BRITISH COLUMBIA DEPARTMENT OF MINES
AND PETROLEUM RESOURCES

HON. W. K. KIERNAN, *Minister* P. J. MULCAHY, *Deputy Minister*

LODE METALS
IN BRITISH COLUMBIA

1960

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(Reprinted from the Report of the Minister of Mines and Petroleum Resources for the Year Ended December 31st, 1960)

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1961

Lode Metals

CONTENTS

	Page
General Review	3
Notes on Metal Mines	6
Alsek River	6
Cassiar	6
Portland Canal	6
Alice Arm	8
Observatory Inlet	10
Queen Charlotte Islands	11
Ecstall River	12
Scotia River	12
Kitimat	13
Cedarvale	13
Hazelton	13
Smithers	13
Eutsuk Lake	14
Omineca	14
Cariboo	15
Clinton	19
Lillooet	20
Anderson Lake	24
Highland Valley	25
Merritt	26
Nicola Lake	41
Greenstone Mountain	41
Tulameen	42
Ashnola River	55
Similkameen River	55
Copper Mountain	57
Princeton	57
Hedley	57

NOTES ON METAL MINES—*Continued*

PAGE

Keremeos 58
Fairview Camp 61
Camp McKinney 62
Beaverdell 62
Greenwood 63
Phoenix 65
Rossland 66
Trail 66
Nelson 66
Ymir 67
Salmo 68
Nelway 71
North Kootenay Lake 72
Woodbury Creek 74
Paddy Peak 75
Kaslo 75
Retallack-Three Forks 75
Sandon 76
Springer Creek 76
Burton 77
North Lardeau 77
South Lardeau 79
Kimberley 82
Windermere 83
McCulloch Creek 85
Revelstoke 86
Skagit River 87
Hope 87
Howe Sound 89
Texada Island 89
Bute Inlet 90
Vancouver Island 90

REPORTS ON GEOLOGICAL, GEOPHYSICAL, AND GEOCHEMICAL WORK 125

GENERAL REVIEW

All principal metals but lead showed an increase in the average Canadian price paid in 1960 as compared to 1959. The price for lead decreased a very small amount. The price for gold was up about 1 per cent owing to a slight change in the average rate of exchange. The price for silver increased a little over a cent an ounce, the price for copper increased about a cent and a quarter, and the price for zinc increased about a cent and a half, compared to 1959. The New York price for silver was steady at 91.375 cents per ounce. The United States price for copper started 1960 at 31 cents per pound and closed just below 27 cents per pound. The New York price for lead was steady at 12 cents per pound, only to fall to 11 cents in December. The East St. Louis price for zinc started 1960 at 12.5 cents per pound and fell to 12 cents at the end of the year.

Gold, silver, copper, lead, and zinc produced at British Columbia lode mines in 1960 had a value of $112,735,769. Miscellaneous metals, including iron ore, nickel, tin, and minor metals recovered at the Trail smelter, had a value of $17,714,969. The total quantity of ore mined at all lode mines amounted to 8,242,703 tons and came from sixty-seven mines, of which thirty-one produced 100 tons or more. The average number employed in the lode-mining industry in 1960, including mines, concentrators, and smelters, was 7,423.

In 1960 twenty-eight mills were operated—sixteen throughout the year and six on a seasonal or intermittent basis. Of the latter, two were operated by lessees and one accepted custom ore. Four mills closed and one small mill at Tofino operated for the first time. The Pioneer mine shut down after thirty-five years of continuous operation, Cowichan Copper after three years, and Hualpai Enterprises after less than one year. At the Mastodon mine, after a seven-year closure, production was resumed in June and ceased in October. Of the year-round operating mills, three treated ores of gold, three copper, seven silver-lead-zinc, two iron, and one nickel.

The Trail smelter recorded custom receipts of 10,043 tons of ore from thirty properties, 9,468 tons of which, from seven properties, obtained a silica bonus in excess of the treatment charge. The smelter also recorded custom receipts of 1,228 tons of lead concentrates and 35,331 tons of zinc concentrates. Totals of approximately 15,470 tons of lead concentrates and approximately 41,660 tons of zinc concentrates were shipped out of the Province for smelting. Copper concentrates were shipped to the Tacoma smelter, except for the output of Cowichan Copper, the copper concentrates recovered by Texada Mines Ltd., and the copper contained in bulk nickel concentrates from Giant Nickel Mines Limited, all of which went to Japan. All iron-ore concentrates, amounting to 1,156,297 tons, were shipped to Japan.

The production of gold was higher than in 1959 and, due partly to a slightly higher value of the American dollar, the total value was approximately 10 per cent higher than in 1959. This was because of increased production at Bralorne, new production at Premier and Camp McKinney, and an increase in the production of copper, of which gold is a by-product. The Pioneer mine closed in August due to depletion of reserves, after thirty-five years of continuous operation. Total production for the life of the mine was approximately 1,331,500 ounces of gold from almost 2½ million tons of ore. The Cariboo Gold Quartz' Aurum mine encountered a better grade of ore than in 1959, and the company was engaged in opening up the new Burnett ore zone in the Mosquito Creek section of the property. The old Cariboo Amelia at Camp McKinney produced again after a lapse of fifty-seven

years since the last company operation and, aided by the bonus for siliceous ore, shipped direct to the Trail smelter.

The output of silver ore was less than the average for some years past. However, more silver was produced than in 1959, because of the increased production of lead.

Copper production about doubled, and was paid for at about 1¼ cents per pound more than in 1959. Cowichan Copper closed down for lack of ore late in 1960, but at the same time it was announced that the Sunloch property had been leased and that the mill at Cowichan Lake would be transferred to the Sunloch at Jordan River.

At Craigmont, preparation of an open pit began in June, and at the end of 1960 construction was under way at the site of the proposed 4,000-tons-per-day mill. At Bethlehem no agreement had been reached at the end of 1960, although a considerable amount of investigational work had been done by the company on behalf of Sumitomo Metal Mining Company of Tokyo. The Old Sport mine of Coast Copper Company Limited was being readied for production, after twenty years of inactivity; the concentrates will go to Japan.

Exploration for copper continued at a good pace, although there was a weakening of activity in some parts of the Merritt-Highland Valley area. Some ground has been gone over by more than one company, and it would seem that techniques for the demonstration of anomalies have rather overshadowed the techniques for their elucidation. Recent work has in no way narrowed the " copper belt," but it has shown that orebodies are not easy to find.

Copper exploration continued in the northwest part of the Province, at several localities, extending from the vicinity of Stewart to the Alsek River. Geological mapping done by Newmont Mining Corporation in the general Leduc-Unuk Rivers area demonstrated an exploration technique new in British Columbia. This was systematic regional mapping, of a sort usually done by governmental agencies, carried out over two seasons by a group of geologists supported by helicopter. As a result, a decision was reached early in January, 1961, to do additional development work on the Granduc property and to investigate other recently discovered showings.

The production of lead was up 16 per cent from that of 1959, an increase largely the result of mining ore with a higher lead content at the Sullivan mine. The output of the other larger mines was lower, and there was a drop in production from the Slocan. The production of zinc showed little change compared to 1959. The Mastodon mine, which had a short period of production in 1952 and had lain idle for nearly seven years, was reopened and the mill operated for five months. The operation failed owing to lack of ore and inability to recover oxidized sulphides.

Work on the Duncan Lake property by Consolidated proved the existence of a mine, but the outlook for lead was deemed too unsatisfactory to warrant an operation at present, and the development crew was withdrawn. Interest in the area did not diminish, however. In other parts of the Province, exploration for lead and zinc was at a low ebb.

The importance of the magnetite deposits in the coastal region continued to grow, in spite of the fact that one operation was closed. Prospecting was done, and several properties were under development or exploration. A magnetite deposit of relatively large apparent size was discovered just east of Kennedy Lake on Vancouver Island, and was at once investigated by diamond drilling. The Annual Report of the Minister of Mines for 1902 records the presence of a " very marked magnetic attraction " at this site and the fact that an unsuccessful attempt had been made to reach bedrock to investigate the cause of the attraction.

Nickel was exported to Japan in the form of a bulk concentrate from the Giant Nickel operation, after termination of a contract with Sherritt-Gordon Mines Ltd.

An activated raise platform, or, more simply, a raise machine, was used at two properties to drive vertical raises 310 and 465 feet. These machines have saved time and expense in driving long raises. Ammonium nitrate blasting agent, introduced into British Columbia quarries in 1957, was the most used blasting material in open-pit mines and quarries in 1960, when more than a million and a half pounds was used, twice the quantity used in 1959.

NOTES ON METAL MINES

ALSEK RIVER*

Copper-Cobalt

Windy and Craggy (Ventures Limited) (59° 137° N.W.) Head office, 25 King Street West, Toronto. H. V. Fraser, president; Alex. Smith, manager; J. McDougall, geologist in charge. The Windy and Craggy groups comprise fourteen recorded mineral claims and are about 20 miles north of the junction of the Alsek and Tatshenshini Rivers.

Copper and cobalt mineralization, occurring in a massive pyrrhotite replacement of pillow lavas, outcrops between the head wall of a cirque and precipitous bluffs to the north. Using a Hiller 12E helicopter for transportation, a 9- by 12-foot prefabricated building was assembled on the property. The helicopter was used to service a crew of eight.

In the period July 28th to October 1st, eleven packsack holes, totalling 800 feet, were drilled and a topographical and geological survey of the property was made.

The property was not visited.

CASSIAR†

Gold

Copco (59° 129° S.W.) This property consists of seventy-three recorded claims—Copco Nos. 1 to 69 and Cote Nos. 1 to 4. These claims, which were located by J. J. Copeland and J. I. Couture, cover the showings formerly held by Benroy Gold Mines Limited and originally known as the Cornucopia group. The group is on the east slope of Quartzrock Creek valley and 2 to 3 miles north of McDame Lake. The showings have been described in the 1947 Annual Report.

During the summer of 1960 a Gibson self-amalgamating mill was installed near the lower extremity of the exposed part of one of the quartz veins containing visible gold. It has been reported that this mill treated 25 tons of vein material during the season.

Work on the property, which was carried out by three men, included the construction of approximately half a mile of road between the Cassiar road and the mill-site.

[References: *Minister of Mines, B.C.,* Ann. Repts., 1946, p. 61; 1947, pp. 70–72.]

PORTLAND CANAL

†Exploration activities supplied by aircraft based at Stewart were carried on by Granduc Mines, Limited, Newmont Mining Corporation of Canada Limited, and The Granby Mining Company Limited.

The Granduc company, under the supervision of G. W. H. Norman and employing a large crew of geologists and geophysical operators, made extensive air-borne geophysical surveys, ground geophysical surveys, and geological surveys in the area lying between Granduc mine and the Unuk River. As a result of their air-borne geophysical surveys, the company in June located twenty-four claims on the north side of Fewright Creek, 248 claims along the Unuk River on the north slope of McQuillan Ridge, and seventy-eight claims at the junction of Gracey Creek and south Unuk River.

* By W. C. Robinson.
† By Stuart S. Holland.

The Newmont company, under the direction of D. M. Cannon, did some exploration work on Surprise Creek west of Meziadin Lake on claims located by R. K. Watson, of Stewart, also on their Todd Creek showing, which was located in September, 1959.

The Granby company prospectors were supervised by Keith Fahrni.

Tide Lake (56° 130° S.E.)*

Gold-Silver

East (Dempster Exploration Company Ltd.)

Company office, 2281 Yonge Street, Toronto. L. Dempster, president; C. Riley, consulting geologist. The property, which is on the west side of the Tide Lake valley, consists of fourteen recorded claims held under option from A. Phillips, of Stewart. The property has been described in the 1946 Annual Report. Work in 1960, which was carried out by a crew of five men under the direction of D. Irving, commenced on June 1st and was suspended on September 30th. Initial work consisted of the cleaning-out of underground workings to make them accessible for the detailed geological examination which followed. Subsequently, 1,248 feet of drilling was done underground and 691 feet of drilling was done on the surface.

Equipment on the property included a Bull Moose C 25 crawler. This tractor was used to construct an airstrip, measuring 1,350 by 60 feet, on the Tide Lake flats. This airstrip enabled the camp to be serviced by wheel-equipped aircraft based at Stewart. The property was not visited.

[References: *Minister of Mines, B.C.*, Ann. Repts., 1927, pp. 106, 107; 1930, p. 117; 1939, p. 66, under the name " Pioneer group "; 1944, p. 53; 1946, pp. 68–72; 1950, p. 76; 1953, p. 90.]

Bowser Lake (56° 129° S.W.)*

Copper

Todd Group

Fifty-two recorded mineral claims, Todd Nos. 1 to 52, are held by Newmont Mining Corporation of Canada Limited. The claims are at the head of Todd Creek, approximately 30 miles north of Stewart. The showings are reported to consist of chalcopyrite-pyrite bearing quartz impregnated fault zones in brecciated dacite. The structures are continuous over distances in excess of 2,000 feet. Quartz and sulphide mineralization are restricted to situations at and near the intersections of two such faults. Minor gold values are associated with the chalcopyrite.

Work commenced in May and continued to September. The work was done by an average crew of eight men under the supervision of T. C. Osborne. Four holes, totalling 1,150 feet, were diamond drilled. Outlying showings were investigated by surface trenching and packsack drilling.

The property was serviced by a Piper Supercub aircraft, which landed on a previously prepared landing-strip. The property was not visited.

Bear Pass (56° 129° S.W.)*

Lead-Zinc

Surprise Group

This property it at the head of a tributary of Surprise Creek, east of Bear Pass, and consists of twenty claims held by record. It has been reported that the showings consist of pods of nearly massive mixed galena, sphalerite, and pyrrhotite in highly fractured limestone at and near its contact with quartzite.

* By W. C. Robinson.

Work during 1960, which commenced in August and was completed in September, was done by Newmont Mining Corporation of Canada Limited. The geology in the vicinity of the showings was mapped in detail and six packsack-drill holes were put down to test the mineralization below the zone of oxidation.

Three men were employed, the crew being serviced by Piper Supercub aircraft which landed on the glacier. The property was not visited.

SALMON RIVER (56° 130° S.E.)*

Gold-Silver-Lead-Zinc

Silbak Premier Mines Limited

Company office, 844 West Hastings Street, Vancouver 1. A. E. Bryant, president; Hill, Starck and Associates, consulting engineers. Under a lease from the company that terminated on September 23rd, 1960, Bermah Mines Ltd. (that is, T. J. McQuillan and his two partners) and a crew of eight men mined and shipped ore from a small high-grade shoot in a newly discovered vein lying on the footwall side of the old Premier glory-hole.

The vein was found in 1959 by one of the partners who walked down through the old glory-hole and found high-grade float which had sloughed from a vein parallel to and 15 feet on the footwall side of the main vein that had been stoped in the glory-hole. During the latter part of 1959, McQuillan and his partners shipped 62 tons of high-grade ore sorted from the slough in the bottom of the glory-hole. This 62 tons of ore contained a total of 650 ounces of gold and 16,829 ounces of silver.

In 1960 a short sublevel drift 30 feet long was driven along the new vein and a raise put through to surface in ore. High-grade ore as a shoot about 35 feet long, 4 feet wide, and 100 feet down dip was benched down through the raise and drawn off through the sublevel.

On the termination of the lease on September 23rd, the company bought the lessees' equipment and, with a crew of twelve men, continued to mine high-grade ore until November 1st, 1960, when operations ceased.

Production during 1960 amounted to 1,282 tons of high-grade ore, 1,239 tons being mined by Bermah Mines Ltd.

[References: *Minister of Mines, B.C.,* Ann. Repts., 1947, pp. 74–82; 1956, pp. 17, 18; *Geol. Surv., Canada,* Mem. 175, pp. 161–166.]

ALICE ARM†

Silver

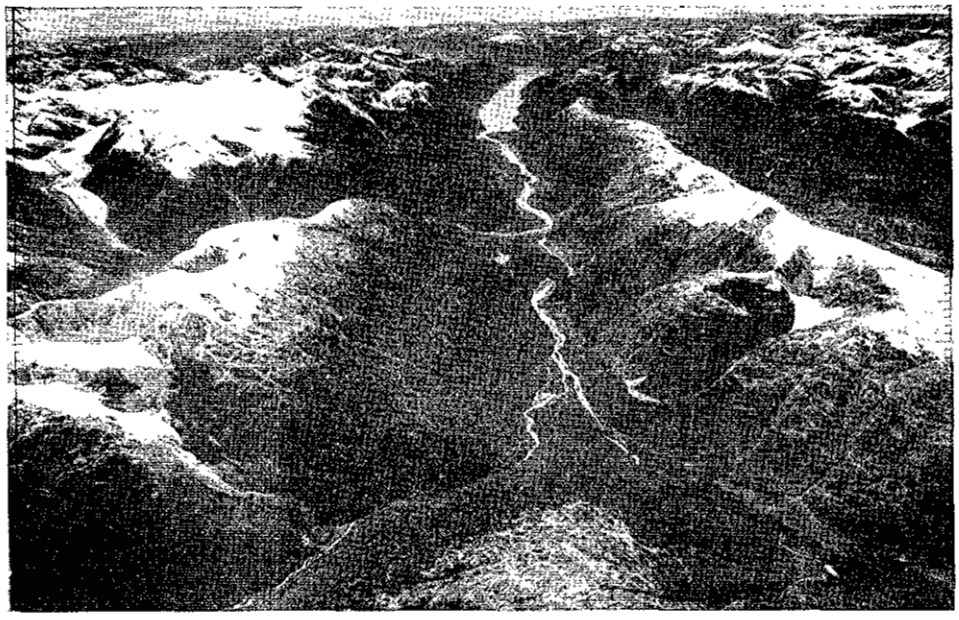
Wolfe (Dolly Varden Mines Ltd.)

(55° 129° N.W.) Company office, 355 Burrard Street, Vancouver 1. W. Clarke Gibson, president; Hill, Starck and Associates, consulting engineers. The property, which comprises four Crown-granted mineral claims, is held under option from the estate of the late Victor Spencer. The claims are on the east slope and bottom of Kitsault Valley about one-quarter of a mile south of Trout Creek. The property has been described in the 1951 Annual Report. During October, 1960, eight holes totalling 1,400 feet were diamond drilled to check the downward extensions of the main vein.

Transportation was by helicopter, although the property can be reached by following 17 miles of good motor-road up the Kitsault Valley from Alice Arm to the old Torbrit mine and thence by 2 miles of tractor-road.

[References: *Minister of Mines, B.C.,* Ann. Repts., 1916, pp. 52, 77; 1928, pp. 85–86; 1951, pp. 97–98; *Geol. Surv., Canada,* Mem. 175, p. 87.]

* By Stuart S. Holland.
† By W. C. Robinson.



(Aerial oblique photo B.C. 510:44.)

Looking down Bear River valley to Stewart at the head of Portland Canal. Junction of American Creek in foreground and of Bitter Creek in mid distance.

(Aerial oblique photo B.C. 510:42.)

Head of American Creek and north end of Bear River ridge. Salmon glacier in centre distance. Adjoins photo above.

Molybdenum

Alice (Kennco Explorations (Western) Limited)

(55° 129° S.E.) Head office, 25 King Street West, Toronto 1. C. J. Sullivan, president; J. R. Woodcock, engineer in charge of property. A total of sixty-eight claims are held—fifty-five by record and thirteen by option. The property is on Lime Creek about 5 miles southeast of Alice Arm. A circular stock, about one-half mile in diameter, intrudes greywacke of the Hazelton group. It has a quartz stockwork and molybdenum mineralization throughout a large part of the northern half of the stock.

Work on the property commenced May 15th and was suspended on October 15th. The average crew consisted of twenty-two men. Twenty holes totalling 12,486 feet were diamond drilled. Some bulldozer and hand trenching was done and approximately 1 mile of road was constructed.

The camp was supplied by coastal boat to Alice Arm and thence by helicopter, as well as by air drops from Beaver aircraft based at Prince Rupert.

Roundy Creek

(55° 129° S.E.) Fifty-eight recorded claims and two fractions, which extend up Roundy Creek from tidewater, were held under option agreement by Southwest Potash Corporation until December 1st, 1960. On Roundy Creek, and about 1¼ miles from tidewater, showings of molybdenite occur in quartz veins and as disseminated flakes in granite, which intrudes folded hornfelsed rocks of the Hazelton group of Jurassic age.

During 1960 exploratory investigations of these showings consisted of geological mapping and the diamond drilling of six holes totalling 2,500 feet. Twelve men, under the supervision of R. W. Hodder, carried out the work from May to September.

In conjunction with the exploration work on Roundy Creek, seven men, under the direction of J. R. Loudon, were engaged in reconnaissance exploration of the Alice Arm-Stewart area from May to September.

Transportation to Roundy Creek was by coastal boat and aircraft, while a helicopter was used extensively for the reconnaissance work.

OBSERVATORY INLET*

Copper

Double Ed (The Consolidated Mining and Smelting Company of Canada, Limited)

(55° 129° S.W.) G. A. Derry, development superintendent. This property of fifteen recorded claims is on Bonanza Creek, 3 miles west of Anyox. During the early part of 1960, work continued on the crosscut adit, which was driven at about 500 feet elevation to investigate further the surface showing of copper mineralization, which is about 500 feet higher than the adit. The adit, which was 1,898 feet long at the end of 1959, was driven an additional 976 feet in 1960, making it 2,874 feet long when completed. Copper mineralization was encountered in the adit, and a total of 14,224 feet of diamond drilling was done underground.

The showing consists of several steeply dipping zones which are siliceous pyrite replacements of sheared andesite flows. Disseminated chalcopyrite is also present in these zones.

* By W. C. Robinson.

An average crew of twenty men was employed. Coastal boats and float-equipped aircraft were used for transportation to Bonanza Creek landing, and trucks were used on the access road to the camp.

Work ceased in June, 1960, and all buildings and equipment were removed from the property.

QUEEN CHARLOTTE ISLANDS*

Graham Island

Manganese

Shag Rock

(54° 132° S.W.) This property is 25 miles west of Masset on the east side of Klashwun Point near Shag Rock. It can be reached by sea or air, but landing may present difficulties in either case. The property is held by Joseph Pauloski, of Masset, by two claims located in 1955. The claims extend northward along the east side of the point from Indian Reservation No. 13, and extend 300 feet or more offshore.

Rock is exposed in the area only along the wide tidal zone, and the showings are on the shore. Basaltic lavas of the Masset formation here strike north to northeast and dip 15 to 20 degrees eastward. The lavas are cut by a north-trending fault, on the east of which the lavas are underlain by dark-grey shale and buff calcareous shale to sandstone of about 75 feet exposed thickness. The fault strikes north 15 degrees east, subparallel to the shore, and dips about 80 degrees eastward. It is filled with 5 to 15 feet of basalt breccia that is cemented by variable amounts of manganite. Fragments in the breccia are angular and as much as 2 feet across, although commonly the large fragments are only 6 to 8 inches across. Fragments range downward in size from these dimensions to a few millimetres; still smaller sizes were not seen. Veinlets of manganite also extend into the volcanic rocks of the west wall of the fault. The mineralization is primary and is Tertiary in age. It is probably related to the Masset volcanism.

The fault and the showings are exposed along the shore for about 550 feet from the beach near the Indian reservation northward to where the shore trends sharply to the west. The best showings appear to be in the northern third of the exposure. Large hand specimens may be taken that contain as much as 50 per cent manganese. At the northern end, where the breccia outcrops like a dyke, one of the higher-grade lenses, about 8 feet high by 50 feet long by 5 feet wide is estimated to contain between 30 and 40 per cent manganese.

Moresby Island

Iron

Harriet Harbour (Silver Standard Mines Limited)

(52° 131° S.E.) Company office, 808, 602 West Hastings Street, Vancouver 2. H. B. Gilleland, manager; A. C. Ritchie, general superintendent. Harriet Harbour is on Skincuttle Inlet, on the southeastern coast of Moresby Island, and is 70 miles south of Sandspit. The properties on Harriet Harbour controlled by Silver Standard Mines Limited were reviewed fully in the 1959 Annual Report. The general geological setting is shown on the preliminary geological map of the southern Queen Charlotte Islands issued by this Department in March, 1960. The main orebody is east of the south end of Harriet Harbour on the Jessie (Lot 1861) Crown-granted claim and the Limestone recorded claim. Additional orebodies have been explored on the Adonis (Lot 1865) Crown-granted claim east of the Jessie on the trail to Ikeda Cove, and on the Magnet (Lot 79) and

* By A. Sutherland Brown.

Dingo (Lot 87) Crown-granted claims southwest of the south end of Harriet Harbour.

A total of ninety-five holes and 19,531 feet of EX core has been diamond drilled since exploration was first started in June, 1959. After a short winter shutdown, drilling recommenced and continued until July, 1960. Of all the drilling done, fifty-three holes totalling 16,364 feet have been drilled on the Jessie and Limestone claims, thirteen holes, totalling 1,081 feet on the Adonis, twenty-two holes totalling 1,531 feet on the Magnet, and seven holes totalling 553 feet on the Dingo. The camp was closed with a caretaker at the end of August, awaiting the arrangement of suitable financing. An agreement for sale of concentrates to the Sumitomo Metal Mining Company of Japan had been completed in December, 1959.

The annual report of the company at June 1st, 1960, stated the ore reserves consisted of 2,238,262 long tons of proven ore containing 51.8 per cent iron and 381,000 long tons of probable ore, mostly in the Jessie ore zone. The small amount of drilling completed since June, 1960, has not altered these reserves.

[References: *Minister of Mines, B.C.,* Ann. Rept., 1959, pp. 11–14; Sutherland Brown, A. and Jeffery, W. G., Preliminary Geological Map of Southern Queen Charlotte Islands, *B.C. Dept. of Mines.*]

ECSTALL RIVER*

Pyrite-Zinc-Copper

Packsack (Texas Gulf Sulphur Company) (53° 129° N.E.) Executive office, 75 East Forty-fifth Street, New York. C. O. Stephens, New York, president; W. R. Bacon, manager of British Columbia operations. This property consists of sixteen claims, a double row of eight claims extending northward from the big bend of the Ecstall River. A description of the property was given in the 1958 Annual Report.

During the summer of 1960 eleven drill-holes, totalling 2,891 feet, were put down to sample the mineralized zone that had been found by prospecting and traced for a strike length of 2,000 feet beneath overburden by electromagnetic work. All the holes are reported to have intersected pyrite mineralization, much of which is massive.

No further work is planned for this property. The property, which was serviced by helicopter, was not visited.

SCOTIA RIVER*

Zinc

Scotia (Texas Gulf Sulphur Company) (54° 129° S.W.) Executive office, 75 East Forty-fifth Street, New York. C. O. Stephens, New York, president; W. R. Bacon, manager of British Columbia operations. This group of four claims is about 10 miles south of Skeena River, on the north bank of an easterly flowing tributary of Scotia River. In 1958 investigation of a rusty hillside revealed the presence of a high-grade zinc showing with minor amounts of lead and copper. The host rock is reported to be a granitic gneiss containing pegmatitic material. The highly irregular showing is on the west flank of an anticline that plunges southward at 30 degrees. In addition to sphalerite, minor galena, and less chalcopyrite, there is a light general development of pyrite and pyrrhotite in the immediate vicinity.

In 1960 ten short drill-holes, totalling 1,865 feet, partially tested the showing over a strike length of 250 feet.

Transportation was by helicopter. The property was not visited.

* By W. C. Robinson.

KITIMAT*

Iron

Iron Mountain (Quebec Metallurgical Industries Ltd.)

(54° 128° S.W.) Company office, 602, 88 Metcalfe Street, Ottawa. N. B. Davies, president; Alex. Smith, engineer in charge. The property is on Iron Mountain, about 6 miles north of Kitimat. It consists of four Crown-granted claims and nine recorded claims. Work on the property commenced in April and was suspended in December, 1960. Five to six men were employed under the direction of H. S. Lazenby. Sixteen EX holes, averaging about 400 feet long, and five packsack-drill holes, averaging 100 feet long, were drilled. A magnetometer survey was also carried out on the property during 1960.

Near the Wedeene River crossing of the Kitimat branch of the Canadian National Railway, a camp, consisting of office, cook-house, bunk-house, and dry, was constructed. The camp was serviced by the railway, which passes through the southern portion of the property.

[References: *Minister of Mines, B.C.*, Ann. Repts., 1929, p. 72; 1959, p. 15.]

CEDARVALE

SEVEN SISTERS MOUNTAIN (54° 128° N.E.)*

Molybdenum

Telkwa Prospector's Club

In 1958 a group, known as the Telkwa Prospector's Club, located twenty claims on the northern slope of Seven Sisters Mountain. Molybdenum mineralization occurs on this property in a showing exposed at the head of the valley of Whiskey Creek and about 300 feet below an area covered by permanent snow. Flakes of molybdenite occur in narrow quartz veinlets in diorite. Although molybdenite is present in only some of the veinlets in a rather limited area, a further mineralized zone under the snow is indicated by the presence of molybdenite-bearing float above the showing.

Access to the property is by 8 miles of foot-trail from the Gull Creek crossing of Highway No. 16.

HAZELTON*

Silver-Lead

Silver Standard (Silver Standard Mines Limited).—(55° 127° S.W.) Company office, 808, 602 West Hastings Street, Vancouver 2. R. W. Wilson, president. The property is on Glen Mountain, 5½ miles north of Hazelton. The mine was leased by John Gallo, of Hazelton. Thirty-seven tons of silver-lead ore was shipped to the Trail smelter during the early part of 1960.

SMITHERS*

Silver-Lead-Zinc

Cronin (New Cronin Babine Mines Limited)

(54° 126° N.W.) Company office, 844 West Hastings Street, Vancouver 1. L. C. Creery, president; Hill, Starck and Associates, consulting mining engineers. The property is on the east slope of Cronin Mountain, about 30 miles by road from Smithers. P. Kindrat, lessee, again operated the mine and mill during part of 1960. Seventy-nine tons of lead concentrate and 66 tons of zinc concentrate were produced and shipped to the Trail smelter.

* By W. C. Robinson.

EUTSUK LAKE*

Molybdenum

CAFB (53° 127° S.E.) Phelps Dodge Corporation of Canada, Limited, 904, 1030 West Georgia Street, Vancouver 5, holds by record fifty-six mineral claims extending northward from Haven (Bone) Lake toward the summit of Red Bird Mountain. Haven Lake is 8 miles west of Pondosy Bay on Eutsuk Lake. The claims cover a small stock of granite porphyry which contains some molybdenite mineralization.

During June a tent camp was established near timberline on the south slope of Red Bird Mountain, and a crew of four men under the direction of J. W. Bryant did some surface trenching and ground sluicing.

The granite porphyry stock on the south side of Red Bird Mountain intrudes a succession of tuffs and volcanic rocks of the Hazelton group. There has been some silicification and pyritization of the granite together with some disseminated molybdenite mineralization. The adjacent Hazelton formation is hornfelsed at and near the contact and is partly silicified along zones of shearing which contain a small amount of molybdenite.

Unmelted snow extending below timberline during June prevented effective prospecting or stripping being done except in a few small areas of exposed ground. Work was stopped and the camp abandoned early in July.

OMINECA†

Mercury

Snell Group (55° 125° N.E.) This property is on Silver Creek, 9 miles south of Omineca River, and consists of thirty claims held by record. It has been reported that diamond drilling had previously indicated two zones of mercury mineralization—one near the east bank of Silver Creek, and another approximately 600 feet to the east. It has been reported that in 1943 and 1944 two attempts were made by The Consolidated Mining and Smelting Company of Canada, Limited, to drive a crosscut to intersect the eastern zone. Both attempts encountered an old channel and the adits were abandoned.

In 1959 hydraulic stripping exposed a surface showing approximately 600 feet northward from the westerly zone previously indicated by diamond drilling. This surface showing consists of lenses of cinnabar mineralization in dolomitic limestone along the Pinchi Lake fault zone. Cinnabar mineralization exists on either side of a fault striking northward. The predominant rock type on the eastern side of the fault is a tuff which contains no cinnabar in the areas exposed.

Work in 1960, which began on May 4th, included the replacement of four bridges and a number of culverts west of Twin Creek on the access road from Germansen Lake. On the property, further ground-sluicing was done in an attempt to expose bedrock north of the showing. Bedrock had not been reached when shortage of water forced a stoppage of work on August 1st.

Work on the property was done by four men under the supervision of E. Bronlund. The project was a joint effort by Bralorne Pioneer Mines Limited, Noranda Exploration Company, Limited, and Canex Aerial Exploration Ltd. Transportation was by truck and aircraft.

Silver-Gold-Zinc

Lustdust (55° 125° N.E.) This group of fifteen claims, held by option, is on Kwanika Creek, 20 miles south of Omineca River. The showings, indicating a sulphide mass, are reported to contain

* By Stuart S. Holland.
† By W. C. Robinson.

values in zinc, silver, and gold. Four men under the supervision of E. Bronlund are reported to have drilled a number of short test-holes and done a considerable amount of trenching by bulldozer. Work commenced on August 1st and ended for the season on October 18th. The project was a joint effort by Bralorne Pioneer Mines Limited, Noranda Exploration Company, Limited, and Canex Aerial Exploration Ltd. The property was not visited.

CARIBOO

WELLS-BARKERVILLE (53° 121° S.W.)

Gold

Aurum, Mosquito Creek (The Cariboo Gold Quartz Mining Company Limited)* Company office, 1007 Royal Bank Building, Vancouver; mine office, Wells. Dr. W. B. Burnett, president; Marcel Guiguet, general manager; J. J. Stone, mill superintendent. Capital: 2,000,000 shares, $1 par value. Changes in the Cariboo Gold Quartz mine have been marked since the purchase of the Island Mountain (Aurum) mine in August, 1954. Following the purchase, the Aurum mine has supplied most of the ore; the original mine closed in September, 1959, and the Mosquito Creek property started production in May, 1959. The Aurum, which was purchased for $300,000 and which was believed to have less than a year's reserves, has since produced over $4,000,000 in bullion. The bulk of this has come from replacement ore, much of which has been found adjacent to previously mined bodies by drilling test-holes with pneumatic drills using flexible drill steel. Current production from the whole mine averages 3,460 tons of ore per month with an average gold content of 0.483 ounce per ton. About 15 per cent of current production comes from the new ore zone, the Burnett zone of the Mosquito Creek property. For the mine as a whole, 67 per cent of the tonnage and 77 per cent of the gold now comes from replacement stopes.

One of the main reasons for the purchase of the Aurum mine was to provide access to the Mosquito Creek property held by the company. Although no ore was proven on this property, its potential was thought good because not only was it on strike with the ore-bearing limestone beds, but " ore making " northerly faults were known to cross it. Furthermore, Mosquito Creek has been a rich placer-gold creek. A drive on the 3000 level was started in January, 1958. This encountered a new fault, the Burnett fault, 2,300 feet northwest of the shaft. This fault strikes north to north 16 degrees east and dips 67 to 80 degrees east, and hence is similar to the main group of northerly striking normal faults of the Wells camp. Ore dragged by the Burnett fault confirms that the post-ore movement has been normal. Significant replacement orebodies are found on both sides of the fault, in M1 stope northwest and 64 stope southeast of the fault. M1 stope has produced to August 31st, 1960, 4,864 tons of ore with an average gold content of 0.60 ounce per ton. M1 has been mined up to the fault above the 3000 level. The 64 orebody has a length of 280 feet on the down-dip side and a thickness of 4 to 8 feet. It was being prepared for mining in September, 1960. In the summer of 1960, hydraulic mining by J. J. Gunn in Mosquito Creek exposed replacement mineralization about 1,000 feet northwest of the Burnett fault, in what appear to be the same strata. To develop the known orebodies and to explore for others, two drifts were started on the levels immediately above and below the 3000 level. It is planned to drive the 3125 level 800 feet and the 2850 level 2,700 feet. To pay for this development, $200,000 in first mortgage bonds has been issued. The drifting on the 3125 level was completed in November. The 2850 drift was still being driven at the year-end and is expected to reach the zone of projected replacement ore in April, 1961.

* By A. Sutherland Brown and A. R. C. James.

The geological environment of the new ore zone is very much like that of the best area of the Aurum mine. The Burnett fault cuts and repeats a large dragfold that is similar in size to the Aurum mine dragfold (*see* Fig. 1). The folding is in

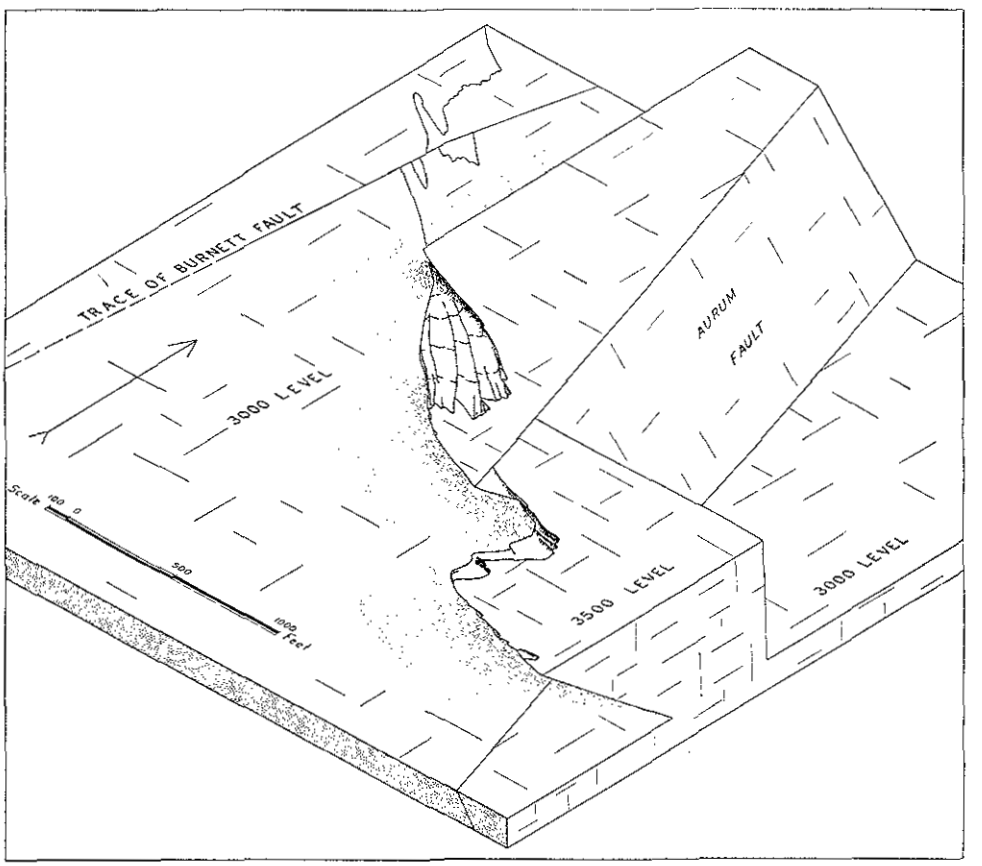


Figure 1. The Cariboo Gold Quartz Mining Company Limited. Isometric sketch showing relation of Aurum dragfold and fault to Burnett dragfold and fault as outlined by the "Rainbow-Baker" contact.

the same sense, involves the same beds, and is of the same attenuated and complexly dragfolded type. Figure 1 shows diagrammatically the relation between the two folds. The Aurum fold is encountered first on the 2625 level, where it plunges at about 22 degrees to the northwest. It flattens and becomes smaller at the 3250 level and appears to die out just below the 3125 level. On the 3000 level it is absent, but 800 feet northwest of the projected position of the Aurum fold the new fold appears. This is repeated in the same manner as the Aurum fold is repeated by the Aurum fault. The Aurum fold was a particularly favourable locus of replacement deposits, especially close to the fault and in the anticline. The size and grade of the M1 and the 64 orebodies indicate that the same may be true of the newly discovered Burnett fold and fault.

The following is a summary of development work done at the mine in 1960:—

Drifting and crosscutting—	Feet
Current development	2,188
Capital development	1,929
Total	4,117
Raising	819
Diamond drilling	15,452
Ribbon steel test-holes	9,488

In addition to the development work being done in the Burnett fault zone, small orebodies or extensions of existing orebodies continue to be found in the older section of the mine. The mine is developed from a main haulage adit at the 4000 level. Eleven levels have been developed from the Aurum shaft, which is a three-compartment internal shaft 1,450 feet deep and collared at the 4000 level. The working stopes are all between the 3250 and 2700 levels.

At the end of the year a crew of 116 men was employed, of which seventy-two were underground. The accident rate at the mine shows a striking improvement on past years. There was only one lost-time accident in 1960, giving an accident rate of 4.1 accidents per million man-hours worked, the lowest of any mine in the Province. This compares very favourably indeed with the rate of 32.6 for 1959, and 64.2 for the average of the last five years. A full-time safety director is employed and regular safety meetings and inspections are carried out.

A total of 39,113 tons of ore was milled, yielding 19,555 ounces of gold. This is approximately a 10-per-cent increase in gold production over 1959 and a 16-per-cent decrease in the amount of ore milled.

[Reference: *B.C. Dept. of Mines,* Bull. No. 38, Geology of the Antler Creek area, pp. 74–79, 82–85.]

Silver

Scarn* Nine recorded mineral claims and fractions extending northeastward up Copper Creek from the twin bridges on the Cariboo–Hudson road make up the Scarn group held by Daniel Jorgenson, of Barkerville. The claims are reached by 16 miles of road east from Barkerville. In an area north of the north branch of Copper Creek, the claims cover mineralized quartz veins containing silver values and some scheelite as well as other scheelite showings along the south branch of Copper Creek previously described in British Columbia Department of Mines Bulletin No. 34, pages 77 and 78.

This report covers only those veins lying north of the north branch of Copper Creek.

Over the past ten years Dan Jorgenson has done a very large amount of prospecting and hand-trenching on the Scarn group. The surface work has been extremely thorough and the vein characteristics are well displayed. In a drift-covered area underlain by black argillite, siltstone, and thin limestone beds belonging to the Midas formation along and east of the Copper Creek fault, he has found and trenched at least six quartz veins. The veins strike 20 to 40 degrees west of north, dip steeply, and cut across the more northwesterly striking formations. Vein quartz is mineralized with silver-bearing tetrahedrite, galena, and small amounts of pyrite and sphalerite. In some instances scheelite is present. The mineralization is for the most part across widths of 3 to 8 inches in veins that are

* By Stuart S. Holland.

3 feet or more wide and in which the balance of the quartz is essentially devoid of mineralization. As a consequence, only narrow widths of well-mineralized quartz were sampled (*see* table of assays). One of the quartz veins cuts a bed of limestone, and in several open cuts along it scheelite is present in the adjacent limestone as well as in the vein.

Fifteen samples were taken from five veins. The widths and assay results are shown in the accompanying tabulation and the sample locations are shown on the accompanying plan, Figure 2.

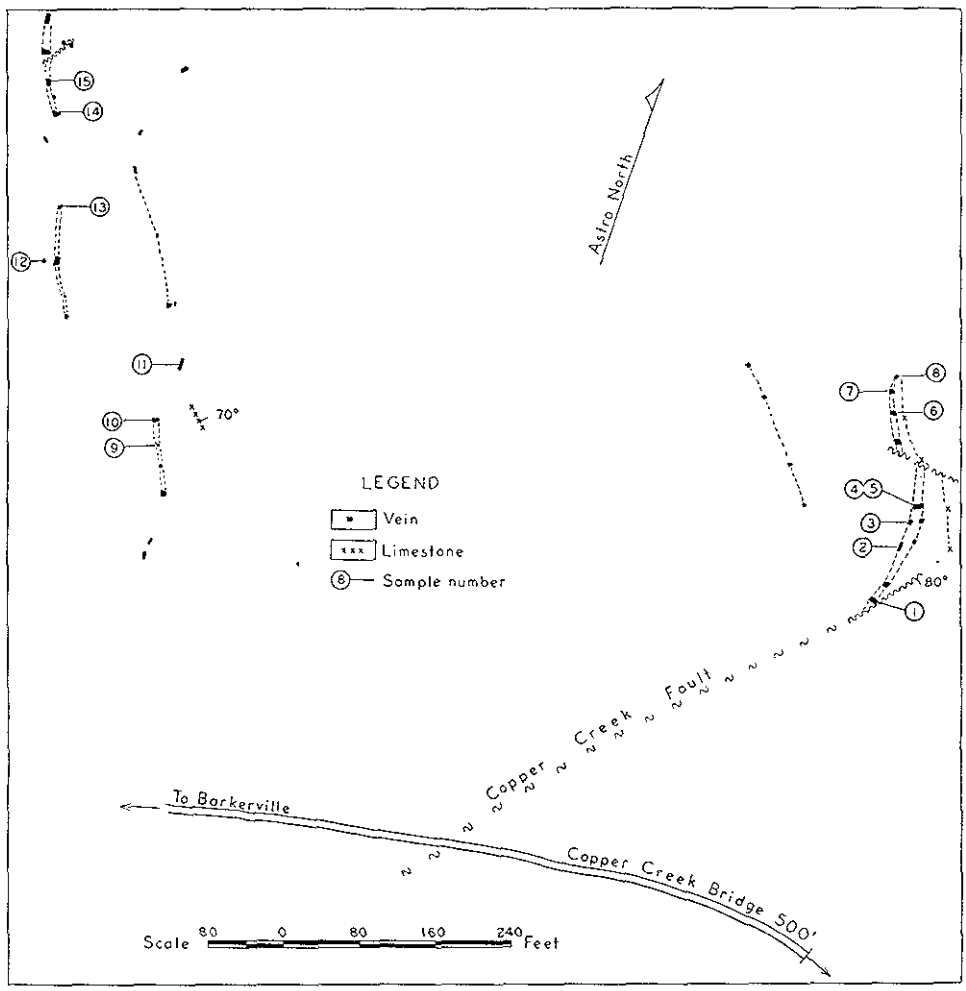


Figure 2. Scarn group. Plan showing veins and sample locations.

In the quartz veins, high silver values are present only where the quartz is well mineralized with tetrahedrite; the gold content is generally very low, and the tungsten content is erratic and controlled in part by the near presence of limestone.

Assays of Samples from the Scarn Group

No.	Width of Vein	Width Sampled	Gold	Silver	Copper	Tungstic Oxide
			Oz. per Ton	Oz. per Ton	Per Cent	Per Cent
1	10′	Selected from 6″	0.03	114.2	4.16	*Nil*
2	3′	10″	0.01	88.6	2.15	Trace
3	3′	3′	Trace	14.5	0.42	0.04
4	8′	2′	*Nil*	Trace	0.01	0.25
5	18″	18″	Trace	0.3	0.04	0.21
6	7′	12″	Trace	0.1	.....	0.06[1]
7	7′	2′	Trace	12.8	0.37	0.08
8	3′	12″	Trace	0.4	.....	0.34
9	8′	48″	0.01	9.3	0.51	0.05
10	8′	6–8″	*Nil*	3.9	0.17	0.11[1]
11	2′	2′	Trace	2.9	0.23	0.59
12	7′	2′	0.02	7.7	0.68	0.19
13	18″–2′	4–6″	*Nil*	9.1	0.46	0.01
14	6′	3″	0.025	27.8	1.83	0.05
15	3½′	3½′	0.01	2.9	0.26	Trace

[1] Silicified limestone.

YANKS PEAK (52° 121° N.E.)*

Gold

Jim

The Jim group consists of eight claims and fractions held by F. H. M. Codville, of Duncan. The property is near Yanks Peak and is 12 miles by road from Keithley Creek ranch. The upper part of the road is best travelled by four-wheel-drive vehicle. The showings comprise quartz veins and lenses containing gold values that outcrop at elevations of from 5,720 to 5,780 feet on the Ridge No. 4 and Jim claims. The showings have been explored underground from an adit at 5,638 feet elevation by about 1,200 feet of drifts and crosscuts.

Work done in 1960 consisted of four diamond-drill holes totalling 500 feet. These holes were drilled in the adit. A crew of from two to three men was employed from June 30th until August 17th.

[Reference: *B.C. Dept. of Mines,* Bull. No. 34, 1954, pp. 65–68.]

CLINTON*

POISON MOUNTAIN (51° 122° S.W.)

Copper

Copper Nos. 1 to 4 (New Jersey Zinc Exploration Company (Canada) Ltd.)

Vancouver office, 905, 525 Seymour Street, Vancouver 2. This property comprises four recorded claims (Copper Nos. 1 to 4) optioned from H. Reynolds, of Lillooet, and sixteen recorded claims held by the present company. The claims are mainly on the west side of Poison Mountain, about 40 miles northwest of Lillooet near the headwaters of Yalakom River and Churn Creek. The property may be reached by 36 miles of jeep-road from Big Bar ferry on the Fraser River, but the easiest approach now is from Lillooet via the Yalakom River road as far as Blue Creek. From here a 12½-mile jeep-road has been made to the camp on Poison Mountain Creek at 5,400 feet elevation. The principal showings are east of Poison Mountain Creek and on the lower westerly slope of Poison Mountain from 5,600 to 6,000 feet elevation. The claims are underlain by sandstones, argillites, and greywacke. These sediments are intruded by diorite porphyry. Recent work indicates complex structure with many flat-lying

* By A. R. C. James.

faults and complex alteration. The mineralization, comprising disseminations and fracture fillings (mainly chalcopyrite and pyrite), is associated with the alteration of both sediments and porphyry.

The showings were apparently first discovered in 1935. A number of pits and trenches were dug between 1935 and 1946 on the exposures on the Copper No. 1 claim north of Copper Creek, a small creek flowing west into Poison Mountain Creek. In 1956 The Granby Consolidated Mining Smelting and Power Company Limited optioned the Copper group of claims and recorded additional ones in the area. This company did a considerable amount of stripping, and diamond drilled ten holes totalling 1,973 feet. All this work was done on what was then thought to be the most favourable zone of mineralization adjacent to and north of Copper Creek. The average assay of a large number of samples taken near the western end of this zone was 0.60 per cent. The Granby company subsequently dropped their option. In 1959 the present company optioned the property and carried out a comprehensive magnetometer and soil-sample survey.

In 1960 a 12½-mile jeep-road was constructed from the Yalakom River road at Blue Creek to the camp at Poison Mountain. A number of bulldozer trenches and access roads were made on the claims (the overburden cover averages about 15 feet) to investigate anomalies indicated by the 1959 surveys. Fifteen vertical holes were diamond drilled, totalling 2,000 feet. The work indicated fairly widespread areas of mineralization, but copper values were generally low, and the option was terminated at the end of the season. A crew of eight men was employed under the supervision of E. Livingstone.

[References: *Minister of Mines, B.C.,* Ann. Repts., 1946, pp. 101–102; 1956, pp. 35–37.]

Porcupine Mountain (51° 122° S.E.)

Gold

Porcupine Mountain (Empire Valley Gold Mines Ltd.)

