CANADA
DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

GEOLOGICAL SURVEY

MEMOIR 249

GEOLOGY AND MINERAL DEPOSITS OF NICOLA MAP-AREA, BRITISH COLUMBIA

BY

W. E. Cockfield

OTTAWA
EDMOND CLOUTIER, C.M.G., B.A., L.Ph.,
KING'S PRINTER AND CONTROLLER OF STATIONERY
1948

Price, 50 cents No. 2485

Tertiary lavas and agglomerates with a gentle southeasterly dip. Deadman River north of Criss Creek. (Pages 2, 35, 38.)

CANADA
DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

GEOLOGICAL SURVEY

MEMOIR 249

GEOLOGY AND MINERAL DEPOSITS OF NICOLA MAP-AREA, BRITISH COLUMBIA

BY

W. E. Cockfield

OTTAWA
EDMOND CLOUTIER, C.M.G., B.A., L.Ph.,
KING'S PRINTER AND CONTROLLER OF STATIONERY
1948

Price, 50 cents No. 2485

CONTENTS

CONTENTS—*Concluded*

Illustrations

PREFACE

Nicola map-area covers roughly 3,000 square miles in the southern interior region of British Columbia. It forms a characteristic part of the southern Interior Plateaux of that province, lying to the east of the Cascade Mountains, and is underlain by sedimentary and volcanic rocks ranging in age from Palæozoic to Tertiary, and by large batholiths of plutonic rocks. Mineral deposits of diverse types occur at widely scattered points. Deposits of gold and silver, lead and zinc, copper, mercury, tungsten, and iron, together with those of industrial minerals and coal, have been found.

Earlier geological work, much of it done more than 50 years ago, was very largely reconnaissance. The present account is based largely on the author's own field work extending from 1939 to 1944. It deals with the geology and mineral resources of the area, and is illustrated by a geological map that was undertaken as part of a plan of systematic geological mapping of the province of British Columbia. Selected references to earlier work are given, and it is hoped these will prove of value in tracing the history of mining, particularly on those properties where little recent work has been attempted.

GEORGE HANSON,
Chief Geologist, Geological Survey

OTTAWA, December 17, 1947

Geology and Mineral Deposits of Nicola Map-area, British Columbia

CHAPTER 1

INTRODUCTION

GENERAL STATEMENT

Nicola map-area covers roughly 3,000 square miles in the southern part of British Columbia between longitudes 120° and 121° west, and latitudes 50° and 51° north. The cities of Kamloops and Merritt, as well as a number of villages, lie within its borders. Within the area are mineral properties that are among the early lode discoveries of the province. The deposits near Stump Lake, for example, were staked between 1882 and 1884; but in spite of these early locations, followed at later dates by other discoveries, the mineral production of the area has remained relatively small compared with that of other nearby districts.

FIELD WORK AND ACKNOWLEDGMENTS

Field work on which this report is based was done during the seasons of 1939, 1940, and 1941, and at intervals in 1943 and 1944. The writer wishes to express his appreciation of the co-operation received from some of the property owners and other residents of the district. Particular thanks are due to Mr. D. B. Sterritt of Kamloops, who placed much information, gathered as a result of his investigations of a number of properties, at the writer's disposal; to Mr. A. E. Sjoquist and Mr. Gordon Dickson, of Kamloops, who showed the writer a number of mineral localities; and to officers of Consolidated Nicola Goldfields, Limited, for information and assistance in the examination of their property. During the course of the field work the writer was ably assisted in 1939 by A. R. Allen, W. H. Mathews, and the late D. Clarke Holland; in 1940 by W. H. Mathews and S. A. Kerr; and in 1941 by W. H. Mathews and K. G. McTaggart.

ACCESSIBILITY

The area is traversed by the transcontinental lines of the Canadian Pacific and Canadian National Railways, both of which pass through Kamloops, 250 miles northeast of Vancouver. In addition, the Nicola and Coldwater branch of the Canadian Pacific Railway, which connects the main line at Spences Bridge with the Kettle Valley branch, passes through Merritt and up Coldwater River.

The district is also accessible by motor road. The Trans-Canada Highway follows the valley of South Thompson and Thompson Rivers. It is joined to the east of Kamloops by a highway that leads south through

Okanagan Valley to the southern Trans-Provincial highway. A second highway leads south from Kamloops to Merritt, where it joins a highway from Spences Bridge that continues south to Princeton. From these highways many roads lead to different localities, so that few parts of the area are not within a short distance of motor transportation.

PHYSICAL FEATURES

Nicola map-area lies to the east of Cascade Mountains within the belt of Interior Plateaux. The topographic features comprise rolling summits and broad upland areas separated by deeply cut valleys. The master valleys include those of Thompson River and its main tributaries, North and South Thompson Rivers, all of which are large streams. The southern part of the area is drained by Nicola River and its tributaries, of which the principal streams are Coldwater River and Guichon Creek. Nicola River flows westerly to join Thompson River at Spences Bridge, beyond the limits of the map-area.

The maximum relief is approximately 5,100 feet, but as many of the larger valleys stand at elevations of 2,000 feet or more above sea-level and few of the hills attain altitudes of more than 5,500 feet, the average relief is very much less. The hills are generally rounded and lack the rugged character of the mountains farther west and south. In many places long, drift-covered slopes rise from the valleys to the upland surface, but locally the hill slopes are rocky and minutely rugged (*See* Plates I, II, and III).

The region is situated within the dry belt of British Columbia, and the rainfall in the lower valleys is exemplified by that at Kamloops, which is between 10 and 11 inches a year. The lower slopes of the valleys are open and covered with sagebrush, and the lower slopes of the hills support an open, park-like forest with little underbrush. Rainfall on the upper slopes is, however, presumably much greater than the figure given, as is evidenced by the change in vegetation to a more dense forest growth.

SELECTED BIBLIOGRAPHY

British Columbia, Minister of Mines, Annual Reports.

Camsell, Charles; Mercury Deposits of Kamloops Lake; Geol. Surv., Canada, Sum. Rept. 1918, pt. B, pp. 17-22 (1919).

Coats, Robert: Propylitization and Related Types of Alteration on the Comstock Lode: Econ. Geol., vol. XXXV, 1940, pp. 1-16.

Cockfield, W. E.: Nicola, British Columbia; Geol. Surv., Canada, Prel. Paper 44-20, 1944.

Cole, L. H.: Gypsum in Canada; Mines Branch, Dept. of Mines, Ottawa, Report No. 245, 1913.

——— Investigation of Mineral Resources and the Mining Industry, 1926; Mines Branch, Dept. of Mines, Ottawa, Report No. 687, 1928.

——— The Gypsum Industry of Canada; Mines Branch, Dept. of Mines, Ottawa, Report No. 714, 1930.

Crockford, M. B. B., and Warren, P. S.: The Cache Creek Series of British Columbia; Trans. Roy. Soc., Canada, vol. XXIX, sec. IV, 1935, pp. 149-161.

Cummings, J. M.: Saline and Hydromagnesite Deposits of British Columbia; B.C. Dept. of Mines, Bull. No. 4, 1940.

——— Industrial Minerals in British Columbia; Bull. Can. Inst. Min. and Met., Nov. 1938.

Daly, R. A.: A Geological Reconnaissance between Golden and Kamloops, B.C., along the Canadian Pacific Railway; Geol. Surv., Canada, Mem. 68, 1915.

DAWSON, G. M.: Preliminary Report on the Physical and Geological Features of the Southern Portion of the Interior of British Columbia; Geol. Surv., Canada, Rept. of Prog. 1877-8 (1879).

——— Report on the Area of the Kamloops Map-sheet; Geol. Surv., Canada, Ann. Rept. 1894, vol. VII, pt. B (1896).

DRYSDALE, C. W.: Geology of the Thompson River Valley Below Kamloops Lake, B.C.; Geol. Surv., Canada, Sum. Rept. 1912, pp. 115-150 (1914).

DUFFELL, S., and MCTAGGART, K. C.: Preliminary Map, Ashcroft, British Columbia; Geol. Surv., Canada, Paper 46-8, 1946.

——— Second Preliminary Map, Ashcroft, British Columbia; Geol. Surv., Canada, Paper 47-10, 1947.

ELLS, R. W.: Nicola Coal-Basin, B.C.; Geol. Surv., Canada, Ann. Rept. 1904, vol. XVI, pt. A, pp. 42-74 (1905).

EARDLEY-WILMOT, V. L.: Diatomite; Mines Branch, Dept. of Mines, Canada, Report No. 691, 1928.

JOHNSTON, R. A. A.: The Copper Claims of Aspen Grove and Aberdeen Camp, B.C.; Geol. Surv., Canada, Ann. Rept. 1904, vol. XVI, pt. A, pp. 74-80 (1905).

——— A List of Canadian Mineral Occurrences; Geol. Surv., Canada, Mem. 74, 1915.

KEELE, J.: Mines Branch, Dept. of Mines, Sum. Rept. 1918, p. 160 (1920).

LINDEMAN, E., and BOLTON, L. L.: Iron Ore Occurrences in Canada; Mines Branch, Dept. of Mines, Canada, vol. I, 1917.

MILLER, A. K., and WARREN, P. S.: A Propinoceras from North America; Amer. Jour. of Sci., vol. XXVI, Sept. 1933, pp. 295-299.

MILLER, A. K., and CROCKFORD, M. B. B.: Permian Cephalopods from British Columbia; Trans. Roy Soc., Canada, vol. XXX, sec. IV, 1936, pp. 23-28.

RICE, H. M. A.: Geology and Mineral Deposits of Princeton Map-area, B.C.; Geol. Surv., Canada, Mem. 243, 1947.

RIES, H., and KEELE, J.: Clay and Shale Deposits of the Western Provinces; Geol. Surv., Canada, Mem. 25, pp. 73-4 (1913).

ROSE, Bruce: Savona Map-area; Geol. Surv., Canada, Sum. Rept. 1912, pp. 151-155 (1914).

SPENCE, H. S.: Bentonite; Mines Branch, Dept. of Mines, Report No. 691, 1928.

STEVENSON, J. S.: Copper, Tourmaline and Hematite Veins at Highland Valley, B.C.; Dept. Min. and Pet., Univ. of Toronto, No. 42, 1939.

——— Mercury Deposits of British Columbia; B. C. Dept. of Mines, Bull. No. 5, 1940.

——— Tungsten Deposits of British Columbia; B.C. Dept. of Mines, Bull. No. 10, 1943.

STEVENSON, Mrs. L. S.: Rhyodacite from the Tranquille Plateau, British Columbia; Amer. Mineralogist, vol. 24, 1939, pp. 446-7.

THOMPSON, E. A., and SADLER, A.: Chemical and Physical Characters of Bentonite; Mines Branch, Dept. of Mines, Sum. Rept. 1921, pp. 73-77 (1923).

UGLOW, W. L.: Geology of North Thompson Map-area; Geol. Surv., Canada, Sum. Rept. 1921, pt. A, pp. 76-78 (1922).

WALKER, J. F.: Clearwater River and Foghorn Creek Map-area, Kamloops District; Geol. Surv., Canada, Sum. Rept. 1939, pt. A (1931).

YOUNG, G. A., and UGROW, W. L.: Iron Ores of Canada—Vol. I; Geol. Surv., Canada, Econ. Geol. Ser. No. 3, 1926.

CHAPTER II

GENERAL GEOLOGY

INTRODUCTORY STATEMENT

The consolidated rocks of the map-area range in age from Carboniferous to Tertiary, and include both sedimentary and igneous types. The latter are much more widespread than the sedimentary rocks, and comprise both intrusive and effusive types.

The Palæozoic era is represented by a group of sedimentary and igneous rocks that outcrop chiefly in the northeastern and southeastern parts of the area. These rocks are of Carboniferous and Permian age.

The Mesozoic era is represented by thick accumulations of volcanic rocks, together with minor amounts of interbedded sedimentary strata and extensive areas of intrusive rocks. Greenstone of Triassic age, with minor amounts of sedimentary rock, underlies a large part of the map-area. It is succeeded by other volcanic and sedimentary rocks that have only a limited distribution in the area but are more widespread to the west and southwest.

Those intrusive rocks that come in contact with the Triassic volcanic rocks invariably cut them. However, granitic boulders are prevalent in the agglomerates near the base of the Lower Cretaceous series. A few small bodies of plutonic rocks are intrusive into Cretaceous or possibly Tertiary formations.

The Cenozoic era is represented by both sedimentary and volcanic rocks. The Coldwater beds of Miocene or earlier age have a fairly limited development, but appear to antedate the period of Tertiary vulcanism. The Tranquille beds, on the other hand, are interbedded with Tertiary volcanic rocks. Palæontological evidence is not sufficient to affirm that these two sedimentary assemblages differ in age, but the structural relations would appear to indicate this. The Kamloops group includes thick accumulations of Tertiary volcanic rocks, which occur in many parts of the area but are thickest in the north.

TABLE OF FORMATIONS

Era	Period	Epoch	Formation		Lithology
Cenozoic	Quaternary	Pleistocene and Recent			Stream alluvium and delta deposits; glacial drift and glaciofluvial terrace deposits
	Tertiary	Miocene or later	Valley basalt		Mainly vesicular basalt
		Miocene or earlier	Kamloops group	Volcanic rocks	Rhyolite, andesite, basalt, with associated tuffs, breccias, and agglomerates
				Tranquille beds	Conglomerate, sandstone, shale, and tuff; thin coal seams
				Coldwater beds	Conglomerate, sandstone, shale, and coal

Era	Period	Epoch	Formation	Lithology
Mesozoic and/or Cenozoic	Cretaceous or Tertiary	Post-Lower Cretaceous	Copper Creek intrusions	Granite, granodiorite, granite porphyry
		Lower Cretaceous(?) or later		Andesite; basalt; picrite, agglomerate, breccia, and tuff; serpentine; minor conglomerate and sandstone
				Conglomerate, sandstone, and shale
Mesozoic	Cretaceous	Lower Cretaceous	Kingsvale group	Rhyolite, andesite, basalt, agglomerate, breccia, tuff; arkose; conglomerate
			Spence Bridge group	Hard, reddish lava
	Jurassic and(?) later	Jurassic and(?) Lower Cretaceous	Coast intrusions	Granite, granodiorite, quartz diorite, diorite, gabbro, and pyroxenite
	Triassic	Upper Triassic	Nicola group	Greenstone, andesite, basalt, agglomerate, breccia, tuff; minor argillite, limestone, and conglomerate
Palæozoic	Carboniferous and Permian		Cache Creek group(?)	Greenstone, slightly sheared
				Argillite, quartzite, hornstone; greenstone and serpentine; limestone, conglomerate, and breccia
Undifferentiated Palæozoic and later				Chlorite schist, quartz-mica schist, amphibolite, and granitic intrusions

DESCRIPTIONS OF FORMATIONS

UNDIFFERENTIATED ROCKS

In certain parts of the area a group of schists and gneisses has been mapped separately. These rocks consist of chlorite schist, quartz-mica schist, amphibolite, and granite-gneiss. They represent metamorphosed rocks in the vicinity of granitic intrusions, and little information on their age was obtained. On the west flank of the batholith that cuts across Nicola Plateau, conglomerates and argillites similar to those of the Cache Creek group, but strongly sheared, were found. The rocks in this section contain much gneissic granitic material. To the north, in the vicinity of Peterson Creek, such rocks apparently form part of an anticline that has been invaded by granitic rocks. They appear conformable with the rocks of the Nicola group to the northeast, but are highly sheared. Few data were obtained on the actual contact. At this point again the rocks contain bands of conglomerate similar to those described above. The rocks shown

in this group are believed to be largely members of the Cache Creek, but Triassic members and younger granitic intrusive rocks are probably also included.

CACHE CREEK GROUP (?)

The oldest rocks recognized in the Nicola map-area form a sedimentary and igneous group that is widespread in the eastern part of the area. These are rocks that Dawson (1879, pp. 79-81; 1896, pp. 44-46B, 103-107B)[1] included with his Cache Creek group. They consist of argillite, quartzite, hornstone, conglomerate and breccia, greenstone and tuff, limestone, amphibolite, gneiss, and schist.

Distribution. The Cache Creek rocks occupy two large areas in the eastern part of the map-area. The more southerly of these is developed along the upper reaches of Nicola River, and extends from that stream across Douglas Plateau to Stump Lake where the rocks disappear beneath more recent rocks. It is separated by a large mass of granitic rocks from the northern belt, which extends from Shumway Lake, Campbell Creek, and the northern slopes of Monte Hills across South Thompson and North Thompson Rivers to occupy most of the northeast quarter of the map-area.

Lithology. Much of the Cache Creek group is composed of hard, dark grey to black argillites that in places are silicified into dense rocks similar to hornfels. Some of the argillites are well bedded, and consist of alternating bands of dark, fine-grained material with thinner bands of lighter coloured and somewhat coarser material. Locally they have a well-defined, slaty cleavage, and in some places are so cut by joint planes that they crumble readily into rubbly slopes. They are interbedded with quartzites, and a little hornstone, conglomerate, and breccia. The conglomerate contains well-rounded pebbles of argillite, chert, quartzite, and feldspar porphyry in a siliceous matrix. The pebbles are generally 1 to 2 inches in diameter, but locally cobbles up to 9 inches in diameter were observed. In places the pebbles are elongated in a single direction, and the matrix of the conglomerate is badly sheared. The conglomerates appear to occur at several horizons, and little success attended the effort to trace them. The distribution of pebbles within the rock varies greatly from place to place; at some places they are abundant and at others not far away along strike they are comparatively scarce. With the conglomerates are associated breccias composed of angular fragments of argillite, chert, and quartzite in a fine-grained, siliceous matrix.

Associated with the rocks described are bands of greenstone, tuff, and agglomerate. These are generally dark to light green rocks, much of the material being apparently fragmental. In the northern part of the map-area greenstone is more important areally, and an attempt has been made on the accompanying map to separate them from the sedimentary rocks. This separation is by no means complete. The rocks were described by Uglow (1922, pp. 76A-78A), who thought them to be a complex of altered basic rocks of intrusive, extrusive, and fragmental characters, and grouped them with Palæozoic or Precambrian rocks. Walker (1931, pp. 132-133A), on the other hand, presented evidence to show that the greenstone at this

[1] References, in parentheses, are to reports listed in the bibliography, pages 2, 3.

locality was intrusive into the Carboniferous (?), and concluded that it was of Triassic age. There is little doubt in the section along Peter Peak Ridge and Mount Harper that the Cache Creek rocks there contain eruptive material (Daly, 1915, pp. 120-121; Dawson, 1896, p. 41B). Farther north, towards the area examined by Walker and Uglow, the writer found some rocks believed to be volcanic breccias and amygdaloids, apparently interbedded with the sedimentary rocks. In many places the softer sedimentary rocks have been crushed against the more competent layers of the volcanic rocks, making it difficult to determine the relations in limited exposures. The greenstone is believed by the writer to be essentially contemporaneous with the sedimentary rocks, but the possibility that it includes intrusive members of contemporaneous or later age is not precluded.

Limestone occurs at many points in an area that extends from South Thompson River, near the eastern margin of the map-area, northwestward towards Jamieson Range. It also occurs in the vicinity of Cold Creek (a tributary of Paul Creek), Heffley Creek, and Heffley Lake, and in the vicinity of the Sullivan Range, and near Buse Hill south of Thompson River. The limestone is generally grey to white; in places the bedding is well marked, but generally it is obscure. Fossils are scarce at most exposures, but locally they are plentiful although poorly preserved, and in some places the beds might be described as coquina.

Although the more important limestone masses are shown separately on the accompanying map, it is not intended to imply that they differ in age from the other members of the group, with which some of them are interbedded. They were mapped separately in the hope that they would afford valuable information on the structure or stratigraphy, but it was found exceedingly difficult to relate the different exposures. Although limestone is of common occurrence in the northeastern part of the map-area, it is scarce elsewhere in the rocks of the Cache Creek group.

The amphibolites of the Cache Creek group are dark green to nearly black rocks that under the microscope show individuals of amphibole altering to chlorite, and in some slides plagioclase in a fine mosaic of feldspar and quartz. Some sections contain much biotite. The amphibole shows ragged ends penetrating the fine-grained matrix, and much of the groundmass is recrystallized so that the original character of the rock is in doubt. It probably represents a fragmental volcanic rock that has been altered.

Included with the rocks of the Cache Creek group are some that are sheared, and that are now biotite slate, and mica and chlorite schists. Dawson separated out the rocks of the northeast corner of the map-area and included them with his Nisconlith and Adams Lake series of Precambrian and Cambrian age respectively. A few scattered fossils were found in limestone and in the less sheared argillite north and south of Heffley Lake in the area included by Dawson in his Adams Lake series. These consisted entirely of crinoid columns and are valueless as diagnostic fossils for correlation purposes. Nevertheless, they do serve to throw some doubt on a separation of these rocks from those of the Cache Creek group. Furthermore, much metamorphosed rocks, locally schists, were found in the area of Jamieson and Wentworth Creeks associated with rocks that undoubtedly form part of the Cache Creek group. It was, consequently, believed that the rocks formerly mapped as Nisconlith on Louis Creek, and

the rocks correlated with the Adams Lake series in the northern part of the map-area, were merely metamorphosed members of the Cache Creek group, and for this reason no subdivision is shown on the map.

Internal Structural Relations. The attitudes of the Cache Creek strata indicate great structural complexity, and no satisfactory section has been worked out. Rapidly changing attitudes indicate complicated folding, and in addition much faulting of the beds has taken place. Members, such as limestone, which ordinarily form good horizon markers, have been so sliced and folded that they cannot be related from point to point, and thus become valueless for the purpose. Daly (1915, pp. 120-121) constructed a provisional section along the ridge of Paul Peak from Kamloops east, showing 13,700 feet of beds, chiefly argillite, sandstone and quartzite, hornstone, limestone, and volcanic materials. In places along this line of section, however, rapidly changing dips give evidence of close folding, but in spite of this, the limestone beds that appear at the eastern end of the ridge are not repeated to the west. The structure is, thus, probably much more complicated than has been assumed, and it is doubtful if the section has any general application to the rocks elsewhere in the map-area.

External Structural Relations. Near the eastern margin of the map-area the Cache Creek rocks are overlain by members of the Nicola group. Both groups are apparently conformable, but the lithology indicates an erosional unconformity, as the basal bed of the Nicola rocks is a conglomerate, 150 feet thick, that has been described by Daly (1915, pp. 122-123). This conglomerate carries rounded and angular fragments of chert, limestone, argillite, quartzite, and quartz, with large fragments of porphyry. Elsewhere, and more particularly in the area south of Kamloops, the separation of the rocks of the two groups presents a problem. This has been discussed at some length by Dawson (1896, pp. 45B, 122-124B) in relation to the Campbell Creek beds. Reference has already been made to the occurrence of conglomerate and breccia at different horizons within the Cache Creek group. It was at first thought that this conglomerate might represent a significant erosional interval between the two groups, but its subsequent discovery at several places in close association with rocks that are lithologically identical with other members of the Cache Creek group renders this conclusion extremely doubtful. The Cache Creek-Nicola contact was, therefore, drawn where the rocks became preponderantly of volcanic origin, that is, at the base of the massive Nicola greenstone. At several places where attitudes could be obtained this treatment appeared to separate rocks that were conformable. However, the rocks on which the Nicola group rests vary in character from place to place, being at one point limestone, at another argillite, and at others amphibolite, and so forth, which would indicate erosion of the Cache Creek rocks prior to the deposition of the Nicola group.

Age and Correlation. Dawson assumed that the limestone masses of the northeast part of the map-area might be equivalents of the Marble Canyon limestone, or upper part of his Cache Creek group farther west. Daly also considered that the limestone forming the eastern part of his section of these rocks along South Thompson River might be the upper part of the Cache Creek group, pointing out that they were overlain by the

rocks of the Nicola group. Some of Daly's fossil evidence would tend to support his contention. Miller, Crockford, and Warren (1933, pp. 295-299; 1935, pp. 149-161; 1936, pp. 23-28) obtained fossils from some of these limestones that would tend to correlate them with the limestones of the Cache Creek group. Elsewhere in this report it is pointed out that the rocks of the Nicola group are in contact with different members of the Cache Creek group, and no new evidence was obtained that would permit a definite correlation of the Cache Creek group limestones with those of Marble Canyon; on the contrary the evidence obtained by the writer would indicate that some of the limestones at least are older than those of Marble Canyon.

Fossils were obtained at many points within the Cache Creek rocks, chiefly from the limestone members, but also from limy pods within the argillites and in one place from a band of conglomerate. The fossil collections were examined by Alice E. Wilson of the Geological Survey, and the following determinations were made:

Rock Face (north slope of Mount Harper)
- *Hapsiphyllum calcareforme* (Hall)?
  - cf. *Campophyllum torquium* (Owen)
- Coral, new form ? small, branching, tripartite
- *Syringopora aculeata* Girty

Mount Harper
- *Lophophyllum profundum* (E. and H.)
- *Productus* sp.
- Bryozoa, undt.
- *Productus* cf. *burlingtonensis* Hall
- *Cyathophyllum* sp., very poor

Mount Rayleigh
- *Aulopora* cf. *curva* Shimer
- *Lophophyllum profundum* (E. and H.)
- *Lithostrotion* sp., finer and smaller than *L. pennsylcanicum* Shimer; finer than *L. banffense* Warren
- Bryozoa
- *Productus* sp.
- *Pugnax* sp.
- *Spiriferina* sp.
- *Composita* sp.
- *Cliothyridina* sp.

Robins Lake (east of Mount Harper)
- Crinoid disks
- *Syncladia biserialis* (Swallow)
- *Fenestella* cf. *rudis* Ulrich
- *Polypora* sp.
- *Productus* sp. close to *P. magnus*
- *Pustula* sp. new?
- *Spirifer* sp. close to *S. rowleyi*

Dome Hills
- Bryozoa
- *Productus* sp.
- *Pustula* sp. near *P. punctatus* Martin but with more angular geniculation
- *Martinia* sp.

Harper's ranch (east of Mount Harper)
- *Martinia* sp.

In addition there were a number of undetermined bryozoa, a brachiopod, and several crinoid stems from various localities.

Dr. Wilson observes that these forms are of Carboniferous age. The fauna is limited and not always well preserved. Part of the associated fauna is suggestive of the coral horizons of the upper part of the Missis-

sippian Rundle formation of southwestern Alberta. Dr. Wilson also notes that a bryozoan horizon at about the middle of the Rundle is represented by an association of forms similar to those of some of these groups.

M. Y. Williams[1] of the University of British Columbia placed at the writer's disposal the results of determinations made on a small collection of fossils sent in to him from the north side of South Thompson Valley, presumably from the limestone near the eastern edge of the map-area. Dr. Williams states: "I find that there are two brachiopods and a number of corals. The brachiopods are in very poor condition, but appear to be *Neospirifer cameratus*? and *Rhynchopora magnicosta*?. The corals are *Zaphrentis* sp., and appear to correspond with the general type found in Carboniferous formations, although I have not identified the species. The brachiopods would appear to place the formation in the lower part of the Pennsylvanian".

Daly (1915, pp. 121-122) made a number of fossil collections from the limestones. These were submitted to Dr. G. H. Girty of the United States Geological Survey, who concluded that the collections represented about the same type of fauna and about the same age. "The geologic age may be Gschelian (Upper Pennsylvanian) but one or two forms, particularly *Spiriferella arctica*, if the imperfect fragment really does belong to that species, suggests the Artinskian (Middle Permian), or at least the White River fauna, which Holtedahl thought represented the Artinskian in Alaska".

Miller and Warren (1933) and Miller and Crockford (1936) report the occurrence of cephalopods from the upper limestone (Daly's member 1) of the section along South Thompson River. These cephalopods include the following:

Propinacoceras americanum Miller and Warren
Paraceltites
Agathiceras cf. *A. suessi* Gammellaro
Adrianites warreni Miller and Crockford

Crockford and Warren (1935) discuss the occurrence of corals, brachiopods, pelecypods, gastropods, etc., from the same member at a locality 12 miles east of Kamloops. The following identifications are given:

Streptorhynchus pelargonatus Schlotheim
Camarophoria cf. *applanata* Tschernyschew
Camarophoria globosa Tschernyschew
Camarophoria karpinskii Tschernyschew
Camarophoria mutabilis Tschernyschew
Camarophoria cf. *plicata* Tschernyschew
Spirifer interplicatus var. *bashkirica* Tschernyschew
Spirifer moosakhailensis Davidson
Spiriferella salteri Tschernyschew
Reticularia (*Squamularia*) *lineata* Tsch. non Martin
Spiriferina billingsi Shumard
Aviculipecten laqueatus Girty ?
Propinacoceras americanum Miller and Warren

The conclusion is reached by these writers that the forms are Permian (probably Middle Permian) and that the beds are to be correlated with the limestones of the Cache Creek group, from which Permian fossils have been obtained at several localities in British Columbia. This correlation is

[1] Williams, M. Y.: personal communication.

also strengthened by the evidence obtained by Girty from Daly's fossils to show that Gs(c)helian (Upper Pennsylvanian) and Artinskian (Middle Permian) may be present.

On the other hand, the writer's collections have been identified with species from the Rundle formation, which is of Mississippian age. Part of the writer's collections, namely, that from Robins Lake north of South Thompson River near the eastern edge of the area, may come from the same member as that from which Miller, Warren, and Crockford obtained their specimens, but taken from a different locality. The remaining collections made by the writer were from the limestone occurrences farther northwest, which in view of the structural complexity, cannot be definitely identified with the upper limestone member from which Miller, Warren, and Crockford obtained their collections. The age determinations of the different collections show a wide variation. The cephalopods obtained by Miller, Warren, and Crockford appear to be the more diagnostic fossils, and there appears to be little doubt that part of the group is Permian and Pennsylvanian, and, therefore, of the same age as the rocks of the Cache Creek group occurring elsewhere in British Columbia. If the Mississippian is also represented the age of the group would be extended beyond that usually assigned to the Cache Creek. In view of this possibility it has appeared best to refer to this group as Cache Creek group only provisionally, until more conclusive evidence is obtained.

NICOLA GROUP

The rocks composing the Nicola group have a large areal development within the map-area. They consist principally of volcanic rocks, with which are associated minor amounts of sedimentary rocks—limestone, argillite, and conglomerate. They extend in a broad belt from the southern part of the area, where, in the vicinity of Nicola Lake, they form the type section (Dawson, 1896, p. 131B), to the northwest part of the area. The belt underlain by the rocks of this group is more than 20 miles wide in the southern part of the area, narrowing to 15 miles in its central part and to less than 5 miles in the northwest part. The rocks of the Nicola group are, however, covered extensively by later volcanic rocks in the northern part of the area. They are also invaded by bodies of plutonic rocks, some of which attain considerable size. Other small areas of Nicola rocks occur along South Thompson River in the vicinity of the eastern margin of the map-area, and in a narrow belt northwest and southeast of Kamloops.

Lithology. The volcanic rocks comprise a number of diverse types, but may be very largely grouped under the general term of greenstone. The typical rocks may be readily distinguished in appearance from rocks of younger volcanic groups, but comparatively unaltered types may be difficult to separate from younger rocks that have undergone alteration. In some instances structural relations are of assistance in separating such doubtful rocks, but these could not always be determined.

The Nicola rocks vary from fine-grained or nearly aphanitic types to very coarsely porphyritic rocks. Green or greenish grey types predominate, but various shades of purple, red, or brown also occur, together with rocks that are dark or nearly black. Associated with the lavas are tuffs, breccias, and agglomerates that also vary in colour and appearance.

Among the lavas the most common type is a grey-green to bright green, fine-grained rock that shows much alteration to chlorite, calcite, and epidote. A very similar rock carries phenocrysts of hornblende, which in many instances has developed by uralitic alteration of augite, and is now partly altered to chlorite. The feldspars usually show advanced alteration, but where determinable are generally andesine. Secondary calcite and quartz are common, and epidote is commonly abundant. The rocks are presumably altered from hornblende and augite andesites. Grey, purple, and red types show little variation in composition from the others, but the groundmass of the purple and red rocks is impregnated with iron oxide. Included are also a number of grey, green, and brown types that approach the composition of basalt.

The group also includes a number of feldspar porphyries, with feldspar crystals ranging from minute size to others with ragged crystals nearly half an inch long. In those specimens of coarse porphyries examined under the microscope the large feldspar phenocrysts were labradorite, and in some thin sections a second generation of smaller feldspar crystals of about the same composition was observed, these being larger than the laths of feldspar making up the groundmass. These, in turn, showed little variation in composition from the larger phenocrysts. Augite was the common ferromagnesian mineral. The porphyritic types generally showed less alteration than those previously described.

Amygdaloidal types are common in both fine-grained and porphyritic rocks, the amygdules being composed of chlorite, calcite, quartz, and chalcedony. Dawson (1896, p. 143B) reports the occurrence of zeolites south of Meadow Creek, but none was found by the writer.

The breccias also vary widely in appearance. In one type the material consists of cognate fragments that differ little in appearance from the matrix, and the character of the rock as a breccia, when altered, can only be distinguished on close examination. On the other hand, some breccias of this type are remarkably fresh in appearance, and might readily be mistaken for rocks belonging to more recent volcanic groups. A very common type of breccia consists of a green, fine-grained rock carrying widely scattered, small, angular fragments of red or purple lavas. Were is not for these fragments the fragmental character of the rock would be difficult to recognize on macroscopic examination. On the other hand, many breccias carry numerous fragments of rock of different colour and character from the matrix.

The agglomerates do not differ greatly from the breccias, but carry in addition fragments of the sedimentary rocks of the group. The most common fragments are of Nicola limestone, many of them carrying obscure fossils.

Beds of tuff occur at several localities in the rocks of the Nicola group, and it is chiefly on these, and on intercalations of sedimentary beds, that data were obtained on the attitudes of the rocks. The tuffs appear to be more prevalent in the upper parts of the section, and are exceptionally well developed in the vicinity of Meander Hills. Dawson (1896, p. 136B) believed that these rocks represented the uppermost part of the Nicola group as developed in this area. They are fine-grained, well-bedded rocks, and are generally grey, green, or black.

Only minor amounts of sedimentary rocks occur with the volcanic rocks of the group within the map-area. The most prominent of these is limestone, which occurs at a number of widely scattered localities. In general the limestone bands can rarely be traced for any considerable distance along their strike. They are prominent on Swakum Mountain, on the hills to the south of Nicola Lake, on the hills to the south of Iron Mountain, and on the western and southwestern slopes of the Promontory Hills, but they also occur at numerous other points in the area. They have yielded fossils at many points, and hence are important in permitting the grouping of some rocks with the Nicola whose ages might otherwise be difficult to determine. The limestones are generally grey to white and partly crystalline.

Argillite is not common in the rocks of the Nicola group within the map-area. It was found near the mouth of Deadman River and at Tobacco Creek, a tributary of this stream, near the northern border of the map-area, at both of which points fossils were obtained. Elsewhere only a few isolated outcrops were observed.

Conglomerate also occurs sparingly. One body appears about a mile north of Stump Lake, and as far as could be ascertained was of lenticular outline associated with limestone and fine-grained, red, tuffaceous rock that passes into breccia along its strike. The conglomerate is red, consisting of well-rounded pebbles of volcanic rocks ranging up to 5 inches in diameter and closely packed in a red, sandy matrix that is possibly tuffaceous. Relatively abundant fossils of one species, *Monotis subcircularis*, are in places closely packed in the matrix. The limestone contains angular blocks of red, tuffaceous rock. At a number of other localities where conglomerate appeared the pebbles were largely of limestone. These conglomerates apparently represent local basins of sedimentation and local unconformities within the Nicola group. No data were secured to show that they represented any general time break.

Some breccias, agglomerates, and other volcanic rocks that in an earlier report (Cockfield, 1944) were grouped with the Cretaceous rocks of the southwest part of the area are now included with the rocks of the Nicola group. These contained many limestone pebbles, and in some places pebbles that in the field were believed to represent plutonic rocks of the region. Close examination of some of these pebbles shows them to be porphyries not differing greatly from porphyritic boulders included in the Nicola rocks elsewhere. Some are badly altered plutonic rocks, but the bodies from which they were derived have not been recognized in the area. The occurrence of limestone pebbles indicates an erosional unconformity between the limestone and the overlying agglomerates, but, as has been pointed out, local unconformities occur at other points within the rocks of the Nicola group. As fossiliferous limestone has been found at several localities within these rocks the writer is of the opinion that they should properly be included with the rocks of the Nicola group.

Structural Relations. Considerable parts of the Nicola group are represented by massive volcanic rocks in which it is difficult to distinguish individual flows. For this reason structural data are relatively scanty, and most of the observations that were made on the attitudes of the rocks depended upon the presence of intercalations of sedimentary rocks or tuff beds.

The contacts between the rocks of the Nicola and Cache Creek groups have already been discussed. The Nicola rocks are overlain unconformably by later volcanic and sedimentary rocks. They are also invaded by all the plutonic rocks of the area with which they come in contact. The occurrence of pebbles of plutonic rocks locally in the Triassic rocks has already been referred to. None of these has been related to the plutonic rocks found in the Nicola area.

In the southern part of the map-area, wherever the attitude of these rocks could be determined at a sufficient number of points to outline the major structures, the rocks of the group appear to be folded along axes running nearly north. This direction is at variance with the regional trend, which is more nearly generally northwest. In the area of the Meander Hills there is indicated a syncline, or more probably a synclinorium, the axis of which, although curved, runs generally north. The continuation of this structure was not found in the hills immediately to the north of Nicola River, but in the vicinity of Stump Lake comparatively few attitudes again indicate a syncline with an axis trending slightly east of north. The flows to the east of the lake dip west; those to the west of the lake dip east; and some well-bedded tuffs on Mineral Hill near Stump Lake strike nearly east and dip north. Dawson (1896, pp. 134-136B) believed that a number of folds were indicated by the exposures west of the Meander Hills. No new evidence on this point was obtained. On Swakum Mountain, however, the limestone bands to the northeast of the summit strike northeast and dip steeply southeasterly; some distance south of the summit, limestone bands strike nearly east and dip steeply south, and three-quarters mile west of the summit the limestone bands strike northwest and dip southwest at more gentle angles. If these limestone occurrences can be assumed to represent a general horizon within the volcanic rocks, the structure is that of an asymmetrical anticline with a southerly plunging, north-trending axis. Elsewhere in the southern part of the area observations of attitudes are too scanty to permit of outlining the major structures. However, it should be noted that the bodies of plutonic rocks in this part of the area have also a general northerly trend.

A few miles to the south of Kamloops the trend of the folds in the Triassic rocks swings to the northwest. The Iron Mask batholith is apparently intruded into one limb of a syncline in the rocks of the Nicola group, the axis of which runs northwesterly towards Kamloops Lake.

Age and Correlation. Evidence with regard to the age of the Nicola group in this map-area rests upon the determination of a few fossils gathered at widely scattered localities. Most of them were obtained from bands of limestone, but some were found in argillites, and also, as mentioned above, from a conglomerate. For the most part the fossils were poorly preserved, and consisted of crinoid columns, with corals, bryozoa, and poorly preserved gastropods. The corals and bryozoa were not determined. The following determinations were made by F. H. McLearn of the Geological Survey:

Stump Lake conglomerate
Monotis subcircularis
Pecten sp.
Late Neo-Triassic

Stump Lake limestone
Star-shaped crinoid stem

South of Iron Mountain
Cassianella sp.
Triassic

Hills South of Nicola Lake
Palaeocardita? cf. *buruca* Boehm
May be Triassic

North of Walhachin
Ostrea?
Lima?
Halobia? or *Daonella?*
Provisionally dated Triassic

Tobacco Creek, Deadman River
Monotis?
Fragmentary ammonites
Provisionally dated Triassic

Deadman River, near mouth
Halobia? or *Daonella?*
Poorly preserved ammonite
Belemnoid
Provisionally dated Triassic

The evidence afforded by these fossils substantiates Dawson's (1896, pp. 50-51B) conclusion that a great part of the assemblage was of Triassic age. However, no fossils of Jurassic age similar to those found by Dawson south of Ashcroft were obtained.

In view of the scanty evidence with regard to age, few correlations can be made. There would appear to be little doubt, however, that the rocks may be correlated with the assemblages of volcanic and sedimentary rocks that occur in adjoining areas to the south and west, and also that they are the equivalents of rocks of somewhat similar character that are widespread on Vancouver Island.

COAST INTRUSIONS

Plutonic rocks underlie considerable parts of the map-area. They include different types and possibly rocks of several different ages, but data are generally lacking that would permit fixing their ages within precise limits.

