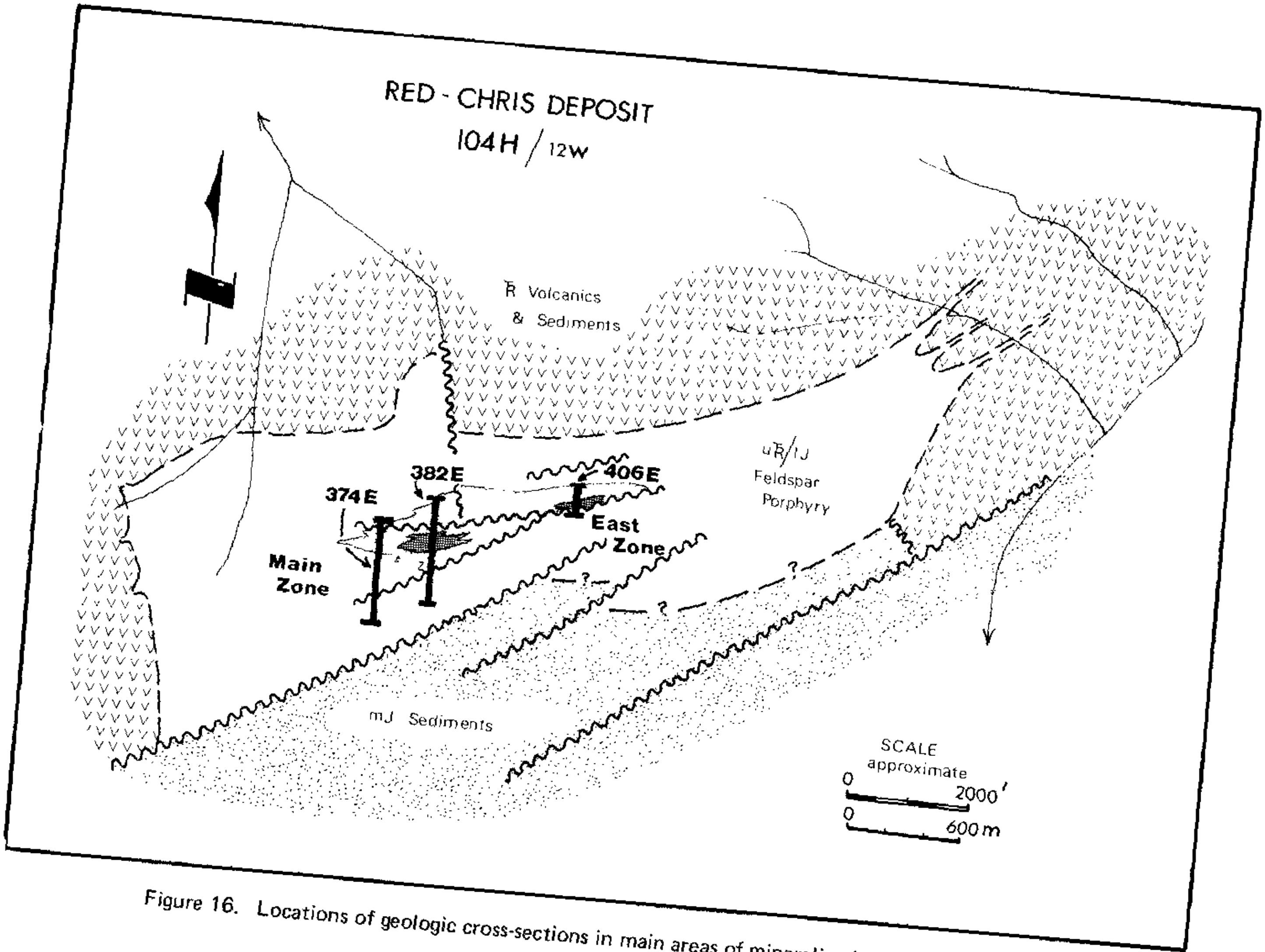

Figure 16. Locations of geologic cross-sections in main areas of mineralized quartz stockworks.