Company office, Box 100, Chilliwack. G. H. Clarke, president. This company holds by record ten mineral claims and three fractions on Porcupine Mountain between the Fraser River and Churn Creek. The property, which is at an elevation of from 6,500 to 7,300 feet, is reached by 29 miles of road from the Fraser River bridge near the Gang Ranch. The principal showings consist of a number of gold-bearing quartz veins in dark-green volcanic rocks. Intermittent work has been done on the showings since they were discovered in 1947.

Approximately two weeks' work was done in September and October, 1960, by a crew ranging from four to eight men (all directors of the company) under the supervision of Earl Brett. It is reported that 2,500 feet of road was built in order to facilitate drilling on the lower levels of the Ogden and Turret claims. The road to the Sugar Bowl fraction was cleared. Repairs were made to the roofs of camp buildings.

[References: *Minister of Mines, B.C.,* Ann. Repts., 1948, pp. 92–95; 1954, pp. 98–100.]

LILLOOET*

Bridge River (50° 122° N.W.)

Gold

Ace†

The Ace Mining Company Ltd., 404, 510 West Hastings Street, Vancouver 2, holds forty-nine recorded mineral claims, ten mineral leases, and forty-four Crown-granted mineral

* By A. R. C. James, except as noted.
† By Stuart S. Holland.

claims covering a considerable area lying for the most part north of the Bridge River and extending for 4 miles west of the junction of Gun Creek. It includes the Wayside, Congress, and Minto mines.

In the autumn of 1959 a new vein was exposed to view about 3,000 feet west of the Congress mine in a rock cut on the new Bridge River road. In December an agreement with Bralorne Pioneer Mines Limited was reached whereby the latter company is to provide funds for exploration work. In the first half of 1960 the showing was traced uphill to the north by a number of irregularly spaced trenches. Surface diamond drilling confirmed the presence of the vein structure down dip to a depth of several hundred feet. In June a drift was started below the Bridge River highway, to explore the shear at depth. The work was done under the direction of J. P. Weeks, chief geologist at Bralorne mine.

The showing, as exposed in the original road cut, is a strongly oxidized mineralized shear striking north and dipping about 55 degrees west. The shear is occupied by quartz mineralized with stibnite, arsenopyrite, and pyrite. A sample taken across 20 inches of strongly sheared and oxidized material assayed: Gold, 0.73 oz. per ton.

Trenching uphill to the north of the road cut picked up the shear along strike for about 500 feet and with exposed widths of as much as 9 feet. Assays of surface samples were sufficiently encouraging for the company to institute surface diamond drilling which confirmed the extension of the vein shear and associated gold values to a depth of at least 200 feet.

By mid-September the drift on the vein shear had been driven a distance of 277 feet. In the drift the shear is seen to have a variable width and to reach a maximum of 5 feet. The shear is not continuously mineralized, but is occupied by several discontinuous lenses of quartz mineralized with stibnite and arsenopyrite. From one a sample taken across 26 inches assayed: Gold, 0.32 oz. per ton. Drifting terminated for the winter on October 31st, at which time the drift was 507 feet long.

A small amount of stripping was done elsewhere on the property in conjunction with the geological mapping done by W. Chinn, of Bralorne mine.

Eight diamond-drill holes totalling 4,848 feet were drilled. Two of these holes, totalling 3,050 feet, were drilled in the Congress mine, and the remaining six in the vicinity of the Discovery vein.

At the end of the season a representative sample of ore from the Congress mine was taken for a metallurgical investigation to be carried out during the winter.

[References: *Minister of Mines, B.C.,* Ann. Rept., 1948, pp. 106–112; Cairnes, C. E., *Geol. Surv., Canada,* Mem. 213, 1937, pp. 102–104.]

Bralorne Pioneer Mines Limited

Company office, 355 Burrard Street, Vancouver 1; mine office, Bralorne. F. R. Joubin, president; J. E. McMynn, general manager; C. M. Campbell, Jr., resident manager; J. S. Thomson, superintendent of mines; C. D. Musser, superintendent of mills. At the end of 1960 this company was operating only the Bralorne mine. The Pioneer mine was closed down in August as a result of the mining out of existing reserves in the 27 vein. The results of development on No. 30 level on this vein proved disappointing, and other exploration failed to indicate new sources of ore. The Pioneer mine was first located in 1897 and has been in continuous production since 1924. In the early thirties it was the leading gold mine in the Province, and in 1933 a total of 82,519 ounces of gold was produced, valued at $2,400,000. By 1944 the Main vein was mined out, but the mine gained a new lease on life when the 27 vein was discovered. In the ensuing years, production

again rose to a maximum of 56,198 ounces in 1957. During the whole lifetime of Pioneer mine a total of nearly 2½ millions tons of ore has been mined, yielding approximately 1,330,000 ounces of gold. The average grade of the ore throughout the working life of the mine was 0.54 ounce of gold per ton. In 1960, 50,163 tons of ore was milled.

Bralorne Mine.—The Bralorne mine is on Cadwallader Creek, a tributary of the Bridge River. It is reached by 51 miles of road from Shalalth or 75 miles from Lillooet, both stations on the Pacific Great Eastern Railway. The property was described in some detail in the 1958 Annual Report. The extensive workings are in a generally northwesterly trending vein system which is now being mined at depths of between 3,200 and 4,100 feet below the surface, with development work proceeding up to a depth of 5,000 feet below the surface.

The workings are approached by a main haulage adit on No. 8 level. There are three internal shafts: the Crown shaft, approximately 2,600 feet deep, from No. 8 to No. 26 level; the Empire shaft, approximately 3,280 feet deep from No. 3 to No. 26 level; the Queen shaft, 2,000 feet deep from No. 26 to a point just below No. 39 level. The major portion of present production is mined in cut-and-fill stopes between No. 26 and No. 33 levels, the 77 vein being the principal producing vein. The ore is hoisted in the Queen shaft to No. 26 level and is then hauled by battery locomotive to the Crown shaft, hoisted to No. 8 level, the main haulage level of the mine, and hauled by trolley locomotive to the mill. In the mill the ore is treated by amalgamation, blanket concentration, and flotation. A sulphide concentrate made by flotation is shipped to the Tacoma smelter. During the latter half of the year, work was in progress on the erection of an entirely new 600-ton cyanide mill to replace the old mill and to provide greater efficiency and improved recovery. It is planned to have the new mill in operation in May, 1961. In 1960, 153,482 tons of ore was milled.

Development work comprised 1,893 feet of drifting, 444 feet of crosscutting, 1,038 feet of raising, and 19,343 feet of diamond drilling. The Queen shaft was sunk from a point 91 feet below No. 37 level to a point 24 feet below No. 39 level station, a distance of 224 feet. A station has been cut at No. 38 level, and a crosscut driven toward the 77 vein; at the end of the year this crosscut was within 250 feet of the vein. Exploratory drifting and diamond drilling was also done on the 51B vein at No. 4 level, and rehabilitation of the Taylor Bridge River crosscut on No. 20 level was carried out with a view to investigating the possibilities of downward extensions of the King structures below No. 14 level.

A sand-fill plant was designed and installed during the year, to use mill-tailings for the hydraulic filling of stopes in place of the present waste fill. The sand and water mixture is pumped from surface to a central reservoir on No. 8 level. From there it is passed downward to the lower workings through a 2⅜-inch diamond-drill hole. The plant is to go into operation in January, 1961, and all new stopes from this date will be sand-filled. Existing stopes will continue to be waste-filled until completion.

The ventilation raise, started in the summer of 1957, was completed by the middle of 1960. This raise, which is 12 feet in diameter and extends from the surface at the old Blackbird portal (No. 4 level) down to No. 25 level, a vertical distance of 3,000 feet, provides an entirely new intake air-shaft and permits cool air from the surface to be supplied direct to the mine workings. A radial fan on the surface at the collar of the raise draws 80,000 cubic feet of air per minute into the mine. Provision is made at the fan housing for installing a second fan in parallel, which could increase the air flow to 120,000 cubic feet per minute. The exhaust air now passes out of the workings via the Crown and Empire shafts and No. 8 and

No. 3 level adits. A comparison of temperature readings taken in various parts of the Queen shaft area in October, 1957, and October, 1960, shows a 5-per-cent drop in dry bulb temperature (from 83.5 to 78.9 degrees) despite the fact that the present workings are deeper. Average relative humidity in the mine was reduced 8 per cent (88 to 81 per cent) over the same period. Average temperature at Queen shaft stations was down 11 per cent from 83.5 degrees in 1957 to 72.3 degrees in 1960.

The number of men employed was 384, of whom 274 were employed underground. Although the year was marred by one fatal accident, it is pleasing to be able to report a marked improvement in the accident rate over last year. The fatal accident occurred in the Queen shaft sinking operations on August 18th. Harold Jessome, an employee of Patrick Harrison and Company, engaged in contract sinking of the Queen shaft, was killed as a result of a Cryderman mucking-machine breaking loose and falling down the shaft. A more detailed description of this accident will be found elsewhere in this Report. Of the non-fatal accidents, a total of twelve compensable accidents was reported during the year. This is a rate per million man-hours of 15.1, which may be regarded as very satisfactory. The accident rate for all lost-time accidents also showed a remarkable improvement. For 1960 this was 19.0 accidents per million man-hours, as compared with 37.3 accidents per million man-hours in 1959, a drop of 49 per cent. When compared with the average lost-time accident rate over the past five years of 47.9, the improvement is even more notable. An active safety organization at this property receives the full backing of management, and regular safety meetings and inspections are held.

Bridge River United Mines Ltd.

Company office, 404, 510 West Hastings Street, Vancouver 1. Raymond R. Taylor, president. Capital: 4,500,000 shares, no par value. This company controls twenty-one Crown-granted claims and fractions on the lower reaches of Hurley River, extending for a distance of 2 miles up the river from a point 1½ miles above Gold Bridge. The property includes the Ural, Forty Thieves, and Why Not claims, which were first located in 1896 and 1897. Intermittent exploration work, both surface and underground, has been done for many years on these claims, which lie on the east side of the deep and rugged canyon of the Hurley River. The claims are underlain mainly by andesite of the Pioneer formation and diorite of the Bralorne intrusions, bounded on the west by an outcrop of serpentinized pyroxenite. Quartz-filled fractures occur in the andesites and diorites, some of which have been traced for over 900 feet. These veins in places contain gold values, but the vein matter has hitherto not generally been found to be of ore grade. A number of adits have been driven at various points at the foot of the canyon bluffs to explore the Forty Thieves, Why Not, Jewess, and other veins which outcrop either close to or on the canyon bluffs. Until the present company began work in 1959, the property had been dormant since 1946.

In 1960, work on the property was begun on May 15th and continued until the end of the year. The first work done was to widen and improve the road along the bottom of the Hurley River canyon, which extends about 1½ miles to the foot of the Why Not bluffs. In September a contract was signed with Rayrock Mines Limited for this company to participate in the exploration of the property. By the end of the year 2,300 feet of diamond drilling had been done, mainly on the Why Not vein structure, and detailed geological mapping of the Why Not tunnel was completed. The Ural No. 3 tunnel (giving access to underground workings on the Forty Thieves vein) was reopened for inspection and geological mapping in December, after a large amount of rock had been bulldozed away from above the caved

adit. A crew of from three to ten men was employed under the supervision of R. R. Taylor. The work was under the general direction of W. E. Clarke, of Rayrock Mines Limited.

[References: *Minister of Mines, B.C.*, Ann. Rept., 1946, pp. 106–112; Cairnes, C. E., *Geol. Surv., Canada,* Mem. 213, 1937, pp. 88–91.]

Hurley River Mines, Ltd. Company office, Box 305, Lillooet. President, Paul Polischuk, Bralorne. Capital: 3,000,000 shares, $1 par value. This company controls several properties in the Bridge River area and one near the head of Lillooet Lake. The largest property is a group of fifty-six claims in the general area northwest of Hurley River about 2½ miles west of Bralorne. The claims extend on either side of Gwyneth Lake and for 1¾ miles southwest of the lake. The property is approached by a road from Bralorne by way of the Alma prospect and the Hurley dam-site. The claims are largely underlain by argillaceous, limy, and volcanic rocks of the Hurley formation, with some granitic intrusives immediately to the east of Gwyneth Lake. Interest in 1960 has been centred on the contract of an easterly striking felsite dyke with the aforementioned rocks on the Gary claim 2,300 feet south-southeast of Gwyneth Lake. Approximately 200 feet of packsack diamond drilling was done here in the spring by Paul Polischuk, and it was reported that significant gold values were obtained in some of the holes. Rayrock Mines Limited optioned the property in June and diamond drilled six holes totalling 1,800 feet in the same area drilled by Paul Polischuk. A crew of five men was employed under the supervision of B. Nekrasov. The option was subsequently dropped.

The company also holds a group of claims, known as the Spruce group, in the upper part of Truax Creek. Some diamond drilling and surface stripping was done on these claims, and a crew of four men was employed under the supervision of Paul Polischuk.

Fraser River (50° 121° N.W.)

Copper

Askom (Tombac Exploration Ltd.) Company office, 510 West Hastings Street, Vancouver 1. Isaac Shulman, president. Capital: 5,000,000 shares, no par value. In January this company optioned a group of twenty-four recorded claims, known as the Askom group, from A. Jenner and John Rickard, of Lillooet. The property is on the west side of the Fraser River in the vicinity of Nesikep Creek, about 15 miles southeast of Lillooet. It is reported that there are four or five outcrops with indications of copper mineralization over a distance of approximately a mile. Work was done on the property over a three-month period in the early part of the year with a total of four men employed under the supervision of J. Sullivan. A number of trenches were dug and sampling was done in the mineralized zones. The assay results from the sampling is reported by the company to have averaged a low percentage of copper, and the option was subsequently dropped.

Anderson Lake*

Gold

Golden Contact (Cassiar Copperfields Limited) (50° 122° N.E.) Company office, 928 West Pender Street, Vancouver 1. John A. McKelvie, president and manager. Capital: 5,000,000 shares, $1 par value. This company holds under option agreement the Golden Contact property, on the north slope of McGillivray Creek about 5 miles by

* By A. R. C. James.

jeep-road from Ponderosa Ranch on the Pacific Great Eastern Railway. The main showings are quartz veins, locally mineralized and containing gold values, within a schistose host rock. The showings were discovered in 1898, and a considerable amount of underground exploration has been carried out over three separate periods—1900–1903, 1932–1938, and 1947–1953. There are six adit levels from the No. 1 at 3,615 feet elevation to the Pep adit at 2,938 feet elevation. The underground workings were inaccessible when the present company took over.

The present company began work in May, 1960. The camp at the 3,000-foot level was rehabilitated. While attempting to open the Fortyniner adit on June 1st, two of the crew were trapped by a cave-in. This involved a major rescue operation, which is described elsewhere in this Report. The men were released safely after thirty hours. After this incident it was decided to bulldoze the unconsolidated and weathered material away from the portals of both the Fortyniner and the Pep adits. Over 8,000 yards of material was moved from the two portals before solid rock was reached. The new portal at the Fortyniner adit was finally set up on October 29th and access was gained to the old tunnel. The Pep adit was opened in July, but caving conditions in the tunnel made progress very slow. In one section a diversion tunnel 110 feet long had to be driven. By the end of the year, access had been gained on this level to the underground workings. The object of this work is to prepare the property for a detailed geological examination and for sampling. The future programme will depend on the results of these findings.

A crew of six men was employed from July to December under the supervision of John McKelvie.

HIGHLAND VALLEY*

Copper

Trojan Consolidated Mines Ltd. (50° 120° N.W.) Company office, 809, 837 West Hastings Street, Vancouver 1. G. L. Conn, president. This company holds about eighty claims and fractions north and east of the south peak of Forge Mountain. For most of 1960 the property continued under option to Rio Tinto Canadian Exploration Limited, which did geophysical and geochemical surveying. A surface diamond-drill hole 341 feet long was drilled about 2,000 feet southeasterly from the Highland shaft. An average crew of six men was employed from May to October under the supervision of L. B. Gatenby and N. G. Mattocks.

Krain Copper Ltd. (50° 121° N.E.) Company office, 1004, 850 West Hastings Street, Vancouver 1. D. F. Farris, president. This company holds about eighty claims and fractions which adjoin the north boundary of the Trojan property. In 1960 a part of the property was optioned for a time by Rio Tinto Canadian Exploration Limited, which did geophysical work and drilled one hole 530 feet long on the D.W. group. This hole was in volcanic rocks for its total length.

Beaver (50° 120° N.W.) This group lies southwest of the Lodge group and is held jointly by Farwest Minerals Limited (company office, 1075 Melville Street, Vancouver) and Beaver Lodge Uranium Mines Limited, of the same address. In 1960 ten claims in the north part of the group were optioned for a time by Rio Tinto Canadian Exploration Limited, which did geophysical surveying.

* By J. M. Carr.

Lodge (50° 120° N.W.) This group of about forty-seven claims and fractions lies between the Trojan and Bethlehem properties and is held by Northlodge Copper Mines Limited (company office, 1075 Melville Street, Vancouver).

In 1960 the group was optioned for a time by Rio Tinto Canadian Exploration Limited, which did geophysical and geochemical surveying and drilled one hole 565 feet in length.

Bethlehem Copper Corporation Ltd. (50° 120° S.W.) Company office, 814, 402 West Pender Street, Vancouver 3. H. H. Huestis, president; C. J. Coveney, chief geologist. This company holds about 158 claims and fractions immediately east of Quiltanton (Divide) Lake, about 30 miles by road southeast of Ashcroft. In 1960 work was mainly done in the vicinity of the East Jersey mineralized zone, on behalf of Sumitomo Metal Mining Company of Tokyo. It included two raises, each about 100 feet in length, from which percussion drilling was done. About 12,000 feet of surface diamond drilling was done, together with some trenching. In addition, three churn-drill holes, each about 300 feet deep, were drilled for water near Witches Brook, of which two were productive. Detailed topographic surveys were made of prospective open-pit and plant sites. Five men were employed, together with a mining crew provided by Intermountain Construction Ltd.

Jericho Mines Limited (50° 120° S.W.) Company office, 104, 569 Howe Street, Vancouver 1. Hamlin B. Hatch, president. This company holds about eighty claims south of Witches Brook, about 7 miles east of Quiltanton (Divide) Lake. In 1959 the company built a road from about 1 mile west of the camp on Witches Brook to a showing where trenching was then done. This showing is 1 mile northwest of a lake which is known locally as Billy Lake and which lies 1 mile northwest of the Billy Lake shown on published maps.

Work done in 1960 included diamond drilling which was partly at this showing and partly at a locality near the road about 2 miles north of Billy Lake. A geophysical survey was also made.

MERRITT*

Geology of the Promontory Hills

Introduction

This account is designed to accompany a geological map of an area of about 24 square miles, extending south and west from the Craigmont mine (Fig. 3). The northern boundary of the area lies partly north of Birkett Creek, on which the mine is situated, and partly south of David Creek. The western boundary is on Indian Reserve No. 9, due north of Canford, and the southern and eastern boundaries are along the valleys of Nicola River and both Stumbles (Ten Mile) and Guichon Creeks, which join the Nicola River near Lower Nicola. The country is only moderately rugged and in part has a pronounced east-northeasterly grain. It is dominated by a dissected ridge whose highest feature is Lookout Point (5,688 feet). North of the ridge, the terrain is typical of the Interior Plateau and is more diversified, with rather bare or park-like south-facing slopes which descend interruptedly to the main valleys, which are at about 2,000 feet elevation. One or two benches and high-level valleys afford rough pasturage or farm land, and in recent

* By J. M. Carr, except as noted.

Figure 3

GEOLOGY OF PROMONTORY HILLS AREA MERRITT

LEGEND

KINGSVALE GROUP
- Andesite flows and volcanic breccias

SPENCES BRIDGE GROUP
- Basic flows, tuffs and agglomerate

NICOLA GROUP
- Feldspathic rocks
- Basalt flow
- Limy and non-limy rocks
- Undifferentiated, non-limy rocks

GUICHON BATHOLITH
- Quartz diorite and diorite

COYLE STOCK
- Diorite and quartz diorite
- Granite

MINOR INTRUSIONS
- Quartz porphyry and explosion breccia
- Outcrop boundary
- Geological boundary
- Bedding (foliation near Coyle stock), inclined, vertical
- Diamond-drill hole
- X Mineralized showing

Scale 0 1 Miles

Astra North

Jackson L.

TITAN QUEEN (PAYSTIN)

CRAIGMONT SURVEYED CLAIMS

To the Aberdeen Mine

ERIC

CRAIGMONT

OPEN PIT

3500 LEVEL

3000 LEVEL

2400 LEVEL

David Cr.

Birkett Cr.

I. R. No. 9

LOOKOUT POINT

Boyle

HANK NO. 30

Windy Cr.

Dry Lake

Stumbles

LOWER NICOLA

To Merritt

Guichon Cr.

C.P.R.

Nicola River

COYLE

Highway No. 8

To Spences Bridge

Nicola R.

CANFORD

50° 10'

121° 00'

1960 p9 27

years there has been considerable logging of Douglas fir and red pine in this part of the area. The climate is semi-arid and no permanent streams occur in the area. Several creeks flow radially from the ridge and are partly linear in course. Access to the area is mainly by an all-weather road to Lookout Point that is 8 miles long and leaves the Merritt–Spences Bridge highway about 7 miles west of Merritt. This road serves the forest lookout and the microwave station at Lookout Point and connects with logging-roads of lesser quality which give wide access to the rest of the area. It also connects with a recently completed jeep-road from Craigmont mine, at a point about 1 mile south of the lookout. Principal access to the mine is by a road leaving the highway at Lower Nicola, which is 6 miles to the west of Merritt and near the Canadian Pacific Railway branch line at Coyle. Natural-gas and oil pipe-lines pass through Lower Nicola and Merritt, respectively.

The Craigmont orebody is on the eastern slope of Promontory Hills, about 2½ miles east-northeast of Lookout Point. It is a massive deposit of chalcopyrite, magnetite, and specular hematite, and occurs in skarns of the Nicola group close to the margin of the Guichon batholith. After the orebody was discovered in 1957, this and adjacent areas have been heavily prospected by a variety of means, including magnetic, electrical, geological, and soil-sampling surveys. Large parts of the area remain covered by mineral claims in good standing, and prospecting still continues. Despite all this work, which is some cases included trenching and diamond drilling, no other mineral occurrences of significance have yet been found. Much of the area either is underlain by rocks of post-mineral age or is obscured by superficial deposits, and probably less than 3 per cent of it is occupied by Nicola outcrops.

The present mapping made use of existing geological information and was done in 1959 and 1960. A preliminary geological map was made by R. Lee, using vertical air photos obtained from Hunting Survey Corporation and transferring the field information to a provisional base map on a scale of 1 inch to 1,000 feet. Following limited additional work in 1960, the final map was compiled on a topographical base map of the same scale, made available by Canadian Exploration Limited and associated companies. A summary of the geological features recognized during preliminary mapping has already been published, together with a general account of the Craigmont orebody, in the 1959 Annual Report. The present account makes no attempt to describe in detail the geology and structure of the Craigmont mine, which are still being investigated.

[References: *Geol. Surv., Canada,* Mem. 249, Nicola Map-area, 1948; *Minister of Mines, B.C.,* Ann. Repts., 1957, p. 28; 1958, pp. 24–27; 1959, pp. 31–34.]

Nicola Group

Strata of the Nicola group, of Upper Triassic age, directly underlie about half the mapped area and contain the Craigmont orebody. They are intruded by the Guichon batholith and by a stock northwest of Lower Nicola, as well as by numerous smaller igneous bodies which are variously of basalt, andesite, and quartz porphyry, or quartz-porphyry breccia. The Nicola rocks are chiefly tuffs, tuffaceous sediments, and limestone together with impure limy beds. Except to the southwest, they generally possess steep dips. The stratigraphy is still uncertain, largely because no reliable marker beds have been recognized and the fossil content of these and other Nicola rocks has so far been insufficiently studied. Lithological mapping has distinguished two kinds of assemblage, characterized by feldspathic and limy rocks, respectively, which occupy a number of more or less extensive belts. These belts strike northeastward across the main part of Figure 3, and are separated by belts

in which the rock types have not been differentiated. Correlation of any of the belts with rocks farther east at the Craigmont mine is not yet possible.

Feldspathic Rocks.—Feldspathic rocks comprise the whole of a persistent belt some 2,500 feet wide and occur less exclusively in two more southerly belts. They are mainly tuffs, with some tuff breccia and volcanic conglomerate, and are characterized by a prevalent purple-red colour as well as abundant white feldspar crystals, which accompany volcanic rock fragments in a dense matrix. Although commonly reddish, the colour of the rocks may show gradations to pale green or white. These differences may be due partly to reduction of iron oxides and to dissemination of epidote by hydrothermal alteration. Rare beds of white quartz tuff and tuff breccia, as much as 100 feet wide, could be traced for no more than a few hundred feet. The rocks are mostly massive or thick bedded, and commonly exhibit a poor to moderate bedding foliation. Thin beds of fine red tuff occur and are generally regular and undeformed. Graded bedding and related sedimentary structures have not been observed.

The feldspathic rocks contain varying proportions of detrital volcanic rock fragments, crystals, and matrix. The rock fragments are of red, brown, green, grey, or black aphanitic material, which is only feebly porphyritic or vesicular. They occur in amounts ranging from as much as 25 per cent in volcanic conglomerates and pebble beds, through intermediate amounts in tuff breccias, to about 10 per cent in medium-grained tuffs. Rounding of the fragments increases with their size—the tuffs and tuff breccias commonly contain unmodified, irregular, or angular fragments which seldom exceed one-quarter inch, whereas the conglomerates have abundant, well-rounded or ovoid fragments as much as 6 inches in size. Southeast of Lookout Point, some beds resembling agglomerate contain unstratified, subangular blocks of volcanic rock as much as 1 foot across.

The crystal detritus, which comprises as much as 25 per cent of most rocks, consists chiefly of whole or broken laths of plagioclase feldspar as large as 2 millimetres, which are in places accompanied by a few quartz grains of similar size. Like the volcanic rock fragments, the crystal debris is distributed haphazardly in the matrix, without perceptible sorting. The matrix itself is a generally dark, tough, and aphanitic material comprising at least one-third of the rock.

Under the microscope the tuffs show additional features. Volcanic fragments are seen to range in size downward to less than 1 millimetre, and to consist of chloritic andesites or basalts showing wide textural variations, from holocrystalline, microporphyritic rocks to glassy microvesicular types. Feldspar fragments show no evidence of attrition following breakage, and the quartz grains are identified as crystals which show magmatic corrosion and are deeply penetrated by the flow-banded matrix. Small well-shaped crystals of augite occur in some rocks, which also contain minute shard-like shapes of fine-grained quartz or feldspar. Magnetite is well disseminated and accounts for the pronounced magnetic susceptibility of the rocks, which can be tested with a suspended hand-magnet. The matrix of the rocks appears as a turbid, largely unresolvable fine-grained aggregate of medium refractive index and is partly flow textured.

In all three belts of outcrop the feldspathic rocks are accompanied by rare flows of basalt lava, which are the only extrusive Nicola rocks seen in the area. The flows are as much as 50 feet thick and may extend laterally for some thousands of feet. They consist mainly of a dark-grey porphyritic rock with abundant small phenocrysts of plagioclase feldspar and others of a dark mineral oriented in the plane of flow. Under the microscope this rock is holocrystalline and consists chiefly of labradorite feldspar, hornblende, and augite with hornblende mantles, together with

much accessory magnetite and some chlorite and epidote. Near the top of a flow the non-vesicular rock passes rapidly into a vesicular, less porphyritic variety which within a few feet may become intimately mixed with red scoriacous lava, and this, by decrease in the number and size of enclosed masses of the vesicular rock, may grade upward into a fissile red rock resembling fine-grained tuff. Where these relationships are sufficiently exposed, they provide the only fully reliable means of identifying the top of any of the Nicola rocks. Unfortunately, only one flow in the main feldspathic belt is exposed in this way.

Limy Rocks.—Limy belts which contain roughly equal proportions of limy and non-limy rocks are numbered southward successively from 1 to 6 (Fig. 3). There are, in addition, scattered outcrops of limy rocks which have not been correlated with the recognized belts. In each belt, all gradations exist between pure limestone and non-limy rocks. The limy rocks are limestones, limy tuffs, tuffaceous limy greywackes, and limy argillites, whilst the non-limy rocks are similar to the undifferentiated rocks which occur elsewhere. As mapped, the belts are lenticular or braided, with a thickness as great as 1,400 feet and commonly much less.

Poorly to well preserved fossils appear restricted to the limy rocks. The pelecypod *Halobia* was identified by W. R. Danner from outcrops in belt No. 1 at Lookout Point and indicates that these rocks belong to the Karnian stage of the Upper Triassic.

The limestones commonly weather grey or tan coloured and are either massive or foliated. Bedding is not generally seen, except at interfaces with other beds or where impure laminæ are revealed by differential weathering. Massive limestone appears confined to the south of the main feldspathic belt, and is the principal component of beds whose thickness is between 50 and 100 feet in belts Nos. 3, 4, and 5, and less elsewhere. It is a grey or white rock which is either porcellainous or unevenly grained and somewhat porous, with casts or fragments of fossils. A somewhat impure variety was seen under the microscope to consist predominantly of fine-grained calcite together with a few clastic grains of calcite, quartz, feldspar, and volcanic rocks.

Foliated limestone is widely distributed and may locally be associated with massive limestone, from which it is probably derived by partial recrystallization under conditions of stress. All limestones seen to the north of the main feldspathic belt and in the eastern part of belt No. 3 are foliated. They occur in beds which seldom exceed 40 feet in thickness and which commonly contain thin layers of rocks similar to those forming adjacent beds. The foliated limestone is a black, grey, or less commonly white rock which seldom contains fossils and has a compact, generally fine-grained texture. Foliation is expressed by differential weathering as a lineated, often contorted or swirly pattern whose strike commonly differs from that of the beds. Some outcrops show a flaggy or platy jointing that is partly curved or warped, and is thought to be mainly controlled by the foliation. The fabric of the limestones is frequently complicated by structures which combine flowage of limestone with brecciation and disintegration of the enclosed thin beds. These structures are described below. Fragments derived from the brecciated beds are dispersed in the limestone, which therefore assumes a very heterogeneous appearance. Some of the foliated limestones are pebbly or gritty, and contain crowded, subangular, or rounded pebbles and smaller fragments of volcanic rocks or occasionally limestone. This sedimentary detritus is oriented more with the foliation than with the bedding and may therefore be hard to tell, in some outcrops, from dispersed tectonic fragments. The foliated limestones and rocks adjacent to them are sparingly traversed by calcite veins. Under the microscope the limestones are seen to be marbles consisting of foliated even-grained aggregates of inequidimensional calcite crystals in

common alignment. Exceptionally, the rocks have an average grain size as great as 3 millimetres. The black foliated limestones differ from the others only in containing carbonaceous streaks and wisps.

Other limy rocks closely resemble their non-limy counterparts amongst the undifferentiated rocks. For example, a tuffaceous limy greywacke may differ from an undifferentiated rock only in the lime content of its fine-grained matrix. This rock would typically consist mainly of lithic or glassy volcanic detritus, quartz, and feldspar grains, together with a plentiful fine-grained matrix. A typical limy vitric tuff is quartz free, and consists largely of closely spaced fragments of volcanic glass set in a limy aphanitic matrix. Such tuffs occur as beds ranging from a few inches to as much as 80 feet thick, and are mainly coloured light to dark brown or green. Although poorly sorted, they frequently possess a granular foliation which may be primary if parallel to bedding but which may, alternatively, lie across the bedding and therefore be secondary.

Limy argillite occurs as beds not more than a few feet in thickness, in association with beds of limestone. It is a soft, fissile, rather fossiliferous, fine-grained rock which is black, brown, or grey in colour and may be banded. Under the microscope it appears foliated and semi-opaque, and contains much finely divided calcite together with scattered angular fragments of quartz and feldspar.

Undifferentiated, Non-limy Rocks.—The undifferentiated, non-limy rocks show a considerable range of fabric and composition. They include lithic, vitric, and quartz tuffs, tuffaceous greywacke, and argillite, all of which are widely distributed. The tuffs and argillite occur either as massive beds as much as 100 feet thick or in thin- to medium-bedded sequences with a variety of other rocks, some of which may be limy. Tuffaceous greywacke is generally restricted to these varied sequences, which are best seen to the north of the main feldspathic belt.

The *lithic tuffs* are hard, compact rocks coloured variously green, grey, dark red, or black. They are mostly of fine- to medium-grained appearance and are characterized by abundant volcanic rock fragments set in a dense matrix which comprises from one-quarter to more than one-half of the rock. They differ from the feldspathic rocks principally in their wider colour range and lack of conspicuous feldspars. The rocks are mostly poorly sorted. The rock fragments, although generally similar to those in the feldspathic rocks, seldom exceed one-quarter inch in size and include pale glassy fragments not seen in the latter rocks. Most are angular or irregularly globular in shape, but in some beds they are lenticular and confer a foliation on the rock. Crystal detritus is subordinate in the lithic tuffs and consists of partly broken plagioclase feldspars up to 1 millimetre in size together with, in some rocks, rounded or broken quartz crystals which are both small and scarce. The aphanitic matrix is coloured either light or dark green, grey, or red and occurs in sufficient quantity to prevent almost all contact between the rock or crystal fragments. Under the microscope it shows the same ultrafine appearance as the matrix of the feldspathic rocks, which it closely resembles. It includes slender microlites of feldspar together with finely granular areas, which may have formed by partial devitrification of the otherwise glassy material. In places the matrix shows a banding. Some of the rocks contain well-disseminated magnetite and possess a pronounced magnetic susceptibility.

The *vitric tuffs* are distinctive, greyish-green or buff-coloured rocks which are tough and well foliated, and characterized by a lenticular granular texture. They occur in alternating beds of differing grain size, ranging from fine to medium grained. In hand specimens they exhibit rather closely packed, lenticular or rudely ovoid fragments of assorted murky-white, grey, or greenish volcanic glass, each with a somewhat fretted outline emphasized by a narrow white border. The fragments are

oriented in a wispily foliated, glassy matrix of pale-greenish, grey, or buff colour, and are seldom accompanied by more than a few small crystal grains of feldspar and occasionally of quartz. Under the microscope a typical specimen of vitric tuff consists predominantly of flow-textured, glassy and microcrystalline fragments, many of which are scarcely distinguishable from the quartzofeldspathic matrix. The latter encloses a few poorly shaped feldspars, either as single or aggregated crystals or, in another specimen, as partly broken grains accompanied by others of quartz. The vitric fragments are mostly between one-half millimetre and 2 millimetres long, and the length is generally about twice, and rarely as much as eight times, the width of the fragment. The shape and common orientation of the fragments, together with the variable, foliated crystallinity and flow-oriented texture of both fragments and matrix, is responsible for the excellent foliation possessed by these rocks.

The *quartz tuffs* are characterized chiefly by conspicuous quartz grains and a porphyritic aspect. They form massive beds which weather white, buff, or dark brown, and are tough grey rocks containing crystals of quartz and white feldspar set in a copious matrix of light- or dark-grey colour. Some of dacitic composition resemble quartz porphyry, and their clastic, bedded nature is obvious only on weathered surfaces or under the microscope. Aphanitic fragments comprise about one-quarter of the dacitic quartz tuffs and blend almost invisibly with the matrix, which differs from the fragments only in a more chloritic and unevenly granular appearance, as seen microscopically. Whole crystals and jagged fragments of plagioclase feldspar as much as 3 millimetres in size are accompanied in the matrix by others of quartz, which also forms rare single crystals within aphanitic fragments. Whether in the fragments or in the matrix, the unbroken quartz crystals possess shapes indicative of magmatic resorption. The crystals include and are veined, embayed, and mantled, partly or completely, by a fine-grained quartzofeldspathic material, which is identical to the aphanitic fragments and is of igneous origin. Another quartz tuff, darker and more foliated than the dacitic quartz tuffs, shows fewer pyroclastic features and a diversity of lithic fragments, of which some are of rather basic, fine-grained rocks. It has an appreciable magnetic susceptibility, which is explained by its relatively high content of disseminated magnetite.

The *tuffaceous greywackes* are thin- to medium-bedded rocks ranging in grain size from siltstones to grits, and occurring as sequences as much as 100 feet thick. They are comparatively well sorted and foliated, and appear to have formed by the rapid deposition of predominantly volcanic detritus, largely of dacitic composition. Stratigraphic tops seem to be indicated in places by scoured or graded beds, but the latter may show a reversed gradation and must therefore be used with caution. Wavy and truncated bedding suggest some pre-consolidational movement or slumping, but effects of this sort are hard to tell from those due to later deformation.

The *greywackes* are grey rocks that commonly weather buff and consist of lithic and crystal fragments set in an aphanitic matrix. A typical rock is estimated to consist of: Quartz, 45 per cent; feldspar, 15 per cent; lithic fragments, 15 per cent; matrix, 25 per cent. The lithic fragments are partly identical with those in the dacitic quartz tuffs and partly microvesicular, flow-textured glassy volcanic rocks. They are mostly subangular to irregular in shape. The crystal grains and fragments vary in both size and roundness; the smaller are mostly freshly broken chips and the larger are about 2 millimetres in size and of varied shape. Some of the quartz is similar to that in the quartz tuffs, and is therefore volcanic in origin. The matrix of the greywacke is a somewhat chloritic quartzofeldspathic aggregate of fine but variable grain size. Some of the greywackes are cherty, partly banded rocks, in which the matrix is excessive and encloses a few lithic fragments as well as numerous small feldspar fragments and quartz granules.

Argillite is a soft, grey, dark-brown, or black partly banded rock which frequently contains pyrite and so weathers rust coloured. It forms lenses and beds which range in width from a fraction of an inch rarely to as much as 100 feet, and which persist in some cases for several hundreds of feet along the strike. The rock is unfossiliferous and uniformly fine grained, and breaks either subconchoidally or with a poor fissility, but where it is locally strongly deformed a perfect cleavage develops. Under the microscope the rock is seen to consist largely of unresolvable dark material containing stray fragments of quartz and feldspar.

Spences Bridge Group

Rocks of the Lower Cretaceous Spences Bridge group occupy the western boundary of the mapped area and include flows, tuffs, agglomerate, and dykes of a general basic composition. They have not been examined in detail and their structure is poorly known. No contacts with adjacent rock units were observed, but the group presumably overlies both the Nicola rocks and the Guichon batholith. The rocks are brown, grey, or green, and weather with a prevalent brown colouration. Porphyritic basalt or andesite is widely distributed and is a massive rock consisting predominantly of a dark, microcrystalline or glassy groundmass in which occur scattered, partly saussuritized laths of plagioclase feldspar together with small crystals of pyroxene and magnetite. A rude flow orientation afforded by the feldspars varies greatly in direction. Lithic tuff is widespread. It is a medium-grained rock somewhat resembling but less indurated than the feldspathic rocks of the Nicola group; in places it contains carbonaceous impressions of plant stems. The tuff consists chiefly of partly rounded black or red fragments of glassy volcanic rocks, some of which are vesicular and others porphyritic, together with varying quantities of whole or broken feldspar laths in a fine-grained matrix. Agglomerate in the northern part of the outcrop area consists of a tuffaceous matrix enclosing somewhat rounded fragments and blocks of porphyritic volcanic rocks at much as 2 feet across. Northerly trending dykes of basalt or andesite cut the Spences Bridge rocks and, in diminishing numbers, also cut the Nicola rocks farther to the east.

Kingsvale Group

Unmineralized andesites and volcanic breccias which occupy a large eastern part of the area are assigned to the Kingsvale group of upper Lower Cretaceous age. The rocks are generally poorly stratified and their structure is obscure. At Craigmont, they overlie part of the orebody and rest on an unevenly eroded surface of weathered Nicola rocks, but to the east in the mine the contact is steep and faulted. A steep contact may also exist along part of the western margin of the Kingsvale rocks, adjacent to and parallel with the Winney Creek lineament.

Although the andesites show few of the features which normally serve to identify extrusive rocks, most if not all are considered to be flows. They are poorly to moderately vesicular, massive rocks, many of which possess a more or less well-developed trachytoid texture due to the linear or planar orientation of phenocrysts. This texture varies widely in attitude and may be steep. At Craigmont the rocks overlie local basal accumulations of tuff and are seen to be stratified. Volcanic breccia is widespread throughout the area and consists of rounded to angular fragments or blocks of andesite which are embedded in a matrix of argillized andesite tuff. The fragments are as much as 2 feet in size and are unsorted and unoriented. Some of the outcrops form cliffs which are eroded to produce hoodoos, such as the rock pinnacles that are seen near the highway. No true sediments have been observed in outcrop, but a coal-ball is reported to have been found in argillic mate-

rial associated with Kingsvale volcanic rocks in the 3000 level at the Craigmont mine.

The Kingsvale rocks mostly weather grey or brown, but some layers show a pervasive reddish alteration, which appears chiefly to involve oxidation of magnetite and kaolinization of feldspar. Other layers are altered to a white colour, and these rocks are argillic and possess swelling properties due to a content of bentonite. At Craigmont, a bentonitic flow some 30 feet thick rests partly on Nicola rocks and is irregularly overlain by fresh andesite in a manner suggesting that the white alteration took place before the succeeding, unaltered rock was deposited. Throughout the Kingsvale rocks, veinlets containing either epidote, quartz, chalcedony, calcite, or a zeolite are sparingly present, and are very rarely accompanied by trace amounts of malachite.

The fresh andesites are light or dark grey, aphanitic rocks containing as much as 30 per cent by volume of phenocrysts. These invariably include prismatic crystals of brown or black hornblende and laths of clear plagioclase feldspar, together with smaller crystals of one or more of the following minerals: green clinopyroxene, brown orthopyroxene, and biotite. Vesicles are rare, small, and irregularly shaped, and may be lined or partly filled by zeolites or other white minerals. Under the microscope the feldspar in some rocks is labradorite, and the aphanitic groundmass of the rocks is seen to contain a little disseminated magnetite and very small crystals of the phenocryst minerals. In hand specimens, fresh andesite shows an appreciable magnetic susceptibility.

Intrusive Rocks

These include rocks of the Guichon batholith and the Coyle stock, and small intrusive bodies which chiefly occur in the Nicola rocks and the Coyle stock.

The Guichon batholith extends for some 40 miles to the north of the mapped area and is known to be of early Mesozoic age. Its eastern contact coincides approximately with Guichon Creek and probably joins the southern contact not far east of the present mapping. The southern contact, as represented in the area, is poorly exposed and has little or no topographic expression. With some irregularities, it strikes westward from the Eric showing for a distance of about 3 miles and then west-southwestward for about the same distance before apparently being covered by rocks of the Spences Bridge group. This western part of the mapped contact probably follows a southwesterly prong of the batholith, which apparently separates Nicola rocks in the present area from others that occur more than 1 mile farther northwest. Where exposed, the batholithic margin is relatively sharp. The marginal batholithic rocks contain dark, fine-grained inclusions and are perceptibly foliated in planes which generally dip steeply and mostly strike parallel to the mapped trend of the contact. The adjacent Nicola rocks are also foliated, and are principally either hornfels or schistose and gneissic rocks which are veined in network fashion by inhomogeneous dioritic material.

The batholithic rocks of the area are principally rather uniform quartz diorites or, at marginal localities such as at Craigmont, diorites. Granite or quartz monzonite was seen in small amounts at the Eric showing, in association with diorite or quartz diorite. A prevalent rock at places more or less removed from the contact is a medium-grained, poorly foliated quartz diorite whose estimated modal composition is typically as follows: Quartz, 15 per cent; orthoclase, 5 per cent; plagioclase, 45 per cent; biotite, 3 per cent; hornblende, 30 per cent; accessory minerals, 2 per cent. A more porphyritic quartz diorite occurs near the contact of the Spences Bridge group, and is a medium-grained rock containing hornblendes as much as 1 centimetre in size.

At Craigmont, two principal varieties of diorite were emplaced prior to mineralization. A finer grained variety enclosing the east end of the orebody is a somewhat foliated mesocratic rock containing small amounts of disseminated quartz and biotite. The other variety is more porphyritic and occurs apparently as tongue-like, partly flat-lying masses in the north wallrocks. It contains subhedral to anhedral hornblendes some of which are as much as one-half centimetre in size.

The Coyle stock intrudes Nicola rocks in the south-central part of the area and is of irregular shape. It apparently consists of several roughly concordant bodies, mainly of quartz diorite, and discordant bodies of granite or quartz monzonite. Its northwestern margin is gently convex and partly coincides with a pronounced topographic lineament that is devoid of exposures. In other directions the margins of the stock are obscured by Kingsvale rocks or by superficial deposits in the Nicola Valley.

In the dioritic bodies the prevalent rock is a fine- or medium-grained, mesocratic quartz diorite which consists chiefly of plagioclase, hornblende, and quartz, and may also contain orthoclase or biotite. This rock is somewhat foliated and encloses dark, fine-grained xenoliths of varied size and shape. The more elongate ones tend to lie in the plane of foliation, which generally strikes northeastward and dips in either direction.

The granitic bodies consist principally of medium- or coarse-grained pink rocks which are chiefly composed of quartz and microperthitic orthoclase in approximately equal proportions, together with plagioclase that may be sufficiently plentiful to justify naming the rock quartz monzonite. Dark minerals are generally less than 10 per cent of the rock, and are either partly chloritized hornblende or biotite, together with a small amount of disseminated magnetite. The rock is mostly massive and free of inclusions, but in places it is both foliated and xenolithic. The inclusions are small, have well-defined outlines, and are of fine-grained granitic composition. The granitic bodies are in contact with both dioritic and Nicola rocks, which are locally strongly chloritized. Where observed the major contacts are steep, irregular, and unchilled, and for considerable distances the country rocks are penetrated by veins of unchilled granite as much as 60 feet thick. Other veins are of aplite, and cut the granite as well as the country rocks.

Most of the Nicola rocks adjoining the stock are contact-metamorphosed equivalents of the undifferentiated strata, which have been partly converted to quartzo-feldspathic hornfels, gneisses, and chlorite or sericite schists. Limestone or granular marble, noted in two places, showed no obvious effects of its closeness to the plutonic masses.

Dykes of andesite and basalt occur in all the mapped units except the Kingsvale group. They are, however, rarely seen in the mapped portion of the batholith and are most numerous in the Nicola group near its contact with the Spences Bridge group. Most of the dykes strike between north-northwest and northeast, but others are roughly concordant with easterly trending structural grains in Nicola and dioritic rocks. The dykes range from a few feet rarely to as much as 200 feet wide, and may be several thousands of feet long. They consist of dark compact rocks which weather variously grey, green, brown, or reddish-brown, and which possess an appreciable magnetic susceptibility. A diabase texture is developed in the centre of the thicker sheets, but elsewhere the rocks are aphanitic and contain phenocrysts rarely as much as one-half centimetre in size. The phenocrysts are principally of white plagioclase feldspar, as well as of hornblende or, less commonly, pyroxene. Although most dykes are poorly vesicular, some have small empty vesicles that occur partly oriented with the phenocrysts.

In the Nicola group these basic dykes are cut by less abundant ones of quartz porphyry and light-coloured andesite. Quartz porphyry dykes were also seen in dioritic and granitic rocks of the Coyle stock. Light-coloured andesite forms thick and rather scarce dykes which strike between north-northeast and north-northwest. It contains abundant small phenocrysts of plagioclase feldspar, prismatic black hornblende, and biotite, which are oriented in a pale-grey aphanitic matrix. The rock resembles others assigned to the Kingsvale group and is identical with andesite of post-mineralization age at Highland Valley.

Quartz porphyry is a tough greenish or grey rock of dacitic composition that weathers brown or buff. It consists of a plentiful aphanitic matrix with phenocrysts of quartz and plagioclase and less abundant hornblende and biotite. It forms dykes and sills as much as 60 feet wide and of diverse attitudes. Southwest of Lookout Point multiple emplacement of these dykes, mainly on north-northeasterly lines, has resulted in explosion breccia within an elongate zone which is as much as 4,000 feet long and 2,500 feet wide. The north end of this zone, which is the part best known, contains screens of massive porphyry which separate the breccia bodies and grade into them. The breccia consists of aphanitic porphyry fragments, crystal debris, and cherty matrix, and has the colour and toughness of massive porphyry. The fragments are angular or irregular in shape and seldom exceed 2 inches, being mostly between one-tenth and 1 inch in size. They are cream or pale buff coloured and contain rare euhedral crystals of quartz which are similar to others which occur partly broken in the breccia matrix. The matrix is a very fine-grained, partly cryptocrystalline, quartzofeldspathic material differing only slightly from the groundmass of the porphyry fragments. Both in outcrop and microscopically, the breccia exhibits a directional fabric which in some outcrops strikes north-northeastward and is parallel to the adjacent porphyry screens. Veins and replacement patches of quartz or epidote are abundant, and films of specular hematite occur rarely on joint surfaces. Pyrite is present in small amounts in porphyry just north of the breccia zone.

Rock Alteration and Mineralization

In the mapped area, the rocks of the Spences Bridge and Kingsvale groups contain no primary mineralization and exhibit, respectively, moderate and weak degrees of propylitic alteration. The Nicola and plutonic rocks show a widespread alteration of several kinds, in places accompanied by copper or iron mineralization.

The Craigmont orebody contains specular hematite, magnetite, and chalcopyrite with minor amounts of bornite, and the adjacent wallrocks are altered to epidote, actinolite, and garnet skarns, and are veined and replaced by orthoclase, quartz, calcite, chlorite, and tourmaline. Pyrite and pyrrhotite also occur near the orebody. Most of the above-mentioned minerals occur widely in the area, though they have not been found in such a comprehensive assemblage as at Craigmont. Skarn minerals are scarcely recorded elsewhere, the sole outcrop being immediately north of the quartz porphyry breccia zone, where a greenish discoloured marble contains a brownish-red mineral assumed to be garnet.