Distribution. One large batholith occupies the southeastern part of the map-area, extending from the southern border northwards to Spahomin Creek, and from the eastern border of the area west to Minnie Lake. A second batholith extends northward from Nicola Lake to Peterson Creek, a distance of 26 miles. It has a width of 4 to 6 miles for much of this distance. A third batholith is exposed along the western edge of the map-area from the Promontory Hills to upper Guichon Creek, a distance of some 28 miles, and it also extends westwards beyond the borders of the map-area. Granitic rocks also underlie a considerable area along the eastern edge of the map-area in the vicinity of Mount Bulman, Wildhorse Mountain, and Campbell Creek, and are covered in part by later volcanic rocks. In the vicinity of Kamloops plutonic rocks form a small but

important body that is referred to in this report as the Iron Mask batholith. In the northeastern part of the area, and particularly between North and South Thompson Rivers, several small stocks appear, and others cut the rocks of the Nicola group in the southern part of the area.

Lithology. The larger bodies of granitic rock vary generally from granodiorite to quartz diorite, but locally gabbro or ultrabasic rocks occur. Most of the specimens examined under the microscope showed relatively small amounts of orthoclase, with the plagioclase feldspars ranging in composition from oligoclase to labradorite. The ferromagnesian minerals are biotite, hornblende, or pyroxene, and in many of the intrusive rocks both biotite and hornblende are present.

Penask Batholith

The intrusive body occupying the southeastern part of the area will be referred to as the Penask batholith. The rocks composing it are grey to pink and medium to coarse grained, and on microscopic examination proved to be granodiorites and quartz diorites. Several Rosiwal analyses were made for the writer by H. M. A. Rice of the Geological Survey. A specimen of quartz diorite showed 6·7 per cent quartz, 68·6 per cent oligoclase (An_{25}), 0·4 per cent orthoclase, and 24·3 per cent accessory and secondary minerals, the former being amphibole and biotite, and the others titanite, apatite, magnetite, sericite, and zoisite or epidote. A specimen of granodiorite showed 19·1 per cent quartz, 59·7 per cent oligoclase (An_{26}), 9·2 per cent microcline, and 12 per cent ferromagnesian minerals. A second showed 13·2 per cent quartz, 18·7 per cent orthoclase, 54 per cent andesine (An_{31}), and 13 per cent amphibole and biotite.

Central Nicola Batholith

This body of rock, which extends north from Nicola Lake, also consists largely of granodiorite and quartz diorite. It is partly sheared, and in some of the specimens the quartz appears as a fine mosaic and as interlocking grains. The rock has at many localities a pronounced gneissic structure, and the enclosing rocks are sheared and injected with granitic material. On Clapperton Creek a small body of siliceous, granitic rock, not examined under the microscope, is probably in faulted relationship to the main mass of more basic rock in that vicinity.

Guichon Creek Batholith

The batholith occupying the area along the western side of Guichon Creek is also composed of granodiorite and quartz diorite. These are typically grey to pink rocks with considerable variation in the amount of quartz and ferromagnesian minerals, the latter being, in most instances, both biotite and hornblende. All specimens examined under the microscope were either granodiorites or quartz diorites, with the exceptions referred to below. In that part of the area along Guichon Creek gabbroic phases are developed locally. The gabbro is a fine-grained, dark grey to nearly black rock, which under the microscope shows calcic feldspar (An_{65}) and augite in about equal amounts, together with much magnetite. Volume analyses were not made of most of the rocks of this area.

One by Rice showed 13·7 per cent quartz, 5·2 per cent orthoclase, 55·5 per cent plagioclase (An_{35}), 11·7 per cent pyroxene, 12·0 per cent biotite, and 1·9 per cent accessory minerals.

A small body of granitic rock south of Nicola River and west of Merritt is of a somewhat different type. This is a red rock with a pronounced graphic texture, and is apparently rich in quartz. A volume analysis by Rice showed it to contain 26·6 per cent quartz, 25·6 per cent orthoclase and micropegmatite, the latter possibly quartz and albite, with some quartz and oligoclase, 46·5 per cent oligoclase (An_{20}), and 1·3 per cent other minerals. The rock is a leucocratic granodiorite, but the content of both quartz and orthoclase with micropegmatite is considerably higher than that of the granodiorites of the Guichon Creek mass.

Wildhorse Mountain Batholith

The granitic rocks around Wildhorse Mountain, Mount Bulman, and Campbell Creek are typically grey, coarse-grained granodiorites and quartz diorites with pale pink phases also developed. On upper Scuitto Creek a mass of granite shows preponderant orthoclase, considerable quartz, oligoclase (An_{25}), micropegmatite, and microperthite. The ferromagnesian mineral is biotite. This rock may form a separate intrusion, but its relations to the surrounding granitic rocks were not obtained. On Weyman Creek, near the southern end of this batholith, isolated outcrops of an ultrabasic rock were found. This is a coarse-grained rock composed of large crystals of pyroxene and amphibole with no feldspar visible to the naked eye. Under the microscope the pyroxene forms large anhedral grains partly altered to amphibole and chlorite.

Iron Mask Batholith

The Iron Mask batholith is near Kamloops. The main exposure is 12 miles long and roughly 2½ miles wide, the direction of elongation paralleling the strike of the enclosing rocks. Similar rocks appear farther to the northwest along the strike at Cherry Bluff and Battle Bluff, where they form an elliptical mass that is partly concealed by Kamloops Lake. Small bodies of apparently related rocks appear on the ridge of Peter Peak. The rocks are medium grained, grey or greenish grey, in some places red and in others very dark in colour, marked by phases that are rich in ferromagnesian minerals. They show considerable alteration.

The batholith varies in composition from syenite to ultrabasic types. Mathews[1] recognized four main types; an intermediate type that makes up most of the batholith, a more acid type, a basic type, and a hydrothermally altered type. All are deficient in quartz, which was found in only one of twenty-two specimens examined. Orthoclase was found in only four and the plagioclase, of the common or intermediate type, ranges from An_{43} to An_{65}. Magnetite and apatite are present in most of the rocks, which are gabbros and diorites. Augite and hornblende are common, and there is a wide variation in the proportion of mafic minerals.

[1] Mathews, W. H.: Geology of the Iron Mask Batholith; unpublished thesis for the degree of Master of Science, University of British Columbia. A number of the writer's slides and specimens were loaned to Mathews, his assistant, and volume analyses quoted below are by Mathews.

The acidic type contains 30 to 45 per cent orthoclase; the plagioclase present ranges from An_{20} to An_{43} and the mafic mineral is augite or hornblende. Quartz is also generally absent from these types, which are syenites and monzonites.

The basic rocks occur only near the southwestern margin of the batholith, and are pyroxenites. Two specimens showed, respectively, 83·5 and 84 per cent augite; 3·0 per cent and 7·0 per cent hornblende; and 11·5 and 6 per cent magnetite.

Also associated with the batholith is a peridotite in which 55 per cent of the rock consists of large rounded grains of olivine and serpentine in a matrix of pyroxene and serpentine. Pyroxene (pigeonite) makes up 25 per cent of the rock, and the serpentine of the matrix, with magnetite and kaolin, 17 per cent. The relations to surrounding rocks are concealed by drift. It is, however, cut by a diorite dyke and is presumably intrusive into the rocks of the Nicola Group.

Other Plutonic Rocks

The plutonic rocks in the northeastern part of the area form several small stocks and sills. These are generally grey to pink, coarse-grained, granitic types. The amount of quartz varies greatly. Orthoclase is abundant, and the plagioclase is oligoclase or oligoclase-albite. The ferromagnesian mineral is generally biotite.

Also occurring in the northeastern part of the area, near Heffley Lake, is a small body of pyroxenite. This is very similar to that described from Weyman Creek, but is much more altered. It consists of large grains of pyroxene and large areas of serpentine with talc?, antigorite, and epidote.

Age and Relations of Intrusive Rocks

Those granitic rocks found in contact with the Nicola group are invariably intrusive into them. Pebbles and boulders of granitic rocks similar to those occurring in the map-area appear in the Lower Cretaceous agglomerates, and where the granitic rocks come in contact with these, except in those instances noted below, no evidences of intrusive relationships were found. It is, therefore, concluded that most of the plutonic rocks, with the exception of a few small bodies occurring in the northern part of the area that are probably post-Lower Cretaceous and may be Tertiary, are post-Triassic and pre-Lower Cretaceous. In most places, however, sedimentary strata that might permit a more precise dating of the batholithic rocks are wanting. It is believed that these plutonic rocks represent a period of intrusion in the Jurassic, but actually there is little evidence to indicate that the bodies represented within the map-area are contemporaneous.

The Guichon batholith extends westward into the adjoining Ashcroft map-area where it has been shown by Duffell (1947) to intrude rocks of Upper Triassic age and to be overlain unconformably by others of Middle and Upper Jurassic age.

SPENCE BRIDGE GROUP

The rocks of the Spence Bridge group have a very limited areal extent within the map-area, being recognized only at the extreme southwest part of the area where they are continuous with similar rocks occurring within

Princeton map-area (Rice, 1947) to the south. The writer had the opportunity of examining certain exposures of these rocks with Rice, and although it is possible that other small bodies may lie within the boundaries of Nicola map-area and have been included with the other volcanic rocks of the area, it is believed that if present they have an extremely limited development, as rocks that could be referred to this group with certainty were not recognized.

In the Princeton area to the south, however, they form an important map-unit, and are described as hard, dense, red and purple feldspar porphyry lavas that in appearance resemble rhyolite but have the composition of andesite. The age of the group is inferred from its stratigraphic position between the Nicola and the Lower Cretaceous groups, and is believed to be Lower Cretaceous.

KINGSVALE GROUP

Distribution. The members of the Kingsvale group are chiefly volcanic rocks. They have only a limited distribution in Nicola map-area, but are more extensively developed to the south and west. They occur chiefly in the extreme southwest corner of the area, extending from Coldwater River across Mount McInnes and the Coutlee Plateau to Nicola River. This area is co-extensive with similar rocks in the Princeton map-area (Rice, 1942, 1945) to the south, and the rocks extend down Nicola River to Spences Bridge (Duffell and McTaggart, 1947). Other rocks that occur near Kamloops Lake and on Criss Creek near the northern boundary of the area have been tentatively included in this group.

Lithology. The Kingsvale rocks consist of rhyolite, andesite, basalt, breccia and agglomerates, tuff, arkose, and conglomerate, but of these types basalt and basalt breccias predominate. They show a wide variety of colours, with black, red, purple, green, buff, brown, grey, and nearly white rocks represented. At some localities near the base of the group an agglomerate with a light green tuffaceous matrix carries boulders of the older rocks, and particularly of the granitic rocks. The breccia is generally well compacted, and much of it has a moderately soft, yellowish green matrix carrying many fragments of different coloured volcanic rocks. This breccia outcrops at many different elevations, and it would be difficult to correlate these occurrences with folding of the rocks. Locally tuffaceous sandstone occurs at the base of the group. In Nicola Valley, near the western edge of the map-area, such rocks occur on the north side of Nicola River, apparently resting on Nicola greenstones. These beds are similar to those occurring at Kingsvale in the Princeton map-area from which fossil collections were made by Rice, but no diagnostic fossils were found at the showing on Nicola River, although carbonized twigs and roots are common. The rocks dip at a high angle, whereas to the south, across the river, the basalts and basalt breccias dip gently southward. The tuffaceous sandstone may not, therefore, represent the actual base of the group as the rocks here may be faulted against the Nicola greenstones. The correlation of the older rocks at this point appears well established, for fossiliferous limestone lenses occur in them.

The section south of Nicola River near the western edge of the area consists of a succession of black, brown, and red, basaltic rocks, both lavas

and breccias being represented. The breccias are repeated at a number of points, occurring between flows. Some of the flows are vesicular or amygdaloidal and the amygdules are composed of chalcedony and other minerals. These occurrences are markedly similar to some of the Kamloops volcanic rocks. The banding of the chalcedony is generally in shades of white or grey, and masses up to 3 inches across may be found. Locally, feldspar porphyries, with small phenocrysts of white feldspar in a dense, red or dark-coloured groundmass, are present.

On the southern slope of Mount McInnes, breccia and agglomerate appear at the base followed by basaltic rock and feldspar porphyries, with basaltic flows towards the top of the mountain. At several points on the southern and southeastern slopes, bands of conglomerate and arkose appear. These strike east to northeast and dip southerly from 10 to 25 degrees. They appear in cliffs from 30 to 50 feet high, but were not traced for any considerable distance along their strike. The occurrences are separated from other rocks by drift-covered areas of considerable size. Lithologically they are very similar to the rocks of the Coldwater beds, and in earlier reports are referred to as patches of Coldwater rocks. No fossils were obtained from them despite a prolonged search. It is believed, however, that they form part of the Kingsvale section.

In the area northeast of Lower Nicola towards Promontory Hills, and also south of Nicola River north and west of Lindley Creek, are light-coloured breccias and volcanic rocks. These are generally red, light green, brown, or light grey. Some are feldspar porphyries and several small masses of quartz porphyry occur. In places the matrix of the breccias is soft and tuffaceous. The rocks differ to some extent in appearance from those composing the Kingsvale section elsewhere, and are included with this group with some doubt, though their general structural relations appear to indicate a relationship. Boulders of these rocks were not found in the Coldwater conglomerates, however, a fact on which Dawson remarked and on which he in part based his conclusions that the volcanic rocks of lower Nicola Valley are of Tertiary age.

In the area south of Coldwater River, that is, on the ridges forming Selish Mountain, which lies southeast of Glenwalker, Iron Mountain, and the ridge north of Kane Valley, a depression running southwest about 2 miles northwest of Courtney Lake, a number of small areas of breccia were shown in an earlier report as part of the Lower Cretaceous group. However, the occurrence of limestone lenses with these rocks appears to indicate that they are part of the Nicola group. Similar rocks occur to the east of Guichon Creek and on both sides of Thompson River near Walhachin. These are now all included with the Nicola group.

Other rocks, which are tentatively correlated with the Kingsvale, are certain breccias in the vicinity of Kamloops Lake. These rocks are practically indistinguishable from the Triassic greenstones, but they carry fragments believed to be derived from the Iron Mask batholith. As the rocks of this plutonic body cut the Triassic greenstones it is obvious that they must be later than the Nicola, if the interpretation of the fragments is correct. There is little reason for including them with the Tertiary volcanic rocks, and they have thus been tentatively placed in the Kingsvale group. Their separation from the Nicola rocks is probably incomplete.

Structural Relations. There appears to be little doubt that the Kingsvale group overlies the Nicola group unconformably. In general its beds dip gently southwestward, whereas in their vicinity the rocks of the Nicola group have high dips. At many places fragments of Nicola rocks and also of rocks younger than the Nicola occur in the Kingsvale agglomerates. Reference has already been made to the occurrence of boulders and pebbles of granitic rocks in these agglomerates, and these granitic rocks invade the Triassic greenstones. At those points where the granitic rocks come in contact with those of Lower Cretaceous age there is no evidence of intrusive action. On the hill slopes on both sides of Nicola River, near the mouth of Guichon Creek, granitic rocks are found close to the outcrops of these volcanic rocks. The actual contact was obscured by talus, but no granitic dykes were found in the volcanic rocks.

Age and Correlation. The data on which the age determination of the Kingsvale rocks is based are obtained very largely outside the map-area. No fossils were obtained from the included sedimentary beds within the area, but, as pointed out, the principal occurrence of these rocks within the area is co-extensive with similar rocks to the south and west. At Kingsvale, within the Princeton map-area, Rice (1947, p. 26) obtained Lower Cretaceous fossils from these rocks. The same rocks also extend down Nicola River towards Spences Bridge, where Drysdale (1914, pp. 136-138) mapped his Spence Bridge group of Jura-Cretaceous age. Recent work by Duffell (1946, 1947) in the Ashcroft area to the west has shown these rocks to be Albian (uppermost Lower Cretaceous). In 1896, Dawson mapped the succession of rocks along Nicola River as part of his Miocene volcanic rocks, divided into his Upper and Lower Volcanic groups separated by the Tranquille beds. The greenish yellow tuffaceous beds that Dawson mapped as Tranquille are evidently the Kingsvale sedimentary rocks for although they resemble the Tranquille beds to a considerable degree, the fossil evidence now indicates that they are of much earlier age.

CRETACEOUS OR TERTIARY SEDIMENTARY ROCKS

Conglomerate, Sandstone, and Shale

Distribution. The rocks included in this group occur in a belt stretching north from Kamloops Lake west of Copper Creek to Criss Creek, and extend northwards on Criss Creek nearly to the northern edge of the map-area. South of Thompson River is a second belt of these rocks near the western edge of the area.

Lithology. The Cretaceous or Tertiary sedimentary rocks consist of conglomerate and sandstone with some shaly interbeds, but are predominantly conglomerate. This rock is prevailingly coarse, with well-rounded pebbles from an inch to 3 inches in diameter. The pebbles are largely the cherts and quartzites of the Cache Creek group, but argillite, greenstone and other volcanic rocks, limestone, and granitic rocks are represented. The matrix is generally grey to light brown, and is either siliceous or arkosic. Much of the conglomerate occurs in thick beds with comparatively thin beds of sandstone between. With the sandstone locally are beds of shale, and both show at a few places poorly preserved carbonaceous markings such as stems and roots, but no diagnostic fossils.

Structural Relations. North of Kamloops Lake the rocks strike generally northwest and dip northeasterly at angles of 30 to 50 degrees. They form the ridge known as Eagle Hill, which lies between Carabine Creek and Sabiston Creek, the latter lying about 2 miles west of the former. They overlie the rocks of the Nicola group unconformably, and are overlain by other volcanic rocks in part assigned to this same age group and in part of Oligocene or Miocene age. It seems probable that their relations with the latter are unconformable, as the beds would be truncated by the latter if projected. In this area they are cut by many small bodies of granitic rock together with aplite dykes, and have been sheared and mineralized in the vicinity of some of these intrusions, as on Criss Creek. In a number of places they are partly carbonatized, and locally they carry some cinnabar.

The rocks south of Thompson River, near the western edge of the map-area, are on the whole less indurated and less metamorphosed than those to the north of Kamloops Lake. On the whole, outcrops in this area are relatively scarce. They strike in general northwest and dip to the southwest at angles varying from 10 to 30 degrees. The overlying volcanic rocks strike northeast and dip 10 degrees southeast. It is some little distance between the points where these measurements were obtained, and an angular unconformity cannot be regarded as established.

Age and Correlation. The Cretaceous or Tertiary sedimentary rocks were correlated by Dawson (1896, pp. 161-162B) and Drysdale (1914, pp. 140, 141) with the Coldwater group on the basis of their lithological similarity, and not because of fossil evidence.

In the vicinity of Criss and Carabine Creeks the rocks are cut by numerous small bodies of granite, granodiorite, and granite porphyry. They also show considerably more metamorphism than the Coldwater rocks seen elsewhere in the area, and in places they are strongly sheared and mineralized in the vicinity of the granitic masses. No such granitic bodies were found cutting rocks whose grouping with the Coldwater was established by fossils. No identifiable fossils were obtained despite an intensive search, and so far as is known coal seams do not occur in them. It must be admitted that this evidence is entirely of a negative character, but as known Cretaceous conglomerates and sandstones do occur in the area it was felt that these rocks should not be grouped with the Coldwater until more evidence of their age was obtained.

CRETACEOUS OR TERTIARY VOLCANIC ROCKS

Andesite, Basalt, Agglomerate, Breccia, Picrite, Serpentine, and Tuff

Distribution. The rocks forming this group are typically developed in a small area to the north of Kamloops Lake near Copper Creek, where a group of volcanic rocks and tuffs are found. These consist of basalt, basalt breccias, augite porphyrites, picrites, serpentine, and tuffs. Picrites in the vicinity of Watching Creek have been correlated with these rocks solely on the basis of lithological similarity. A third area of rocks of somewhat different lithological characters occurring on the east side of Durand Creek is also included in the group.

Lithology of Rocks of Carabine Creek. The rocks of Carabine Creek immediately overlying the conglomerates and sandstones of Eagle Hill consist of purple and green, basaltic breccias. These show fragments of purple or green feldspar porphyry in a matrix of similar composition. Accompanying them are bands of dark grey tuff, fine-grained diabase or basaltic dykes, and small bodies of picrite porphyry. The last exhibit only isolated, badly disintegrated outcrops, and their contacts with the volcanic breccias are not shown. These rocks all occur on the hill to the west of Carabine Creek. The hill to the east exposes several bands of picrite porphyry, augite porphyrite, and basic tuff; sills or flows of augite porphyrite; and bodies of serpentine rock. The petrography of these basic rocks was studied for the writer by Dr. E. Poitevin of the Geological Survey.

Dr. Poitevin reports that the ultrabasic rocks here described belong to the group of picrite porphyries (porphyritic limburgites). Their porphyritic texture and the presence of a vitreous base show them to be closely related to rocks of effusive character, although rocks of this type are known to occur as dykes.

The picrates are generally soft rocks, which in hand specimens are seen to contain a large proportion of hard, dark green or reddish phenocrysts in a soft, soapy, light green, aphanitic groundmass, and weather with badly pitted surfaces. Locally they are hard and dense, and the porphyritic nature is not readily determinable. The reddish phenocrysts owe their colour to staining with oxide of iron.

The least weathered specimen of the picrites was obtained from an outcrop on a small ridge just east of Carabine Creek, and is a greenish black, fine-grained rock resembling an ordinary peridotite. According to Poitevin, olivine, pyroxene, and serpentine may be distinguished under the binocular microscope, but the porphyritic character of the rock is not readily apparent until examined under the polarizing microscope. Approximately 60 per cent of the rock is composed of altered phenocrysts of olivine, some of them with very sharp crystallographic outlines, but most of them showing rounded forms due to magmatic corrosion. These phenocrysts are now very largely replaced by mesh antigorite serpentine, but remnants of the olivine are visible within some. Monoclinic pyroxene also occurs as phenocrysts, but these are smaller and much less abundant than the olivine phenocrysts. They are not so well crystallized, and due to alteration are somewhat dull under polarized light. The interesting feature of the rock is a groundmass consisting of small augite prisms set in a pale yellowish to colourless glass. These minute pyroxene prisms and the glass are generally fresh, but some chlorite occurs as an alteration product of the glass. Magnetite occurs as an accessory mineral, principally in the groundmass, both as nearly perfect octahedra and as anhedral grains.

A second specimen differs from the above in the greater abundance and fresher appearance of the pyroxene crystals and the presence of minute biotite flakes and shreds in the groundmass. In this specimen the pyroxene phenocrysts are yellowish green, with well-developed crystallographic outlines and optical properties near those of pigeonite. The olivine phenocrysts are now largely altered to talc, and it appears that the production of this mineral is an alteration phase following that of

serpentinization, as many of the phenocrysts, although replaced by talc, still display the characteristic mesh structure with its accompanying secondary hematite and limonite patterns.

A third specimen does not differ greatly from the second in appearance. Originally the two rocks were alike, but the third specimen now shows an additional stage of alteration in the groundmass, in the olivine phenocrysts, and in some of the pyroxene phenocrysts. This phase of alteration has resulted in the production of needles or acicular crystals of tremolite, to be seen in the groundmass and in the olivine crystals at their contact with the groundmass. Many of the original olivine, and some of the pyroxene, phenocrysts are almost completely replaced by a confused fibrous aggregate of tremolite generally known as *pilite*. It appears that the olivine phenocrysts of this rock were first altered to mesh antigorite, in which the structure was pictured by ribbons of secondary iron compounds. The serpentine was then partly altered to talc and the remainder to *pilite*. The tremolite fibres and acicular crystals are still fresh, with good optical properties, and it is difficult to conceive that such small needles could have survived the period of alteration of the serpentine into talc. This is the reason for assuming that the tremolite crystallized last. At the contact between the matrix and some olivine phenocrysts many long acicular crystals of tremolite traverse both media for some distance, but as a rule the contact zone is a confused fibrous aggregate of tremolite. Some of the pigeonite crystals are partly altered to tremolite, the alteration beginning along the cleavage planes.

A fourth specimen is a reddish, compact rock, which under the binocular microscope displays porphyritic structure; the phenocrysts are altered olivine and pyroxene, and the matrix is composed of serpentine, carbonate, and ferrocarbonate. The carbonate, which approximates dolomite in composition, also occurs as veinlets traversing the rock.

Under the polarizing microscope this rock appears to be a highly altered picrite porphyry. A parallel alinement of the former olivine and pyroxene phenocrysts suggests either flow structure or a sedimentary feature. The altered olivine crystals are characterized by rounded, elongated forms. The original nature of the matrix is confused by several secondary minerals. Dolomite is the most abundant of these. It replaces some of the antigorite of the olivine, the pyroxene, and the original matrix. Chlorite is an alteration product of the pyroxene, and talc replaces some of the antigorite. Secondary quartz and plagioclase feldspar are scattered as grains or small masses throughout the matrix; they are also found in two other types of rock at this locality, the augite porphyrite and the basic tuff.

The augite porphyrite is a reddish, porphyritic rock composed of pyroxene crystals in a fine-grained, reddish groundmass. The specimens of this rock examined by Dr. Poitevin showed that the original constituents have been largely altered and new species introduced. The groundmass in particular is impregnated with a reddish oxide of iron to such an extent that its identification is impossible. Of three specimens examined, the freshest was found to contain much glass, in which are small altered pyroxene prisms and poorly defined grains of what may have been orthoclase and plagioclase. In the groundmass are also secondary chlorite

(penninite) after pyroxene, fresh, secondary orthoclase and albite, secondary epidote, and a little quartz, calcite, and iron oxide. In this groundmass are scattered large phenocrysts of pyroxine near pigeonite in composition. Some of these are fresh, with perfect crystallographic outlines; others have a ragged appearance due to chloritic alteration. Other phenocrysts present are crystals or laths of plagioclase feldspar, exhibiting albite twinning, and orthoclase crystals, some of which show Carlsbad twinning. These feldspar phenocrysts are generally difficult to identify, due to alteration to sericite and saussurite. A characteristic feature of the rock, however, is the formation of minute crystals of fresh albite and orthoclase, some filling fissures in the pigeonite phenocrysts or forming radiating groups in the groundmass. Later alteration, probably hydrothermal, is evidenced by epidote associated with calcite and quartz forming small nests or filling minute fissures in the matrix.

To the east of Carabine Creek there is a considerable thickness of augite porphyrite tuff. This is a fine-grained, purplish red rock, which shows good bedding and crossbedding (Plate III A). Because it has been partly serpentinized, this rock was originally believed to be related to the picrites, but chemical analysis proves that it is not. A thin section, when examined under the microscope, shows that it is composed of minute fragments similar in appearance and composition to fragments that may be obtained by crushing the augite porphyrite rock previously described, except that no secondary epidote is visible in the tuff.

The tuff is characterized by fragments composed of phenocrysts of pigeonite still embedded in their original matrix. A chemical analysis of this rock made by R. J. C. Fabry of the Mineralogical Section of the Geological Survey, is given below (a), with two other analyses for comparison:

	(a)	(b)	(c)
SiO_2	50·97	51·48	52·56
Al_2O_3	14·97	16·24	13·37
Fe_2O_3	3·06	2·69	6·70
FeO	1·31	4·70	0·76
CaO	7·10	4·41	6·14
MgO	9·08	7·97	8·53
Na_2O	0·99	3·25	3·24
K_2O	5·95	5·75	4·62
H_2O+	2·09	2·32	2·39
H_2O-	0·59	0·20	0·12
TiO_2	0·53	0·82	1·56
P_2O_5	0·39	0·40	—
MnO	0·05		
CO_2	2·54		
S	0·12		
	99·77		
Less O/S	0·05		
	99·72	100·23	99·99

(b) is an augite porphyrite from Piz Tgietschen Punteglia District, Graubunden, Switzerland.[1]

(c) is an augite minette also from Graubunden, Switzerland. Both rocks are described by U. Grubermann.[1]

[1] Washington, H. S.: A Description of the Quantitative Classification of Igneous Rocks; U.S. Geol. Surv. Prof. Paper 99, pp. 442-3 (1918).

The figures given for the alkalis show that orthoclase was the predominant feldspar of this rock.

A second type of tuff is a fine-grained, dark green, compact rock, with apparent bedding planes marked by thin bands of magnetite. According to Poitevin, the thin section does not show any positive sign of sedimentation or flowage; the rock is a mass or network of amphibole with quartz and feldspar in which larger secondary crystals of amphibole are scattered. Some antigorite grains altering to talc are also visible. Some of the amphibole, which is near actinolite in composition, is partly altered to talc and chlorite. The secondary feldspars are mainly plagioclase, and seem to have been formed along with quartz by a process similar to that responsible for the formation of these two minerals in the augite porphyrite and altered picrite. There is also much secondary magnetite with patterns similar to those found in the picrite porphyry and which are so characteristic of it. The rock is unquestionably a recrystallized basic tuff, and there is some evidence that it is a picrite porphyry tuff that has been subjected to a pilitic type of alteration.

A serpentine from the Painted Bluffs is a greenish rock with dark chloritic spots that may have been phenocrysts. In thin section no original mineral is visible, but some crystal forms of olivine and pyroxene may be observed. The two most abundant minerals are antigorite serpentine and dolomite; chlorite and amphibole, partly altered to talc, are in subordinate quantities. By comparison with the other rocks previously described the serpentine carries almost no magnetite, hematite, or limonite. No quartz or feldspar is visible, and although the rock is a very altered basic one, the absence of secondary iron oxide seems to rule out the hypothesis that it is similar to the picrites already described.

The serpentine is interbanded with augite porphyrite tuff to form the vividly coloured Painted Bluffs to the east of Copper Creek. In many places, however, the serpentine cuts across the bedding of the tuff, and, presumably, is a basic mass injected into the tuffs in the vicinity of a volcanic cone. On account of the soft character of some of these rocks they are eroded into badland topography on a small scale (Plate III B).

Lithology of Rocks on Watching Creek. Picrites also occur on Watching Creek, where they are dark green to nearly black, mottled with light green, or red and green, the red colour being due to iron oxide in the olivine crystals. Two specimens were examined by Poitevin. One appears under the microscope to be identical with the one just described from Copper Creek, but more altered. To the naked eye, however, the rock differs in being markedly porphyritic. Reddish, altered olivine phenocrysts and smaller pyroxene phenocrysts occur in a groundmass of small pyroxene prisms and glass. The reddish colour of the olivine phenocrysts is due to the presence of secondary hematite, and not to the alteration into iddingsite or bowlingite.

Very little of the original material is now visible. The olivine crystals have lost some of their sharp contours and have been transformed into mesh antigorite, partly replaced by secondary colloidal serpentine, with the formation of much iron sesquioxide visible along the lines of the original mesh pattern. Serpentinization, however, was not restricted to olivine; a considerable part of the groundmass has been transformed into antigorite pseudomorphic after minute prisms and some of the larger

phenocrysts of augite. Chlorite material derived from the glass is intimately mixed with the antigorite laths. The serpentinized areas of the groundmass generally assume rounded forms and exhibit rather sharp contacts with the unaltered parts of the groundmass. A little accessory magnetite is also present, but most of the iron ore is secondary hematite.

A sample of this rock, analysed by R. J. C. Fabry, is given below (a) together with analyses of two other similar rocks for comparison:

	(a)	(b)	(c)
SiO_2	39·71	37·36	40·12
Al_2O_3	5·14	4·76	7·76
Fe_2O_3	6·88	6·61	7·35
FeO	0·38	6·12	8·66
MgO	31·48	31·11	23·69
CaO	4·63	1·19	6·53
Na_2O / K_2O	0·39	Trace	0·53
H_2O+	8·91	10·37	4·03
H_2O-	1·26	0·65	—
TiO_2	0·16	0·79	0·37
P_2O_5	0·09	0·06	0·18
MnO	0·40	Trace	
Cr_2O_3	0·39	0·62	
NiO	0·11	0·04	
S	0·27		
CO_2	None	None	Trace
BaO	.....	.....	.....
SrO	.....	.....	.....
SO_2	.....	.....	.....
	100·50		
Less O/S	0·10		
	100·40	99·68	100·22

(b) Picrite porphyry from Crystal Falls iron-bearing district of Michigan.[1]
(c) Picrite, Highweek, Newton Bushel, Devonshire, England.[2]

	(a)	(c)
Orthoclase	2·02	3·34
Albite	2·62	9·43
Anorthite	11·40	14·46
Hematite	6·40	
Magnetite	0·70	10·67
Ilmenite	0·30	0·76
Chromite	0·45	
Pyrite	0·54	
Diopside	2·30	13·40
Hypersthene	31·62	
Olivine	29·56	44·09

A second specimen from Watching Creek, although differing markedly in appearance from the first, proved, on examination under the microscope, to have the same mineralogical composition and to have suffered the same type of alteration. The difference in appearance is due to prominent,

[1] Clements, J. Morgan, and Smith, Hugh Lloyd: Crystal Falls Iron-bearing District of Michigan; U.S. Geol. Surv., Monographs, vol. XXXVI, 1899, p. 219.
[2] Washington, H. S.: op. cit., 1918, p. 727.

reddish, pseudomorphic phenocrysts after olivine. These phenocrysts not only exhibit the usual antigorite mesh structure, with minute ribbons of secondary hematite and possibly limonite along the mesh patterns, but the antigorite in places is stained by iron-bearing solutions without decreasing the translucence of the serpentine. It was first thought that iddingsite or bowlingite might be present, but the reddish antigorite has neither the refringence nor the birefrigence of these two varieties of serpentine.

Lithology of Rocks from Durand Creek. A belt of rocks of dissimilar character to those described above, occurring on the east side of Durand Creek, has been tentatively assigned to the same group. These consist of agglomerate and conglomerate, apparently overlain by green, red, and brown flow breccias and lavas. The basal agglomerate apparently rests on rocks of the Nicola group, for large angular blocks of fossiliferous limestone occur in it, as well as fragments of volcanic rocks, red felsite, feldspar porphyry, and greenstone. The matrix is red or green tuffaceous material, which grades upward into conglomerate with fine sandy interbeds. Pebbles and boulders of limestone, greenstone, red felsite, red agglomerate, cherty tuff, argillite, and green feldspar porphyry were found, together with boulders of the granitic rocks of the region. These beds strike north to northeast and dip east or southeast at angles of 25 to 40 degrees. They are thus overlain to the east by volcanic rocks consisting of breccias and lavas that cannot be definitely correlated with the flows overlying the agglomerates to the west of Durand Creek. The relations to these apparently overlying lavas are in general obscured in an area of few outcrops. The rocks may be an extension of the agglomeratic material on Mount Savona deposited against a protruding mass of earlier volcanic rocks and subsequently tilted. It is considered possible, however, that they correspond with that part of the section at Copper Creek represented by basalt breccias.

Structural Relations. The agglomerates, picrites, augite porphyrite, tuff, and serpentine extending eastward from Carabine Creek overlie, apparently unconformably, the conglomerate of Eagle Hill. The rocks of both groups strike northwest, but whereas the dips of the conglomerate range up to 40 or 50 degrees those of the tuff beds in the overlying volcanic rocks are about 10 to 20 degrees. From Carabine Creek east the tuffs dip easterly at gentle angles, but a short distance east of the railway tunnel at Copper Creek, where a small body of granitic rocks is intrusive into them, the beds dip steeply west. The structure here is an asymmetric syncline. From this point eastward the structure is complex. Rapid changes of strike and dip are indicative of sharp local folds, and probably of considerable faulting. In places the strike swings to the east, and the dips reach 75 or 80 degrees either northerly or southerly (*See* Plate III A). Immediately east of the Painted Bluffs, and separated from the most easterly exposures of the augite porphyrite tuff by a drift-covered area about a quarter of a mile wide, the agglomerates of the Kamloops volcanic group strike northwest and dip 30 to 40 degrees southwest. It seems probable that an angular unconformity separates the tuffs and serpentine from the overlying volcanic rocks, which in general are conformable with the Tranquille beds. The augite porphyrite tuffs, therefore, probably underlie the Tranquille beds unconformably.

As pointed out above, tuffs belonging to the group under discussion are cut by a small body of granitic rock similar to that which cuts the conglomerates on Eagle Hill.

The relations between the picrite porphyry and the augite porphyrite tuff are uncertain, as exposures along the contacts of the two are relatively poor, owing to the soft friable nature of both rocks. The tuff, apparently, overlies the picrite immediately to the east of Carabine Creek, and is overlain by more picrite, tuff, and thick sills or flows of augite porphyrite, followed by more tuff, picrite, and the basic tuff described above. Where seen, the contacts between the picrite and the augite porphyrite tuff in general parallel the bedding, at least for short distances; but the contact between the picrite and the overlying basic tuff is irregular, with projections of the latter into the underlying picrite in the manner of sedimentary dykes. Proof that the picrites were effusive is, therefore, lacking, but they are associated with materials of volcanic origin.

Age and Correlation. Dawson correlated the conglomerates of Eagle Hill with his Coldwater group, the volcanic group under discussion with his Lower Volcanic group, and the pyroclastic rocks with his Tranquille beds. As has been pointed out, proof is lacking that the Eagle Hill conglomerate is the equivalent of the Coldwater. On the other hand, the evidence that might tend to throw doubt upon such a correlation is entirely of a negative character. It has been shown that there are reasons for assuming an unconformity between the pyroclastic rocks of the Painted Bluffs and the Tranquille beds with which Dawson correlated them. There is at other points, however, some evidence of unconformable relations between the Coldwater beds and the overlying volcanic rocks of the Kamloops group. The unconformity between the rocks near Copper Creek and the rocks of the Kamloops group cannot, therefore, definitely establish that the conglomerates of Eagle Hill and the overlying assemblage of volcanic and pyroclastic rocks are not contemporaneous with some members of the Kamloops group. In view of the doubt, however, it was considered that these rocks should not be definitely correlated with those of the Kamloops group until proof of their age was obtained.

The picrites of Watching Creek were correlated with the Copper Creek rocks solely on lithological grounds.

COPPER CREEK INTRUSIONS

The name Copper Creek intrusions has been applied to several small bodies of intrusive rock that occur in the vicinity of Copper Creek. These rocks are younger than the intrusive rocks grouped as the Coast intrusions, and they have, consequently, been mapped separately.

Distribution. The Copper Creek rocks have only a very limited areal extent. They occur as small stocks from Kamloops Lake northward along Eagle Hill and Carabine Creek to Criss Creek near the northern border of the map-area. They are intrusive into the conglomerates of Eagle Hill, and into the volcanic and pyroclastic rocks around Copper Creek.

Lithology. These rocks are generally fine grained, grey to pink, with biotite the principal ferromagnesian mineral. Some of them are porphyritic. In composition they range from granite to diorite. Those specimens examined under the microscope were holocrystalline, fine-grained

granite and diorite. One showed feldspars in porphyritic relation to the remainder of the rock. The stock at Copper Creek shows considerable alteration. This rock was not examined under the microscope, but hand specimens contain considerable quartz, and much of the mica is altered to limonite.

Structural Relations. The Copper Creek intrusions cut both the conglomerates of Eagle Hill and the volcanic and pyroclastic rocks along Carabine Creek, but have not been recognized in association with the other formations of the area. In most instances they have exerted little metamorphic effect, but apophyses of aplite from the body on Criss Creek cut the adjacent sedimentary strata, which are locally sheared, and both the aplite and the sheared rock are mineralized (Diamond S group). Where the picrite and pyroclastic rocks at Copper Creek are in contact with the intrusions of this group the contact is almost perpendicular to the bedding, and a dyke of the granitic rock also cuts across the bedding.

Age. There seems little doubt that these intrusive rocks are younger than the sedimentary rocks of Eagle Hill or the pyroclastic rocks of the Painted Bluffs. The Eagle Hill conglomerates were correlated by Dawson with his Coldwater group, and the rocks of the Painted Bluffs with his Tranquille group. As has been pointed out, this correlation is not based on fossil evidence, and the possibility remains that these rocks may be earlier than Eocene. The intrusive rocks have not been found to cut Tertiary rocks whose age has been proved by fossil evidence. With the evidence at hand, therefore, it appears best to class them only as post-Lower Cretaceous.

KAMLOOPS GROUP

This name is proposed to include most of the recognizable Tertiary rocks within the map-area, including both the Coldwater and Tranquille beds as well as large accumulations of volcanic rocks. Dawson (1896) divided his Tertiary volcanic rocks into two groups, a Lower Volcanic group and an Upper Volcanic group, separated in places by the Tranquille beds. He believed that the Coldwater beds antedated the period of vulcanism. Drysdale (1914) used the term Kamloops Volcanic group to designate the volcanic rocks of these two groups of Dawson and included with them the sedimentary Tranquille beds. He mapped the Coldwater group as distinct and antedating the period of vulcanism. Rose (1914) designated the rocks as the Kamloops series, and included with them both the Upper and Lower Volcanic groups as well as the intervening Tranquille beds. He also mapped the Coldwater series as distinct. Although there are structural and stratigraphic reasons for considering the Coldwater and Tranquille beds as distinct, present palæontological evidence does not support the view that there is any marked difference in age between them. Consequently, they have been included with the group to which a slightly different name is now given. In the mapping of these sedimentary rocks, however, the earlier practice has been followed of assigning them, where possible, either to the Coldwater or to the Tranquille. Where such a classification appears doubtful, the strata are shown as undivided. The Coldwater and Tranquille beds are similar, consisting of conglomerate, sandstone, and shale, but the Tranquille beds contain in addition much tuffaceous material that does not appear to be represented in the Cold-

water. The sedimentary rocks are for the most part soft, and do not furnish abundant outcrops; consequently, it is difficult to find satisfactory sections. Volcanic rocks are the most abundant members of the group.