Diamond-drill core from 14 drill holes totalling approximately 2 880 metres in three sections was examined in detail. The sections are located in the Main Zone, East Zone, and in a gypsum stockwork zone west of the Main Zone (Fig. 16). The nature of the pyrite-chalcopyrite-bearing quartz stockwork and related carbonate-hematite-magnetite-chlorite-clay alteration assemblage will be studied and described in *Geology, Exploration and Mining in British Columbia, 1976.*

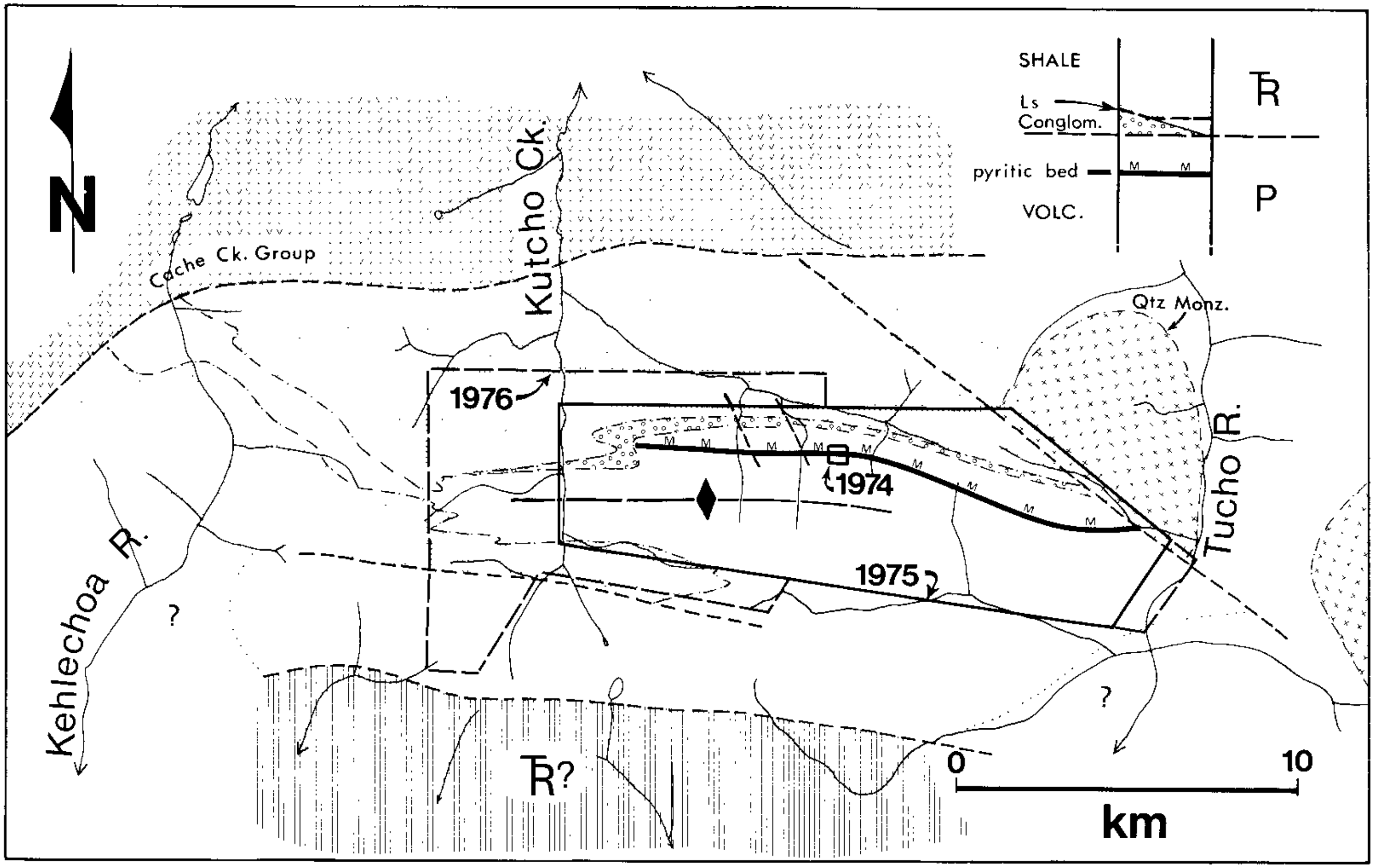

Figure 17. Major geological units mapped during 1974, 1975, and 1976, Kutcho Creek map-area.

KUTCHO CREEK MAP–AREA
(104I/1W)

By A. Panteleyev and D. E. Pearson

Geological investigations in the Kutcho Creek area begun in 1974 (GEM, 1974, pp. 343-348) proceeded in 1975 (Geological Fieldwork, 1975, pp. 86-92; Geology in British Columbia, 1975, in press), and continued in 1976. Work advanced in three main directions:

(1) Mapping was extended to the west of Kutcho Creek where volcanic and sedimentary rocks similar to those hosting the known sulphide deposits are now known to occur.

(2) Structure in the vicinity of the main mineralized zone was studied in detail and earlier interpretations were refined.

(3) A substantial amount of diamond-drill core and a number of critical outcrops were examined in detail in order to obtain a better understanding of lithology in the mineralized part of the stratigraphic succession.