Orthoclase metasomatism seems to have occurred only within or close to the margins of the plutonic rocks, and orthoclase is a feature of some of the mineralized prospects mentioned below. The most widespread alteration is one involving epidote, chlorite, and quartz, together with calcite or ankeritic carbonate, and generally accompanied by small amounts of pyrite or specular hematite. Epidote is most abundant, and occurs as veinlets, alone or with other minerals, and as disseminations which may locally form as much as 20 per cent of some impure limy rocks, feldspathic tuffs, or flow rocks. Undifferentiated rocks which are affected by this type

of alteration generally contain less epidote, are a greenish- or bluish-grey in colour, and are traversed by seams and veinlets of quartz, carbonate, epidote, and chlorite. Large expanses of these altered rocks occur on either side of the road to Lookout Point, north of the main belt of feldspathic rocks and continuing through the limy belt at Lookout Point. In the feldspathic belt, epidote alteration and weak hematite mineralization are widespread. To the southeast of Lookout Point, bedding joints in feldspathic rocks are commonly veneered by specular hematite, with the result that breakage to the joints forms southerly facing cliffs. Specular hematite occurs in several other units, generally together with epidote and chlorite. Pyrrhotite was noted only in bedded strata on Lookout Point, where it occurs weakly disseminated with pyrite and occasional chalcopyrite. Chalcopyrite is fairly common in the altered rocks of the mapped area, and more often than not is associated with hematite or pyrite in equally small amounts. The principal copper showings have all recently been trenched or diamond drilled and their positions are shown on Figure 3. The Titan Queen (Paystin) and Eric showings are about 5,000 feet northwest and 8,000 feet east of the Craigmont orebody, respectively, and are located respectively within and at the margin of the Guichon batholith. They are generally similar to other showings elsewhere in the batholith, and involve a locally intense replacement by chlorite, quartz, and tourmaline, accompanied by chalcopyrite or bornite, at faults or shear zones in orthoclase-enriched batholithic rock. Magnetite is reported at both showings, and the adjacent outcrops contain weak disseminations of chalcopyrite.

About 6,500 feet south-southwest of Lookout Point, on the Hank No. 30 mineral claim, diamond drilling intersected weak iron and copper mineralization in steeply dipping basalt flows and tuffs in the feldspathic belt. Adjacent outcrops are strongly epidotized and contain a little specular hematite, pyrite, and chalcopyrite. Parts of the core contain these metallic minerals and slender veinlets and minor disseminations of magnetite, together with garnet, albite, quartz, calcite, chlorite, and epidote. Rare sections of limy strata are partly converted to skarny rock. The drilled area coincides with a strong but narrow positive magnetic anomaly which is reported to trend north-northeastward, parallel to the strike of the layered rocks. An oriented 1-inch cube of flow rock cut from a piece of core from a vertical drillhole showed magnetic polarization in a vertical direction when tested with a suspended hand-magnet. Observation of the cube showed that numerous magnetite veinlets, partly with chalcopyrite, tended to share a common strike and to dip at all angles. Flow orientation of feldspar phenocrysts in the cube of rock was variable but tended to be steep and to strike approximately parallel to the veinlets.

About 3,000 feet south-southeast of this anomalous area, in the vicinity of Hank No. 4 claim, trenches expose limy and non-limy strata and quartz porphyry, together with a weak mineralization which differs from the foregoing principally in the absence of magnetite.

Immediately east of the road to Lookout Point, hornfels is exposed together with marble in trenches adjacent to the northern margin of the Coyle stock, and is partly replaced and veined by orthoclase feldspar. Where brecciated and chloritized, the hornfels contains small amounts of specular hematite and chalcopyrite.

Structure

The present mapping affords only limited evidence of the structure of the Promontory Hills area, largely because it does not establish the stratigraphy of the Nicola rocks, which are those of greatest interest in the area. The following discussion of structure is based on the evidence available, which is by no means conclusive.

Part of the major structure of the Nicola group appears to be a steeply dipping homocline adjacent to the margin of the Guichon batholith. To the south, the strata are mainly north dipping and their structural relationship to the rocks close to the batholith is conjectural.

The strike of the Nicola rocks varies with that of the batholithic margin. In general, the strata strike northeastward in the central part of the area and eastward in the southwestern and northeastern parts. From the batholithic margin southward to, and inclusive of, limy belt No. 3, they mainly dip steeply or are vertical, but to the south of this belt they either are steep or dip northward at moderate angles. Stratigraphic tops can be verified at only a few places. In limy belt No. 1 at Lookout Point, graded bedding in two adjacent beds is in opposed directions, but scoured bedding in a third outcrop and graded bedding 1,500 feet to the southwest both suggest that the strata face south. This is confirmed by a flow top, already described, in the northern part of the main feldspathic belt to the southeast of Lookout Point. It is therefore tentatively concluded that the exposed sequence, at least as far southward as belt No. 3, is homoclinal and faces south.

No important faults are recognized in the area. Small faults and breccia zones are numerous in the older rock units and have also been seen in the Kingsvale rocks. In the Nicola rocks these small faults and breccia zones commonly dip steeply and strike parallel to the bedding. Strike faults of large displacement have not been recognized but might not have been found in the present mapping. Many topographic lineaments occur in the area, and are both concordant and discordant to the trend of the Nicola rocks. Lineaments on Winney and Birkett Creeks, respectively, coincide with the margin of the Kingsvale rocks. At Craigmont, these rocks are known to be partly faulted against the Nicola rocks, and similar relationships may be expected elsewhere. Other lineaments are not known to contain faults, although several are coincident with zones of rock alteration. One such lineament, about 2,000 feet long and of northerly trend, passes between the two described showings on the Hank group, in the west-central part of the area. At Craigmont, numerous small faults of pre-mineral age occur, in addition to others whose relative age is not known.

All the folds identified in the area are small and are closely associated with limestone. Folding on a somewhat larger scale may exist in certain places where limy rocks possess variable strikes and dips, for example, at the bulge in belt No. 1 and at the western limit of belt No. 5. Small steeply plunging dragfolds of Z-shape are numerous throughout all but the western parts of limy belts Nos. 1, 2, and 3, and also occur at Craigmont. Dragfolds of diverse shape and attitude and with amplitudes as great as 30 feet were noted during preliminary mapping to the south of belt No. 6 in the extreme southwestern part of the area, and occur locally elsewhere. The diverse plunge of dragfolds in the area cannot be explained by major folding into simple anticlines and synclines. At present no complete explanation of the dragfolding can be given, but it appears likely that the steeply plunging dragfolds have resulted from strike-slip movement in upturned beds. The direction of this apparent relative movement was right handed, or north side moving east, and its cause is so far unknown.

The complex structures prevalent in the northernmost limy belts were partly investigated by mapping on a scale of 50 feet to the inch at Lookout Point. This flat and relatively well-exposed area, which measures about 1,500 feet northeasterly and as much as 600 feet across, covers the full width of limy belt No. 1 at this point, and is about one-third underlain by outcrops. The strata in general strike eastward and are either vertical or dip steeply in one or other direction. Their lithological character has already been described. They comprise a variegated sequence of

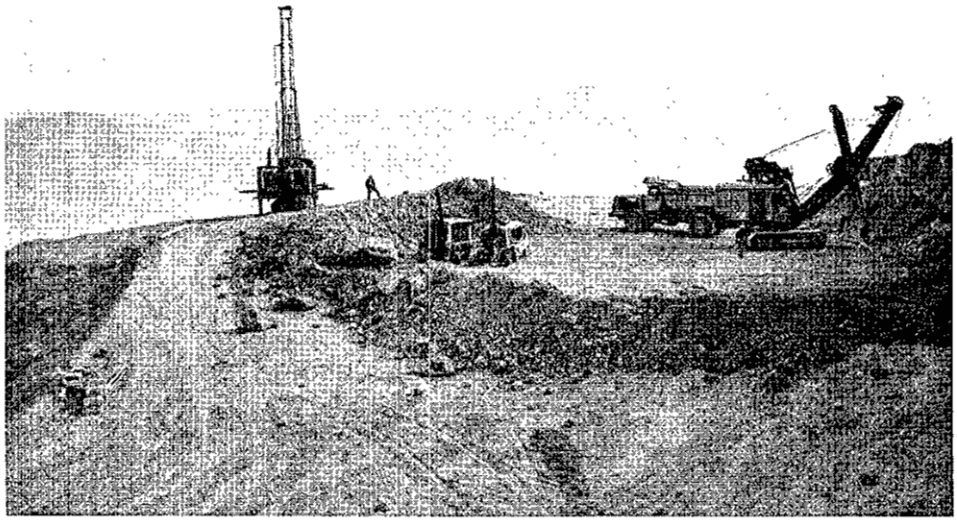
massive to thin-bedded rocks which include foliated limestones, thin beds of limy argillite and argillite, and granular to coarsely fragmental limy and non-limy rocks. Single beds could not in general be traced between outcrops, and the mapping consisted principally of recording the distribution, nature, and attitude of the secondary structures present in the rocks. The non-limy beds of thickness exceeding a few feet are massive, but the remaining beds show a variety of secondary structures which include foliation, cleavage, dragfolds, and less easily defined structures which have apparently resulted from the modification of the other structures.

Cleavage forms one or occasionally two sets of steeply dipping fractures striking between northeast and northwest in rocks other than limestone. The fractures are spaced at irregular intervals, ranging from one-quarter inch to several inches, and are discordant to other structures. They locally offset the bedding planes by successively repeated displacements, each not exceeding a fraction of an inch.

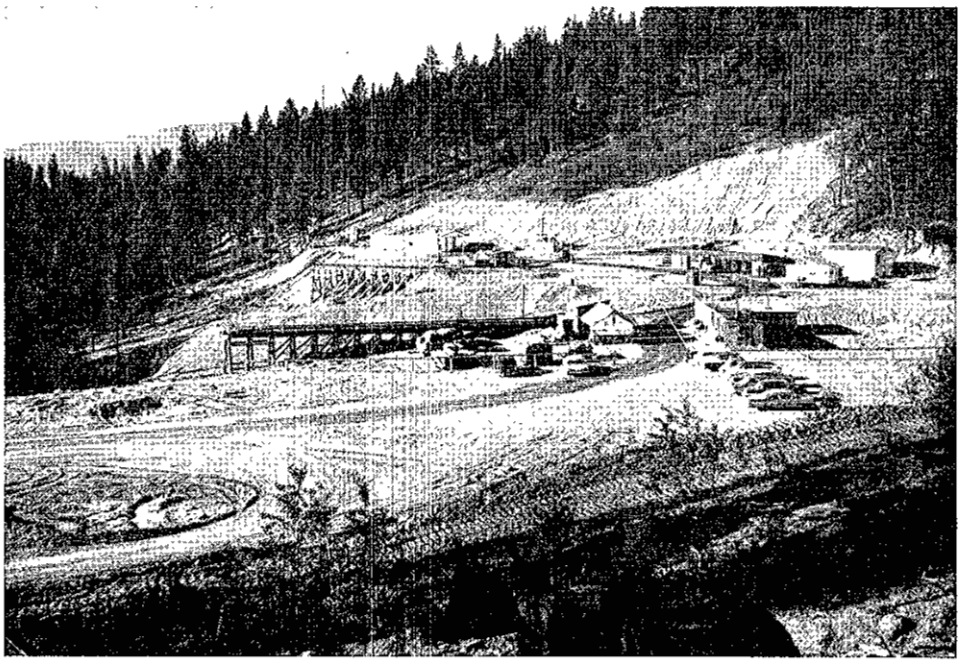
Foliation, in the restricted sense used in this discussion, is a secondarily imposed granular orientation which generally lies at variance with, and frequently obscures, the bedding. At Lookout Point, almost all the foliation strikes in various northeasterly directions and possesses steep dips, which are generally either vertical or toward the northwest but may occasionally be toward the southeast. In rocks other than limestone it strikes between north 35 degrees east and north 55 degrees east. In the limestones, it strikes in various directions, mostly ranging from north 35 degrees east to almost parallel with the bedding, and is locally dragfolded and interrupted, deflected, or convoluted adjacent to brecciated rock fragments contained in the limestone. The gritty and pebbly limestones, which are full of detrital rock fragments, are commonly foliated in a northeasterly direction subparallel to the bedding and the fragments are oriented in the foliation. Fine-grained, banded, non-limy beds, generally of siltstone or argillite, show plications or wrinkles of very small amplitude whose axial planes correspond in direction with the foliation of adjacent beds.

Dragfolds are small and confined within limestone beds, whose interfaces with adjacent, more competent beds are occasionally warped, buckled, or wrinkled, but are not dragfolded. The limestone beds include layers, 1 foot or less thick, of banded argillite, vitric tuff, or other compact rocks, which are separated by limestone layers ranging from an inch or two in thickness to several feet. The limestone beds may be as much as 40 feet thick, and they alternate with relatively non-limy massive assemblages as much as 80 feet thick. The dragfolds may be simple or complex, and may be either well preserved or greatly disrupted by brecciation. The amplitude of the unbrecciated dragfolds is generally not more than 1 or 2 feet, and may be much less. Exceptionally, it is as much as 15 feet, and such folds contain more of the competent layers and correspondingly less of limestone. The axes of the folds vary somewhat in plunge, but most are steep or vertical. With few exceptions, dragfolds are Z-shaped and their axial planes strike northeastward and dip steeply, roughly parallel to the foliation of the containing limestone. Simple S-shaped dragfolds are rare, and probably in all cases are subsidiary to larger adjacent Z-shaped dragfolds. Where the structure is least complicated, a limestone bed strikes uniformly between massive beds and contains thin and well-spaced layers of contrasted rock which are thrown into successive steep-plunging Z-shaped dragfolds. The dragfolds are several feet apart and correlate with those of adjacent layers along northeasterly steep axial planes that are parallel to the limestone foliation.

From such simple forms as this, the folds may show increasing degrees of complication, attenuation, and finally disruption. Their most disordered state is exemplified by a limestone bed containing trains of tabular rock fragments, dis-



Craigmont Mines Limited. Stripping the orebody at 4,100 feet elevation. September, 1960.



Craigmont Mines Limited. Office and service buildings at 3500 level. September, 1960.

persed along foliation planes which trend almost parallel to the bed but are partly contorted. Where the folds are less disrupted, flowage of limestone is shown by its penetration of the folded layers in a swirly foliated manner. Limited flowage is evidenced elsewhere by the entry of limestone into cleavage cracks in the confining beds, and by the lensing-out of thin limestone beds by dragfolding.

The foremost structural pattern at Lookout Point, of steeply dipping beds which are dragfolded predominantly in Z-shapes with steep axes, appears to persist in belts Nos. 1 and 2, and possibly in more southerly belts, as far eastward as the Kingsvale contact. In belt No. 1 it persists for some distance to the west of Lookout Point, but is then obscured by the complex structure present in the bulge in this belt.

At Craigmont, some 2½ miles easterly from Lookout Point, the same pattern of steep Z-shaped dragfolds occurs to the west of the ore zone. The observed dragfolds are small and widely spaced, and are broken by northerly striking shears with limited right-handed displacements. In the ore zone, small dragfolds of uncertain attitude are poorly preserved and appear disrupted in the manner described at Lookout Point. The orebody itself has a configuration suggestive of larger dragfolds. The significance of this configuration and the control of mineralization are not well known and are beyond the scope of this report.

Copper-Iron

Craigmont (Birkett Creek Mine Operators Ltd.) (50° 120° S.W.) Head office, 700, 1030 West Georgia Street, Vancouver 5. R. G. Duthie, superintendent, Merritt. This company controls 115 claims and fractions on behalf of Craigmont Mines Limited. The Craigmont orebody is on Merrell Nos. 7 and 8 claims and McLeod Nos. 5 and 6 claims, and is south of the north fork of Birkett Creek at surface elevations between 3,800 and 4,200 feet.

In 1960 rapid progress was made in preparing this important new mine for production. From January to November, work done included 424 feet of crosscutting on the 3500 level and 2,620 feet of drifting and 459 feet of crosscutting on the 3000 level. A vertical ventilation raise 463 feet long was driven between the same two levels with an Alimak raise platform, and a third level was started from a portal site at approximately 2,400 feet elevation to the south of Birkett Creek, near the Aberdeen road. From January to October, 50,535 feet of diamond drilling was done, mostly from underground. Preparation of an open pit began in June and, by the end of October, about 1 million cubic yards of overburden together with 345,000 cubic yards of waste rock were removed. Construction began of four buildings on a plant-site near the portal of the 2400 level, a pit shop at 3,700 feet elevation, a power-line from the plant-site to 3,700 feet elevation, and two water pipe-lines, each 4 miles long, from Nicola River to the plant-site. At the end of the year about 177 men were employed at the mine, including twenty diamond drillers on contract and about 100 men employed by Kie Mining Company (Peter Kiewit Sons Company of Canada Ltd.), which held the contract for preparation of the open pit.

During the year a deep extension of the western part of the orebody was discovered. As presently known, the Craigmont orebody has a vertical range of about 1,500 feet and is about 2,200 feet long in horizontal projection. In November, semi-proven and probable ore reserves amounting to 22,241,000 tons grading 2.09 per cent copper and 19.8 per cent iron were estimated by both the consultants and the operators. Production of copper concentrates is planned to start in 1961 at a milling rate of 4,000 tons per day.

Betty Lou and Lou (Canex Aerial Exploration Ltd.) (50° 120° S.W.) Company office, 700, 1030 West Georgia Street, Vancouver 5. J. D. Simpson, president. This company holds about thirty claims and fractions in the adjoining Betty Lou and Lou groups at Lookout Point in the Promontory Hills. Work in 1960 consisted of trenching, line cutting, and geophysical surveying. Four men were employed for a few weeks under the supervision of A. Allen.

P.C.M., Cap, Domino, Hank, Freda (Britmont Mines Limited) (50° 120° S.W.) Company office, 402, 25 Adelaide Street West, Toronto 1. S. A. Perry, president. This company holds more than 100 claims on the south slope of Promontory Hills. Work in 1959 and 1960 included about 755 feet of diamond drilling and some geophysical surveying, followed by soil sampling. Drill-holes included two on the Hank group, two which are said to be on the Domino group, and one on the P.C.M. group. No significant mineralization is reported in the holes. A small crew was employed for a part of each year under the supervision of F. J. Hemsworth.

Copper

Aberdeen (Torwest Resources Limited)* (50° 120° S.W.) This property on Broom Creek, 11 miles north of Lower Nicola, consists of the Aberdeen and the Westlock Crown-granted claims and the Crown 21 to 28 recorded claims. The Aberdeen is an old property on which mining was carried out many years previously. A 250-foot vertical shaft was dewatered and retimbered in 1959, and in 1960 a one-compartment headframe was installed over it. A hoistroom was built and equipped with a small hoist obtained from the Copperado. Some underground sampling was done. A crew of three men was employed under the direction of R. E. Renshaw.

NICOLA LAKE*

Copper

Kim (Kennco Explorations (Western) Limited) (50° 120° N.W.) Company office, 1030 West Georgia Street, Vancouver 5. The Kim group of thirty-seven recorded claims is 3 miles north of the north end of Nicola Lake and one-half to 2 miles west of Moore Creek. Geochemical and geophysical surveys were made, and bulldozing and some diamond drilling were done. A crew of twelve men was employed under the supervision of R. W. Stevenson.

GREENSTONE MOUNTAIN*

Copper

D.R.G. (Kennco Explorations (Western) Limited) (50° 120° N.W.) Company office, 1030 West Georgia Street, Vancouver 5. The D.R.G. group of seventy-six recorded claims is 15 miles southwest of Kamloops in a straight line. It lies south of Greenstone Mountain and extends one-half mile south of Roper Lake. Geochemical prospecting, some geophysics, and some bulldozing were carried out. A crew of thirteen men was employed under the supervision of R. W. Stevenson.

* By David Smith.

TULAMEEN*

Lawless Creek Area

The Lawless Creek area is 22 miles west of Princeton and extends northwest from the Tulameen River along both sides of Lawless Creek. Most of the bedrock belongs to the Nicola group. Observations made in 1959 suggested that it might be possible to deduce the rock sequence and structure of that part of the Nicola group included within the Lawless Creek area. Unfortunately, these hopes were not realized in the 1960 mapping. For most of the area, only a general lithologic description can be given, together with notes on the structure. A small section about the mouth of Lawless Creek was studied more intensively than other parts of the area, and is described in more detail in order to illustrate the complexities.

The general geography of the area is outlined in Figure 4. The two main roads converge on Tulameen, 2 miles to the east, which is served by the Kettle Valley Railway and by roads from Princeton and Merritt. The more northerly road was built by the British Columbia Forest Service as an access road to assist potential logging. The principal streams are the Tulameen River and Lawless Creek. Three tributaries of Lawless Creek—namely, Grasshopper, Skwum, and Henning Creeks—divide the country to the west into four sub-radiating ridges, the most southerly of which is Grasshopper Mountain. Northeast of Lawless Creek is a mountain mass carrying several summits separated by shallow saddles; the south part of this mass is known as Mount Rabbitt and the north part as Spearing Mountain. The valley of Lawless Creek is generally steep-walled, and for much of its southern part is a canyon. Henning Creek enters at grade, and its valley is also steep-walled in its lower part. The valleys of Skwum and Grasshopper Creeks are hanging and are rather broad, with moderate slopes. The character of Tulameen River valley changes abruptly half a mile below the mouth of Lawless Creek. Above this point the valley is broadly V-shaped, with the river generally incised in a rock canyon. Below this point the river meanders over a broad alluvial floor.

Till covers a large part of the area. It is generally at least 20 feet thick on the slopes of Mount Rabbitt and Spearing Mountain and on the ridge between Skwum and Henning Creeks, and in these areas natural rock exposures are rare. Elsewhere in the area the till is generally thinner and more patchy, exposing a variable amount of rock; Grasshopper Mountain and the ridge between Henning and Lawless Creeks are typical. The crest of the ridge between Grasshopper and Skwum Creeks differs somewhat; it is veneered by only 1 to 3 feet of overburden, yet outcrops are scattered, small, and rubbly. This overburden, mainly till, thickens down the slopes of the ridge. Along the Tulameen River above the alluvial flats, and along Lawless Creek below the access-road bridge, the till has been largely eroded. Above the access-road bridge, outcrops along Lawless Creek are almost entirely restricted to the right bank.

Alluvial and talus deposits are small and scattered. Apart from the broad flood-plain of the lower Tulameen River, alluvium occurs as scattered terraces farther up the river and along upper Lawless Creek, as a valley flooring along Grasshopper Creek, and as stream-channel deposits. Talus cones are largely restricted to the south slope of Grasshopper Mountain.

Most of the area is thickly timbered with Douglas fir, balsam, spruce, hemlock, pine, and less cedar and poplar. Open patches occur on the southwest slope of Mount Rabbitt and the south slope of Grasshopper Mountain.

* By G. E. P. Eastwood.

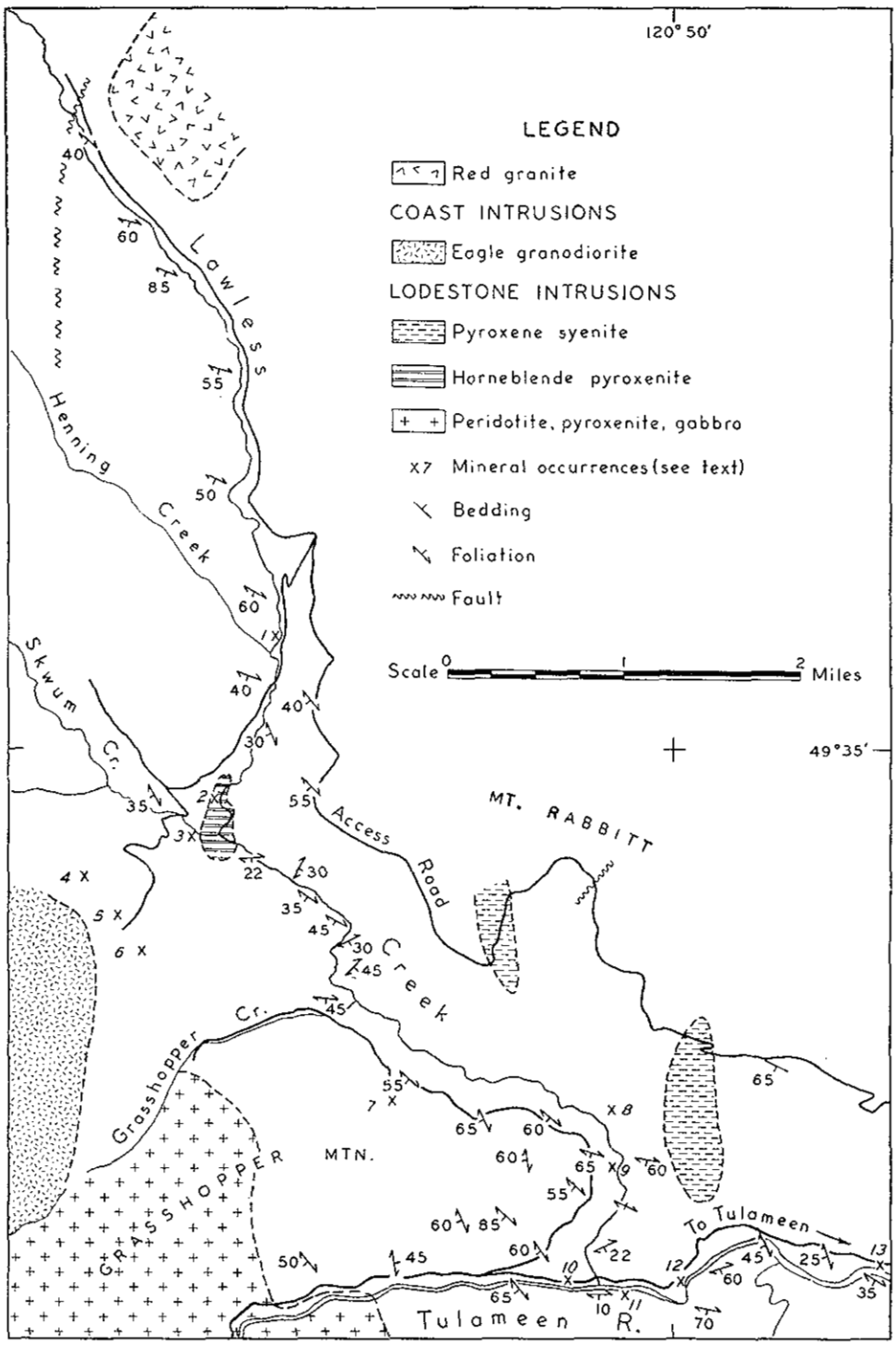


Figure 4. Outline map of Lawless Creek area showing mineral occurrences and principal intrusions.

Camsell included Lawless Creek in his geological mapping of the Tulameen district. Rice made minor rectifications when incorporating this mapping in the Princeton sheet. El Alamein mine and vicinity was geologically mapped by J. S. Stevenson in 1949. The 1960 mapping was on a base at 1 inch to 500 feet with 50-foot contour interval, aided by aerial photographs at 3 inches to the mile.

[References: Camsell, Charles (1913), Geology and Mineral Deposits of the Tulameen District, B.C., *Geol. Surv., Canada,* Mem. 26; Rice, H. M. A. (1947), Geology and Mineral Deposits of the Princeton Map-area, British Columbia, *Geol. Surv., Canada,* Mem. 243; Stevenson, J. S. (1949), *Minister of Mines, B.C.,* Ann. Rept., 1949, pp. 124–127.]

General Geology

TABLE OF FORMATIONS

	Alluvial and glacial deposits; minor talus.
	Non-conformity.
Otter intrusions?	Red granite.
Coast intrusions	Eagle granodiorite.
Lodestone intrusions	Pyroxene syenite, coarse-grained gabbro, pyroxenite, peridotite, dunite.
	Intrusive contact.
	Buff-coloured feldspar porphyry and aplite.
	Relations unknown.
	Medium- to fine-grained diorite and gabbro.
	Intrusive contact.
Nicola group	Lavas, flow breccia, and pyroclastics, mostly intermediate to basic; greenstone; subordinate sediments, including black argillite, siltstone, greywacke, conglomerate, schist, and limestone.

Nicola Group

The oldest volcanic and sedimentary rocks in the Tulameen district were named by Camsell the Tulameen group. They were subsequently correlated by Rice with Dawson's Nicola group, of Triassic and Lower Jurassic age. No fossils were found in the present mapping.

In Lawless Creek area these rocks are highly varied and show marked changes over short distances, along the strike as well as across it. They have undergone mild thermal metamorphism through most of the area, and are baked and recrystallized along contacts with some of the stocks. They have been squeezed and probably closely folded, with production of a coarse regional cleavage or foliation in most of the rocks. Finally, they have been shattered by a network of faults. The resulting pattern is kaleidoscopic. Outcrop is generally inadequate to unravel the complexities, and in any case an inordinate amount of time would be required.

A majority of the Nicola rocks in the area are dense or fine grained and dark greyish-green; they have not been closely identified, and are here termed greenstones. They may be andesitic in composition, and may include lavas, flow breccias, pyroclastics, greywacke, and mixed pyroclastics and greywacke. Interbedded with the greenstones, and in part intergrading or intertonguing with them laterally, are bands of dacite, rhyolite, fine-grained dark sediments, sedimentary schists, limestone, and minor pebble and granule conglomerate.

Relatively small bodies of dacite were identified, by field observation only, on the east end of Grasshopper Mountain, at the mouth of Grasshopper Creek, and in the northwest part of the area. Rhyolite was identified by Stevenson on lower Lawless Creek, but has not been identified elsewhere in the area. These rocks are described below, in the section on lower Lawless Creek.

Thin bands of dark sediments are sparingly interbedded with greenstones through most of the area, and somewhat larger patches of these rocks occur in the southwest. The rocks are black argillites, silty argillites, and phyllites, and dark-grey siltstones and impure quartzites. The bands range in width from a foot or two

to a few tens of feet. Some are relatively isolated, others are grouped in zones, separated by thin bands of greenstone. Neither bands nor zones could ordinarily be traced from outcrop to outcrop, although a series of black phyllite exposures along Grasshopper Mountain road from near the Rabbitt mine to Grasshopper Creek may be of a single band. It is not known whether this apparent lack of continuity of bands is caused entirely by folding and faulting or also by lensy deposition. The larger patches of dark sediments were found on the Tulameen River above the foot of Grasshopper Mountain road, and on the south slope of Grasshopper Mountain toward the Lodestone stock; they could not be traced to the northwest.

Sedimentary schists, with subordinate limestone, appear to underlie a considerable part of the ridge between Grasshopper and Skwum Creeks east of the granodiorite. A wedge of these sediments reaches down to Lawless Creek just below the small pyroxenite stock, and scattered outcrops were found westward and southwestward to Law's Camp. The colour varies from creamy white to various shades of grey, brown, and green. Toward the contact with the Eagle granodiorite, seams of limestone are intercalated along the schistosity, growing generally thicker and more numerous westward. They culminate in two or three lensy bands of coarsely crystalline limestone, 200 or 300 feet wide, against the contact. This limestone-bearing zone can be traced southward along the granodiorite contact to Grasshopper Creek; it is covered to the northwest. A similar or the same limestone-bearing zone can be traced along the granodiorite contact from the summit of Mount Britton for many miles to the southeast.

Pebble conglomerate was found only in the southern part of the area. Small outcrops of it on lower Lawless Creek are described below. A larger band, about 100 feet wide, was followed 3,500 feet northwest from the southeast corner of the area, and it may extend to outcrops of pebble conglomerate on the access road 4,000 and 8,000 feet farther to the northwest.

The greenstones are characterized by a medium- to dark-green or greyish-green colour and generally by dense or fine-grained texture and well-developed but relatively widely spaced cleavage or foliation. Some are, however, porphyritic or medium grained. Commonly the foliation is the only structural feature apparent, but many outcrops exhibit greenstone fragments or calcite lenses, rarely pillow-like structures. These various types of greenstone are commonly closely interbanded and also grade into each other along strike.

Medium-grained greenstone is sparingly scattered through the area. The texture is generally granular rather than interlocking and suggests that the rock may be tuffaceous. One band contains chips of argillite.

Four types of greenstone with a porphyritic appearance were distinguished in the field; they are believed to have had diverse origins. One type containing equant feldspar grains is probably largely tuff or greywacke. A second type contains oblong creamy-white feldspar phenocrysts, as much as 7 millimetres long, set in a dense green groundmass. It is exposed on the access road opposite the mouth of Skwum Creek and as several other bands crossing Lawless Creek. The bands are thick, generally exceeding 100 feet, and are texturally uniform, suggesting that they may be lava flows. A third type is characterized by attenuated cream-coloured feldspar laths. The most striking exposure is beside the access road just east of the second switchback, where the laths attain lengths of 1½ inches and thicknesses of one-quarter inch. This rock could be a dyke or flow, but from varied occurrences it is concluded that the feldspar laths have been introduced. A fourth type is characterized by hornblende prisms about 1 millimetre across, and also by unusually dark-green colour and by hematite coatings on slip surfaces. This rock is

exposed on Lawless Creek for 1,200 feet above the access-road bridge. Ankerite veins and zones of ankerite replacement are very common in this rock, though uncommon in Nicola rocks elsewhere in the area. It is suggested that considerable iron has been introduced, possibly with other constituents, and that the unique characters are metamorphic.

Fragmental greenstones are more common in the southern part of the area, and are described in the following section. Structures suggestive of pillow rinds were seen in two small patches on Lawless Creek, between Skwum and Grasshopper Creeks. Large epidote knots in a band of bluish-green greenstone on the Tulameen River below Lawless Creek may also represent pillows.

About 80 per cent of the greenstone effervesces with 6N hydrochloric acid. In some outcrops the calcite is not visible to the naked eye, and in others it occurs as tiny fracture veinlets or scattered grains or lenses. The origin(s) of these lenses is unknown. In some places, particularly on the Tulameen River just above Lawless Creek and in the northwest corner of the area, the lenses attain lengths of 2 to 3 feet and suggest fragments of disrupted limestone beds. Many lenses the size of a quarter or half dollar leave a deeply ribbed cavity surface when they weather out, possibly suggesting organic structures. Other lenses resemble amygdules. Weathered greenstone surfaces commonly look worm-eaten due to the solution of the smaller lenses.

Intrusive Rocks

Small bodies of diorite and gabbro scattered across the southern part of the area differ markedly in appearance from the Lodestone diorite and gabbro, and probably do not belong to the Lodestone intrusions. They appear somewhat more sheared, suggesting that they may be older. The largest is in the southeast corner; it is a dyke 600 feet wide and traceable for half a mile north from the river, traversing the beds at a small angle to the right. Another dyke about 100 feet wide occurs in El Alamein mine. Several others a few tens of feet wide intrude rhyolite along the lower part of Lawless Creek. An outcrop of diorite occurs northwest of the Rabbitt mine. The rock is dark green in colour, and where fine grained closely resembles green Nicola volcanic rocks. The large body is much more massive than the volcanics, but the smaller bodies are more or less foliated. Two dark porphyry sills in the lower canyon of Skwum Creek may belong to this group.

Buff feldspar porphyry has been found principally on the ridge between Grasshopper and Skwum Creeks and along the adjoining segment of Lawless Creek. Innumerable sills, a few feet to a few tens of feet thick, have been injected into Nicola sedimentary and volcanic rocks. Taken as a whole, the porphyry shows a complete gradation from porphyritic granite through feldspar porphyry to aplite. Around Law's Camp on top of the ridge it is generally massive, but nearer Skwum and Lawless Creeks it is generally somewhat foliated. Several small bodies of feldspar porphyry and aplite are included in the area shown as hornblende pyroxenite on Figure 4. In a few places where the two rocks were seen directly in contact, the pyroxenite showed marked chilling against the porphyry. At one contact, fragments of aplite were found in pyroxenite. The porphyry appears somewhat more sheared and contains considerably more pyrite than the pyroxenite; it is considered to be the older.

The main Lodestone stock, a portion of which is shown in the southwest corner of Figure 4, was briefly described in the Annual Report for 1959, and will not be further discussed here. A small outlying body of hornblende pyroxenite occurs at the mouth of Skwum Creek. As already noted, it contains inclusions of feldspar porphyry and aplite. The rock is mostly coarse grained and greenish-black to

black, consisting of roughly equal amounts of pyroxene and hornblende. Here and there it also contains some biotite. It is slightly magnetic. In three places it was seen to pass into a fine-grained dark brownish-grey gabbro near contacts, but on Skwum Creek coarse-grained pyroxenite is separated from Nicola greenstone by a 5-foot zone of ankerite. Veins of ankerite are also found in places inside the pyroxenite, which generally appears to be little altered against them. In an outcrop 400 feet above the mouth of Skwum Creek a little slip-fibre asbestos is present along minor shears in the pyroxenite.

Two narrow dykes of peridotite or picrite intrude Nicola rocks on Lawless Creek. One is nearly a mile above the mouth of Henning Creek, the other a quarter mile above the mouth of Grasshopper Creek. It is not known whether they belong to the Lodestone intrusions.

Two small stocks of pyroxene syenite intrude Nicola rocks on the southwest slope of Mount Rabbitt, and are exposed in cuts on the access road. The rock is identical with pyroxene syenite of the Lodestone stock on Tanglewood Hill and evidently belongs to the Lodestone intrusions. The rock consists of coarse white or pale-green feldspar and medium-grained pyroxene and amphibole. A small body of this rock occurs just below mineral occurrence No. 8, and other bodies may be present on the same slope.

The Eagle granodiorite underlies a large area to the west. A lobe of this mass extends into Lawless Creek area between Grasshopper and Skwum Creeks. As exposed just west of Law's Camp, the rock is slightly gneissic, coarse grained, and is mottled white and black by its principal minerals, quartz, feldspar, and biotite. This intrusion was assigned by Rice to the Coast intrusions, and was considered by both him and Camsell to be younger than the Lodestone intrusions.

In the northwest corner of the area a stock of red granite intrudes Nicola rocks in a hill east of Lawless Creek. Two small dykes of red granite cross the creek a little farther south. The rock is generally massive and medium grained and consists of pink to red orthoclase, green saussuritized plagioclase, quartz, and subordinate hornblende. The actual contact of the stock with Nicola rocks is exposed only along a small creek to the south, where it is irregular in detail. Near the stock, Nicola volcanics have been baked, and possibly partly silicified, to a light-green rock that rings when struck with a hammer. The red granite appears to fit Camsell's description of the Otter granite near Tulameen.

In addition to the above intrusions, the Nicola has been injected by a variety of dykes, especially along Tulameen River. Dykes of pinkish-grey syenite porphyry are sparingly but widely distributed. They are characterized by coarse feldspar phenocrysts and needles of dark-green amphibole, and closely resemble syenite porphyry dykes that intrude pyroxenite of the main Lodestone stock.

Structural Geology

Most of the Nicola rocks display a planar parting or coarse cleavage with a spacing commonly of several inches. This parting was found to be parallel to the axial planes of the few folds observed, and to bedding where recognizable beds were not folded. Breccia fragments are locally squeezed parallel to the parting. Locally on the north slope of Grasshopper Mountain, and more generally around Law's Camp, the parting becomes close-spaced, platy minerals tend to be aligned parallel to it, and the parting grades into schistosity. For this parting the general term foliation is used in this report.

The general trend of the foliation is west-northwest, but there are marked local divergences in the southern part of the area. Dips are in general to the south.

Figure 4 shows attitudes that are averages for the small areas they represent. North of the access-road crossing of Lawless Creek the strike is fairly uniform, although the dip varies. South of this bridge, however, both strike and dip vary widely. Between Skwum and Grasshopper Creeks, transitions between patches of markedly different attitude are abrupt and may represent faults.

The fold structure in the Lawless Creek area is not known. The variations in attitude noted above are believed to be related, not to the primary folding, but to later deformation. Dragfolds are scarce, small, and vary in plunge. They can rarely be tied into the lithologic pattern. The majority indicate a movement of southwest side over northeast.

Nicola rocks have been intensively faulted in some parts of the area. Three of the broadest fault zones of the area are exposed in the access-road cuts. One fault zone traverses both Nicola rocks and pyroxene syenite at the second switchback. The second, shown on Figure 4, is prominently displayed east of the second stock of pyroxene syenite. It is a zone of gouge and breccia nearly 200 feet wide, flanked by broad zones of pyritic silicified rock. A sample of this pyritic rock assayed: Gold, *nil*. The third, also shown on Figure 4, crosses the access road near its north end. Greenstone is sheared over a width of several hundred feet, but gouge and rock alteration are minor. This shear zone was inferred to continue south along a strong topographic lineament crossing the ridge between Lawless and Henning Creeks.

Lower Lawless Creek

The complexity of the Nicola rocks is illustrated by exposures along the lower part of Lawless Creek, on the east end of Grasshopper Mountain, and along the adjoining part of the Tulameen River. Figure 5 shows the distribution of the main rock types in this section. Some generalized rock units have been outlined, and are numbered from northeast to southwest. Faults are lettered. Some indirect evidence suggests that the numbered units may form an ascending sequence. Correlation with rocks farther up Lawless Creek is uncertain.

Unit 1 is predominantly massive green dacite. It forms high canyon walls along Lawless Creek. Regional foliation is indistinct or lacking. Small shear zones occur here and there. Epidote metacrysts are sprinkled through the rock in places, giving it a yellowish cast, otherwise it appears uniformly fine grained. Tiny feldspar phenocrysts can be detected in some places with the aid of a pocket lens. Interbedded sediments were not found, and fragmental bands generally are not common. Southeast of fault H however, massive dacite passes outward to fragmental dacite in which the fragments are increasingly rounded toward the greenstone contact. Elsewhere fine-grained dacite passes to fine-grained greenstone with only a darkening of colour and increase in foliation.

Unit 2 is a heterogeneous assemblage of varied andesitic volcanic rocks, including about 10 per cent of interbedded sediments. The volcanic rocks include fine-grained, calcareous, and fragmental greenstones, and the sediments include tuffaceous rock, black argillite, greywacke, and banded quartzite. The greenstone is normally medium to dark green or greyish-green. It is generally well foliated, though only on the north slope of Grasshopper Mountain is it sufficiently closely cleaved to be called phyllite or schist. Some of the greenstone effervesces with 6N hydrochloric acid; some does not. The calcite occurs partly in veinlets, partly as disseminated grains. Fragments were found in greenstone mainly in the northeast part of the unit, although faintly discernible bodies may have been missed in areas of poor exposure. The fragments range in size from half an inch to 3 inches across, and from ellipsoidal bodies just discernible on the cleanest surfaces, through

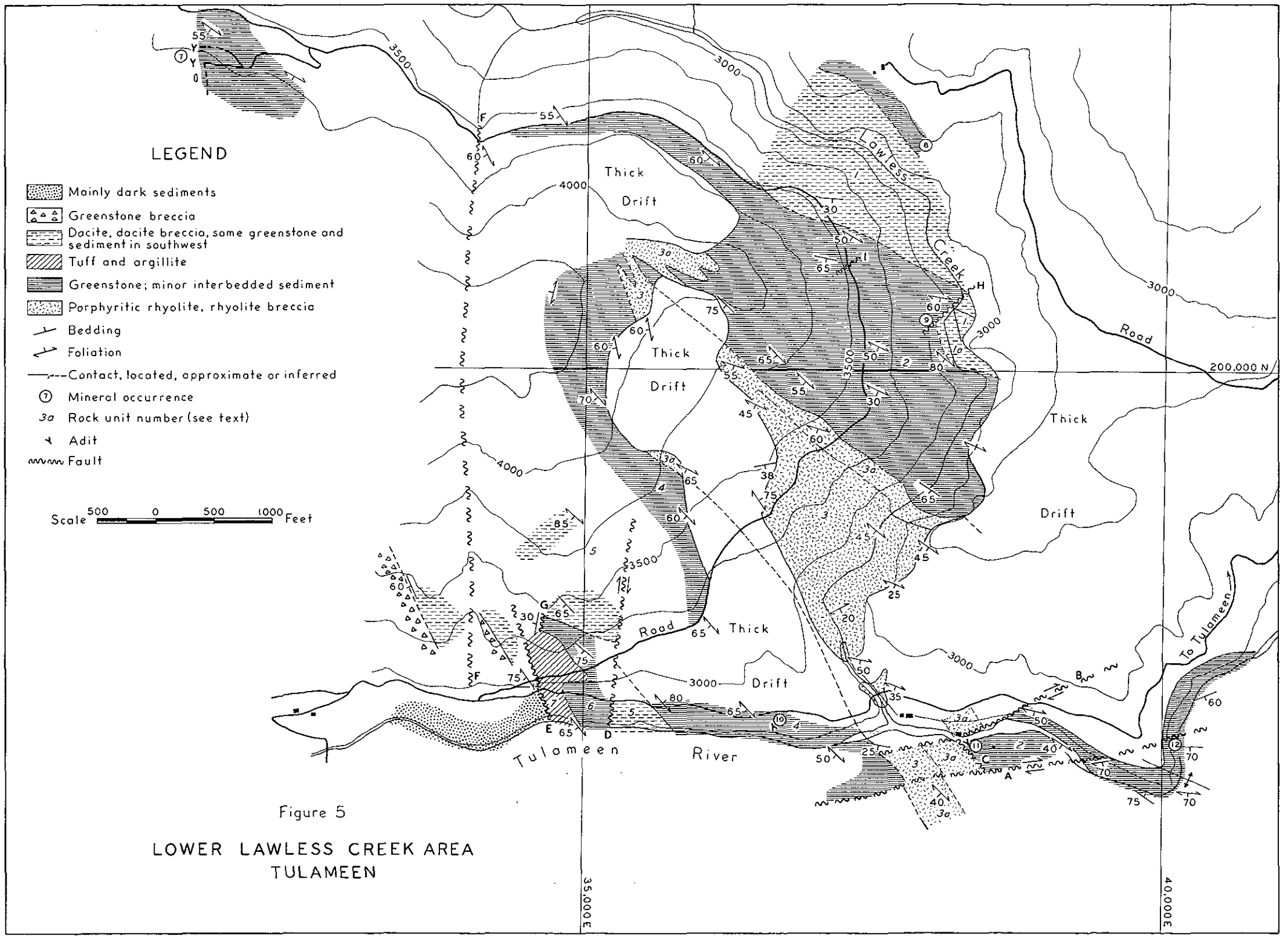


Figure 5

LOWER LAWLESS CREEK AREA
TULAMEEN

more obvious angular fragments, to sub-rounded bodies of somewhat variable colour and texture. The fainter bodies appear to be much the more common.

A fine-grained dark-green rock studded with square grains of white or pale-green feldspar, less commonly also quartz, 1 to 3 millimetres across, is closely interbedded with black argillite just north of the downstream end of fault A. It is probably a tuff or tuffaceous sediment.

Beds and narrow bands of black argillite and silty argillite are scattered through the unit and make up less than 5 per cent of it; they are more common on the Tulameen River than on Grasshopper Mountain. On the river the beds are repeated by tight folding and appear to be squeezed.

This unit exhibits most of the lithologic and structural problems encountered in mapping the Nicola group as a whole. The origins of the rocks and their relationships to each other are rarely apparent. Differing rock types occur here and there, but some lack definite contacts and most cannot be traced beyond individual outcrops. Exposures along the Tulameen River demonstrate that sediments change character markedly in short distances across folds.

Unit 3 is an irregularly lens-shaped body of well-foliated porphyritic rhyolite and porphyritic rhyolite breccia. The widest section is on Lawless Creek, where most of the rock is medium to dark brownish-grey and fine grained, with small feldspar phenocrysts. Locally, as by the bridge, the phenocrysts are ellipsoidal. To the northeast this rock grows much lighter in colour and passes to siliceous breccia consisting of pale-buff fragments, as much as 6 inches long, in a light-green matrix. This breccia is separated at the creek from greenstone of unit 2 by 8 to 10 feet of limestone containing diverse rounded fragments, but elsewhere is directly in contact with greenstone. The breccia maintains nearly uniform width to the southeast, but the rhyolite narrows sharply. Along the Tulameen River both the matrix and fragments of the breccia are generally green, but one narrow band, close to the transition to non-fragmental rhyolite, is distinguished by white fragments and matrix. The southwesterly exposures of rhyolite on the river are mostly green and foliated without discernible breccia. They do, however, contain some thin bands of white rhyolite, two thicker bands of green rhyolite breccia, and a small patch of massive grey rhyolite. The contact with greenstone of unit 4 is gradational.

Northwest of Lawless Creek the rhyolite changes character. In nearly all outcrops it is pale buff in colour, and fragments are discernible at several places in the section. At the same time, fragments are harder to recognize because there is less colour difference between them and their matrix, and for this reason the breccia band on the northeast cannot be traced with certainty. Beds of greenstone and of dark-brown or dark-grey siltstone and quartzite are intercalated in the rhyolite. The rhyolite passes under a large covered area, and where it emerges it is greatly thinned. On the crest of the east ridge of Grasshopper Mountain, rhyolite breccia intertongued with greenstone of unit 2 may represent the tails of small folds.

It is provisionally suggested that the non-fragmental rhyolite on Lawless Creek and to the southeast is the upturned edge of a very viscous flow, exposed near its outer margin. The pale fragment-bearing rhyolite northwest of Lawless Creek is interpreted as a marginal breccia. The breccia band on the northeast may be either flow-top breccia or explosive breccia.

Unit 4 is predominantly greenstone and cannot be distinguished from unit 2 where rhyolite is absent. Where best exposed, on the Tulameen River, unit 4 differs in several respects from unit 2, but it appears to grow more like unit 2 when traced onto Grasshopper Mountain. On the river it is a dense green or olive-green calcareous rock commonly containing lenses or slabs of grey calcite or limestone. It also contains several thin bands of black silty argillite and phyllite, mostly confined

within a central zone 100 feet wide. The calcite or limestone lenses range from the size and shape of a dried pea to slabs an inch or two thick and several feet long, rarely to angular bodies 4 inches across. The slabs appear to be primary structures, possibly disrupted beds or pillow rinds.

Above the Grasshopper Mountain road, lenses and slabs of calcite are less common, although the greenstone remains generally calcareous, and there is considerable tuff and greywacke along the rhyolite contact. Argillite beds and greenstone fragments are uncommon.

Units 5, 6, and 7 have been mapped over a much smaller area and are less well established. Unit 5 consists primarily of dense pale-green dacite like that constituting unit 1, but on Grasshopper Mountain it has interbedded calcareous greenstone and dark sediments. Unit 6 consists of calcareous greenstone that locally grades to impure limestone; on good exposures it shows faint fragments. Unit 7 consists basically of a massive green or greenish-grey rock that may be tuff. This rock is directly in contact with the calcareous greenstone at the river, but above the main road it is interbedded with black argillite which increases toward the northeast. Unit 7 is truncated on the southwest by fault E.

Southwest of fault E no semblance of pattern could be found in the rocks. Along the river they are principally black argillite and silty argillite, much injected by granitic dykes and sills. Above the road they are principally breccia and various dacitic rocks, with two narrow bands of dark sediments. Between faults E and F the breccia includes fragments of silty black phyllite and grey limestone. The dacite is locally dark coloured and medium grained, resembling diorite, but no contacts are visible.

The true sequence of the units is not definitely known, because unquestionable evidence of stratigraphic top is lacking. Cleavage-bedding relations were not found. Dragfolds are scarce, small, and vary in plunge by about 35 degrees. It is not certain that all the dragfolds are related to the primary folding; some may have formed in a later age of the deformation. Most of the better-shaped dragfolds may, however, be related to the primary folding; they show some reversals inside the rock units, and at the sharp bend of the Tulameen River they are consistent with a small anticline in unit 2. The average plunge is gently southeast. At and near contacts of units, most of these better-shaped dragfolds indicate overriding to the northeast. This in turn suggests that units 1 to 7 form an ascending sequence.