Coldwater Beds

The Coldwater beds occur chiefly in the southern part of the map-area, principally in the Merritt and Quilchena coal basins.

The Merritt coal basin lies in an area of Coldwater rocks about 12 miles long and from 1 mile to 3 miles wide. Part of the area presumed to be underlain by these rocks lies within the heavily drift-covered area of Nicola Valley; its boundaries are to a large extent conjectural and the drilling done in Nicola Valley has not aided materially in their definition.

A second area underlain by these rocks is on Quilchena Creek, and is about 7 miles long by 2 miles wide.

Rocks that are probably correlative with the Coldwater occur on Guichon Creek to the northwest of the Merritt basin. This area is shown by Ells (1905, map) to connect with the Merritt basin and to extend up Lindley Creek, a small stream entering Nicola River nearly opposite the mouth of Guichon Creek. The reported coal outcrops on that creek were, however, not found by the writer. The occurrence on Guichon Creek is mapped from two small outcrops, although considerable debris from the rocks appears in the glacial drift.

The rocks of the Coldwater group consist of sandstones, shales, and conglomerate, with seams of coal. The sandstones are generally yellow to buff coloured or grey, and vary from siliceous to arkosic. Some of the sandstone is hard and massively bedded, and some is soft and friable. Locally the sandstone contains small pebbles and becomes conglomeratic. The beds immediately overlying the rocks of the Nicola group are derived very largely from their waste, and consist of coarse, poorly sorted material resembling a breccia. The shales vary considerably in colour, but are generally thinly bedded and friable. Several coal seams occur within the rocks of the group, but they have not been correlated. The sections at the Middlesboro collieries show seven seams, but it is not known whether all the coal measures are represented.

The best section of the Coldwater group is in Coal Gully southwest of Merritt, where Dawson measured a total thickness of 424 feet of beds containing four coal seams. Elsewhere in the Merritt area outcrops are such that no satisfactory section may be obtained. Generally they are of the harder conglomeratic sandstones. It seems probable that the beds change in composition from place to place, making correlation difficult. The sections at the Middlesboro collieries showed a total thickness of 770 feet of strata from the base of the No. 1 seam to the base of the No. 2 seam. Ells (1905, pp. 51-57) gives details with regard to seams developed at the time of his report and encountered in the drilling.

Several drill-holes have been put down in Nicola Valley from near the junction of Nicola and Coldwater Rivers eastwards. The data on these holes cannot be correlated in every case. One hole near the junction of the two rivers penetrated through drift into the underlying Nicola rocks without encountering the coal measures, and several holes bored from this locality eastward encountered superficial deposits to depths of

from 200 to 280 feet. These holes indicate that the coal measures may be eroded along part of the basin, and that the Merritt basin may be distinct from that of Guichon Creek. The narrowness of the valley for some distance below Merritt, and the fact that a drill-hole reached volcanic rocks without encountering the coal measures suggest that these may be lacking in this part of the valley. The limits of the coal measures underlying the valley towards Nicola Lake are also a matter of conjecture. Outcrops of the coal measures occur along the lower part of Hamilton Creek, which flows toward Merritt from the northern slope of Mount Nicola, and drilling northwest of the mouth of that creek has penetrated to them. A hole was drilled farther east, near the mouth of the creek, but no record of the data obtained is available. The statement made on an old map is that disturbed ground was encountered.

The rocks correlated with the Coldwater north of Nicola Valley are chiefly conglomerates, with some sandstone, the lower beds being formed of coarse, poorly sorted material. The conglomerates contain closely packed, well-rounded pebbles with some blocks of a comparatively soft, yellow sandstone that contains fragments of ammonites. No such sandstone rock is known to outcrop in the vicinity, yet it is difficult to see how it could withstand prolonged transportation. The ammonites proved to be too fragmentary for determination, but are definitely of pre-Tertiary age. The beds in this area dip generally steeply to the east.

The Coldwater rocks exposed in Coal Gully are in the form of an open syncline, with probably an anticline at the head of the gully, and an anticline near the mouth of the gully (Ells, 1905, pp. 50-51). Near the margin of the basin, however, the rocks to the southwest are bent into sharp folds. The workings of Middlesboro collieries in this section show a series of sharp folds, with the axes plunging southeast and with dips on the limbs ranging up to 70 degrees or in places even vertical. Some faulting has also taken place. In the largely drift-covered area that extends under Nicola Valley, there are a few exposures near the Diamond Vale colliery and on the lower part of Hamilton Creek. At the present working of the Diamond Vale colliery the strike of the strata is north 77 degrees west and the dip 26 degress southwest. The strata on Hamilton Creek are in open folds, with the axes trending northeast, but at the Normandale mine, which is situated on the old Nicola road about a mile north of the creek, the strata are much disturbed. Here the exposures are within a few hundred feet of the margin of the basin. Not enough evidence is available at present to afford details of the structure.

The exposures on Quilchena Creek do not add greatly to the data given above with regard to the Coldwater. Because they are soft the rocks are concealed within much of the area in which they are presumed to occur. The strata consist of conglomerate and conglomeratic sandstones, shales, and sandstones. A section in a gully on the east side of the creek exposes about 400 feet of sediments in which conglomerate and conglomeratic sandstones make up probably 50 per cent of the beds, sandstone about 40 per cent, and shale the balance. Throughout, the strata strike north 30 degrees west and dip 25 degrees northeast. On the west side of Quilchena

Creek, towards the northern end of the basin, the strata strike northeast and dip southeast at angles of from 60 to 85 degrees. Here they are probably overlain by the nearly horizontal basalts referred to elsewhere.

Relations of the Coldwater Beds to Adjacent Rocks. The Coldwater beds lie unconformably on those of the Nicola group and include considerable detrital material from it. Pebbles of Nicola volcanic rocks and limestone appear in the Coldwater conglomerates, as well as pebbles of chert, and numerous pebbles of the granitic rocks of the region. It is probable that they also contain material from the Cretaceous volcanic rocks, but these cannot be recognized with the same assurance. The conglomerate and sandstone lying in Kane Valley, in the southern part of the map-area near Courtney Lake, may be part of the Coldwater. They are derived very largely from the waste of the red breccias of the Nicola, but also contain many limestone pebbles.

It would appear also that the Coldwater beds lie unconformably below the Miocene or earlier volcanic rocks. Dawson stated that such an unconformity existed (1894, p. 190B). Southwest of Merritt, near the edge of the coal basin, the Coldwater strata are bent into sharp folds, with dips of 70, 80, or even 90 degrees. On the hill immediately to the west and only a few hundred yards from the intensely folded Coldwater rocks is a scarp of Tertiary volcanic rocks. The contact of these volcanic rocks with the underlying Nicola and the occurrence of outlying masses separated from the main body by erosion make it appear that these volcanic rocks conform in attitude to the slope of the hill on which they were extruded, having a dip of between 5 and 10 degrees. This assumption is confirmed to some extent by flow lines within the lavas.

Further, the Coldwater rocks underlying Nicola Valley are folded, with dips ranging from probably 10 to 30 degrees or more. Part of Nicola Valley south of the river between Merritt and Nicola is underlain by a flat bench composed of nearly horizontal vesicular basalt flows. On Quilchena Creek the same relations hold, benches of nearly horizontal vesicular basalt occurring within 100 yards of steeply inclined conglomerate beds. There appear to be five separate flows involved, with thicknesses ranging up to about 20 feet and wedging out towards the edges. The contacts are without interbedded material, but the surfaces of the flows show ropy structure and are fresh and unweathered. It is probable from the piles of talus at the foot of the scarp that the lavas extended much farther out towards the centre of the valley, thus overlying the steeply dipping Coldwater, and that erosion of the soft, underlying shale caused the face of the cliff to fall away in recurrent landslides. The bedding of the Coldwater, if projected, is truncated by the lava cliff. The evidence is, therefore, that these volcanic rock are unconformable with the Coldwater. Reasons are presented later, however, to show that these lavas are the valley basalts and possibly younger than some of the volcanic rocks of the Kamloops group. Further, the Coldwater rocks, so far as known, differ from the Tranquille rocks in having no tuffaceous beds or lava flows intercalated with them. It is, therefore, concluded that the volcanic rocks of the Kamloops group and the Tranquille beds overlie the Coldwater beds unconformably.

Age of the Coldwater Beds. The following fossils were determined by W. A. Bell of the Geological Survey from collections made in the Merritt area:

Lot F1	*Alnus carpinoides* ? Lesquereux *Fraxinus quilchenensis* (Penhallow)=*Hydrongea fraxinifolia* (Lesquereux) Brown
Lot F2	*Trochodendroides arctica* (Heer)
Lot F3	*Woodwardia maxoni* Knowlton *Equisetum similkameenense* Dawson *Trochodendroides arctica* (Heer) *Leguminosites ? arachioides* Lesquereux *Nyssa* sp.
Lot F32	*Sphaerium* sp. cf. *S. gemma* Dall
Lot F33	*Sphaerium* sp. cf. *S. gemma* Dall *Sequoia langsdorfii* (Brongniart) Heer
Lot F18	*Alnus carpinoides* Lesquereux *Sequoia langsdorfii* (Brongniart) Heer

Bell reports "The plants seemingly belong to a flora homotaxial with the Tertiary flora of the Kitsilano near Vancouver. Their age is considered to be probably Oligocene or Lower Miocene".

With regard to the species of *Sphaerium*, A. LaRocque of the Geological Survey advises: "The shells submitted by Cockfield from the Coldwater group all belong to a single species, which is probably new. It strongly resembles, however, *Sphaerium gemma* Dall from Brock River, Northwest Territories, from which it differs in being about twice as large and somewhat more inflated. Unfortunately, there is no good evidence for precisely dating the beds from Brock River. In the report of the Canadian Arctic Expedition, 1913-18, vol. XI, pt. A, p. 27, W. H. Dall states with regard to identified fossil shells from Brock River, that 'the age of the deposit is Upper Eocene or Oligocene, probably contemporaneous with the leaf beds of Nenilchik on Cook's Inlet, Alaska, one of the most abundant of the Arctic species being identical with an Anodonta described from the latter locality by Mayer' ".

It will thus be seen that the palæontological evidence obtained gives little support to the view that the Coldwater and Tranquille beds are of distinct ages. For that reason the Coldwater beds are included with the Kamloops group, but mapped as a separate member of that group wherever possible.

Tranquille Beds

The principal areas underlain by the Tranquille beds are near the mouth of Tranquille River; near Red Point, a prominent bluff on the north side of Kamloops Lake 5 miles southeast of Copper Creek; Red Lake, and Deadman River in the northwest corner of the map-area; and in the vicinity of Dufferin Hill, a low hill 2 miles west of Kamloops, Buse Hill, and on Scuitto Creek on the south side of South Thompson Valley. These are relatively small areas, and, as the rocks in general are soft, outcrops are poor.

The Tranquille beds consist of sandstone, shale, and conglomerate, with tuff beds and, locally, thin seams of lignite. The section varies from place to place, and some evidence was obtained to indicate that not all the beds represent a single band within the Kamloops volcanic rocks. The sandstones are generally tuffaceous, and except locally, where they are well indurated in thin beds, are soft and friable. The shales and tuffs are

also commonly friable. The latter are prevailingly buff coloured, although locally they become white or pink. In many places they have disintegrated so that the slopes are covered with the soft sandy material. In places these tuffs grade upward into agglomerates, so that no distinct line may be drawn between them and the overlying volcanic rocks.

South of Kamloops Lake, patches of the Tranquille beds outcrop south of Tranquille station on the Canadian Pacific Railway. They are exposed again to the west of Dufferin Hill, and probably follow the depression south of this hill that is traversed by the Trans-Canada Highway. The beds outcrop again on Guerin Creek, a small, intermittent stream occupying the depression southeast of Dufferin Hill, where Dawson (1896, p. 169B) reported the occurrence of coal seams. Dawson's section here shows a number of narrow seams of coal interbedded with shale, clay, and sandstone. These coal exposures have been disturbed by mine workings that are now caved, so that the coal outcrops cannot be seen. A rough section made about 4 miles west of Dufferin Hill showed some 50 feet of yellow sandstone, dark shale, and buff-coloured tuff. These beds contained a few fossils. Below them is a body of augite porphyrite about 50 feet thick, and below this again 20 feet of sandstone and shale, 60 feet of massive tuff, then shale, sandstone, and a narrow band of conglomerate with the base concealed.

Tranquille beds consisting of yellow tuffaceous sandstone, shale, and buff-coloured tuff occur along the south slope of Mara Hill and near the mouth of Tranquille River. They grade upward into buff-coloured agglomerates of the overlying volcanic rocks. Along the face of Mara Hill the rocks are nearly horizontal, whereas near the mouth of Tranquille River they dip eastward at angles of around 30 degrees. Narrow bands of hard sandstone occur in the shales. The beds apparently thin out rapidly going west. On Battle Bluff are other exposures separated from these by coarse-grained volcanic rock.

At Red Lake buff-coloured impure diatomite mixed with tuffaceous material apparently overlies the dense basaltic rocks in the area, and has provided some fossil plants. The exposures are limited to a few cuts that have been made in the overlying superficial deposits, but are now sloughed in.

On Deadman River, sedimentary beds correlated with the Tranquille occur at a number of localities. In the cliffs of volcanic rocks west of Deadman River (*See* Plate I), near Gorge Creek, a tributary entering that stream from the west 5 miles above the mouth of Criss Creek, interbeds of tuff appear at several horizons between brown vesicular basalts. On the opposite side of the river, and somewhat farther south, is a section of conglomerate capped by a thin bed of sandstone, which causes the rocks to weather in the form of hoodoos. The conglomerate lies on badly fractured and iron-stained volcanic rocks, and is divisible into two parts, a lower 10 to 15 feet of red conglomerate and an upper 25 feet of white conglomerate capped by a foot of hard, crossbedded sandstone. Lower on the slopes much tuffaceous material forms soft talus slopes, and may represent part of the Tranquille beds. The conglomerate and sandstone strike north 20 degrees west and dip 30 degrees southwest, whereas the prevailing dip of the upper basaltic flows nearby is here to the southeast. The conglomerate contains boulders of conglomerate and sandstone similar

to that at Eagle Hill, in addition to boulders of rocks similar to some of the Tertiary lavas. No fossils were obtained at this point, and no proof of the age of the sedimentary rocks was obtained. No similar rocks of proven Tranquille age were found, but if they overlie tuffaceous beds lower in the section, as seems probable, they should be grouped with the Tranquille beds.

At Split Rock, near the mouth of Criss Creek, tuffaceous sandstones and friable, thin-bedded shales are overlain, apparently conformably, by black merocrystalline basalt. Fossils were obtained from this locality, including two fossil fish that have not been identified.

North of Buse Hill are several bands of buff-coloured tuff. Owing to their friable nature, they are exposed chiefly as talus on the hillside. Other beds of tuffaceous sandstone were found near Scuitto Creek, where some fossil plants were collected. Near McGlashan Lake, a small lake 3 miles southeast of Mount Scuitto, are bedded, cream to pink weathering tuffs overlying conglomerate and overlain by basalt. The outcrops suggest extensive landslips with large blocks of rock sliding down the slope 100 feet or more. At this locality considerable petrified wood has been reported.

Fossils were collected from the Tranquille beds at several places, and were identified by W. A. Bell of the Geological Survey as follows:

Sequoia langsdorfii (Brongniart) Heer
Ginkgo adiantoides (Unger) Heer
Carpinus grandis Unger
Quercus paucidentata ? Newbury
Ostrya sp. *oregoniana* Chaney
Ulmus ? sp.
Antholithes sp.

Other forms were included in the collections, but proved too fragmentary for determination. Fossil fish were obtained at Split Rock on Deadman River and Red Point, west of Frederick on Kamloops Lake, and pelecypod and crustacean fragments from upper Tranquille River. Bell states that "The plants, with the exception of the remains of *Sequoia*, are much too fragmentary to be of value . . . . The number of identified species is too few to warrant any remarks on correlation. However, there is a slightly larger collection from Tranquille Creek made by L. M. Lambe in 1906, which includes all the above species and a few additions. Assuming all the specimens are from the same formation, I would provisionally consider the age to be Oligocene or Lower Miocene."

The evidence furnished by the fossils alone with regard to the respective ages of the Coldwater and the Tranquille beds may be insufficient at present to be considered conclusive. However, in general the Tranquille beds appear to be conformable with the underlying and overlying volcanic rocks. Evidence was presented on the previous pages to show that the Coldwater beds lay unconformably below some of these volcanic rocks, and thus, although the beds of the two groups do not occur together, there may be considered to be a time interval marked by diastrophism between the deposition of the Coldwater and the Tranquille beds. This conclusion, however, is based on the assumption that volcanic activity at the different localities was essentially contemporaneous; which may not be so. If the conglomerates on Eagle Hill and Criss Creek are considered as Coldwater, as they were by Dawson, there would seem to be little doubt

of the unconformable relations of the two groups. It may thus be concluded that although there are good grounds for considering the Coldwater and Tranquille unconformable, actual proof has not been found.

Undivided Tertiary Sedimentary Rocks

Several areas of Tertiary sedimentary rocks have not been assigned to either the Coldwater or Tranquille beds. Areas underlain by such rocks occur in the vicinity of Mount Nicola, and extend southwestward to the southern edge of the map-area. These rocks consist of red and grey conglomerates and red sandstones. Much of the material composing the rocks is quite evidently derived from the erosion of the Nicola breccias that lie to the west, and from the nearby Nicola greenstones and limestones. Pebbles of fossiliferous limestone are not uncommon in the conglomerate. These rocks are quite similar to the parts of the Coldwater group, and would be referred to that group except for the fact that in the Princeton map-area to the south they are intercalated with volcanic rocks[1], a fact that suggests that they should be more properly referred to the Tranquille beds.

Other areas of conglomerate and sandstone occur on the Batchelor Range to the northwest of Kamloops. The conglomerate is composed of comparatively small, well-rounded pebbles in a sandy matrix, and is accompanied in places by a soft red sandstone. The areas underlain by these rocks are in a locality where bedrock is covered with a fairly heavy mantle of drift, so that outcrops are scarce. No data were obtained on the ages of these rocks. Dawson, however, placed them in the Coldwater group on lithological grounds.

Kamloops Volcanic Rocks

The volcanic rocks of the Kamloops group are widely distributed in the map-area, but except in its northern part their areal extent is relatively small. In the vicinity of Kamloops Lake, and stretching north from it to the northern border of the map-area, they are widespread. Areas of considerable size appear south of Thompson River at Mount Savona, Buse Hill, Monte Hills, and Mount Bulman. A wide area of these rocks also stretches northward for nearly 12 miles from the head of Stump Lake.

Lithology. The Kamloops volcanic rocks comprise a considerable thickness of rhyolites, trachytes, andesites, and basalts, together with feldspar porphyries, but the group is very largely composed of basalt and basalt breccia. The rocks show a wide range of colour from white, through various shades of red, pink, mauve, brown, buff, grey, and green to black. They are usually massive and fine grained, but are locally porphyritic and in places coarsely so. Occasionally they are so coarse grained as to resemble fine-grained plutonic rocks, though when examined under the microscope small amounts of interstitial fine-grained groundmass may be seen.

The flows in the vicinity of Merritt consist of light grey or mauve rocks containing small and generally rounded grains of feldspar, with widely scattered crystals of hornblende, or biotite, or both, in a very

[1] Rice, H. M. A.: oral communication.

fine-grained groundmass, which commonly has marked flow lines. Those sections examined under the microscope showed a few large crystals and many small laths of andesine feldspar in trachytic arrangement in a microcrystalline groundmass. The rock is a trachyte-andesite. Volcanic breccia does not appear to form any considerable part of the section in this locality, although common at other places, unless those rocks in the vicinity of Lower Nicola, which have been referred with some doubt to the Lower Cretaceous, should be included with this group.

Other small bodies referred to this group are found at isolated points throughout the southern part of the area. They consist of breccias, agglomerates, and grey to buff-coloured tuffs, together with dense vesicular and non-vesicular lavas. In places amygdules and masses of agate or chalcedony occur with the lava flows.

The thickest accumulations of these volcanic rocks are in the area around Kamloops Lake. Here Dawson (1896, pp. 173-174) has calculated that a thickness of 5,300 feet is represented, excluding 1,000 feet of the section represented by the rocks of the Coldwater group. At Battle Bluff the lavas rest on granitic rocks, and consist of coarse-grained feldspathic types with sedimentary interbeds similar to those of the Tranquille group.

These are overlain by the Tranquille beds, which are in turn overlain by thick accumulations of agglomerate, breccia, tuff, and lava flows that are largely basalts (*See* Plate I). The buff-coloured tuffs of the Tranquille group grade upward into agglomerates, the matrix of which is the same material. A large part of Tranquille Plateau is underlain by basaltic breccia and flows. A considerable part of the basalt carries olivine, and locally has segregations of groups of olivine crystals forming masses an inch or more in diameter. Locally columnar jointing is well developed (Plate IV A), but on the whole is comparatively rare. The rock is not all, however, so basic. On upper Tranquille River, near the point where it is crossed by the Red Lake road, a white volcanic rock has been described by Mrs. Stevenson (1939, pp. 446-7) as a rhyodacite, a porphyritic rock with phenocrysts of sanidine, oligoclase, quartz, and biotite, in a fine-grained, white, microcrystalline groundmass that makes up 87 per cent of the rock.

A thick section exposed on Mount Savona has been described by Dawson (1896, pp. 172-173). It consists of basalt and trachyte near the base overlain by thick accumulations of agglomerate, more basalt and trachyte, and a second, thick agglomerate. The agglomerate is coarsely bedded, but the contacts of individual beds are indefinite. They strike west to northwest and dip south or southwest at about 10 degrees. The agglomerate erodes into cliffs, many of which are carved into hoodoos capped by boulders. The boulders are nearly all, if not all, of types found in the Tertiary volcanic rocks, and some of them are very large and partly rounded, but not waterworn. One boulder near the summit measured 11 by 6 by 6 feet. At some places the basalts are amygdaloidal, the amygdules being composed of chalcedony. The trachytes are generally grey to nearly white porphyritic rocks, with small phenocrysts of feldspar and biotite. Similar rocks occur along the valley of Deadman River in the northwestern part of the area, where massive agglomerates are capped by basalt flows. The rocks there have also a gentle southerly dip (*See* Plate I).

Where these rocks extend north from Stump Lake, pale-coloured feldspathic types are exposed near Napier Lake and Dropping-Water Creek, which flows into the head of Napier Lake. At the latter place Dawson (1896, p. 234) found tuff beds with plant and insect remains, and mapped them as part of his Tranquille group. Much buff-coloured tuff occurs in this vicinity, but the exposures are mostly talus and the rock was not mapped separately. It is overlain by basalt breccia, and, in the vicinity of Brigade Lake, by nearly horizontal basalt flows. In the area around Brigade Lake, and McConnell Lake, a small lake about 2 miles north of Le Jeune Lake, these basalts rest on the older rocks, and at some places include boulders of granite in the lower parts of the flows.

Near the eastern margin of the map-area, south of South Thompson River, the Kamloops volcanic rocks occupy a large area. On the lower slopes of Buse Hill there is much tuff and agglomerate, whereas on Monte Hills and Mount Bulman the exposures are largely basalt. Local interbeds of sedimentary rock with fossils have been found. Exposures of the older rocks at a number of points indicate that the volcanic rocks accumulated on a surface having considerable relief.

Age Relations. Many of the widely scattered occurrences in the southern part of the map-area have provided no criteria for determining the age of the volcanic rocks, and they are correlated on the basis of their lithological similarity to known Tertiary types.

The exposures southwest of Merritt are included with the Kamloops group on the basis of their relationships to the Coldwater beds. It has been pointed out that the Coldwater rocks at the margins of the Merritt basin have dips ranging up to 70 degrees or higher, whereas the volcanic rocks a few hundred yards away lie apparently very nearly horizontally. It is believed that the volcanic rocks at this point are, therefore, unconformably above the rocks of the Coldwater, whose age is established by fossil evidence.

In the northern part of the map-area much of the evidence with regard to the age of the Kamloops volcanic rocks is obtained from the interbedded strata of the Tranquille beds. The volcanic rocks both underlie and overlie these sedimentary rocks, in most places conformably. The fossil evidence that has accumulated to date is not sufficient to establish an age difference between the Tranquille and the Coldwater beds. There is, nevertheless, no evidence of volcanic activity associated with the known Coldwater rocks and there does appear to be some evidence of an unconformity between them and the overlying Kamloops volcanic rocks. Along the lower slopes of Mara Hill there is no marked division between the tuffaceous members of the Tranquille beds and the overlying agglomerates; the sedimentary rocks are sandstone with buff-coloured tuff that grades upward into an indistinctly bedded, buff agglomerate, with boulders gradually increasing in number upward. Fossils were found at many localities in beds within the lava flows, as on Deadman River, Red Point (on Kamloops Lake near Frederick), Tranquille River, Mara Hill, Dufferin Hill (a low hill about 2 miles west of Kamloops), Monte Hills, and a number of other points. Although there is a considerable degree of similarity between these and some of the Lower Cretaceous rocks, there is no doubt that they represent a distinct age group.

It will be recalled that Dawson divided the volcanic rocks into two groups, one of which was older and the other younger than the Tranquille beds. However, the Tranquille has such a limited areal extent that it was not found practicable to carry out this subdivision as there appeared to be no definite lithological characters on which it could be based. Moreover, it appears highly probable that the Tranquille beds do not represent a single horizon within the volcanic rocks. For these reasons this subdivision of the volcanic rocks was not attempted.

The volcanic rocks of the Kamloops group overlie all the consolidated formations of the area, with the possible exception of a group of basalts described below, which may be younger.

VALLEY BASALT

At a few places in the map-area are small areas of basalt that have been mapped separately from the Kamloops volcanic rocks because of their apparent age relations. So far as is known they occur only in some of the principal valleys, and in the field were referred to as valley basalts in contrast with some of the plateau basalts. They are generally grey to black, fresh appearing, and vesicular, but in places are dense. Petrographically it is probable that these basalts could be matched from among the other Tertiary volcanic rocks of the area, and, consequently, it is possible that other flows not mapped separately belong in this group. They were distinguished only in the southern part of the map-area in the valley of Nicola River, a short distance above Merritt, in the valley of Quilchena Creek, and between Salmon and Rush Lakes near the eastern border of the map-area. At the first two places these lavas form flat benches a few hundred feet above the level of the streams. The flat bench that forms a scarp facing Nicola River is underlain by these rocks. On Quilchena Creek the same conditions are repeated, where exposures of these rocks occur at intervals on the west bank of the creek from about 2 miles above its mouth to near the southern boundary of the map-area, and may be more extensive than indicated on the map. As in general they form a scarp facing the valley, it was assumed that unless occasional outcrops occurred along the edge of the bench they were absent. The rocks were, therefore, mapped as small, discontinuous areas rather than as a single connected flow. The occurrence at Salmon Lake lies in the valley bottom and not on a bench as is the case of the other exposures.

Only one specimen was examined under the microscope. This was a dark grey rock, aphanitic in texture, with a number of small vesicles. Under the microscope the rock is quite fresh, and is seen to be composed essentially of plagioclase feldspar and augite with small amounts of brown interstitial glass. The feldspar occurs in the lath-shaped forms about 0·3 to 0·5 mm. or less long. This feldspar is labradorite, An_{55}. The augite grains are slightly larger than the feldspar grains. The rock shows an ophitic texture with the augite surrounding and interstitial to the feldspar laths.

As pointed out above, these rocks, judging from the limited areas of outcrops, are horizontal or nearly so. The lower flows may have an initial dip corresponding to that of the surface on which they were extravasated. In the area along Nicola River the underlying Coldwater rocks have suffered severe deformation. At the edges of the basin dips of 70 degrees

to nearly vertical are found, and in some instances the beds may be overturned. Such high dips occur near the Normandale coal showing on the north slope of Nicola Mountain, less than a mile from the outcrops of these horizontal basalts. In Nicola Valley itself the Coldwater strata are dipping 25 to 30 degrees. On Quilchena Creek, the Coldwater strata are dipping from 50 to 80 degrees at a point only a few yards from the practically horizontal basalt. There seems little doubt, therefore, that an angular unconformity exists between the Coldwater beds and these lavas. Their relations to the rocks of the Kamloops group are not known. It would appear, however, that these rocks have not undergone any pronounced diastrophic movements, and that they thus may be comparatively young. On Quilchena Creek, the lower basalt flow was found resting on unconsolidated material that was believed to be greenstone talus (Plate IV B). Small fragments of the greenstone are included in the basalt near its lower contact. The lavas are, nevertheless, of pre-Pleistocene age, as they form large glacial erratics that have been carried for long distances from their nearest source.

The age of the vesicular lavas is thus Miocene or younger, but not more recent than Pleistocene. The fact that they are practically horizontal, and that in the one place they overlie unconsolidated material, makes it appear that they represent the most recent consolidated rocks of the area, and they may be of Pliocene age.

PLEISTOCENE AND RECENT DEPOSITS

Pleistocene and Recent deposits are of considerable importance in the area for they cover much of the bedrock. They include glacial drift, the deposits of Glacial streams and lakes, and the deposits of Recent streams. The evidence indicates that all the map-area was covered by ice during Pleistocene time, for glacial striæ are found near the higher summits and glacial erratics are widespread.

Boulder clay is the most prevalent of the unconsolidated deposits. It requires no description for it is similar to the boulder clay found elsewhere, consisting of unsorted material characteristic of such deposits. It covers much of the surface of the valley walls and uplands, and is also prevalent in the valleys themselves.

Other deposits consist of the stratified, sorted and partly sorted deposits of sand, gravel, and clay that form benches and terraces along the sides of the valleys (Plate V A). No detailed study of these was made, but they were presumably formed in streams flowing at the margins of ice that filled the central parts of the valleys, and possibly also in lakes formed by the damming of valleys by the ice.

Of special interest in this connection are deposits of silt. These form almost continuous terraces along the margins of South Thompson Valley from Kamloops eastward. They are grey to nearly white, very fine-grained silts that form well-defined horizontal or nearly horizontal strata and show a glistening appearance due to the large number of contained mica flakes. The beds range from a fraction of an inch to several feet in thickness. They have been described in detail by Dawson (1879, pp. 142-44; 1896, pp. 283-290), Daly (1915, pp. 147-151), and others, so that no lengthy account is necessary here. The terraces attain elevations

of 300 to 400 feet above the level of the river, rising slightly towards the valley walls (Plate V B), and have been thoroughly dissected by a large number of branching gullies. These are the deposits of lakes fed by glacial streams. Although the chief development of the silts is along South Thompson River they are found at several other points, such as Cherry Bluff, Tranquille, North Thompson River, Nicola Valley above Merritt, and other localities.

The Recent deposits consist principally of stream deposits, which are largely reworked glacial materials.

The glacial striæ observed in the course of field work have been plotted on the accompanying map, No. 887A, together with those striæ observed by Dawson. In addition, the direction of ice movement, as deduced from drift ridges, has been plotted in a number of places. Generally only those striæ that indicate the movement of ice on the higher parts of the area have been plotted. The evidence indicates that the ice advanced from the northwest towards the southeast and south. This direction of movement is also borne out by the scattering of blocks of conglomerate across the upland surface from the Iron Mask mine towards Shumway Lake. These erratics presumably came from Eagle Hill near Copper Creek, and have been transported nearly 20 miles from their point of origin. Erratics of basalt from the Tertiary flows are also of common occurrence throughout the area.

CHAPTER III

MINERAL DEPOSITS

GENERAL STATEMENT

The mineral deposits of the area include several diverse types and occur at widely scattered points. Deposits of gold and silver, lead and zinc, copper, mercury, tungsten, and iron, together with those of industrial minerals and coal have been found. Some of these are among the earlier lode discoveries of the province, those around Stump Lake, for example, having been found between 1882 and 1884. However, in spite of the number of discoveries that have been made the mineral production of the area remains relatively small compared with that of other nearby mining areas. As some measure of the mineral production, the value of metal mined in the area has been calculated by the writer from figures supplied by the British Columbia Department of Mines to amount to $1,678,990. Lode gold production amounted to 13,610 ounces, valued at $385,649.94, and placer gold[1] at 1,216 ounces, valued at $25,617.42. Silver production amounted to 316,384 ounces, copper to 6,048,892 pounds, and lead and zinc to 2,223,158 and 378,223 pounds, respectively. The balance of metal production is made up of small shipments of iron ore and of mercury.

Coal production amounted to 2,701,600 long tons, valued at approximately $11,617,000, and small amounts of industrial minerals such as gypsite and natron bring the estimated total to $13,313,000. This figure does not take into account those from the production of limestone, building stone, gravel, or sand.

The greater part of the mineral output has been furnished by very few properties, and even in these operations have been to some extent intermittent. However, the evidence of widespread mineralization justifies further prospecting, in the hope that other productive mines will be found.

CLASSIFICATION OF DEPOSITS

For purposes of description the deposits have been divided into several groups, as follows:

- Metalliferous deposits
  - Placer gold deposits
  - Gold and silver deposits
    - Stump Lake area
    - Swakum Mountain area
    - Vein deposits in rocks of the Nicola group surrounding the Iron Mask batholith
    - Gold-silver deposits in rocks of the Cache Creek group
    - Gold-silver deposits in and around small bodies of intrusive rocks
  - Silver-lead-zinc deposits
  - Mercury deposits

[1] The figures for placer production are admittedly incomplete as those for early production cannot be separated from those for other mining districts.

Copper deposits
  Associated with the Iron Mask batholith
  Highland Valley camp
  Other copper deposits
Iron deposits
  Vein deposits
  Bog-iron deposits
  Contact metamorphic deposits
Deposits of industrial minerals
Coal deposits

As these divisions are partly topical and partly geographic, it should be understood that they do not necessarily form clear-cut types, but that some overlap occurs between deposits described under different headings. Thus, some of the mineral deposits of Swakum Mountain are closely allied to others described under the heading of copper deposits, and some of the vein deposits in the Nicola rocks surrounding the Iron Mask batholith are closely allied to the copper deposits associated with the Iron Mask batholith.

METALLIFEROUS DEPOSITS

PLACER GOLD DEPOSITS

References: B.C. Minister of Mines, Ann Repts.: 1887, p. 276; 1888, p. 316; 1889, p. 291; 1890, p. 377; 1892, p. 540; 1895, p. 596; 1896, p. 565; 1899, p. 735; 1900, pp. 874-6; 1901, p. 1081; 1933, p. 183.

Placer mining has been carried on in the map-area since the early sixties. This work has generally been on a small scale, and apparently yielded low returns. The total production of placer gold within the map-area is not definitely known. Figures supplied the writer by the British Columbia Department of Mines show a production of 1,216 ounces of gold, but definite figures of early output are not available, being included with those of other mining divisions.

Tranquille River

Tranquille River was worked as a source of placer gold early in the sixties. Very little information is available as to the yield, as the creek was worked for many years by Chinese.

In the period from 1895 to 1896 some attempt was made to work bench claims by hydraulicking. Work was done by the Thompson River Hydraulic Company, and by J. A. Russel on the Cosmopolitan claim. Few details are given with regard to this work or to the ground held.

Following the failure of a dredging project on North Thompson River near the mouth of Jamieson Creek, the dredge was moved in 1902 to Tranquille River, and attempts were made in the next 2 years to work a flat on the lower reaches of the stream. This was not a success from an economic standpoint.

Placer mining by individuals working in a small way is still in progress. This work is confined to the lower reaches of the stream, below the canyon, and is on stream gravels that are largely derived from Glacial materials, but some of which may be pre-Glacial. The returns are probably small. In the period from 1932 to 1945 production from this stream amounted to 343 ounces of gold.

Jamieson Creek

Jamieson Creek is also stated to have been worked for placer gold in the sixties. This work is reported to have yielded good returns, but attempts to reach bedrock in the valley bottom failed because of the flow of water encountered. A dredge was installed about 1900 on a property that included the lower part of Jamieson Creek and about 1½ miles of North Thompson River upstream from Jamieson Creek. The dredge worked for 2 months of 1901 with unsatisfactory results. It is stated that the gold occurred in the form of bar deposits, which are unsuitable for dredging.

Deadman River

Small amounts of gold were obtained from Thompson River just below the mouth of Deadman River, about a mile below the outlet of Kamloops Lake. Deadman River here cuts through a large raised delta deposit. The miners are stated to have recovered from 25 to 45 cents a day and for short periods as much as $1 a day from gravels lying between high and low water levels. Shallow test pits put down on the Indian Reserve three-quarters mile up Deadman River from its mouth showed very fine gold.

Criss Creek

Several shafts were sunk at the junction of Criss Creek and Deadman River by the Branch Ranch Mining Company. One of these is stated to have reached a depth of 35 feet. Thompson River Mining Company sunk shafts in the same area to depths of 35 to 40 feet without reaching bedrock. Gold is stated to have been obtained by Chinese miners a short distance up Criss Creek.

In that part of the creek from 2 to slightly more than 3 miles above its mouth, four men were working the gravels in 1940. Bedrock here lies at a depth of from 7 to 10 feet. Above the workings the overburden probably deepens, as no outcrops were found along the sides of the creek for a considerable distance. The stretch of the creek being worked is narrow and steep walled, and the gravels contain many boulders. One man, Fred Morris, stated that he had worked there at intervals for 6 years. He reports his maximum winnings to have been $7 for a single day and as much as $65 a month obtained by steady work. Criss Creek is credited with the production of only 16 ounces of gold in recent years.

GOLD AND SILVER DEPOSITS

Vein Deposits Near Stump Lake

References: B.C. Minister of Mines, Ann Repts.: 1885, p. 496; 1886, p. 212; 1887, pp. 274-6; 1888, pp. 314-6, 319-21; 1890, p. 377; 1916, p. 429; 1917, pp. 228-30; 1918, p. 239; 1919, p. 184; 1920, p. 168; 1922, p. 144; 1930, pp. 205-6; 1931, p. 115; 1933, pp. 178-80; 1934, pp. D24-5; 1935, p. D13; 1936, pp. D14-21; 1938, pp. A39, D35; 1939, pp. A42, 76; 1940, pp. A23, 62; 1941, pp. A24, 58; 1942, p. A57; 1943, p. A61; 1944, pp. A40, 56; Bull No. 10, 1943, p. 107. Dawson, G.M.: Report on the Area of the Kamloops Map Sheet; Geol. Surv., Canada, Ann. Rept., vol. VII, 1894, pp. 333-35B (1896).

A group of mineral deposits consisting of quartz veins and shear zones carrying quartz veins occurs in the vicinity of Stump Lake. These veins are in some instances remarkably persistent in strike and dip, one vein

having been traced for a length of nearly 1,800 feet and having been proved by underground workings and drilling to a depth of more than 1,000 feet. The veins range up to a maximum width of 9 feet, but are commonly less than 2 feet.

The rocks in the vicinity of Stump Lake consist of greenstones of the Nicola group. They are chiefly fine-grained, chloritized, volcanic rocks, in places porphyritic, together with tuffs, breccias, and minor amounts of limestone, conglomerate, and quartzite. The sedimentary rocks do not, however, occur near the mineral deposits. The lavas are generally massive, and it is exceedingly difficult to distinguish the boundaries of individual flows. However, a number of measurements of attitude were obtained on tuff beds and on the intercalated sedimentary rocks, and these indicated that the major structure is probably a syncline with the axis trending and plunging north. This structure is undoubtedly complicated by local folding and faulting. Actually, rocks found on the western limb of the assumed fold were not observed on the eastern limb.

South and northeast of the mines the volcanic rocks are underlain by strata believed to belong to the Cache Creek group. Both groups are cut by large bodies of granitic intrusions that lie some 8 miles northeast and 3 miles west of Mineral Hill, on which the principal showings occur. These plutonic rocks vary somewhat in composition, but are generally quartz diorites or granodiorites. There is no evidence that the plutonic rocks are closely associated with the orebodies. Basaltic dykes cut and offset the veins, but these may be related to extensive flows of Tertiary lavas that occur a few miles to the north.

The mineral deposits consist of both veins and shear zones; the former occur in fracture zones in which the amount of quartz varies from place to place, with the balance of the lode made up of bleached, altered, silicified greenstone carrying more or less pyrite.