The approximate extent of the volcanic map unit in which the sulphide deposits occur was determined from east of Tucho River to west of Kutcho Creek. The north and northwest boundary is a fault contact with rocks of the Cache Creek Group; to the east, quartz monzonite intrusions occur; and on the south are greenstones and phyllites of possible Triassic age. The favourable volcanic unit continues to the west and west-southwest of Kutcho Creek for at least 15 kilometres and probably for a considerably greater distance.

Volcanic rocks are locally overlain by conglomerate, a more or less continuous limestone unit commonly a few tens of metres in thickness, and a thick sequence of shale and sandstone (Fig. 17).

The structural style described in 1975 held up to closer scrutiny. The major structure mapped is an east-west-trending anticlinorium, the northern limb of which contains a number of smaller folds.

The presence of a folded unconformity can be demonstrated. Volcanic rocks are Early Permian (275±15 m.y.) as determined from a Rb-Sr isochron date provided by Dr. R. L. Armstrong of the University of British Columbia. The volcanic rocks are, therefore, temporal equivalents of the Cache Creek Group but are more closely correlative on a lithologic basis with the Asitka Group.

The overlying sedimentary sequence consists of a thick lens of polymictic conglomerate, a persistent limestone unit and a thick succession of shale, siltstone, and sandstone. A sparse fauna collected from two localities in the limestone includes pelecypods, gastropods, and Schleractinian corals, the latter indicating a Middle Triassic or younger age (the identification was provided by Drs. J.W.H. Monger and E. W. Bamber of the Geological Survey of Canada). We now regard the limestone unit to be part of the Sinwa Formation (late Upper Triassic) as described by Souther (*Geol. Surv., Canada,* Mem. 362, pp. 22, 23).

The coarse quartz-eye-bearing feldspathic chlorite schists referred to in 1975 as 'grits' (Geological Fieldwork, 1975, p. 88; Geology in British Columbia, 1975, in press) were re-examined. Their origin still remains an enigma. The lack of grading and sorting rules out a detrital on clastic origin and the rocks are now interpreted to be, at least in part, subaqueous ash flows. On the basis of chemical composition, mineralogy, and grain size we believe they are genetically related to the coarse-grained trondhjemites that are exposed along the southern part of the map-area. Some homogeneous, evenly textured quartz-eye feldspar crystal schists may be porphyries that were emplaced as dykes or sills.

Work is continuing in order to provide detailed descriptions of mineralogy and chemical composition of volcanic rocks and to yield a better understanding of the origin and depositional environment of major stratigraphic units.

A number of replicate stream and groundwater samples were collected and analyses determined that waters in the Kutcho Creek area are generally pure and of high quality although a number of samples were markedly anomalous in copper, zinc, iron, and sulphate. The samples serve as a base for further environmental and water quality studies.

COAL INVESTIGATIONS

EAST KOOTENAY COALFIELD

By David E. Pearson

INTRODUCTION

Systematic 1:10 000 scale mapping of the Crowsnest Coalfield commenced in the 1976 field season, when approximately 120 square kilometres was mapped. The area covered by the mapping project is indicated on Figure 18. The intent of this ongoing study is to provide up-to-date and reliable data for a thorough evaluation of coal resources.

The sub-areas mapped include freehold ground held by Kaiser Resources Ltd. and Kaiser Coal (Canada) Ltd., and also Parcel 73, the Northern Dominion Coal Block.

STRUCTURE

Structure is the single most important factor in localizing the coal measures in this district, and an understanding of it is fundamental to any discussions of geology.

Two types of structure dominate the district. First, there are reverse faults, the movement surfaces of which dip steeper than the bedding but in the same direction. The attitude of these faults changes about the Sparwood syncline (indicated on Fig. 18, to the east of Sparwood and to the west of Natal and Michel). These faults are caused by failure during flexural slip folding – the mechanism that caused this syncline.

Second, there are much larger faults that transect the area between Olson and Hosmer. These are regarded as thrust faults, the effect of which is to juxtapose allochthonous thrust plates E to B upon plate A (Fig. 18). The syncline indicated on thrust plate B has an overturned western limb, caused by drag against plates C, D, and E as they were pushed toward the northeast. This is illustrated diagrammatically on Figure 19, which is a cartoon section across the key area of the Northern Dominion Coal Block. From these two figures it is apparent that sections that are the right-way-up, sit directly upon sections with the same dip value, but which are inverted.

Such large-scale structures do not permit the uninterrupted tracing of coal seams, so that correlation by other methods must be utilized. They do, however, render useless the mining potential of some geographic areas while enhancing that of others.