The lower Lawless Creek section is chopped up by faults, which appear to belong to three sets characterized by the following strikes:—

(1) East-northeast to northeast—A, B, H, I.

(2) North-northeast to north—D, F, G, etc.

(3) Strike faults—C, E.

Faults of group (1) are further characterized by right-handed offset of beds, although A and B show left-handed drag. Faults A and B each offset a band of white rhyolite breccia about 300 feet. Where exposed just below El Alamein mill, fault B dips 40 degrees north. Fault A may be steeper.

Faults of group (2) are characterized by northerly strikes and near-vertical dips. Some are marked by breccia zones. Where determinable, the offset is right-handed. Fault D is inferred from truncation of beds in riverside exposures and from a vertical wall showing drag and slickensides indicating right-handed movement. Its extension across Grasshopper Mountain has not been demonstrated, but it may be partly responsible for the large shift in the southwest contact of the rhyolite. Fault F is exposed as a broad zone of mildly sheared rock in the Grasshopper Mountain road cut. It is inferred to follow a topographic lineament across Grasshopper Mountain, and may continue northward to a wide fault zone exposed

on the access road. The amount and direction of movement on it are unknown. Fault G terminates unit 6 to the northwest. Along the Tulameen River, near El Alamein mine, there are three north-striking zones of fault breccia 2 to 5 feet wide. Two of these are below the mill and each offsets a quartzite-bluish greenstone contact about 30 feet to the right. Some of the fragments are well rounded and resemble pebbles.

The strike faults are by nature less conspicuous than the others. Fault E was identified because it is slightly crosscutting, gradually truncating unit 7. Fault C is host to mineralization and is exposed by El Alamein adits. It is mainly a zone of anastomosing shears in black argillite, but it has also brecciated the adjacent diorite. The Enniskillen adit exposes a gouge band 3 to 4 inches wide. Both mine faults are generally parallel to the regional foliation. The displacements are unknown.

Mineral Deposits

Mineral occurrences visited in 1960 are shown by number on Figure 4 and are mentioned below. Descriptions of some of these occurrences, and of others not mentioned here, are given in the memoirs by Camsell and Rice, in Annual Reports, and in Department of Mines Special Report No. 1937-17. None is large, most are very small, yet together they emphasize the wide distribution of mineralization.

The following production is recorded:—

	Year	Tons Shipped	Gold	Silver	Copper
			Oz.	Oz.	Lb.
Law's Camp	1916	30	30	466	869
Rabbitt mine	1939	21	88	24	.....
	1940	1,361	924	524	.....
	1941	50	45	36	.....
Totals	.....	1,432	1,057	584	.....
El Alamein	1949	.....	40	7	.....
	1950	.....	65	.....	.....
	1951	.....	96	18	.....
Totals	.....		201	25	.....
Area totals	.....	.....	1,288	1,075	869

1. Two small cuts have been made in the right bank of Lawless Creek 700 feet above the mouth of Henning Creek. They expose small amounts of chalcopyrite and galena in two quartz-carbonate veins striking northwest and slightly east of north.

2. On the west bank of Lawless Creek, 1,500 feet above the mouth of Skwum Creek and just above the old road to Law's Camp, galena and less chalcopyrite are irregularly disseminated in part of an inclusion of feldspar porphyry in pyroxenite. Across Lawless Creek, in the cut of the old road, there is a faint malachite stain on carbonatized pyroxenite, with one small fracture veinlet of sphalerite and chalcopyrite.

3. At a bend in Skwum Creek, just west of the pyroxenite, a north-striking gently west-dipping quartz-carbonate vein contains chalcopyrite, sphalerite, and galena with pyrite across 5 inches over an exposed length of 32 feet. A sample over this width assayed: Gold, 0.02 oz. per ton; silver, 1.1 oz. per ton; copper, 0.45 per cent; lead, 0.31 per cent; zinc, 0.5 per cent. Two small pockets of chalcopyrite and sphalerite were found farther up Skwum Creek, between the upper falls and the road to Law's Camp, in quartz-carbonate veins under minor flat-lying gouge zones.

4, 5, and 6. Law's Camp. *See* page 53.

7. *Rabbitt Mine.*—This property is on the north slope of Grasshopper Mountain at 3,700 to 3,950 feet elevation, half a mile southeast of Grasshopper Creek. It is reached by a short branch off the Grasshopper Mountain logging-road. Development and mining were carried on between 1937 and 1941. Workings include two adits, now caved, a stope broken through to surface, and extensive trenching and pitting. The workings follow two quartz-carbonate veins which strike north 10 degrees west and north 40 degrees east and intersect at the stope. Both veins were seen to contain considerable disseminated pyrite and some disseminated chalcopyrite. It is reported that native gold, a telluride, galena, and sphalerite are also present. The pattern of mining would suggest a pipe-like orebody at the intersection of the veins.

[References: Rice, H. M. A. (1947), Geology and Mineral Deposits of the Princeton Map-area, B.C., *Geol. Surv., Canada,* Mem. 243, p. 99; *B.C. Dept. of Mines,* Special Report No. 1937–17, p. 6; *Minister of Mines, B.C.,* Ann. Rept., 1940, p. 61.]

8. Copper mineralization was found in 1960 by J. W. Welden, of Tulameen, 1¼ miles east of the Rabbitt mine, across Lawless Creek and at an elevation of 3,200 feet. Trenching on the nose and north flank of a ridge has disclosed blebs and disseminated grains of chalcopyrite, together with a general malachite staining, in rubbly siliceous greenstone over a surface area of about 800 square feet. The probable size and shape of the body could not be deduced from present exposures. The rock is traversed by at least one flat-lying shear.

9. A copper showing was encountered on the west bank of Lawless Creek nearly a mile from its mouth. At the foot of a bluff and talus slope a large slump block contains a 2-inch vein of massive pyrite and chalcopyrite which assayed: Gold, 0.02 oz. per ton; silver, 6.3 oz. per ton; copper, 13.03 per cent. Directly above this block the trace of a mineralized shear zone gradually climbs the bluff northward. At its readily accessible south end this zone strikes north 80 degrees west, dips 43 degrees south, and is 2½ feet thick. It consists of a hangingwall band of barren breccia and a footwall band of sheared argillite and greenstone containing clots and disseminations of pyrite and chalcopyrite. Quartz is minor in both places.

10. *Enniskillen.*—This showing is on the north bank of the Tulameen River, 1,000 feet above the mouth of Lawless Creek. It is on the former Enniskillen No. 1 claim, which was located by W. Britton in 1939. The ground is now included in the Rambler Group, located in 1959 by Mrs. D. Petch, of Tulameen. Workings include a 10-foot adit and some caved pits and trenches. The country rock is a 30-foot band of black argillite in Nicola greenstone. The adit follows a bedded shear in the black argillite that contains some scattered grains of pyrite and chalcopyrite and small lenses of calcite.

[Reference: *Minister of Mines, B.C.,* Ann. Rept., 1949, p. 129.]

11. *El Alamein Mine.*—The mine and a pilot mill are 1,600 feet below the mouth of Lawless Creek, on the Wildcat Crown-granted mineral claim owned by V. Golden, of Vancouver. El Alamein Mines Limited in 1949–50 erected the pilot mill on the north side of the Tulameen River and drove two adits into a bluff face on the south side. The property has lain idle since 1951. N. N. MacKenzie, of Vancouver, diamond drilled two holes from surface in 1959 and one hole of 98 feet in 1960, in addition to several short holes from the upper adit. The adits trend south-southeast and are connected by a raise. The lower is about 10 feet above normal river level and is about 150 feet long. The upper is about 15 feet higher and 300 feet long. They follow a shear zone 4 to 8 feet wide in a diorite dyke. The material of the zone is largely sheared black argillite, and subordinate sheared and

brecciated diorite. The zone exhibits both anastomosing and branching shears, and is offset a few feet by several small cross-faults. Veins and veinlets of quartz and calcite are scattered through it. Pyrite, chalcopyrite, and native gold occur both in the veinlets and disseminated in sheared or brecciated diorite. The gold does not occur uniformly along the lode, but appears to be concentrated in pockets or shoots. The controls of these shoots have not been determined.

[References: *B.C. Dept. of Mines,* Special Report *1937–15*; *Minister of Mines, B.C.,* Ann. Repts., 1949, pp. 124–129; 1950, p. 112; 1951, p. 128; 1959, p. 53.]

12. On the left bank of the Tulameen River, in the canyon section half a mile below the mouth of Lawless Creek, J. W. Welden, of Tulameen, in 1960 discovered pyrite, chalcopyrite, and sphalerite disseminated in a bedded quartz vein 2 to 6 inches wide. The vein is in interbedded argillite and greenstone just south of the projected position of an east-west fault.

13. In the southeast corner of the area, on the left bank of the Tulameen River directly below the foot of Logan's logging-road, copper-zinc mineralization was in 1960 exposed by bulldozing and by blasting on ground held by J. W. Welden. A bulldozed trench parallel to the river, 50 feet long, together with natural outcrops farther west, exposes granule conglomerate and 5 feet of rhyolite tuff lying above black argillite. The upper few feet of the black argillite is strongly sheared and brecciated. These rocks are thrown into a broad arch plunging about 35 degrees into the river. On the crest of the arch the tuff contains calcite stringers and stringers and ragged disseminations of sphalerite and minor chalcopyrite. No ore mineralization was seen in the black argillite, and the granule conglomerate had not been exposed on the crest of the arch. The mineralization appears to die away on the flanks.

Gold-Copper-Zinc

Law's Camp (The Consolidated Mining and Smelting Company of Canada, Limited)

The company optioned six Crown-granted claims, owned variously by The Penticton Sawmills Limited, Mrs. Ben Marcotte, and several estates; optioned thirty-five recorded claims, and holds thirteen claims by record. The principal showings are on the St. George (4), St. Lawrence (5), and Liverpool (6) Crown-granted claims, which lie in an approximate north-south line along the east brow of the ridge between Grasshopper and Skwum Creeks. The company built a short piece of road from the Skwum Creek branch of the Forestry access road to join the old Law mining-road at Skwum Creek, and rehabilitated the road up to the camp. A tent camp was established at the old camp-site. Thirteen holes were diamond drilled, aggregating about 3,000 feet. Magnetometer and E-M surveys were made, and an area around the showings was geologically mapped. All work ceased early in September. Twelve men were employed for most of the season, under the direction of D. W. Heddle.

The general geology is outlined in Figure 4 and on the preceding pages. Figure 6, a generalization of plane-table mapping by the company, indicates the main rock types in the mine area. They are dark schistose sediments and light-grey or white coarsely crystalline limestone of the Nicola group, dykes and (or) sills of feldspar porphyry, and Eagle granodiorite. The main body of granodiorite is exposed just west of the area of Figure 6, but an outlying body is exposed in the northwest part of the area, near the St. George showing. Areas shown as schist include many seams and thin bands of limestone, many dykes or sills of feldspar porphyry and aplite, and a few bodies of greenstone. Feldspar porphyry and greenstone occur

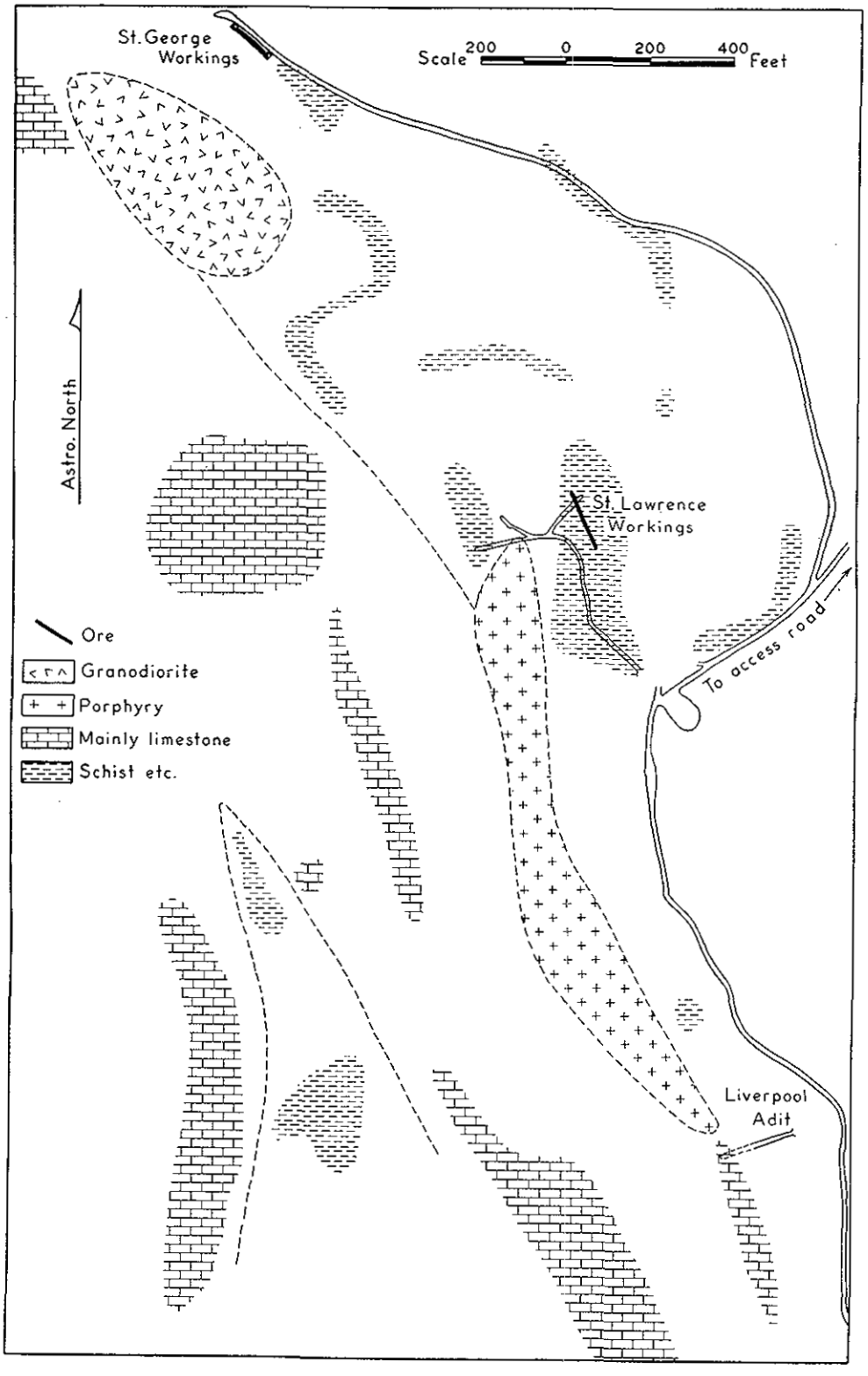


Figure 6. Law's Camp. Principal showings.

to a lesser extent in the main limestone areas. The fold structure is unknown. Bedding is indistinct in the limestone. It may be represented in the schists by the limestone seams, to which schistosity is parallel. This schistosity swings from strike north 20 degrees west, dip 35 degrees west at the St. Lawrence showings to strike north 55 degrees west, dip 50 degrees southwest at the St. George. Many small faults can be seen in the St. Lawrence adit and in some outcrops. The over-all fault pattern is not evident.

The St. Lawrence ore zone is exposed in three inclined shafts over a length of 150 feet. A trench and short adit 100 feet farther south and the main adit about 90 feet lower encountered only a breccia band at the projection of the vein, and a fourth shaft 40 feet farther north along strike was sunk in limestone. Drilling appeared to confirm that the orebody is a lens sharply limited along strike and down dip. As exposed in the south shaft, the orebody is bedded and consists of 6 feet of nearly massive sulphide lying between schist walls. Pyrite and sphalerite predominate; chalcopyrite and quartz are minor. The next two adits to the north were not accessible; fragments of ore and limestone are mingled with schist on the dumps. The relationship of this limestone to the breccia band is not known. The breccia band is 4 to 6 feet thick in the above-mentioned trench and in drill-holes, but narrows to 2.5 feet in the main adit. Two small pods of sphalerite are exposed in a drift off the main adit, but they lie some 10 feet in the hangingwall of the breccia band. A 50-foot-thick breccia band exposed along the road to the St. George showings may or may not be a continuation of the St. Lawrence breccia band. It is heavily pyritized, but no ore minerals were seen in it.

The St. George orebody is exposed in two shafts 90 feet apart, southwest of the 50-foot breccia band. The shafts are now unsafe, but the dumps indicate the ore is nearly massive pyrrhotite containing a little chalcopyrite. The walls are limestone. Here again the drilling indicated the body is a lens sharply limited along strike and down dip.

The Liverpool body was entered by an adit now inaccessible. The dump consists of black schist and massive pyrite containing a little chalcopyrite. Drill-holes on either side and down dip failed to find ore mineralization.

ASHNOLA RIVER*

Copper

Rick (Kennco Explorations (Western) Limited)

(49° 120° S.E.) Company office, 1030 West Georgia Street, Vancouver 5. The Rick group of eighty-one recorded claims is southeast of Placer Mountain near the head of McBride Creek, a tributary of the Ashnola River. Twelve miles of road was constructed. Geological, geochemical, and geophysical surveys were made, and a total of 3,000 feet of diamond drilling was done. A crew of five men was employed under the direction of C. S. Ney.

SIMILKAMEEN RIVER†

Copper

Deep Gulch (Copper Mountain Mines Ltd.)

(49° 120° S.W.) Company office, 1500 Marine Building, 355 Burrard Street, Vancouver 1. R. Collishaw, president; A. C. Skerl, consulting geologist. This company (formerly named Deep Gulch Mines Ltd.) holds about thirty claims and fractions which are mostly on the west side of the Similkameen River near the Hope–Princeton highway 15 miles south of Princeton.

* By David Smith.
† By J. M. Carr.

Work done in 1960 included geophysical surveys and about 1,000 feet of diamond drilling, of which some is reported to have intersected mineralization.

Friday Creek Development Co. Ltd.

(49° 120° S.W.) Company office, 1614 Burrard Building, 1030 West Georgia Street, Vancouver 5. D. F. Hamelin, president. This newly formed company holds twenty-two claims and fractions comprising the Ilk, Elk, and Ni groups under option from Len and Irvine Ashley, of Princeton. The property lies east of the Hope–Princeton highway about 17 miles by road south of Princeton, and adjoins the southern part of the Deep Gulch property. The showings are astride Friday Creek at about 3,200 feet elevation, and are accessible by vehicle either from the north through the Deep Gulch property or from the south by 2 miles of dirt road which joins the highway nearly 3 miles south of the Kennedy Lake turn-off.

In 1958 Phelps Dodge Corporation (Canada) Ltd. extended bulldozer trenches to north and south of Friday Creek for distances of 1,400 and 3,400 feet, respectively. Work done in 1960 by the present company includes road-building and bulldozer trenching, together with about 1,000 feet of diamond drilling and a geophysical survey. This work was concentrated near Friday Creek, in the vicinity of old workings that are now caved or destroyed and were formerly known successively as the Wheeler group and the Gladstone group.

The showings are in rocks of the Copper Mountain stock, whose western margin occurs between the southernmost trenches. In these trenches, gabbro or diorite is exposed within about 300 feet of contact metamorphosed basic volcanic rocks which strike northwestward and possess steep dips. The volcanic strata are partly sheared and pyritized. The margin of the stock is also located in trenches on the Deep Gulch property at a distance of about 1 mile north-northwest of the Friday Creek showings.

Exposures are mainly of monzonite and diorite or gabbro. Mica pyroxenite occurs on both sides of Friday Creek, and is a rock not previously recorded in the stock. It apparently forms a northerly trending body about 200 feet wide and at least 350 feet long. As seen south of the creek, the pyroxenite contains a 15-foot-wide section of gabbro and is enclosed to east and west by gabbro, or diorite, which grades rapidly to monzonite. The margins of the pyroxenite are sharp and somewhat irregular. Throughout the trenched area the plutonic rocks are traversed by varying amounts of pink pegmatite. The pegmatite consists principally of orthoclase feldspar together with biotite, plagioclase feldspar, and some quartz. It forms veins of diverse attitude, ranging in width from a fraction of an inch up to several feet. Numerous exposed sections of the plutonic rocks are virtually free of pegmatite, as also are scarce dykes of andesite porphyry which cut diorite and monzonite.

Except in pyroxenite, copper mineralization appears to be distributed in close relationship to pegmatite. Bornite and chalcopyrite occur separately or together, and are partly changed to malachite. Chalcocite is reported on the property, and pyrite was seen in small amounts in the few sections of core that were examined. The copper minerals are chiefly visible in and adjacent to pegmatite, as small pods and local disseminations where pegmatite veins intersect, or as lenses in a few of the wider veins. The most widespread mineralization is probably in the western part of the pyroxenite body, where bornite appears less restricted to the vicinity of pegmatite but in addition occurs disseminated and on hair-line fractures in the pyroxenite, together with introduced biotite. The grade of such mineralization is difficult to estimate. Platinum, palladium, gold, and silver are reported to occur in varying amounts in assayed samples of copper-rich material selected from the

Friday Creek vicinity. A sample of bornite-rich material taken from a narrow vein about 2,600 feet south of Friday Creek assayed: Gold, 0.54 oz. per ton; silver, 6.2 oz. per ton; palladium, trace; copper, 28.06 per cent. Platinum was not detected in the sample.

[References: *Minister of Mines, B.C.,* Ann. Repts., 1929, p. 277; 1958, pp. 30–31; 1959, pp. 53–54; *Geol. Surv., Canada,* Mem. 171, 1934, pp. 47–48; Mem. 243, 1947, pp. 89–90.]

COPPER MOUNTAIN*

Copper

Copper Mountain (The Granby Mining Company Limited).—(49° 120° S.W.) Company office, 1111 West Georgia Street, Vancouver 5. L. T. Postle, president. Under a lease held by the H.G. Mining Co. Ltd., mining was carried out in the open pit. Three shipments of ore were made totalling 41 tons.

PRINCETON*

Copper

F.H. (Kennco Explorations (Western) Limited).—(49° 120° N.W.) Company office, 1030 West Georgia Street, Vancouver 5. The F.H. group of 103 recorded claims is at Jura station, 6 miles north of Princeton. Surface prospecting, some geophysical work, and some diamond drilling were carried out. A crew of three men was employed under the supervision of J. M. Anderson.

HEDLEY†

Gold

French (French Mines Ltd.) (49° 120° S.E.) Company office, 314, 718 Granville Street, Vancouver 2; mine office, Hedley. W. B. Burnett, president; J. S. Biggs, mine superintendent. The French mine is on the Oregon mineral claim on the east side of Cahill Creek, a southwesterly flowing tributary of the Similkameen River about 5 miles east of Hedley. It is at an elevation of 3,900 feet and is reached by a branch from the Nickel Plate road about 3 miles from the highway.

A short history of the property is given in the Annual Report for 1957 and descriptions in the Reports from 1950 to 1959. The geology in the vicinity is shown on Geological Survey of Canada Map 568A, Hedley.

The mine is in a salient of Triassic and later(?) sediments described (1959) as a band of limy strata up to 60 feet wide between fine-grained dark-coloured tuffs. The salient extends about a mile southwestward into younger granodiorite and is about half a mile wide. The strata in the vicinity of the mine consist of tuffs overlying 15 to 20 feet of limestone which in turn overlies cherty tuffs. Locally limestone has been completely replaced by silica. The mineralization is in a garnet-pyroxene skarn which appears to have formed in part along fractures rather than as a consistent replacement of beds. There is not, therefore, necessarily a direct relationship between the distribution of skarn and the attitude of bedding planes.

The axis of the orebody trends northwest and plunges toward the southeast. At the southwest end of the mine the orebody curves to east-west and finally swings round nearly to northwest. It is flat-lying for most of its length; the dip steepens eastward, and in the central part the orebody rolls steeply northwest between the 3,920- and 3,835-foot levels.

* By David Smith.
† By N. D. McKechnie and David Smith.

The tuffs in the ore zone show strong brecciation which is pre-silicification; there is also some healed limestone breccia. A pillar in the largest stope shows minor folds in limestone overturned flatly to the northeast, and elsewhere there are fragments of limestone in " footwall " tuffs, indicating overturned beds. Limestone-tuff contacts usually are very irregular, and blocks of tuff in limestone are not uncommon. Some of these suggest engulfment by the limestone by solid flow under great stress, such as might obtain during severe folding. Individual stopes may be flat or steep dipping; an unusual feature is the common overlapping. One stope that breaks through to surface has upper and lower branches that join to form one large chamber, the whole having the shape of a recumbent saddle. Partially completed sections in the mine files indicate that the whole structure is an overturned nappe-type fold with minor folds on the limbs, not all of them on parallel axes. Such a structure could include all of the observed features enumerated above.

If the major controlling structure at the French mine is a recumbent fold, the ore structure is quite possibly repeated elsewhere in the vicinity. A mineral deposit within such a structure might show little vertical depth but could have appreciable lateral extent, as does the French ore zone. This possibility should be considered in exploring mineral showings in the neighbourhood.

The ore zone is displaced, about 15 feet each, by several steep-dipping cross-faults, striking north-northeast to northeast. These are in the hangingwall of a northeast-striking fault dipping 40 degrees southwest which cuts off the ore zone, the Cariboo fault. If, as seems likely, the Cariboo fault is a thrust fault, the ore in its footwall should be sought to the west of the present zone.

The mine is developed from three adit levels—the 3920 level (Kelowna), the 3835 level (Granby), and the 3785 level (Cariboo). In 1960 mining and development was carried out on all three levels. The ore is mined by open stoping and is slushed to transfer raises. The operation averages 45 to 50 tons per day, the ore being trucked to the cyanide mill on the flat east of Hedley. The following is a summary of work done in 1960:—

Drifting	ft.	421
Raising	ft.	157
Crosscuts	ft.	237
Diamond drilling—		
Underground	ft.	4,920
Surface	ft.	1,688
Ore milled	tons	13,553
Gold recovered	oz.	6,420

A crew of seventeen men was employed in all operations—six underground and eleven on the surface. No important changes were made in the present installations. No accidents were reported.

KEREMEOS*

Silver-Gold

Horn Silver (Canada Radium Corporation Limited)

(49° 119° S.W.) Company office, 1024, 85 Richmond Street West, Toronto, Ont. The old Horn Silver mine is on the east slope of Richter Mountain on the east side of the Similkameen River valley, 16 miles south of Keremeos. The present property comprises the Horn Silver and Silver Bell Crown-granted mineral claims, registered owners G. F. Ramsey, Ulrich Tishhauser, and Howard Graham, all of Keremeos, and seven recorded claims, the Silver Bell 1 to 5 and Silver Bell 7 and 8, in the name of Canada Radium Corporation

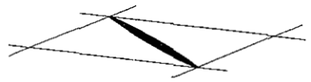
* By N. D. McKechnie.

Figure 7

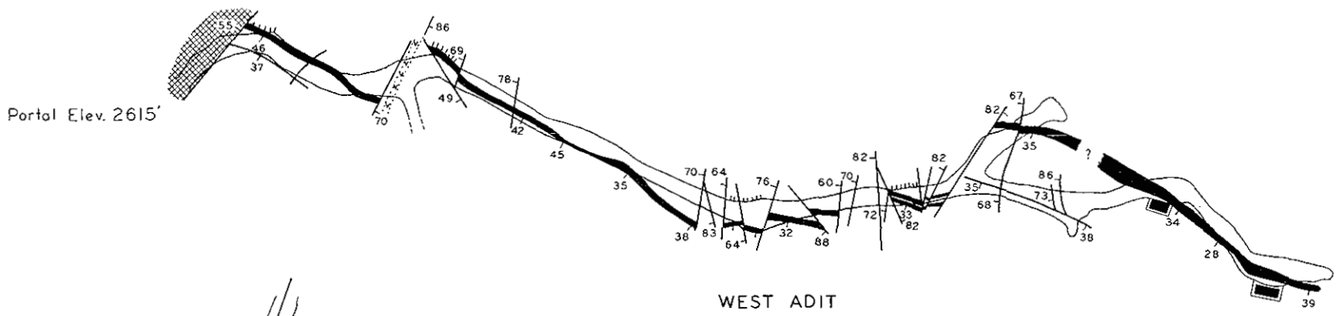
HORN SILVER MINE

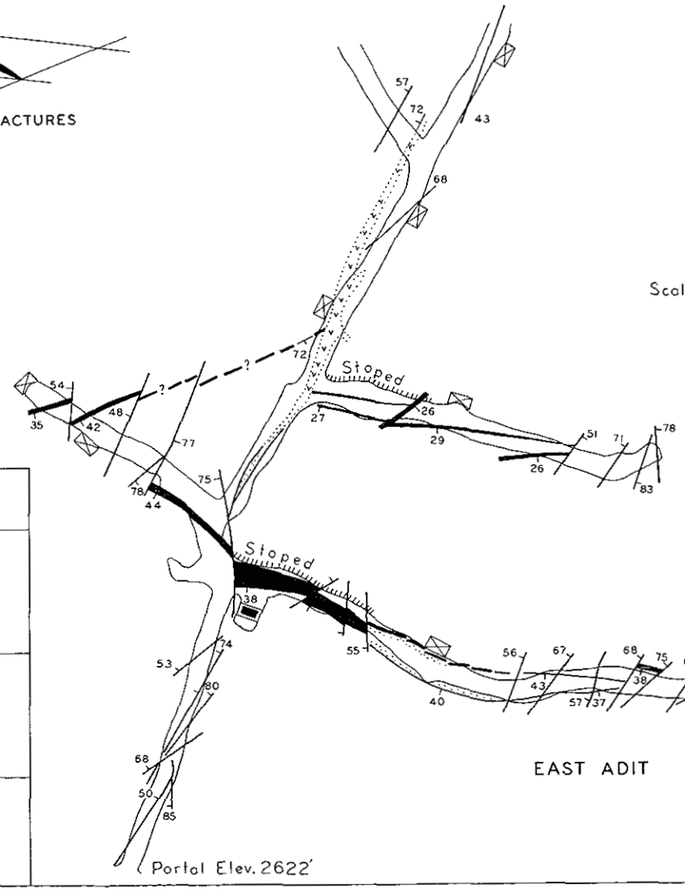
LEGEND

- Sulphides
- Syenite
- Quartz
- Pyroxenite
- Granodiorite porphyry
- Monzonite
- Fault
- Strike and dip
- Raise, bottom
- Winze, top
- Stope, bottom

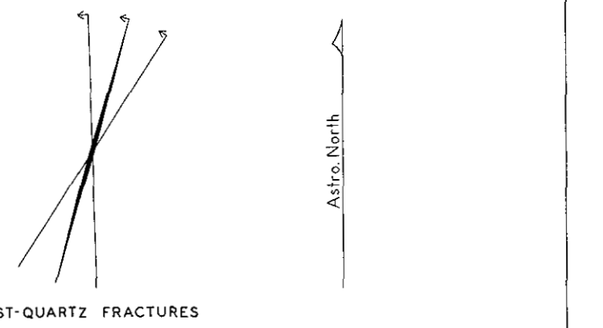


PRE-QUARTZ FRACTURES

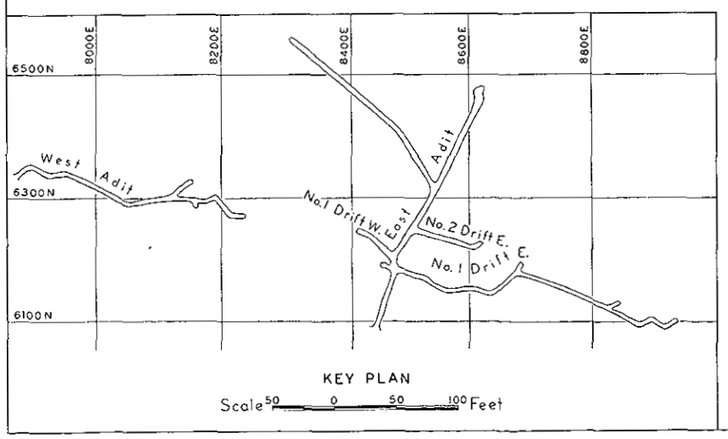




Scale 20 0 20 40 60 Feet



POST-QUARTZ FRACTURES



KEY PLAN

Scale 50 0 50 100 Feet

Limited. A jeep-road, now in need of repair, leads from the Keremeos–Chopaka highway, past the old loading-platform at 1,300 feet elevation, to the east portal at 2,622 feet elevation in a distance of about 1 mile. A good foot-path connects the east portal with the west portal.

The Horn Silver claim was Crown-granted in 1909 and the property was under development every year from 1914 to 1922. In 1925 Horn Silver Mining Corporation built a small mill, rated at 22 tons per day capacity, near the site of the present loading-platform. The mill operated in 1926 only, when it treated 700 tons. The company reorganized in 1927 as Big Horn Mines Limited, under Dominion charter, and confined its work to underground development. Further development was done during 1929, but in 1930 the property was closed. The mine and milling equipment had been removed by 1933. In April, 1958, Canada Radium Corporation began a programme of drifting, crosscutting, raising, and diamond drilling which continued until September, 1959. No work was in progress in 1960.

The total production, chiefly shipping ore, is 5,878 tons containing 682 ounces gold (0.116 ounce per ton); 249,090 ounces silver (42.4 ounces per ton); 131 pounds copper; 1,471 pounds lead; 85 pounds zinc. Tests of a composite sample by Horn Silver Mining Corporation in 1925 showed *nil* in bismuth, antimony, and nickel.

The property is described or mentioned in the Annual Reports for 1915 to 1930, inclusive, 1933, 1958, and 1959. The general geology of the area is shown on Geological Survey of Canada Map 341A, Keremeos.

The Horn Silver mine lies in the Kruger syenite, which forms a band about 1 mile wide trending east to southeast for 4 miles from the Similkameen Valley, then turns due south and widens to about 3 miles at the International Boundary. It is bordered on the north and east by the older Kobau group of quartzites, schists, and greenstones, and on the south and west by a large mass of younger granodiorite. Two to 3 miles east of the mine the syenite-granodiorite contact is offset to the left on two northeastward-striking faults.

The Horn Silver deposit (Fig. 7) consists of quartz veins, mineralized with sulphides, in a shear zone in a monzonite phase of the syenite.

The monzonite is a medium-grained dark-grey rock with a pinkish cast, which locally may be quite pronounced, given by the potash feldspar. The rock shows little alteration, involving scattered grains of calcite, a little sericite, and some conversion of pyroxene to hornblende.

The monzonite is cut by dykes of granodiorite porphyry, pyroxenite, and syenite. None was found in contact with any other, so their age relationships are not known for certain.

The granodiorite porphyry is a fresh-appearing rock composed essentially of elongated phenocrysts of feldspar and dark-green hornblende. In thin-sections the phenocrysts are seen to be microcline with chipped and crushed edges. The groundmass is microcline, muscovite, hornblende, minor plagioclase, and a few grains of quartz. Most of the feldspars are fractured, and sericite has formed in the streaks and small patches of finely crushed material. The only exposure of this rock in the mine workings is a large dyke at the portal of the West adit. It is presumed to be allied to the main mass of granodiorite.

The pyroxenite is exposed only in one place in the workings, in No. 1 East drift about 320 feet east of the main crosscut. It is composed essentially of pleochroic clinopyroxene in part converted to amphibole, biotite, and about 10 per cent or less of microcline and perthite. Secondary alteration is confined to a little talc.

Syenite is exposed in both the West and East adits. It is a coarse-grained pink rock composed chiefly of microcline and perthite, hornblende, biotite, plagioclase,

and quartz. A little talc borders some of the hornblende, and the feldspars are sericitized along cleavages. Structural relationships indicate the syenite to be the youngest of the three dyke rocks.

The controlling structure of the Horn Silver mine is a shear zone some 80 feet wide which strikes north 85 degrees west and dips 40 degrees south. A subsidiary shearing, visible within the main shear zone and also in minor vein directions elsewhere, strikes north 70 degrees east and dips 55 degrees southeast. Lenticular quartz veins striking north 60 degrees west and dipping 35 degrees southwest occupy tension fractures in the north 85 degrees west shear zone and are in echelon to the left. Oreshoots controlled by this shear system would have a flat westerly plunge of about 10 degrees.

The pre-mineral shear zone is faulted by a later system consisting of two shear faults: strike north, dip 55 degrees west and strike north 35 degrees east, dip 65 degrees northwest. Tension fractures, occupied by syenite dykes, strike north 15 degrees east and dip 70 degrees west. Displacement on the north-south faults is to the right; that on the north 35 degrees east faults to the left. Observed displacements are of a few inches to a few feet only, but break the veins into short lengths.

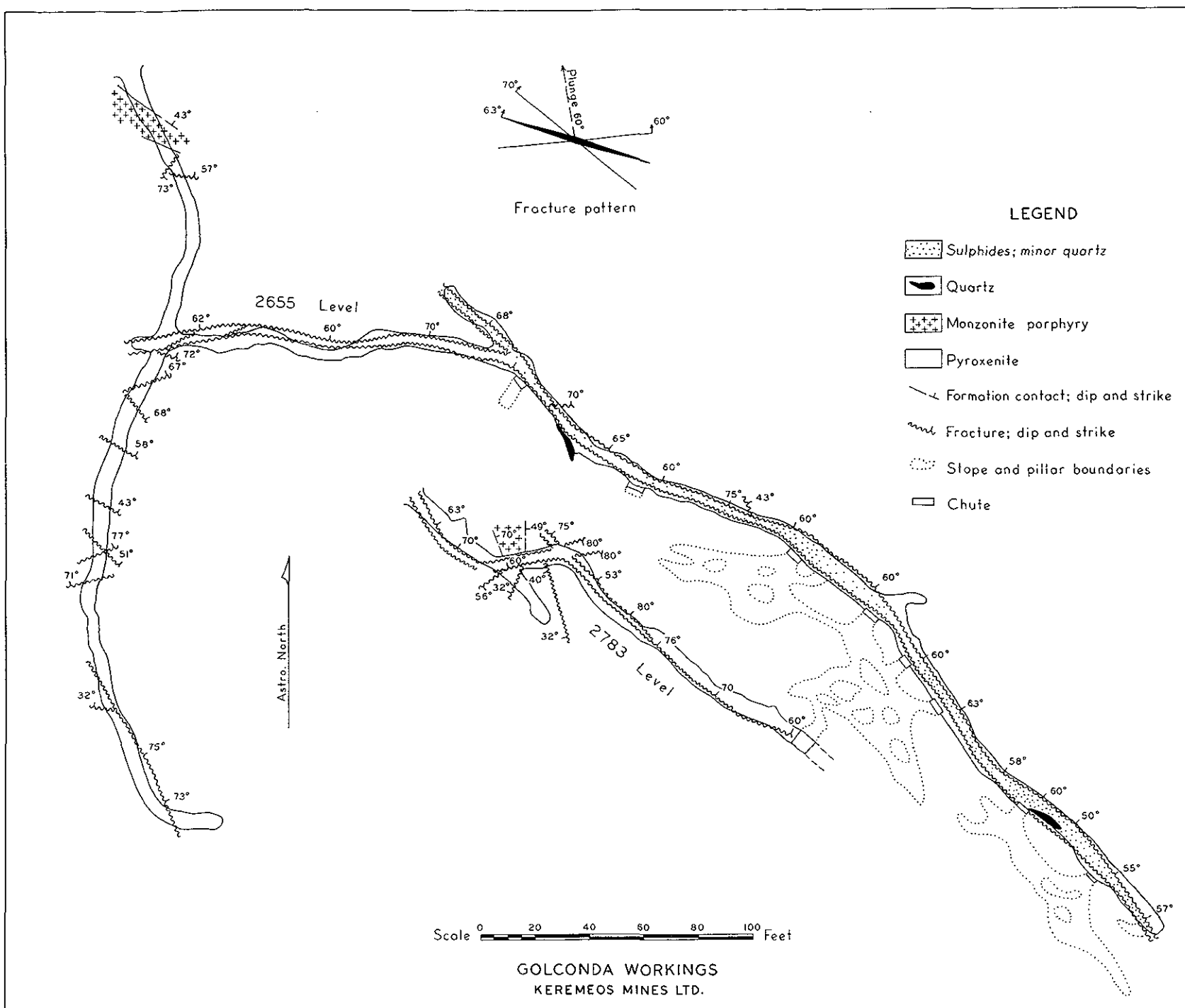
The quartz veins are up to 5 feet wide, and are often sheeted. They are mineralized with galena, argentite, tetrahedrite, pyrite, and chalcopyrite. Native silver, cerargyrite, and pyrargyrite are reported but were not seen by the writer. The metallic minerals commonly occur in bands in the quartz, usually near the walls. The 1958 Annual Report notes that gold assays appear to vary directly with the proportion of pyrite present.

Quartz veins terminate against syenite in the East adit except at the junction with No. 2 East drift (Fig. 7), where discontinuous stringers of quartz pass from the vein through the syenite. This suggests at least two ages of quartz, the later post-syenite. The syenite also contains a little pyrite.

Earlier Annual Reports refer to other workings, but at present two adits are accessible. The present workings (Fig. 7) consist of the West adit, driven on a faulted quartz vein, and the East adit, a north-trending crosscut with two drifts, No. 1 and No. 2, and a long exploratory drive to the northwest. Raises and small stopes were driven on the veins from the drifts. Raises also were driven from the crosscut north of the drifts to intersect the flat-lying veins, and some stoping was done from them.

The quartz veins pass southeastward from the footwall side of the shear zone to the hangingwall side as successive lenses in echelon to the left. Faulting has obscured the relationships, but the longer continuous veins illustrate the pattern. The quartz in the west adit possibly represents two veins; the westerly one is repeatedly faulted to the north. No. 1 West and East drifts in the East adit are on one vein in the hangingwall side of the zone as far as the sharp northward swing of No. 1 East drift. The working becomes a crosscut and picks up an extension of the vein in the footwall side of the zone exposed by No. 2 East drift. This pattern of quartz veining should repeat both horizontally and vertically as far as the shear zone persists. Raises toward the east end of No. 1 East drift show quartz which may represent veins lying above those in the workings rather than faulted segments of these veins.

The shear zone is not everywhere well defined. Much of the movement seems to have been taken up by opening of the tension fractures which now contain quartz. In places shearing is very weak between quartz lenses. In such places the zone might not be recognizable in drill core.



GOLCONDA WORKINGS
KEREMEOS MINES LTD.

Figure 8

Copper-Molybdenum

Golconda (Keremeos Mines Ltd.) (49° 119° S.W.) Registered office, c/o Hamilton, Reid and Patterson, 725 Rogers Building, Vancouver; mine office, Olalla. W. W. Geminder, manager. The property is on the south fork of Olalla Creek, a southeastward-flowing tributary of Keremeos Creek, about 1½ miles by road west of the settlement of Olalla. It includes the Copper King Crown-granted mineral claim and, by agreement with Lind J. Lievre, the Trout Fractional, Wright Fractional, and North Star Fractional recorded mineral claims.

Mentions of the property are in Annual Reports from 1899, the most descriptive in 1910, 1917, 1918, 1922, 1923, 1927, and 1946. The geology of the region is shown at 1 mile to the inch on Geological Survey of Canada Map 628A, Olalla.

The deposit is in a pyroxenite stock intruding sedimentary and pyroclastic rocks of the Triassic(?) Shoemaker formation. The pyroxenite in turn is intruded by dioritic rocks and, in the mine workings, by monzonite porphyry.

The deposit is a shear zone up to 5 feet wide striking north 51 degrees west and dipping 70 degrees northeast. The shear zone is mineralized with quartz in the form of stringers and large lenses containing pyrite, chalcopyrite, and molybdenite.

The shear zone is composed of the following elements: Two shear plane directions, one striking north 85 degrees east and dipping 60 degrees to the north, the other striking north 51 degrees west and dipping 70 degrees northeast; tension fractures striking north 73 degrees west and dipping 63 degrees northeast. The dominant shear strikes northwestward and controls the over-all direction of the mineralized zone. The subsidiary shear and the tension fractures are evident in abrupt changes of direction along the mineralized zone and, particularly the tension fractures, in the orientation of some large quartz lenses. A plunge of 60 degrees in the direction north 10 degrees west is indicated by the pattern.

The workings (Fig. 8) consist of two adits 128 feet apart vertically, the 2655 level and the 2783 level. As shown, the 2655 level encountered a north 85 degrees east striking shear at about 100 feet from the portal. A drift eastward along this shear, which is sparsely mineralized, encountered the main shear zone at about 120 feet from the crosscut. From there the zone was followed for a short distance northwest and for some 330 feet to the southeast. The shape and position of stopes are shown; the plunge of the oreshoots is indefinite, although some similarity to the postulated plunge direction is indicated.

A 45-tons-per-day mill produces both a copper and a molybdenum concentrate.

FAIRVIEW CAMP*

Silica-Gold

Fairview (The Consolidated Mining and Smelting Company of Canada, Limited) (49° 119° S.W.) Head office, Trail; mine office, P.O. Box 337, Oliver. G. S. Ogilvie, property superintendent. This property consists of thirty-six Crown-granted claims. The mine lies about 5 miles to the west of Oliver. Quartz is mined and shipped to Trail for use as flux. All production has been from No. 3 level. Operations were continuous throughout the year, and 24,573 tons of quartz was shipped. Development work included 40 feet of raising and 169 feet of diamond drilling. A crew of six men was employed.

* By David Smith.

Gold

Morning Star (The Consolidated Mining and Smelting Company of Canada, Limited)

(49° 119° S.W.) Head office, Trail. This property consists of four Crown-granted claims as follows: Morning Star, Lot 443; Evening Star, Lot 543; Silver Crown, Lot 442; August, Lot 1050. The claims lie about 5 miles west of Oliver. The underground workings on the Morning Star were dewatered and geologically mapped. Surface diamond drilling totalling 1,409 feet in six holes was done on the Morning Star, August, and Evening Star. Four trenches were bulldozed on the Silver Crown. A crew of six men was employed under the supervision of G. S. Ogilvie.

CAMP McKINNEY

Gold

Cariboo-Amelia (McKinney Gold Mines Limited)*

(49° 119° S.E.) Mine office, Rock Creek. Hill, Starck and Associates, consulting mining engineers; A. G. Ditto, general superintendent. This property consists of the following Crown-granted claims held under option: Cariboo, Alice, Emma, Maple Leaf, Waterloo, Wiarton, Sawtooth, Okanagan, and Amelia. Early in the year the shaft was completed to No. 5 level. Except for a small tonnage (700 tons) obtained from the old workings on No. 3 and No. 5 levels, production for 1960 has come from new workings on No. 5 level east. Two 150-foot holes were diamond drilled on No. 4 level, and three holes at 45 degrees were diamond drilled on No. 5 level.

Production in 1960 totalled 4,370 tons of ore, which was trucked 16 miles to Rock Creek and shipped to the Trail smelter.. It had an average content of 1.2 ounces gold and 1.7 ounces silver per ton, and 65 per cent silica. A crew of nineteen included fourteen men underground and five men on the surface.

Gold-Silver

Old England†

(49° 119° S.E.) This property on Jolly Creek 2 miles east of the Cariboo-Amelia mine consists of three Crown-granted claims—the Old England (Lot 658), Victoria (Lot 218), and Snowdon (Lot 583)—surrounded by twenty-four recorded claims owned by R. W. Wylie, of Vancouver. The claims are reached by following a local road called the Jolly Creek trail for about 1 mile from the point where it leaves the road to the Cariboo-Amelia, some 2 miles from the mine. On the Old England several workings were driven and small shipments of ore were made before 1900, and at least one adit was driven about 1930. The showings are in calcareous greenstones containing lenses of black argillite. They are shear zones and quartz veins locally containing gold in association with pyrite, galena, and sphalerite. In the summer of 1960 three holes were diamond drilled on the bench east of Jolly Creek, about half a mile downstream from the point where the Jolly Creek trail crosses the creek.

BEAVERDELL*

Silver-Lead-Zinc-Cadmium

Highland-Bell (Mastodon-Highland Bell Mines Limited)

(49° 119° S.E.) Company office, 502, 1200 West Pender Street, Vancouver 1; mine office, Beaverdell. K. J. Springer, president; O. S. Perry, manager; A. Zelmer, mine superintendent; R. Ross, mill superintendent; B. Goetting, mine engineer. The property consists of thirty-two Crown-granted claims and four claims held by record.

* By David Smith.
† By J. T. Fyles.

Production for 1960 was obtained from the 2800, 2900, and 3000 levels, the main haulage being the 2900 adit. The winze to the 2800 level was completed in 1959, and stoping has now commenced from this new area. In 1960 the normal production of 70 to 75 tons per day was maintained. Some exploration work was carried out on the Sally property.

The following is a summary of operations for 1960: Drifting and crosscutting, 859 feet; raising, 559 feet; diamond drilling 5,294 feet; ore mined, 18,204 tons. An average crew of forty men was employed, of whom twenty-five worked underground.

Silver-Lead-Zinc

Bounty Fraction (Sheritt Lee Mines Ltd.)

(49° 119° S.E.) Company office, 530, 470 Granville Street, Vancouver 2. K. E. Wickstrom, president. This property consists of seven Crown-granted claims and fractions—the Standard, Black Diamond, Bounty, Logan, Reco, Black Bess, and the Bounty Fraction. At the point at which the lower adit on the Bounty Fraction is connected with the bottom of the shaft, two drifts have been driven to the east and west. Work on the east drift was continuous throughout 1960. Some underground diamond drilling was done on the Bounty Fraction and some in the old workings on the Bounty claim. An underground and surface survey was carried out as part of the 1960 programme. An average crew of six men was employed. Supervision of the property was assumed by D. Sheck in the latter part of the year.

Silver-Lead

Silver Scandie

(49° 119° S.E.) Mine office, Beaverdell. D. Hood, president and manager. This property consists of seventeen claims held by record—the Scandie, Scandie 1 to 3 and 5 to 17, inclusive. It is on the slope of Mount Wallace south of Dry Creek, 3 miles south of Beaverdell. The upper adit was driven an additional 90 feet to a total length of 190 feet. A new adit, at a lower level just off the valley floor, was driven 155 feet. A combination machine-shop, warehouse, and compressor-house was built in a cleared area east of the lower portal. An average crew of three men was employed.

GREENWOOD

Copper

West-Coast Resources Ltd.*

(49° 118° S.W.) Company office, 569 Howe Street, Vancouver 1. Hamlin B. Hatch, president. This company owns and controls a great many mineral claims in the general Greenwood-Grand Forks area. In 1959 an air-borne geophysical survey was made by Lundberg Explorations Limited of an area of about 1,600 square miles, extending from Grand Forks to about 7 miles west of Midway, and from the International Boundary for 12 miles north. The survey combined magnetic intensity readings with the two-plane rotary-field electromagnetic method.