The veins generally strike northerly and dip easterly, the strike of the principal veins varying from north 45 degrees west to north 25 degrees east, and the dip generally from 45 degrees to nearly vertical. One vein, the Joshua, which dips easterly in the upper workings, is reported to turn to a westerly dip in the lower workings, but these were flooded at the time of the writer's examination so that this part of the vein could not be seen. The veins vary greatly in width, ranging from about an inch to 9 feet, but are commonly less than 2 feet. The wall-rock along the veins is altered and bleached for varying widths. In spite of their narrowness, the veins are remarkably persistent along their strike. Branches of the veins lead into the walls, but in many instances these appear to feather out within a short distance, or to be relatively unimportant. In some instances they curve back to rejoin the main veins. One important vein, however, the King William, may be regarded as a branch of the Enterprise vein.

The shear zones carry veins, stringers, and bunches of quartz or, in places, calcite. In several places well-defined veins apparently pass out into shear zones that mark their continuation along strike or dip.

The ore minerals consist of pyrite, galena, sphalerite, tetrahedrite, chalcopyrite, bornite, scheelite, and small amounts of arsenopyrite, pyrrhotite, and native gold[1]. The proportion of sulphides varies sharply from place

[1] Warren, H. V.: Personal communication. Arsenopyrite, pyrrhotite, and native gold were detected during microscopic studies made at the University of British Columbia.

to place, and parts of the veins are only sparsely mineralized with them. The values may be said to occur in the form of ore shoots with relatively low-grade or narrow parts of the veins separating them.

The veins are cut and offset by many small faults. The displacement is generally only a few feet, the greatest offset noted being 40 feet horizontally. As has been pointed out by Hedley (B.C. Minister of Mines, 1936, p. D19), this faulting is not strictly post-mineral but is part of the fracture pattern in which the veins were formed.

(62)[1] Consolidated Nicola Goldfields, Limited

The property of this company embraces a large tract of land extending from the eastern shore of Stump Lake to the hillside east of the Kamloops-Merritt highway. It is situated about halfway between Merritt and Kamloops, and consists of upwards of one hundred and twenty claims, having an area in excess of 5,500 acres (Figure 1). It is a consolidation of several groups, such as Nicola Mines and Metals, Limited, Mineral Hill, Nicola Dome, Conn Owen, Jenny Long, and Johannesburg. The property is owned by Consolidated Nicola Goldfields, Limited, of 506 Dunsmuir Street, Vancouver. A general view of the camp is shown in Plate VI A.

Some of the claims in the vicinity of Mineral Hill were staked between 1882 and 1885. Work by Nicola Mining and Milling Company prior to 1890 included the sinking of the Joshua, Tubal Cain, and King William shafts, whereas the Star Company put down the Star (Enterprise) and Planet shafts. Work was suspended around 1890, and there appears to have been comparatively little work done until 1916 when Donahue Mines Company, Limited, of Seattle, started work on the Joshua and Tubal Cain veins. A mill was built by this company, but was only operated for a short time. Operations by the company were stopped in 1920.

In 1925 Planet Mines and Reduction Company, Limited, started work on the Enterprise vein. The shaft was deepened to the level of the present crosscut adit (320 feet) and the adit itself was driven. A mill was built and operated from 1929 to early in 1931, when the company stopped work. Nicola Mines and Metals Company acquired the property of the Planet Company and in addition a number of other claims. The company did development work on the Joshua, Tubal Cain, and Enterprise veins and there was some production. In 1937 a reorganization took place whereby the present company, Consolidated Nicola Goldfields, Limited, acquired the holdings of Nicola Mines and Metals and the other groups. From 1939 to 1942 the company was developing the mine and rebuilding the mill, which was operated at intervals. Operations were suspended in 1942.

Figures supplied by the British Columbia Department of Mines show that the mines owned by this company have produced 77,605 tons of ore, which yielded 8,494 ounces of gold, 252,939 ounces of silver, 40,822 pounds of copper, 2,205,444 pounds of lead, and 367,869 pounds of zinc. This production was in the period from 1916 to 1944.

[1] Numbers, in parentheses, are those of the properties named or located on Map No. 887A (in pocket).

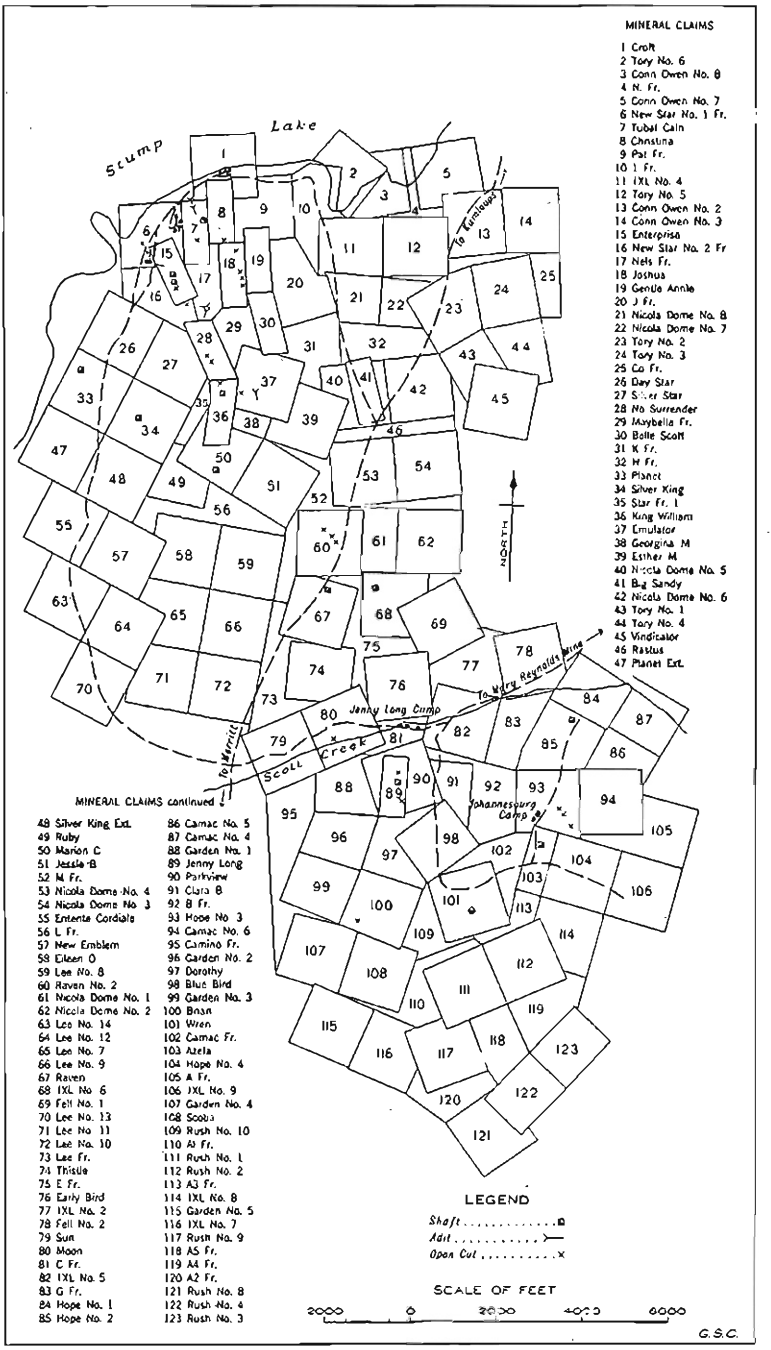


Figure 1. Mineral claims of Consolidated Nicola Goldfields, Limited, at Stump Lake.

The property contains several veins. Of these the Enterprise, King William, Tubal Cain, Joshua, Jennie Long, and Johannesburg have received the most attention (Figures 2, 3). Nearly all of the ore mined covered by the figures given above came from the Enterprise and King William veins.

Enterprise Workings. The Enterprise workings develop two of the principal veins of the property, the Enterprise and the King William. The

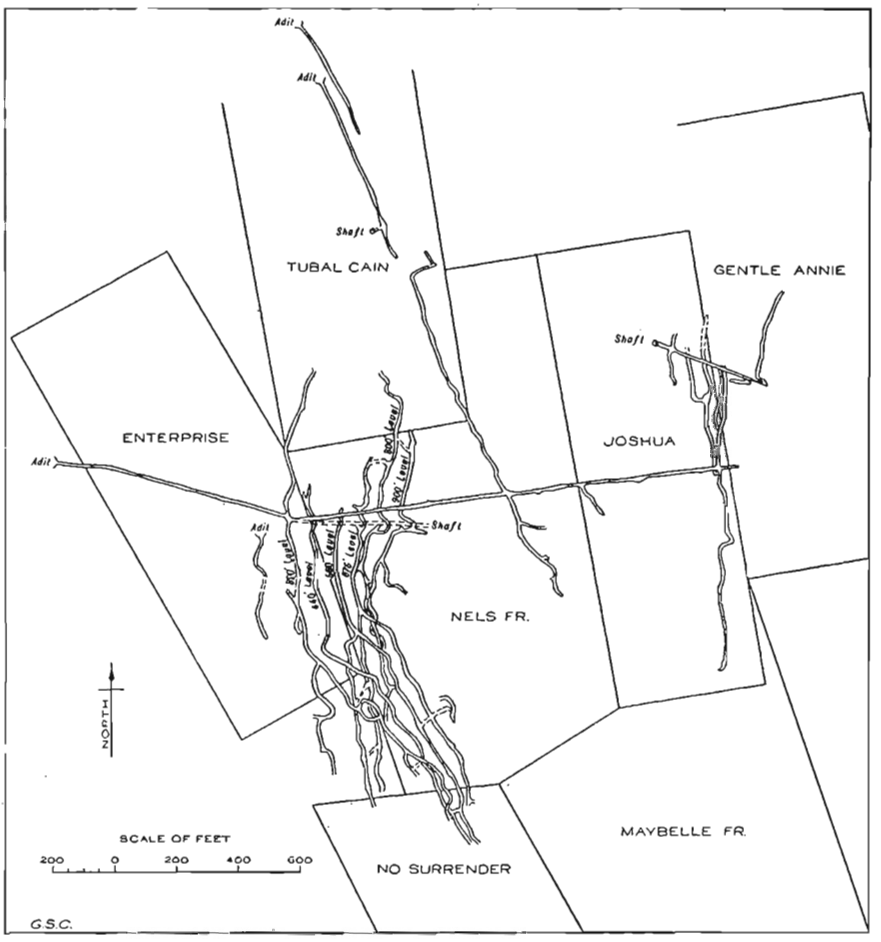


Figure 2. Main workings on the Enterprise, King William, Tubal Cain, and Joshua veins, Consolidated Nicola Goldfields, Limited.

latter is regarded as a branch of the former, striking toward exposures in a shaft and open-cuts on the King William and No Surrender claims, but a gap of some 900 feet separates the northern exposures of the King William vein in these surface workings and the southernmost drifts on it from the Enterprise workings (Figures 2, 3).

The *Enterprise vein* was originally developed by an inclined shaft sunk for 320 feet on the dip of the vein. The present workings are opened by an adit that intersects the vein 760 feet from the portal and near the bottom

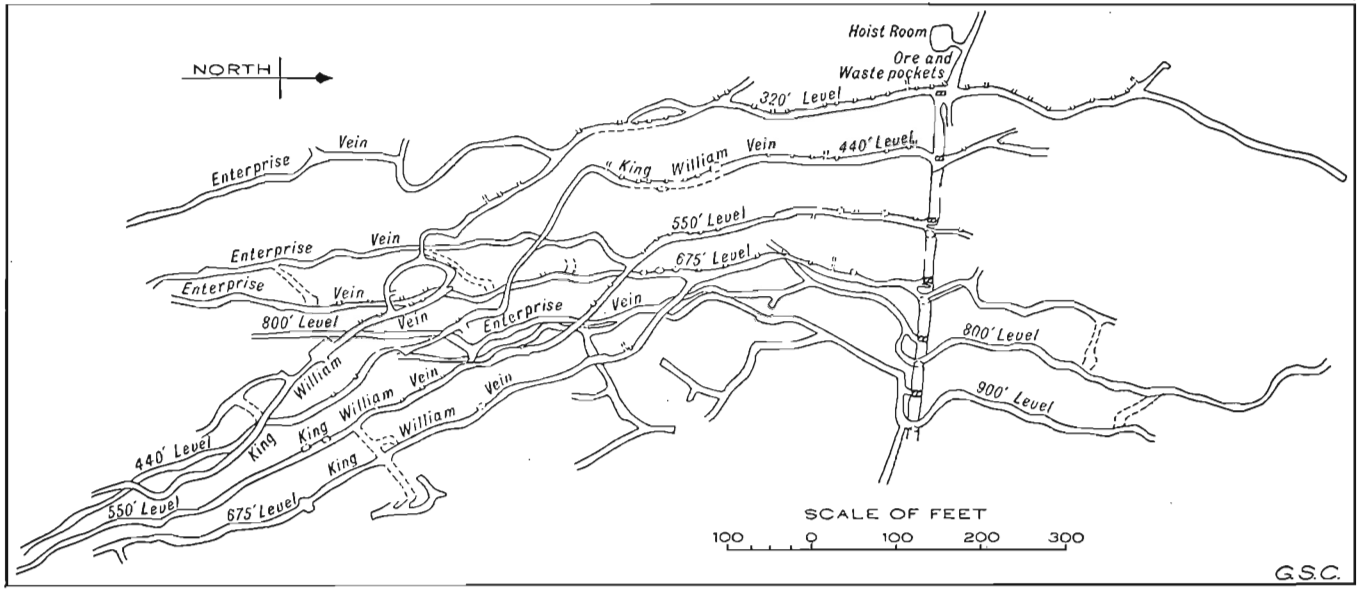


Figure 3. Main underground workings on the Enterprise and King William veins, Consolidated Nicola Goldfields, Limited.

of the old shaft, and continues eastwards to crosscut the Tubal Cain and Joshua veins. Drifting has been done from this crosscut on all these veins (Figures 2, 3), and the workings are referred to in this report as those of the 320-foot level.

From the point where the adit intersects the vein, an internal shaft or winze has been sunk following the dip of the vein to below the 900-foot level, and workings have been driven from it at the 440-, 550-, 675-, 800-, and 900-foot levels (Figures 2, 3).

Above the 320-foot level is a working known as the 190-foot level, which has been driven from the old shaft. Stoping has been carried out above this level in two sections, 210 and 300 feet long.

The 320-foot level has been driven 480 feet north of the winze and nearly 1,000 feet south of it. The King William vein branches off 375 feet south of the shaft, and evidently appeared as the main vein at the time stoping was done, for the stope followed this branch of the vein. Ore has been stoped on the Enterprise and King William veins above the 320-foot level for a continuous length of 820 feet, forming the longest single ore shoot in the mine. South of the intersection of the two veins an ore shoot 290 feet long is reported to occur in the Enterprise vein.

The 440-foot level has been driven on the Enterprise vein 120 feet north of the winze and 400 feet south of it. The vein has been stoped out over a considerable part of this distance. It has not been driven on south of the intersection of the King William vein.

The 550-foot level has been driven for only 45 feet north of the winze and for 930 feet south of it. Stoping was carried on south from the shaft to the intersection of the King William vein, but that part of the large ore shoot north of the shaft on the upper levels was not found to continue on this level. One shoot of ore 200 feet long was found south of the intersection with the King William vein; no connection has been driven from this ore shoot to the one occupying a similar position on the 320-foot level.

The 675-foot level has been driven 240 feet north of the winze and 930 south of it. The vein has been stoped out for part of the distance between the winze and the intersection with the King William vein; south of this intersection an ore shoot 360 feet long was found. Only a short shoot of low-grade ore was found to the north of the winze.

The 800-foot level has been driven on the Enterprise vein for 480 feet north of the winze with a raise to the 675-foot level near the end of the latter. The level has also been driven some 810 feet southerly from the winze. A branch vein leads to the southwest 150 feet along this drift.

The 900-foot level has been driven about 300 feet north of the winze and 630 feet south from it. A shoot of ore 135 feet long immediately south of the winze has been stoped out. The vein on this level has been intruded by a basaltic dyke that follows the vein fissure and crosses the vein at several points, breaking it into isolated segments.

The Enterprise vein varies considerably in width, being commonly under 2 feet. Swelling and pinching are characteristic. There are many changes in strike, which is generally slightly west of north, swinging to northeast in the northern section. The dip varies from 40 to 80 degrees, but is commonly about 50 to 55 degrees. The ore occurs in shoots separated by leaner or narrower parts of the vein, and these shoots have possibly a

general rake southward. The largest shoot is that stoped above the 320-foot level. It continues down to and below the 440-foot level, but shortens materially with depth, so that the section north of the winze, which is 210 feet long on the 320-foot level, is only about 80 feet long on the 440-foot level and was not encountered on the 550-foot level.

The *King William vein* does not differ greatly from the Enterprise vein of which it forms a branch. It attains a greater width at some points, at one place reaching 9 feet, and on the upper levels appears to be the more important of the two veins. On the lower levels, where it joins the Enterprise vein, the King William vein is rather inconspicuous, amounting to little more than a fracture in the rock carrying small amounts of quartz. The point of intersection of the two veins gets progressively closer to the winze on each of the lower levels (Figure 3).

The King William vein has been drifted out south from its intersection with the Enterprise vein on each of the levels except the 800-foot. On the 320-foot level it has been drifted out for 720 feet and stoped for about half that distance; on the 440-foot level it has been followed for nearly 900 feet, but in part of that distance passes into the foot-wall of the stope on the vein, which is about 450 feet long.

On the 550-foot level the vein has been drifted on for 900 feet southerly from its intersection with the Enterprise vein. Some stoping has been done in the northern part of this drift, and was also in progress at the time of the writer's visit on an ore shoot, stated to be 400 feet long, near the southern end of the drift.

The 675-foot level has been driven for 780 feet on the King William vein, but for 300 feet south from the intersection with the Enterprise vein it has been intruded and broken by a basaltic dyke. Near the face, a section of the vein 260 feet long attains a maximum width of 9 feet. A winze has been sunk on this part of the vein to the 800-foot level, and short drifts run in both directions from it, but these workings were inaccessible at the time of the writer's visit.

On the 900-foot level only the narrow part of the vein near its intersection with the Enterprise vein had been drifted on, and this drift had turned and followed a branch vein back towards the Enterprise vein. Driving southwards on this vein was resumed after the writer's visit.

Some diamond drilling has been done on the vein below the 900-foot level.

At the surface the King William vein is opened by a shaft, now inaccessible, but stated to be 170 feet deep with levels at 40 and 170 feet. A stope has mined out part of the vein to the surface. Immediately south of the shaft an open-cut has been driven from which a carload of ore was shipped. From these workings the vein has been traced northerly for some 800 feet by means of open-cuts to the point where it passes under an area of thick drift. These cuts are now largely sloughed in, but several cuts on the No Surrender claim show an altered zone 7 feet wide with a quartz vein 20 inches wide well mineralized with sulphides. A parallel strand of quartz 8 inches wide lies 3 feet in the foot-wall of this. These cuts are about 900 feet southerly from the King William vein as exposed in the Enterprise mine workings.

Tubal Cain Mine. The Tubal Cain mine is developed by a shaft 170 feet deep and by two adits. The vein is also intersected by the adit from the 320-foot level of the Enterprise mine, and considerable drifting has been done on it at that level. The vein lies between the Enterprise and Joshua veins.

From the shaft a short level, now inaccessible, is reported to have been driven at a depth of 60 feet. An adit some 500 feet north of the shaft and 100 feet below the collar has been driven to connect with the shaft and extended 110 feet southerly beyond it. A second adit some 200 feet farther north and 100 feet lower is inaccessible. The vein in the upper adit shows short lengths from 2 to 4 feet wide between which the vein is less than a foot wide.

The 320-foot or adit level of the Enterprise mine has been driven to crosscut the Tubal Cain vein, which is expressed on this level by two steeply dipping shear zones diverging southward. These are cut 1,000 feet southerly from the Tubal Cain shaft, and where intersected by the adit are 250 feet apart. The westernmost has been drifted on for 380 feet south of the adit, but this working was found to be blocked at a point 150 feet south. North of the adit this shear zone has been drifted on for 780 feet, reaching a point nearly vertically below some of the upper workings. The drifts on this westerly shear zone show only short lenses and stringers of quartz and silicified rock. A crosscut was driven from the end of this working to the eastern branch of the vein, which was then drifted on for 180 feet northerly. A short stope has been driven above this last working. The zone is here about 5 feet wide, and shows a strong quartz vein that is well mineralized in places. South of the adit the easterly shear zone has been drifted on for 140 feet. It carries only stringers of quartz and calcite.

An *intermediate shear zone* was intersected by the crosscut adit some 300 feet easterly from the Enterprise shaft, and was drifted on for 115 feet southerly from this adit. Where first discovered the zone contained a vein of quartz a foot wide, but this diminished rapidly southward in the drift, and much of the working exposed only a crushed zone with small quartz stringers.

Joshua Mine. The Joshua mine is developed by a shaft to a depth of 755 feet on the dip. Drifts have been run from the shaft at the 100-, 200-, 300-, 400-, 550-, and 750-foot levels. In addition, the 320-foot adit level of the Enterprise mine is continued to intersect the Joshua vein, which is cut 2,160 feet from the portal (*See* Figure 2). This vein is drifted out 330 feet northerly on this level to connect with the Joshua shaft, which is encountered a few feet above the old 400-foot level. The vein is also drifted on for 650 southerly from the adit. The shaft is filled with water to within a few feet of the 320-foot level.

The Joshua vein follows a fracture and shear zone striking nearly north and dipping 60 degrees east. Below the 400-foot level the dip is stated to be towards the west.

The 100-foot level is a short drift run about 115 feet south and 130 feet north of the shaft. Above the level the vein has been stoped out for a length of 60 feet south of the shaft, and a stope from below has broken through the floor of the level for a length of 35 feet. That part of the vein remaining averages about a foot wide and carries only sparse sulphides.

The 200-foot level is blocked to the north of the shaft, but is reported to be 50 feet long. It has been driven 160 feet south of the shaft with an ore pass near the southern end. The vein has been stoped above this section for a length of roughly 80 feet.

The 300-foot level has been driven 140 feet north and 340 feet south of the shaft, with a length of 160 feet stoped out above the south drift.

The 320-foot or adit level is 330 feet long from the shaft to the adit and has been continued 650 feet south of the adit crosscut. The vein on this level varies in width from 2 inches to more than 30 inches, but is generally about 10 inches wide. South of the crosscut the drift shows a strong quartz vein for 200 feet, a much narrower quartz vein for another 200 feet, and finally a sheared zone with stringers of quartz and calcite. The vein thus gives indications of feathering out in this direction.

Masses of scheelite about 3 or 4 inches in diameter appear in the quartz on the dump at the Joshua shaft, but only small amounts of scheelite were found underground.

Emulator Vein. The Emulator workings are situated about 3,000 feet slightly east of south from the Joshua shaft. At the surface a line of cuts and trenches indicates that the vein is striking north 25 degrees west and dipping 75 degrees northeast. The principal open-cut is 120 feet northwest of the Emulator adit and 58 feet above its floor. It shows the vein to be 8 feet wide, tapering down to 5 feet at the end of the cut, where it consists of a number of stringers of quartz with country rock between. Open-cuts and trenches trace the vein in both directions, but are now largely sloughed in.

An adit has been driven as a crosscut for 90 feet and as a drift for about the same distance northwest of the intersection. The vein is 5 feet wide beyond the intersection, but gradually pinches towards the face. Near the face it is cut by a fault, but the displacement is small. The sulphide mineralization is sparse, and gold values are relatively low, although good values are reported to have been obtained in the open-cuts. Small amounts of scheelite appear in the vein.

Silver King. The Silver King shaft is situated about 3,500 feet slightly west of south from the Enterprise adit. It is sunk on a vein zone that strikes north 20 degrees east and dips 65 degrees northwest. The zone is poorly exposed, but contains a band of quartz a few inches wide and a few additional narrow stringers. The shaft is filled with water to within 25 feet of the collar.

Planet. The Planet shaft is about 2,800 feet southwest of the Enterprise workings. It is said to be 100 feet deep, but was filled with water to within 30 feet of the collar. The vein strikes north to north 10 degrees east and dips steeply easterly. It is composed of a band of quartz from 8 to 18 inches wide, with several quartz stringers separated from this by altered country rock. There are two open-cuts south of the shaft; the first is 85 feet south, partly sloughed in, and shows an 18-inch quartz vein in the north end; the second does not encounter the vein. Two cuts north and northeast of the shaft also do not show the vein.

Jenny Long Mine. The Jenny Long mine is inaccessible, and the following account is taken from Hedley's report for the British Columbia Department of Mines (1936) and from mine maps and sections. The mine is situated some 13,000 feet southeast of the Enterprise workings.

The surface work is largely sloughed in. According to Hedley, this work showed two parallel, north-south bodies of quartz and one trending northwest.

The shaft is stated to be sunk on the westerly of the two north-south veins, with an inclination of 56 degrees. The vein was followed for 90 feet where it left the foot-wall of the shaft, which was continued to a depth of 280 feet with workings at the 65-, 165-, and 265-foot levels. The 65-foot level is shown by the mine maps to have been driven about 200 feet northerly and 280 feet southerly from the shaft. The No. 1 vein was traced for 180 feet northerly from the shaft, and is shown 30 feet from the No. 2 vein at the shaft, gradually converging with the latter at the northern end of the workings. It is probably a branch of the No. 2 vein, which has been traced the length of the workings. In the north end of the working, a third vein with a strike of north 50 degrees west has been followed by a drift 160 feet long. According to Hedley, the vein system averages less than 29 inches of quartz in width, but locally the quartz reaches widths of 6 feet. Some stoping has been done on the veins.

The 165-foot level is about 90 feet long, excluding the crosscut from the shaft to the vein. About 40 feet of the drift is north of the crosscut, and encounters a vein near its north end that has not been drifted on, but which may be one of the veins referred to above. The southern drift shows a vein near the shaft. The relations of these to the veins in the upper level are not clear.

The 265-foot level is about 50 feet long, including the shaft crosscut. It encountered a vein, but the relations with the veins above are not known.

Part of the quartz on the mine dump carries scheelite. According to Hedley, "values, judging from the intensity and character of mineralization in different parts of the mine, must be erratic, and close sampling is necessary for determination of averages".

The most recent work was done by Kootenay Nevada Mines, Limited, under the direction of the late John F. Coats. Since this work was done the 35-ton mill on the property has been dismantled.

Johannesburg Mine. The Johannesburg camp is situated about 16,000 feet southeast of the Enterprise mine and about 3,500 feet southeasterly from the Jenny Long workings.

The main showing is at a shaft on the Azela claim. This shaft is stated to be 78 feet deep, but is filled with water to within 20 feet of the surface. The occurrence consists of a shear zone 6 to 8 feet wide, striking north 15 degrees east and dipping 55 degrees southeasterly. At the collar the shear zone carries a little quartz; however, judging from the dump, a number of strands of quartz were encountered in sinking the shaft. The quartz carries pyrite, galena, sphalerite, and a little scheelite. No chalcopyrite nor tetrahedrite was observed.

About 750 feet northeasterly from the shaft, two pits show a vein zone striking north 40 degrees west and dipping steeply northeast. In one pit the zone is 3 feet wide, with 14 inches of heavily oxidized country rock

carrying bunches of quartz. In the other, the zone shows 8 feet of quartz with 10 inches of altered rock on the footwall. Some 500 feet southeasterly, another pit exposes the zone rather poorly. Here the quartz is about a foot wide. These cuts showed only scanty sulphide mineralization.

Several cuts and a shallow shaft have been dug alongside the road near the Johannesburg camp. These are now largely caved in. The shaft shows a quartz vein 10 inches wide with galena and a little copper carbonates. The relation to the other showings is not apparent.

Another shaft, known as the Johannesburg shaft, is situated 3,000 feet northeast of the Azela shaft. It is filled with water to within 60 feet of the collar, and the upper part is tightly lagged so that little information can be obtained. A small amount of quartz carrying pyrite and galena appears on the dump.

Moon Claim. Two cuts occur about 4,500 feet northwest from the Jenny Long mine. At one of these a vein zone striking north 5 degrees west and dipping 55 degrees southwest carries three quartz stringers, 1 to 3 inches wide. Considerable scheelite appears in the quartz. At the other cut, a quartz vein, partly exposed, carries sparse sulphides and a grain or two of scheelite. Some 1,800 feet northeast two cuts, probably on the Thistle claim, disclose vein zones striking north 20 degrees east and dipping 50 degrees southeast. The cuts are now partly sloughed in, but quartz stringers up to 3 inches wide appear in the zones. These carry little sulphide.

Raven Claims. A shaft has been sunk alongside the highway on the Raven claim. This working is inaccessible, being filled with water to within 15 feet of the collar. A quartz vein 18 inches wide, well mineralized with pyrite and galena, is exposed. It strikes north 20 degrees east and dips 55 degrees southeast.

On the west side of the road, two cuts 100 feet apart have been made on a northwesterly striking shear zone about 4 feet wide that carries stringers of quartz parallel with the walls. In the more northwesterly cut, a central band of quartz 8 inches wide appears with altered rock on either side.

Other Claims. Shafts and cuts on the IXL, Nicola Dome, and Marian C claims were seen, but the cuts were found to be sloughed and the shafts inaccessible, so that little information could be obtained. An adit on the Belle Scott claim was also found to be caved.

Summary. Of the different veins on the Consolidated Nicola Goldfields property it would appear that the King William and Enterprise offer the best opportunities for further development. A very large part of the production to date has been from them. The Tubal Cain vein has shown comparatively little ore, although explored for a considerable distance, and on that part of the Joshua vein that was seen the ore shoots seemed comparatively small. With the information at hand it is difficult to assess the ore possibilities of the other veins.

On the Enterprise and King William veins the largest ore shoot occurred in the upper levels; the lengths of individual shoots found on the lower levels were considerably shorter. The causes of the localization of

ore shoots in the veins have not been determined, and, consequently, predictions as to their occurrence in other parts of the veins cannot be made. There appeared, however, a tendency of the ore shoots to rake southwards, although this cannot be stated as a rule that applies in every case. It would, therefore, appear that development work southwards on the lower levels of the King William and Enterprise veins might offer the best chances of finding ore shoots, more particularly as such work would be driving towards the King William shaft, which is stated to have shown some promise. Although some work has been done in this section without obtaining the desired results, the possibilities have not been exhausted.

No estimate was made of the amount of ore developed in the Enterprise and King William veins, and no sampling was undertaken by the writer other than for the scheelite content (B.C. Minister of Mines, Bull. 10, 1943 (revised), pp. 107-115). Hedley (B.C. Minister of Mines, 1936, p. D20) estimated that a total of 8,300 tons of reasonably assured ore was available to a depth of 50 feet below the 550-foot level, and it is believed that since 1936 extraction may have very nearly kept pace with the development of profitable ore.

(64) Jean Group (Mary Reynolds)

References: B.C. Minister of Mines, Ann. Repts.: 1887, p. 276; 1888, pp. 314, 315, 321; 1889, p. 290; 1896, p. 562; 1917, p. 229; 1918, pp. 239, 244; 1919, pp. 184, 189; 1922, p. 144; 1927, p. 213; 1928, p. 222; 1929, p. 245; 1930, p. 206; 1934, p. D25.

This group of eight claims is in part a re-staking of the Mary Reynolds property, which had reverted to the Crown and had been thrown open for re-location. The locators are W. McMaster, Murray Doyle, and Don Matheson. The property is situated about 2 miles by road from the Merritt-Kamloops highway. It is one of the very early claims staked in Stump Lake area, and has produced a small amount of gold-silver ore. In general characteristics it is similar to the other Stump Lake deposits.

A number of open-cuts, now largely sloughed in, three shafts, and three adits have been driven on the property. The main shaft is 96 feet deep, and is inaccessible. A level has been driven 35 feet below the surface, and access to it may be had by means of an ore chute leading to one of the adits. This adit is about 240 feet long.

South of this, an adit has been driven 145 feet northwest to intersect the vein zone, which has been drifted on for 25 feet. This working gains an additional depth of only 35 or 40 feet. About 100 feet lower on the hill, an adit was driven 84 feet towards the vein zone, but was never completed. Northwest of the main shaft are two shafts 26 and 11 feet deep, but the condition of the ladders prevented close examination of the workings.

Two vein zones on the property strike northeast and steeply southwest to steeply northwest. They apparently converge towards the north, and are stated to have been proved over a horizontal distance of 900 feet by cuts and diamond drill holes. These zones range up to 6 feet in width, and carry veins and stringers of quartz mineralized with pyrite, chalcopyrite, galena, zinc blende, and tetrahedrite. No scheelite was observed in the workings or on the dump.

From the main shaft a cut extends northerly about 100 feet, but the zone can be seen only at its northern end where it strikes north 50 degrees

east and dips 75 degrees northwest. Three hundred feet northeasterly, a second shaft has been sunk, probably on the same zone. Here it is 5 feet wide, and is nearly vertical.

About 100 feet easterly, the third shaft has been sunk 10 feet on a fracture zone striking north 40 degrees east and dipping 85 degrees southeast. It is 4 to 5 feet wide, and carries stringers of quartz and calcite.

An open-cut at the side of the road lies 240 feet southwest of the main shaft. It is now largely sloughed. An old shaft, now caved, has been sunk 15 feet southwest of this cut, and an adit now runs under this shaft and continues as a drift along the zone for about 240 feet. Here an ore pass connects with the 35-foot level driven from the shaft. In this level the zone has been stoped out over a width of 8 feet and is now lagged above the level. That part of the level continuing north of the shaft could not be reached. The vein zone in this level and in the adit level is largely from 18 to 24 inches wide, and carries narrow stringers of quartz. Thirty feet from the portal of the adit a crosscut of 25 feet to the northwest cuts another zone striking north 20 degrees east and dipping 75 degrees southeast. This zone carries only narrow stringers of quartz.

Approximately 200 feet southwest of the above mentioned adit, another adit, 35 feet lower, has been driven 145 feet northwest to crosscut the main vein zone. This has been drifted on for 25 feet. It carries small stringers of quartz.

(63) Don Group (Scottie)

The Don group of eight claims, staked by W. McMaster, Murray Doyle, and Don Matheson, lies about 1¼ miles northwest of the Jean, at the crest of a ridge overlooking Stump Lake Valley. The property is a re-staking of the former Scottie group, a Crown-granted property that reverted to the Crown and was thrown open for re-location.

The workings include several shallow shafts and some open-cuts, and may be divided into a southern group and a northern group. The southernmost working found is a shaft about 20 feet deep on a vein zone 4 feet wide that strikes north 10 degrees west and dips 60 degrees east. This zone carries numerous narrow stringers of quartz sparsely mineralized with pyrite, chalcopyrite, galena, and zinc blende. About 20 feet northerly, a cut has been made on the zone, but is now sloughed.

About 130 feet northeasterly from the shaft, a second shallow shaft has been sunk on a zone striking north 20 degrees west and standing almost vertically. This is also 4 feet wide, and carries narrow stringers of quartz. About 65 feet northwest, a cut has been driven on the zone, but is now filled in. Some quartz, with sparse sulphides, is visible on the dump.

About half a mile north from these showings is the northern group of which the principal working is an inclined shaft 50 feet deep. This follows a vein zone striking north 10 degrees west and dipping 35 degrees northeast. At the bottom of the shaft the zone is 5½ feet wide, and carries veins and stringers of quartz and calcite. At this point the hanging-wall shows 18 inches of vein quartz. Very little sulphide appears in the zone. Small amounts of scheelite appear in the quartz from the bottom of the lagging, which extends one-quarter of the way down the shaft, to the bottom of the shaft. Two channel samples, the first cut across 35 inches of the north wall

of the shaft at the bottom, and the second across 34 inches 20 feet from the bottom, assayed 0·05 per cent WO_3 and 0·25 per cent WO_3 respectively.

Southerly from the shaft is an open-cut now sloughed in, but which does not appear to have encountered the mineral zone.

Swakum Mountain Deposits

Several mineral deposits occur on Swakum Mountain. These include both veins and replacement deposits in limestone and in greenstone. A considerable amount of work has been done on some of the deposits, but as most of the workings are shafts that were filled with water at the time of the writer's visit, many of the deposits could not be seen. Most of the claims are situated high up on the mountain slopes at altitudes of around 5,000 feet above sea-level. A mountain road leads north from Nicola to the Alameda property, a distance of 13 miles, and continues on to the Last Chance claim. In this distance the road climbs 3,200 feet. It may be traversed without difficulty in dry weather as far as the Alameda property, but beyond that point the road crosses swampy ground and cannot be used by the ordinary car or heavy truck. Light trucks with good road clearance have been taken in to the Last Chance property. This road is not more than three-quarters of a mile from any of the showings.

The first discovery was apparently made by Thomas Hunter, who staked the Peacock (Hunter) group prior to 1900. This group is, however, situated some miles from the other properties and is described elsewhere under the heading of copper deposits. Of the remaining properties the original discovery was made by Oscar A. Schmidt in 1916, who staked the Lucky Mike, now the Last Chance, claim. The discovery of the showings on the surrounding claims followed, many of them being staked by Mr. Schmidt and associates. Some work was done on the Last Chance (Lucky Mike) in 1917, and a small shipment made. About 1927 a company known as Thelma Mines, Limited, was formed to work the property and carried on work until 1930 or 1931, when work was suspended. In 1934 the properties were taken over by Sheffield Gold and Silver Mines, Limited, and were prospected and developed by them until 1940. In 1941 the properties of the Sheffield company were sold by court order and acquired by C. A. Calkins of Vancouver. Certain claims that, presumably, were not part of the holdings of the company were retained by Oscar Schmidt. The original discovery, the Lucky Mike, apparently lapsed and was re-staked in 1942 as the Last Chance claim.

Small shipments of ore have been made from time to time for test purposes. Figures supplied by the British Columbia Department of Mines show a production of 26 tons from the Lucky Mike, which yielded 2 ounces of gold, 137 ounces of silver, 1,932 pounds of copper, and 1,753 pounds of lead, whereas the Thelma produced 89 tons of ore, yielding 1 ounce of gold, 7,419 ounces of silver, 9,683 pounds of lead, and 10,237 pounds of zinc. The Alameda is credited with the production of 3 tons of ore, yielding 1 ounce of gold, 52 ounces of silver, and 576 pounds of lead.

These deposits all occur in the greenstones and limestones of the Nicola group. The limestones are interbedded with the greenstones, but so far as the outcrops indicate, consist of a series of lenses rather than continuous beds. Limestone outcrops at intervals from the Last Chance, passing west

of the main summit of Swakum Mountain south to and beyond the Thelma claim. Along this belt the limestone and enclosing greenstone are dipping eastward at steep angles. About a mile west of the Thelma, limestone lenses appear on the Corona claims and extend northwestward at intervals towards Sophia Lake. There the rocks dip southwestward at a somewhat lower angle. At several places on the southern slope of the mountain a westerly strike and southerly dip are indicated. If these limestone lenses may be assumed to belong to a general horizon in the volcanic rocks the major structure would appear to be an asymmetrical anticline with the axis plunging to the south. Plutonic rocks do not appear in the immediate vicinity of the deposits. An aplite dyke occurs a few hundred feet from the workings of the Last Chance claim, and others were observed near the workings of the Gold Gossan No. 2. One outcrop of granitic rock was found in a drift-covered area on the north slope of the mountain about half a mile north of the Last Chance property.

A large granitic batholith that extends from Nicola Lake northward lies about 2 miles east of the mineral showings. Another batholith extends northward along the west side of Guichon Creek some 5 to 6 miles west of the mineral showings.

The deposits consist of veins, disseminations, and replacements carrying lead, zinc, and copper minerals, and in one deposit fair amounts of scheelite. Under present conditions the deposits would be of value chiefly for their content of precious metals. The Last Chance deposit, situated farthest north along the eastern limb of the assumed fold, is at the contact of greenstone and limestone, and is of the contact-metamorphic type, though there is no indication at the surface of an intrusive rock that might have caused the metamorphism. It consists of a gangue of skarn rock, chiefly garnet and epidote, with varying amounts of chalcopyrite, pyrrhotite, pyrite, and scheelite. Disseminations of copper minerals also occur in the greenstone some little distance from this contact-metamorphic body. The deposit is described elsewhere in this report. Farther south the showing at the Alameda shaft has chalcopyrite, together with galena and sphalerite, in a quartz vein, and at the Thelma and Bernice shafts the ore minerals are principally sphalerite and galena with tetrahedrite. These are presumably lower temperature types than the Last Chance deposit, and may suggest a temperature zoning around a concealed body of intrusive rock. It cannot be affirmed, however, that the deposits are contemporaneous, nor that they emanated from a single source.

The vein deposits possess some points of similarity with the veins at Stump Lake, but have not been proved to be as strong nor as continuous as the veins at that locality. The amount of work done on them is, however, much more limited.

(60) Thelma Group

References: B.C. Minister of Mines, Ann. Repts.: 1926, p. 199; 1927, p. 213; 1928, p. 224; 1929, p. 246; 1930, p. 207; 1934, p. D23; 1935, p. D14.