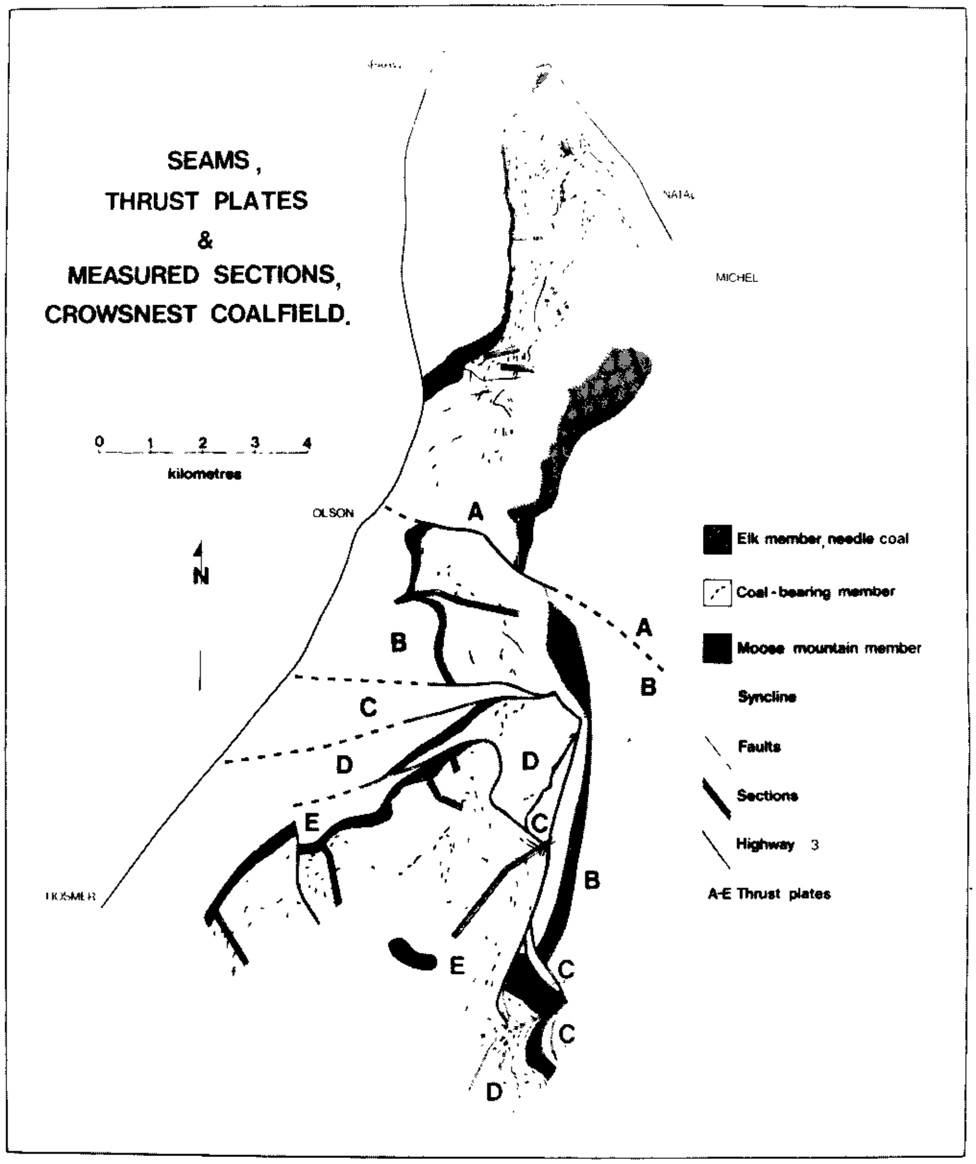

Figure 18. Area mapped in 1976 field season.

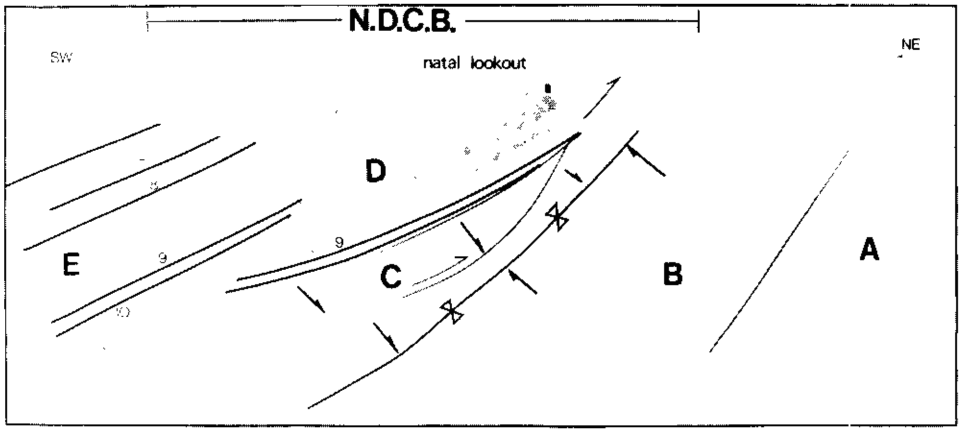

Figure 19. Cartoon section across the Northern Dominion Coal Block. Open arrows indicate relative movement along thrust surfaces; closed arrows indicate stratigraphic tops; grey bands on plates E and D indicate the positions of the prominent '9-seam' sandstone bodies.