In 1960 Tombac Exploration Ltd. obtained a short-term examining option on eight groups of claims, each of which covered one or two anomalies determined by the Lundberg survey. Stripping or trenching, ground geophysical work, and diamond drilling were variously done. Some of the anomalies were found to be due to graphite. Large quartz veins were indicated on the Mona group.

* By M. S. Hedley.

The following is a brief statement of the groups, their locations, and the amount of work done on each:—

Group	Location	Work Done					
		E.M.	Mag-netom.	Geochem.	Pros-pecting	Stripping	Diamond Drill
Fab	Fisherman Creek, 7 miles north of Grand Forks	×	×	×	×	....	....
Mona	Gibbs Creek	×	....	×	×	×	3 holes
Snow	Wright Mountain	×	....	....	×	....	....
Frank-Barry	3 miles south of Greenwood	×	....	....	×	×	....
Fall	4½ miles north of Greenwood, east of Boundary Creek	×	....	×	×	....	....
Mar	2 miles southwest of Greenwood	×	....	×	×	×	....
King Solomon	Copper Camp, 5½ miles northwest of Greenwood	×	....	×	×	....	2 holes
Baseline	Lee Creek, 10 miles northwest of Midway	×	×	....	×	....	....

The work was done by a small crew under the direction of Joseph Sullivan. The option terminated in August.

Copper-Gold-Silver

Mother Lode (Consolidated Woodgreen Mines Limited)*

(49° 118° S.W.) Company office, 204, 569 Howe Street, Vancouver 1; mine office, Greenwood. R. A. Brossard, president; C. W. S. Tremaine, manager; G. F. Groves, chief engineer. The property, in existence since 1891, comprises the Mother Lode, Primrose, Crown Silver, Florence, C.O.D., Sunset, and Sunflower Crown-granted mineral claims. The Mother Lode mine was opened by the B.C. Copper Co. Ltd. in 1896 and was one of the principal copper producers of the Boundary District until the close of operations in 1918. The present company began work in 1956 with the erection of a 1,000-ton mill. Work ceased in August, 1957, but was resumed after a reorganization of the company in 1959, at a milling rate of 500 tons per day.

The Mother Lode and adjacent orebodies lie in the " Deadwood mineral zone " at and near the contact of the Brooklyn formation with the underlying Knob Hill. The exact nature and relationships of some of the rocks are in question, and consequently the stratigraphy and geologic structure of the area are in doubt.

The description of the Mother Lode orebody in Memoir 19, now long out of print, is quoted as follows: " The zone consists essentially of actinolite, garnet, epidote, calcite, and quartz in which metallic minerals chalcopyrite, pyrite, and magnetite have been deposited in certain favourable areas, so concentrated as to form irregular orebodies of considerable size. The gangue rock is tough, compact, and usually dark green from the prevalence of actinolite. Where garnet and epidote predominate, the rock is harder, denser, and yellowish green or pale brown in colour. The rock is generally massive, but also occurs roughly banded from alternating layers of the several gangue minerals."

The present property includes the Mother Lode and Sunset orebodies, lying about 1,800 feet apart on a northwest-southeast line about parallel to Deadwood Creek. The Mother Lode is on the northwest.

The Mother Lode orebody lies between crystalline limestone on the northwest and a fault, strike north 15 degrees east, dip 80 degrees east, on the southeast. The

* By N. D. McKechnie.

orebody strikes north 30 degrees east, curving eastward at the northeast end, and the dip is described in Memoir 19 as steepening from 45 to 70 degrees southeast and steepening to nearly vertical in the lower part. The limestone widens northward. Near the northwest corner of the pit, drill cores show that the limestone arches over mineralized skarn.

On the northwest side of the present Mother Lode pit a dragfold is exposed having a plunge of approximately 25 degrees to the southwest. The localization of the orebody may be related in some way to dragfolding of this sort.

At the Sunset there are two orebodies, flat lying and of irregular shape. They have been mined partially in two main pits, an east pit and a west pit, and in some smaller pits covering a distance from northwest to southeast of about 400 feet. Bedding on the west side of the east pit strikes north-south and dips about 50 degrees east; on the east side of the west pit the strike is north-south and the dip 35 degrees west. Diamond-drill holes to the underlying Knob Hill formation show that the dip flattens toward the east side of the east pit. The rock immediately underlying the ore is siliceous breccia, similar to that at the Mother Lode. The only limestone observed was a faulted block at the north side of the west pit.

Mining of ore and removal of waste has been carried out primarily on the Mother Lode with some stripping and ore removal at the Sunset A total of 201,497 tons of ore was mined and milled in 1960. Milling, at near rated capacity of 650 tons per day, was continuous throughout the year. A crew of thirty-six men was employed.

[References: *Geol. Surv., Canada,* Mem. 19, Mother Lode and Sunset Mines, Boundary District, B.C., 1913; Mem. 21, Geology and Ore Deposits of Phoenix, Boundary District, 1912; Paper 45-20, Greenwood-Phoenix Area, B.C.; Seraphim, R. H., Geology and Copper Deposits of the Boundary District, *C.I.M.,* Trans., Vol. LIX, 1956.]

PHOENIX*

Copper-Gold-Silver

Phoenix Copper Company Limited

(49° 118° S.W.) Company office, 1111 West Georgia Street, Vancouver 5; mine office, Phoenix. L. T. Postle, president; J. H. Parliament, manager. This property consists of sixty-three claims as follows: Twenty-nine Crown-granted, twenty-seven held by location, and seven leased. The mine and concentrator were operated continuously throughout 1960. Shipment of the 3,000 tons of concentrate stockpiled at the mine due to the strike at the Tacoma smelter was completed in May.

In January, 1960, a third ball-mill unit was put into production, increasing the mill capacity to 1,000 tons per day. The average tonnage milled during the year was 950 tons per day. A small amount of ore from the Stemwinder mine was milled on a custom basis.

Production of ore for the most part was from the Old Ironsides pit. A third shovel shift was started in June and continued throughout the remainder of the year to increase the removal of waste and to improve the operation's flexibility. No work was done in the Snowshoe pit. A small amount of ore was mined on the Rawhide claim by agreement with the owners. The Idaho claim, northwest of the Ironsides, was acquired and a small open pit started. No diamond drilling or underground mining was done. During 1960, 576,731 tons of waste was removed and 340,112 tons of ore transferred to the mill. A total of 346,638 tons was milled.

A total crew of fifty-eight men was employed as follows: Surface, nineteen; open pit, twenty; and crusher and concentrator, nineteen.

* By David Smith.

Copper-Gold-Silver

Stemwinder (Continental Consolidated Mines Ltd.).—(49° 118° S.W.) Company office, 201, 535 Howe Street, Vancouver 1; mine office, Greenwood. Activity on this property was limited to transporting the stockpile of ore to the nearby Phoenix Copper mill for concentration. A watchman was at the mine throughout the year.

ROSSLAND*

Gold-Copper

Velvet (Mid-West Copper & Uranium Mines Ltd.) (49° 117° S.W.) On May 16th, 1960, this property was leased by Mid-West Copper & Uranium Mines Ltd. to the Velvet Mine Leasers—R. Lefevre, H. W. Lefevre, J. C. Urquhart, B. W. Price. Company office, P.O. Box 389, Rossland. The property is on the western slope of Sophie Mountain, 11 miles from Rossland on the Rossland–Christina Lake highway.

All mining was done on No. 7 level, where 239 feet of drifting and 152 feet of raising were completed. The ore is trammed to the coarse-ore bin on the surface at No. 7 level, where it is crushed and carried to the fine-ore bin. From the fine-ore bin it is transported by a gravity tram to the 150-ton mill in the bottom of Sheep Creek valley. The mill operated part time in milling 4,264 tons, producing 308 tons of concentrate, which was shipped to the Tacoma smelter. The concentrates contained: Gold, 355 oz.; silver, 1,066 oz.; copper, 146,171 lb. In the period May 15th to December 31st, seven men were employed, including the four lessees.

TRAIL*

Gold

W.D. (W.D. Mining Company Ltd.) (49° 117° S.W.) This property is owned and operated by W.D. Mining Company Ltd. The company consists of five men with equal shares. F. Donelly, of Trail, president. Mine office, 1360 McLean Street, Trail. All work on the property is done by the five partners on a part-time basis. The property is on the west side of the Columbia River, 5 miles south of the Trail bridge along the Casino road. In 1960, 35 feet of diamond drilling was done from surface. A small amount of mining was done, 30 tons of ore shipped to the Trail smelter containing 21 ounces of gold. A major breakdown of the compressor prevented further mining.

NELSON*

Silver-Lead-Zinc

Big Mac (49° 117° S.E.) This property consists of fifteen recorded claims owned by R. Pond and R. McCandlish, of Nelson. An additional eight claims located south of the Big Mac group are called the Jumbo group. The property is east of the Great Northern Railroad tracks, 3 miles south of Nelson. The first showing is at an elevation of 3,150 feet, which is 500 feet above the railroad.

The mineralization occurs in a shear zone in volcanic rocks and follows a general strike of north 25 degrees west, veering to north at the north end and dipping 75 to 80 degrees east. The vein is 4 to 5 feet wide where observed. On the south end the zone is cut off by a granite contact. There is some impure limestone in the volcanics, and it appears that the limestone is more extensive at the north end of the property. Mineralization is mainly zinc with some lead and silver.

* By J. D. McDonald.

The Big Mac group was optioned to Sheep Creek Mines Limited in July, 1960. Five diamond-drill holes were completed, with a total footage of 791 feet. The option was dropped in December, 1960.

Gold-Silver-Lead-Zinc

Hummingbird (49° 117° S.E.) This property consists of eight recorded claims owned by F. Arnot and E. Arnot, of Nelson. It is at the summit between Apex and Selous Creeks. The property is accessible by a jeep-road from a point 7 miles south of Nelson on the Nelson–Salmo highway.

A lease was given to L. DeCoch to mill the dump ore from the old workings. A portable jaw crusher, jig, and sluice-boxes were set up and some trial runs were made, with good gold recovery being reported.

There are a number of showings on the property. The old workings are in a quartz vein 6 to 24 inches wide containing good gold values. Above these workings are two veins containing lead and zinc values, and below are some outcrops of lead-zinc mineralization with zinc predominant. All veins appear to be blanket veins following the bedding of the sediments. The general strike is northeast and the beds dip approximately 45 degrees southeast. A granite contact lies a short distance to the east.

Gold-Silver

White (Kenville Gold Mines Limited) (49° 117° S.E.) D. Norcross, of Nelson, has three claims under lease from Kenville Gold Mines Limited. These include Lot 2556 and are known as the White mineral claims. The property is accessible by road one-half mile past the Kenville mill on the old Eureka mine road. The vein is in a shear zone in granodiorite. Development consisted of sinking a 48-foot shaft and 51 feet of drifting along the vein from the shaft bottom. Twelve tons of ore was shipped to the Trail smelter, with returns of 1.59 ounces of gold per ton and 8.6 ounces of silver per ton. All work was done by Mr. Norcross, except for a three-week period when one man was employed.

YMIR*

Gold

Yankee Dundee (Yankee Dundee Mines Limited) (49° 117° S.E.) Company office, 404, 510 West Hastings Street, Vancouver 2; mine office, Ymir. R. Sostad, president. Capital: 4,000,000 shares, 50 cents par value. This company diamond drilled the Bonus vein, reporting a 3.2-foot intersection of ore above the 2000 level. In August, 1960, the property was optioned to Newmont Mining Corporation of Canada Limited. Two diamond-drill holes were drilled by Newmont to check the extension of the Bonus vein between the 2000 level and the intersection obtained by Yankee Dundee Mines Limited. The option was dropped in December.

Gold-Silver

Goodenough (Hyrock Goodenough Mines Ltd.) (49° 117° S.E.) Registered office, 507 Stock Exchange Building, Vancouver 1. Capital: 50,000 shares (N.P.L.). This property was under the sole management of E. W. Nilson, who died suddenly of a heart attack. A shipment of 11 tons was made to the Trail smelter. This assayed 0.385 ounce of gold per ton. Operations were suspended in October.

* By J. D. McDonald.

Silver-Lead-Zinc

Ruby (Universal Minerals Ltd.) (49° 117° S.E.) Company office, 575 Howe Street, Vancouver 1. J. E. LaFleur, president. Capital: 5,000,000 shares, 50 cents par value. This property is under option to Universal Minerals Ltd. from E. Haukedahl, of Ymir, and A. Erdahl, of Nelson. It consists of fourteen recorded claims and two fractions. It is 4½ miles southeast of Ymir, at an elevation of from 3,000 to 5,000 feet, and is accessible by road. It is adjacent to the southwest boundary of the Jackpot property. Mineralization occurs in a dolomitic limestone band. In November and December five holes were drilled, with a total length of 1,290 feet.

SALMO*

Sheep Creek (49° 117° S.E.)

Gold

Nugget.—This mine, which was formerly part of the Reno holdings in the Sheep Creek area, is owned and operated by A. Endersby, of Fruitvale. A small amount of development work was done intermittently during the year.

Aspen Creek (49° 117° S.E.)

Lead-Zinc

H.B. (The Consolidated Mining and Smelting Company of Canada, Limited) Company office, Trail; mine office, Salmo. J. C. MacLean, property superintendent; J. M. B. Scarborough, mine superintendent; N. Doyle, mill superintendent. The H.B. mine is on the west side of Aspen Creek, with the main camp on the north side of Sheep Creek, 7 miles by road from Salmo. The ore occurs as zinc-lead replacement in dolomite. There are five zones, known as No. 1 or east orebody, No. 2 or west orebody, two flat-lying orebodies named X-1 and X-2, and No. 4 orebody which lies between X-1 and X-2.

Mining in No. 1 and No. 2 orebodies is by blast-holes and slusher drifts, the drilling being done from sublevels on the hangingwall and footwall. Holes are drilled with 2⅛-inch tungsten carbide bits. Hoists used in the slusher drifts are 50- and 60-horsepower electric slusher hoists. Production from blast-hole stoping accounted for 77 per cent of the total production. The total long-hole footage for the year was 128,809 feet. The first of the large pillars in No. 1 orebody was blasted in July, breaking 116,000 tons of ore with 30,000 pounds of powder. This is a powder factor of 0.26 pound per ton.

In the other ore zones, open stoping was done, slashing and benching with jacklegs using a panel system of pillars and stopes. Production from these stopes was 15 per cent of the total production. During the year primary development was done in 81 block in No. 1 ore zone. Secondary development in the other areas continued as scheduled. Development: Total, 7,419 feet; drifting and crosscutting, 525 feet; sublevels, 3,877 feet; raising, 3,017 feet.

Main haulage is on the 2800 level, with diesel locomotive and 6-ton Granby cars. Ore is hauled from ore-passes underground to the coarse-ore bin on surface. Other levels are the 3200, 3300, and 3500. These are served by internal shaft, with the hoistroom at the 3500 level.

The mine is ventilated with a 70,000-cubic-feet-per-minute fan located adjacent to the old Oxide mine workings. The fan exhausts to surface, and the main intakes are the 2800 and 3500 adits.

* By J. D. McDonald.

Underground diamond drilling was 18,957 feet, and surface diamond drilling was 3,296 feet.

The Garnet zone, which lies west of the other zones, and outcrops at surface above the 2800 adit level, was outlined during the year.

The milling rate averaged 38,700 tons per month, with a total production of 464,408 tons. This was the highest in the West Kootenay area. The average number of men employed was 120, fifty-four of whom were employed underground.

The mine-rescue team trained regularly and competed in the West Kootenay competition. There were two lost-time accidents during 1960.

Boy (The Consolidated Mining and Smelting Company of Canada, Limited).—Company office, Trail. This group of four recorded claims adjoins the H.B. mine to the south, on the southern side of Sheep Creek. In May and June 3,500 feet of road was constructed, starting at the east end of the first bridge beyond the old H.B. mine road and trending southwest up the hillside. Two holes were drilled with a total length of 1,062 feet.

Lead-Zinc-Silver-Molybdenite

Double "B" Group

This property of ten recorded claims is owned by F. W. Cartwright and W. Cartwright, of Nelson. It is on Hedgehog Creek, east of the H.B. mine. Approximately 1 mile of road leads to the present workings. In 1960 stripping and trenching were done in the limestone adjacent to the granite contact. Showings of sphalerite and molybdenite were exposed by the stripping.

IRON MOUNTAIN (49° 117° S.E.)

Lead-Zinc

Jersey (Canadian Exploration Limited)

Head office, 700 Burrard Building, Vancouver; mine office, Salmo. G. A. Gordon, general manager; J. D. Little, assistant general manager; C. M. McGowan, general superintendent; R. G. Weber, mine superintendent; H. A. Steane, general mill superintendent; E. A. Erickson, mill superintendent. This company is a wholly owned subsidiary of Placer Development Limited. Operations have been confined to the Jersey mine since July 31st, 1958. The property is reached by two roads which leave the Nelson–Nelway highway 4 and 5½ miles respectively south of Salmo, the north road being the main access road. The lead-zinc concentrator is alongside the Nelson–Nelway highway and is served from the mine by a conveyor system. The mine and main camp are located on the summit between Sheep Creek and Lost Creek.

All production came from the Jersey lead-zinc mine. The ore zones occur in dolomitized limestone along folds which plunge gently to the south. Seven ore zones are now recognized. From west to east they are: A, B, C, D, E, F, and G. Two types of mining are being done—trackless mining in A, D, E, F, and G zones and conventional track mining in A, C, and D zones.

The main haulage for the trackless mine is via the 4200 Dodger and 4200 Jersey adits to the ore-pass to the underground crusher on the Emerald 3800 level. Haulage is by 8-ton Dumptors, both overhead and front-end loaders being used for loading. Seventy per cent of loading is done with front-end loaders. Drill jumbos mounted on caterpillar tracks are used for drilling. A giraffe mounted on a truck is employed full time for barring and checking backs. Some of the stopes in the trackless mine are being mined by conventional open stoping, with jacklegs and

slushers, and trackless haulage for transportation of the ore. These are classed as low head-room stopes and account for 50 per cent of the trackless production.

The main haulage in the track mine is on the 4000 level, hauling to an ore-pass system leading to the underground crusher. Locomotives are diesel-electric, using a 37-horsepower diesel M.G. set on a standard battery-locomotive chassis. Mining is by conventional open stopes with jacklegs and slushers. Work is being done below the 4000 level, using the south "A" winze inclined at 32 degrees.

In the fall of 1960 a pillar-recovery programme was started in " D " zone in the track mine. Main pillar recovery will be in "A" zone of the trackless mine. The Alimak raise machine will be used for drilling off the pillars, which range up to 90 feet in height. The track for the raise machine will be bolted to the pillar wall. Drilling will be done from a bar mounted on the platform and chained to the pillar wall, using liners, 1-inch steel, and 2-inch tungsten carbide bits. The platform and cage have been modified with a frame to allow it to rest on a truck deck for transportation. The last two rows of holes at the back will be loaded with a special type of powder to give a smooth and safer back. The ore, when blasted, will be scraped to a loading point, and there will be no necessity for going under the back in a blasted area.

Total development was 10,052 feet, consisting of 1,348 feet of 16- by 16-foot drifting, 7,265 feet of subdrifting, and 1,439 feet of raising.

Ventilation is maintained with three reversible fans which normally blow into the mine. Two 48-inch 60-horsepower fans rated at 60,000 cubic feet per minute at a 4½-inch water-gauge draw air from the Dodger 4400 level, and one 50-horsepower fan rated at 72,000 cubic feet per minute at a 3½-inch water-gauge draws air from the old Emerald 4600 level. Auxiliary ventilation of headings and stopes is with 30-inch 20-horsepower Axivane fans rated at 12,000 cubic feet per minute at an 8-inch water-gauge and 36-inch 50-horsepower Axivane fans rated at 23,000 cubic feet per minute at a 10-inch water-gauge. Vent-pipe is 30-inch neoprene, nylon impregnated collapsible pipe.

The concentrator treated 364,424 tons of ore during 1960, an average of 30,369 tons per month. The track mine produced 30 per cent of the total and the trackless 70 per cent, of which 50 per cent was low head-room stoping. Concentrates were shipped to the Bunker Hill smelter at Kellogg, Idaho, for the first ten months of the year; zinc concentrates were shipped to the Trail smelter in November and December. Tailings were impounded in the tailings pond adjacent to the Salmo River. During 1960 the sides of the pond were raised. Experimentation with growth of various types of plants, grasses, and trees on the tailings pond are being carried out to determine the best effective cover.

A mine-rescue team practises regularly in the mine, and competed in the West Kootenay Mine Rescue Competition. The property maintained the excellent safety record of the past two years, having only one lost-time accident over six days during 1960. This performance won for the mine the Regional John T. Ryan Safety Trophy for 1960. The average number of men employed was 160, with eighty-five working underground.

Tungsten King This property, comprising eighteen Crown-granted mineral claims and fractions, is adjoined on the north by the Emerald and Jersey holdings of Canadian Exploration Limited and on the south by the Truman holdings of American Zinc, Lead and Smelting Company. The claims are owned by L. R. Clubine, of Salmo, and R. O. and E. Oscarson, of Spokane, Wash. The property is 2 miles from the Nelson–Nelway highway by way

of the Lost Creek road. Stripping and trenching were done during the summer on new showings exposed in 1959. Mr. Clubine has reported that an option on the property was taken by American Zinc, Lead and Smelting Company.

NELWAY*

Silver-Lead-Zinc

Reeves MacDonald Mines Limited

(49° 117° S.E.) Company office, 413 Granville Street, Vancouver 2; mine office, Remac. L. M. Kinney, Metaline Falls, Wash., general manager; F. R. Thompson, manager; W. Pollock, mine superintendent; F. Irwin, mill superintendent. Capital: 3,000,000 shares, $1 par value. This company owns the Reeves MacDonald mine on the Pend d'Oreille River, on the Nelway–Waneta road 4 miles west of Nelway. Lead-zinc replacement orebodies in limestone have been developed from the 1900 level. Four orebodies are being mined—the Reeves, B.L., O'Donnell, and No. 4 bodies.

Mining above the 1900 level in the Reeves and O'Donnell orebodies has been completed. The No. 4 and B.L. orebodies are developed and producing. These four orebodies are faulted segments of a single ore zone.

The major development is now in the Reeves, below the 1900 level. This section is serviced by No. 2 and No. 3 shafts. The No. 2 shaft is used as a service shaft for hoisting men and supplies. It is located in the footwall of the Reeves orebody, inclined at 52 degrees, with the hoistroom on the 1900 level. The No. 3 shaft, which is inclined at 55 degrees, is the production shaft. The main ore-pockets for the shaft are located below the 1320 level. The hoistroom is on the 1900 level.

Extension of No. 3 shaft below the present bottom 1100 level started in July. Sinking is being done on a one-shift basis using a Cryderman mucker and a crew of three men. One muck skip was altered so that mucking could be done directly into it with the Cryderman, and it would remain satisfactory for hoisting ore from the 1320 ore-pockets. The Cryderman mucker is mounted in the other compartment with wood stringers along the bottom and top of the frame. Sinking to the 980 level, a distance of 146 feet, has been completed. The 980 level station has been cut out. Further sinking will be done with a sinking hoist on the 1100 level, allowing full use of the No. 3 shaft above the 1100 level for production.

Mining is done with long-hole machines, drilling down-holes from horizontal slots slashed to the ore outline. These slots are located at 50-foot intervals and are mined with jacklegs and slushers. A vertical slot is cut along one pillar and a series of down-holes are drilled and blasted at regular intervals, retreating to the opposite pillar. Drilling was previously all done with 2⅛-inch tungsten carbide bits, with holes at 6- by 7-foot spacing. Change is now being made to 3-inch tungsten carbide bits on 1¼-inch carburized hexagonal steel in 5-foot sections, with holes at 10- by 12-foot spacing. At the year-end 50 per cent of the holes drilled were 3-inch.

Development of the B.L. zone and the 1100, 1320, 1460, and 1520 levels of the Reeves zone continued throughout the year. Drifting and crosscutting totalled 524 feet; sublevels, 1,796 feet; raising, 1,987 feet.

The mill operated continuously at an average rate of 34,273 tons per month, with a total production of 411,282 tons. Zinc concentrates were shipped to the Trail smelter. Lead concentrates amounting to 2,550 tons were shipped to the smelter at Kellogg, Idaho. The remainder was stockpiled. The number of men employed was 103, of whom fifty-eight worked underground.

* By J. D. McDonald.

NORTH KOOTENAY LAKE*

RIONDEL (49° 116° N.W.)

Silver-Lead-Zinc

Bluebell (The Consolidated Mining and Smelting Company of Canada, Limited)

Company office, Trail; mine office, Riondel. D. S. Campbell, property superintendent; J. B. Donald, mine superintendent; T. F. Walton, mill superintendent. This property is at Riondel, on a small peninsula 1½ miles long, on the east shore of Kootenay Lake, 6 miles by road north from the southern trans-Provincial highway at Kootenay Bay ferry landing. The ore deposits are sulphide replacements in a limestone band ranging from 100 to 150 feet in stratigraphic thickness, striking north and dipping 35 to 38 degrees to the west, under the lake. There are three separate ore zones—the Kootenay Chief at the south end, Bluebell in the centre, and Comfort to the north. Main production is from the Kootenay Chief zone.

The mine is serviced by No. 1 shaft, inclined at 35 degrees, on the north side of the Kootenay Chief zone. It is completely timbered for its entire length of 1,625 feet. The levels are at intervals of 150 vertical feet, with No. 2 level and No. 5 level extended north to the Bluebell and Comfort zones.

Due to a heavy inflow of thermal water with large quantities of carbon dioxide gas in No. 1 shaft below No. 8 level, it was necessary to seal the shaft below No. 8 level. In 1959 a development programme was started to drain off the thermal water below No. 8 level from No. 9A level, pump it to surface, and then raise No. 1 shaft to No. 8 level. It was planned to sink an internal vertical winze from No. 8 level (elevation 960 feet) to No. 9A level (elevation 735 feet) in the footwall rock, then drift out to limestone and establish a drill station for drilling 4-inch drainage holes to tap the thermal water. In 1960 the sinking was completed, sumps and pump station were excavated, and the drift to the limestone was extended close to the limestone footwall. A water-tight door, designed to withstand a pressure of 250 pounds per square inch, is being installed in this drift.

Development work was confined mainly to the Kootenay Chief and Comfort ore zones. The raising from No. 5 level to No. 2 level in the Comfort zone was completed. Stoping above No. 3 level along the footwall is now being done. In the Kootenay Chief zone No. 8 level was extended south and stope development was started. Other development was mainly stope development on No. 5 and No. 6 levels of the Kootenay Chief. Development work in 1960 was as follows: 1,126 feet of drifting, 5,907 feet of crosscutting, 3,884 feet of raising, and 106 feet of shaft sinking. Diamond drilling consisted of 21,545 feet of exploratory drilling.

Mining methods are open stoping, cut-and-fill stoping with deslimed tailings, and minor shrinkage stoping. Several longitudinal pillars were recovered in the upper levels. Old shrinkage stopes at the Comfort have been filled with deslimed tailings in preparation for recovery of the pillars. A total of 65,590 cubic yards of deslimed tailings was placed in cut-and-fill and open stopes for pillar recovery. The use of plastic pipe for transportation of the deslimed tailings has proven very successful.

Present pumping is at the rate of 3,600 imperial gallons per minute, of which 1,600 imperial gallons per minute is thermal water. Main pump stations are on No. 5 and No. 8 levels, and a major pump station is being installed on No. 9A level. The pumps are all centrifugal, with capacities from 300 to 1,000 imperial gallons per minute and motor power ranging from 40 to 300 horsepower. The No. 8 level

* By J. D. McDonald.

pump station has 550 installed horsepower in pumps capable of pumping 3,600 imperial gallons per minute against a dynamic head of 325 feet. There are also two 300-horsepower high head pumps capable of handling 1,400 imperial gallons per minute to surface against a dynamic head of 1,020 feet. The No. 5 level pump station has seven pumps with an installed 1,350 horsepower capable of pumping 4,500 imperial gallons per minute against a dynamic head of 680 feet. All pumps run at 3,600 r.p.m., except three 1,000-imperial-gallons-per-minute pumps which operate at 1,800 r.p.m. These slow-speed pumps have shown little tendency to cavitate or seize up due to deposits on wear rings and impellers. Considerable maintenance is required on the high-speed pumps. The No. 9A level will have an installed capacity of 4,600 imperial gallons per minute with 700 horsepower. To minimize pump corrosion from thermal water, three of the 1,000-imperial-gallons-per-minute pumps will be all bronze and one stainless steel. Total installed horsepower in all main and secondary pump stations will be 3,132 horsepower, and the capacity to pump water out of the mine will be about 6,800 imperial gallons per minute. Discharge lines presently consist of two 12-inch-diameter pipe-lines extended up the manway of No. 1 shaft.

Main ventilation is induced by three units in parallel of 48-inch dual-duty aerofoil fans which are flameproof and waterproof. Each unit has two 30-horsepower 550-volt 3-phase 60-cycle counter-rotation motors with automatic butterfly dampers. Each of these units is rated at 50,000 cubic feet per minute at a 7.6-inch water-gauge. Ventilation is maintained at all times due to the critical carbon dioxide gas problem. A separate auxiliary stand-by diesel unit supplies power in the event of power outages.

In July, 1960, a seismic survey was made on the bottom of Kootenay Lake adjacent to the Bluebell mine to determine the position of bedrock. The survey was made for the company by Hunting Survey Corporation Limited, of Toronto.

The equipment used was the " Sparker," a continuous seismic underwater profiling instrument. With this equipment a high-voltage power supply is triggered at regular intervals, producing vibrations of audio frequency. The pulses of sound energy so formed travel through the water and are partially reflected from the bottom and some strata beneath. The reflected pulses are picked up by a hydrophone, and a continuous record is made on elecrically sensitive paper. The survey showed that the lake bottom is relatively flat. A line surveyed across the lake indicates the bedrock valley bottom to be more than 1,100 feet below the surface of the lake, covered by at least 700 feet of sediments, which probably are largely silt. It should be pointed out that the maximum depth of valley bottom is not of direct concern to the operation.

Mine-rescue and first-aid classes were held. Mine-rescue teams practised regularly underground. Two teams competed in the West Kootenay competition at Trail. The team captained by P. Rowan won the West Kootenay competition and competed in the Provincial competition in Cranbrook. The average number of men employed was 289, of whom 173 were employed underground.

The concentrator treated 255,571 tons of ore, or 700 tons per calendar day.

AINSWORTH (49° 116° N.W.)

Silver-Lead-Zinc

Highlander, etc. (Yale Lead & Zinc Mines Limited)

Company office, 525 Seymour Street, Vancouver 2; mine office, Ainsworth. H. M. Turner, of Western Mines Limited, property manager; C. Anderson, mill superintendent. Capital: 5,000,000 shares, $1 par value. This company controls most of the mineral claims lying between Coffee and Cedar

Creeks. The property was closed in December, 1958, and since then has been worked by lessees. The mill operated part time during 1960 and milled ore for lessees of the Highlander, Crow Fledgling, and Krao mines, and Western Mines Limited. This is the only mill available for milling ore in the Kaslo-Ainsworth area. A three-man crew was employed part time.

	Milled in 1960	Silver	Lead	Zinc
	Tons	Oz.	Lb.	Lb.
Crow Fledgling	125	199	11,568	6,017
Highlander	4,300	7,653	517,057	148,834
Yale Lead & Zinc Mines Limited (mill clean-up)	367	1,038	48,916	32,761
Krao	60	135	4,960	1,954
Western Mines Limited (includes thickener clean-up)	590	7,083	401,098	208,393
Totals	5,442	16,108	983,599	397,959

P. Gilchrist and C. Hartland, leasing the Banker orebody, hand-sorted ore and shipped it to the Trail smelter. Leasing operations ceased in the fall of 1960. Production: Ore shipped, 57 tons. Gross content: Silver, 1,134 oz.; lead, 67,685 lb.; zinc, 3,861 lb.

In the Highlander mine, T. G. Laughton and three partners, working mainly above the 1900 level, removed pillars and did development to reach new ore below the two worked stopes. Production: 4,300 tons mill feed; 25 tons ore shipped to Trail smelter. Gross content: Silver, 925 oz.; lead, 36,661 lb.; zinc, 1,575 lb.

Kootenay Florence, Lakeshore (Western Mines Limited)

Company office, 850 West Hastings Street, Vancouver 1; mine office, Ainsworth. H. M. Wright, president; H. M. Turner, superintendent. Capital: 3,000,000 shares, $1 par value. This company owns a large group of mineral claims lying south of Lendrum Creek and astride Princess Creek. The mine plant and mill are on the Nelson–Kaslo highway 2 miles north of Ainsworth. M. B. Sirak and partner mined in the Kootenay Florence during the early part of the year. Mining ceased in June, and a clean-up of the dump and thickener in the mill was made during the summer. There was no production for the remainder of the year. The ore was trucked to the Yale Lead & Zinc mill and the concentrates were shipped to the Trail smelter. Production: Ore milled, 590 tons.

WOODBURY CREEK*

Gold-Silver-Lead-Zinc

Scranton (Scranton Mines Limited)

(49° 117° N.E.) Company office, 1519 Marine Building, 355 Burrard Street, Vancouver 1. A. A. Loeb, president; C. J. Bailer, general manager; C. E. Lind, mine manager. Capital: 3,000,000 shares, $1 par value. This company owns the Scranton group of claims in Kokanee Glacier Park, astride Pontiac Creek, a tributary of Woodbury Creek. The mine camp is on Pontiac Creek, at an elevation of 5,600 feet, and is reached by 11½ miles of road from a point on the Nelson–Kaslo highway 8 miles south of Kaslo.

A limited amount of development and exploration work was done during the period May to September, 1960. A total of 93 feet of drifting and crosscutting was done on the lower Pontiac vein at an elevation of 5,800 feet. About 300 feet of surface stripping with a bulldozer was completed. Total underground diamond

* By J. D. McDonald.

drilling was 143 feet. The operation closed on September 28th. Three men were employed for a total of 135 man-shifts for the season.

PADDY PEAK*

Silver-Lead-Zinc

Utica (Lajo Mines Limited) (49° 117° N.E.) Company office, 717 West Pender Street, Vancouver 1; mine office, Kaslo. R. Mintz, president; J. A. Cooper, manager. This company holds a long-term lease on the Utica mine from Utica Mines (1937) Limited. The mine is at the head of Twelve Mile Creek, about 15 miles from Kaslo. A new section of road was completed in 1960, which by-passes the rock bluffs in the lower stretch of the road. It is now possible to haul concentrates from the mine with big trucks.

In the spring of 1960, stope development was completed on the vein above No. 5 level. These stopes were mined by shrinkage stoping. After stoping was completed, the ore was pulled from chutes on No. 5 level and hand-trammed to the ore-pass. The main haulage is No. 7 adit level (elevation 5,950 feet), on which a diesel locomotive and 2-ton side-dump cars haul to the coarse-ore bin on surface.

In the 50-ton mill, graphite in the flotation circuit gave considerable trouble in separation of the lead and zinc concentrates. The concentrates were shipped to the Trail smelter. An average of nine men was employed when the mine was operating. In the first week in October the mine closed down for the winter.

Production: Ore milled, about 4,000 tons. Gross content: Silver, 34,872 oz.; lead, 68,376 lb.; zinc, 123,858 lb.

KASLO*

Lead-Zinc-Silver

Empire (49° 117° N.E.) This property consists of eight recorded claims owned by E. Muller, of Helix, Ore. Mine office, Kaslo. E. Augustine, mine manager. It is 3 miles by road north of the highway, from a point about 10 miles west of Kaslo on the Kaslo–New Denver highway. Two men were employed for three months extending the drift along the vein. The vein is vertical and appears to be along an argillite contact with a maximum width of 5 feet. A total of 35 tons of development ore was shipped to the Trail smelter. Gross content: Gold, 1 oz.; silver, 300 oz.; lead, 9,725 lb.; zinc, 9,655 lb.

Black Fox (New Ainsworth Base Metals Ltd.) (49° 117° N.E.) Company office, 623, 470 Granville Street, Vancouver 2; mine office, Kaslo. W. Inverarity, president; J. Donovan, manager. Capital: 4,000,000 shares, no par value. This property is 10½ miles by road from Kaslo on Keene Creek, one-half mile past the Cork Province mine. Mining started in December, 1960, and approximately 250 tons of ore was shipped to the Yale Lead & Zinc mill at Ainsworth.

RETALLACK-THREE FORKS*

Silver-Lead-Zinc

Texas, Fourth of July (July Silver Mines Ltd.) (50° 117° S.E.) This property, formerly known as Lucky Edd Mines Limited, was incorporated on September 19th, 1960, as July Silver Mines Ltd.; mine office, Kaslo. V. J. Dresser, president; L. N. Garland, manager. This company has optioned a group of Crown-granted mineral claims at the headwaters of Robb Creek, a tributary of Kaslo River.

* By J. D. McDonald.

The property is reached by 6 miles of road which leaves the Kaslo–New Denver highway at Retallack and follows the west side of Robb Creek in a southerly direction. Two miles of road was constructed in 1960 to the Texas and Fourth of July claims, to complete the road to the property.

SANDON*

Silver-Lead-Zinc

Silversmith, etc. (Carnegie Mining Corporation Limited)

(49° 117° N.E.) Company office, 416, 25 Adelaide Street West, Toronto; mine office, New Denver. A. W. White, president; J. C. Black, manager. Capital: 5,000,000 shares, no par value. This company is controlled by Violamac Mines Limited. The property consists of forty-six Crown-granted and six recorded claims and fractions which include the Silversmith, Slocan Star, Richmond-Eureka, Ruth-Hope, and Slocan King mines on Sandon Creek, south of Sandon.

In the Ruth-Hope mine the main adit was retimbered. No mining was done on any of the mines in this group.

The concentrator, employing a crew of three men, milled 6,842 tons of ore, of which 6,227 tons was from the Victor mine and 615 tons from the Lone Bachelor.

Victor (Violamac Mines Limited)

(49° 117° N.E.) Company office, 416, 25 Adelaide Street West, Toronto; mine office, New Denver. A. W. White, president; J. C. Black, manager. Capital: 5,000,000 shares, $1 par value. In July, 1960, the controlling interest in Violamac Mines Limited was bought by New Dickenson Mines when they obtained 1,484,700 shares. The Victor mine is 2½ miles by road northwest of Sandon, or 2½ miles by road southeast of Three Forks.

Pillar recovery continued during the year, and some additional development found new pockets of ore. The main haulage is maintained on No. 7 level. On the 4150 sublevel, 100 feet above No. 7 level, new development opened up a narrow vein in 754 stope. The main production came from stopes operating above and below No. 5 level.

The average number of men employed up to September 30th was twenty. The crew was reduced to ten men for the remainder of the year. Production was 6,227 tons, which was milled in the Carnegie mill, producing 481 tons of lead concentrates and 1,030 tons of zinc concentrates.

Lone Bachelor (Lone Bachelor Mines Limited)

(49° 117° N.E.) This company is controlled by Violamac Mines Limited, which owns the adjoining Victor property. The property was leased in 1959 to E. Perepolkin, L. Fried, and E. DeRosa, who continued working in 1960. Mining was above No. 4 level. Production was 615 tons of mill feed, which produced 93 tons of lead concentrates and 120 tons of zinc concentrates; 83 tons of ore was shipped to the Trail smelter.

SPRINGER CREEK*

Silver

Anna (Silver King Mines Limited)

(49° 117° N.E.) This group of five claims was optioned by Silver King Mines Limited; mine office, Silverton. B. Marasek, president and manager. The property is on the northern side of Springer Creek, adjoining the Ottawa mine on the east. It is accessible by 5 miles of good road from Slocan City.

* By J. D. McDonald.

On the Anna, two shear zones in granite parallel each other, striking north 10 degrees east and dipping 35 degrees to the east. These appear to parallel the shears in the Ottawa and Arlington mines. The ore in the shear zones occurs in siliceous stringers and lenses. The only metal of value in the ore is silver, which occurs as native silver, argentite, stephanite, and tetrahedrite. The ore-bearing vein is normally 6 to 12 inches wide where observed, but widens out in some places related to rolls in the vein. Samples taken from a 6-inch vein in the old workings in No. 3 tunnel assayed 190 and 160 ounces of silver per ton.

All previous stoping was done above No. 3 level at an elevation of 4,760 feet. The last recorded work done on the property was in 1927. In July, 1960, a new level called No. 4 level was started in the west vein, 90 feet below No. 3 level, at an elevation of 4,670 feet. In 1960, 565 feet of drifting was done, 35 feet short of a point from which a raise is driven to No. 3 level for access and ventilation. An average crew of six men was employed from July to December. One mile of road was built from the Ottawa mine road to No. 4 adit. Four tons of ore was shipped to the Trail smelter.

Ottawa (Skylane Mines Limited) (49° 117° N.E.) Company and mine office, Slocan City. A. Semeniuk, president and manager. This company, formerly the Yukon Western Mining and Prospecting Co. Ltd., was reorganized as the Skylane Mines Limited. The company holds an option on the Ottawa mine on the north side of Springer Creek, 5 miles by road from Slocan City. Stoping was done intermittently on No. 8 level, a small amount of high-grade ore being shipped to the Trail smelter. When operating, four men were employed.

BURTON*

Silver-Lead-Gold

Millie Mack (49° 117° N.W.) This property is owned by Mrs. N. W. Forster, and is optioned by W. Isaacs, of Burton. It is on the south slope of Silver Mountain, which lies on the north side of Caribou Creek, 14 miles from Burton. A logging-mining road leaves the main highway at Burton and follows Caribou Creek up the north side for 10 miles. From this point a new road was constructed during the summer, climbing from an elevation of 3,100 feet at Blue Grouse Creek to the property at 5,800 feet, a distance of 3½ miles. The top one-half mile will require more work to make it passable for four-wheel-drive vehicles.

Some stripping was done, and about 14 tons of ore was shipped to the Trail smelter. The ore exposed by stripping shows mineralized pieces of quartz in a flat-lying bed of graphitic argillites and schists. It is overlain by argillites and underlain by andesite. There are considerable old workings, which are all caved. Three men were employed for three months constructing the road and stripping.

NORTH LARDEAU

FERGUSON (50° 117° N.E.)*

Silver-Lead-Zinc

Black Warrior, Elsmere.—This property, owned by J. Main, of Ferguson, is at the headwaters of Ferguson Creek, 10 miles by trail from Ferguson. The trail was cleaned out and repairs made to a bridge.

* By J. D. McDonald.

Hall Creek (50° 117° N.E.)*

Silver-Lead-Zinc

Bannockburn

The Bannockburn property is on the south side of the headwaters of Hall Creek, a tributary of the Duncan River. It comprises two groups of Crown-granted claims, one owned by J. Gallo, of Howser, and the other by Sheep Creek Mines Limited. The property is reached by 17 miles of road from a point on the Lardeau–Gerrard road about 3 miles south of Gerrard. The road follows Healy Creek, crosses a pass to the head of Hall Creek, and in 1959 was extended about 3 miles down the southeast side of Hall Creek to Bannockburn Creek. In August, 1960, the road was continued southward up Bannockburn Creek to the old Bannockburn adit, a distance of almost 1½ miles.

The property was discovered many years ago, and most exploration was done before 1920. In the early work several open pits, a short shaft, and an adit were made on showings of high-grade galena in limestone called the Bannockburn vein. These old workings are at an elevation of about 6,000 feet on the lower slope of a spectacular ridge of limestone northwest of Mount Abbott, which forms part of the Lime Dyke (*see* Walker, Bancroft, and Gunning, 1929). A second series of showings which constitute the Shelagh vein are about 600 feet to the southwest and for the most part several hundred feet above the Bannockburn vein. The Shelagh vein, though discovered many years ago, has attracted attention only recently. In 1955 The Granby Mining Company Limited, then The Granby Consolidated Mining Smelting and Power Company Limited, in addition to some exploration work on the Bannockburn vein, mapped and sampled and made trenches and short packsack diamond-drill holes on the Shelagh vein. In September, 1960, Sheep Creek Mines Limited drilled four holes, totalling 1,049 feet, one at the end of the new road below the Bannockburn vein and three to explore the Shelagh vein.

The showings are in quartzite and limestone near the top of the Hamill group of rocks, a thick quartzitic sequence below the Badshot limestone. The uppermost quartzite of the Hamill group is a light-grey to brown blocky rock containing visible rounded white and opalescent quartz grains in a calcareous cement. On the Bannockburn property this quartzite contains galena and is known as the Shelagh vein. It is as much as 40 feet thick. White finely crystalline limestone which weathers to a cream colour overlies the quartzite. This limestone, which contains the Bannockburn vein, varies greatly in thickness and is commonly more than 100 feet thick. A few hundred feet of grey and green phyllite overlies the limestone and underlies the Badshot limestone, which forms Mount Abbott and the Lime Dyke.

Near the showings the rocks dip steeply to the northeast and form a tight overturned anticline with low plunge. The axial plane dips steeply to the northeast and lies between the Shelagh and the Bannockburn veins. The anticline is clearly outlined in cliffs northwest of Hall Creek and on the property causes a repetition of the quartzite, limestone, and phyllite just described.

The Shelagh vein contains very fine-grained sulphides, mainly galena, disseminated in calcareous quartzite. Minor pyrite and sphalerite are present, and small amounts of chalcopyrite and tetrahedrite are reported. Although most of the galena is disseminated, some relatively coarse galena is contained in quartz veinlets within the quartzite. Pyrite grains are locally rusty, but in general the mineralized zone is not marked by a conspicuous gossan. The mineralized quartzite is exposed at intervals for about 3,500 feet along the strike. Most commonly it is 4 to 10 feet thick, and at one place is as much as 40 feet thick. Samples taken by the writer indicate

* By J. T. Fyles.

an average grade across the 40-foot width of: Gold, *nil;* silver, 0.5 oz. per ton; lead, 4.02 per cent; zinc, 1.3 per cent. About 1,000 feet to the southeast where the mineralized quartzite is 10 feet thick, a sample assayed: Gold, *nil;* silver, 0.03 oz. per ton; lead, 1.97 per cent; and zinc, 0.2 per cent. A few hundred feet farther to the southeast the mineralized zone assayed: Gold, *nil;* silver, 1.1 oz. per ton; lead, 5.59 per cent; and zinc, 0.5 per cent, across a width of 12 feet. Three holes were drilled by the Sheep Creek company in 1960 to intersect the mineralized quartzite a few hundred feet below the outcrop. One hole is reported to have encountered mineralization like that on surface. Northwest of Hall Creek, more than a mile from the showings on the Bannockburn property, similar mineralization is found in the same quartzite near the crest and down the southwest limb of the same anticline found on the property. Exposures in Hall Creek suggest that mineralization becomes scattered or dies out down the dip of the quartzite.

In the Shelagh vein the sulphides have formed by replacement of the carbonate cement between the quartz grains in the quartzite. Replacement is thought to have been controlled by the structure. Dragfolds, locally with sheared limbs, are common near the mineralized quartzite. They have a low plunge and a shape that suggests they have not formed by interbed slippage during the formation of the large anticline, but are superimposed on the anticline. Probably these dragfolds and related shears on the southwest limb and near the crest of the anticline have provided a favourable structure for mineralization, and it is suggested that the long axis of the deposit has a low plunge parallel to the plunge of the dragfolds.

The Bannockburn vein consists of lenses of massive galena with more or less sphalerite, pyrite, and minor chalcopyrite in limestone. At least three lenses are exposed in old trenches and in a shaft, above the caved portal of an old adit at the end of the new road. The lenses are one above the other and are up to a few feet wide and a few feet high. They appear to plunge at a low angle to the southeast and have been found in the old workings a few hundred feet along the plunge. The old adit driven southwestward beneath the showings did not encounter mineralization like that on surface, and a hole drilled down to the southwest at 45 degrees from a point about 100 feet northeast of the adit portal also did not encounter mineralization. It passed through the limestone into the underlying quartzite. The suggestion obtained from surface exposures of the sulphide lenses is that they are pencil-like replacements of the limestone that have formed at intersections of relatively gently dipping beds and a steeply dipping cleavage.

[References: Walker, J. F., Bancroft, M. F., and Gunning, H. C., Lardeau Map-area, British Columbia, *Geol. Surv., Canada,* Mem. 161, 1929, p. 77.]

SOUTH LARDEAU*

Lead-Zinc

Duncan (The Consolidated Mining and Smelting Company of Canada, Limited)

(50° 116° S.W.) Company office, Trail. J. J. McKay, development superintendent until September, when R. Douglas was in charge for the last three months of operation. This company has an option from J. Gallo and associates, of Howser, on a group of forty-nine mineral claims held by record, one Crown-granted mineral claim named the Grizzly, and eight claims held by retention lease. This group of claims has in recent years been called the J.G. and is now referred to by the company as the Duncan. The claims cover a band of calcareous rocks mineralized with galena and sphalerite, which strike north 20 degrees west and dip steeply to the east.

* By J. D. McDonald and J. T. Fyles.

A development programme which was started in June, 1959, was completed in October, 1960. This programme was concentrated on the north end of the peninsula, where extensive underground work was done. The mine and camp-site are on the shoreline of Duncan Lake on the west side of the peninsula, about 2 miles from the northern tip. The mine is 4 miles by boat north of Howser or 12 miles by good road. The road follows the shoreline on the east side of the lake, crossing over to the west side of the peninsula.

In October the mine was closed for an indefinite period, until such time as the mining of lead ore is more attractive to the company. Total development in 1960 was 4,096 feet, made up of drifting and crosscutting, 3,623 feet, and raising, 473 feet. The total for the entire programme was 6,565 feet, including an adit at an elevation of 1,800 feet, 35 feet above lake level, that was driven 990 feet to the mineralized zone; drifts were extended north and south along the strike; crosscuts were driven to the west at regular intervals for diamond drilling; a vertical raise was driven from the 1800 level to surface, a distance of 346 feet.