The Thelma group consists of seven claims, and forms the southeasterly group of the holdings of C. A. Calkins. The principal workings consist of an adit and shaft on the Thelma, a shaft on the Bernice, and an adit on the Old Evelyn, together with a number of open-cuts.

The Thelma shaft at the time of the writer's visit was full of water, but is stated to be 220 feet deep, inclined at 80 degrees west. A level has been driven north for 28 feet at a depth of 65 feet; another was driven south for 40 feet at a depth of 125 feet, with a crosscut east for 20 feet at the end of the level. At 200 feet a level was driven 80 feet south with a crosscut 40 feet easterly about 40 feet from the shaft and another driven 90 feet west from the bottom of the shaft. According to the reports of the British Columbia Minister of Mines and to information supplied the writer, the ore was followed down to a depth of 65 feet in the shaft where it is stated to be 4½ feet wide. The shaft left the orebody at this point, and although considerable drifting and crosscutting has been done at lower levels, the orebody has not been found in these.

At the surface an open-cut leads to an adit that runs in to the shaft and continues for 80 feet northerly beyond it. This adit reaches a depth of only a few feet below the surface, and the back is tightly lagged for much of its length, so that little information can be obtained from it. In the open-cut the mineral zone is from 10 to 15 feet wide, and is situated in limestone practically at the contact with greenstone. An ore shoot 10 to 12 feet wide and 25 feet long has been mined from this open-cut, and from it material was sorted for shipment. The best of the ore encountered in this cut and by the adit has been removed. Some narrow streaks of galena appear along the walls of the adit, and apparently both the galena and sphalerite occur as streaks and disseminations in the limestone.

For some distance north and south of the Thelma workings the mineral zone does not outcrop. About 150 feet northerly from the shaft an open-cut and adit have been driven into the hillside. The open-cut shows a mineralized zone in greenstone about 15 feet wide, and this is followed 15 feet south by the adit. A number of slips traverse the greenstone in different directions, and the rock is brecciated in places. Small bunches of galena and sphalerite appear in the greenstone.

The Bernice shaft lies 350 feet northerly from the Thelma shaft. It is reported to be 115 feet deep, and is inclined at 65 degrees easterly, but at the time of the writer's visit was full of water. At 65 feet in the shaft drifts are reported to have been run 80 feet north and 70 feet south, and at the bottom of the shaft a drift was run 90 feet to the north and 20 feet to the south with a 24-foot crosscut easterly from the latter working. There are no outcrops in the immediate vicinity of the Bernice shaft, and the relation of the mineral showings to those at the Thelma cannot be ascertained. As shown by the ore on the dump, the deposit consists in part of narrow veins and stringers of quartz penetrating greenstone, which is partly altered to ankerite along them. The best of the ore was reported to be in two veins, 2 inches and 18 inches wide respectively, with less intensely mineralized greenstone between them. The ore minerals are pyrite, galena, and sphalerite. The dumps at the Thelma and Bernice were examined for scheelite, but with negative results. An assay of fluorescent material showed it to be hydrozincite.

An adit has been driven on the Old Evelyn claim 1,500 feet northerly from the Bernice shaft. This adit has been driven through a body of low-grade material at the portal, and continued on a narrow vein in greenstone. The mineralized zone at the portal is about 8 feet wide, and shows narrow streaks of galena in greenstone adjacent to a limestone band. About 20

feet from the portal a winze has been sunk 10 feet, but is now full of water so that the mineralized zone it was presumed to follow cannot be seen. The adit continues for 60 feet beyond the winze, following a quartz vein that strikes nearly north and dips at a very low angle west. The vein filling is partly crushed country rock and partly quartz; in general the quartz makes up a stringer 1 to 2 inches wide in crushed and sheared rock 4 to 6 inches wide. Thirty feet from the face a working has been run south along the dip of this vein, which feathers out, but its place is taken by another located in the foot-wall about 3 feet from the first vein. The quartz shows very little sulphide mineralization.

(58) Alameda Group

The Alameda group of ten claims lies to the north of the Thelma group, but separated from it by the claims of the Old Junie group. No workings were seen on the Old Junie claims.

The principal showing lies on the Old Alameda and Alameda No. 1 claims, practically on the line between them. The workings consist of a shaft, stated to be 125 feet deep but full of water at the time of the writer's visit, and several open-cuts north and south of the shaft. The shaft is inclined at 60 degrees to the west, and is reported to flatten to 35 degrees in its lower part. At 55 feet there is a drift of about 15 feet to the north with a stope some 18 feet above the drift, and a drift 27 feet south at the same level. At the bottom of the shaft a drift runs 13 feet north and 7 feet south. The vein, which is reported to be 2 feet wide, apparently strikes northerly and dips westerly. The vein material on the dump shows quartz with well-marked comb structure, well mineralized with pyrite, galena, sphalerite, and chalcopyrite. On the north side of the shaft a cut was excavated on the vein, but the working is now caved. The material on the dump is well mineralized. At 110 feet north of the shaft an open-cut, now sloughed in, shows several narrow stringers of quartz that may represent the continuation of the vein in this direction. About 200 feet south of the shaft, a trench, partly caved, shows about 2 feet of quartz that may be the continuation of the vein in that direction. The quartz is almost barren of sulphides.

A vertical shaft is sunk near the northwest corner of the Alameda No. 1 close to the line between that claim and the Last Chance. The lower part of the shaft is filled with water and the upper part could not be examined closely because of caving near the collar. The mineral showing lies at the contact of limestone and greenstone, and forms a zone from 3 inches to 8 or 9 inches wide consisting of altered limestone with epidote and calcite, pyrrhotite, chalcopyrite, and a little sphalerite. About 35 feet south is a small outcrop in which a cut has been excavated. This is now sloughed in. The exposure shows a little sphalerite.

On the Alameda No. 2 claim a shaft, about 2,000 feet southeast of the Old Alameda shaft, has been excavated at the foot of a small bluff. It is reported to be 20 feet deep, but was full of water at the time of the writer's visit. The shaft follows a mineral zone consisting of a vein and a number of stringers. The vein is from 6 inches to 2 feet wide and carries crushed and sheared country rock and a stringer of quartz ranging up to 2 inches wide. Much of the quartz has comb structure and open cavities,

and carries a little sulphide. A number of other stringers run in different directions on either side of this vein. The principal mineral is pyrite, with a little chalcopyrite and galena. The amount of sulphide is not great, and examination of the dump revealed only a small proportion of quartz in the excavated material.

On the Alameda No. 3 claim, situated in the draw that passes between the two peaks of Swakum Mountain and a little to the north of the peaks, a shaft, said to be 18 feet deep but at the time of examination nearly full of water, has been excavated on a vein that strikes north 30 degrees east and dips steeply northwest. The vein is about 6 feet wide, but is not mineralized across its entire width. On the hanging-wall side there is a narrow mineralized streak, and masses of sulphides occur across 2 feet near the foot-wall. The intervening rock is greenstone carrying bunches of quartz. The showing has not been traced in either direction.

On the Alameda No. 4 claim the workings lie about 1,000 feet southerly from those on the Alameda No. 3. An open-cut in limestone shows numerous stringers and irregular bunches of quartz and calcite with sparse amounts of chalcopyrite, galena, and sphalerite. The zone carrying these stringers is 6 to 8 feet wide without defined walls. Some 200 feet southerly is another cut, also in limestone, from which considerable massive pyrite has been excavated. The foot-wall of the zone strikes north 50 degrees east and dips 80 degrees southeast, but the hanging-wall is indefinite. A large number of stringers of calcite appear and show some pyrite, but no massive pyrite such as was seen on the dump was seen in place.

On the Old Alameda No. 5 claim a pit about 8 feet deep was excavated a few hundred yards south of the peak of Swakum Mountain in a breccia consisting largely of fragments of limestone in a tuffaceous matrix. Sparse pyrite appears in the breccia. Tetrahedrite and galena have been reported from this showing, but were not seen by the writer.

The Old Alameda No. 6 claim lies to the west of Swakum Mountain peak adjoining the Gloria No. 1, a claim of the Gold Gossan group. A vein appears in a shaft that is on the line between the Alameda No. 6 and the Gloria No. 1 claims, and, beyond a drift-covered interval of 90 feet, what is possibly another vein has been traced 105 feet to the Old Alameda No. 6 shaft.

The shaft on the boundary of the two claims is 15 feet deep and is sunk on a vein ranging from 5 to 12 inches in width, striking north 10 degrees east and dipping 70 to 80 degrees westerly. The vein carries stringers of quartz generally 2 inches or less wide. A split goes off the vein about halfway down the shaft, leaving a horse of country rock from about a foot to 3 feet wide at the bottom of the shaft between the two branches. A little pyrite was observed, but no galena nor sphalerite.

About 60 feet south of this shaft a trench failed to disclose the vein. About 30 feet farther south an open-cut shows what may be the same or probably a second parallel vein striking north 10 degrees east and dipping 75 degrees west. The vein is 4 to 6 inches wide, and consists of quartz showing well-defined comb structure but comparatively little sulphide minerals. A little chalcopyrite and pyrite occur in widely scattered grains. Bismuth telluride with high gold and silver content is reported to have been found in this working, but none was observed by the writer. About 45 feet

farther south the vein appears in a second cut that indicates a slight curve in the vein to the east. It has here the same characteristics as described above.

The Alameda No. 6 shaft has been sunk on this vein some 60 feet southerly from the last cut and is 50 feet deep. The lower 10 feet of the shaft was filled with water at the time of the writer's visit. The vein exposed by this working is 8 to 14 inches wide with strongly sheared greenstone and one or more stringers of quartz 1 to 6 inches wide making up the vein. The quartz carries pyrite and chalcopyrite, and gold telluride has been reported from this working. Parts of the vein show considerable sulphide minerals.

(59) Corona Group

The Corona group consists of four claims, and lies about 3,500 feet westerly from the Thelma and on the western limb of the assumed anticline previously referred to (page 60).

The principal working consists of a vertical shaft, now flooded, and reported to be 65 feet deep. It is stated to have no lateral workings. The lode is said to strike north 40 degrees east, dip 80 degrees northwest, and to be 30 inches wide at the bottom of the shaft where it consists of a well mineralized streak 10 inches wide on the hanging-wall and a 2- to 3-inch streak on the foot-wall, separated by less mineralized greenstone. Galena and sphalerite are said to occur in streaks and masses through the quartz of the mineralized streaks. Greenstone on the dump shows a network of quartz stringers, but these contained comparatively little sulphides. A small quantity of sacked ore stored at the cabin is evidently hand sorted; it contains much galena and sphalerite, and a little tetrahedrite.

About 250 feet south of the shaft a trench has been dug on a small knoll. This shows greenstone heavily iron-stained and altered to ankeritic carbonate, but no galena nor sphalerite. Another knoll of similar material lies 65 feet to the west.

An open-cut has been excavated 55 feet east of the shaft. It is 15 feet long, but is partly caved. The greenstone in the cut is strongly leached and iron-stained, shows much ankeritic carbonate, and is traversed by several narrow quartz stringers.

Some 80 feet northeast of this cut a shaft has been started on a shattered zone in greenstone. This zone is about 5 feet wide. On the hanging-wall 15 inches of badly sheared and brecciated greenstone carries stringers of quartz. It is underlain by 4 feet of brecciated greenstone not so heavily sheared but also carrying quartz stringers. The quartz contains some galena, sphalerite, and copper carbonates, derived possibly from tetrahedrite. About 65 feet north of this working a trench 50 feet long has been excavated, but is now largely sloughed in. The country rock is greenstone with considerable limonite and ankerite, but the trench does not show the zone occurring at the shaft.

Some 100 feet farther north, an open-cut has been excavated on a mineralized zone in greenstone that is largely altered to ankeritic carbonates. One prominent vein striking north and dipping 20 degrees west consists of about 12 inches of quartz and included country rock. The quartz shows comb structure, and is sparsely mineralized with pyrite, galena, sphalerite, and copper carbonates. Smaller stringers appear in the altered zone, some following joints in the greenstone.

(56) Gold Gossan Group

The Gold Gossan group consists of the Gloria No. 1 and Gold Gossan No. 2 claims, owned by Oscar A. Schmidt of Burns Lake, and the How claim, owned by M. H. Laidlaw of Merritt.

A showing on the line between the Gloria No. 1 and the Alameda No. 6 claims has already been described. In addition, a shaft 50 feet deep on the Gloria No. 1 was full of water at the time the property was visited. The material on the dump showed quartz and calcite with sparse pyrite and chalcopyrite, and limonite. Gold telluride has been reported from this vein.

The other showings of the group are on the steep slope of a small ridge on the Gold Gossan No. 2 claim. Narrow veins and bunches of copper and silver-lead minerals appear at points on a small bluff of greenstone. At the northern end of the showings on the cliff face is a lode that varies from 6 to 14 inches in width striking west and dipping north at 17 degrees. The lode shows narrow veins of quartz and much silicified greenstone with bunches of pyrite and chalcopyrite. In the greenstone even at some distance from the lode are small irregular bands of calcareous material carrying considerable epidote and grains of these sulphides. A short distance south of this showing the lode shows two stringers of quartz with the foot-wall stringer showing masses of galena. Minor amounts of scheelite appear in the lode and in the adjacent greenstone, but in no place in sufficient quantity to be deemed worthy of sampling.

About 60 feet south of these showings an incline has been driven 37 feet down the dip of what is probably the foot-wall stringer. In this working this is from 2 to 6 inches wide, filled with brecciated rock and quartz. Small masses of galena and a little chalcopyrite appear in it, but no scheelite was seen.

Some 250 feet farther south an adit has been driven westerly on a lode that strikes north 65 degrees west and dips 75 to 80 degrees north. The adit was driven 30 feet westerly to where it encountered an aplite dyke striking north. This was followed for 69 feet, and then a crosscut was driven 21 feet westerly. The lode is from 3 inches to 2 feet wide, and consists of sheared greenstone mineralized largely with pyrite. Only low gold values are reported. The lode apparently crosses the aplite dyke where it is 3 inches wide, but was not followed. A second stringer 2 to 3 inches wide crosses the north drift and appears in the crosscut 10 feet from the face. It shows sheared greenstone with pyrite. A third stringer about an inch wide appears near the face of the crosscut.

A number of other quartz stringers appear on the summit of the ridge where a few shallow pits and open-cuts have been excavated. These are generally only a few inches wide, and are sparsely mineralized with pyrite and chalcopyrite.

(61) A Group

The claims of the A group were not seen by the writer, having been staked by F. W. Humble in 1944 subsequent to the writer's visit.

Vein Deposits in Triassic Volcanic Rocks Surrounding the Iron Mask Batholith

Several mineral showings occur in the Triassic volcanic rocks surrounding the Iron Mask batholith. These show little difference in mineral content from others within the batholith, but are in general more regular

veins and contain considerable quartz, which is not usually abundant in deposits within the batholith. For purposes of this report they are grouped with other vein deposits of the area.

(38) Noonday Group

References: B.C. Minister of Mines, Ann. Repts.: 1898, p. 1102; 1899, p. 731; 1900, p. 889; 1901, p. 1078.

The Noonday group, situated about 4 miles south of Kamloops, was staked by O. S. Batchelor and associates. The claims are now believed to have lapsed, and no work has apparently been done on the property for years.

The showings consist of quartz veins in volcanic rocks. The workings are now caved and inaccessible, so that little can be seen of the deposit. The principal showing is at a shaft said to be 100 feet deep, but now caved at the collar. This shows a quartz vein 18 inches wide, striking north 40 degrees west and dipping 75 degrees southwest. The quartz carries some iron oxide, but no sulphide was observed in it. A small vein of calcite has been traced 50 feet northerly from the shaft by means of open-cuts. All the cuts in the vicinity have sloughed in, and the quartz vein cannot be seen any distance from the shaft.

(43) Chance Group

The Chance group is situated 6½ miles southwest of Kamloops, between the Edith Lake and Lac La Jeune roads. It is owned by H. R. Graham. An unimproved road leads to the property.

The mineral showings are shear zones in Triassic volcanic rocks. These zones carry veins and stringers of quartz mineralized with pyrite, chalcopyrite, and galena. Low values in gold are reported, with occasional high assays.

The principal workings consist of a shaft 180 feet deep sunk on a shear zone striking north 80 degrees west and dipping 60 degrees southwest. This shaft has short levels driven from it at depths of 100 and 120 feet. It was filled with water to immediately below the 120-foot level. The shear zone as exposed in these workings is about 5 feet wide and carries veins and stringers of quartz; some of these attain widths of 12 to 14 inches. In places, the stringers curve off into the walls of the shear.

The 100-foot level has been driven 10 feet northwest of the shaft and 12 feet southeast. The stringers on this level may be observed to pinch and swell.

The intermediate level at 120 feet is about 10 feet long, driven northwest of the shaft. It shows the shear zone crossed by small slips, and quartz stringers running off into the walls.

On the surface a trench exposes the shear zone for about 15 feet at a point 75 feet northwest of the shaft. Fifty feet from the trench, in a direction north 30 degrees west, is another trench that shows a shear zone running towards the first shear at an angle of 40 to 50 degrees. This contains two veins of quartz, one a foot wide and the other 6 inches, lying 8 inches apart.

Twenty feet northeast of this showing is an open-cut about 30 feet long, 8 feet wide, and as much as 15 feet deep. The rock carries small amounts of chalcopyrite disseminated through it.

Southeast of the shaft about 200 feet, a cut shows a quartz vein striking north 45 degrees east and dipping vertically, which is obviously not the continuation of the zone in the shaft.

About 250 feet easterly from the shaft, a shear zone about a foot wide, striking north 70 degrees west and dipping 50 degrees southwest, appears in an open-cut. This zone carries considerable quartz, and is apparently nearly parallel with the zone appearing in the shaft. It is shown in another cut 40 feet to the southeast. A similar zone, but slightly flatter, appears in another cut 75 feet to the southeast. Two more cuts in the next 40 feet fail to show this zone. Two other cuts were seen: one 150 feet easterly does not show the shear zone, and one 300 feet easterly shows stringers of quartz that cannot be related to the zone.

(42) Gold Plate Claim

The Gold Plate claim is situated on the northern slope of an open hill about 6 miles southwest of Kamloops and ½ to ¾ mile east of the Lac La Jeune road. There is no road to the property, but a car may be driven to within a short distance of it across the open range land. The claim was owned by E. S. Batchelor of Kamloops, but is believed to have lapsed.

The mineral showings consist of narrow veins and stringers of quartz and calcite carrying galena, tetrahedrite, azurite, and malachite. Assays reported to the writer showed low values in gold. The veins and stringers cut flows, tuffs, and breccias of Triassic age. The flows and breccias are massive, but attitudes on tuff beds indicate that the volcanic rocks strike north 30 degrees west and dip 67 degrees southwest.

In the lowest cut a stringer with a maximum width of 3 inches, striking northwesterly and dipping steeply southwest, is exposed for about 6 feet. It carries small masses of galena.

The next cut, 100 feet northwest, is about 25 feet long and 20 feet high at its face. It has been driven on a stringer 1 inch to 3 inches wide that strikes north 10 degrees east and dips 65 degrees northwest. Other stringers of similar character appear 10 feet in the hanging-wall. Twenty feet northeast of the face of this cut a stringer that ranges up to 6 inches in width is shown in a cut. This pinches to 1 inch 10 feet to the northwest. It is mineralized with galena, tetrahedrite, azurite, and malachite.

Fifteen feet southerly, a large pit shows a number of stringers that split and reunite to include lenticular masses of rock between them. Other stringers cross the included masses of rock. These stringers show sparse tetrahedrite. Twenty-five feet southwest an open-cut has been made on one of these stringers, which is 2 to 4 inches wide mineralized with tetrahedrite.

About 145 feet southeast of this cut, an incline has been driven northwest at a slope of 40 degrees towards the other workings. It follows a vein 8 to 10 inches wide that is sparsely mineralized with galena and tetrahedrite. The vein is faulted along several small slips. A short drift has

been run southerly from the bottom of the incline. A long trench has been run 100 feet northwest of this incline, apparently looking for an outcrop that could be followed by an adit underneath the other showings. No vein appears in the trench.

(39) Rogers' Workings Near Jacko Lake

A group of workings, stated to be those of G. Rogers, lies some 6 miles southwest of Kamloops near the Iron Mask-Lac La Jeune road and Jacko Lake. The names of the claims are not known to the writer.

The mineral showings consist of quartz veins carrying tetrahedrite, malachite, and azurite cutting Triassic volcanic rocks. The occurrence is close to the contact of these rocks with the rocks of the Iron Mask batholith.

Three adits have been driven at intervals from the bottom of the low hill on which the showings occur. The lowest is 135 feet long, of which 100 feet is in drift. The next is 300 feet south and 100 feet higher than the second, and is 25 feet long, of which 15 feet has been driven in rock. The third is 200 feet southerly from the second and starts as an open-cut 50 feet long with the adit at the end driven 28 feet. None of these adits has reached the veins.

Sixty-five feet southwest of the uppermost adit, an adit has been driven 18 feet. This apparently lies in the hanging-wall of a quartz vein that crosses near the portal. The vein is exposed in a cut 20 feet southwest of the portal and has a width of from 10 inches to 2 feet. It strikes northeast, has a variable dip, and is sparsely mineralized with tetrahedrite, malachite, and azurite. The vein also appears in a pit 25 feet farther southwest. About 200 feet southwest, and probably about 15 feet in the foot-wall of this vein, a cut exposes quartz, but is now badly sloughed in. About 50 feet in the hanging-wall and slightly northeast of the last exposure, an old shaft, now caved, and a line of cuts, now sloughed in, indicate the occurrence of a quartz vein with the same minerals. These showings suggest that several parallel veins may be present.

From 115 to 135 feet west of the last showings, a group of cuts, now largely sloughed in, shows one body of quartz about 8 feet wide. This cannot be related to the other showings. An adit has been driven at a point 125 feet west to intersect a body of quartz 4 feet wide that appears in a pit on the surface immediately ahead of the adit. This adit does not attain a depth of more than a few feet.

Gold Deposits in Palæozoic Rocks

Some work has been done on a group of mineral deposits that have formed in Palæozoic sedimentary rocks. In a general way these deposits show similarity with others in volcanic rocks surrounding the Iron Mask batholith. They are quartz veins and mineralized shear zones carrying pyrite, chalcopyrite, and, in places, tetrahedrite. The beds in which they occur are faulted, and in some cases at least the deposits have suffered post-mineral movement. A small production has been made from a few of the deposits.

(28) Hilltop Claim

References: B.C. Minister of Mines, Ann. Repts.: 1899, p. 732; 1901, p. 1079; 1905, p. 195; 1913, pp. 192-3; 1924, p. 147.

The Hilltop claim, owned by E. T. Batchelor, is located north of Thompson River about 3½ miles from Kamloops, at an elevation of 1,000 feet above the river. It has produced 13 tons of ore, which yielded 5 ounces of gold and 55 ounces of silver.

The mineral showings consist of quartz veins, and the workings are partly caved.

The main working is a shaft, said to be 25 feet deep, but now caved at the bottom of the first ladder. The vein here is reported to be 3 feet wide. Three pits have been dug southeast of the shaft, but two of these do not reach bedrock. The third, about 100 feet from the shaft, discloses a sheared zone striking northwest and dipping 75 degrees southwest. This shows 20 inches of quartz and sheared country rock.

Several pits and trenches have been dug in a direction north 60 degrees west from the shaft. One hundred feet in this direction a pit shows a few stringers of quartz; a second pit 55 feet farther on shows a vein striking north 65 degrees west and dipping 45 degrees southwest. This vein, together with inclusions of country rock, is about 3 feet wide. Seventy-five feet farther on, a sheared zone striking east and dipping 60 degrees south appears. It is about 2½ feet wide, and carries irregular bands of quartz. An adit and open-cut, now caved, were driven at a point 110 feet farther northwest. Immediately southwest of this, a cut has been driven on a shear zone striking north 50 degrees west and dipping 65 degrees south. It carries bunches of quartz. Seventy feet farther northwest another open-cut and adit have been driven for 70 feet. The adit is 5 feet long, and exposes a shear zone striking north 10 degrees west and dipping 70 degrees north.

The different veins and shear zones encountered have not been traced along their strike. Brewer obtained one sample that assayed $3.20 in gold a ton. Later samples by the British Columbia Department of Mines, taken in the shaft, gave gold, a trace, silver 1·2 ounces a ton; and one of heavily mineralized material assayed: gold 0·062 ounce a ton, and silver 5 ounces a ton. No such heavily mineralized material was seen by the writer, the quartz carrying little sulphide.

(50) Riverside Claim

References: B.C. Minister of Mines, Ann. Repts.: 1913, p. 193; 1914, p. 361; 1932, pp. 145-6 (*See* Goldfield group); 1934, p. D28.

The Riverside claim lies 15 miles by road northeast of Kamloops, on a low, bare hill that rises to 2,500 feet above sea-level. It is a re-staked part of a group formerly known as Kamloops Goldfields. The claim is owned by E. T. Batchelor of Kamloops. In 1936 it was prospected by D. B. Sterritt, of Kamloops, and associates, and about 3 tons of ore running 0·5 ounce in gold a ton shipped to the Trail smelter. The property was worked under lease by Gordon F. Dickson of Kamloops during the winter of 1940-1, and about two carloads of ore were sorted and shipped. It is understood that this assayed 0·37 ounce of gold and 3 ounces of silver a ton.

The rocks in the vicinity are argillites, quartzites, breccia, and limestone of the Cache Creek group. These have in general a northwest strike and a variable but generally high dip. Considerable faulting has taken place in the vicinity of the deposits.

The showings consist of veins and stringers of quartz that follow one or more shear zones. The zones strike easterly and dip about 30 to 50 degrees south. In places the zones have defined walls, but in others the walls are indefinite and difficult to follow. Quartz veins within the zones are discontinuous, and there are numerous stringers of quartz together with much silicification of the wall-rock. The quartz veins in general have an easterly strike and a low southerly dip, but a few dip steeply; some dip to the north. The country rock itself carries some sulphide minerals, and in most places in the vicinity of the deposits is weathered rusty brown. The quartz veins and silicified rock carry sparse pyrite and chalcopyrite. Tetrahedrite, with high values in silver, was found in one stringer that is off the line of the strike of the nearby zone. Calcite stringers intersect the rock at some of the showings. Values are principally in gold, but high values in silver are obtained at scattered points.

The zone, or zones, has been traced westerly from a small saddle at the east side of the hill across the top of the ridge and down the west side for about 900 feet by means of open-cuts, pits, and trenches, a shallow shaft, and a short adit. In the westernmost cuts the gold and silver content is much less than at most of the other showings.

At the eastern end of the zone two cuts (A and B, Figure 4) may be faulted segments of a vein zone. The easternmost of the two discloses a quartz vein 15 inches wide with 25 inches of silicified rock on the foot-wall. The other cut exposes a much narrower quartz vein. Scattered sulphides appear in the quartz.

The next westerly group of workings (C, D, E, F, G, Figure 4) consists of four cuts and a shaft. These disclose a shear zone ranging up to 6 feet in width, which is best seen in the shaft, where the walls appear to be fairly well defined, dipping southerly at 40 to 50 degrees. A vein of quartz 12 inches wide appears on the hanging-wall; a narrower but well-mineralized band appears on the foot-wall, with the intervening rock shattered and filled with stringers of quartz and calcite. The shaft is 45 feet deep, with a short crosscut in a shattered zone at the bottom. Near the bottom of the shaft there is a well-mineralized streak on the foot-wall, with the intervening rock shattered and filled with stringers of quartz and calcite. The shaft is 45 feet deep, with a short crosscut in a shattered zone at the bottom. Near the bottom of the shaft there is a well-mineralized streak on the foot-wall, and an adit has been driven to try to intersect this but has not attained its objective. This group of workings is about 200 feet westerly from the first group and covers the vein zone for about 150 feet.

The next group of cuts to the southwest (H, I, I_1, Figure 4) should have intersected the zone, but did not do so. As one of these is a long stripping it seems probable that the zone has been faulted. Two of the cuts pick up a narrow quartz stringer carrying tetrahedrite. A sample across this stringer is reported to have assayed 0·08 ounce gold and 130·83 ounces silver to the ton.

The next group of cuts (J, K, L, Figure 4) lies about 250 feet southwest of the shaft on the western slope of the hill, and from one of these an adit has been driven easterly for 150 feet and then turned northerly as a crosscut towards the shaft. At the upper cut of this group the zone has been largely stoped out from the adit below. There were apparently two veins with silicified rock between forming a zone about 4 feet wide. At

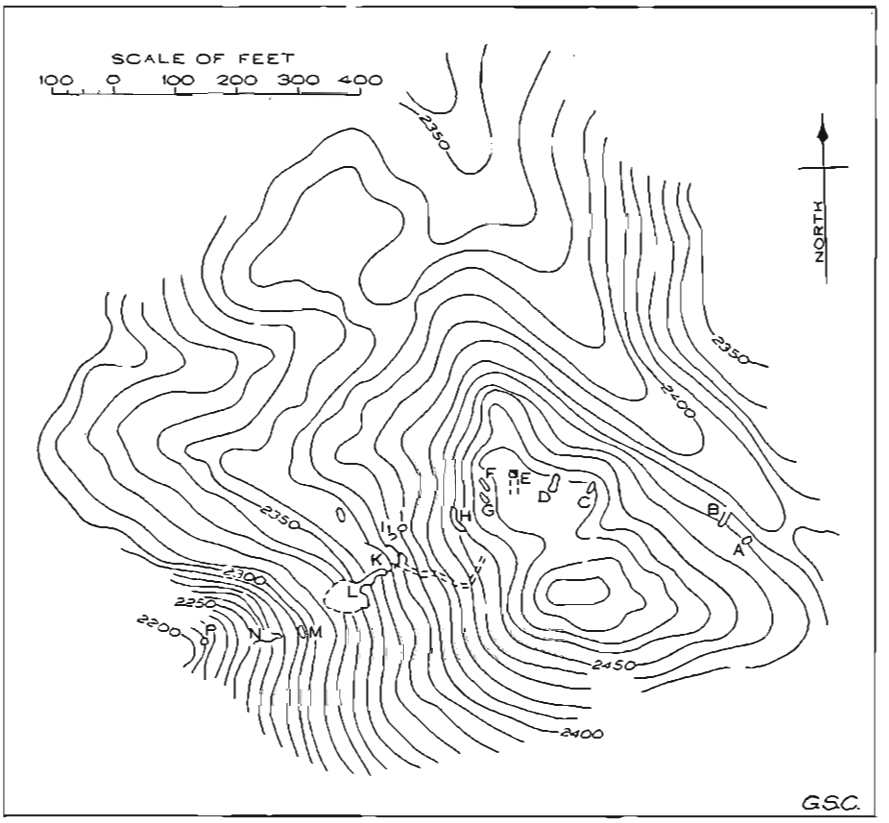


Figure 4. Workings on Riverside claim.

the adit entrance the zone has also been stoped out, but a vein about 14 inches wide appears at one point in the floor of the cut. Stringers and bunches of quartz appear in the walls of this vein across a width of about 10 feet. Two main stringers diverge westerly and widen to veins of 10 inches and 8 inches respectively in the next cut west. In the adit the best section of the vein has been stoped out to the cut above. This section is 45 feet long. The adit then follows a zone of stringers and bunches of quartz, but is difficult to follow as no defined walls could be observed. The values in this section are lower than in the stoped section, although occasional high assays were obtained. The crosscut towards the shaft does not disclose ore.

From 150 to 250 feet southwest of this adit is another group of cuts (M, N, P, Figure 4). The higher of these cuts shows a quartz vein 10 inches to 2 feet wide that has a similar attitude to the veins above, but cannot be an extension of any of them unless it has been faulted between the two groups of cuts. The second cut shows only stringers of quartz, and the third is sloughed in. The assay returns on samples obtained in these cuts are low.

(49) Clairdon Mining Company

The group of claims prospected by Clairdon Mining Company, Limited, is about 9 miles southeast of Kamloops on a hill slope overlooking Campbell Creek.

The showings consist of quartz veins and stringers in shear zones in Palæozoic sedimentary rocks near the contact with granitic intrusions. They carry small amounts of pyrite and chalcopyrite. Gold assays of as much as $50 a ton are reported to have been obtained from some sections of the veins, but it is difficult to relate the different showings.

The lowest workings seen consist of a shallow shaft and an adit 20 feet below driven westerly towards it. At the shaft a shear zone 4 feet wide, striking north 30 degrees east and dipping 50 degrees northwest, shows stringers of quartz 3 to 4 inches wide. On the hanging-wall about 10 inches of gouge, consisting of crushed country rock, quartz, and graphite, carries pyrite and iron oxide. This is reported to have yielded free gold. At the face of the adit a drift has been run on a shear zone about 6 feet north and the same distance south of the adit. This zone shows short lenses of quartz generally 2 to 3 inches wide. In the northerly drift, the shear carries almost no quartz and consists of graphitic gouge.

Another adit, 850 feet south 50 degrees west, and nearly 300 feet higher, has been driven 240 feet northwest, but encounters only narrow stringers of quartz running northwest and dipping southwest.

A third adit is 100 feet northwest of the second and 50 feet higher. It starts as an open-cut 50 feet long, and continues as an adit to the bottom of an old shaft, where the shear zone it follows is lost in a fault. The adit has been driven 65 feet beyond the bottom of the shaft, along a shear zone that strikes north 10 degrees west and dips 40 degrees southwest. Immediately south of the open-cut it branches into several narrow zones. In that part of the adit between the cut and the bottom of the shaft, the zone has been stoped out and timbered. The adit beyond the shaft shows only stringers of quartz. On the surface southwest of the shaft, several cuts have been made for a distance of 275 feet. The first of these cuts shows only country rock and the next two are sloughed in. The farthest cut exposes a narrow quartz vein striking north 70 degrees west and dipping 80 degrees southwest.

Beginning some 600 feet northerly from these upper workings, and stretching north and northwest for a distance of about 200 feet, many cuts have been made along the flat top of the hill above the steep slope. Some of these are caved, so that relations cannot be observed. Several show narrow veins and shear zones with quartz, but these cannot be definitely related to one another.

(48) Constant Group

Reference: B.C. Minister of Mines, Ann. Rept., 1933, p. 195.

The Constant group, situated about 5 miles southeast of Kamloops, is owned by H. Stephens, of Kamloops, and associates. Exploratory work has been done on a number of quartz veins occurring in the rocks of the Cache Creek group. The showings are spread over a considerable area, but none of the veins has been traced for any distance on the surface.

The principal working is a 20-foot, inclined shaft that follows a shear zone striking southeast and dipping 40 to 50 degrees southwest. It ranges from 6 feet in width at the top of the shaft to about 18 inches at the bottom, and carries a quartz vein 2 to 14 inches wide. The zone is oxidized and carries much limonite. At the bottom of the shaft there are bunches of quartz in the country rock. A grab sample of the oxidized material is reported to have assayed 3 ounces of gold a ton. Two samples taken by Freeland (1933, p. 195) assayed: gold 0·70 ounce and silver 11·5 ounces a ton, and gold 2·1 ounces and silver 1 ounce a ton respectively.

The vein has been exposed in a trench a few feet northwest of the collar of the shaft, but the trench is now sloughed in and the vein concealed. The quartz on the dump shows some pyrite and a little chalcopyrite. Several other trenches have been dug southeast and northwest of the showing, but at the time of the writer's visit were sloughed in.

(17) Allies Group

References: B.C. Minister of Mines, Ann. Repts.: 1924, p. 147; 1931, p. 107; 1932, p. 145; 1933, p. 193; 1934, p. D26; Bull. No. 1, 1932, p. 67.

The Allies group of eight claims, owned by E. T. Batchelor of Kamloops, is situated near the head of Cannel Creek, a tributary of Watching Creek, about 24 miles by road from Kamloops. The property was prospected extensively by Vancouver interests under the direction of D. B. Sterritt of Kamloops because of the discovery of high-grade gold ore. This discovery was later proved to consist of float, but considerable work was done to try to find similar ore in place.

The claims lie in a small basin near the head of the creek where older rocks are exposed, capped by relatively flat-lying Tertiary basalt. The older rocks exposed consist of serpentine cut by dykes of grey porphyry. The porphyry dykes do not, so far as has been observed, cut the basalt. Quartz veins and stringers within the porphyry carry pyrite, galena, and chalcopyrite, and constitute the ore.

At the original discovery extremely large blocks of porphyry projecting from the surface of the ground give the appearance of an outcrop, but a shaft with a drift underneath these in boulder clay showed the blocks to be float. The porphyry at this point is a dark grey, dense rock with phenocrysts of hornblende and feldspar. It carries considerable quartz in small veins and stringers. Two samples across stringers of 5 inches and 8 inches are reported to have yielded 1·42 ounces and 1·32 ounces of gold to the ton respectively.

From this Discovery or No. 1 shaft (Figure 5) float consisting of brownish earth with quartz and blocks of porphyry was followed westerly up the hill. This brown earth where panned is reported to have shown many colours of free gold. A group of pits 300 feet west of the discovery

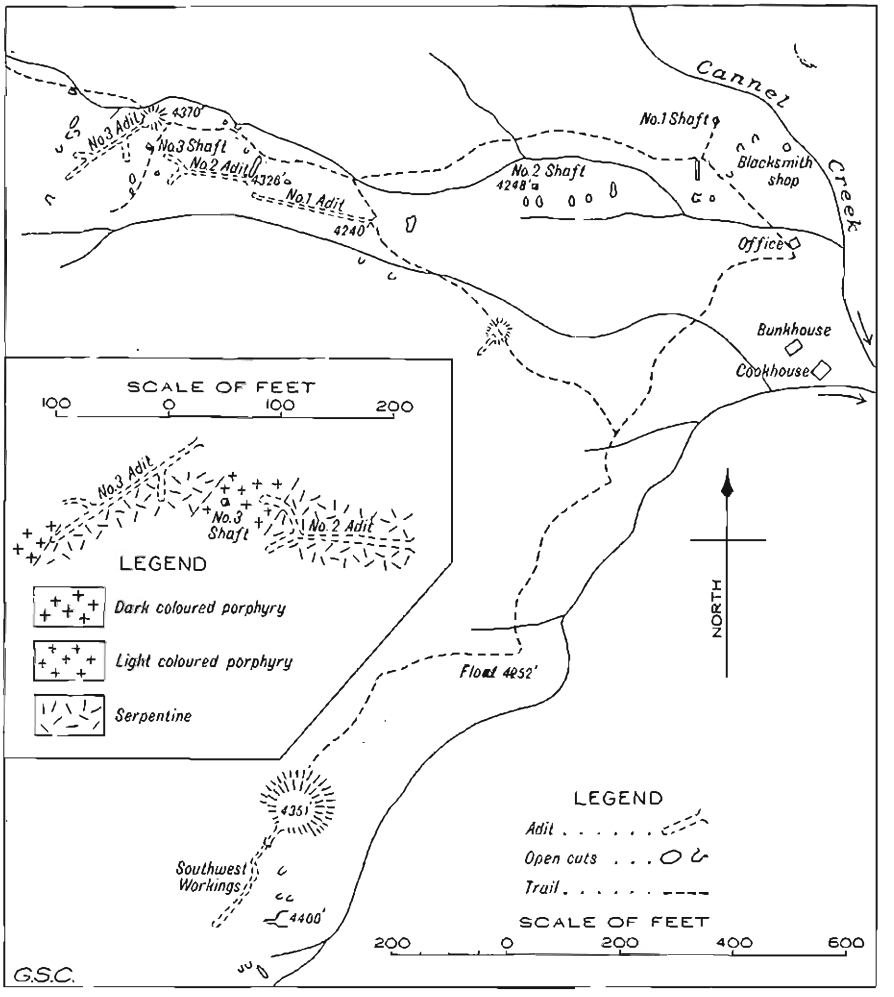


Figure 5. Workings on Allies group.

shaft prospected a small ridge showing this brown earth with quartz and porphyry, and a shallow shaft proved that the material was float resting on top of clay.

About 200 feet farther west pits were made on a similar showing where the brown soil with quartz and porphyry was thickest. This rich material was not found farther west, so an adit was started into the hill

and driven 175 feet. It penetrated blue clay. A second adit was then commenced 240 feet westerly from the first adit, and was driven 105 feet into the hill with a crosscut 30 feet long at the face. This working encountered serpentine. A crosscut driven northwest at 105 feet encountered a porphyry dyke, lighter in colour than the ore porphyry at the original discovery and carrying very little quartz or sulphide minerals.

A third adit was started about 50 feet northwest of the face of the second adit, and was driven southwesterly into the hill 158 feet. It penetrated 3 feet into a dark grey porphyry. A crosscut was run 20 feet northwest at 105 feet, but failed to encounter the porphyry.