Stratigraphy

The trace of a basal sandstone, the Moose Mountain Member, from Sparwood Ridge to Hosmer Ridge is indicated on Figure 18, along with the trace of the lowermost Elk Member. The coal measures sit between these two members. The base of the 'Elk Member,' on plate A, is taken as the thick conglomerate above which 'needle coal' is first found. Needle coal is a cannel coal that displays fossil pine needles on weathered surfaces. A similar conglomerate, possibly the same one, is found beneath needle coals on thrust plates B and E.

On Figure 18, every occurrence of coal over 500 centimetres thick is indicated and where significant shale bands split seams, more than one seam is indicated. Correlation of such exposures along Sparwood Ridge is excellent, and continuity of most seams (10 through 1) is demonstrable (Fig. 20). With certain exceptions, the measured section on Razor Ridge (on thrust plate B) can, in general, be correlated with the measured sections on Sparwood Ridge; the exceptions being that seam 9 is missing on Razor Ridge and a thick sand above the **trace** of 9 seam becomes more apparent.

Correlation of seams on thrust plate E is less reliable. From the eastern margin of the plate on Wheeler Ridge to its northern apex on Hosmer Ridge, correlation is good (Fig. 21, measured sections D and C). Correlations along the western side of Hosmer Ridge, however, are poor (measured sections A to C, Fig. 21), and should be regarded as tentative.

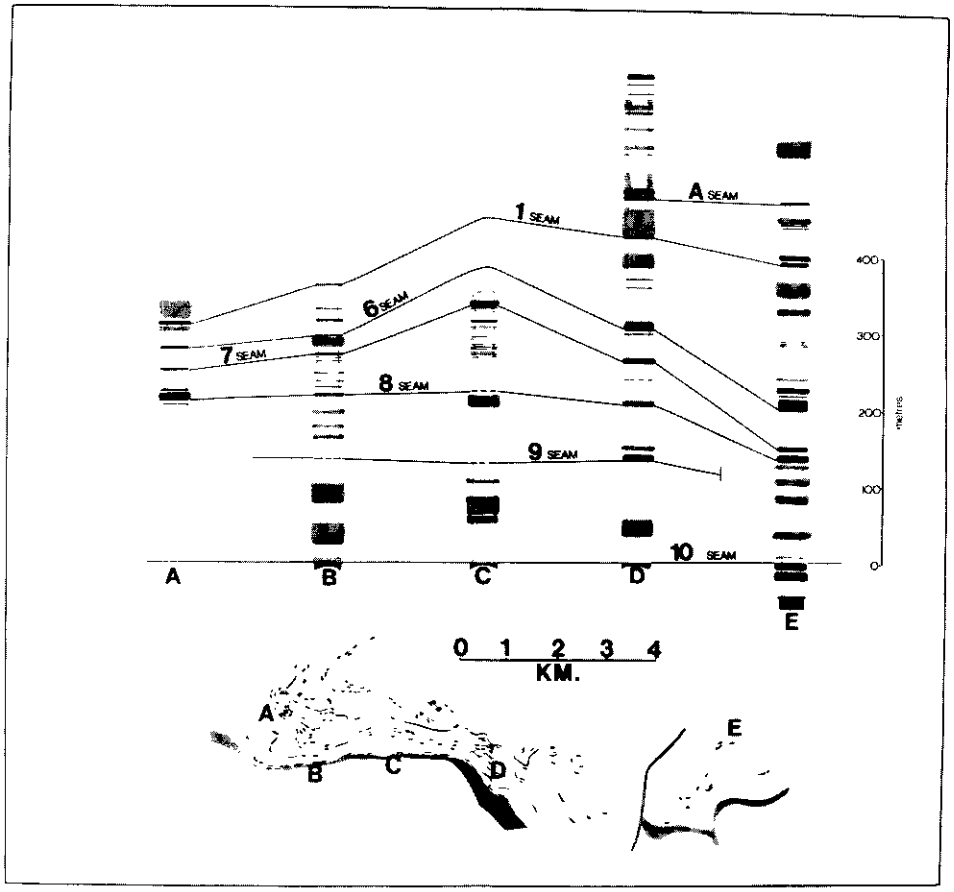

Figure 20. Correlation of measured sections on Sparwood Ridge. Grey areas on diagram indicate the positions and thicknesses of major sandstone bodies. Razor Ridge section is included on the far right of the diagram (Section E).