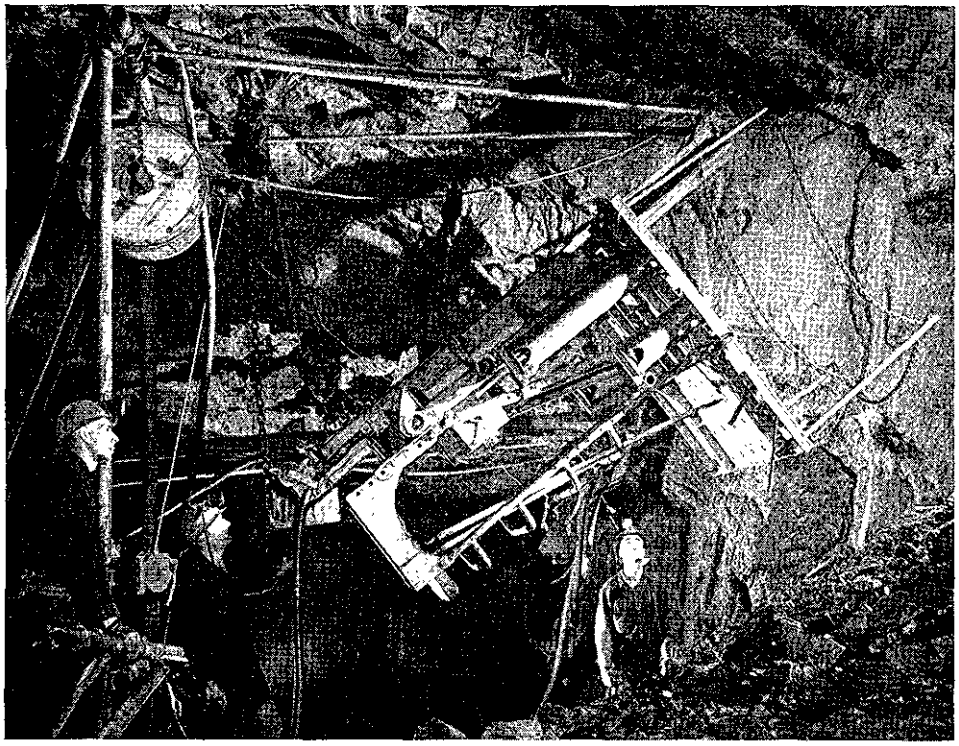
The underground work was directed mainly to exploring and developing mineralization in zones known as the No. 5, No. 6, No. 7, and No. 8. The crosscut passed through No. 6 zone, and the drift followed No. 7 and No. 8 zones. No. 5 zone is beneath the present level. The zones in general form a series of lenses in echelon with long axes plunging at low angles to the north. In cross-section they dip steeply to the east and are a few tens of feet thick and more than 100 feet high. Parallel to the plunge, the zones are several thousand feet long, though the full length of any one zone has not been determined. Mineralization exposed underground consists of very fine-grained galena, sphalerite, pyrite, and minor pyrrhotite disseminated in dolomite. The long axes of the mineralized zones plunge parallel to the axes of major and minor folds in the area, and the deposit appears to be a structurally controlled replacement of the dolomite.

An interesting feature of underground operations was the use of a raise climber in driving 310 feet of vertical raise. This is the second time that a machine of this type has been used in British Columbia. The machine was used to drive the centre compartment of a three-compartment vertical shaft. The size of this pilot raise was 7½ by 6 feet. The plan was to raise the pilot shaft to surface from the 1800 level, a distance of 346 feet, and slash the shaft to full size, 7½ by 20 feet, as the timber was installed from the surface downward. Before installing the raise machine, a cut-out for the machine was made, and 36 feet of raise was driven by conventional methods. The machine was installed and ready for operation in fourteen man shifts.

The crew for the raise consisted of a shift leader, raise miner, and a third miner assisting during the mucking cycle for two hours. The crew did their own tramming. The average cycle consisted of: two hours for mucking; one and one-half to two hours to travel to the face in the raise machine and to bar down and install one 6½-foot section of track; two hours to drill off a twenty-six-hole 8-foot round using 1⅜-inch tungsten carbide bits for the square and 1½-inch bits for the cut holes; one and one-half to two hours to load and blast the round using 1⅛- by 8-inch 75 per cent Forcite powder primed with electric blasting-caps, series 0–11.

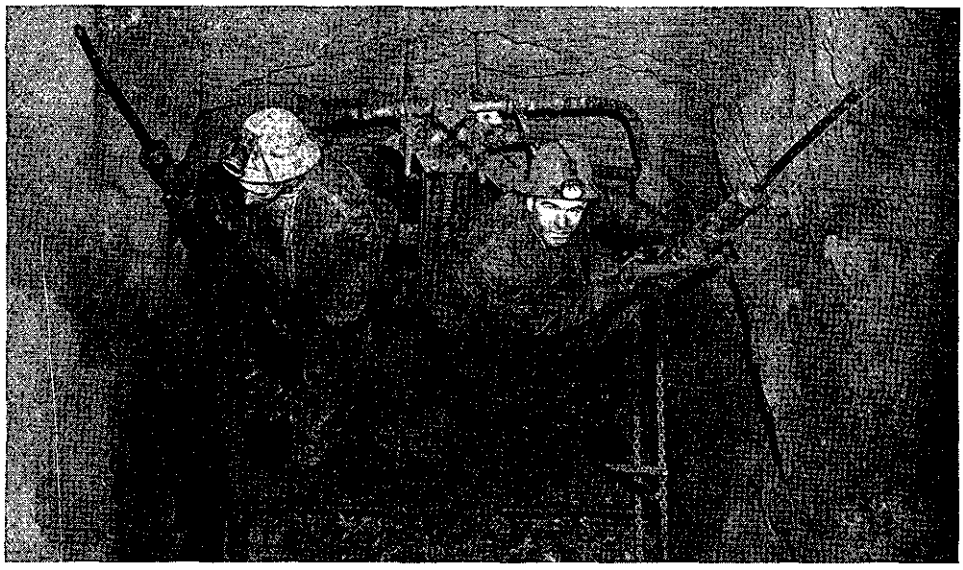
A total of 310 feet of raise was driven in seventeen days, or fifty-one shifts, for an average advance of 6.1 feet per shift. The productivity, including the third man, was 2.46 feet per man shift. One shift was required for geological mapping, and one shift for plumbing raise. The raise was completely stripped of rail and all equipment in twenty-four man shifts.

Regulations laid down by the Chief Inspector of Mines and District Inspector of Mines governed the operation of the machine with regard to safety. Several additional safety features were employed by the management. A steel plate was



(Cominco photo.)

The Consolidated Mining and Smelting Company of Canada, Limited. Raise machine in hinged position at bottom of vertical raise in Duncan mine.



(Cominco photo.)

Raise machine in position for drilling.

installed so that it could be swung into a position covering the bottom of the raise during mucking. A second feature, used in stripping the raise, was a pipe scaffold with a plank covering to protect the men on the platform. Ventilation of the raise was good at all times.

The cost of raising with this equipment was considerably less than that of conventional raising. The rate of advance was greatly increased, and there were no accidents.

An extensive diamond-drilling programme was completed in 1960. Underground drilling to check the downward extension of the ore zone totalled 19,710 feet. Surface diamond drilling amounted to 9,250 feet, of which 4,014 feet was drilled in five holes on No. 7 zone on the peninsula and 5,236 feet in twelve holes on No. 3 zone on the Hinck ranch.

Until the time of shut-down twenty-five men were employed at the mine, of whom seventeen were employed underground. In addition, an average of six men was employed on the surface diamond drilling.

[Reference: *Minister of Mines, B.C.*, Ann. Rept., 1959, p. 71.]

Mag (The Consolidated Mining and Smelting Company of Canada, Limited)

(50° 116° S.W.) Company office, Trail. This property consists of nineteen recorded claims situated south of Glacier Creek, at an elevation of about 5,000 feet. A portion of the property covers claims previously known as the Bonaventure group on the south side of Glacier Creek, and the Al and High Hope on the north side of Hamill Creek. A road was completed to the property in June. It leaves the Howser–Argenta road about 2 miles south of the Glacier Creek bridge and climbs 3.1 miles up the west slope of Lavina Mountain from an elevation of 1,825 to 5,190 feet. Exploration work done in the period July to November consisted of geological mapping, 500 cubic yards of trenching, and 3,323 feet of diamond drilling in eleven holes. Nine men were employed under the supervision of company geologist T. W. Muraro.

Showings on the property are in calcareous rocks of the Badshot formation on the western limb of a large isoclinal anticline, which plunges to the north at about 10 degrees and is overturned toward the west. Quartzites and phyllites in the core of the anticline are overlain by limestone and dolomite, and these rocks in turn are overlain by dark-grey phyllite. The calcareous rocks are a few hundred feet thick, but, because of a peculiar dragfold which plunges to the north more or less parallel to the slope of the hill, they outcrop extensively on the claims. The showings have been exposed at intervals by bulldozer trenches and road cuts over a distance along the strike of the calcareous rocks of more than a mile and over a vertical range of about 2,000 feet. They consist of zones of gossan locally containing galena and sphalerite in more or less weathered dolomite. Diamond drilling encountered sulphides at no great depth but was hampered by broken ground and by an abnormally low eastward dip of the dolomite.

KIMBERLEY*

Silver-Lead-Zinc

Sullivan (The Consolidated Mining and Smelting Company of Canada, Limited)

(49° 115° N.W.) Company office, 215 St. James Street West, Montreal; western headquarters, Trail. W. S. Kirkpatrick, Montreal, president; R. D. Perry, Trail, vice-president and general manager. Sullivan mine office, Kimberley. J. R. Giegerich, general superintendent; R. M. Porter, mine superintendent; H. J. Chalmers, Chapman Camp, superintendent, Sullivan concentrator. The Sullivan mine is on Mark Creek,

* By D. R. Morgan.

2 miles north of Kimberley, and the concentrator is at Chapman Camp, 2 miles south of Kimberley. The holdings include 678 Crown-granted claims and fractions. The following report prepared by the management is a synopsis of the operations:—

"During 1960 the mine produced and the concentrator treated about 2,522,000 tons of ore; seventy-six per cent of which was produced from the section above 3900 level and twenty-four per cent from below 3900 level.

"The total development footage was 51,755 feet. This included drifting on the new 2600 and 2700 levels, driving a conveyor gallery 1,500 feet, and other related development for the new 2500 level crushing chamber. The installation of the steel shaft sets between 2850 and 2400 levels was completed and this section of No. 1 shaft was put into operation.

"The total backfill placed was 617,336 cubic yards. This consisted of 293,424 cubic yards (48%) of planned cave, 194,337 cubic yards (31%) of float rock with five per cent iron sulphides added, placed in ten stopes below 3900 level, 124,143 cubic yards (20%) of gravel, and a minor amount of development work.

"The ventilation system supplied fresh air and exhausted 900,000 c.f.m. of contaminated air. A new exhaust ventilation shaft (No. 40) was completed in the south section of the mine; this replaces No. 9 shaft. The total number of primary fans in operation was thirteen. Their power requirement was 1,425 horsepower.

"The accident frequency and severity rates were slightly above last year's all-time low. The mine had 26 lost-time accidents, the same as in 1959, and 1,665 days lost, resulting in a frequency rate of 15.1 and a severity rate of 965 per million man-hours worked. The concentrator had 10 lost-time accidents with a total time loss of 400 days, a frequency rate of 13.0 and a severity rate of 518 per million man-hours worked.

"No. 1 shaft section, employing about 120 men, completed the year without a lost-time accident. There were no fatalities at either the mine or the concentrator in 1960.

"Seventeen Sullivan mine and concentrator employees obtained their Industrial First Aid Certificates. Eight First Aid classes were held and 137 employees passed the St. John's First Aid examinations.

"Eight men were trained in Mine Rescue work and obtained Department of Mines Certificates. Total trained since 1930 has been 263. Team refresher training was given to 25 active Mine Rescue men.

"The concentrator operated 254 days during 1960 at an average of 9,930 tons per day. Employees at the year end totalled 839 at the mine and 390 at the concentrator."

WINDERMERE*

Toby Creek (50° 116° S.E.)

Silver-Lead-Zinc

Mineral King (Sheep Creek Mines Limited)

Company office, 6, 490 Baker Street, Nelson; mine office, Toby Creek. H. E. Doelle, managing director; J. B. Magee, resident manager. The mine is at Toby Creek, 28 miles by road southwest of Athalmer. It is on the ridge between Jumbo and Toby Creeks, and is entered by three adit levels driven from the mountainside north of Toby Creek. No. 7, the lowest or main haulage level, is at an elevation of 4,775 feet, No. 3 level at 5,460 feet, and No. 2 level at 5,595 feet. Three intermediate levels have been driven from an inclined shaft in the workings but do not extend to the surface. The mine is operated by the open-stope method, and the workings are in four parallel orebodies known as

* By D. R. Morgan.

the " A," " B," " C," and " D." A full description of the deposit is included in the 1959 Annual Report.

The mine produced 194,507 tons of lead-zinc ore during 1960, most of the ore coming from the workings above No. 4 level. The ore was developed and mined from all levels between No. 2 and No. 6 levels, and its extraction extended across the " A," " C," and " D " zones. No. 7 level was extended 1,150 feet in a northerly direction for future development, and it is expected to enter the limestone horizon in the near future. Total development work at the mine included 3,458 feet of drifting and crosscutting, 1,793 feet of raising, and 17,116 feet of diamond drilling. There were no major changes to the operation, and the ore reserves remained fairly constant. It is pleasing to report the operation produced its one-millionth ton of ore during 1960 since the commencement of operations in March, 1954.

The production of barite during 1960 averaged 500 tons per month. It was mined from the " C " and " D " zones above No. 3 level, and was transported from the mine via No. 3 level and the surface incline. Further deliveries of barite from the area will be limited as the major reserves are now between No. 3 and No. 4 levels. The barite is shipped in a crude state, and is trucked to Invermere for shipment by rail.

The mine was ventilated by both mechanical and natural means. Approximately 29,000 cubic feet of air per minute was exhausted from the workings, and of this quantity 18,000 cubic feet per minute was supplied by a 15-horsepower electrically driven fan which is located on the No. 2 intake airway. The remainder was natural ventilation. This quantity was found to be sufficient for the requirements of the workings.

The concentrator operated at 90 per cent capacity throughout the year and produced 14,873 tons of zinc and 7,155 tons of lead concentrates. The concentrates were trucked to Invermere for shipment by rail. New construction and alterations made on the surface during 1960 were limited to the building of a duplex family dwelling at the mine camp, an employees' laundry-room, and an addition to the camp kitchen. One mile of access road was built up Jumbo Creek, and three surface diamond-drill holes were drilled to obtain knowledge of the geological structure on a number of claims owned by the company on the north side of the mine workings. Some 200,000 board feet of mine timber was cut on the claims.

The average number of men employed was ninety-nine, of whom fifty-four were engaged underground.

Paradise (Sheep Creek Mines Limited)

Company office, 6, 490 Baker Street, Nelson; mine office, Toby Creek. H. E. Doelle, managing director; J. B. Magee, resident manager. This property is at the headwaters of Springs Creek, a tributary of Toby Creek. The mine is at an elevation of 7,800 feet, and is 20 miles by road west of Athalmer. The mine has been inactive since 1955.

Commencing in May, 1960, the road leading from Jack Pine Flat on Toby Creek to the mine was repaired, and a crew of nine men rehabilitated the surface buildings and 7800 adit level. No. 2 winze, collared from the 7800 level, was dewatered and a diamond-drill hole was started from the 7700 level. Approximately 1,100 tons of ore was mined from above the 7800 level and was trucked to the Mineral King concentrator. Average grade of ore: Silver, 5.5 oz. per ton; lead, 4.8 per cent; zinc, 8.2 per cent. Operations were suspended for the winter late in November, with the exception of the diamond drilling. A fatal accident involving the death of one of the workmen occurred underground in August.

Silver-Copper

HORSETHIEF CREEK (50° 116° N.E.)

Ptarmigan (The Selkirk Ptarmigan Mines Limited)

Heinz K. F. Seel, president, Edgewater. This mine is located at the headwaters of Red Line Creek, a tributary of McDonald Creek, which in turn is a tributary of Horsethief Creek. It is at an elevation of 8,600 feet and is accessible by means of a 29-mile road leading from Wilmer. The mine is an old operation that was abandoned for many years. The present company was formed in 1958 to continue operations after the owner, Mr. Seel, had removed a large quantity of ice from the workings. There are over 3,000 feet of development tunnels in the old workings, and production during the past three years has been obtained from small cut-and-fill stopes on two of the levels.

A crew of three men, including a geologist, worked at the mine for a period of two weeks in the summer getting a number of samples from various parts of the workings. There was no production in 1960.

Copper

BOBBIE BURNS (50° 116° N.W.)

St. Andrew Mining Co. Ltd.

Head office, 1501, 1030 West Georgia Street, Vancouver 5. This company holds 234 mineral claims in the Warren Creek area, 30 miles northwest of Spillimacheen. The claims extend from the headwaters of Rocky Point Creek to Warren Creek, and down both sides of the latter creek for a distance of 3 miles. Access is by means of a logging-road, 14 miles long, from Parson to the confluence of Warren Creek and Bobbie Burns Creek, and about 10 miles of road along Warren Creek. A report on a previous prospect in the area is included in the 1920 Annual Report.

A reconnaissance has been made of the property, and most of the 1960 activities were directed to diamond drilling and the building of access roads. The drilling was done by contract, and a number of holes totalling 2,250 feet had been completed by October. Approximately 14½ miles of roads was constructed. The total number of men employed, including the drilling crews, was ten. Exploration was suspended for the winter in November.

Gold

McCULLOCH CREEK*

Argo Exploration & Mining Company Limited

(51° 118° S.E.) Registered office, 201, 1027 West Broadway, Vancouver 9; mine office, 1202 First Street West, Revelstoke. *H. B. Zavitz, president; A. E. Horne, managing* director. Capital: 10,000 shares, no par value. This company holds twenty-seven mineral claims and four placer leases on the headwaters of Graham Creek, a tributary of French Creek. The property is accessible by road from Mile 57 on the Big Bend highway. The road follows the north side of the Goldstream River for a distance of 5 miles, then turns and follows McCulloch Creek to the summit at 6,000 feet between McCulloch Creek and Graham Creek, a distance of 13½ miles, then 1 mile of road switchbacks down to Graham Creek, a drop in elevation of 1,000 feet.

The rocks in the area are mainly mica and chloritic schists, striking northwest and dipping flatly to the northeast. A general fracture system in the area strikes north 10 degrees east and dips steeply to the west. Quartz veins follow the fracture system, ranging in width up to 8 feet. Some veins are heavily mineralized with pyrite and some are unmineralized.

The McCulloch Creek road was extended from the Stanmack property 6 miles over the McCulloch Creek summit. A camp was established on Graham Creek at

* By J. D. McDonald

an elevation of 5,050 feet. Two small prefabricated buildings were erected, 1,000 feet of 18- to 10-inch pipe was hauled in and installed, and two No. 4 monitors, pressure-box, and 132 feet of 3- by 3-foot sluice-boxes, which were prefabricated in Revelstoke, were set up. Six to eight men were employed during the summer.

REVELSTOKE*

Silver-Lead-Zinc

Mastodon (Mastodon Zinc Mines Limited)

(51° 118° S.E.) Head office, 502, 1200 West Pender Street, Vancouver 1; mine office, Revelstoke. K. J. Springer, president; J. M. Parker, mine manager; R. F. Lambert, mine superintendent; R. G. Gould, mill superintendent. This company holds about fifty Crown-granted claims crossing the ridge between LaForme and Carnes Creeks about 17 miles north of Revelstoke. The main camp and mill are on the north side of LaForme Creek at an elevation of about 3,400 feet, 4½ miles by road from Mile 17 on the Big Bend Highway. The mine is on the divide between LaForme and Carnes Creeks at an elevation of 5,000 feet. It is serviced from the main camp by an incline and about 1 mile of level haulage from the top of the incline to the mine. In the summer of 1960 a road was constructed a distance of 3.3 miles, connecting the mine to the mill.

The mine, which had been idle since October, 1953, was reopened in 1960. Rehabilitation of buildings, machinery, and mine started in April and production began in June.

The Mastodon orebodies are replacements of calcareous rocks, principally by sphalerite. A complete geological description of the property is given in the Annual Report for 1959.

There are four main levels—the 5500, 5300, 5100, and 5000. The 5100 level is the main haulage level, using a small battery locomotive and 2-ton V-cars for hauling and dumping into a coarse-ore bin on surface. Open stoping was done with jacklegs and slushers. Development: 290 feet of crosscutting and drifting, 350 feet of raising. Some underground diamond drilling was done. No work was done on the 5000 level. Ore was hauled from the coarse-ore bin at the mine to the coarse-ore bin at the top of the incline, over about 1 mile of narrow-gauge railroad, using 48-horsepower diesel locomotive and 2-ton V-cars. The ore was transferred to the mill by 3-ton skips via the incline. A new road built from the mill to the mine was completed in September to enable ore haulage by truck and thus eliminate the incline and extra handling of the ore.

The 200-tons-per-day mill treated 15,532 tons of ore in the operating period, averaging 0.2 ounce of silver per ton, 0.5 per cent lead, and 9.5 per cent zinc. The ore contained zinc oxides which were not recoverable. Concentrates were trucked to Revelstoke and thence by rail to the Trail smelter.

All mining ceased on October 16th, and the property was closed on November 15th. During the period of operation the average number of men employed was seventy, of whom forty-five were employed underground.

Wigwam (The Consolidated Mining and Smelting Company of Canada, Limited)

(51° 118° S.E.) Head office, Trail. This property consists of fourteen recorded claims. It is on the north side of Akolkolex River, which empties into the Columbia River at a point about 14 miles south of Revelstoke. The property is accessible by road which leaves the Revelstoke–Arrowhead highway 10½ miles south of Revelstoke, and follows a southeasterly direction for 5 miles to Akolkolex River then turns and goes

* By J. D. McDonald.

north up the river for 5 miles. Approximately 5 miles of road was cleared, and some geological mapping was done on the property. Mineralization occurs in quartzites adjacent to a limestone bed which is believed to be part of the Badshot formation.

SKAGIT RIVER*

Copper

A.M. (Canam Copper Company, Ltd.) (49° 121° S.E.) Company office, c/o Room 609, 850 West Hastings Street, Vancouver 1. W. M. Sharp, resident engineer. This property, comprising eight Crown-granted and fifty recorded claims, is astride the divide on the west boundary of Manning Park, about 4 to 6 miles by road from the Hope–Princeton highway, 26 miles east of Hope. Detailed descriptions of this property have appeared in the Annual Reports for 1938, 1949, 1954, and 1959.

In September a contract was commenced by Intermountain Construction Ltd. to extend the 8- by 8-foot No. 15 level or 4300 adit a distance of approximately 1,300 feet. Commencing at the adit face, a distance of 4,350 feet from the portal, a crew of twenty men completed 1,168 feet of crosscutting. This work was done to investigate the possible extension below No. 10 level of the main ore zone.

Copper-Lead-Zinc

Gold Coin (Earlcrest Resources Ltd.) (49° 121° S.E.) Company office, 212, 678 Howe Street, Vancouver 1. This property, comprising twenty-seven recorded claims, is on Shawatum (Ten Mile) Creek, a tributary of Skagit River, 25 miles southeast of Hope. It was reported that between mid-July and mid-November a crew of nine men, working under the direction of R. Stokes, was employed in magnetometer surveying, geological mapping, and trenching on a large low-grade zone containing copper, lead, and zinc with minor amounts of silver and gold.

HOPE*

Nickel-Copper

Pride of Emory (Giant Nickel Mines Limited) (49° 121° S.W.) Company office, 844 West Hastings Street, Vancouver 1; mine office, Hope. W. Clarke Gibson, president; R. E. C. Richards, mine superintendent; C. Major, mill superintendent. The property is at the head of Stulkawhits (Texas) Creek, which flows eastward into the Fraser River about 6 miles north of Hope. From a point on the Trans-Canada Highway 10 miles north of Hope, a good gravel road 5.1 miles long leads up Stulkawhits Creek valley to the mill and surface buildings at the 2600 adit portal. A branch road from this point gives access to the 3550 adit portal. The adit numbers designate elevations above sea-level.

The Pride of Emory showing was found in 1923 by Carl Zofka, and since that time development and production have been carried on by several different companies. A short summary of earlier development is given in the 1959 Annual Report. In 1959 Giant Mascot Mines Limited acquired Newmont Mining Corporation's interest in Western Nickel Mines Limited and on May 26th joined with Pacific Nickel Mines Limited to form a new company, Giant Nickel Mines Limited. The mine was immediately prepared for production, which was begun on July 5th, 1959. Apart from occasional temporary stoppages, production has been continuous since that time.

* By J. E. Merrett.

The ore occurs in a number of separate orebodies, the principal ones being the Pride of Emory, the Brunswick Nos. 1, 2, and 5, and the 2663, which was mined out in 1958. The first four orebodies mentioned are mainly above the 3550 level. The orebodies are steeply plunging pipe-like deposits and occur in an irregular stock-like intrusion of ultrabasic rocks approximately 1½ square miles in area. They comprise disseminated and massive sulphides, of which pyrrhotite, pentlandite, and chalcopyrite are the most common. The ore reserves at the end of 1960 are estimated as approximately 700,000 tons with an average nickel content of 1.18 per cent. The mine is developed from two adit levels—the 3550 level, with portals on both west and east sides of the mine, and the 2600 level, which is the main haulage level. An ore-pass and an internal inclined shaft join the two levels.

Mining in 1960 was confined to the Pride of Emory and Brunswick No. 1 orebodies, the former being the main source of mill feed. Development of the A and B zones of the Pride of Emory was completed and development of the C zone was in progress at the year-end. The A zone was mined out to the 4075 level by conventional underground longhole methods. The ore from the 4075 level to the surface (100,000 tons) was mined by open-pit methods employing caterpillar tractors and air tracks. Longholing of the B zone was in progress at the end of the year. The ore from this area is drawn from the stopes by 50- and 60-horsepower slushers to the main Pride of Emory ore-pass and dropped to the 3550 level. The Brunswick No. 1 orebody was mined to the surface, and work is now in progress to explore and develop the Brunswick Nos. 2 and 5 orebodies above the 3550 level. The following is a summary of development work done in 1960:—

	Feet
Drifting and crosscutting	1,211
Raising	2,013
Diamond drilling	11,363
Longhole footage	134,278

The milling process was changed from selective to bulk flotation in March on the completion of the current contract with Sherritt-Gordon Mines Limited. The new three-year contract with the Sumitomo Metal Mining Company calls for a bulk nickel concentrate. The concentrates are trucked from the property to Vancouver Wharves bulk-loading plant at North Vancouver by two Mack truck-trailer units.

In 1960 a total of 250,261 tons of ore was milled. A total of 19,995 tons of concentrates, containing 4,295,316 pounds of nickel and 1,578,312 pounds of copper, was shipped.

The crew in December comprised 132 men, of whom seventy-five were employed underground. The accident rate at Giant Nickel mine in 1960 was not good. There was a total of fifty-one lost-time injuries, giving an accident rate per million man-hours of 162.0. This compares with a rate of 28.0 for all lode mines in the Province. Accidents in many categories of underground work were high, but the largest single cause was in the transportation and handling of materials. It is to be hoped that now the mine is entering on its third year of operation, a really determined effort will be made to reduce this accident rate.

[References: *Minister of Mines, B.C.,* Ann. Rept., 1954, pp. 161–163; *Geol. Surv., Canada,* Mem. 190, 1936.]

HOWE SOUND*

Copper-Zinc

Britannia (Howe Sound Company (Britannia Division)) (49° 123° N.E.) Head office, 500 Fifth Avenue, New York, N.Y.; mine office, Britannia Beach. William M. Weaver, Jr., president; Frederick A. McGonigle, vice-president; D. W. Pringle, manager; A. MacCutcheon, general superintendent. Shrinkage, cut-and-fill, filled square-set, sublevel caving, and blast-hole mining methods were used to remove ore from remnant pillars and from broken but hitherto unrecovered ore reserves in the Victoria and No. 8 orebody areas. The largest portion of the ore produced was obtained from the No. 8 shaft area. Rehabilitation work was done on two levels off No. 7 shaft, in the lower Bluff orebody. No. 8 shaft was reconditioned below the 5100 level to the bottom or 5700 level, 1,200 feet below sea-level.

Exploration development was done locally in many areas, but most of it was done in the Victoria mine on the extension of 41-234 drift, easterly along the Britannia shear zone, in an investigation of this area below the Fairwest mine workings, the most easterly ore occurrence in the Britannia deposit. This drift was extended 3,883 feet to a total length of 5,106 feet. Diamond drilling was done at regular intervals without additional ore being disclosed. In the No. 8 shaft area a crosscut was driven toward the shear zone 317 feet on the 5700 level. Development work done included 9,493 feet of drifting, 2,035 feet of crosscutting, 7,695 feet of raising, 11 feet of winze sinking, and 20,982 feet of diamond drilling.

In 1960, 409,751 tons of ore was milled to produce 28,818 tons of copper concentrate, 10,121 tons of zinc concentrate, and 31,418 tons of pyrite concentrate. The copper and zinc concentrates were shipped to the Tacoma and Anaconda smelters, respectively, and, except for a small shipment of pyrite concentrate to Nichols Chemical Company Limited at Barnet, the pyrite was stockpiled for future sale. Some metallic copper was recovered by precipitation, by passing mine drainage water over iron shavings. In addition, part of the mill tailing was sold to Lafarge Cement company and to Construction Aggregates Ltd.

During the year twenty-two employees were successful in passing a mine-rescue training course, thirty-four a first-aid training course, and thirteen the shiftboss examination. Four employess obtained shiftboss certificates.

The average number of men employed was 364, of whom 246 were employed underground.

TEXADA ISLAND*

Iron-Copper

Texada Mines Ltd. (49° 124° N.W.) Registered office, 626 West Pender Street, Vancouver 2; mine office, Box 35, Vananda. A. D. Christensen, San Francisco, president; B. L. Alexander, general manager; J. Kenneth Halley, chief engineer; J. Yuill, mine superintendent; L. D. Smillie, mill superintendent. This property, comprising eight Crown-granted and twelve recorded mineral claims, is at Welcome Bay, 3 miles northwest of the mine camp at Gillies Bay on the southwest coast of Texada Island.

Open-pit mining methods were used to remove ore and waste. Eight drills were used to drill holes 3, 4, and 6 inches in diameter. Blasting was done with 40 per cent Forcite, 75 per cent Giant Gelatin, Hydromex, ammonium nitrate and diesel-oil mixture, and Primacord, using electric detonators. Loading and transportation equipment included six 2½-cubic-yard-capacity diesel-driven shovels, one Michigan front-end loader, two D-8 Caterpillar tractors, five 22-ton-capacity and six 27-ton-capacity trucks.

* By J. E. Merrett.

The waste stripping programme, commenced in 1959, was continued on the Boulder Nest, Paxton, Prescott, and Yellow Kid pits, a total of 1,600,219 solid cubic yards of rock being removed in 1960. Of this total, 97 per cent was removed from the Prescott and Yellow Kid pits, more than half of it from the Yellow Kid pit.

Underground, 225 feet of raising and 405 feet of sublevel drifting were completed beneath the Paxton and Yellow Kid pits.

Diamond-drill exploration was done continuously throughout the year, 11,672 feet having been drilled on the surface and 12,180 feet underground.

An aircraft landing strip more than 2,000 feet long, for the use of small aircraft, was under construction close to the mine.

Additions to the camp included two thirty-two-man bunk-houses and a community hall.

The mill produced magnetite concentrate by a wet magnetic separation process, and the chalcopyrite was recovered by flotation. The concentrates were shipped to Japan.

Production: Ore mined, 869,673 tons; ore milled, 867,736 tons; iron concentrate, 419,651 tons; copper concentrate, 7,927 tons. The average number of men employed was 216.

BUTE INLET*

Copper

Colossus (Phelps Dodge Corporation of Canada, Limited) (50° 125° N.E.) Company office, 904, 1030 West Georgia Street, Vancouver 5. W. A. Hutchison, Toronto, general manager; D. C. Malcolm, Vancouver, resident geologist. This company holds options on four Crown-granted and forty-one recorded mineral claims and fractions in the vicinity of Buker Creek on the north side of Estero Basin of Frederick Arm, west of the south end of Bute Inlet.

A crew of three men was employed reopening 2 miles of trail from Estero Basin to the old mine workings, which consist of four adits between elevations of 1,055 and 1,300 feet. The adits were reopened and geological mapping was done on the surface and underground.

In addition, prospecting was done in the Coast Range, using a helicopter based at Estero Basin and at Jervis Inlet.

VANCOUVER ISLAND

BENSON LAKE (50° 127° S.E.)†

Iron

Empire Development Company Limited Company office, 1012, 736 Granville Street, Vancouver 2; mine office, Port McNeill. E. C. Oates, general manager. The mine is operated by Mannix Company Ltd. (company office, 546 Howe Street, Vancouver 1), which has a 60-per-cent interest in Empire Development. A. Ostgard is project manager. The remaining interest in Empire Development is held by Quatsino Copper-Gold Mines Limited, who are the original owners of the ground which now includes the present operation.

The property consists of a block of forty-five Crown-granted claims on which the operating pits are situated. There are also another eleven Crown-granted claims and at least seven recorded claims in the area. A reciprocal agreement exists involving exploration rights to iron mineralization by Empire Development on the

* By J. E. Merrett.
† By W. G. Jeffery.

northerly adjoining Coast Copper property, and to copper mineralization by The Consolidated Mining and Smelting Company of Canada, Limited, on Empire Development property.

The Empire mine lies at an elevation of 2,500 feet on the west side of the Benson River valley approximately 2 miles south of Benson Lake, and on the east flank of Merry Widow Mountain. The concentrator and mine camp are in the valley at an elevation of 800 feet. Access to the open pits is by tote-road about 4 miles in length, and ore is brought down the hillside by tramline. Access to the mine camp is by a 25-mile gravel road from Port McNeill on the east coast of Vancouver Island. Details of the mining, milling, and shipping processes may be found in the Annual Report for 1959.

Magnetite occurrences have been known in the area from 1897, but the initial development was of copper mineralization, and the present magnetite orebodies have been developed from showings originally considered to be of lesser interest. After some exploration work, Quatsino Copper-Gold Mines Limited suspended operations in 1931, but diamond drilling of the magnetite showings was commenced in 1950. Further work in 1951 and 1952 proved the existence of magnetite orebodies on the Merry Widow No. 5 (Lot 1533) and the Kingfisher Fraction (Lot 1532) Crown-granted claims. Empire Development Company Limited was formed in 1956, and production commenced in 1957. To the present time, production has been as follows:—

Year	Ore (Tons)	Concentrate (Tons)
1957	121,423	82,668
1958	572,404	272,495
1959	863,176	393,558
1960	1,046,989	463,240

In 1960 the number of men employed averaged 142. A total of 11,675 feet of diamond drilling was completed during the year.

Acknowledgments.—The writer, with one assistant, used the mine as a base for mapping the surrounding area during the summer of 1960, and wishes to express his appreciation to the staff of Empire Development Company Limited for their co-operation. The following preliminary notes on the regional geology are based on the writer's observations, and the detailed geology of the mine is developed partly from the writer's work and partly from the observations and ideas of John Lamb, company geologist, to whom in particular the writer wishes to express his thanks.

The mine is in an area of fairly rugged topography with an over-all relief of about 2,500 feet. Apart from summits above about 3,500 feet elevation, the country is wholly wooded, in places with heavy underbrush. The amount of outcrop varies greatly, but the better exposures are usually found in the creeks, which are normally difficult and slow for travel. Annual rainfall is over 100 inches. Precipitation during the field season of 1960 from May to September amounted to approximately 10 inches, and there were dry sunny spells of considerable duration through the summer months.

Regional Geology

The region is underlain by rocks of the Vancouver group, similar to those described in the Zeballos-Nimpkish area by Hoadley (1953). These rocks consist of a series of interbedded volcanic and sedimentary rocks. The lowermost unit is the Karmutsen group of unknown thickness. The upper horizons are of Upper Triassic age. Upper Karmutsen rocks underlie large areas to the north and east

of the Empire mine, and consist of thick green and purplish amygdaloidal flows with very little sedimentary material.

The Quatsino limestone formation rests conformably on top of the Karmutsen group. The unit is a crystalline limestone, ranging in colour from white and grey to blue. In places it is well bedded, usually in beds ranging from 6 inches to about 4 feet thick, but elsewhere it is very massive rock with little indication of bedding. The Quatsino limestone is of the order of 4,000 feet thick. The major part is unfossiliferous, but a few fossils collected in the upper horizons have been tentatively identified as Upper Triassic by W. R. Danner (personal communication). Exposures occur across a broad belt of relatively low-lying country northwest of the mine along the valley of the Benson River, south of Benson Lake, east of the mine, and extending southeast in the general direction of Zeballos. Areas underlain by limestone are generally characterized by sink-hole topography, and a noticeable feature is that undergrowth is less dense than over areas underlain by other rock types.

Rocks of the Bonanza group lie above the limestone. Exposures of the Bonanza group occur to the northwest, west, and south of the mine. In places these rocks can be subdivided into a sedimentary part and a dominantly volcanic part. The sedimentary rocks comprise the lowermost part of the Bonanza group and have an approximate thickness of 300 to 400 feet where they are exposed south of the mine. The Quatsino limestone grades rapidly into thin-bedded impure carbonaceous limestones, black calcareous argillites, argillites, and tuffaceous argillites. This lower sedimentary unit of the Bonanza group is not present in all parts of the area. Overlying the sediments is a thick series of pyroclastic rocks, the top of which is not exposed in the area. The division between the sedimentary and volcanic units of the Bonanza group is somewhat arbitrary as the contact appears gradational, although no complete exposures were seen in the field. The predominance of volcanic or normal sedimentary rocks is the basis for separation. The volcanic unit is composed of tuffs and agglomerates with some lava flows. Tuffs are predominantly brown, green and greenish-grey, or purple; minor amounts are creamy grey with a cherty texture. Agglomerates are abundant, some of the fragments ranging in size up to a foot across. Flow rocks occur in limited amounts. There are some exposures of a distinctive feldspar porphyry flow rock which contains amygdules. At the base of the volcanic sequence a coarse limy agglomerate was observed, very similar to that described in a similar stratigraphic position in the Zeballos area by Hoadley (1953).

Throughout the Vancouver group, and especially in the volcanic units, numerous fine-grained green rocks occur as dykes, sills, and irregular intrusive bodies. In most places they are similar to the rocks which they invade, and field identification in limited exposures is difficult.

To the west of the Empire mine the Vancouver group rocks are intruded by a large crystalline igneous mass. Exposures show contacts with the Quatsino formation and the Bonanza group, but there are no surface contacts with the Karmutsen group rocks. In other reports this intrusive mass has been referred to as the Coast Copper stock from its proximity to the orebodies in the Old Sport mine (Coast Copper Company Limited), which lie about 2 miles to the north of the Empire mine. The Coast Copper stock is similar to the igneous rocks of the Coast Range.

Recent mapping has shown that the Coast Copper stock is composed of diorite and monzonite. The more easterly part, nearest to the Empire mine, is a narrow elongated mass extending north and south. Contacts dip steeply outward, ranging from near vertical to about 50 degrees east at the mine. The rock ranges in colour

from white to grey, and the more basic parts are dark greenish-grey. The composition changes from place to place, but in general the rock is a diorite with gabbroic phases. Remnants of metamorphosed volcanic rocks of the Bonanza group are included within the stock.

Lying farther to the west and partly separated from the diorite-gabbro by a large mass of Bonanza group volcanics is another intrusive phase of the Coast Copper stock. This rock is pink or pinkish-brown monzonite occurring as an elongated mass trending northwest. Contacts with the diorite-gabbro show rapid gradation but have not revealed a clear age relationship. The only evidence suggesting a later age for the pink monzonite is that it contains abundant inclusions, some of which appear to be dioritic in composition.

The Vancouver group rocks within the region form a monoclinal sequence with an over-all northwest strike and a dip of about 30 degrees southwest. Apart from minor rolls and undulations indicated by variations in strike and dip, there are no major fold structures within the area. The Coast Copper stock has caused some local folding and bending in adjacent bedded rocks.

Faults can be divided into two groups. The major displacements occur on faults striking north at a small angle to the strike of the beds. These are apparently normal faults, and within the district they produce repetition of the Quatsino limestone at the surface. Faults of the other set range in strike from east to northeast and have been recognized in detailed work in the vicinity of the orebodies. They are not as persistent as the northerly striking faults, and displacements have been small. In some cases they have caused the development of deep gullies and ravines in the drainage pattern, but otherwise such faults are not readily detected.

Local Geology

The geological setting of the magnetite orebodies of Empire Development Company Limited is similar to that of many other magnetite showings along the British Columbia coast. Magnetite is present in limestone and volcanic rocks where they both occur close to the margins of the Coast Copper stock. The distribution of these rocks and the magnetite exposures are shown on the accompanying geological map (*see* Fig 9).

Bedded Quatsino limestone strikes generally west of north and dips southwest, with moderate variations in strike and dip. The most prominent change is a northeast strike around a bulge of the Coast Copper diorite-gabbro protruding to the east, in the vicinity of the Merry Widow and Kingfisher orebodies. The orebodies are emplaced where the bedding strike tends to coincide with the northeast strike of steep southeasterly dipping faults. There are other magnetite exposures in the area, but investigation has shown so far that they are small and sporadic. Superimposed on the over-all attitude of the limestone are rolls and gentle folds with dip variations of the order of 10 to 15 degrees. Limited exposure in the Merry Widow pit and evidence from diamond drilling suggests that the limestone is locally more severely folded. To the north, in the vicinity of the Shamrock (Lot 1492) and Blackjack (Lot 1498) showings, there are very steep dips where the limestone is adjacent to the intrusive.

Bonanza group rocks overlie the limestone and occur as a discontinuous rim around the edge of the Coast Copper stock. These rocks consist of metamorphosed volcanic agglomerates, tuffs, and flows. Other than in exposures of agglomerate with clear textural features, the rocks are dense, fine grained, and green, with little evidence of structure, and are hard to distinguish from abundant intrusive rocks in the area. The few bedding attitudes observed conform to the general structure, with

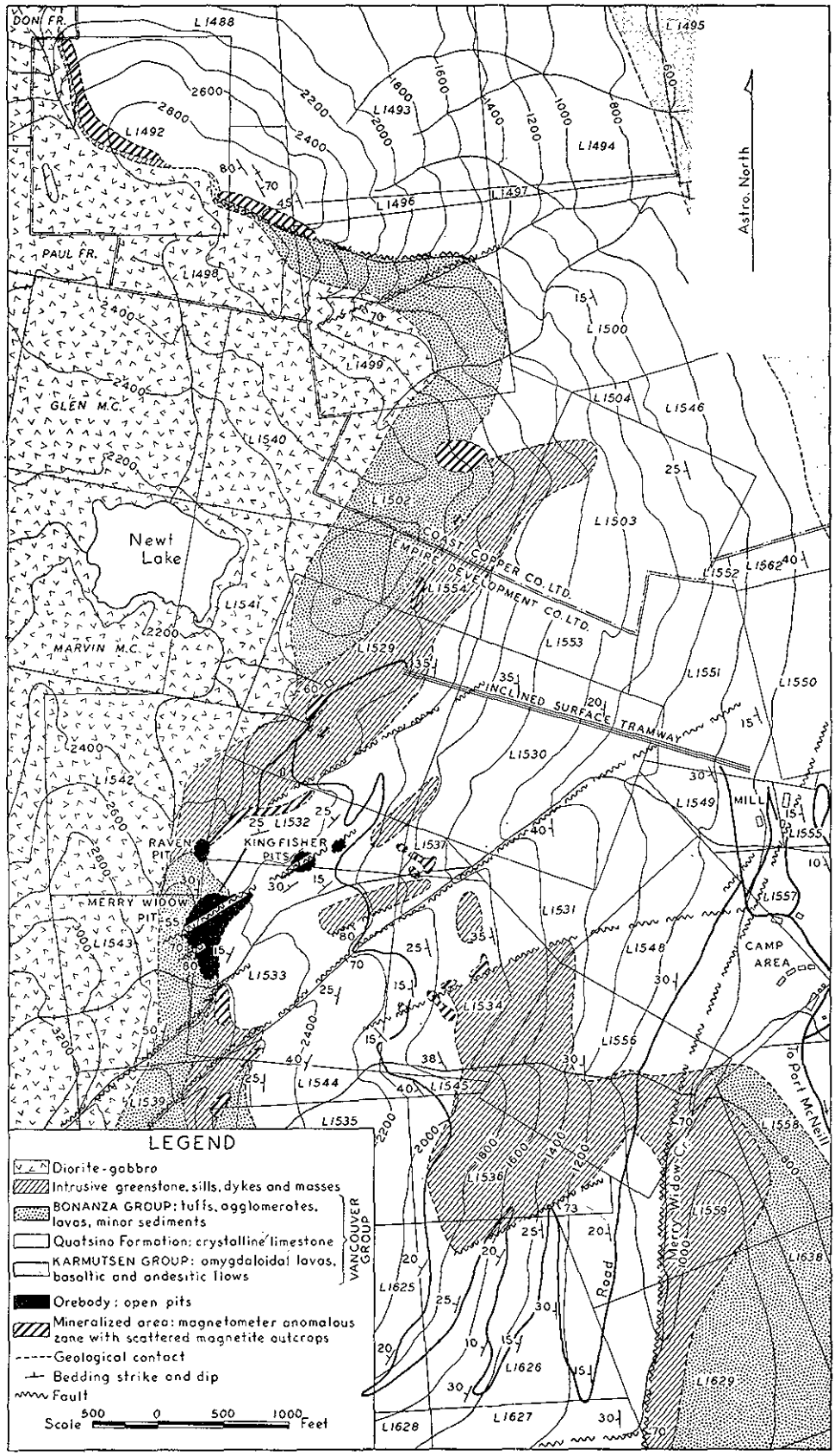


Figure 9. Empire Development Company Limited. Geology in the general vicinity of the mine workings.

moderate dips to the west. The headwall of the Merry Widow pit exposes Bonanza rocks with a uniformly massive character and commonly no trace of bedding, that could well be considered as intrusive were it not for the fact that development occasionally reveals relict bedding, mainly as a colour banding ranging from dark green to cream. Where these rocks occur close to the diorite intrusive, they are altered to a pyroxene-plagioclase gneiss. Under the microscope the green host rock adjacent to the Merry Widow orebody exhibits a fluid texture, with laths of plagioclase feldspar in places flowing round a rare feldspar phenocryst.

The Coast Copper stock intrudes the limestone and volcanic rocks, along a contact that trends roughly northward close to the mine orebodies. In composition this intrusion is essentially diorite, but in places there are dark gabbroic phases. In most places the dip of the contact is steep, ranging from 90 to 70 degrees outward to the east. However, where the contact lies west of the Merry Widow pit, diamond drilling and recent development show that the contact dips 55 degrees east. Close to areas of magnetite mineralization the margins of the intrusive stock contain magnetite grains disseminated through the crystalline fabric. Contact metamorphic effects on the limestone appear to be almost wholly those of recrystallization, and such limestone has a coarse sugary grain and is friable where weathered. The fresh rock is a white marble. Close to the diorite the volcanic rocks are metamorphosed, the main effect being an obliteration of bedding features. Intrusion of the diorite stock appears to have caused some minor folding in the limestone along the margins, but no broad-scale disruption of the beds has been observed.

In part, the intrusive green volcanic rocks (greenstones) are thought to represent an intrusive phase of the vulcanism which deposited the Bonanza group pyroclastics. The larger bodies are shown in Figure 9, but there are numerous dykes and sills, often with crosscutting relationships, throughout the Quatsino limestone and Bonanza volcanic rocks. These rocks are dense, fine grained, vary in colour from light greyish-green to dark green, and have a variety of compositions. On the tote-road, exposures of a large body of greenstone are of andesitic rocks composed of a felted mass of plagioclase and ragged amphibole.

North of the pits the road close to the mine warehouse exposes a number of fine- and medium-grained intrusive rocks. Greyish-green andesite is cut and brecciated by a very fine-grained rock which is composed almost wholly of equigranular quartz and potash feldspar, and which may be termed alaskite. This produces a very distinctive texture, as the edges of all the brecciated fragments are bleached white by the alaskite, but the only mineralogical change seen microscopically is a reduction in the amount of opaque iron minerals. The alaskite also cuts a diabase porphyry rock, and is in turn cut by fine-grained basaltic trap dykes and another basaltic porphyry which is very similar in appearance to the diabase. Close to these exposures the green intrusives are cut by granodiorite, which has been termed microdiorite in the field, and which is almost certainly an apophysis of the diorite-gabbro stock. The mine workings have exposed granitic and quartz diorite dykes with a typical aplitic sugary texture.

Within the magnetite orebodies, some dyke rocks were seen with inconclusive post-ore relationships. An example is an altered diabase in the Raven pit. Other dykes definitely post-ore in age were observed. In the Merry Widow pit, a fine-grained basaltic dyke with abundant chlorite cuts massive magnetite with smooth polished walls. In the Kingfisher pit a very fine-grained banded dark-green post-ore dyke is composed of chlorite with some sericite, epidote, and calcite.

Faults are numerous in the vicinity of the mine. Two sets are described above. A north-striking fault follows the bed of Merry Widow Creek for part of its course, and has caused repetition of the Quatsino limestone to the east. Along and in the

vicinity of this fault, small showings of copper and iron sulphides and cobalt bloom have been observed, but the fault is remote from the present orebodies and from many other showings, and appears to have no structural connection with them.

The east- to northeast-trending faults are numerous in the vicinity of the orebodies. All have steep southerly dips. Movements on them have been negligible or small, and, unless exposed by creeks which tend to form deep gullies along them, their surface expression as seen in the open pits is not very extensive. One fault crosses the tote-road south of the Kingfisher pits and forms a steep-sided gully. Individual limestone beds on either side of the fault can be matched. Farther down the creek the movement has been of the order of some tens of feet. There is field evidence that at least part of the movement on these faults took place after emplacement of the diorite-gabbro stock. Exposures in a creek within the diorite in the northern part of the map-area show a brown sheared and fractured zone about 9 inches wide containing lenses and stringers of quartz.

In addition to the steeply dipping faults, the Kingfisher pit reveals evidence of movement along the bedding planes in the limestone. The plane of movement lies along the base of a sill, which dips 20 to 25 degrees west, and contains green clayey gouge and slickensides, indicating an overthrust of the hangingwall to the northeast. In the hangingwall, breccia, containing matching fragments of skarny green sill rock with selvedges of magnetite and chlorite, is healed by coarsely crystalline calcite. Other pods of coarse crystalline calcite with associated magnetite occur in the footwall of the thrust. Excavation has revealed that magnetite occurs down dip under this horizon, proving that either the thrust or the sill was a structure controlling ore emplacement.

Other evidence of movement, not fully revealed by the texture of the limestone, includes boudinage structures seen in some sills, and fragments of dyke rocks separated by gaps of 6 inches to several feet. Close examination shows flow structures in the limestone which fills such breaks.

Orebodies

The Merry Widow and Kingfisher orebodies have been the major source of ore, with the Raven pit providing minor amounts in 1960. The Kingfisher orebodies are now worked out, and all production is from the Merry Widow pit.