A shaft was sunk in the overburden in the area lying between the face of the second adit and the portal of the third. This encountered the same band of porphyry as appeared in the adit below. A crosscut was run for 13 feet in the glacial drift on top of the porphyry, but did not disclose high-grade ore.

Some 1,500 feet southwest of the discovery shaft a second group of workings has located porphyry dykes with low-grade ore. Between the two groups of workings the surface is covered with fairly thick superficial deposits, but near the southwest workings a ridge of float similar to that of the original discovery, but much lower in grade, was found. A series of pits showed the sources of this float to lie higher up the hill, and an adit 215 feet long was then driven southwest into the hill. It encountered alternating serpentine and porphyry. The largest of these porphyry bodies is 80 feet wide, with the others ranging to 2 or 3 feet. Although some of this rock appears identical with that of the original discovery, only low values were obtained. A cut in the hillside above the adit shows heavily silicified and pyritized rock, but assays showed only low gold values.

The source of the high-grade float at the No. 1 shaft has, consequently, not been found. It seems highly probable that the float originated within the basin, which is not large. However, a considerable part of it is covered with gravel, sand, and clay, thus making the task of finding the point of origin of this rich float difficult. The porphyry dykes found at the different showings, although differing in appearance, are probably related.

Vein Deposits in and around Small Bodies of Intrusive Rocks

Several deposits occur in close association with small bodies of intrusive rocks in the northern part of the map-area. Veins, in many cases fairly wide, occur within the intrusions, but are also found within the intruded rocks. They include deposits near Jamieson Creek, at Ramage on the opposite side of North Thompson River from Jamieson Creek, and several properties on Criss Creek. Many of the workings are now inaccessible, and at some of the showings that could be seen sulphide minerals were sparse. Pyrite, galena, and sphalerite are the common ore minerals; others include chalcopyrite, arsenopyrite, and pyrrhotite. At one or two localities molybdenite appears. So far as is known these deposits have not been productive.

(21) Homestake and Molly Gibson Claims

References: B.C. Minister of Mines, Ann. Repts.: 1899, p. 732; 1901, p. 1080; 1904, p. 232; 1913, pp. 216, 217; 1930, pp. 189-90; 1931, p. 107; 1935, pp. D9-10. Dawson, G. M.: Mineral Wealth of British Columbia; Geol. Surv., Canada, Ann. Rept. 1887-8, vol. III, pt. R, p. 79; Report on the Area of the Kamloops Map Sheet; Geol. Surv., Canada, Ann. Rept. 1894, vol. VII, pp. 336-337B. Uglow, W. L.: Geol. Surv., Canada, Sum. Rept. 1921, pt. A, p. 101.

The Homestake and Molly Gibson are adjoining claims on the north side of Jamieson Creek 1,000 to 1,500 feet above the creek. The Homestake is owned by Mrs. C. C. Way and associates of Kamloops, and the Molly Gibson by K. D. Panton of Vancouver. The two claims do not form a group, but are described as a unit as the writer was unable, in the absence of anyone familiar with the ground, to determine the respective boundaries. It is possible that some of the workings described lie on the Francis claim of George Mackey. The workings in general are so caved that an adequate examination could not be made.

The mineral deposits are quartz veins mineralized in those parts seen with scattered, sparse pyrite, galena, arsenopyrite, and sphalerite. Undoubtedly heavier mineralization occurred at some points.

What is believed to be the main shaft of the Homestake lies on the hillside about 1,500 feet above the valley of North Thompson River. This shaft has been sunk on a vein that strikes northwest and dips 60 degrees southwest, but the working is caved and cannot be examined. The shaft is sunk on the hanging-wall side of the vein and is reported to be 75 feet deep. On the foot-wall side an exposure in a cut shows a width of 18 to 20 feet of vein matter. Southeast of the shaft, a line of cuts, now caved, has apparently traced the vein for 150 feet. About 250 feet southeast of the shaft is an adit, now caved at the portal. About 350 feet northerly from the shaft, a knob of granitic rock is traversed by stringers and small veins of quartz in a zone 50 feet wide. The largest of these is about a foot wide. They contain little sulphide. About 150 feet west of the shaft, a cut discloses a quartz stringer 2 inches wide.

Some 400 feet southwest of the shaft, trenches, now sloughed, have been excavated around a small mound, and considerable quartz float may be observed.

About 450 feet southwest of the first shaft is another, now caved, that was apparently sunk on a number of quartz stringers striking northwest and dipping 60 degrees southwest. The quartz apparently widened in the shaft, for blocks 5 inches thick appear on the dump. About 200 feet to the south, a vein has been exposed in a shallow pit. It does not show defined walls, but is about 6 feet wide. An outcropping of quartz appears 50 feet northwest of the pit and a cut has been made 150 feet northwesterly, apparently tracing the vein, but this cut is now sloughed in. Some 100 feet southwest of the shallow pit a group of cuts has been made around a small bluff to trace a vein striking north 30 degrees west and dipping 45 degrees southwest. The vein is 7 feet wide, with a horse of granitic rock 5 feet wide near its centre. It is obscured by overburden a short distance along its strike.

Some 1,000 feet farther southwest a shaft, now caved 10 feet below the collar, has been sunk on a quartz vein 5 feet wide striking north 30 degrees west and dipping 60 degrees southwest. Very little sulphide appears

in that part of the vein now exposed. Two hundred and fifty feet farther southwest a cut has been made on a vein 12 feet wide striking nearly north and dipping 75 degrees west. It carries very little sulphide. About 60 feet north along its course and 40 feet higher, a group of cuts, now largely sloughed in, has been excavated around a small bluff. A vein 2 feet wide is exposed at the top of this bluff. Three hundred and fifty feet southeast of this showing a cut has been made on a quartz vein 12 inches wide striking north and dipping 80 degrees west.

Values ranging up to 1·10 ounces in gold and 34·2 ounces in silver a ton have been reported by Dawson (1888, p. 60R; 1894, p. 337B). Samples taken by the British Columbia Department of Mines (1913, p. 217) show assays ranging from traces to 0·05 ounce a ton in gold for quartz sampled in place, and up to 0·40 ounce in gold a ton from samples from dumps.

(19) Pole Star

References: B.C. Minister of Mines, Ann. Repts.: 1913, p. 217; 1935, pp. D9-10.

The Pole Star claim, situated between Jamieson and Lanes Creeks, is a Crown grant reported to have reverted to the Crown and held under lease by E. W. Rawson of North Kamloops.

Although the writer had no guide to the property, workings believed to be those of the Pole Star were found to be largely caved. An incline shaft, said to be 50 feet deep, is partly caved about 20 feet below the collar, and as there was no ladderway, the working could not be examined. The incline follows a quartz vein about 8 feet wide near the contact of a small body of granite and schist. The quartz seen on the dump is sparsely mineralized with pyrite, galena, and sphalerite, but high assays in gold and silver are reported to have been obtained from this working.

About 100 feet northerly along the strike are two trenches. The easterly trench shows the contact of the granite body with schist and along it is an irregular bunch of quartz with a maximum width of 2 feet. No sulphide was observed. The other trench immediately to the west is largely sloughed in, so that relations cannot be seen, but considerable quartz was apparently found in the trench. Another small body of granite lies a short distance to the north.

Gold Bug

This property, owned by M. Salk, of Kamloops, and associates, was not examined owing to the condition of the ladders in the shaft.

(20) Francis

The Francis claim, owned by G. Mackey, lies about 2 miles up Jamieson Creek from North Thompson Valley. On it, an adit has been driven into the bank about 50 feet above creek level, and then continues as an incline on a quartz stringer. The incline could not be examined, but the adit appears to crosscut a number of quartz stringers in schist that run parallel with the schistosity. Only sparse pyrite was observed in the quartz. Some 600 feet south of the adit, an outcrop of sheared argillite is cut by a dyke of feldspar porphyry some 40 to 50 feet wide. The outcrop shows stringers and bunches of quartz, but very little sulphide.

Several cuts appear some distance up the hill north of Jamieson Creek. These are described under the Homestake and Molly Gibson, although it is not known definitely that they lie on that ground.

(18) Royal Star Group

The Royal Star group of eight claims, owned by M. Salk and associates of Kamloops, is situated about 3 miles up Jamieson Creek from North Thompson Valley. A logging road has been constructed to within half a mile of the property. The showings are situated along the east bank of Jamieson Creek near stream level, and consist of quartz stringers in schistose rocks. The stringers carry pyrite, pyrrhotite, and (?) galena.

At the southernmost exposure a short incline has been put down on quartz stringers that strike north 15 degrees east with the schistosity of the enclosing mica schist, but cut across the dip. The stringers pinch and swell to a maximum of 5 inches. Pyrite, pyrrhotite, and calcite are sparsely distributed through the quartz. About 35 feet northerly from this showing, a band of sericite schist 6 feet thick is underlain by graphitic schist, and carries quartz stringers and bunches of quartz sparsely mineralized with sulphides. The schists show numerous drag-folds. A third showing, about 150 feet north of the last, is about 200 feet above the creek on a small cliff face of argillite and quartzite. Between the two showings, a band of crystalline limestone outcrops. The quartzite and argillite carry a number of quartz stringers. An open-cut has been driven on a stringer 3 to 8 inches wide that crosscuts the sedimentary beds at a small angle. Galena is reported from this working, but was not found by the writer. Gold values are reported to have been obtained at some points, but the amount of sulphide is small.

(22) Quartz Lodes near Ramage

Some work has been done on the east side of North Thompson River about 650 feet above the valley, near Ramage station on the Canadian National Railway, about 24 miles north of Kamloops. Apparently the showings there were last staked by P. Pellandini, but they do not appear to have been recorded.

The showings are quartz lodes very similar in general characteristics to those occuring near Jamieson Creek. They attain widths up to 30 feet and are sparingly mineralized with galena, chalcopyrite, pyrite, and sphalerite. They appear to be confined to a body of granitic rock cutting the Palæozoic rocks in this vicinity.

The lowest exposures seen are about 650 feet above the level of the valley bottom in a body of coarse-grained, granitic rock. At this point a lode strikes north 15 degrees west and dips steeply southwest. The walls are not well defined, and stringers of quartz project into them. The quartz is about 15 feet wide. An incline at 45 degrees has been driven 15 feet southeast. Fifty feet southerly and at about the same elevation, an adit has been driven a few feet on an irregular mass of quartz that appears to be a branch from the other body. The showing consists of irregular bunches of quartz in which are masses of unreplaced granite. The two deposits extend back up a cliff, and 80 feet higher a cut has been made on the lode directly above the last workings. This cut is now sloughed, but

the lode appears to have a width of 30 feet and to be striking north 20 degrees west. It carries grains of malachite and cerussite, but very little sulphide.

Two hundred feet farther southeast along the strike, the lode is exposed by another cut, and is 8 feet wide. It was not traced beyond that point.

A second lode appears 65 feet northeast of the last cut. It is exposed in a cut, and appears parallel with the last deposit and from 2 to 4 feet wide. No further workings or exposures were found.

(2) Diamond S. Group

The Diamond S. group of claims is situated on Criss Creek about 3 miles northwest of Red Lake post office. The Diamond S. claim is owned by Jack Smith of Red Lake, and the Diamond S. Nos. 1, 2, and 3 claims by Wm. Smith and W. J. Moffatt of Kamloops. The claims are re-stakings of older prospects, and from the descriptions it is believed that they may be the claims referred to in the British Columbia Minister of Mines reports (1899, p. 937; 1900, p. 890; 1901, p. 1090; 1902, p. 193) under the names Mersey, Humber, and Afton. Some years ago the gold-silver showings on the claims were prospected by D. B. Sterritt, of Kamloops, and associates. The writer is indebted to Mr. Sterritt for plans and assays of some of the workings.

Several pits on part of the Diamond S. claim expose quartz veins carrying pyrite and molybdenite. These lie along a small gulch draining to Criss Creek. On Criss Creek itself are showings of more complex sulphide ore carrying gold and silver, copper, lead, and zinc. These showings are probably also on the Diamond S. claim, but some may be on adjoining claims.

The rocks in the vicinity consist of sandstone, shale, and conglomerate intruded by a nearby body of granitic rock, for some distance from which the sedimentary beds have been highly sheared and converted into schistose conglomerate, gneiss, and schist.

The cuts on the quartz veins that show molybdenite are in the sedimentary rocks close to the intrusive contact. Many of them are sloughed in, so that the attitudes of the different veins cannot be obtained, and it is, consequently, difficult to relate the different showings.

The most southerly and highest of the cuts along the small gulch draining to Criss Creek was observed on the east bank of the gulch. Here a quartz vein 3 feet wide in altered sediments strikes southeast and dips 60 degrees southwest. The quartz carries a little pyrite and small grains and masses of molybdenite. A second cut driven 20 feet northwesterly along the strike partly exposes a quartz vein distinct from that in the last two cuts. It is 5 feet wide, strikes east, dips 65 degrees south, and is sparsely mineralized with pyrite and molybdenite. A sample across this cut is reported to have shown 0·3 per cent molybdenite.

Some 250 feet downstream on the opposite side of the gulch are several small stringers of quartz carrying pyrite, but no molybdenite was seen. About 300 feet farther downstream, also on the west bank of the gulch and 50 feet above its bed, a cut exposes a quartz vein about a foot wide. This strikes east and dips 60 degrees south. The vein contains masses of pyrite and grains and small masses of molybdenite, and the wall-rocks carry bunches of quartz.

About 400 feet farther northwest, a quartz vein 2 feet wide, striking south 70 degrees east and dipping 62 degrees southwest, is partly exposed. It carries small masses of pyrite and molybdenite. A second cut about 20 feet away but somewhat off strike, now sloughed in, apparently encountered a quartz vein.

On the eastern side of the creek about 200 feet northerly from the last exposures a quartz stringer 4 inches wide appears in altered granite. This is heavily iron-stained, but no molybdenite was seen.

The gold-silver showings occur along Criss Creek itself, the first being located at a sharp bend in the creek about 250 yards downstream from the mouth of the gulch on which the quartz veins were found. Here a cut was driven to prospect for the extension of deposits found farther down the creek. The rock is chlorite schist, with irregular bodies of quartz. These bodies are generally up to 10 feet long and 3 or 4 inches wide. Sparse pyrite and sphalerite were noted in the quartz. Assays show up to 0·03 ounce of gold and 1·80 ounces of silver a ton across a width of 19 inches.

About 250 feet downstream and on the northern side of Criss Creek, a number of small cuts and strippings have traced a zone for about 100 feet to where it disappears in the creek bed. The rock is highly sheared, with bands of aplite running parallel with the shearing. Veins of quartz that pinch and swell from mere stringers up to 2 or 3 feet in width also follow the shearing, and many stringers of quartz traverse the rock in various directions. One main vein of quartz near the creek may be observed to pinch out in 35 feet. The cuts show a zone about 20 feet wide, in which distance there are three mineralized bands separated by aplite dykes. Both the aplite and the quartz carry sulphides. In places the sulphide mineralization is heavy. Pyrite, galena, chalcopyrite, sphalerite, tetrahedrite, malachite, and azurite were observed. Much of the heavy sulphide carries only low values. The two best samples reported at this group of workings were 0·20 ounce gold and 21·20 ounces of silver a ton across a width of 15 inches, and 0·13 ounce of gold and 15·60 ounces of silver a ton across 30 inches.

About 100 yards downstream, around a sharp bend and on the opposite side of the creek, the rock is cut by aplite dykes across a width of 100 feet. Within the belt three intensely sheared zones, striking north 50 to 60 degrees west and dipping 50 degrees southwest, carry quartz veins and stringers. Galena and sphalerite are probably more prevalent than in the other workings, and pyrite and chalcopyrite are less common. Three short adits have been driven on the shear zones. Assays show up to 0·04 ounce of gold and 8·58 ounces of silver a ton across 60 inches.

(1) Veron Group

The Veron group of four claims, owned by Paul Tickolis of Red Lake, is situated on the west side of Criss Creek, about 3 miles northwest of Red Lake post office. An unimproved road leads from the Red Lake road to the top of a steep descent to Criss Creek, beyond which the property may be reached by trail.

The showings consist of quartz veins in rocks that have been badly sheared and altered close to the contact of a nearby granitic mass, but are believed to represent altered Cretaceous or Tertiary sedimentary rocks. Few outcrops appear in the vicinity of the showings. The veins are

mineralized with pyrite, tetrahedrite, zinc blende, and molybdenite. Many of the showings consist of quartz float and of broken material lying virtually in place.

An open-cut and adit have been driven at the lowest showing. The adit is only a few feet beneath the surface and does not disclose the walls of the vein. Quartz occurs low down in the walls for about 10 feet in the adit, with broken rock above, and the face is also in quartz. The quartz is heavily impregnated with sulphides, chiefly pyrite and tetrahedrite, with some molybdenite. The attitude of the vein is not known. A sample cut in mineralized quartz across the face, a distance of 6·5 feet, assayed: gold, a trace; silver, 0·09 ounce a ton. Above the adit a stripping has been made and quartz shows in this and to the southeast, but it is doubtful if the vein matter is in place.

A group of cuts 250 feet to the east discloses quartz float carrying pyrite and some molybdenite.

About 200 feet westerly from the adit, an open-cut partly exposes a quartz vein about 3 feet wide. This appears to be striking northwest and dipping 75 degrees northeast. Higher up the hill several cuts have encountered quartz float, but the vein matter has not been found in place.

A group of cuts 250 feet to the east discloses quartz float carrying pyrite and some molybdenite.

About 200 feet westerly from the adit, an open-cut partly exposes a quartz vein about 3 feet wide. This appears to be striking northwest and dipping 75 degrees northeast. Higher up the hill, quartz float was seen in several cuts, but no veins in place.

About 1,000 feet northeast from the adit there is a group of cuts. The first two are each about 10 feet long and about 10 feet apart. They show granite on the foot-wall of the cut and an altered carbonate rock with considerable mariposite on the hanging-wall. Stringers of quartz intersect the granite. Thirty feet easterly a quartz vein is shown in a cut about 6 feet long. The vein is 3 feet wide, strikes east, and dips 40 degrees north. It is not exposed in the cuts previously mentioned, although these cross its strike. Two slips offset the vein in the cut. The vein carries pyrite, tetrahedrite, zinc blende, and molybdenite, the last mineral occurring in masses up to an inch in diameter. Mineralization on the whole is sparser than at the other workings. The wall-rock is sheared and carbonatized, and contains considerable mariposite.

The indications are that veins of considerable size occur, but up to the time the property was last examined (September 1941) work had not progressed far enough to relate the various showings. One gold assay of $5 a ton is reported to have been obtained, but a sample by the writer of well-mineralized material failed to show appreciable gold values.

SILVER-LEAD-ZINC PROPERTY

(68) Comstock of B.C., Limited

(Iron Mountain)

References: B.C. Minister of Mines, Ann. Repts.: 1927, p. 212; 1928, p. 224; 1929, p. 245; 1930, p. 207.

This property, situated on Iron Mountain south of Merritt, includes twenty-one claims, comprising the Leadville, Yellowville, Yellow Jacket, Hornet, and Comstock groups. The property was discovered in 1927 by

Emmitt Todd. The showings are situated near the summit of the mountain, and may be reached by road and trail from Merritt. A road that formerly led to the property requires a small amount of work in order to be made passable. The country rock in the vicinity consists of volcanic rocks of the Nicola group. The mineral deposit occurs in a fissure zone striking about north 25 degrees east, with a dip of 80 degrees to the northwest. This zone is reported to have been traced at the surface for several hundred feet, but prospecting has been retarded to some extent by heavy drift cover over part of the area. The zone is marked by heavy impregnation of the rock with barite, which is accompanied by galena, zinc blende, and pyrite. The amount of sulphide in the barite varies considerably.

A shaft has been sunk at one point to a depth of slightly more than 100 feet, and this discloses a vein 5 feet wide with good walls. This working was inaccessible at the time of the writer's visit. Some high-grade ore carrying 65 per cent lead is stated to have been extracted from this shaft, and there is stated to be 370 tons of ore on the dump with an estimated content of 15 per cent lead. The silver content is generally low.

At the bottom of the shaft the vein is stated to have been displaced by a fault with a low dip, and sinking was abandoned. It was proposed to drive a crosscut 175 feet lower down, but this work apparently was not completed.

Outcrops of what is apparently the same vein occur 50 feet southerly and 100 feet northerly from the shaft.

This property was worked by lessees in 1947, and some ore was shipped.

MERCURY DEPOSITS

Mercury deposits occur in a belt roughly 8 miles wide, extending from Tunkwa Lake on the south to Criss Creek, a distance of about 23 miles. The deposits occur mostly in volcanic rocks of differing ages, and are accompanied in some instances by silicification with chalcedonic quartz, intense alteration of the rock to ankeritic carbonates, and the development of dolomite veins or stringers in shear zones and fracture zones. The cinnabar in many instances occurs in or at the edges of dolomite veins or stringers, but cinnabar also appears in small masses in chalcedony and in silicified rock. By far the larger number of deposits discovered lie to the north of Kamloops Lake. However, many carbonate zones occur on the hills sloping north to the lake, particularly in the area from Durand to Cherry Creeks. This section has perhaps not been prospected as thoroughly as the area north of Kamloops Lake. The total production of mercury to date amounts to 143 flasks.

Several carbonate zones also occur in the rocks bordering Deadman River from Kamloops Lake to slightly beyond Criss Creek, where the older rocks pass beneath Tertiary lavas. This area was prospected some years ago under the direction of the Provincial Department of Mines, but no cinnabar was found.

Zones of carbonate alteration also appear in the rocks north of Kamloops Lake between Kamloops and Mara Hill, but no discoveries of cinnabar have been reported from this area.

Large carbonate zones were also noted on upper Nicola River near the eastern edge of the map-area. No cinnabar was found associated with these zones.

(24) Mercury Group

(Tunkwa Lake)

References: Camsell, C.: Mercury deposits of Kamloops Lake; Geol. Surv., Canada, Sum. Rept. 1918, pt. B, p. 20 (described under name of Summit group). Stevenson, J. S.: Mercury Deposits of British Columbia; B.C. Dept. of Mines, Bull. No. 5, 1940, pp. 57-59.

The Mercury group of three claims, owned by Gordon F. Dickson of Kamloops, is a re-staking of an old property that had been allowed to lapse. It is situated some 15 miles south of Savona, on the Merritt highway about a mile easterly from Tunkwa Lake.

The deposit consists of volcanic rock, part of which is banded tuff, altered to ankerite and veined with dolomite. The carbonate zones carry stibnite, tetrahedrite, malachite, azurite, and cinnabar, the last usually as thin films and small masses in the dolomite. A retort had been erected on the property by the previous owners, but so far as is known there was no production. In the autumn of 1941 some prospecting was done on the property by D. B. Sterritt and associates of Kamloops. A total of just under 100 pounds of mercury was produced from a cut driven to the east of the shaft.

The deposit occurs in an area of open, rolling range land with small knolls and drift ridges and some small ponds. Most of the area is drift covered. Outcrops of carbonate rock are found in a group of knolls clustered about a small pond (Figure 6). The nearest rock outcrop to these mineral showings lies some 900 feet southerly, where an outcrop of greenstone occurs at the edge of another small pond. This greenstone is overlain about half a mile south by Tertiary basalt.

The original working consisted of a shaft, now filled with waste from other workings. The main working on the property now consists of a shaft, said to be vertical for 20 feet and then to continue as an incline. This is sunk on the western side of a small knoll (Plate VI B) that forms the main outcrop of the property. The shaft is filled with water to within 15 feet of the collar, and the remainder is tightly lagged. South from the shaft a line of cuts forms practically a continuous open-cut for 80 feet on the west side of the knoll. The knoll itself continues south for 160 feet from the shaft, and at its end a trench, largely in gravel but exposing about 12 feet of the carbonate rock, has been dug. About 50 feet beyond the end of this knoll smaller and lower knolls appear and show carbonate rock for about 80 feet farther. Beyond this the continuation of the zone is assumed for some distance by the occurrence of broken fragments of ankerite in the soil.

Two smaller knolls appear on the east side of a small pond about 200 feet easterly and 300 feet northeasterly, respectively, from the shaft.

The shaft and the main knoll are located on a strongly sheared zone in which the rock is altered to ankerite and cut by veins and stringers of dolomite. This zone of alteration is at least 70 feet wide, and although alteration appears more intense on the west side of the knoll the eastern side is also altered and veined with dolomite. In many places the rock is shattered and appears as a breccia cemented with dolomite. In the line of cuts extending south from the shaft very little cinnabar was found. Steven-

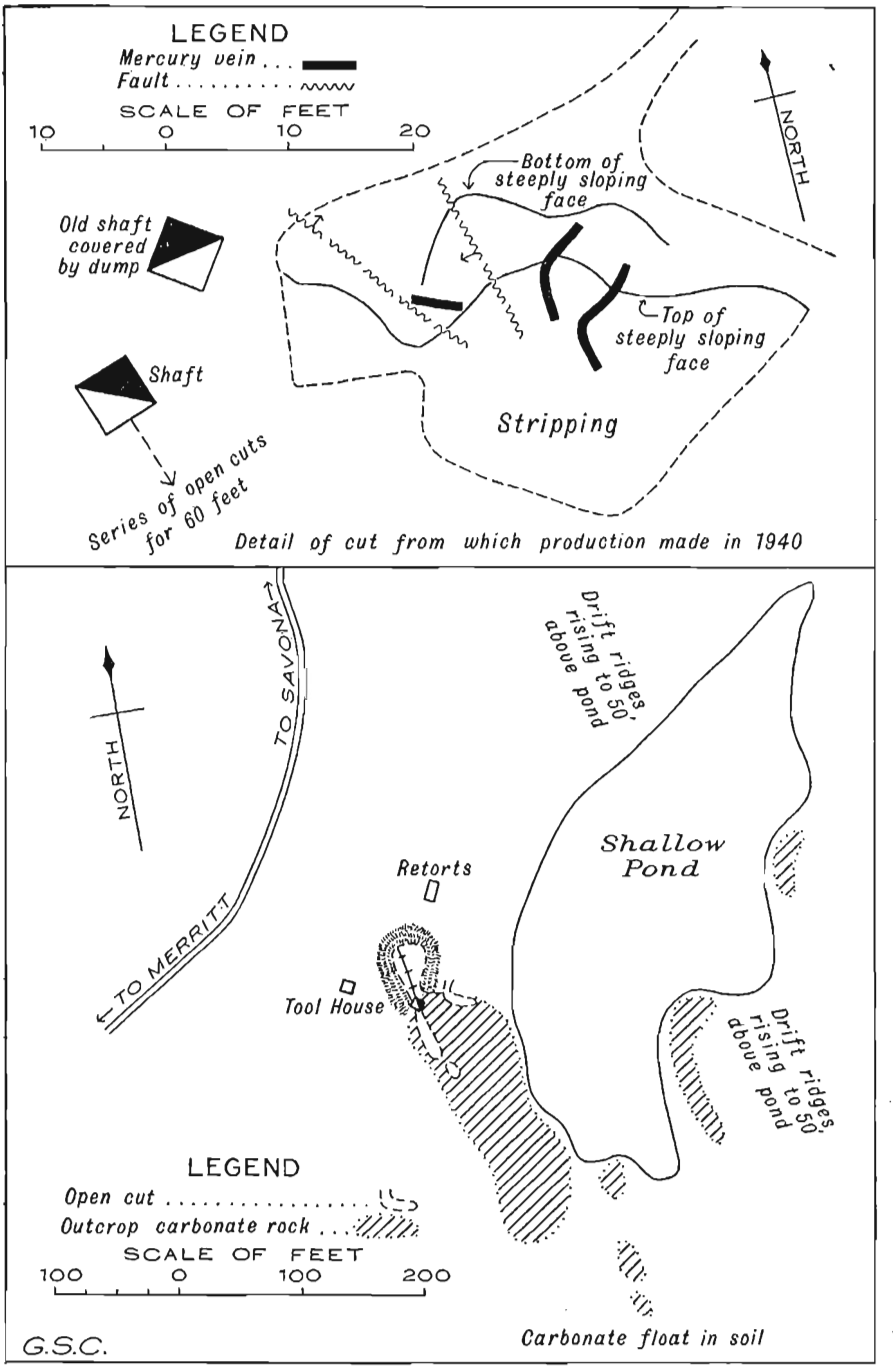


Figure 6. Plan of Mercury group, Tunkwa Lake.

son reports finding cinnabar about 20 feet south of the shaft, and about 65 feet south narrow veins of dolomite in the altered rock carry masses of stibnite and a little disseminated cinnabar.

East of the shaft is an irregular cut and stripping. The cut itself is about 40 feet long, measured along the knoll, and 8 or 10 feet wide, and bedrock has been cleaned off for a varying distance above the long edge of the cut. Several narrow bands carrying cinnabar were found in this cut. That nearest the shaft is a strong fracture zone striking north 50 degrees west and dipping nearly vertically. A large number of stringers of dolomite from $\frac{1}{8}$ to $\frac{1}{4}$ inch wide appear along this zone, and carry small masses of cinnabar. The maximum mineralized width is about 2 feet. Assays reported to the writer range up to a maximum of 0·08 per cent mercury across 2 feet. About 10 feet to the east is a second zone running about north 30 degrees west. This is about a foot wide, but has no defined walls. It carries numerous stringers of dolomite with masses of stibnite and small masses of cinnabar. Unaltered angular fragments of rock appear in the dolomite. A third zone, running north and dipping 45 degrees east, was also found. It is about a foot wide and carries a little cinnabar in dolomite stringers. A fourth zone, about 6 feet to the east, is somewhat narrower. It carries stibnite, tetrahedrite, azurite, and malachite, but no cinnabar was seen in it. The production of mercury previously mentioned was made from this cut.

The trench made across the south end of the knoll failed to show any cinnabar, although dolomite and ankerite appear. A sample taken here by the writer before the trenching was done assayed 0·01 per cent mercury.

The two other knolls on the east side of the small pond have been trenched. The rock there is partly altered to ankerite, and is veined with dolomite, but no cinnabar was found.

A grab sample taken by the writer of the cobbed ore in the retort before the mining was done by Mr. Sterritt contained 1·26 per cent mercury. This ore had evidently been sorted from the open-cuts on the west side of the knoll.

(15) North Pine and South Pine Claims

The North Pine claim is owned by W. J. Villiers of Savona, and the South Pine by John Wilson of Savona. The property is situated on the south side of Kamloops Lake nearly due south of Copper Creek, about 3 miles by road east of Savona and only a few hundred yards from the Savona-Kamloops highway.

The mineral deposit consists of veins along fractures in altered volcanic rocks. Dolomite veins occur along these fractures and carry small amounts of tetrahedrite, azurite, malachite, and cinnabar. The rock itself is partly silicified and partly altered to ankerite.

The deposit is exposed by an open-cut that is partly in overburden and partly in rock. The material along one side of the cut is broken rock very nearly in place. The cut itself is about 35 feet long, of which 12 feet is in overburden. Where it enters rock it deepens to about 5 feet. This deep part of the cut is 5 feet long, beyond which the cut rises abruptly and

then more gradually to the face. Two fractures appear in the cut. The main fracture strikes north 50 degrees west and the other diverges from it at an angle of about 30 degrees. Along the fractures the rock is filled by narrow stringers of dolomite. The main vein at one point is nearly 2 feet wide, but pinches rapidly in either direction. At the deepest part of the cut the fractures are 2 feet apart, with intervening, silicified, volcanic rock intersected by a network of dolomite stringers. The dolomite carries small masses of tetrahedrite, with considerable malachite and azurite as stain and small masses and thin films of cinnabar.

(25) Hansen Claims

Claims reported to have been staked by A. Hansen lie about 2 miles south of the Kamloops-Vancouver highway. Nobody was on the ground when the writer visited the location, and although some of the claim posts were found the names of the claims could not be ascertained. No workings were seen in the vicinity.

About 1½ miles south of the highway a band of greenstone, about 150 feet wide and 250 feet long, is largely altered to ankerite and is cut by many narrow stringers of dolomite. No cinnabar was observed, and the relations of the greenstone band to the surrounding rocks could not be determined.

(9) Charbonneau Property

References: Stevenson, J. S.: Mercury Deposits of British Columbia; B.C. Minister of Mines, Bull. No. 5, 1940, pp. 55-57.

The Charbonneau property lies within a quarter mile of the village of Savona. Some prospecting for mercury was done on it by Jules Charbonneau, but any claims covering the ground have now lapsed.

Several cuts have been put in on dolomite-bearing zones, but no cinnabar was found in the workings. One cut lies close to the Canadian Pacific Railway, about a quarter mile east of Savona station. In this cut the rock is largely altered to ankeritic carbonates and talc, cut by veins and stringers of dolomite. The veins are 1 inch to 4 inches wide and strike northeast. No cinnabar was found in the cut nor in the broken rock that had been removed from it. The nearest outcrops to the cut consist of coarse, green, volcanic breccia.

In the bed of a dry gulch about a quarter mile south of Savona station, a lode has been stripped. Its full width cannot be seen owing to sloughing, but Stevenson reports it to be 42 inches wide with a strike of south 75 degrees east and a dip of 70 degrees southwest. The lode consists of fragments of rock cemented by dolomite. About 200 feet farther south, on the east side of the dry gulch, a cut has been dug to intersect the downward extension of an outcrop of ankeritized greenstone that appears 15 feet above on the hillside. This cut has now sloughed in, but the bedrock apparently consisted of breccia. No cinnabar was seen at either of these cuts. The bedrock in the gulch is fairly well exposed, and consists of coarse green breccia with numerous thin stringers of calcite. No other ankerite or dolomite zones were seen.

(11) Cinnabar Claims at Copper Creek

(Cinnabar Mining Company of B.C.)

References: B.C. Minister of Mines, Ann. Repts.: 1891, p. 574; 1892, p. 540; 1893, p. 1068; 1894, p. 751; 1895, p. 696; 1896, p. 568; 1897, p. 614; 1898, p. 1105; 1900, pp. 891, 892; 1901, pp. 1080, 1230; 1903, pp. 246, 248; 1909, p. 139; 1910, p. 129; 1913, pp. 184, 194, 195; 1918, p. 237; 1924, p. 149; 1925, p. 167; 1926, p. 185; 1927, p. 198; Bull. No. 5, 1940, pp. 33-45. Camsell, C.: Geol. Surv., Canada, Sum. Rept. 1918, pt. B, p. 19.

Several claims staked for cinnabar lie on the slope immediately to the north of Copper Creek station on the east side of Carabine (Copper) Creek. They embrace the claims formerly held for many years by the Cinnabar Mining Company of B.C., and which reverted to the Crown for taxes and were later leased to Mr. F. L. Gorse and Kamloops Mercury Mines, Limited. Subsequent to the work of the writer in 1941 Mr. Gorse reported that he had secured an option on the holdings of Kamloops Mercury Mines.

The property was one of the early cinnabar discoveries in the province, having been staked in the early nineties. Intensive work was started on the claims in 1894, and they were taken over by the Cinnabar Mining Company of B.C. in 1895. This company did considerable exploratory work and erected two retorts, but operated them for only a short time, producing somewhat over 100 flasks of mercury. From 1896 to 1924 very little work was done, but in the latter year the property was reopened by Mr. J. Fleetwool Wells, who operated it for 3 years. He obtained about 5 flasks of mercury. Very little further work was done on the property until 1940 when it was leased by Kamloops Mercury Mines, Limited. The total production reported by the British Columbia Department of Mines is 143 flasks, and the property remains the only one within the area that has produced more than a few hundred pounds of the metal. In 1940 some stripping was done by Kamloops Mercury Mines and a short adit was driven. In 1941 Mr. Gorse did prospecting work on the J claim and erected two pot retorts, with which a few pounds of mercury were recovered. Since the date of the writer's examination further stripping has been done.

The mineral deposits occur both in volcanic and sedimentary rocks. The most prevalent type is a greenish breccia consisting of large and small, rounded and angular fragments of greenish basaltic rock in a matrix of similar material. Associated with it is a purple breccia that is merely a colour variation of the same rock. Dark grey, blocky, fine-grained tuffs are interbedded with the breccias, and the assemblage is cut by light grey, rusty weathering, basaltic dykes. Apparently overlying these volcanic rocks are picrites, augite porphyrites, and tuffs that are described elsewhere in this report. In some places the picrites are largely altered to magnesite. The ultra-basic rocks are cut east of Copper Creek by a small stock of granitic rock.

A group of sedimentary rocks consisting mostly of conglomerate with sandstone and some shale underlies the volcanic breccias referred to above, and are cut by small bodies of granitic rocks.

Cinnabar appears in both the sedimentary and volcanic rocks, but is confined largely to the latter, and is associated with veins and stringers of dolomite that occur in fracture and shear zones in the rock. These veins range from a mere seam to 4 feet thick, traverse the rock in a number of directions, and consist of fairly pure white dolomite. Cinnabar is also

associated with thin, discontinuous films of dolomite that traverse the rock, some of which shows silicification with chalcedonic quartz. The cinnabar occurs as small masses at the margins of the dolomite films, but was also noted as small masses in the rock dissociated from the dolomite films. The prevalent occurrence is, however, as thin films and small masses in the veins and stringers of dolomite. Cinnabar was the only sulphide seen, but stibnite and tetrahedrite have been reported from the workings.

No samples were taken by the writer for assay. It was judged that from the amount of cinnabar present most of the ore seen would constitute only low-grade material. In the adit shown as working C of the north group of workings (*See* Figure 7), a short stringer of high-grade ore may be observed near the face. At this place streaks of massive cinnabar up to ¼ inch wide appear, and a sample by Stevenson across 8 inches assayed 3·2 per cent mercury.

On Figure 7 the principal workings on the J claim and those of the south and central workings of Kamloops Mercury Mines, Limited, are lettered to correspond with the descriptions in the text.

Workings on the J Claim. Cut A (Figure 7) is now partly sloughed in, and little can be learned of the mineral zone at that point. The rock is a brown weathering porphyry cut by numerous small stringers of dolomite that trend northeast to east. The largest stringer is about 2 inches thick. No cinnabar was seen at this cut.

At cut B (Figure 7) a dolomite vein strikes about north 70 degrees west and is nearly vertical. The cut is 25 feet long and in this distance the vein pinches and swells several times with a minimum thickness of 8 inches and a maximum of 30 inches. About 10 feet from the upper end of the cut a branch vein runs into the westerly wall. It is 5 inches wide and carries fine hair lines of cinnabar. Although this mineral has been reported from the larger vein, it was not observed in it by the writer. About 15 feet southeasterly from the cut is an old working that was apparently driven on the dolomite vein, and vein matter taken from the dump shows fine hair lines of cinnabar that are minutely curved, suggestive of folding in the rock. The lines are also displaced about a quarter inch by numerous fractures. The veins in these cuts run towards a zone that is exposed in cuts C, D, E, and F.

Cuts C, D, E, and F (Figure 7) mark the locus of a shear zone that strikes north 20 degrees east and dips 60 degrees west. The included purple volcanic rock carries small veins and stringers of dolomite, some of which run off into the walls. Near the north end of the zone a vein of dolomite 1 inch to 2 inches thick lies along the hanging-wall, underlain by 2 inches of sheared rock and 8 to 10 inches of silicified rock veined with stringers of dolomite. Cinnabar was seen in the dolomite vein along the hanging-wall of the zone, but was observed only in extremely small amounts in the dolomite stringers near the foot-wall.