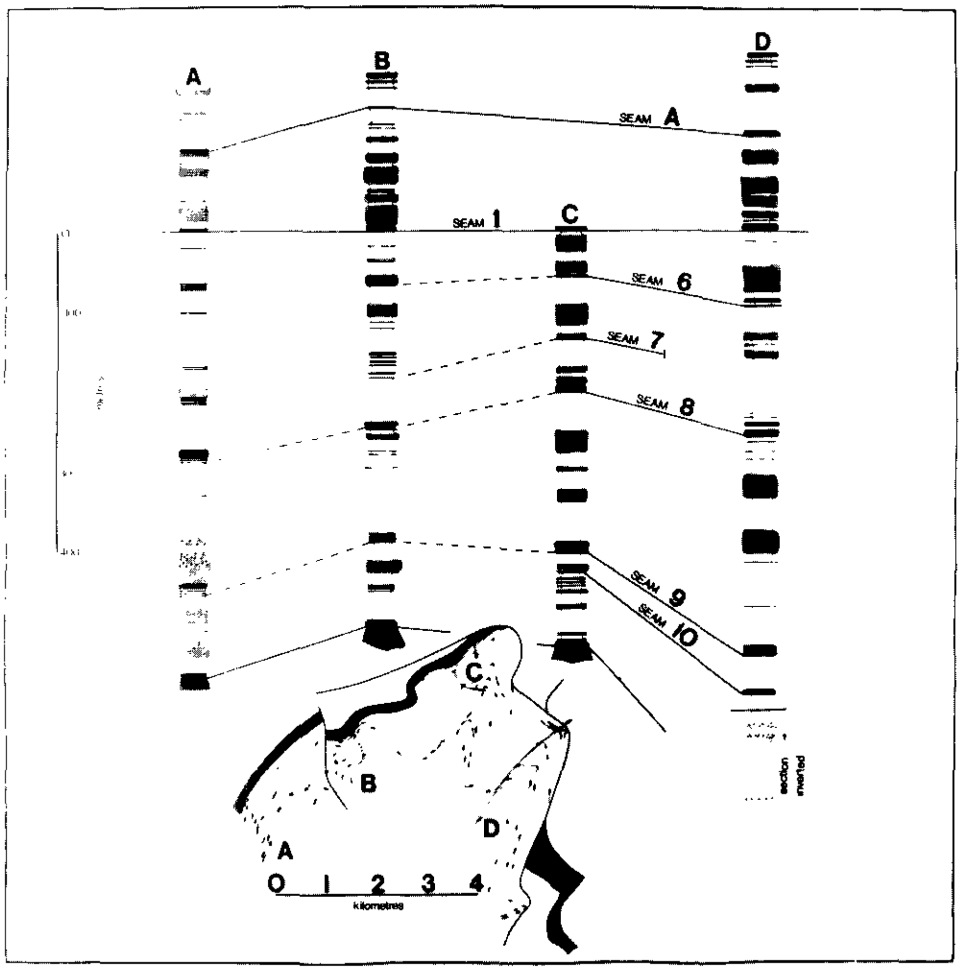

Figure 21. Correlation of measured sections on thrust plate E (Hosmer Ridge, Wheeler Ridge Area). Dark grey areas are basal Moose Mountain Member; medium greys in sections are prominent sandstone bodies; the light grey area is inverted Elk Member. Dashed lines indicate uncertain and tentative correlations.

Since the construction of Figures 20 and 21, it has been realized that the 4-metre-thick shale that splits 10 seam on Razor Ridge (section E, Fig. 20) thickens to the south (palinspastically the southwest), so that seams labelled 9 and 10 in sections C and D (Fig. 20) are respectively Upper 10 and Lower 10, separated by 15 metres in section C, and 41 metres in section D. No other correlations between the various plates have been attempted at this early date.

LABORATORY STUDIES

Laboratory studies on 125 channel samples of coal (approximately 1.5 tonnes) are to be performed. Each sample is to be ranked petrographically, and the maceral types identified. X-ray diffraction of the low-temperature ash will determine what constitutes mineral matters in these samples. X-ray fluorescence of whole coal is planned using whole-coal internal standards obtained from the Illinois Geological Survey.

ACKNOWLEDGMENTS

The able field assistance rendered by David Grieve, Frank Gigliotti, and Kevin Campbell is sincerely appreciated by the writer.

GEOLOGY OF THE SOUTHEASTERN PEACE RIVER COALFIELD

By B. P. Flynn, R. D. McMechan, and M. McMechan

At present the Peace River Coalfield is the subject of an extensive and continuing study by various Government departments, including the British Columbia Ministry of Mines and Petroleum Resources, which during the 1976 field season conducted a geological program over the southern one-third of the coalfield. The study was initiated as a result of a paucity of information on the geology, structure, and economic potential of this area relative to the remainder of the coalfield. The objectives were twofold: firstly the regional mapping of the licenced and unlicenced areas on a scale of 1:50 000 and secondly to assess the coal potential of the known coal-bearing strata and the economic status of the Minnes Group.