In the Merry Widow orebody, magnetite ore occurs as sheets or lenses, with irregularities, which lie within Bonanza volcanic rocks adjacent to the limestone contact. The attitude of these magnetite layers is parallel to the intrusive contact, dipping approximately 55 degrees east.

There are two Kingfisher orebodies, on which are the Kingfisher Central and Kingfisher East pits. The terminology was derived from the initial magnetometric work which outlined an elongated anomalous zone with three wider parts. Orebodies were found under the central and easterly of these three bulges, but no ore was found to underlie the western end of the anomaly. Both orebodies are wholly contained within the limestone, and are very steeply plunging pipes of magnetite, nearly circular in cross-section. The central pit is between 150 and 200 feet in diameter, and the east pit is approximately 100 feet in diameter. They have been worked to depths of about 300 feet, as access has been possible from the side of the steep slope on which they are situated. They now have been abandoned, as economic limits controlled by access, drainage, and waste-to-ore ratio have been reached. Diamond drilling has shown that the two orebodies merge below the present floors and then fade, so that there remains only a relatively small tonnage of magnetite. These pits have provided 419,460 tons of ore.

The Raven orebody is a part of an elongated mineralized zone of disseminated magnetite that probably lies along a fault. The ore opened up at the western end is fine-grained massive magnetite which is about 70 feet wide and appears to extend in a northerly direction.

In the ore zones, magnetite varies from massive to disseminated. Where enclosed in limestone, the ore tends to be massive, with sharp clean contacts with the host rock, whereas contacts with both extrusive and intrusive volcanic rocks are gradational in character. Due to this fact, the exposures in the Kingfisher pits have revealed more distinct relationships of ore with host rock than in the Merry Widow pit.

Bedding structures can, in places, be traced into the magnetite, and the ore has been observed to pass outward into stringers which lie along bedding planes and follow dykes and sills in the limestone. A number of minor showings in the region consist of thin selvedges of magnetite along intrustive volcanic rock contacts.

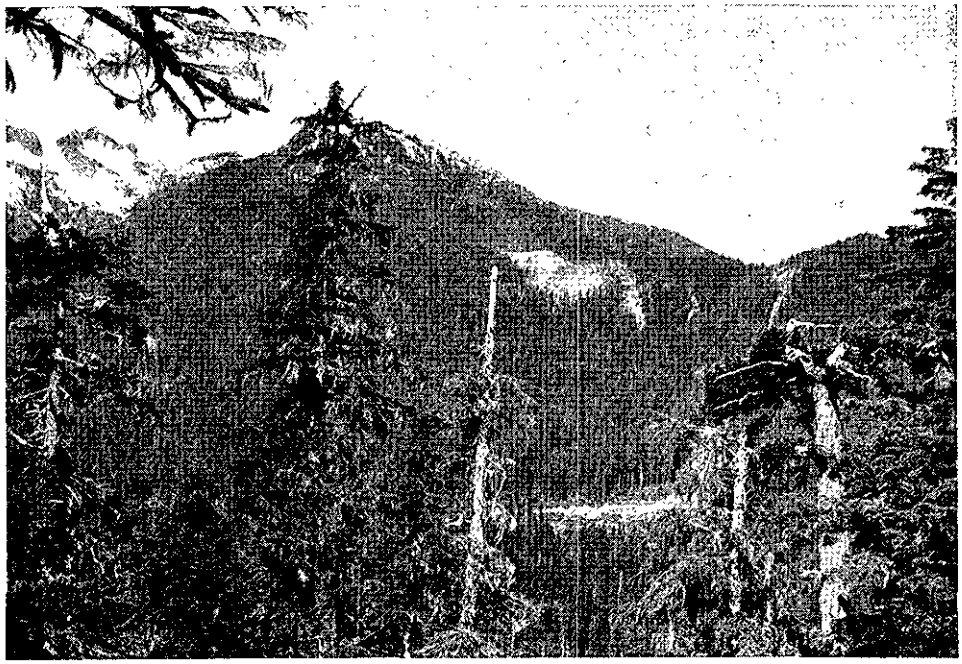
Magnetite with a coarse mammillary texture has been found amongst broken ore in the Kingfisher pits, and also in broken ore in the Merry Widow orebody where it is enclosed by limestone. The nodules exhibit smoothly "crackled" intersecting faces. Sections through the nodules show a radiating structure and a concentric banding. The bands appear to be related to grain size as the outer layers are thin, fine grained, and dense, whereas at the centre of any one nodule the magnetite is coarser and the banding is wider and less prominent. The hollows between the nodules are commonly filled with coarsely crystalline friable magnetite. The writer has not seen examples of such mammillary structure in place.

Mammillary surfaces and associated radiating and concentric banded structures are termed colloform textures. The curved surfaces are thought to be the result of surface tension effects and therefore represent a colloidal or gel origin. The curvature is convex toward the younger or free surface. The finer grain near the surface indicates that crystallization proceeded from the free surface inward. Colloform textures are thought to indicate deposition at low temperatures and low pressures, and rapid precipitation is known to promote gel formation.

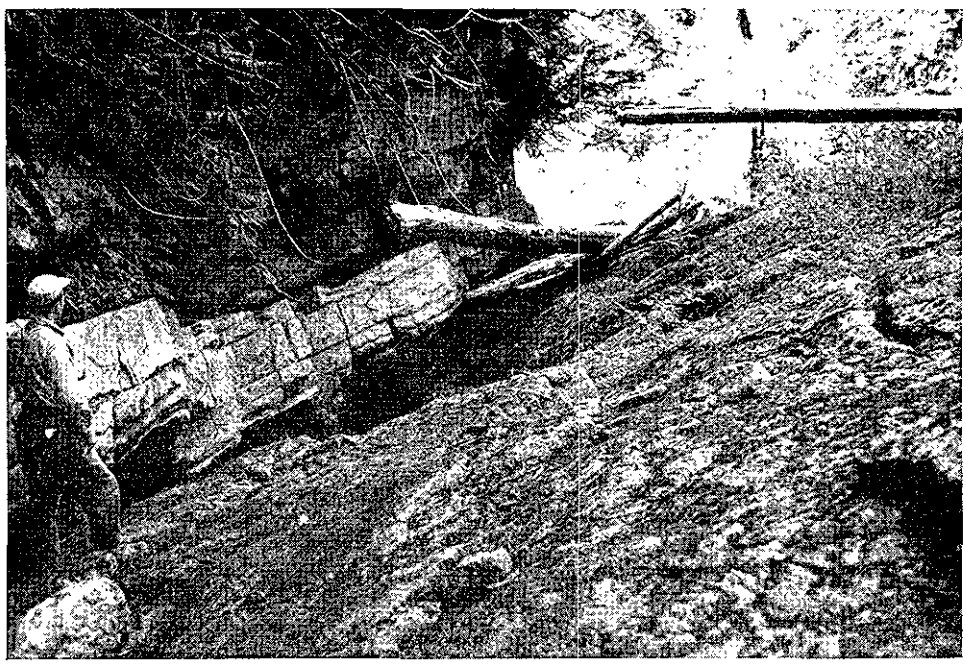
Colloform texture is known in many minerals, and frequently the deposits are in limestone, but, to the writer's knowledge, colloform magnetite has not been described previously. The texture implies that the formation of magnetite took place in open space fillings at low pressures. Colloform magnetite has only been found where the host rock is limestone. The solubility of limestone may have allowed the rapid enlargement of openings, and thus allowed an equally rapid deposition of iron oxides. Alternatively, the effect of the limestone may have been to neutralize acid solutions, although if that were so one would expect colloform magnetite to be more widespread in distribution.

Banded ore, showing as variations in the size of magnetite grains and the amounts of dark-green chlorite and white calcite associated with the magnetite, was observed in parts of the orebodies.

Minor amounts of pyrite, chalcopyrite, and pyrrhotite are distributed throughout the orebodies, in places accompanied by quartz. As has been noted in other accounts of the Coastal "contact metamorphic" deposits, the sulphides appear to be later in age than the magnetite mineralization. Development of the Raven pit disclosed a substantial body of sulphides on the east side of the magnetite zone. The dominant mineral is pyrrhotite with lesser chalcopyrite and pyrite. Veins of crystalline sphalerite and calcite cut across the massive pyrrhotite. Small amounts of crystalline arsenopyrite have been found in the Merry Widow orebody, with calcite, pyrrhotite, and chalcopyrite.



Empire Development Company Limited. Open pits at 2,500 feet elevation connected by tramline (partly hidden on right) with mine camp in Benson River valley. Merry Widow Peak, 4,600 feet elevation, on far left.



Quatsino limestone conformably overlying amygdaloidal flows of the Karmutsen group.

Brown garnet, epidote, actinolite, and chlorite are the skarn minerals which, together with calcite and small amounts of pinkish-red microcline, are found throughout the magnetite masses, at the margins of orebodies, as isolated masses, and as selvedges along the margins of dykes and sills. The skarn mineralization and masses of unreplaced host rock form the gangue of the ore zones. Crosscutting relationships shown by veinlets indicate that magnetite, together with calcite and some epidote, is later in age than the massive garnet and epidote skarn.

Bluish-green actinolite crystals, largely converted to calcite, in many places occur with the late crystalline calcite. Rarely, open vugs containing clear calcite were found.

The Merry Widow orebody is a contact metasomatic magnetite deposit and appears to be the result of successive mineralizing periods of silicates, oxides, sulphides, and carbonate, which have replaced volcanic rocks immediately adjoining both the Coast Copper stock and limestone. The orebodies are developed where the intrusive contact has the lowest dip in the locality, and also where a bulge in the intrusive has caused a change in the strike of the bedded rocks. These appear to be the dominant structural controls, but formation of the deposit may have been assisted by a local concentration of faults with northeasterly strikes and southerly dips.

The structural effect of the intrusive stock on the Kingfisher deposits is less clear. The most important control appears to be the northeasterly striking fault which extends along strike from the Merry Widow pit, but the reason for the location along this fault plane remains unknown. The shape of the ore zones and their fusion at depth implies that mineralizing solutions ascended from an underlying source.

Areas with anomalous magnetometer readings and small magnetite exposures are shown on Figure 9. Investigation by Empire Development company has shown that most do not constitute ore.

Two of the larger anomalous areas (Blackjack, Lot 1498, and Shamrock, Lot 1492) were investigated with a diamond drill during the end of 1960. Scattered magnetite outcrops in coarsely crystalline friable limestone and accompanying anomalous magnetometer readings were distributed over two narrow zones about 100 feet wide and about 800 feet and 1,200 feet long.

These magnetite showings lie on the north side of the large bulge in the Coast Copper stock, and they are separated by a smaller bulge in the outline of the intrusive. Steep dips in nearby limestone outcrops suggest local severe folding. The position and attitude of some of the magnetite outcrops indicate that structural control of ore location involves the attitude of the intrusive, fold structures and bedding in the limestone.

An interesting specimen was collected from an outcrop in the Shamrock showing which exposes magnetite 3 feet thick interbedded in coarse crystalline limestone dipping 20 degrees west, and exposed over a distance of about 25 feet. Part of this outcrop showed a finely banded texture with uniform layers of magnetite one thirty-secondth of an inch wide separated on the weathered surface by gaps about half this wide, possibly where thin layers of carbonate had weathered out. This layering exhibits apparent fold structures a few inches in size. The layers tend to fuse on some parts of the folds. No similar thin layering was observable in the surrounding limestone. The unbroken and consistent nature of the magnetite lamellæ indicates that the magnetite replaced a fossil algal structure, or, less likely, a slump structure in a finely bedded sediment, but there is no evidence of rocks with either of these features in the vicinity. If such structures had existed in the limestone

and had been obliterated by contact metamorphism, that would imply that magnetite formation occurred prior to emplacement of the intrusive rock. There remains the possibility that these magnetite laminations may be a form of colloform texture.

[References: Gunning, H. C., *Geol. Surv., Canada,* Sum. Rept., 1929, Pt. A, p. 94; Bacon, W. R., *Minister of Mines, B.C.,* Ann. Rept., 1952, p. A 228; Hoadley, J. W., *Geol. Surv. Canada,* Mem. 272, 1953.]

Copper

Old Sport (Coast Copper Company, Limited)

Company office, Tadanac; mine office, Port McNeill. H. G. Barker, property superintendent. This property consists of forty-eight Crown-granted claims, situated on the southern shore of Benson Lake and southward along the valley of the Benson River. After a long history of development, work commenced in 1960 to bring the mine into production. As no information has been published since 1931 apart from the recording of 5,456 feet of diamond drilling in 1956, the following will serve as a brief résumé of the history and geological setting of this copper deposit.

The claims were developed from 1911 onward, and control changed hands several times. In 1916 The Consolidated Mining and Smelting Company of Canada, Limited, assumed control and organized the present company. Apart from a period of inactivity in 1921 and 1922, development continued until 1931, when economic conditions forced the closure of operations. At that time, development included about 5 miles of underground workings and many thousands of feet of diamond drilling. There was an established camp, a hydro-electric generating system on the Raging River that provided all power, including that required for underground haulage, and a good road and water connection to Jeune Landing at tidewater on the west coast of Vancouver Island. Following 1931 these assets fell into decay.

The decision to reopen the mine has been aided by the recent demand for minerals by Japan, and by the existence of a good 25-mile road running from Port McNeill to the workings of Empire Development, lying approximately 2 miles to the south of the Coast Copper deposit. Rehabilitation of the camp and the building of 1½ miles of road to the mine-site were completed in the second half of 1960. At the end of the year fifteen men were employed.

Local relief is of the order of 2,500 feet and annual rainfall is over 100 inches.

In the vicinity of the Old Sport mine a thick series of basic volcanic rocks (Karmutsen group) is overlain by Upper Triassic limestone (Quatsino formation), and these rocks are covered by a sequence of dominantly pyroclastic rocks (Bonanza group). The whole is usually referred to as the Vancouver group. These rocks are intruded by an irregular body of igneous rock which varies in composition from gabbro to quartz diorite. Because of its similarity to the Coast Range batholiths, this is usually classified as a Coast Range intrusion, and has been termed the Coast Copper stock.

The bedded rocks occur as a monoclinal sequence, striking west of north and dipping about 30 degrees southwest. Over a much larger region there is evidence that the rocks are part of a broad fold structure, and that the Old Sport mine is on one limb of a large open fold. Within the local monoclinal sequence, local variations in dip and strike signify gentle rolls and undulations in any one horizon. Faults are widespread and can be divided into two groups. Those showing most displacement strike north at a slight angle to the strike of the beds. They are apparently normal faults and have caused repetition of beds in the outcrops. Faults of the other set have a strike ranging from east through northeast and generally do

not appear to have caused much displacement. The intrusive contact has a dip ranging between near vertical and about 50 degrees to the east (outward). In the vicinity of the mine, interpolation between the surface and a drill-hole to the intrusive from the workings shows an over-all dip of 72 degrees outward over a vertical range of 3,200 feet.

The orebodies at the Old Sport mine occur at the contact of the limestone with the underlying volcanic rocks. The zone dips about 37 degrees southwest toward the easterly dipping intrusive contact. The mineralized zone is divided in many places into a hangingwall and a footwall section by a dark volcanic rock which has previously been termed the " included diorite." To date there is no proof as to whether this is a flow rock or intrusive. The hangingwall section of the ore, lying above the included diorite, is not present everywhere. The main mineralization occurs between the " included diorite " and andesite flows of the volcanic rocks, but replacement in the mineralized zone has proceeded to such an extent that it is difficult to establish how much of the host rock was limestone and how much was volcanic.

Faulting is widespread throughout the mine, but displacements do not amount to more than a few feet in most places, and there are long stretches where there is little or no important faulting.

The ore zone consists mainly of garnet, epidote, magnetite, and calcite, with chalcopyrite and bornite occurring as veins, lenses, and disseminations in the silicates and magnetite. There are also lesser amounts of amphibole, chlorite, quartz, pyrrhotite, and pyrite.

The mine has been developed on the fifth, seventh, eighth, tenth, twelfth, fourteenth, and sixteenth levels, with a level interval of 200 feet except for Nos. 7 and 8 levels, which are 100 feet apart. Nos. 5 and 8 levels are connected to the surface by adits, and the other levels are served by internal inclined shafts. No. 5 level is about 800 feet above sea-level, and the maximum extent of development along strike is of the order of 6,000 feet.

[References: Dolmage, V., *Geol. Surv., Canada,* Sum. Rept., 1918, Pt. B; Gunning, H. C., *Geol. Surv., Canada,* Sum. Rept., 1929, Pt. A; *Minister of Mines, B.C.,* Ann. Repts., 1911 to 1931, 1956.]

Nimpkish Lake (50° 126° S.W.)*

Iron

Nimpkish, Klaanch, etc. (Nimpkish Iron Mines Ltd.)

Company office, 205, 850 West Hastings Street, Vancouver 1; mine office, Camp A, Beaver Cove. S. V. Wines, project manager; D. Burns, mine superintendent; R. Bick, mill superintendent. Mining and ore-treatment operations are described in the Annual Report for 1959, page 134. Statistics for 1960: Ore mined, 480,000 tons; waste stripped, 163,265 solid cubic yards; concentrate shipped, 283,000 tons. The average number of men employed was fifty-five.

Magnetite was discovered in the area in 1897, and the deposits were reported on by E. Lindeman in 1910, who drew a magnetic map which fairly accurately indicates the orebodies now being mined on the Iron Crown claim (Lot 126).

The Iron Crown claim lies about 5 miles south of the southern end of Nimpkish Lake on the southwest bank of the Nimpkish River, and south of the junction of the river and Mukwilla Creek. On the opposite side of the Nimpkish River a creek flows from a small lake into the river.

* By W. G. Jeffery.

The regional geology has been described by Gunning (1930–1933) and Hoadley (1953). In the vicinity of Nimpkish Iron Mines, basic volcanic rocks underlie crystalline limestone, and the contact between them trends northwest through the Iron Crown claim. The volcanic rocks have been intruded by rocks ranging in composition from monzonite to gabbro. The magnetite deposits lie within an embayment of the intrusive rock with tongues extending across the river to the north and south of the workings.

The valley of the Nimpkish River is less than 500 feet above sea-level, and is extensively covered with drift material, so that natural outcrops are very scarce, apart from those occurring along the river banks. Before the present operations began, magnetite was observed on the southwest river bank over a length of 180 feet, forming cliffs 25 to 30 feet high. Smaller outcrops of magnetite were mapped at distances of 100 feet and 600 feet southwest from the river bank.

Diamond drilling and subsequent excavation have proved the presence of four orebodies, which have been named the East, South, Road, and River. The developments have proved that the South and Road orebodies are connected by a neck of magnetite, and this entity constitutes the major source of ore. The East orebody is small. The River orebody is an extension of the river-bank exposure. The three large orebodies (River, Road, and South) are shaped like elongated basins with their long axes lying roughly parallel to the surface trace of the limestone-volcanic rock contact. Ore depths are as great as 200 feet, and the walls dip inward at angles of the order of 70 degrees.

The headwall of the main pit exposes massive crystalline limestone with no definite indication of bedding. Fracturing is noticeable in limestone adjacent to magnetite, and there is also much fractured, polished, and slickensided intrusive greenstone, some of which is basaltic.

The major part of the ore is enclosed within and intimately associated with greenstones, some of which are dykes and sills and some are rocks of the regional volcanic assemblage. Feldspar porphyry is abundant, with phenocrysts constituting from 5 to 20 per cent of the rock. In places there are a few amygdules, most of which contain calcite, but some are filled with epidote. A specimen taken from the river bank below the River orebody is composed of fine-grained hornblende with sericite, chlorite, and epidote distributed heterogeneously through the rock. A similar rock was taken from a drill-hole below the River orebody, but these rocks are so close to the ore deposit and the intrusive contact that metamorphism and alteration have been extensive.

Exposures of granitic rock occur in the river both up and downstream from the ore zone, and also within the ore zone itself. Upstream from the mine the intrusive is quartz monzonite, a coarse-grained rock with large anhedral quartz grains, andesine, potash feldspar, and green hornblende largely altered to biotite and chlorite.

Within the ore zone, diorite occurs as a plug between the South and Road orebodies, and there are small exposures in the River open pit. Downstream, steep walls of diorite are exposed where the intrusive extends across the river. The attitude of the diorite contact in the vicinity of the iron deposits is not known, but the intrusive plug in the ore zone must have steeply dipping contacts.

The ore is composed of magnetite with minor copper and iron sulphides, skarn minerals such as calcite, chlorite, epidote, and garnet, and included fragments of country rock. Skarn is mostly developed in the greenstone areas of the pits. Close to the limestone-magnetite contact, masses of coarsely crystalline pyroxene intergrown with magnetite were picked up from the broken ore, although this material was not seen in place. The small East orebody is mostly enclosed with limestone, and contacts are sharp and well defined. Crystalline garnet, in places up to one-half

inch across, is disseminated through the limestone close to the magnetite, and also in steeply dipping bands traceable for distances of 1 to 2 feet.

The magnetite is dense and fine grained, and small amounts of pyrite, pyrrhotite, and chalcopyrite are found as irregular masses throughout the ore. All these sulphides have been found forming a lamellar pattern within magnetite, in occurrences close to the limestone contact. In one specimen, lamellar pyrrhotite and chalcopyrite were cut by a veinlet of pyrite, indicating that some of the pyrite is probably a part of later mineralization.

Magnetite in the River orebody forms an intrusive relationship with greenstone rocks, in places developing a brecciated greenstone cemented by iron ore. This in turn is cut by calcite veins, and where calcite is abundant it cements angular fragments of both greenstone and magnetite. Parts of the River orebody contain magnetite fragments with rims of pyrite surrounded by coarsely crystalline calcite. Much of the late calcite is associated with euhedral cubes of pyrite. Brown sphalerite set in calcite was also observed by the writer.

A structural feature in the ore is the intersection of the magnetite by numerous slip planes, commonly well polished and often with chlorite developed along them. The slip planes are randomly oriented and movements were probably small, but they are indicative of some post-ore disturbances. Additional evidence of post-ore activity is indicated by the occurrence of dykes cutting through the magnetite. One rock exposure with somewhat debatable relationships is composed of fine-grained quartz, mica, and chlorite with scattered grains of pyrite, and may be termed an alaskite dyke. Another observation was of a dyke cutting cleanly through massive magnetite in the River orebody and exposing smooth, polished, and slickensided walls. The rock is a feldspar porphyry with a basaltic matrix now extensively altered.

Exposures to date have revealed that this deposit is in a similar environment to other magnetite deposits along the west coast. It appears to be genetically related to the diorite intrusion, adjacent limestone and volcanic rocks, and possibly to faulting.

[References: Lindeman, E., Iron Ore Deposits of Vancouver and Texada Islands, B.C., *Canada Dept. of Mines,* 1910; Gunning, H. C., *Geol. Surv., Canada,* Sum. Rept., 1929, 1931, 1932; Hoadley, J. W., *Geol. Surv., Canada,* Mem. 272, 1953.]

ZEBALLOS (50° 126° S.W.)*

Iron

F.L. (Zeballos Iron Mines Limited) Company office, Room 504, 850 West Hastings Street, Vancouver 1; mine office, Zeballos. A. H. Upton, president; F. E. Worthington, engineer-in-charge. This company, a subsidiary of International Iron Mines Limited, owns seven recorded claims and holds thirteen Crown-granted claims under lease from Ventures Limited and eighteen recorded claims under option from various owners, on the west side of Zeballos River on the west coast of Vancouver Island. The claims extend from the river mouth to a point 3 miles upstream to Blacksand Creek, astride which is an occurrence of magnetite.

The geology of the property is described in British Columbia Department of Mines Bulletin No. 27, page 125; in the Annual Report for 1952, page 231; and in Geological Survey of Canada Memoir 272, as the Ford Magnetite Deposit, page 66. The most complete published map accompanies Memoir 272 and is on a scale of 150 feet to the inch. In brief summary, the deposit occurs on a narrow southwest-

* By N. D. McKechnie and J. E. Merrett.

ward-striking lobe of sedimentary and volcanic rocks of the Quatsino and Bonanza formations that protrudes nearly across the Zeballos batholith. The magnetite bodies replace tuff beds and andesitic flows along their contact with a thick bed of underlying limestone. The magnetite is both massive and disseminated in a skarn derived mostly from the volcanic rocks. The structure is described as a southeastward plunging anticline, and the deposits are thought to be at or near the crest. Diamond drilling has shown that the large bodies of magnetite exposed at surface have limited extensions in depth.

In 1959 and 1960 an additional nineteen diamond-drill holes were drilled from surface; of these, ten drilled in 1960 totalled 2,765 feet. The distribution of the holes is shown on Figure 10. A section (Fig. 10) is drawn showing the distribution of magnetite in the 1959–60 holes and an interpretation of the intersections. The shallow depth of the magnetite as shown is confirmed by an old hole drilled just north of this section, diamond drill hole No. 6. It is shown on a section in the 1952 Annual Report.

A possible structural interpretation of the occurrence is offered. An association such as this of heterogeneous and comparatively thin-bedded volcanic rocks with a thick bed of limestone in a folded structure may produce dragfolds in the volcanic rocks. Fracture zones associated with the dragfolds could provide the channelways for the mineralizers to enter the formations and from which replacement by magnetite could take place. The magnetite bodies would be restricted to friable zones within the dragfolds. There would be possibilities of repetitions within a zone of dragfolding.

Since June, 1960, the construction contractors, Hunstone and Wood Limited, completed 3½ miles of truck-road from the Zeballos River road to the main magnetite outcrop at an elevation of 2,500 feet and completed 1,300 feet of gravel fill at the river mouth preparatory to constructing a road to the loading-dock site.

A right-of-way was cleared for an inclined surface tram extending from the main outcrop to the mill-site near the river.

Sayward (50° 125° S.W.)*

Iron

Iron Mike Office, c/o Caldwell and Hartt, R.R. 1, Campbell River. The Iron Mike group consists of seventeen claims held by record. It is about 4 miles southwest of Sayward and 3 miles west of the junction of the White and Salmon Rivers.

Work done on the claims at the time of the writer's visit in June consisted of stripping of magnetite showings on the Iron Tom, Iron Dick, Iron Mac, Iron Dan, and Iron Mike claims and a number of dip-needle traverses by R. B. Hartt, discoverer of the magnetite. Outcrops are scarce.

The rocks are limestones, basalts, and tuffs intruded by granitic rocks and gabbro. Magnetite occurs principally with the tuffs and is accompanied by skarn alteration. There is a spatial relationship to the gabbro.

The principal showings are near the boundary between the Iron Mac and Iron Jim claims. Massive magnetite is exposed to a depth of about 10 feet in one pit; grains and blocks of brown garnetite are included in the magnetite. Magnetite shows in various exposures to a point nearly half way across the Iron Mac. The continuity of magnetite between exposures is not known. Along the location-line between the Iron Tom and Iron Dick claims, magnetite shows in a succession of small pits for a distance of about 200 feet; again, continuity between exposures is

* By N. D. McKechnie.

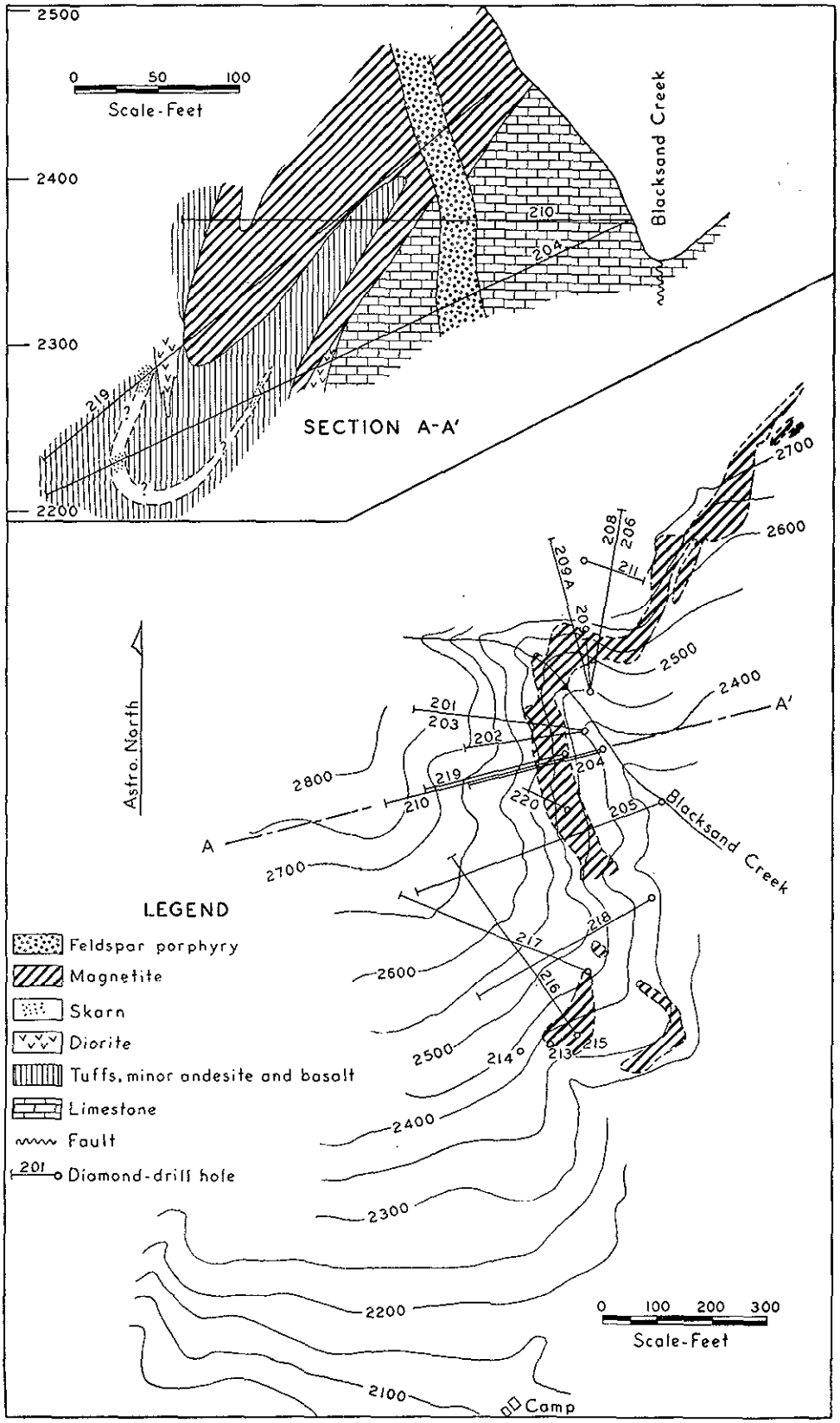


Figure 10. Zeballos Iron Mines Limited. Plan and cross-section of F.L. ore zone.

in doubt. On the Iron Mike and Iron Dan claims there are four exposures of veins and stringers of magnetite in garnetite in banded tuffaceous rocks; the distance between the first and last exposures is about a claim length.

Dip-needle readings taken by Mr. Hartt in the presence of the writer indicated areas of appreciable to strong magnetic attraction underlain by overburden, and in one instance limestone, on the Iron Herb, Iron Jim, Iron Milly, Iron Sue, and Iron Sally claims.

Nootka Sound (49° 126° N.W.)*

Iron

Hualpai Enterprises Ltd.—Operations at this property, 1 mile north of Head Bay on Nootka Sound, were suspended in January, with no ore having been shipped in 1960. The company assets were placed in the hands of a liquidator for disposal.

Herbert Inlet (49° 125° S.W.)*

Gold

Berton Gold Mines Limited

Company office, 610 Jervis Street, Vancouver 5; mine office, Herbert Inlet via Tofino. B. L. Clayton, president; J. C. Jackson, manager. This company owns twenty-one Crown-granted and two recorded mineral claims on the south slope of Abco Mountain at the head of Herbert Inlet on the west coast of Vancouver Island. The company formerly operating this property was known as Abco Mines Limited. Previous work on the property comprised extensive surface stripping on several vein occurrences and the driving of adits at elevations of 2,300 and 2,145 feet. Eighty-six tons of ore was shipped during the period 1935 to 1938.

A truck-road, 1½ miles long, extends from the camp and loading-dock at the mouth of Cotter Creek to a new adit commenced in 1960 at an elevation of 1,000 feet. The 1000 level adit was driven a distance of 450 feet northward along a strong shear zone. It was reported the adit had intersected a narrow quartz vein which followed the adit for a short distance. A crew of three men was employed.

Bedwell River (49° 125° S.W.)†

Gold

You (Tanar Gold Mines Ltd.)

Company office, 285 Seventeenth Street, West Vancouver; A. D. Ross, president. The property is on You Creek, a northwestward-flowing tributary of the Bedwell River and about 13 miles upstream from the head of Bedwell Sound. It consists of four Crown-granted mineral claims—Ex (Lot 1644), Ten (Lot 1645), You (Lot 1646), Eight (Lot 1647)—and twenty recorded claims—the D'Or 1 to 20. The principal showings are on the You claim on the steep northwest slope above You Creek at an elevation of about 2,000 feet.

Access is by chartered boat from Tofino to the head of Bedwell Sound. From there a truck-road, now in need of minor repair, traverses a distance of about 7½ miles to the old Musketeer mine, beyond which point the road deteriorates to a primitive trail which leads to the You workings.

The showings were first located in 1912 and Crown grants were obtained in 1921. In 1923 a small cyanide mill was installed; no figures on its production are available, but the remains suggest a capacity of about 5 tons per day.

Notes on the property appear in Annual Reports for the years 1913, 1915, 1916, 1917, 1921, 1922, 1929, 1930, 1932, and 1933; that in the 1921 Report is

* By J. E. Merrett.
† By N. D. McKechnie.

the most complete. H. Sargent describes the occurrence in detail in Bulletin No. 8, Preliminary Report on Bedwell River Area, 1940, pages 55–60. The geology of the region and the position of the Crown-granted claims are shown on the map accompanying Bulletin No. 13, Supplementary Report on Bedwell River Area, 1941.

The workings, essentially as described in Bulletin No. 8, consist of an upper drift adit 337 feet long, some trenching below this adit, and a lower drift adit about 7 feet long and 120 feet lower in elevation than the long adit. The portal of the upper adit is in the precipitous bed of a southward-flowing tributary of You Creek. Above the portal the vein is exposed at intervals in the creek bed.

The mineral occurrence is a gold-bearing quartz vein, with minor carbonate, which follows a shear in an andesite dyke in quartz diorite country rock. As exposed in the upper adit, the vein strikes north 60 degrees east and dips about 85 degrees northwest for 200 feet then swings to north 45 degrees east in strike and dips 80 to 85 degrees southeast. The dyke is 3 to 6 feet thick until, just beyond the swing in strike of the vein, it thickens to a maximum of about 12 feet, then thins again to 4 feet at the drift face. The vein follows the hangingwall of the dyke except at the thick section, where both walls of the vein are andesite. Gouge occurs alternately on either wall of the vein and, locally, on the footwall of the dyke. The vein quartz is well shattered and in places is easily removed with a hand-pick. The vein is seen to pinch out in trenches about half way between the two adits. At this point another quartz vein in the footwall of an andesite dyke is on the west or hangingwall side of the upper adit vein and about 6 feet from it. A narrow quartz vein striking north 74 degrees east and dipping 47 degrees northwest connects the two. At the lower end of the trench the andesite dyke pinches out. In the lower adit a vein on the footwall side of an andesite dyke dips 76 degrees northwest. It is not certain that this vein is continuous with the quartz last seen in the trench.

Vein widths in the upper adit range from 3 inches to nearly 2 feet; the average for the length of the drift is about 9 inches. Vein widths in the trenches are about 6 inches, and at the lower adit the width is 3.5 inches.

The quartz is erratically mineralized with sulphides which occur as thin bands and irregular masses. Pyrite, the most abundant sulphide, is the earliest, followed by chalcopyrite, sphalerite, and galena. No gold was seen.

No samples were taken by the writer. An assay section showing a composite of sampling results obtained at different times by several engineers was provided by the present company. Calculations by the writer indicated two higher-grade gold sections in the upper adit; the first, starting just inside the portal, averaged 3.48 ounces per ton over a width of 7.6 inches, or 0.73 ounce over 3 feet, for a length of 47.5 feet; the second, starting 145 feet from the portal, averaged 1.84 ounces over a width of 10.2 inches, or 0.52 ounce over a width of 3 feet, for a length of 108 feet.

An indication of a possible rake of shoots in the You vein is given by the calculated orientation of the intersection between the main vein and the small connecting vein exposed in the trenches, assuming the two veins to be parts of the same fracture system. This calculated orientation implies a rake of about 20 degrees northeast. Correlation of the higher-grade sections in the adit with higher-grade sections in the creek-bed exposures above the adit indicates a possible rake slightly flatter to the northeast.

Four men were employed for a period of one month surface stripping the vein.

Tranquil Inlet (49° 125° S.W.)*

Gold

Tofino Mines Limited

This property, 2½ miles north of Tranquil Inlet on the west coast of Vancouver Island, is owned by Moneta Porcupine Mines, Limited, and was under lease to Allied Mining Services Limited, Room 26, 425 Howe Street, Vancouver 1. David A. Sloan, manager. A crew of three men was employed for a two-month period completing the driving of 35 feet of raise, retimbering 165 feet of raise, and mining 200 tons of ore between the 15th and 17th levels. Of the 200 tons mined, 53 tons was milled in a 3- by 4-foot Marcy grate-type ball mill. Work was discontinued in November.

Kennedy Lake (49° 125° S.E.)†

Iron

Kennedy Lake Iron (Noranda Exploration Company, Limited)

British Columbia office, 202, 2256 West Twelfth Avenue, Vancouver 9; mine office, Ucluelet. J. R. Billingsley, mine manager. This company, a wholly owned subsidiary of Noranda Mines, Limited, owns eight recorded claims and holds by option twenty-five recorded claims on Draw Creek between Maggie and Kennedy Lakes, 7 miles east of Ucluelet on the west coast of Vancouver Island. Access to the property is by way of 2½ miles of MacMillan, Bloedel and Powell River Limited logging-road from the shore of Kennedy Lake on the Alberni–Tofino road, approximately 10 miles from the Tofino–Ucluelet road.

The occurrence of magnetite in the vicinity of Draw Creek was first mentioned by W. Fleet Robertson in the 1902 Annual Report, page 210, in the section entitled "The Iron Ores of the Coast." Draw Creek is referred to as "Magnetic Creek," and the report states that "magnetic iron and a strong local magnetic attraction had been reported on Magnetic Creek. . . ." The creek bed was examined for float, but none was found, nor was magnetite found in place. In the light of recent developments, the following sentence is interesting: "While no magnetite could be found at any point on the creek, a rather remarkable magnetic attraction was observed at a point about 4 miles up the stream, which may possibly be caused by a body of ore under the surface and as yet unexposed." In the summer of 1907 a study was made of iron deposits on Vancouver and Texada Islands, and the results were published in Publication No. 47, Mines Branch, Ottawa, 1909. On page 16 it is noted that work done on Magnetic Creek, 4 miles from Maggie Lake, had failed to expose bedrock, but the presence of a strong magnetic attraction was verified. The property was relocated in January, 1960, by E. Chase, who carried out dip-needle surveys in the same magnetic area.

Preliminary diamond drilling was started in March and continued after Noranda Exploration Company, Limited, took over the property in May. A total of 22,542 feet of diamond drilling, principally of AX core size, was completed in eighty holes.

There is no map of the geology of the area. The magnetite is shown by diamond drilling to lie in a series of limestone and volcanic rocks, chiefly tuffs, presumably of the Vancouver group. The rocks show degrees of alteration to serpentine, metamorphic pyroxenite, and epidote-garnet skarn; silicification is general though not intense. The limestones are recrystallized. Chrome garnet was recognized in one thin-section of a skarn rock. The limestone-volcanic series is intruded by syenite porphyry and dioritic rocks. Magnetite is found in both limestone and volcanic

* By J. E. Merrett.
† By J. E. Merrett and N. D. McKechnie.

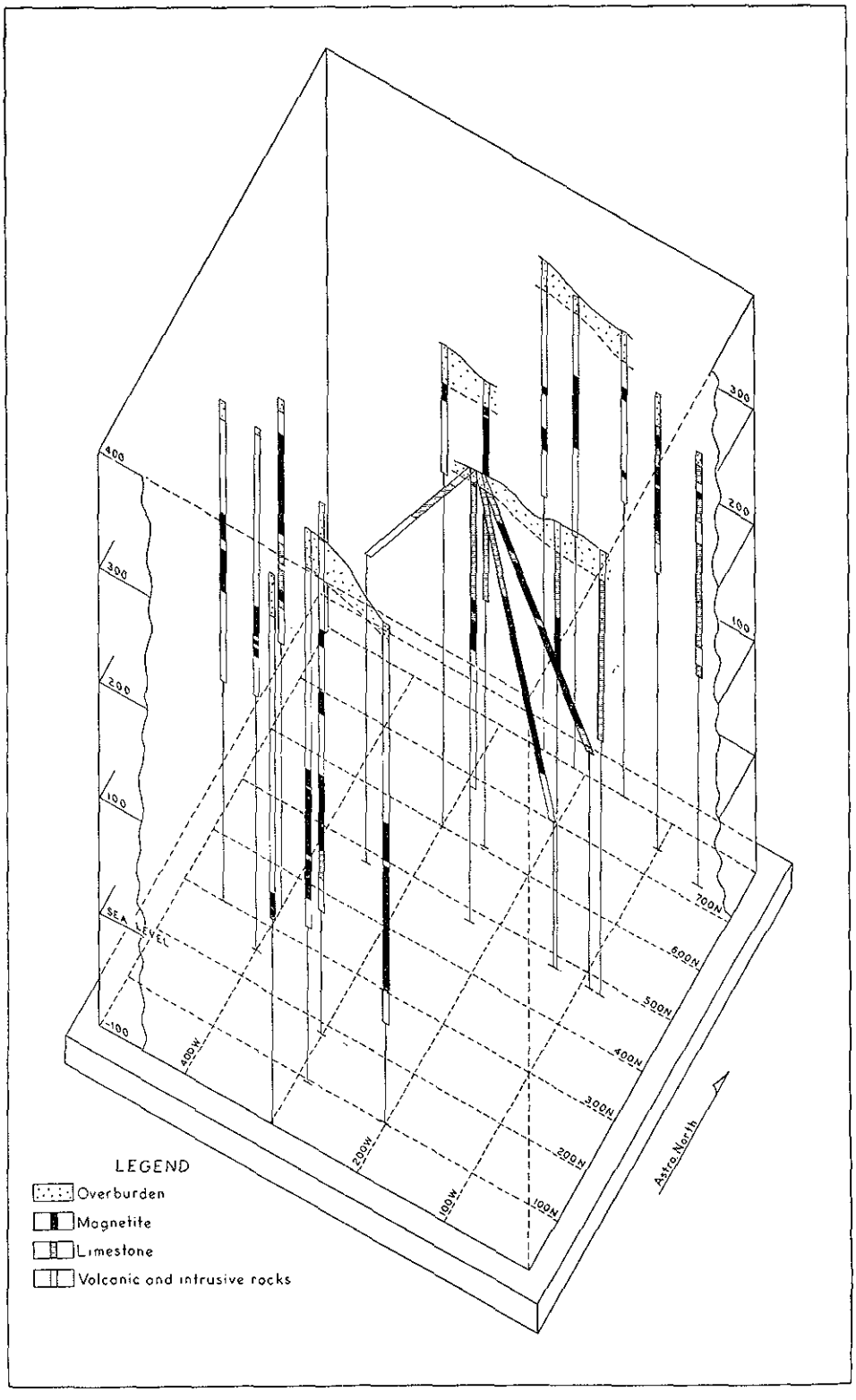


Figure 11. Block diagram illustrating diamond drilling on Kennedy Lake iron property.

rocks and along contacts between the two. It may or may not be directly associated with skarn.

Two main areas of magnetic highs were found in an area with a north-south length of about 1,500 feet and a width of about 500 feet on the C.C. Nos. 3, 4, 5, and 6 mineral claims and the C.C. No. 2 Fraction. The stronger anomalies were in the north half of the area.

The distribution of magnetite and limestone is shown in projection on Figure 11. Not all of the holes drilled could be shown without too much confusion. The limestone is thickest toward the east side and either pinches out or is eroded toward the west; holes on the extreme west side show no limestone. A possible interpretation of the magnetite intersections is that of an arch-shaped body plunging flatly east of north. If this is true, there are several magnetite-bearing horizons.

A survey grid was established over the property and the most important claims surveyed. No construction or underground work was done, but a cut 20 feet deep was made to obtain sufficient ore for mill test purposes.

The number of men employed varied between six and twenty-six.

[References: *Minister of Mines, B.C.*, Ann. Rept., 1902; Publication No. 47, Iron Ore Deposits of Vancouver and Texada Islands, B.C., *Mines Branch,* Ottawa, 1909.]

Great Central Lake (49° 125° S.E.)*

Gold

Apex, Morning (Sileurian Chieftain Mining Company Limited)

Company office, 995 Marine Drive, North Vancouver. William R. Miller, president. The property comprises twenty-eight recorded claims, including the former Apex and Morning groups, north of Doran Lake between Sproat and Great Central Lakes, 26 miles north of Alberni. The property, at an elevation of 2,100 feet, was serviced by helicopter from the Kopan Developments Limited camp on Great Central Lake.

British Columbia Department of Mines Bulletin No. 1, 1932, reports the occurrence to be quartz veins mineralized with pyrite and pyrrhotite mainly, with lesser amounts of galena, sphalerite, and chalcopyrite, and carrying gold and silver.

It was reported a crew of two men completed four X-ray diamond-drill holes totalling 430 feet and located approximately 50 feet below the main vein.

Della Lake (49° 125° S.W.)†

Copper

Big Interior (Kopan Developments Limited)

Company office, 1500 Marine Building, 355 Burrard Street, Vancouver 1. W. W. Dennis, president; A. Robertson, manager; G. L. Mill, property manager. This company, formerly Slocan Van Roi Mines Limited, holds options on eight Crown-granted and eighteen recorded claims in the Big Interior Mountain area in Strathcona Park on Vancouver Island. They are 8 miles northwest of the west end of Great Central Lake.

A supply camp was established on Great Central Lake, from which point the property was serviced by helicopter. Between September and November a crew of fifteen men was employed in geological and topographical mapping and in completing 4,000 feet of diamond drilling in a total of twenty-six holes. This work was done in the vicinity of the west wall of the Big Interior Mountain cirque, the summit, and the Bedwell River slope of the summit.

* By J. E. Merrett.
† By N. D. McKechnie and J. E. Merrett.

The geology of the property is described in Bulletin 13, Supplementary Report on Bedwell River Area, pages 61 to 77, under Ptarmigan and Big I. The rocks in the vicinity of the present work are limestones and volcanic flows intruded by quartz diorite. At the time of the writer's visit in November, the ground was snow covered, so this account is confined to a discussion of the drilling results.

Twenty-three holes were drilled on the southerly shoulder of the mountain above the cirque, eighteen of which encountered mineralization, consisting of pyrrhotite, chalcopyrite, and minor pyrite. The distribution of the mineralized sections in fifteen of the holes conforms with a plane striking nearly north-south and dipping 55 to 65 degrees east. Many of the drill cores cross the plane at low angles, and if the plane represents a sulphide-bearing zone, it is evident that the true widths indicated by many of the holes are narrow, measuring 5 feet and less. Holes T10, T11, and T17, however, indicate true widths up to about 20 feet. It may be significant that these widths seem to correspond to a flattening of dip. Hole A7, drilled wesward from near the bottom of the cirque, at an elevation of about 3,650 feet, cored 13 feet of pyrrhotite-chalcopyrite-pyrite mineralization in andesite on what could be the downward projection of this plane.

Tsolum River (49° 125° N.W.)*

Copper

Domineer (Qualicum Mines Limited)

Operating company, Noranda Exploration Company, Limited. British Columbia office, 202, 2256 West Twelfth Avenue, Vancouver 9; mine office, Box 956, Courtenay. In September, W. I. Nelson, Jr., replaced K. G. Rose as property manager. The operating company is a wholly owned subsidiary of Noranda Mines, Limited. This property, comprising four Crown-granted and seventy-five recorded claims and having an approximate area of 17.6 square miles, is near the summit and on the northeast slope of Mount Washington, 15 miles northwest of Courtenay. Access is by public motor-road to the Comox Logging Company gate near the southwest end of Wolf Lake. From there logging-roads and a short connecting road lead to the camp at about 4,000 feet elevation. The claims lie within the land grant of the Esquimalt and Nanaimo Railway Company Limited, the owners of the base-metal occurrences and with whom an operating agreement was made by Noranda Exploration Company, Limited.

Mt. Washington Copper Co. Ltd., the owners of the claims and the precious-metal occurrences therein, formed a new company, Qualicum Mines Limited, in conjunction with Noranda Exploration Company, Limited, in order to develop the property. By the terms of the agreement, when one million dollars has been spent on the property, Noranda will be entitled to 52 per cent of Qualicum Mines Limited and Mt. Washington to 48 per cent, with funds being provided to Qualicum Mines at the rate of 70 per cent by Noranda and 30 per cent by Mt. Washington.

The general geology of the region is outlined in Geological Survey of Canada, Summary Report, 1930, pages 56 to 78. The geology in the vicinity of the property is briefly outlined in the 1959 Annual Report. Noranda mapping shows the sedimentary and volcanic rocks to be intruded by a stock and sills of quartz diorite. The age of the sediments is postulated as late Cretaceous.

The mineralization consists of chalcopyrite, pyrite, and arsenopyrite in a flat-lying quartz vein which is shown in drill core to cut the quartz diorite. It apparently passes into the diorite from a friable quartzitic horizon in the sediments, and the controlling factor may well have been the friable horizon. Some of the core, logged

* By J. E. Merrett and N. D. McKechnie.

since 1959, shows the vein at a sill contact, and in no instance does the vein attitude in the quartz diorite differ appreciably from that conforming to the flat-lying sediments, suggesting that the position and orientation of the vein fracture was related to structural characteristics of the sediments rather than to those of the quartz diorite.

Approximately 1½ miles northeast of the Domineer No. 1 claim, narrow lenses and low-grade disseminations of chalcopyrite are exposed in the bed of Murex Creek, where Triassic andesite and basalt are cut by dioritic intrusive rocks. About a mile farther upstream, disseminated sulphides show in brecciated volcanic rocks in the creek bed.

In 1960 work began late in May with electromagnetic surveying, followed by trenching and diamond drilling on the various conductors thus located.

Boyles Bros. Drilling Company Ltd. completed 1,695 feet of diamond drilling in a total of eleven holes, and Noranda Exploration Company, Limited, did 375 feet of packsack drilling in ten holes. Additional test-hole drilling was done by Mt. Washington Copper company in sampling and tracing one of the better upper showings.