Near the northerly end of cut C a vein of dolomite believed to be the continuation of the vein in cut B is split into two strands, with a foot of altered rock between. The vein carries very thin seams of cinnabar. The shear zone does not show beyond the vein and may be displaced by the vein fissure, or the vein may run into the zone near this point. Near the south end of cut C, the section as exposed in the shear zone from the hang-

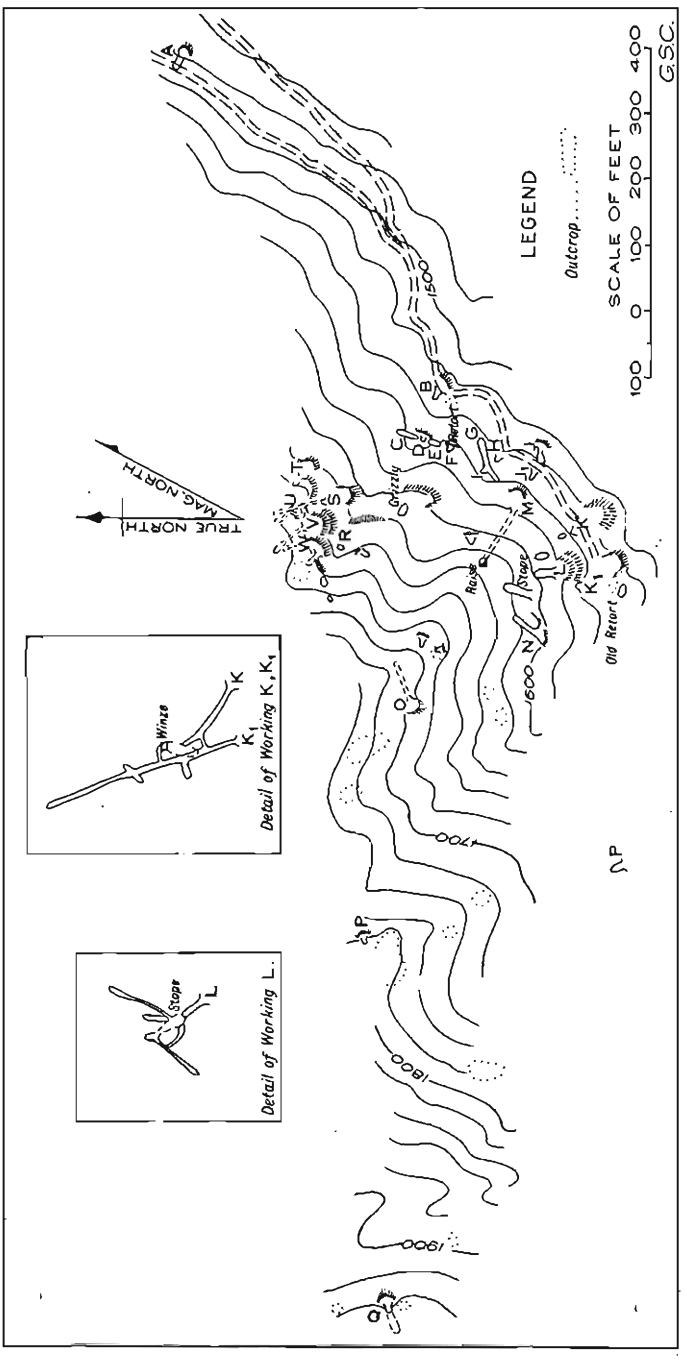


Figure 7. South workings, Copper Creek mercury claims.

ing-wall to the foot-wall consists of a stringer of dolomite ½ inch thick, 2 inches of rock, a dolomite stringer ½ inch thick, and 14 inches of silicified rock with many discontinuous dolomite stringers. Several of the stringers within the silicified rock show a fair amount of cinnabar.

The zone at cuts D, E, and F (Figure 7) is similar in its general characters to that at cut C. Locally small, discrete masses of cinnabar appear in the silicified rock dissociated from the dolomite stringers.

Cut G is a long curving trench partly in overburden and partly in rock. It does not expose the shear zone found in the other cuts, but the vein of dolomite exposed in cuts H and I is shown here. This vein is 4 to 8 inches wide, and carries thin films of cinnabar.

Cuts J and J_1 partly expose a vein of dolomite, probably 1 to 2 feet thick, that carries small grains of cinnabar. The continuation of this vein is shown by a deep cut and adit M of the south group of workings of Kamloops Mercury Mines. This vein pinches and swells from a maximum of 2 feet to a few inches, and shows a small amount of cinnabar.

South Workings. A group of workings that have been referred to as the south workings on this property lie immediately north of some of the working on the J claim. Their location is shown on Figure 7. It is thought that a considerable part of the production made in the past came from these workings. The lower adits K and K_1 run into an old stope that is also connected with the adit L. The easternmost adit, K, follows a vein of dolomite that strikes north 60 degrees west, is very nearly vertical, and varies in thickness from 6 inches to 2 feet. It carries cinnabar in thin films. The adit extends to the stope referred to that has been driven on a fracture zone running north 25 to 30 degrees east and carrying numerous dolomite stringers striking in different directions. The drift was carried into a winze that was full of water, but is reported to be 30 feet deep. This stope has been carried to the surface. The adit K_1 is connected with adit K by two short crosscuts. It encounters a zone with a number of carbonate stringers striking in different directions.

An adit at L (Figure 7) has been driven into the stope at an elevation of 25 feet above adit K, and a drift has been run southerly from the stope for about 100 feet. This encounters a fault striking north 40 degrees east and dipping 35 degrees southeast, beyond which the working is not in the mineral zone. A short crosscut to the southeast also encounters a fault. The adit L itself follows a dolomite vein 6 inches to 1 foot wide with a steep dip.

At the surface the stope exposes a fracture zone striking northeasterly and containing a number of veins parallel with it. One vein striking north 35 degrees east runs towards working N, and has been stoped out from below in that working, so that it cannot be examined. The foot-wall is well defined, but the hanging-wall is indefinite. A number of dolomite stringers pass out into the walls at varying angles.

Adit M (Figure 7) is driven on the continuation of the vein in cuts J and J_1. This is a dolomite vein, and it pinches and swells from a maximum width of 2 feet to a few inches. The vein carries a little cinnabar. A short raise has been driven from the adit to the surface.

A short adit, O, higher up the hill shows several dolomite stringers striking across it, but no cinnabar was observed in them. About 75 feet easterly from the portal a dolomite vein 4 feet wide, striking north 25 degrees

east and dipping 85 degrees southwest, outcrops. No cinnabar was seen at this exposure, but at a cut 35 feet to the north thin films of cinnabar appear in the dolomite.

Adit P is a short working following a dolomite vein 18 inches wide that shows included fragments of country rock. Small stringers of dolomite cut the rock in various directions, and grains of cinnabar appear in these.

Adit Q is also a short working considerably higher up the hill to the west. It also shows many stringers of dolomite and some of these carry a few small grains of cinnabar. About 500 feet northerly from this working is another carbonate zone that shows occasional scattered grains of cinnabar.

Central Workings. In the central group of workings (R, S, and T, Figure 7) are three adits at about the same elevation. Adit R is partly blocked at the portal and completely caved about 45 feet in. The part that could be seen showed several small stringers of dolomite with scattered, thin films of cinnabar. The second adit branches about 50 feet from its portal; the northwesterly branch is caved, but presumably leads to a raise; the westerly branch runs to a raise that was driven on a zone showing stringers of dolomite, but no cinnabar was seen in the accessible part of the working. Adit T is a short working driven northwesterly in a body of picrite. This rock is intersected by many faults, with hematite along the planes, and carries thin stringers of dolomite with a little cinnabar.

Adit U is driven a few feet along the contact between breccia and porphyry, the contact being a fault zone. Both rocks carry stringers of dolomite, but no cinnabar was observed.

Adit V is 80 feet long, and also shows a number of dolomite stringers. No cinnabar was seen in this working, but a sample by Stevenson at one point assayed 0·5 per cent mercury across 4 inches.

Adit W is short, and exposes a few stringers of dolomite with films of cinnabar near the face. Stevenson reported an assay of 0·6 per cent mercury across 2 feet in this working. A large open-cut immediately southwest of this adit shows breccia cut by basaltic dykes that carry numerous stringers of dolomite. Cinnabar was observed in a few of these.

Above the caved adit R is a stope driven on a fault zone with a well-defined foot-wall. This stope has been carried over a width of 7 to 8 feet, reaching the surface in two openings, one of which could not be examined. In the other a number of dolomite stringers appear, striking in different directions. A large open-cut extends around the top of the stope and this also showed a number of dolomite stringers carrying scattered, thin films of cinnabar.

North Workings. The north workings are situated about half a mile northerly from the south and central workings, and consist of a main adit, three shorter adits, and a number of open-cuts and adits that have barely been driven under cover.

The main working adit (A, Figure 8) is connected with adit O and with the surface by raises and stopes that were inaccessible at the time of the writer's visit. This adit has been driven as a crosscut northwesterly, and about 135 feet from the portal encounters a mineral zone running northeast. A drift has been run a short distance on either side of the adit, and a raise driven to the surface. The back of the drift to the southwest has been stoped for about 20 feet above the level, and could not be examined.

A second zone was encountered 70 feet farther in the adit, and a drift followed it to the southwest and was stoped above for a length of 15 feet and to an average height of 12 feet. Above the stope are a number of irregular openings apparently following high-grade ore. The drift follows a fault for several feet and then a dolomite vein 2 to 5 inches wide. Only a few grains of cinnabar were noted.

Adit B is a short working driven in 1940. It was started on a tuff bed showing talc, ankerite, and small stringers of dolomite with a little cinnabar. At the surface a strong fault zone striking northeast and dipping 70 degrees northwest occurs about 20 feet beyond the portal and carries stringers of dolomite with showings of cinnabar. The working apparently passes through this zone, but is tightly timbered at that point.

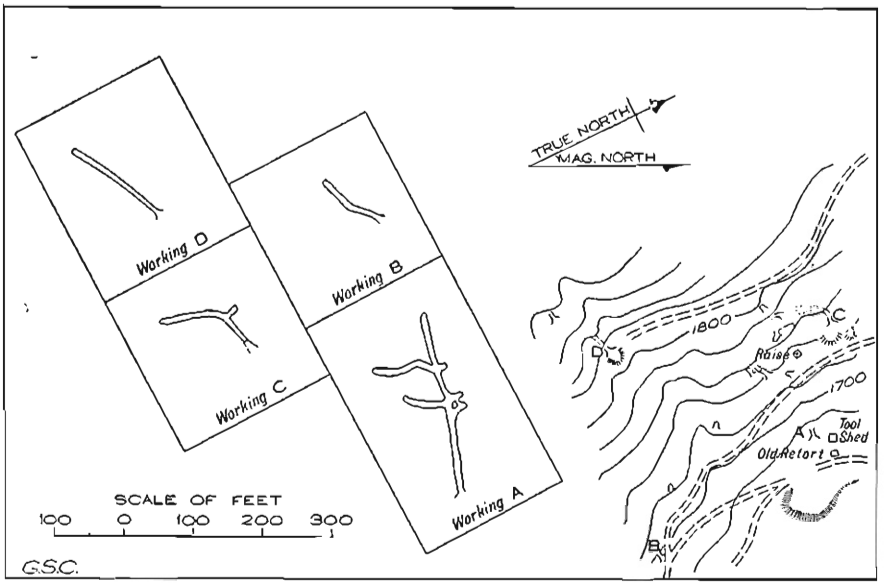


Figure 8. North workings, Copper Creek mercury claims.

Working C is a short adit with a stope to the surface and a stope from adit A below. At the face of the adit a short stope has been driven on a dolomite vein 6 to 8 inches wide, which is well mineralized with cinnabar. A sample by Stevenson across 8 inches assayed 3·2 per cent mercury.

Working D is a short adit on a dolomite vein, which is cut off by a fault 30 feet from the portal. At the portal the vein is 4 feet wide, but beyond the fault only stringers of dolomite appear. No cinnabar was seen at this working. Another adit now 50 feet higher on the hill is caved at the portal.

Several other open-cuts and short adits are shown on Figure 8. These do not disclose more than stringers of dolomite with a few showings of cinnabar. Some of the tuff beds in this vicinity are striking northeast and dipping northwest. This attitude is at variance with that of the beds elsewhere in this vicinity suggesting that the beds are folded locally.

A few workings higher on the hill and believed to lie off the property show carbonate minerals in conglomerate, but no cinnabar was seen. Similar mineralization was seen farther west towards Sabiston Creek, where a few grains of cinnabar were observed.

(14) Cinnabar Prospect East of Copper Creek

A cinnabar prospect occurs north of the east end of the railway tunnel a few hundred yards east of Copper Creek station. So far as is known the prospect has been abandoned, and the names of the claim and of the locator are not known. The cuts and adits occur along a steep, dry gulch.

The upper working, which commences as an open-cut and continues as a 4-foot adit, has been driven southerly. A large number of dolomite stringers from $\frac{1}{4}$ inch to 1 inch wide intersect the rock, which is a tuff. One set follows the bedding planes; other sets cross the bedding at various angles. The width of the zone carrying the stringers is not shown. Scattered small grains of cinnabar occur in the dolomite.

About 25 feet easterly a second cut, now largely sloughed in, apparently exposed a similar zone. A pile of rock at one end, evidently made while digging the cut, shows stringers of dolomite with a few grains of cinnabar. The rock at this cut does not carry as many veins of dolomite as that at the upper cut.

Easterly 125 feet from the last cut two others have been made, one on each side of the small gulch. A body of granitic rock crosses immediately below them, and the volcanic rocks show numerous stringers of quartz and dolomite. These vary up to about 1 inch wide, and some carry a few grains of cinnabar. The cut on the north side of the draw has a 10-foot adit at its end driven westerly. The rock throughout the working is veined with stringers of quartz and dolomite.

(10) Sabiston Property

References: Camsell, C.: Mercury Deposits of Kamloops Lake; Geol. Surv., Canada, Sum. Rept. 1918, pt. B, p. 20 (referred to as Independent group). Stevenson, J. S.: Mercury Deposits of British Columbia; B.C. Dept. of Mines, Bull. No. 5, 1940, pp. 48-49.

A mercury prospect is near Sabiston flats about 2 miles westerly from Copper Creek station. The property was a Crown grant that had reverted to the Crown and had been leased to R. C. Neville in 1940.

The mineral deposits consist of vein zones along which dolomite stringers have been formed. The deposits are in volcanic rocks consisting of greenstone and feldspar porphyry, which show wide zones of alteration to ankerite.

The principal showing occurs at what will be termed the lower adit. This adit is on the westerly side of a dry gulch about 100 feet above and 300 feet from the railway track, and about 50 feet above the bed of the gulch. It has been driven north 40 degrees west on a vein zone for 18 feet, and thence north for 10 feet to crosscut the zone, which is about 10 feet wide. The adit follows a vein of dolomite 1 to 3 inches wide, and contains narrow films of cinnabar. On the northerly side of the portal the vein zone contains a number of stringers of dolomite a fraction of an

inch wide, most of which run in the direction of the zone. A few cross the rock in other directions. Films of cinnabar were found in some of these stringers.

Farther up the dry gulch above the adit, a number of zones of carbonate were found. These are, in general, irregular in shape and show alteration of the rock to ankerite, with dolomite stringers, generally less than an inch thick, cutting the altered rock. No cinnabar was observed in these zones.

Approximately 1,500 feet upstream from the lower adit is another group of workings that may or may not be on the same group of claims as the adit. There an open-cut has been made on a shear zone in the east bank of the dry gulch. The zone strikes north 10 degrees east and dips 70 degrees southeast. It carries a thin vein of dolomite composed of a number of stringers across a width of 2 inches, and shows a little malachite and azurite. These minerals in other properties of a similar type are indicative of the presence of tetrahedrite, but this mineral was not observed.

Fifty feet upstream, and also on the east bank of the gulch, an adit has been driven 100 feet northeasterly, with a short crosscut in either direction at its face, and a 12-foot crosscut southeast about 50 feet from the portal. The adit follows a sheared zone trending northeast, but is an old working partly caved. The rock is intersected by small stringers of dolomite, but no cinnabar was observed either in place or on the dump.

(7) Jane, Plaza, and Rose M. Groups

The Jane and Plaza groups are located on the ridge lying between Carabine Creek and Sabiston Creek, which lies about 2 miles westerly from Carabine Creek. The Rose M. adjoins the Plaza and extends westerly from Sabiston Creek up the slopes of Mount Uren. It probably also adjoins some of the claims of the Davis group. The Jane and Plaza groups are owned by E. H. Kellner, Kamloops, and the Rose M. is stated to have been staked by E. R. Miller of Tofino. The initial claims of the Jane group lie about a mile west of Copper Creek and about the same distance north of Kamloops Lake.

The properties had been staked only a short time previous to the writer's visit in September 1940, and only limited prospecting work had been done.

The rocks exposed consist of lavas with tuffs and breccias, which are overlain by conglomerate, shale, and sandstone. These sedimentary rocks are in turn overlain by other volcanic rocks.

Very little can be said about the mineral showings, many of which at the time of the writer's visit were represented only by float. The deposits, however, appear to be associated with zones of ankerite alteration in the volcanic rocks, but some also appear in the sedimentary beds.

The showings on the Jane group lie near the common corner of the four claims that comprise the group. The workings comprise three open-cuts, which are old and largely sloughed in. In one open-cut a band 16 to 20 inches wide of silicified sandstone carries stringers of dolomite that range up to 1½ inches in width. They carry thin films of cinnabar, and small masses of cinnabar also occur in the silicified rock. The zone appears to have a northerly trend, but is not well exposed. The next cut, 50 feet to the northwest, has been excavated in a fine-grained, green, volcanic breccia.

This rock is not mineralized. The third cut, 70 feet northeast of the first, has been driven northwesterly for 25 feet, and is largely sloughed in. The rock is a badly weathered conglomerate with a sandy matrix. No evidence of mineralization was seen.

The next group of workings lies on the Plaza claims. These workings are roughly 2,500 feet northwest of the cuts described above and lie 150 feet southeast of the common corner of the four claims making up the group. They comprise four cuts in a line running northerly. The first has not been sunk to bedrock. Float encountered in making the cut consisted of silicified volcanic rock cut by stringers of dolomite, and is judged to be nearly in place. The next cut is also in the broken material overlying bedrock. It shows silicified rock with ankerite and narrow stringers of dolomite. The third cut is 35 feet northerly and slightly east of the line joining the other cuts. The loose rock in it is heavily altered to ankerite and contains narrow stringers of dolomite. The fourth cut, 20 feet north of the last, is still in overburden. No cinnabar was found in the altered rock on the dumps of these cuts.

Along the edge of the steep slope that lies east of Sabiston Creek, a number of zones of ankeritized greenstone are indicated by the talus. Some of this material carries thin stringers of dolomite, but no cinnabar was observed. No workings had been driven on these zones at the time of the writer's visit.

As the Rose M. group had not been prospected and as no work had been done on it at the time of the writer's visit, no examination was made.

(8) S. and T. Group

(Davis Property)

References: Stevenson, J. S.: Mercury Deposits of British Columbia; B.C. Minister of Mines, Bull. No. 5, 1940, pp. 49-51.

The S. and T. group of eight claims, owned by Thomas Seeley of Vancouver, covers the ground formerly staked as the Bee group by John Davis of Savona. The claims are located on the steep southern slope of Mount Uren about a mile east of Savona station on the Canadian National Railway.

The showings consist of carbonatized greenstone along zones of shearing. The rock is converted to ankerite, and this is veined by dolomite. Cinnabar occurs as small masses and thin films in the dolomite.

At the lowest showing (A, Figure 9) a zone of ankerite 8 to 10 feet wide is exposed for 30 feet, gradually tapering west and running out under the alluvium of a small draw to the east. This has a strike of north 80 degrees west and a dip of 42 degrees northeast. It is cut by a number of veins that run in various directions. No cinnabar was seen in this zone. What may be the extension of this zone lies 200 feet easterly (B, Figure 9) and continues for 200 feet. Here the zone attains a maximum thickness of 15 feet; the foot-wall strikes north 80 degrees west and dips 30 degrees northeast. A few narrow veins of dolomite, mostly parallel with the foot-wall, cut the zone. These range from $\frac{1}{8}$ inch to 2 inches wide. Near its eastern end the zone narrows to 4 feet, with a central vein of dolomite 6 to 10 inches wide. No cinnabar was found at any of these showings.

About 120 feet northerly from this zone (C, Figure 9) a shallow trench 30 feet long exposes a zone that continues beyond the trench at each end as an outcrop. At its easterly end it is 10 inches wide, strikes north 40 degrees west, and dips 60 degrees northeast. Along the hanging-wall is a vein of dolomite, and stringers of dolomite run out from this into the sheared rock. Thirty feet westerly the zone widens to 10 feet, and shows a network of dolomite veins intersecting the ankerite. Here, also, a vein of dolomite branches north and beyond it the zone narrows to 2 feet.

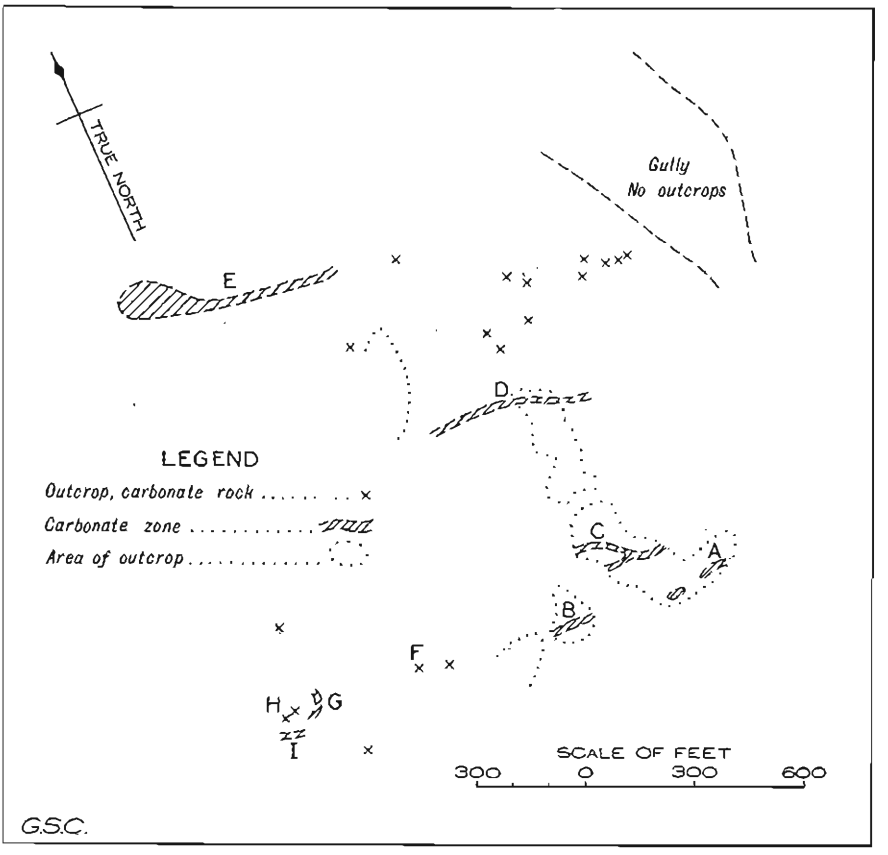


Figure 9. S. and T. property, Savona.

Forty feet farther a zone 5 feet wide, striking south and dipping 30 degrees west, branches off. The main zone narrows to a stringer west of this branch, but widens again to 5 to 10 feet. A few small masses of cinnabar were observed.

The next showing is located 450 feet northerly up the hill in a small saddle (D, Figure 9) and consists of a group of shallow strippings now partly sloughed in. A shear zone, with a general easterly trend, 2 to 4

feet wide is indicated. This carries veins and stringers of dolomite running in the direction of the shear. One vein attains a width of 8 inches. A few small masses of cinnabar were found.

Two hundred and fifty feet northeast of the last showing is a group of outcrops where the rock is altered to ankerite. These are scattered over a length of 400 feet and a width of 100 feet. No dolomite was observed in them. Five hundred feet northwest of these is a carbonate zone running westerly for 600 feet and gradually increasing in width to as much as 30 feet at its western end, where it disappears under drift (E, Figure 9). The rock is largely altered to ankerite, but the zone contains few stringers of dolomite and no cinnabar was seen.

Four hundred feet westerly from the first showing described, a shear about 2 feet wide striking east (F, Figure 9) and dipping north carries four narrow stringers of dolomite. The same zone is exposed 75 feet farther west.

Three hundred feet west, a shear zone striking north 15 degrees west and dipping 55 degrees southwest is followed by a cut curving with the dip down the hill (G, Figure 9). The zone is 10 inches wide and the rock in it is largely altered to ankerite, and is veined by dolomite. A vein of dolomite 1 to 3 inches wide lies along the foot-wall, and a number of thin stringers of dolomite parallel the walls. Thin films and small masses of cinnabar occur in the dolomite. About 50 feet west is a carbonate zone exposed in two cuts in a small gully (H, Figure 9). This zone strikes north 50 degrees east and dips 50 degrees northwest. It ranges up to 4 feet in width with the upper 2 feet consisting of breccia intensely altered to ankerite. The lower 2 feet, also intensely altered, carries a few stringers of dolomite. No cinnabar was observed. About 50 feet south, a zone 3 feet wide is traced by two cuts about 40 feet apart (I, Figure 9). It strikes north 75 degrees east and dips 45 degrees northwest. The rock shows some silicification and is partly altered to ankerite. Narrow stringers of dolomite occur through this material. No cinnabar was seen.

(4) Mac Mercury Group

(Criss Creek)

References: B.C. Minister of Mines, Ann. Repts.: 1896, p. 568; 1900, pp. 891, 892; 1924, p. 149; 1929, p. 236; 1933, p. 183. Stevenson, J. S.: Mercury Deposits of British Columbia; B.C. Minister of Mines, Bull. No. 5, 1940, pp. 52-53.

The Mac Mercury group is on the steep hillside that slopes southerly to Criss Creek 2 to 3 miles above the mouth of the creek. The property consists of eight claims owned by Fred Morris of Savona.

The deposits consist of veins and stringers of dolomite in zones of ankeritized greenstones. The greenstones carry thin interbeds of tuff, argillite, and limestone, but such sedimentary material was not observed in close connection with the mineral deposits. Cinnabar, stibnite, realgar, quartz, azurite, and malachite were the minerals found in the deposits, and tetrahedrite is probably also present.

The workings consist of a number of short adits, open-cuts, and a shallow shaft. The principal workings are situated near the location line along either side of which the group of claims has been staked (Figure 10).

There are two cabins on the property, a lower cabin on the creek and an upper cabin about 1,700 feet northerly up the hill near a group of workings. Along the bank of the creek are a number of carbonate zones within 1,800 feet upstream from the cabin to where the rock passes under alluvial deposits. These show more or less intense alteration of the greenstone to ankerite, chiefly along fractures in the greenstone. Some of these zones contain a few dolomite stringers, but cinnabar has not been found in them. Considerable cinnabar has, however, been found in washing the creek gravels for placer gold.

A cut about 1,700 feet north of the lower cabin and 300 feet southeast of the upper cabin partly exposes an ankerite zone in greenstone. No cinnabar was observed. Two cuts, 380 feet southwest of this, are sloughed in so that bedrock is not exposed, but, judging from the float, they encountered carbonate zones but no cinnabar.

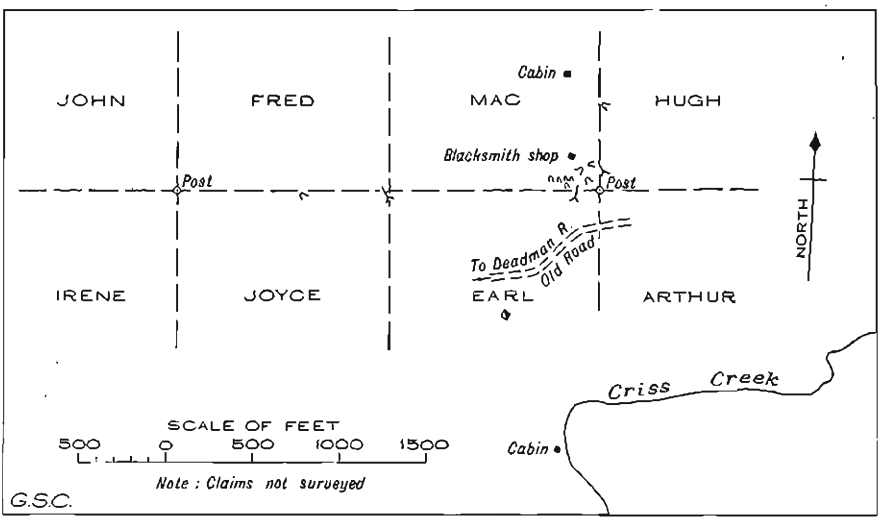


Figure 10. Mac Mercury group, Criss Creek.

One hundred feet south of these, a cut 30 feet long, also partly sloughed in, shows the rock altered to ankerite. Considerable dolomite in small veins appears in the material removed from the cut.

One hundred feet easterly, an adit 8 feet long follows a vein of dolomite 1 inch to 4 inches wide. This vein carries inclusions of greenstone. Along it the rock is altered to ankerite for varying distances. Many fractures filled with specular hematite appear in the ankerite. No cinnabar was seen in the working.

An open-cut 170 feet southeast shows an ankerite zone with a narrow vein of dolomite near the face of the cut. No cinnabar was found.

Two hundred feet westerly an adit 15 feet long has been driven into the hill. The walls of the adit are in rock, but the roof is still in overburden. This adit follows a northwesterly fault. The greenstone is jointed along the fracture, and considerable hematite appears in the joints. Neither dolomite nor cinnabar was seen.

One hundred and fifty feet northwest is a group of cuts. One of these off line with the others follows a stringer of dolomite ½ inch wide striking northeast. The remaining cuts trace a zone of alteration for about 125 feet diagonally up the hillside. This zone carries numbers of small stringers of dolomite and bunches of quartz with stibnite, realgar, azurite, and malachite. No cinnabar was seen in the workings, but this mineral is reported to have been obtained from at least one of the cuts, a number of which are now sloughed in.

An adit situated about 1,000 feet westerly from this group of cuts is 51 feet long, with the first 12 feet in drift. In the next 27 feet it follows a dolomite vein striking north 20 degrees west, dipping 60 degrees southwest, and averaging 3 feet in width. The final course of the adit cuts away from the vein. Immediately above the adit on the hillside is a cut that exposes the same dolomite vein as in the adit. Here the vein is 3 to 4 feet wide, is exposed for a length of 20 feet, and carries angular fragments of greenstone. Small masses and thin films of cinnabar occur in the dolomite; malachite, azurite, and realgar were also observed. Two samples taken by Stevenson across 42 and 36 inches of dolomite showed nil and 1·7 per cent mercury respectively.

Two cuts occur 480 feet westerly from the adit. The rock there is partly altered to ankerite and shows small stringers of dolomite ¼ to ½ inch wide. No cinnabar was seen.

The highest cut on the property is 1,450 feet westerly from the last group, and only about 100 feet below the contact between greenstone and Tertiary basalt. The rock at the cut is an altered breccia, the cut itself following a narrow vein of dolomite. A number of narrow stringers of dolomite intersect the rock in various directions, and carry thin films of cinnabar.

About 800 feet northwest of the lower cabin, an incline has been sunk on the steep slope a distance of 6 feet, following a dolomite vein that strikes north 10 degrees east and dips 60 degrees northwest. This vein is 2 to 6 inches wide, and carries small masses of realgar. Cinnabar has been reported from this working, but was not seen by the writer.

(5) Hardie Mountain

Reference: Stevenson, J. S.: Mercury Deposits of British Columbia; B.C. Minister of Mines, Bull. No. 5, 1940, pp. 45-48.

A number of workings occur on the lower western slope of Hardie Mountain about 4 miles by road from Copper Creek station. These prospects were at one time Crown-granted claims belonging to Hardie Cinnabar Mines, Limited, but they reverted to the Crown and the ground was thrown open for re-location in 1939. A certain amount of prospecting work, chiefly stripping with a bulldozer upon an upper bench of Hardie Mountain, was done by Kamloops Mercury Mines, Limited, in 1940.

The main workings are adits, apparently driven to intersect reported showings of cinnabar in open-cuts on a relatively flat area at the top of the steep slope, but none of these adits reached points underneath the open-cuts, nor was any cinnabar observed in them.

The rocks in the vicinity consist of a group of volcanic types, feldspar porphyry, andesite, tuff, breccia, and basalt, cut by small bodies of granitic rock.

The adits are driven into a steep, open hillside that rises from the valley of Carabine Creek to the relatively flat area referred to above. The lowest adit is less than a quarter of a mile from the Carabine Creek road and about 250 feet above it. This adit is caved and inaccessible, but, judging from the dump, encountered a fine-grained, banded tuff containing small stringers of dolomite. No cinnabar was seen.

The second adit, 400 feet northeasterly and 250 feet higher, has been driven northeasterly for 172 feet through lavas and tuffs. These rocks are intersected by scattered stringers of dolomite, generally about an inch wide. No cinnabar was seen in these stringers.

The third adit is 550 feet northeasterly from the second and about 130 feet above it. It was partly caved at the portal, but was found to be driven 193 feet in a direction north 60 degrees east. Two short crosscuts have been driven northwesterly at 72 and 155 feet respectively from the portal, and a raise driven northwest at 118 feet from the portal. The adit encountered amygdaloidal rock, feldspar porphyry, breccia, and basalt, and the crosscuts and raises follow narrow fault zones that strike north to northwest and dip west to southwest. Much of the rock is altered to ankerite, leaving unaltered masses at the centres of the altered parts. A number of narrow stringers of dolomite cut the rock, but no cinnabar was seen with these.

An open-cut 200 feet northeast of the third adit is now sloughed. The fourth adit, 200 feet northeast of this cut, has been driven 136 feet northeasterly in rocks of the same type as above. One hundred feet from the portal the rock is intersected by narrow stringers of dolomite ranging up to 2 inches in width. No cinnabar was seen in these. Other dolomite stringers occur about 6 feet from the portal. The walls and back of the drift in many places are coated with crystals of selenite.

A fifth adit, 250 feet northwest of the fourth, was found to be caved at the portal.

A number of cuts lie on the more gentle slope about 100 feet in elevation above the uppermost of the adits. One of these nearly 700 feet northeast of the fourth adit is caved. A second cut beyond this showed amygdaloidal basalt. A third cut 150 feet southwest of these was found to be sloughed in. A trench 225 feet southeast of the first cut showed dolomite stringers in two small zones at its northern face, but no cinnabar was seen in these.

The remainder of the workings are situated a considerable distance north of these cuts. In addition to a number of cuts that are now sloughed in, and a shallow inaccessible shaft, a long irregular trench has been excavated with a bulldozer. Stringers of dolomite were seen in the rock excavated from some of these workings and in the rock along the trench, but none of these was observed to carry cinnabar.

(6) Mercury Group

(Hardie Mountain)

The Mercury group of eight claims, owned by Thomas Hardie and Jack Smith of Red Lake, and the Hg group of five claims, owned by D. B. Sterritt and Gordon F. Dickson of Kamloops, are located on Hardie Mountain. The claims lie on a relatively flat bench approximately 900 feet above

the valley of Carabine Creek and adjoin the claims (Hardie Mountain group) prospected by Kamloops Mercury Mines, Limited, in 1940. Considerable prospecting was done on these claims by D. B. Sterritt and associates in 1940 and 1941. A road has been brushed out to the property from the Copper Creek-Red Lake road. This leaves the main road near the top of the steep hill descending to Carabine Creek, and follows the flat mentioned above for more than a mile to the camp.

The mineral deposits occur on a group of three knolls that rise about 300 feet above the general level of the bench referred to, and that are locally

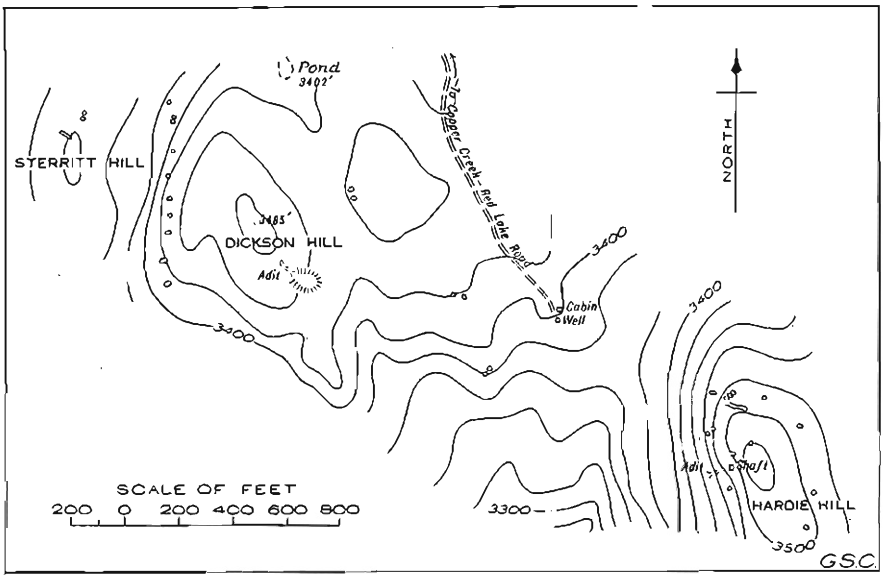


Figure 11. Workings on the Mercury group, Hardie Mountain.

referred to as Hardie[1], Dickson, and Sterritt Hills (Figure 11). The surface is very largely covered with overburden so that rock outcrops are relatively scarce.

The rocks in the vicinity of the mineral deposits are volcanic types cut by dykes of granite porphyry. Specimens of the rocks from near the mineral deposits showed considerable silicification by chalcedonic quartz, and the feldspars are generally too altered for determination. The volcanic rock was evidently porphyritic, for in some sections the ghosts of feldspar crystals are preserved, surrounded by chalcedonic quartz, which is replacing part of the groundmass, but preserving unreplaced patches of the groundmass within it. Narrow stringers and irregular masses of chalcedony occur together with narrow stringers of dolomite. The cinnabar in general occurs as small grains within the silicified rock, but locally occurs as abundant, very finely divided grains that colour the chalcedony a pale pink. In a few instances the cinnabar is associated with veins of carbonate. The silicification of the rock and development of small grains of cinnabar

[1] Hardie Hill should not be confused with Hardie Mountain. It is a small knoll rising from a bench on the northwestern slope of that mountain.

through it has taken place over considerable areas. A number of engineers have sampled the showings. The results were furnished the writer by Mr. D. B. Sterritt, and those quoted are averages of samples by different men.

The small knoll referred to locally as Hardie Hill (Figure 11) is 850 feet southeast of the mine camp. The main working is a shaft 35 feet deep with an incline said to be driven for 20 feet from the bottom. An adit some 40 feet lower has been driven towards the bottom of the shaft, but not far enough to reach it. At the shaft there is a fractured zone 4 to 7 feet wide with the foot-wall striking north 10 degrees east and dipping 85 degrees northwest. The zone is traversed by small veins of chalcedony, and grains of cinnabar appear both in the veins and in the adjacent rock. An average of the different samples on the north wall at the bottom of the shaft was 0·096 per cent mercury across 6·35 feet. Similar samples at the collar showed 0·13 per cent mercury across 4·2 feet. The portal of the adit is some 80 feet southwest of the shaft and the adit has been driven 75 feet northeast. Near the face a silicified zone 2½ feet wide shows numerous stringers of chalcedonic quartz with grains of cinnabar. Narrow discontinuous stringers of dolomite also occur showing thin films of cinnabar. Assays of this zone average 0·366 per cent mercury across 3·9 feet.

At the surface a zone of silicified rock with disseminated cinnabar stretches north from the shaft, but has no defined walls. About 50 feet north of the shaft the zone appears to branch, one branch running north and the other northeast. Much of the rock carries small disseminated particles of cinnabar and small stringers of chalcedony coloured pink by the finely divided cinnabar. The discrete particles of cinnabar apparently occur with chalcedony in the rock. The zone has a width ranging up to 12 feet. The average of samples cut on this zone is 0·15 per cent mercury across an average width of 4·8 feet. The northeast branch of the zone runs out under overburden; the northerly branch has been traced for an additional distance of 100 feet, but is narrower. Two long trenches have been run easterly across the trend of the zones, one at 150 and the other at 200 feet north of the shaft. The southern of these, 130 feet long, encounters four mineralized bands, of which the zone trending north from the shaft is believed to be the third from the entrance to the cut, where it is 2 feet wide. The widest zone is at the entrance of the cut, where it is mineralized across a width of 10 feet. A similar broad zone occurs in a cut 40 feet south, and may be continued in another cut 100 feet north. The average of assays in the two southern cuts on this zone is 0·12 per cent mercury across a width of 5·67 feet. The next long cut north also discloses four zones, but these cannot be definitely related to zones in the long trench to the south. The average of assays on a zone at the mouth of this cut is 0·10 per cent mercury across 6·53 feet.

About 100 feet northeast of the shaft a cut follows a zone trending northeast. This is about 24 inches wide, and shows narrow discontinuous stringers of dolomite carrying thin films of cinnabar. An average of the assays taken across this zone shows 0·13 per cent mercury across a width of 2 feet.

Three small cuts on the east side of the small knoll locally known as Hardie Hill show silicified rock with narrow veinlets of chalcedony. Discrete grains of cinnabar occur both in the rock and in the chalcedony.

Dickson Hill is a small ridge about 1,200 feet northeast of the camp or about 2,000 feet northeast of Hardie Hill (Figure 11). A considerable amount of float with cinnabar is scattered across the top of the hill, and a short adit has been driven northeasterly into it. This adit shows three stringers of chalcedonic quartz striking northeast and dipping southeast. Two lie within 6 feet of one another, and the third is 10 feet nearer the face. No cinnabar was seen in the stringer nearest the portal; the other two show small areas where the quartz is coloured by finely divided cinnabar.

A zone has been traced for 600 feet along the western slope of Dickson Hill by a line of cuts. The showings vary from a foot to 9 or 10 feet in width. The rock at the cuts is veined with chalcedony and dolomite, and cinnabar occurs in association with both, but also as single grains within silicified rock. Assays taken across these showings range from traces to 0·5 per cent mercury, and the average of samples reported to the writer is 0·116 per cent mercury across a width of 5·9 feet. These apply in general to the southern and central cuts; the writer has no assays from the northern cuts of this group.