The map-area lies approximately 100 kilometres south of Dawson Creek and extends from Kinuseo Creek on the north to the Alberta border on the south, over a strike distance of 70 kilometres, encompassing an area of 840 square kilometres. Coal licences held by McIntyre Mines Limited – Canadian Superior Exploration Limited (Monkman-Belcourt) and Denison Mines Limited (Belcourt and Saxon) cover the coal-bearing strata in two northwesterly trending belts. The Saxon property received only cursory examination and is not dealt with in this report.

GEOLOGY

The map-area is underlain by Upper Jurassic and Lower Cretaceous strata, and is bounded on the west by Paleozoic strata (thrust over the Lower Cretaceous formations along their entire strike length) and on the east by Upper Cretaceous formations. The main lithological units are shown on Figure 22. Stott (1968) provides an excellent account of the stratigraphy of the coalfield and only comments pertinent to the map-area follow.

Minnes Group strata occupy the core of a broad northwesterly trending anticlinal structure which extends the length of the map-area.

The Minnes Group was mostly prospected for coal and not mapped in the same detail as the Bullhead and Fort St. John Groups, due to lack of marker horizons, a lack of economic coal seams, and the intense structural deformation.

The Bullhead and Fort St. John Groups occupy two narrow linear belts along the limb of the anticlinal structure. The Cadomin Formation overlies the Minnes Group unconformably and, although greatly variable in thickness, provided an excellent marker horizon readily traceable throughout the map-area. Both the Gething and Moosebar Formations are thinner in the map-area than in the central and northern areas of the coalfield. The Gething Formation ranges from 20 metres to 120 metres and the Moosebar