The test-holes drilled by Mt. Washington Copper company are on the Domineer No. 22 claim and extend the mineralization exposed in a trench there and also in the cores of 1958 holes Nos. 1 to 4 (*see* Fig. 23, Ann. Rept., 1959, p. 136). The results are illustrated in isometric projection in Figure 12. The flat-lying sulphide-bearing quartz was cut in test-holes Nos. 1 to 8. In diamond-drill hole 58-4 it is in tuffs, but from diamond-drill hole 58-2 to test-hole 1 it has diorite on one or both walls. In test-holes 7 and 8 it has a tuff footwall and from here eastward apparently dips below the depths of test-holes 9, 10, 11, and 12. These last four holes show sulphides in tuffs in what appears to be a persistent zone about 10 feet wide, lying about 20 feet above the quartz vein. The tuffs are highly silicified, but the sulphides are rather sparse. A projection of the quartz eastward from test-holes 1, 7, and 8 indicates that it may lie about 30 feet below the mineralized tuff. This interval suggests that the mineralized tuff may correspond to the exposure west of diamond-drill hole 58-2 mentioned in the 1959 Annual Report.

Trenching on the western slope of Mount Washington disclosed small amounts of chalcopyrite and considerable pyrrhotite disseminated in quartzite. Some trenching was done also on a molybdenite showing above McKay Lake.

The road to the upper workings was rebuilt during the summer, but work in that area was suspended in September in order to build a camp on Murex Creek at about 2,200 feet elevation. An extensive low and high electromagnetic survey, closely controlled by transit surveying, was conducted in the Murex Creek area, and at the end of the year trenching was in progress on a strong conductor thus located.

The average number of men employed was nine.

NITINAT (48° 124° N.W.)*

Copper

Nadira Mines Limited

Company office, 620 Howe Street, Vancouver 1. O. G. MacDonald, president; G. E. Apps, superintendent. The property comprises fifty-four recorded claims at and north of the headwaters of Horse Creek, a westward-flowing tributary of Parker Creek which enters the Nitinat River 7 miles northeast of Nitinat Lake.

* By N. D. McKechnie.

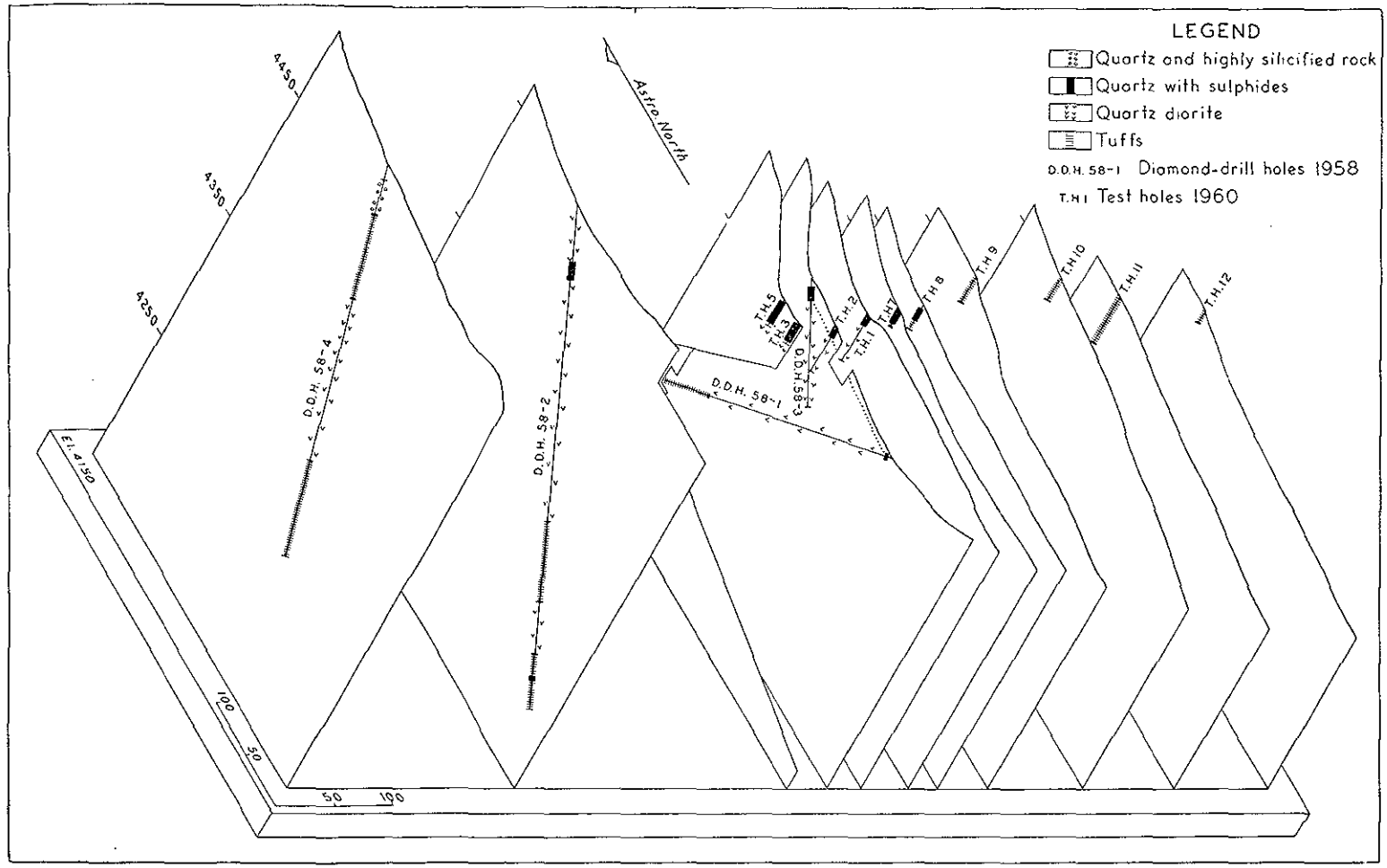


Figure 12. Qualicum Mines Limited. Block diagram illustrating diamond drilling on Domineer No. 22 mineral claim.

Descriptions of the mineral occurrences are in the Annual Reports for 1931 and 1932 under Southern Cross, for 1953 under Bornite, and for 1956, 1957, and 1959 under Nadira. There is no published geological map of the region.

The rocks are basaltic flows, with minor intercalations of limestones and thin-bedded tuffs, on the eastern contact of a dioritic stock. The volcanics and limestones are intruded by numerous dykes and sills of diorite and feldspar porphyry. A zone containing ilvaite-brown garnet-epidote skarn strikes northwestward across the O.G.M. 18A mineral claim, between elevations of about 1,350 to 1,800 feet. The mineralization, chalcopyrite, pyrite, and a little bornite, is associated with skarn.

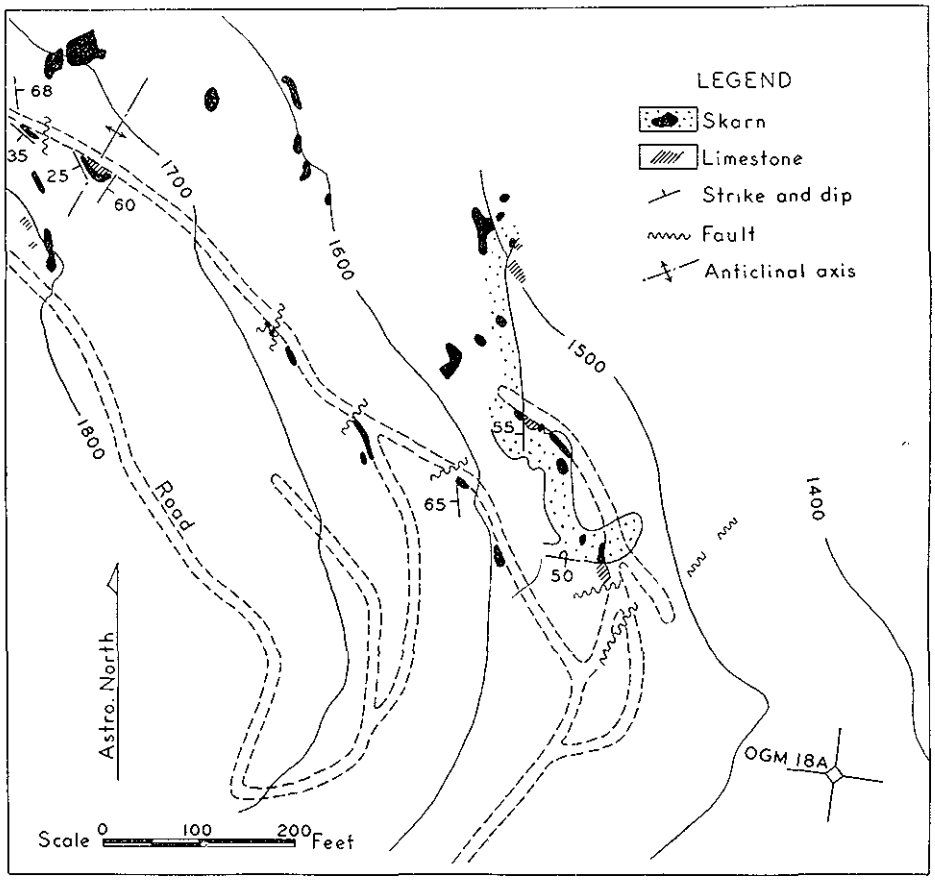


Figure 13. Nadira Mines Limited. Possible correlation of part of skarn zone.

The mineralized area is bounded on the northwest by a nearly north-south striking fault dipping 70 degrees east. Nothing is known of the movement, but the appearance of the fault suggests that it may be appreciable. Near the northwest corner of O.G.M. 18A the fault shows mineralized skarn which is drag material. Near the southeast corner of O.G.M. 18A another post-mineral fault, apparently smaller than the first, strikes northeast and dips 60 degrees southeast. Numerous and apparently minor post-mineral faults, striking north to northeast and generally steep dipping to east or west, are exposed along tractor-roads and in outcrops.

Lack of marker beds or of readily recognizable and continuous pre-mineral fractures has made exploration of the occurrence difficult. Recent work has ex-

posed possible relationships which may be used to advantage. A small dragfold at a skarn-limestone contact is exposed on the upper tractor-road about 100 feet from its end. It plunges southwestward. About 650 feet farther southeast along the same road a faulted but readily recognizable anticlinal crest plunges about 20 degrees southwestward. In both instances the skarn has a limestone footwall; in the second exposure the hangingwall also shows and is a finely banded tuff. About 300 feet northwest of the southeast corner of O.G.M. 18A a series of exposures along and north of a tractor-road follows the 1,550-foot contour for some 300 feet. The exposures are of skarn with a limestone footwall in what probably represents a crumpled zone against the northeast-striking post-mineral fault (Fig. 13). The average strike of this contact, ignoring local crumples, is slightly west of north and the dip is about 60 degrees west. This possibly represents the west limb of an anticline having a northeastward-striking axial plane and, if so, it may be possible to trace it to the faulted anticline some 500 feet to the northwest. The folding on northeast axes probably is a cross-folding which, if it is due to the strong north-south post-mineral fault, may be found only in that vicinity.

A crew of six men was employed for five months open-pitting on surface outcrops of ore. A test run of 5,142 tons of ore was trucked to the Cowichan Copper Company's mill on Cowichan Lake. The 261 tons of copper concentrate produced was shipped to Japan.

COWICHAN LAKE (48° 124° N.E.)*

Copper

Blue Grouse (Cowichan Copper Co. Ltd.)

Company office, 620 Howe Street, Vancouver 1; mine office, Lake Cowichan. Oswood G. MacDonald, president and general manager; A. H. Harder, mine manager; G. E. Apps, mine superintendent; H. Arms, mill superintendent. The property consists of three Crown-granted and sixty recorded claims. It includes two old properties, the Blue Grouse and Sunnyside, on the south side of Cowichan Lake about 3 miles by road northwest of Honeymoon Bay.

The mine has been developed by two adits—the main haulage or 1100 level and an upper level known as the 1340 level. Open shrinkage stoping methods were used to remove the ore in the various zones between 1100 level and the surface above the 1600 level horizon.

Mining and milling operations were suspended in mid-November after the available ore reserves above 1100 level were depleted. Underground exposures on 1100 level and diamond drilling below it indicate a downward continuance of ore, but a shaft will be necessary before mining can be done below that horizon.

In 1960, 66,419 tons of ore was milled and 4,901 tons of copper concentrate was shipped from the Hatch Point loading-dock to Japan.

A summary of production from this property is: Previous operators between 1917 and 1919 shipped approximately 2,500 tons of ore grading 6 per cent copper; the present company shipped 22,338 tons of ore grading 5.99 per cent copper during the years 1954 to 1957; the flotation mill commenced operation in 1957, and from then to November, 1960, 248,500 tons of ore, grading 2.73 per cent copper, was milled to produce 23,650 tons of concentrate. The total copper production from 1917 to 1960, inclusive, was approximately 16,000,000 pounds.

* By J. E. Merrett.

Copper

KOKSILAH RIVER (48° 123° N.W.)*

King Solomon (Cellardor Mines Ltd.)

Company office, 620 Howe Street, Vancouver 1. Oswood G. MacDonald, president. This company controls the King Solomon, Queen of Sheba, Koksilah, and Bluebell Crown-granted claims and a large surrounding group of recorded claims. The property is near Kinsol station on the Canadian National Railway. It is at about 1,000 feet elevation, north of the Koksilah River, about 7 miles south of Duncan. It is reached by 5 miles of road from a point on the highway 2 miles south of Duncan. The four original claims were Crown granted more than fifty years ago. A crew of four men enlarged the lower adit for a distance in excess of 400 feet to permit the use of mechanical mucking and tramming equipment.

Iron

PORT RENFREW (48° 124° N.E.)*

Bugaboo Creek Iron (Noranda Exploration Company, Limited)

British Columbia office, 202, 2256 West Twelfth Avenue, Vancouver 9. O. W. Nichols, property superintendent. This property comprises seven Crown-granted and three recorded mineral claims on Bugaboo Creek, approximately 10 miles north of Port Renfrew. The Crown-granted claims are held by option agreement by Noranda Exploration Company, Limited. Access is by 5 miles of rough truck-road up Gordon River and by 6 miles of good pack-trail. Additional access is by way of helicopter, two landing strips having been constructed for this type of aircraft.

The ore consists of massive magnetite occurring within zones of pyroxene and garnet skarn formed along or near the contacts of the Upper Jurassic Coast Intrusions with Triassic limestone. Two relatively high-grade orebodies, the Daniel and the Conqueror, have been located. Some sulphur is present in the form of pyrite and pyrrhotite, but other impurities are negligible.

Between May and November six men were employed completing 6,169 feet of AX core diamond drilling in twenty-two holes and on improving the pack-trail.

Copper

JORDAN RIVER (48° 124° S.E.)*

Sunloch and Gabbro (Sunro Mines Limited)

Head office, Tadanac. The property is on the Jordan River about 1 mile upstream from the mouth and is reached by a road which leaves the Victoria highway about one-half mile east of the River Jordan Post Office. The original showings were diamond drilled in the past and were explored by adits from the Jordan River canyon, 2 miles upstream from the river mouth and at elevations of from 500 to 1,000 feet above sea-level. Work was begun in 1917 and resumed at intervals. Three principal mineralized zones, designated upstream as the Cave, Central, and River zones, were defined. The results of the work to 1950 and the geology of the deposit were fully described in the 1950 Annual Report, pages 180 to 193. In 1957 an adit was started from the east side of Jordan River at an elevation of about 100 feet above sea-level and driven to a total length of 7,805 feet beneath the surface showings.

In 1960 an operating lease to remove the ore from the Cave, Central, and River zones was obtained from The Consolidated Mining and Smelting Company of Canada, Limited, by Cowichan Copper Co. Ltd. Late in December a small crew was sent to the property to reopen the underground workings and to prepare for active operation.

* By J. E. Merrett.

TABLE XV.—LODE-METAL PRODUCTION IN 1960*

Property or Operator	Location of Mine	Owner or Agent	Ore Shipped or Treated	Product Shipped	Gross Metal Contents					
					Gold	Silver	Copper	Lead	Zinc	Cadmium
NORTHERN BRITISH COLUMBIA			Tons		Oz.	Oz.	Lb.	Lb.	Lb.	Lb.
Atlin Mining Division										
Cornucopia (Benroy)	McDame Creek	J. J. Copeland and J. J. Couture, Whitehorse, Y.T.	25	Bullion	34	3				
Liard Mining Division										
Nil										
CENTRAL BRITISH COLUMBIA										
Cariboo Mining Division										
Cariboo Gold Quartz and Aurum	Wells	The Cariboo Gold Quartz Mining Co. Ltd., Vancouver	39,113	Bullion	19,555	2,732				
Clinton Mining Division										
Nil										
Omineca Mining Division										
Cronin Babine	Smithers	Lessees from New Cronin Babine Mines Ltd., Vancouver	1,015	Lead concentrates, 79 tons; zinc concentrates, 66 tons	16	9,054		91,720	76,002	948
Silver Standard	Hazelton	J. Gallo, lessee from Silver Standard Mines Ltd., Vancouver	37	Crude ore	6	5,208	737	11,422	12,306	
COAST AND ISLANDS										
Alberni Mining Division										
Tofino	Tranquil Inlet	Tofino Mines Ltd., Vancouver	53	Bullion	15	2				
Nanaimo Mining Division										
Merry Widow No. 5 and Kingfisher	Benson Lake	Empire Development Co. Ltd., Vancouver	1,046,989	Iron concentrates, 453,563 tons						
Nimpkish	Beaver Cove	Nimpkish Iron Mines Ltd., Vancouver	479,250	Iron concentrates, 283,083 tons						

* Subject to revision.

TABLE XV.—LODE-METAL PRODUCTION IN 1960—*Continued*

Property or Operator	Location of Mine	Owner or Agent	Ore Shipped or Treated	Product Shipped	Gross Metal Contents					
					Gold	Silver	Copper	Lead	Zinc	Cadmium
COAST AND ISLANDS—*Continued*			Tons		Oz.	Oz.	Lb.	Lb.	Lb.	Lb.
Nanaimo Mining Division—Continued										
Prescott, Paxton, Yellow Kid, Yellow Jacket	Texada Island	Texada Mines Ltd., Vancouver	867,736	Iron concentrates, 419,651 tons; copper concentrates, 7,927 tons	1,517	33,181	1,958,743	.....	.....	.....
New Westminster Mining Division										
Pride of Emory	Choate	Giant Nickel Mines Ltd., Hope	250,261	Bulk nickel and copper concentrates, 19,995 tons	.....	.....	1,578,312	.....	.....	.....
Skeena Mining Division										
Silbak Premier	Premier	Silbak Premier Mines Ltd., Vancouver; Bermah Mines Ltd., lessees, Vancouver; F. W. Robinson, c/o Silbak Premier Mines Ltd., Vancouver	1,282	Crude ore	7,548	203,570	16,258	118,326	201,318	.....
Vancouver Mining Division										
Britannia	Britannia Beach	Howe Sound Co. (Britannia Division), Britannia Beach	409,751	Copper concentrates and precipitates, 29,224 tons; zinc concentrates, 10,121 tons; tailings, 58,767 tons	8,590	77,991	18,203,368	419,598	12,215,595	47,236
Victoria Mining Division										
Blue Grouse	Cowichan Lake	Cowichan Copper Co. Ltd., Lake Cowichan	66,419	Copper concentrates, 4,901 tons	.....	14,802	2,534,673	.....	.....	.....
Nadira	Nitinat	Nadira Mines Ltd., Vancouver	5,142	Crude ore; milled at Cowichan Copper and produced 261 tons of concentrates	.....	.....	136,530	.....	.....	.....
SOUTH CENTRAL BRITISH COLUMBIA										
Greenwood Mining Division										
Bounty Fraction	Beaverdell	Sheritt Lee Mines Ltd., Vancouver	12	Crude ore	1	1,221	.....	1,085	2,218	.....
Brooklyn-Stemwinder	Greenwood	Continental Consolidated Mines Ltd., Vancouver	905	Crude ore	30	196	19,028	.....	.....	.....
Cariboo-Amelia	Rock Creek	McKinney Gold Mines Ltd., Vancouver	4,370	Siliceous ore	5,204	6,830	.....	65,545	65,479	.....

Highland-Bell	Beaverdell	Highland-Bell Ltd., Vancouver	18,204	Lead concentrates, 1,903 tons; zinc concentrates, 872 tons; jig concentrates, 231 tons	570	903,614	----	856,522	1,183,460	8,372
Mother Lode	Greenwood	Consolidated Woodgreen Mines Ltd., Vancouver	201,497	Copper concentrates	5,273	17,850	2,326,276	----	----	----
Phoenix	Greenwood	Phoenix Copper Co. Ltd., Grand Forks	346,638	Copper concentrates, 10,728 tons (includes 2,344 tons from 1959 stockpile and shipped in 1960)	7,782	48,768	5,118,943	----	----	----
Providence	Greenwood	S. J. Kleman, Greenwood	5	Crude ore	2	541	----	224	168	----
Silver Scandie	Beaverdell	Silver Scandie Mines Ltd., Beaverdell	6	Crude ore	----	350	----	451	840	----
Kamloops Mining Division										
Gift	Kamloops	Burns & Dutton Concrete and Construction Co. Ltd., Richmond	4,055	Crude iron ore	----	----	----	----	----	----
Lillooet Mining Division										
Bralorne	Bridge River	Bralorne Pioneer Mines Ltd. (Bralorne Division), Vancouver	153,482	Bullion; gold concentrates, 3,409 tons	114,116	23,908	----	----	----	----
Pioneer	Bridge River	Bralorne Pioneer Mines Ltd. (Pioneer Division), Vancouver	50,163	Bullion	26,971	5,397	----	----	----	----
Nicola Mining Division										
Aberdeen	Merritt	Torwest Resources Ltd., Vancouver	37	Crude ore	----	18	5,800	----	----	----
Osoyoos Mining Division										
Fairview	Oliver	The Consolidated Mining & Smelting Co. of Canada, Ltd., Trail	24,573	Silica flux	----	----	----	----	----	----
			13,553	Bullion	6,373	319	----	----	----	----
French	Hedley	French Mines Ltd., Vancouver	1,500	Molybdenite (MoS_2) concentrates; copper concentrates, 141 tons	2	460	61,060	1,406	----	----
Golconda	Keremeos	Keremeos Mines Ltd., Olalla	508	Siliceous ore	60	1,077	----	1,527	1,017	----
Susie	Oliver	W. J. Cudworth, Penticton, lessee from American Smelting & Refining Co., Wallace, Ida.								
Similkameen Mining Division										
Copper Mountain	Copper Mountain	M.G. Mining Co. Ltd. and The Granby Mining Co. Ltd., Vancouver	41	Crude ore; clean-up material, 26 tons	538	235	18,218	----	----	----
Vernon Mining Division										
Rex 86	Kelowna	R. Bruch and J. E. van Gundy, Kelowna	----	Tailings	1	1	----	4	4	----

[1] Estimated.

TABLE XV.—LODE-METAL PRODUCTION IN 1960—*Continued*

Property or Operator	Location of Mine	Owner or Agent	Ore Shipped or Treated	Product Shipped	Gross Metal Contents					
					Gold	Silver	Copper	Lead	Zinc	Cadmium
SOUTHEASTERN BRITISH COLUMBIA			Tons		Oz.	Oz.	Lb.	Lb.	Lb.	Lb.
Fort Steele Mining Division										
Sullivan	Kimberley	The Consolidated Mining & Smelting Co. of Canada, Ltd., Trail	2,522,554	Lead concentrates, 184,916 tons; zinc concentrates, 233,017 tons; tin concentrates, 482 tons	362	5,283,170	784,200	273,008,000	234,130,000	.....
Golden Mining Division										
Mineral King	Toby Creek	Sheep Creek Mines Ltd., Nelson	195,702	Lead concentrates, 7,155 tons; zinc concentrates, 14,873 tons	.....	198,636	173,810	9,531,057	16,980,049	43,441
Nelson Mining Division										
Euphrates	Apex	L. Soukeroff and B. Logan, Nelson	11	Crude ore	6	68	.....	344	206	.....
Gold Belt	Salmo	A. Endersby, Fruitvale	143	Crude ore	57	51	.....	603	645	.....
Goodenough	Ymir	E. R. Nilson, Ymir	11	Crude ore	4	11	.....	257	364	.....
H.B.	Salmo	The Consolidated Mining & Smelting Co. of Canada, Ltd., Trail	464,408	Lead concentrates, 5,595 tons; zinc concentrates, 34,347 tons	.....	72,158	.....	7,917,580	38,718,480	328,523
Hummingbird	Taghum	Carter-Logan-Holmes, c/o W. L. Carter, Nelson	22	Mill clean-up	.....	55	.....	788	2,146	.....
Jersey	Salmo	Canadian Exploration Ltd., Vancouver	364,424	Lead concentrates, 5,769 tons; zinc concentrates, 25,103 tons	.....	27,054	.....	9,664,738	29,499,477	228,530
Kenville (White Lease)	Nelson	D. H. Norcross, Nelson	12	Crude ore	19	16	.....	70	47	.....
Kootenay Belle	Salmo	M. M. Arishenkoff, Shoreacres	4,377	Siliceous ore; tailings, 12 tons	151	513	.....	10,577	10,054	.....
New Arlington	Erie	G. D. Fox, Trail	52	Crude ore	37	105	.....	1,776	2,194	.....
Reeves MacDonald	Remac	Reeves MacDonald Mines Ltd., Vancouver	411,282	Lead concentrates, 2,547 tons; zinc concentrates, 22,653 tons	.....	25,231	.....	3,694,962	24,793,300	159,851
Revelstoke Mining Division										
Mastodon	Revelstoke	Mastodon Zinc Mines Ltd., Vancouver	15,532	Zinc concentrates, 2,062 tons	8	3,010	.....	97,778	2,478,430	12,141
Slocan Mining Division										
Anna	Slocan	Silver King Mines Ltd., Vancouver	4	Crude ore	.....	757	.....	34	13	.....
Banker	Ainsworth	P. Gilchrist and C. Hartland, Ainsworth	57	Crude ore	.....	1,134	.....	67,685	3,861	.....

Bluebell	Riondel	The Consolidated Mining & Smelting Co. of Canada, Ltd., Trail	255,571	Lead concentrates, 17,251 tons; zinc concentrates, 29,554 tons	.....	354,397	368,000	25,688,460	29,904,260	141,387
Bosun	Silverton	W. H. McLeod, Silverton	14	Crude ore	.....	326	.....	1,062	4,566	.....
Crow Fledgling	Ainsworth	T. Lane, Ainsworth	125	Crude ore	.....	246	.....	14,514	6,534	21
Empire (Rusty No. 2)	Kaslo	E. Muller and E. Augustine, Kaslo	35	Crude ore	1	300	.....	9,725	9,655	.....
Highlander	Ainsworth	T. G. Laughton, lessee from Yale Lead & Zinc, Toronto	4,325	Lead concentrates, 357 tons; zinc concentrates, 164 tons; crude ore, 25 tons	3	8,879	.....	565,213	186,693	868
Kootenay Florence	Ainsworth	M. B. Sirak, lessee from Western Mines Ltd., Ainsworth	590	Lead concentrates, 138 tons; zinc concentrates, 96 tons	.....	3,392	.....	191,688	94,155	.....
Krao	Ainsworth	T. Lane, Ainsworth	64	Lead concentrates, 3 tons; zinc concentrates, 3 tons; crude ore, 4 tons	.....	169	.....	6,535	3,129	13
Laura M.	Ainsworth	M. B. Sirak, Ainsworth	539[1]	Lead concentrates, 45 tons; zinc concentrates, 32 tons	.....	1,064	.....	63,242	33,536	141
Lone Bachelor	Sandon	E. Perepolkin, lessee, Hills	698	Lead concentrates, 93 tons; zinc concentrates, 120 tons; crude ore, 83 tons	8	21,969	.....	249,345	159,366	891
Millie Mack	Burton	W. Isaacs and J. Figner, Burton	14	Crude ore	6	137	.....	669	362	.....
Ottawa	Slocan	Skylane Mines Ltd., Slocan	14	Crude ore	.....	2,966	.....	189	94	.....
Ruth Hope	Sandon	E. H. Petersen, Sandon	2	Crude ore	.....	187	.....	2,130	78	.....
Shirley	Kootenay Bay	F. W. Stainton, Trail	1	Crude ore	.....	16	.....	346	57	.....
Silver Mountain	Sandon	Silver Mountain Mines Ltd. (and Reco Leasers), Sandon	115[1]	Lead concentrates, 10 tons; zinc concentrates, 13 tons	.....	1,036	.....	13,876	14,154	86
Utica	Kaslo	Lajo Mines Ltd., Kaslo	4,000[2]	Lead concentrates, 93 tons; zinc concentrates, 132 tons	2	34,872	.....	68,376	123,858	817
Victor	Sandon	Violamac Mines Ltd., New Denver	6,227	Lead concentrates, 481 tons; zinc concentrates, 1,030 tons	104	99,176	.....	675,045	1,214,182	8,252
Western Mines	Ainsworth	Western Mines Ltd., Ainsworth	.....	Thickener clean-up: Lead concentrates, 16 tons; zinc concentrates, 20 tons	.....	299	.....	17,722	19,083	108
Wonderful	Sandon	E. H. Petersen, Sandon	2	Crude ore	.....	191	.....	2,376	62	.....
Yale Mill	Ainsworth	Yale Lead & Zinc Mines Ltd., Ainsworth	367	Mill clean-up: Lead concentrates, 39 tons; zinc concentrates, 27 tons	.....	1,038	.....	48,916	32,761	124
Trail Creek Mining Division										
I.X.L.	Rossland	J. A. Ruelle, Rossland	0.04	High-grade ore	19	4	.....	.....	.....	.....
Velvet	Rossland	Mid-West Copper & Uranium Mines Ltd., Vancouver; lessees, Velvet Leasers, Rossland	4,264	Concentrates, 308 tons	355	1,066	146,171	.....	.....	.....
W.D.	Trail	W.D. Mining Co. Ltd., Trail	30	Crude ore	21	3	.....	60	60	.....

[1] Estimated.

Lode-metal Deposits Referred to in the 1960 Annual Report

The names of the properties are arranged alphabetically within five areas. Each area consists of the mining divisions listed below. The table shows the principal metals produced or indicated in the deposits in 1960:—

Northern British Columbia.—Atlin, Liard.

Central British Columbia.—Cariboo, Clinton, Omineca.

Coast and Islands.—Alberni, Nanaimo, New Westminster, Skeena, Vancouver, Victoria.

South Central British Columbia.—Greenwood, Kamloops, Lillooet, Nicola, Osoyoos, Similkameen, Vernon.

Southeastern British Columbia.—Fort Steele, Golden, Nelson, Revelstoke, Slocan, Trail Creek.

Property	Mining Division	Latitude and Longitude	Gold	Silver	Copper	Lead	Zinc	Tungsten	Cadmium	Iron	Manganese	Uranium	Chromium	Tin	Nickel	Molybdenum	Silica	Sulphur	Mercury	Cobalt	Page
Northern British Columbia																					
Copco	Liard	59° 129° S.W.	2	1																	6, 117
Windy and Craggy	Atlin	59° 137° N.W.			3															3	6
Central British Columbia																					
Aurum, Cariboo Gold Quartz	Cariboo	53° 121° S.W.	1	2																	15, 117
CAFB	Omineca	53° 127° S.E.														3					14
Cronin Babine	Omineca	54° 126° N.W.	2	1		1	1		2												13, 117
Jim	Cariboo	52° 121° N.E.	3																		19
Lustdust	Omineca	55° 125° N.E.	3	3			3														14
Porcupine Mountain	Clinton	51° 122° S.E.	3																		20
Scarn	Cariboo	53° 121° S.W.		3																	17
Silver Standard	Omineca	55° 127° S.W.	2	1	2	1	1														13, 117
Snell Group	Omineca	55° 125° N.E.																	3		14
Coast and Islands																					
A.M.	N. West'r.	49° 121° S.E.			3																87
Alice	Skeena	55° 129° S.E.														3					10
Apex, Morning	Alberni	49° 125° S.E.	3																		110
Berton	Alberni	49° 125° S.W.	3																		106
Big Interior	Alberni	49° 125° S.W.			3																110
Blue Grouse	Victoria	48° 124° N.E.		2	1																115, 118
Britannia	Vancouver	49° 123° N.E.	2	2	1	2	1		2												89, 118
Bugaboo Creek Iron	Victoria	48° 124° N.E.								3											116
Colossus	Vancouver	50° 125° N.E.			3																90
Domineer	Nanaimo	49° 125° N.W.			3																111
Double Ed	Skeena	55° 129° S.W.			3																10
East	Skeena	56° 130° S.E.	3	3																	7
Empire Development (Merry Widow, Kingfisher)	Nanaimo	50° 127° S.E.								1											89, 117
F.L.	Nanaimo	50° 126° S.W.								3											103
Gold Coin	N. West'r.	49° 121° S.E.			3	3	3														87
Harriet Harbour	Skeena	52° 131° S.E.								3											11
Hualpai	Nanaimo	49° 126° N.W.								3											106
Iron Mike	Nanaimo	59° 125° S.W.								3											104
Iron Mountain	Skeena	54° 128° S.W.								3											13
Kennedy Lake Iron	Alberni	49° 125° S.E.								3											108
King Solomon	Victoria	48° 123° N.W.			3																116

Shipping Mines.—(1) Metal contributed at least 10 per cent of gross value of the shipment. (2) Metal contributed less than 10 per cent of gross value of the shipment. Production for 1960 is listed in Table XV.

Non-shipping Mines.—(3) Metal present, indicated by assay or mineralogical determination.

LODE-METAL DEPOSITS REFERRED TO IN THE 1960 ANNUAL REPORT—*Continued*

Property	Mining Division	Latitude and Longitude	Gold	Silver	Copper	Lead	Zinc	Tungsten	Cadmium	Iron	Manganese	Uranium	Chromium	Tin	Nickel	Molybdenum	Silica	Sulphur	Mercury	Cobalt	Page
Coast and Islands—Continued																					
Nadira	Victoria	48° 124° N.W.			1																112, 118
Nimpkish, Klaanch	Nanaimo	50° 126° S.W.								1											101, 117
Old Sport	Nanaimo	50° 127° S.E.			3																100
Packsack	Skeena	53° 129° N.E.			3	3	3														12
Pride of Emory	N. West'r	49° 121° S.W.			1											2					87, 118
Roundy Creek	Skeena	55° 129° S.E.															3				10
Scotia	Skeena	54° 129° S.W.					3														12
Shag Rock	Skeena	54° 132° S.W.									3										11
Silbak Premier	Skeena	56° 130° S.E.	1	1	2	2	2														8, 118
Sunloch, Gabbro	Victoria	48° 124° S.E.			3																116
Surprise Group	Skeena	56° 129° S.W.				3	3														7
Telkwa	Skeena	54° 128° N.E.															3				13
Texada (Prescott, Paxton, Yellow Kid, Yellow Jacket)	Vancouver	49° 124° N.W.	2	2	1					1											89, 118
Todd Group	Skeena	56° 129° S.W.			3																7
Tofino	Alberni	49° 125° S.W.	1	2																	107, 117
Wolfe	Skeena	55° 129° N.W.		3																	8
You	Alberni	49° 125° S.W.	3																		106
South Central British Columbia																					
Aberdeen	Nicola	50° 120° S.W.		2	1																41, 119
Ace	Lillooet	50° 122° N.W.	3																		20
Askom	Kamloops	50° 121° N.W.			3																24
Beaver	Kamloops	50° 120° N.W.			3																25
Bethlehem	Kamloops	50° 120° S.W.			3																26
Betty Lou, Lou	Kamloops	50° 120° S.W.			3					3											41
Bounty Fraction	Greenw'd	49° 119° S.E.	2	1		2	1														63, 118
Bralorne	Lillooet	50° 122° N.W.	1	2																	21, 119
Bridge River	Lillooet	50° 122° N.W.	3																		23
Cariboo-Amelia	Greenw'd	49° 119° S.E.	1	2		2	2														62, 118
Copper Mountain	Similk'n	49° 120° S.W.	1	2	1																57, 119
Copper Nos. 1 to 4	Lillooet	51° 122° S.W.			3																19
Craigmont	Nicola	50° 120° S.W.			3					3											40
D.R.G.	Kamloops	50° 120° N.W.			3																41
Deep Gulch	Similk'n	49° 120° S.W.			3																55
F.H.	Similk'n	49° 120° N.W.			3																57
Fairview	Osoyoos	49° 119° S.W.																1			61, 119
French	Similk'n	49° 120° S.E.	1	2																	57, 119
Friday Creek	Similk'n	49° 120° S.W.			3																56
Gift	Kamloops	50° 120° N.E.								1											119
Golconda	Osoyoos	49° 119° S.W.	2	2	1	2															61, 119
Golden Contact	Lillooet	50° 122° N.E.	3																		24
Highland-Bell	Greenw'd	49° 119° S.E.	2	1		2	1			2											62, 119
Horn Silver	Osoyoos	49° 119° S.W.	3	3																	58
Hurley River	Lillooet	50° 122° N.W.	3																		24
Jericho	Kamloops	50° 120° S.W.			3																26
Kim	Kamloops	50° 120° N.W.			3																41
Krain Copper	Kamloops	50° 121° N.E.			3																25
Law's Camp	Similk'n	49° 120° N.W.	3		3		3														53
Lodge	Kamloops	50° 120° N.W.			3																26
Morning Star	Osoyoos	49° 119° S.W.	3																		62
Mother Lode	Greenw'd	49° 118° S.W.	1	2	1																64, 119
Old England	Greenw'd	49° 119° S.E.	3	3																	62
P.C.M., Cap, Domino, Freda, Hank	Nicola	50° 120° S.W.			3					3											41
Phoenix	Greenw'd	49° 118° S.W.	1	2	1																65, 119
Pioneer	Lillooet	50° 122° N.W.	1	2																	21, 119
Providence	Greenw'd	49° 118° S.W.	1	1		2	2														119
Rex 86	Vernon	49° 119° N.E.	1	2		2	2														119
Rick	Similk'n	49° 120° S.E.			3																55
Silver Scandie	Greenw'd	49° 119° S.E.		1		2	1														63, 119
Stemwinder	Greenw'd	49° 118° S.W.	1	2	1																66, 118

LODE-METAL DEPOSITS REFERRED TO IN THE 1960 ANNUAL REPORT—*Continued*

Property	Mining Division	Latitude and Longitude	Gold	Silver	Copper	Lead	Zinc	Tungsten	Cadmium	Iron	Manganese	Uranium	Chromium	Tin	Nickel	Molybdenum	Silica	Sulphur	Mercury	Cobalt	Page
South Central British Columbia—Continued																					
Susie	Nicola	49° 119° S.W.	1	1		2	2														119
Trojan	Kamloops	50° 120° N.W.			3																25
West Coast Resources	Greenw'd	49° 118° S.W.			3																63
Southeastern British Columbia																					
Anna	Slocan	49° 117° N.E.		1		2	2														76, 120
Argo	Revelstoke	50° 118° S.E.	3																		85
Banker	Slocan	49° 116° N.W.		1		2	2														120
Bannockburn	Revelstoke	50° 117° N.E.		3		3	3														78
Big Mac	Nelson	49° 117° S.E.		3		3	3														66
Black Fox	Slocan	49° 117° N.E.		3		3	3														75
Black Warrior, Elsmere	Revelstoke	50° 117° N.E.		3		3	3														77
Bluebell	Slocan	49° 116° N.W.		2	2	1	1		2												72, 121
Bosun	Slocan	49° 117° N.E.		1		1	1														121
Boy	Nelson	49° 117° S.E.				3	3														69
Crow Fledgling	Slocan	49° 116° N.W.		2		1	1		2												74, 121
Double "B"	Nelson	49° 117° S.E.		3		3	3									3					69
Duncan	Slocan	50° 116° S.W.				3	3														79
Empire	Slocan	49° 117° N.E.	2	1		1	1														75, 121
Euphrates	Nelson	49° 117° S.E.	1	1		1	2														120
Gold Belt	Nelson	49° 117° S.E.	1	2		2	2														120
Goodenough	Nelson	49° 117° S.E.	1	2		1	1														67, 120
H.B.	Nelson	49° 117° S.E.		2		1	1		2												68, 120
Highlander	Slocan	49° 116° N.W.	2	2		1	1		2												73, 121
Hummingbird	Nelson	49° 117° S.E.		1		1	1														67, 120
I.X.L.	Trail Cr'k	49° 117° S.W.	1	2																	121
Jersey	Nelson	49° 117° S.E.		2		1	1		2												69, 120
Kootenay Belle	Nelson	49° 117° N.E.	1	2		1	1														120
Kootenay Florence, Lakeshore	Slocan	49° 116° N.W.		2		1	1														74, 121
Krao	Slocan	49° 116° N.W.		1		1	1		2												74, 121
Laura M.	Slocan	49° 116° N.W.		2		1	1		2												121
Lone Bachelor	Slocan	49° 117° N.E.	2	1		1	1		2												76, 121
Mag	Slocan	50° 116° S.W.		3		3	3														82
Mastodon	Revelstoke	51° 118° S.E.	2	2		2	1		2												86, 120
Millie Mack	Slocan	49° 117° N.W.	1	1		1	2														77, 121
Mineral King	Golden	50° 116° S.E.		2	2	1	1		2												83, 120
New Arlington	Nelson	49° 117° S.E.	1	2		1	1														120
Nugget	Nelson	49° 117° S.E.	3																		68
Ottawa	Slocan	49° 117° N.E.		1		2	2														77, 121
Paradise	Golden	50° 116° S.E.		3		3	3														84
Ptarmigan	Golden	50° 116° N.E.		3	3																85
Reeves MacDonald	Nelson	49° 117° S.W.		2		1	1		2												71, 120
Ruby	Nelson	49° 117° S.E.		3		3	3														68
Ruth Hope	Slocan	49° 117° N.E.		1		1	2														121
St. Andrew	Golden	50° 116° S.W.			3																85
Scranton	Slocan	49° 117° N.E.	3	3		3	3														74
Shirley	Slocan	49° 116° N.W.		1		1	2														121
Silver Mountain	Slocan	49° 117° N.E.		1		1	1		2												121
Silversmith, etc.	Slocan	49° 117° N.E.		3		3	3														76
Sullivan	Fort Steele	49° 115° N.W.	2	2	2	1	1														82, 120
Texas, Fourth of July	Slocan	50° 117° S.E.		3		3	3														75
Tungsten King	Nelson	49° 117° S.E.				3	3														70
Utica	Slocan	49° 117° N.E.	2	1		1	1		2												75, 121
Velvet	Trail Cr'k	49° 117° S.W.	1	2	1																66, 121
Victor	Slocan	49° 117° N.E.	2	1		1	1		2												76, 121
W.D.	Trail Cr'k	49° 117° S.W.	1	2		2	2														66, 121
Western Mines	Slocan	49° 116° N.W.		2		1	1		2												74, 121
White	Nelson	49° 117° S.E.	1	2		2	2														67, 120
Wigwam	Revelstoke	51° 118° S.E.		3		3	3														86
Wonderful	Slocan	49° 117° N.E.		1		1	2														121
Yale	Slocan	49° 116° N.W.		1		1	1		2												74, 121
Yankee Dundee	Nelson	49° 117° S.E.	3																		67

REPORTS ON GEOLOGICAL, GEOPHYSICAL, AND GEOCHEMICAL WORK

Reports accepted to the end of 1958 for credit on assessment requirements for properties held under the *Mineral Act* and the *Placer-mining Act* since January 17th, 1947, and reports on geochemical surveys accepted since April 6th, 1951, are listed in the Annual Report for 1958. Starting with 1959, each Annual Report lists the reports accepted during the current calendar year. A copy of each report may be examined in the office of the Mining Recorder for the mining division in which the property is. A second copy of each report is filed in the office of the Chief of the Mineralogical Branch, Department of Mines and Petroleum Resources, Victoria.

The property name is that which appears to be in most common use. It is not feasible to list all the claim names in each property. The author of each report is given and the principal for whom the report was written.

REPORTS CREDITED FOR ASSESSMENT, 1960

Geographic Position		Property *Owner or Principal* Author of Report Date of Submission of Report	Kind of Work		
1° Quadr.	Quarter		Geological	Geophysical	Geochemical
49° 117°	S.E.	"A" Group McIntyre Porcupine Mines Ltd. J. A. C. Keefe and J. W. MacLeod. December 14, 1960.	....	×	×
49° 118°	S.E.	Anomaly 1–48 Claims West Coast Resources Ltd. H. Lundberg and F. J. Hemsworh. March 10, 1960.	....	×	....
49° 118°	N.W.	Moe Nos. 1–6 Phoenix Copper Company Ltd. and The Granby Mining Company Limited. P. R. Matthew. February 17, 1960.	....	×	....
49° 118°	N.W.	Ox Nos. 1, 5, 9 Fractions and Caberfae Fraction Phoenix Copper Company Ltd. P. R. Matthew. March 24, 1960.	....	×	....
49° 118°	S.W.	Texas Group The Granby Mining Company Limited. K. C. Fahrni. November 30, 1960.	×	....	....
49° 120°	S.E.	F. H. Group Kennco Explorations (Western) Limited. J. M. Anderson and J. A. Gower. June 13, 1960.	×	×	×
49° 122°	S.E.	Grand Trunk, Rambler, Morning Star, Stonie Creek K. C. McTaggart. W. H. White. February 29, 1960.	....	×	....
49° 120°	S.E.	South Pasayten Claims R. J. Perelli. Edward P. Chapman. October, 20, 1960.	....	×	....
49° 120°	S.W.	Whip and Saw Groups Texas Gulf Sulphur Company. W. R. Bacon. July 26, 1960.	×	×	×
50° 120°	N.W.	DRG Mineral Claims Kennco Explorations (Western) Limited. R. W. Stevenson. *September 23, 1960.*	×	×	×

REPORTS CREDITED FOR ASSESSMENT, 1960—*Continued*

Geographic Position		Property Owner or Principal Author of Report Date of Submission of Report	Kind of Work		
1° Quadr.	Quarter		Geological	Geophysical	Geochemical
50° 120°	S.W.	Lil Group L. B. Gatenby. L. B. Gatenby. October 15, 1960.	---	×	---
50° 120°	S.E.	Molly and B.E. Claims Spokane Syndicate Limited. C. F. Millar. November 17th, 1960.	---	×	---
50° 120°	S.W.	Shot Claim Group Prospectors Airways Co. Ltd. Roderick Macrae. December 29, 1960.	---	×	---
50° 120°	N.W.	Stump Lake Area Stump Lake Metal Mines Ltd. W. P. McReynolds and E. B. Nichols. May 20, 1960.	---	×	---
50° 121°	S.E.	K.T.I. Groups 1 and 2 Kennco Explorations (Western) Limited. R. W. Stevenson. January 7, 1960.	---	×	×
50° 121°	N.E.	Cache Claims Cache Creek Silica Co. Ltd. D. D. Campbell. March 23, 1960.	×	---	---
50° 121°	S.E.	Hank, Domino, Freda, P.C.M., and Cap Claims Britmont Mines Limited. F. J. Hemsworth. December 16, 1960.	---	---	×
50° 122°	N.W.	Hurley River Groups 1 and 2 Hurley River Mines Limited. Walter E. Clarke. November 22, 1960.	×	---	---
50° 122°	N.W.	Jean and June Claims Gray Rock Mining Company. Clive W. Ball. April 13, 1960.	×	---	---
50° 122°	S.W.	Tug No. 1 Mineral Claim A. C. Skerl. A. C. Skerl. April 8, 1960.	×	---	×
50° 124°	S.W.	Star and Ace Claims Norco Resources Ltd. H. H. Cohen. May 26, 1960.	---	×	---
50° 125°	N.W.	H. S. Group H. H. Cohen. H. H. Cohen. November 3, 1960.	×	---	---
50° 125°	N.E.	Fred 1–13, Red 1–12, J.D. 1–3 Fractions Phelps Dodge Corporation of Canada Limited. D. C. Malcolm. August 17, 1960.	×	---	---
50° 126°	S.W.	Fern Hill, Cedar Hill, and Trygg Fractions George Uebel. J. S. Ives. June 7, 1960.	×	---	---
51° 119°	S.E.	Buzz, Blip, and Bell Claims Magnum Copper Limited. D. W. Smellie. April 1, 1960.	---	×	---
51° 120°	S.E.	The Windpass Lease Fort Reliance Minerals Limited. A. D. Wilmot. December 28, 1960.	×	×	---

REPORTS CREDITED FOR ASSESSMENT, 1960—*Continued*

Geographic Position		Property Owner or Principal Author of Report Date of Submission of Report	Kind of Work		
1° Quadr.	Quarter		Geological	Geophysical	Geochemical
52° 122°	N.E.	Axis and J.G. J. Gallo and A. Berglund. R. A. Knutson. May 24, 1960.	---	×	---
52° 122°	N.W.	Brooks 1–16 Claims Island Prince Copper Limited. J. S. Scott. March 22, 1960.	---	×	---
52° 122°	N.E.	Duncan Claims J. Gallo. R. A. Knutson. May 31, 1960.	---	×	---
53° 122°	N.W.	Wed 13–80 Claims Totem Minerals Limited. R. A. Knutson. March 10, 1960.	---	×	---
54° 121°	S.W.	Lucky and Chalco W. L. Cannon. M. M. Menzies. September 14, 1960.	---	×	---
54° 122°	S.E.	Ace Groups I and II Totem Minerals Limited. Basil T. Wilson. September 1, 1960.	---	×	---
54° 126°	S.W.	Owl 1–12 and Nadina 1–4 Claims Farwest Mining Limited. W. M. Sirola. February 3, 1960.	---	×	---
55° 127°	S.W.	Strike and Ridge Groups G. L. Oates. G. L. Oates. November 3, 1960.	---	×	---
56° 130°	S.E.	Blue 1–3 and Mona 1–8 Granduc Mines Limited. G. W. H. Norman. March 23, 1960.	×	---	---
56° 130°	S.E.	Geo, Ajax, and J.P. Groups Granduc Mines Limited. G. W. H. Norman. February 4, 1960.	×	---	---
58° 129°	N.W.	Eye Group Totem Minerals Limited. R. A. Knutson. June 16, 1960.	---	×	---
58° 130°	N.W.	Raft Group Totem Minerals Limited. R. A. Knutson. June 16, 1960.	---	×	---
58° 130°	N.W.	Tuya 2 and 4 Erik Ostensoe. Roderick Macrae. January 14, 1960.	×	---	---
59° 133°	S.E.	Cop Claim Groups 1 and 2 Totem Minerals Limited. Basil T. Wilson. August 19, 1960.	---	×	---

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1961

IM-361-964