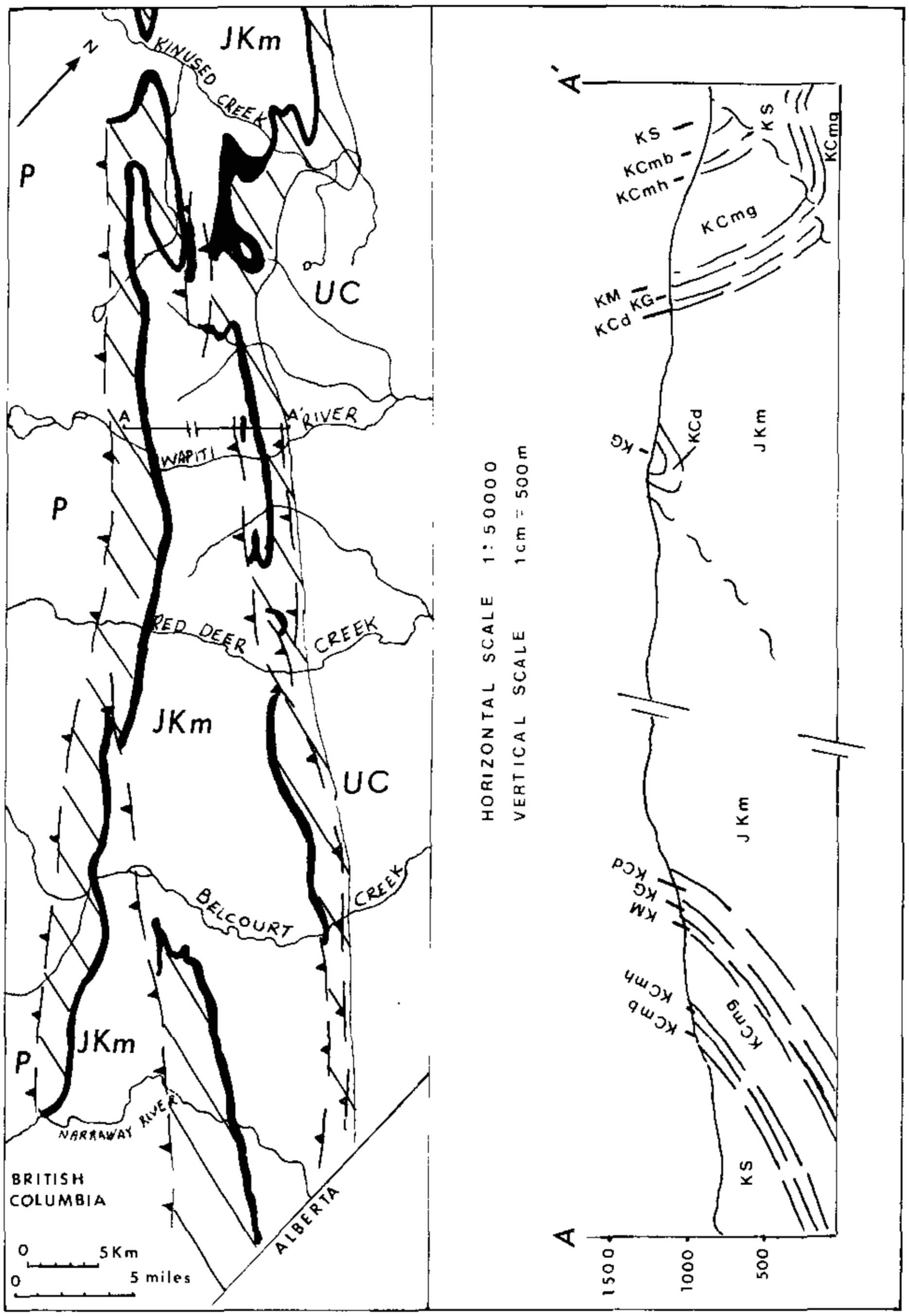

Figure 22. Generalized geological sketch map and cross-section.

LEGEND

UC — **UPPER CRETACEOUS**

LOWER CRETACEOUS

FORT ST. JOHN GROUP

KS — **SHAFTESBURY FORMATION**

SHALES, SILTSTONES, AND SOME SANDSTONE

COMMOTION FORMATION

KCmb — *BOULDER CREEK MEMBER*

FINE TO COARSE–GRAINED SANDSTONE, CONGLOMERATE, AND MINOR SHALES

KCmh — *HULCROSS MEMBER*

DARK MARINE SHALE WITH SIDERITIC CONCRETIONS, SOME SILTSTONE

KCmg — *GATES MEMBER*

FINE TO COARSE–GRAINED CARBONACEOUS SANDSTONES, CONGLOMERATE, MUDSTONE, SHALE, AND COAL

KM — **MOOSEBAR FORMATION**

DARK MARINE SHALE AND MUDSTONE

BULLHEAD GROUP

KG — **GETHING FORMATION**

CARBONACEOUS SANDSTONE, CONGLOMERATE, MUDSTONE, AND COAL

KCd — **CADOMIN FORMATION**

MASSIVE CONGLOMERATE, SOME SANDSTONE

JKm — MINNES GROUP

THIN–BEDDED SANDSTONES, MUDSTONES, SHALES, AND COAL

P — **PALEOZOIC**

UNDIFFERENTIATED

SYMBOLS

GROUP OR FORMATION BOUNDARY . . . .

THRUST FAULT . . . .

Formation averages 45 metres thick. The Gates Member of the Commotion Formation varies from 360 metres in the southwestern belt to 510 metres in the northeastern belt. A transitional zone, characterized by bioturbation and worm burrows, between the marine Moosebar Formation to the non-marine Gates Member, will be useful in determining the Moosebar/Gates contact, especially in drill holes.

The position of the recessive Hulcross Member was in most cases inferred, due to lack of outcrops and dense tree cover, as was the position of the Boulder Creek Member over most of the northern part of the northwestern belt. The Hulcross Member averaged 45 metres and the Boulder Creek Member 90 metres thick.

STRUCTURE

Structurally the map-area can be divided into three belts: a central belt occupied by the Minnes Group which has undergone faulting and intense folding, both on a major and a minor scale; a southwestern belt of Bullhead and Fort St. John Groups which is relatively undeformed with dips in the order of 30 degrees to 50 degrees to the southwest, and finally a northeastern belt of deformed Bullhead and Fort St. John Groups characterized by *en echelon* folds trending northwest, which are cut by southwesterly dipping thrust faults.

COAL POTENTIAL

The Minnes Group, although coal-bearing, appears to have little economic potential due to the thin nature of the seams (less than 1 metre) and the intense structural deformation undergone by the Group.

The Gething Formation and Gates Member are the chief coal-bearing strata of the coalfield with the Gething Formation being dominant in the north and the Gates Member in the south. This was borne out in the map-area. However three seams between 1 and 2 metres were located within the Gething Formation indicating that the formation is worthy of continued exploration. The Gates Member has the greatest economic potential in the map-area. With the limited amount of data provided by trenching, correlation could only be very tentative. Seams range from a metre up to 10 metres thick.

A very conservative estimate of the inferred resources of 1 400 million tonnes of coal was computed for the Gates Member within the map-area.

REFERENCE

Stott, D. F. (1968): Lower Cretaceous Bullhead and Fort St. John Groups, Between *Smoky and Peace Rivers, Rocky Mountain Foothills, Alberta and British Columbia, Geol. Surv., Canada,* Bull. 152.

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