The workings on Sterritt Hill lie about 300 feet northwest of the line of cuts on Dickson Hill. Two cuts close together near the northern end of the hill show stringers of dolomite. Both the dolomite and the adjacent rock carry small masses of cinnabar. Assays across the zone show 0·072 per cent mercury across 2·09 feet, with the best sample assaying 0·28 per cent across 8 inches. A third cut about 100 feet southeast shows a narrow mineralized streak at either end, but assays of samples yielded only traces.

(3) Last Chance Group

The Last Chance group of two claims, owned by Messrs. Jack Smith and T. R. Hardie of Red Lake, is situated near the top of a steep slope that rises some 1,500 feet above Criss Creek, and is roughly 4 miles in a direct line from the mouth of the creek. There is no road to the property. A trail up Criss Creek passes within a mile of the property, and another trail from the Smith ranch near Red Lake post office joins this Criss Creek trail.

Showings of cinnabar occur in a red breccia that underlies beds of coarse conglomerate. The property has not produced, but a number of cuts have been put in. Most of these are now sloughed to the extent that little can be seen of the relations of the various showings.

The main showing is in a large open-cut along a fracture zone that ranges from 6 to 17 inches in width. The rock exposed is largely altered to carbonates across the full width of the cut, which is about 5 feet. Along the fracture zone, which strikes north 15 degrees east and dips 45 degrees northwest, the rock is strongly jointed, and thin stringers of dolomite with films of cinnabar appear along the joints. Some of the films of cinnabar are remarkably persistent, one being observed over an area 18 inches long and 12 inches wide on a block that had been excavated. Most of the fracture zone is concealed in the rubble on the floor of the pit. At one point where the zone could be dug into, cinnabar was found as thin films along joints about half an inch apart across a width of 6 inches. This showing was sampled, and assayed 0·04 per cent mercury. It is reported by the owners that cinnabar has been found across the widest part of the zone, but none was seen there by the writer.

Three cuts, spaced south and southeast of the main cut for a distance of 175 feet, are now sloughed, so that the bedrock is not exposed. Considerable dolomite was encountered in making these cuts, and is now piled on the dumps. No cinnabar was found in this, but tetrahedrite with malachite and azurite occur in the cut farthest southeast.

Another cut 25 feet northwesterly from the main showing is also largely sloughed. The rock is apparently a red breccia considerably altered and carrying small stringers and masses of dolomite. No cinnabar was seen in place, but a little was found in dolomite veins on the dump. Outcrops of conglomerate appear a short distance north of the cut.

A group of three cuts lies to the northwest of the last cut. These are all sloughed, so that bedrock is visible only at one or two points. The rock is intersected by thin stringers of dolomite along fractures. No cinnabar was found in place, but in the dumps of the northern and central cuts thin films of cinnabar were observed in some of the dolomite. The third cut showed abundant dolomite, but no cinnabar was seen. One other cut about 570 feet northwesterly from this group of cuts was found. It also was sloughed, so that the bedrock could not be seen. The material piled on the dump showed narrow stringers of dolomite carrying thin films of cinnabar.

COPPER DEPOSITS

Copper minerals occur at many places throughout the map-area, and a large number of claims have been staked. The copper production of the area amounts to 6,048,892 pounds, having come chiefly from the Iron Mask, Copper King, Aberdeen, and Snowstorm mines. Of these the Iron Mask has furnished by far the greater part of the ore, being credited with a production of 5,194,871 pounds.

For purposes of description the properties have been divided into three groups as follows:

(*a*) Deposits associated with the Iron Mask batholith.
(*b*) Deposits of the Highland Valley Camp.
(*c*) Other deposits.

Deposits Associated with the Iron Mask Batholith

Copper deposits are found around the periphery of the Iron Mask batholith from Edith Lake to Sugarloaf Hill on the one side and from Separation Lake (about 2 miles northeast of Edith Lake) to near Cherry Bluff on the other. A few occur in the central part of the batholith. Many are situated in the batholithic rocks, and some in the intruded rocks at the borders of the plutonic mass. They are impregnations, veins, stockworks, and mineralized shear zones in the country rock, and some of the impregnation deposits appear to have no solution channels. The principal copper minerals are chalcopyrite and bornite, with some chalcocite, cuprite, azurite, and malachite. Chrysocolla and lead minerals have also been reported. Magnetite and pyrite are common; hematite is less common. Quartz is generally present only in minor amounts, but calcite is common. Gold values are generally low, but a few of the deposits carry good gold values.

Some of the deposits are accompanied by considerable wall-rock alteration. Owing, however, to the fact that most of the mine workings are inaccessible, it was difficult to study the spatial relations of this alteration

to the orebodies. Although the alteration is in certain instances intense in the general vicinity of the orebodies, it does not appear to be confined to the immediate wall-rocks, and some intensely altered rock occurs at considerable distances from known orebodies. The alteration involves the albitization of plagioclase feldspar, with the development of carbonate, chlorite, and epidote. The altered rocks are associated with bands of albitite that are more probably the result of albitization of the wall-rocks with leaching of the dark minerals than intrusion as dykes. The amount of albite in the slides of altered rock examined by Mathews[1] ranged from 67 to 86 per cent. Calcite and siderite are common, and form as much as 6 per cent of the rock. Chlorite and epidote make up from 8 to 26 per cent, the former replacing augite and hornblende and the latter occurring in the same manner but more usually irregularly distributed with no apparent relations to the earlier minerals. Apatite also appears in small quantities in the altered rocks.

The writer has no data to prove that this alteration was accomplished at an earlier stage than the mineralization, but its occurrence at some little distance from known orebodies suggests that alteration and ore deposition may have been to some extent independent processes. Coats (1940) discussing the propylitization of the Comstock lode, suggests that it was not due to the vein-forming solutions, but to hydrothermal alteration at rather higher temperatures than those usual in epithermal ore deposition. In the case of the Iron Mask deposits the mineralization is probably mesothermal, but the wall-rock alteration may have been due to the action of solutions at fairly high temperatures. Although the alteration is not invariably closely related to the orebodies, it is sufficiently diagnostic to be used to some extent as an indicator that orebodies are near by, and thus in prospecting and development work would afford a somewhat larger target than the orebodies themselves. It was found to be most marked in the vicinity of the Iron Mask mine, and this proved to be the largest orebody so far developed in the camp. There is, however, some alteration in evidence in nearly all the deposits in this group.

There also appears to be a relatively close association between the copper deposits and certain veins of magnetite that are discussed in another connection, but that also occur within the rocks of the Iron Mask batholith. The veins of magnetite carry apatite, some calcite, and at one locality at least chalcopyrite and malachite. Stringers of magnetite with apatite and copper minerals occur at some of the showings of the Copper King mine.

The deficiency of quartz, the abundance of magnetite and calcite, and the general arrangement of these deposits with respect to the periphery of the batholith are all features that would relate them closely in origin to the rocks of the batholith. Their occurrence within the hydrothermally altered rocks of the batholith, however, would suggest that they are connected with the very late phases of the intrusion and consolidation of this rock, or that they come from a deep-seated magmatic source not exposed at this locality.

A large number of claims were staked following the discovery of copper minerals, but many received only limited development and have since lapsed. Of the claims that were Crown granted, a considerable number have reverted to the Crown for taxes. The principal producer was the Iron

[1] Mathews, W. H.: Geology of the Iron Mask Batholith; unpublished thesis for the degree of Master of Science, University of British Columbia. A number of the writer's slides and specimens were loaned to Mathews, his assistant, and volume analyses quoted below are by Mathews.

Mask mine, which commenced production in 1904 and continued intermittently until 1928. Many of the workings are now caved so as to be inaccessible, and in the descriptions that follow most of the information has had to be compiled from earlier reports. It is unlikely that the properties described comprise a complete list of the mineral showings, as when the field work was done the writer did not have a guide familiar with the entire camp. However, it is believed that most of the principal showings are dealt with.

(32) Iron Mask Mine

References: B.C. Minister of Mines, Ann. Repts.: 1896, pp. 566, 567; 1897, p. 612; 1898, pp. 1102, 1103; 1899, p. 730; 1900, p. 889; 1901, pp. 1077-8; 1902, p. 190; 1903, p. 179; 1904, p. 229; 1905, p. 195; 1906, p. 174; 1908, p. 121; 1909, p. 139; 1910, pp. 127, 128; 1913, pp. 185-7; 1914, p. 361; 1915, pp. 210-11, 212-15; 1916, p. 266; 1918, pp. 233-4; 1919, p. 178; 1920, p. 168; 1922, pp. 147, 149; 1923, p. 149; 1924, p. 141; 1925, p. 167; 1926, pp. 184-5; 1927, p. 198; 1928, pp. 208-9.

The Iron Mask property, comprising the Iron Mask, Erin, Copper Queen, Emeroy, Sunrise, Prince of India, Kentucky, Neighbor, Gladiator, and Excelsior claims, and the Jumbo, Bonnie Jean, Delta, Lucky Strike, Cyclone, and Ben Hur fractions, was the principal copper producer of the properties around the Iron Mask batholith. It is situated about 4 miles southwest of Kamloops.

The property was one of the early locations on Coal Hill,[1] having been staked in August 1896. In its early stages, the property changed hands several times, finally being acquired by Kamloops Mines, Limited. This company worked it from about 1903 until 1910 when it was acquired by the Kamloops Copper Company, who operated the property, except during several years when it was closed down, until 1927, when it was reorganized as the Continental Copper Company. The property apparently closed down in 1928, and has not been operated since. The Iron Mask mine produced, between 1901 and 1928, from 189,230 tons of ore a total of 3,630 ounces of gold, 41,292 ounces of silver, and 5,194,871 pounds of copper. The Iron Mask claims reverted to the Crown and are held by individuals.

G. F. Dickson of Kamloops recently secured a lease on the Erin claim and has shipped small amounts of ore from the upper levels. The Iron Mask is owned by W. A. Urquhart of Vancouver.

The mine workings are now mostly inaccessible, and the following account is derived largely from the listed reports of the Minister of Mines for British Columbia. A plan of the workings is contained in the report for 1926.

The property lies near the contact between the body of plutonic rocks referred to as the Iron Mask batholith and Triassic volcanic rocks of the Nicola group. Part of the intruded rocks is highly metamorphosed. Copper carbonates and small amounts of sulphides appear at a number of points surrounding the workings, and open-cuts and other small workings had been made on a number of these showings. At some of these, the ore appeared to have been concentrated where numerous small bodies of albitite, probably alterations of the diorite, appear. Not all of these concentrations, however, were sufficiently large to form ore.

[1] Coal Hill lies about 4 miles southwest of Kamloops.

There appear to have been two principal orebodies, referred to as the Iron Mask and the Erin. The former filled a fracture zone with a well-defined foot-wall striking north 65 degrees east and dipping nearly vertically. On the hanging-wall side, next to the solid ore, a black, crushed country rock appeared. Brewer states that examination of the plans showed that this orebody had a stope length of 179 feet between the third and second levels, with a width of 5 feet; on the fourth level, the stope is 175 feet long with a width varying from 5 to 20 feet, but on the fifth and sixth levels it had a greater maximum width. The orebody had a decided pitch to the east.

The Iron Mask shaft was sunk on an incline of 68 degrees to the 750-foot level. This followed the ore down to a depth of 690 feet, where the orebody was cut off by a fault with a slight dip to the southwest. The Iron Mask shaft is now inaccessible, having caved near the collar.

The Erin orebody strikes north 39 degrees east and dips 65 degrees southeast. The foot-wall is well defined, but in the hanging-wall mineral penetrates the cleavage planes of the rock and apparently forms a zone of low-grade material with indefinite boundaries. The high-grade material apparently varied from 5 to 8 feet in width, and the total width of the orebody was generally 30 feet, but in one place reached 50 feet. No estimate was made by Brewer of the proportion of the orebody carrying high-grade ore because of the extreme variation in width of that material. Between the orebody and the igneous rock that forms the hanging-wall there is a variable width of crushed black rock carrying such small quantities of copper minerals as to make it unprofitable to mine. Generally an irregular but well-defined line of demarcation separates this from the higher grade ore, but at many points the high-grade material merges gradually into it.

The Erin shaft is located 1,300 feet east of the Iron Mask shaft, and is sunk to a depth of 330 feet. It is open to the 150-foot level, but below that the workings are inaccessible. These indicate that the orebody reached a width of 40 feet, and are in the oxidized zone. A fair sized body of oxidized ore still remains above the 150-foot level. The Erin workings are, however, connected with the 750-foot level of the Iron Mask workings by means of a raise from the latter. Long crosscuts have been run northerly on this level from both the Erin and Iron Mask workings for the purpose of locating the Iron Mask orebodies below the fault referred to above. In this work several small bodies of ore were encountered, one of which was stated (1928) to be 120 feet long and 12 feet wide, although much of the material was low grade. Considerable diamond drilling was done in this section.

The Norma shaft, about 1,050 feet northerly from the Erin shaft, has been sunk to a depth of 200 feet, with a crosscut about 600 feet long extending southerly from the bottom. Water stands in this shaft about 60 feet below the collar.

About 700 feet northeast of the Iron Mask shaft, another shaft was sunk about 40 feet (Brewer, 1913) on the Emeroy claim on a showing of copper carbonates. This work exposed a vein 5 feet wide striking north 65 degrees east and dipping 70 degrees southeast, and carrying copper carbonates and oxides. The relationship of this to the Iron Mask orebody was not established.

Several prospect holes have been opened along a line of exposures of copper carbonate minerals a few hundred feet to the south and southeast of the Iron Mask shaft. At these points narrow stringers of copper sulphides occur with the carbonates, but no strong vein is indicated as on the Iron Mask.

A little work has also been done on the Lucky Strike claim, lying to the south of the Iron Mask. Here a vein between 3 and 4 feet wide is stated to have been opened up by a shallow shaft and a drift along the vein. The workings are inaccessible.

(36) Evening Star Group

References: B.C. Minister of Mines, Ann. Repts.: 1899, pp. 731-2; 1902, p. 191; 1903, p. 180; 1904, p. 231; 1905, pp. 194, 195; 1906, p. 174; 1908, p. 122; 1913, pp. 187-8; 1916, p. 266.

This group of three claims, Evening Star, Golden Star, and Bill Nye, is situated about 6 miles southwest of Kamloops, immediately south of the Iron Mask mine. It is owned by Messrs. McArthur, Harper, and Morrison of Kamloops. Only small shipments have been made, resulting in the production of 29 ounces of silver and 5,628 pounds of copper.

On the Bill Nye, which adjoins the Iron Mask group, are several open-cuts, but none of these had been sunk sufficiently deep to reach bedrock. A shaft has also been sunk 40 feet, but was caved at the time of examination. The cuts are stated to have exposed copper carbonate minerals disseminated through the gravel. A vein of copper ore was reported in the shaft, but this was not verified by Brewer (1913).

On the Golden Star, there are trenches, a short adit, and a winze, but Brewer (1913) states that these were caved so that an examination could not be made. He states that examinations made previously showed "that in the open cut and adit . . . there was a zone several feet in width composed partly of surface gravel cemented together and partly of igneous rock, badly shattered and broken up; this material was permeated with copper carbonates and some chalcopyrite. There were no well-defined walls nor any well-defined vein shown in the winze but . . . all of the rock . . . carried more or less copper ore disseminated through it . . . ; the values were too low grade to be considered commercially. The strike of this mineralized zone is nearly east and west."

On the Evening Star, near the western boundary and only a short distance from the work on the Golden Star, an adit 150 feet long has been driven into the base of the ridge on which the claims are staked, and apparently crosscuts the same zone as on the Golden Star, but this adit was driven farther into solid rock and there were indications of vein structure. A shaft was sunk to a depth of 90 feet, and at a depth of 40 feet is stated to have encountered a body of ore 4 feet wide that was drifted on for 20 feet. A second body 6 feet wide is reported at the bottom of the shaft. These workings are now inaccessible.

(27) Copper King

(Cherry Creek)

References: B.C. Minister of Mines, Ann. Repts.: 1897, p. 613; 1898, pp. 1103-4; 1899, p. 733; 1900, p. 690; 1901, p. 1079; 1902, p. 191; 1903, p. 180; 1906, p. 177; 1908, p. 122; 1909, p. 140; 1919, p. 179; 1922, p. 149; 1924, p. 141; 1929, p. 228; 1930, p. 194; 1935, pp. DS-9; 1939, p. 89F.

The Copper King property, consisting of nine Crown-granted claims, is owned by Baroness Sartorio, and is situated north of the Vancouver-Kamloops highway about 16 miles west of Kamloops. The property is approximately a mile south of the Canadian Pacific Railway, but the nearest railway station, Cherry Creek, is 2½ miles distant by road.

The claims were staked in 1897 by J. H. Hill. Little work was done until 1936 when the property was acquired by A. N. Gray, who shipped between 900 and 1,000 tons of ore stated to average 0·3 ounce in gold and 4·4 per cent copper. The claims were acquired by Mr. Beckman in 1908, and on his death passed to the present owner. In 1929, a small shipment of ore was made from the stope and dump. In 1939 and 1940, the property was worked by the McKelvie Brothers until a small mill on the property was destroyed by fire in 1940. The Copper King is credited with the production of 7,491 tons of ore, which yielded 1,183 ounces of gold, 2,180 ounces of silver, and 391,381 pounds of copper.

The ore minerals comprise chalcopyrite, pyrrhotite, and bornite, with some magnetite, along a fractured zone in diorite. Veins of magnetite show a close connection between this deposit and the iron deposits in the vicinity.

The principal working is a stope 112 feet long and varying in width from 10 to 40 feet. This is stoped to the surface from the level below. The minerals are disseminated in the country rock, with small stringers of mineral also appearing along fractures. A number of fracture planes trend north to northeast, but the deposit has no defined walls.

The principal underground workings consist of two levels. The upper level, which was reached by a shaft and is now accessible by way of the stope, has been stoped out along its length. Beyond the north end of the stope the level continues to the north, with a crosscut to the east for 15 to 20 feet. The drift could not be examined, but the crosscut shows some copper minerals.

The lower level, 72 feet below the upper, is an adit about 600 feet long with several crosscuts driven to pick up the downward extension of the ore above. Although the zone does extend down to this level, it is sparsely mineralized. This level is connected with the one above by means of a raise.

An open-cut 200 feet northwest of the stope discloses considerable epidote and little disseminated magnetite and chalcopyrite. About 100 feet northeast of the stope, a trench has been driven across the general trend of the orebody. The rock here shows a little copper carbonate stain. Two hundred feet northeast from the stope, a cut 30 feet long has at one end a shaft that is caved 20 feet below the collar. The rock is cut by narrow stringers of magnetite, striking north 20 degrees east and dipping from 70 degrees southeast to vertical. Abundant epidote is developed along the

joint planes. The magnetite is accompanied by chalcopyrite and malachite. In another cut 150 feet southwest of the last the only mineral seen was a little malachite.

(29) Pothook Claim

References: B.C. Minister of Mines, Ann. Repts.: 1898, p. 1103; 1899, p. 730; 1906, p. 176.

The Pothook claim lies northwest of Sugarloaf Hill. It is a Crown-granted claim that has reverted to the Crown for taxes. On it a shaft has been sunk to a depth of 330 feet. According to provincial government reports there is a drift southerly for 40 feet at the 75-foot level, a drift southerly for 243 feet at the 150-foot level, and a drift southerly for 320 feet at the 240-foot level. At the bottom of the shaft a drift has been run for 84 feet. The country rock is fine-grained diorite.

On the east side of the shaft at the surface, a streak of well mineralized ore trends north 40 degrees east, and is 4 to 5 feet wide. West of it the rock has been shattered and carries some copper minerals. The mineral zone at the shaft is from 15 to 20 feet wide.

One hundred feet northeasterly from the shaft, an open-cut has been made on a shear zone striking nearly east, with a nearly vertical dip. Throughout the length of the cut the hanging-wall is shattered and impregnated with chalcopyrite and malachite. The zone appearing in the shaft apparently turns to intersect this zone. Bornite and chalcocite are reported to have been obtained from the workings.

(31) Iron Cap Claim

The Iron Cap Claim, which lies about half a mile northwest of the Iron Mask mine, is an old Crown grant that reverted to the Crown for taxes, and was leased by G. C. Scatchard. Several claims were staked around this, but these are now believed to have lapsed. The property was prospected under lease by D. B. Sterritt of Kamloops at intervals from 1937 to 1940, and small shipments of high-grade gold-copper ore were made. In 1938 a shipment of 36 tons assayed 0·44 ounce gold and 1·10 ounces silver a ton and 1·08 per cent copper. No shipping was done in 1939. In 1940, shipments of 222 tons had a gross value of $7,563.56. The total production of the property is 209 ounces of gold, 414 ounces of silver, and 9,462 pounds of copper from 263 tons of ore.

Very little can be seen of the mineral occurrence, as the stopes were carried to the surface. The deposit is apparently a mineralized shear zone, 6 feet wide, in monzonite of the Iron Mask batholith, and carries veins and stringers of chalcopyrite varying from a fraction of an inch to 4 or 5 inches wide. Narrow alteration zones of pink albitite appear in the monzonite and are associated with the ore. Very little quartz appears in the ore. Pyrite occurs in the wall-rock, but does not carry appreciable gold values. Veins of magnetite are reported to have cut the rock, but were not found to be directly associated with the ore. The zone was prospected on the surface by means of open-cuts, and found to run northwest and dip southwest.

A large cut was made at the shaft. Southeast of this, cuts were made for a distance of 80 feet, but, although rusty zones were found in the granitic rock, no ore was obtained. Northwest of the shaft, cuts found ore for about 90 feet. The ore found in these cuts is stoped out from the level below.

Beyond these cuts a dry gulch running northeast is probably along the fault found in the workings. A number of cuts made beyond this on rusty zones in the granitic rock have failed to disclose ore and, consequently, the extension of the shear zone beyond the fault has not been found.

The shaft follows the dip of the zone to a depth of 125 feet. Levels have been driven at 60 and 120 feet. The shaft is full of water below the 60-foot level, and the 60-foot level has been back filled with waste, so that these workings could not be examined. The 120-foot level is stated to be 35 feet long southeast of the shaft and 60 feet long northwest of it. It did not disclose much ore. A wedge of ore was followed up with a small stope but lost in a fault zone above the level.

The 60-foot level extends about 25 feet southeast of the shaft and 85 feet northwest, and was driven as far as the fault referred to. The ore above the level was stoped to the surface.

The gold content of the ore from this property is considerably higher than that of many properties associated with the Iron Mask batholith.

(34) Python Group

References: B.C. Miniser of Mines, Ann. Repts.: 1896, p. 566; 1897, p. 613; 1898, p. 1102; 1899, pp. 730, 731; 1900, p. 889; 1901, p. 1078; 1902, p. 191; 1908, p. 121; 1909, p. 139; 1910, p. 127; 1911, p. 181; 1913, pp. 189, 190; 1915, p. 215; 1916, p. 266.

The Python group, consisting of the Noonday, Python, Python No. 2, and Copper Head claims, includes the earliest claims staked on Coal Hill, some of the claims having been staked in 1896. The claims that were Crown granted have reverted to the Crown and are open for leasing. The Python group has produced 4,800 pounds of copper from about 30 tons of ore.

The workings on the property were found to be caved. According to Brewer, the Python shaft is 123 feet deep with drifts on the 56- and 110-foot levels. Sinking was discontinued because of excessive water encountered, and because the ore dipped away from the shaft to the southwest at 110 feet. At that depth, a crosscut 68 feet long was run and this showed the ore to consist of a stockwork of stringers and narrow veins in crushed country rock.

About 225 feet west of the shaft a mineralized area more than 40 feet wide showing copper oxides and carbonates has been prospected by an open-cut. This is stated to lie in volcanic rocks of the Nicola group. An adit 525 feet in length has been driven to crosscut this orebody. The face of this is about 190 feet vertically below the summit of the ridge and almost under the open-cut referred to. For 490 feet the adit parallels the cleavage planes of the rock, stated to resemble diorite, but at that point a well-defined fracture plane, striking about north 60 west, forms a foot-wall between the diorite and a mineralized stockwork that is exposed beyond this point. This stockwork is crosscut by the adit to the face, or for a distance of 60 feet. It is made up of stringers and impregnations, chiefly of copper carbonate but with some sulphides, in a gangue of crushed country rock and quartz cemented with calcite. The grade of the mass is evidently very low. The adit had not been driven to the southern or hanging-wall of the body.

On the Noonday claim a vertical shaft has been sunk to a depth of 75 feet (according to Brewer) on an outcrop of copper carbonates, apparently low grade. There are indications that this may be the extension of the orebody on the adjacent Lost Chord claim. A short distance down the shaft the ore dipped away, and the sinking was continued vertically, but no crosscutting had been done from the bottom of the shaft. It was later reported (1925) that some drifting had been done on the 50- and 100-foot levels and that encouraging results had been obtained from the former.

(33) Orphan Boy Group

References: B.C. Minister of Mines, Ann. Repts.: 1903, p. 180; 1904, p. 231; 1906, p. 176; 1907, p. 131.

The Orphan Boy group of four claims lies on Coal Hill west of the Python group and about 4 miles west of Kamloops. The ore is stated to occur in diorite, and consists of chalcopyrite disseminated across a width of about 20 feet, with streaks of solid mineral. A shaft 40 feet deep, with a crosscut at the bottom, and a number of open-cuts comprise the workings.

O. K. Group

References: B.C. Minister of Mines, Ann. Repts.: 1899, p. 731; 1904, p. 232; 1906, p. 176.

The O.K. group is situated midway between the Iron Mask and Python groups at the centre of Coal Hill, which is about 4 miles southwest of Kamloops. The rock in the vicinity is a medium-grained diorite to gabbro. The ore apparently occurs in bunches and streaks throughout the rock and is stated to be chiefly chalcopyrite carrying gold. There are stated to be two zones, the lower of which was believed to be the extension of the Iron Mask body. This is stated to have been opened by a shaft 85 feet deep with crosscut at 50 feet. The other zone has been opened by an adit, a shaft 20 feet deep, and surface cuts.

(37) Kimberley Group

References: B.C. Minister of Mines, Ann. Repts.: 1898, p. 1102; 1899, p. 730; 1900, p. 889; 1901, p. 1078; 1906, p. 177; 1908, p. 122; 1909, p. 139; 1913, p. 191.

The Kimberley group, consisting of the Kimberley, Charlotte, Last Chance, Morning Star, Occidental, Stemwinder, and Keystone Crown-granted claims, is situated near the southeastern extremity of Coal Hill. It is owned by Baroness Sartorio. The group has not been examined by the writer.

The deposit is stated by Brewer to consist of impregnations of iron pyrite in igneous rock. It is reported that there is no defined orebody, but simply small quantities of pyrite along cleavage planes in the rock with copper stains through the rock. Workings comprise a shallow shaft, an adit 200 feet long, and a long, deep open-cut.

(40) No. 7 Claim

Reference: B.C. Minister of Mines, Ann. Rept. 1906, p. 176.

The No. 7 claim, which lies near Jacko Lake, was Crown granted and has reverted to the Crown. A number of shallow cuts have been made on the property, but these have largely sloughed. They are reported to have disclosed a body of magnetite carrying copper minerals.

(41) Wheal Tamar (Kamloops Queen)

References: B.C. Minister of Mines, Ann. Repts.: 1899, p. 731; 1900, p. 889; 1901, p. 1078; 1904, p. 231; 1905, p. 195; 1906, pp. 174, 176; 1907, p. 131; 1908, p. 121; 1909, p. 140; 1910, pp. 127, 128; 1911, p. 181; 1913, pp. 190-1; 1916, p. 216.

The Wheal Tamar claim, formerly a Crown grant owned by O. S. Batchelor, has reverted to the Crown. It is situated in the Jacko Lake section about 2 miles south of the Python and the same distance southeast of the Evening Star.

The workings, which are now caved and inaccessible, consist of four shafts, an adit, and several shallow trenches. Brewer (1913) states that these are both crosscutting and along the line of strike of outcroppings of low-grade copper carbonate ore in surface gravel, and that no continuity could be demonstrated between the various exposures, although shafts Nos. 1, 2, and 4 may possibly indicate continuity along a northeast line. Shaft No. 1 was sunk 60 feet on an outcrop where carbonates were in the surface gravel; this could not be examined. Shaft No. 2 is situated southwest of No. 1 and is 50 feet deep sunk in country rock stained with carbonates and showing as well little mineral in the cleavage planes of the rock. Shaft No. 4, northeast of No. 1 shaft, is 18 feet deep, sunk in an outcrop of low-grade ore. Shaft No. 3 is 50 feet deep with a crosscut driven 50 feet northerly at the bottom, in which are exposed several stringers of ore from the thickness of a knife blade up to 12 inches. An adit has been driven into the base of the hill for about 100 feet. This is aimed to crosscut the formation under No. 1 shaft, at which point it will have 100 feet of backs, but an additional 100 feet is necessary to reach its objective. The portal of the adit was caved at the time of examination. Brewer states that all of the ore found was low grade, but that there was considerable evidence of mineralization at the surface and the probability of finding ore in fissures in the country rock. Some diamond drilling was done on the property, but the results of this are not known to the writer.

(45) Utopia Claim

The Utopia claim, situated about 6½ miles south of Kamloops west of the Brigade Lake road, was staked by T. Ray. No work has been done recently, and it is stated that the claim has lapsed.

The mineral deposits consist of shear zones in the Iron Mask diorite, carrying pyrite, chalcopyrite, malachite, and azurite. Quartz is sparingly present.

The showings lie on a moderately steep hill sloping down to the road. The lowest consists of a mineralized shear zone exposed in a shaft 10 feet deep. The zone strikes north 20 degrees east, dips 80 degrees northwest,

and is about 8½ feet wide, but includes several horses of unsheared rock. The shear carries small stringers of albitite. Pyrite is the chief sulphide, with a little chalcopyrite and copper carbonates. Assays from this showing reported to the writer show a maximum of 0·04 ounce of gold a ton.

Four hundred feet easterly from this shaft an open-cut has been dug, with a short adit at its southwestern end. The cut is 60 feet long and the adit 20 feet. The workings follow a sheared zone striking north 10 degrees west and dipping 75 degrees southwest. It is about a foot wide in the cut with very heavy sulphide mineralization in the wall of the adit. The width of this cannot be seen. G. Dickson reported that he shipped some ore from this working, and that the best gold assays obtained ran $21 a ton.

One hundred and twenty-five feet northerly along the strike another pit shows a shear zone, possibly the same as the last but striking north 50 degrees east. This is not so heavily pyritized, but contains considerable magnetite.

Three hundred and twenty-five feet farther north, two pits show what is presumed to be the same zone striking north 30 degrees east. It shows 18 inches of leached and iron-stained rock with pyrite and copper carbonates. Some albite appears in the sheared rock.

(46) Dewey Group

References: B.C. Minister of Mines, Ann. Repts.: 1898, p. 1103; 1899, p. 731; 1901, p. 1078; 1904, p. 230.

The Dewey group, consisting of three claims, the Dewey, Black Beauty, and Cyclone, is situated alongside the Brigade Lake road, about 6 miles south of Kamloops. The claims were formerly Crown granted, but have reverted to the Crown.

The writer found the workings to be inaccessible. An adit reported to be 85 feet long was caved at the portal, and a shallow shaft was partly filled with water, with the upper part of the shaft tightly lagged. According to the reports of the British Columbia Minister of Mines, there is a vein 3 to 4 feet wide mineralized with chalcopyrite, and carrying low values in gold.

From the material on the dump it is judged that the wall-rock is diorite and that the ore carries a little quartz, chalcopyrite, and azurite and malachite. No outcrops were seen in the vicinity of the workings. A sample of picked ore is stated to have assayed 0·08 ounce of gold and 0·4 ounce of silver a ton.

(44) Fargo Group

The Fargo group, which lies 6½ miles south of Kamloops near Edith Lake, was staked and prospected by C. H. King and L. G. Smith. A shipment of one carload of ore running about 2 per cent copper and 0·06 ounce of gold a ton is reported to have been made. No work has been done recently, and it is believed that the claims have been allowed to lapse. The showings consist of veins in the Iron Mask diorite. These carry copper minerals.

The principal showing is at an inclined shaft stated to be 30 feet deep with a drift to the north at the bottom. These workings are inaccessible because of water in the shaft. The vein strikes north 10 degrees west and dips 75 degrees to the west. It ranges up to 5 feet in width at the collar, tapers to a foot, and then swells again to 5 feet. The best mineralized part is a band a foot wide along the hanging-wall, which contains considerable chalcopyrite. Below this is about 12 inches of more sparsely mineralized material carrying considerable malachite and azurite. The wider part of the vein could not be reached for close examination. Ten feet below the surface the heavily mineralized streak is leached, and the mineral is largely limonite and carbonates. This vein has been traced only 20 feet south and 10 feet north from the shaft by stripping, and both strippings are now sloughed.

Another shaft has been sunk at a point 150 feet southwest of the other. This is inaccessible as there is no ladderway. It has been sunk 20 feet on a vertical vein that is 14 inches wide at the collar and appears to widen near the bottom of the shaft. It also strikes north 10 degrees west. Three pits have been put in at distances of 90, 145, and 185 feet northerly along the strike. Two of them have not reached bedrock and the third is sloughed. It is not known if this encountered the vein.

(47) Grey Mask Group

The Grey Mask group is situated about 7 miles south of Kamloops near Separation Lake, and adjacent to the Merritt highway. It was staked by Joe Surina. Work on the claims has been abandoned, and they are now believed to be lapsed.

The deposit is apparently a mineralized zone in diorite carrying magnetite, chalcopyrite, a little quartz, calcite, and copper carbonates. Some high assays in gold were obtained by Surina.

The principal working is a shaft stated to be 28 feet deep, with a drift 40 feet to the south at the bottom. This working is inaccessible, but some of the mineral matter obtained from it may be seen. Similar material was found in a well 140 feet to the southwest and between the two is an open cut now filled in. No outcrops were observed in the vicinity.

(35) Sugarloaf Hill

Several workings were found near the east end of Sugarloaf Hill. It was reported to the writer that these were made by O. S. Batchelor, and that the claims on which they lie are now lapsed. The names of the claims were not ascertained.

The easternmost working is an inclined shaft about 50 feet deep. It follows a shattered zone about 4 feet wide in diorite striking north 30 degrees east and dipping 75 degrees southeast. The brecciated rock carries sparsely disseminated pyrite and chalcopyrite. Heavy sulphide was apparently encountered in sinking the shaft, as some of it is piled on the dump, but similar material was not seen in place. Only the upper part of the shaft could be examined. In places the diorite is altered to albitite.

A second shaft 1,000 feet northwest is about 30 feet deep, but could not be examined closely because of the condition of the ladderway. It is sunk on a shattered zone in diorite, with small bands of albitite, and the wall-rock shows considerable alteration to epidote. The zone is mineralized with pyrite, chalcopyrite, and a little quartz.

About 150 feet farther northwest, a pit has been sunk on a shattered zone striking northwest. This is 6 to 8 feet wide, but includes a central horse of relatively unaltered rock. Irregular bands of pyrite and chalcopyrite appear in the shattered rock. These range from an inch or two to 8 or 10 inches in width, and show copper carbonate stains. The rock southeast of the cut contains many thin bands of albitite and narrow quartz veins, with a small amount of pyrite, chalcopyrite, and malachite. About 75 feet northwest, and possibly 50 feet lower, a short adit was run towards this zone. It apparently did not reach its objective as no mineralized material was seen on the dump. One hundred and fifteen feet northwest and a little farther downhill is a second adit partly caved at the portal. This was not examined, but apparently encountered some heavy sulphide mineralization.

Copper Deposits of the Highland Valley Camp

Copper deposits occur in the batholithic rocks that border Guichon Creek on the west. They appear to be related in their general characters to those of the Highland Valley camp, which is underlain by the same batholithic rocks and lies partly in and partly to the west of the map-area. The Snowstorm group is the principal representative of the Highland Valley deposits that occurs within the limits of the map-area.

The deposits consist of veins and disseminations of copper minerals in the granitic rocks, and in the case of the Snowstorm mine the disseminations occur over wide areas. Bornite, chalcopyrite, and chalcocite, together with the carbonates, malachite and azurite, are the chief copper minerals. Molybdenite is fairly common, and small amounts of scheelite have been reported from the drill cores at the Snowstorm mine. Quartz, calcite, specular hematite, and, in one case at least, tourmaline, form the gangue minerals. Tourmaline and hematite are also characteristic of the other Highland Valley deposits (Stevenson, 1939, pp. 127-133).

Wall-rock alteration was studied at only one property, namely the Snowstorm. Here the rock consists of a grey quartz diorite containing considerable sericite, chlorite, and epidote, and in some places secondary quartz. The feldspar is in many places highly altered to kaolin, but deuteric albite appears to be uncommon, thus differing from the wall-rock alteration found at many of the copper properties in and around the Iron Mask batholith. Earlier reports have mentioned the association of the mineralization with dark basaltic dykes (B.C. Minister of Mines, 1919). One specimen of rock, believed to be of this type, was examined and proved to be composed almost entirely of secondary minerals, quartz, chlorite, sericite, and epidote. The quartz occurs as interlocking grains that are presumably deuteric; chlorite, the next in abundance, occurs in irregular masses throughout the rock and lends the rock its greenish colour. The

sericite in part outlines what were originally feldspar crystals, which are of about the same size as those occurring in the unaltered diorite. The epidote occurs as grains and as veins traversing the rock. Magnetite and bornite occur as disseminated grains. Where seen by the writer this rock did not exhibit the tabular characteristics of a dyke, and it is believed that it may be the alteration product of the granitic rock.

Another altered phase was found to consist of a light-coloured, kaolinized rock. Under the microscope the feldspars of this rock were seen to be largely altered to kaolin, with a little sericite and much epidote in masses. The rock carried considerable quartz and a little chlorite. It is veined with bornite, and carries disseminated chalcopyrite and much molybdenite.

The bodies of disseminated ore minerals are associated with fracturing of the rock. The ore minerals occur in narrow, discontinuous seams, along which the rock is altered for varying widths, to a mass of quartz, sericite, epidote, and chlorite. Among the ore minerals are bornite and chalcopyrite, but near the surface malachite is by far the most common.

The fresher rocks in the general vicinity of the ore deposits show some alteration of the feldspars to sericite and kaolin, and much of the biotite is altered to chlorite.

(51) Snowstorm Group (Windy Pass, Tunnel, and Cu Groups)

References: B.C. Minister of Mines, Ann. Repts.: 1901, p. 1090 (Last Chance); 1907, p. 137; 1914, p. 362; 1915, pp. 259, 270, 446; 1916, pp. 265, 518; 1917, p. 223; 1918, p. 238; 1919, p. 181; 1920, p. 168; 1923, pp. 150, 159; 1924, p. 149; 1929, p. 237. Drysdale, C. W.: Geol. Surv., Canada, Sum. Rept. 1915, pp. 87-88.

The Snowstorm group, now known as the Windy Pass, Tunnel, and Cu groups, is a re-staking of the former claims. The present holdings consist of twenty-four claims owned by Butalma Mines, Limited, of Vancouver, and Anyox Metals of Vancouver. They are situated on the eastern slope of Forge Mountain to the north of Witches Brook, near the western edge of the map-area. The main showings occur at elevations of from 4,000 to 5,300 feet. The property was re-staked by C. H. Allen in 1937 to cover the Snowstorm group, which consisted of twenty-three surveyed claims and fractions. The group itself was staked in 1905, and was a relocation of former claims such as the Last Chance claim and the Ball group (Handball, Football, etc.). The Snowstorm group was developed by a shaft and a small amount of drifting on the Snowstorm claim, and during 1915 and 1916 a shipment of 96 tons of ore was made. This assayed from 27 to 31·64 per cent copper, from 0·7 to 0·10 ounce of gold a ton, and from 5·08 to 6·77 ounces of silver a ton. Brewer (1916) lists an additional shipment of 40·5 tons that assayed: gold, nil; silver, 11·52 ounces a ton; and copper, 23·71 per cent. Figures supplied by the Department of Mines at Victoria show a total production of 8 ounces of gold, 789 ounces of silver, and 76,754 pounds of copper.

In 1919 diamond drilling was done by the British Columbia Department of Mines on the Snowstorm and Orkney claims, and this was followed

by the driving of a 280-foot adit and much open-cutting on the Iona claim in preparation for diamond drilling. Operations ceased in 1921, and the claims subsequently lapsed. They were re-staked in 1937, and in 1940 the workings were cleaned out and the Snowstorm shaft sunk a few feet. In 1942, the property was optioned to Ventures, Limited, and Anyox Metals at which time some new claims were staked. Diamond drilling was carried out to explore the Iona showing and also a showing on the Jersey and Guernsey claims. In the plan (Figures 12, 13) the former

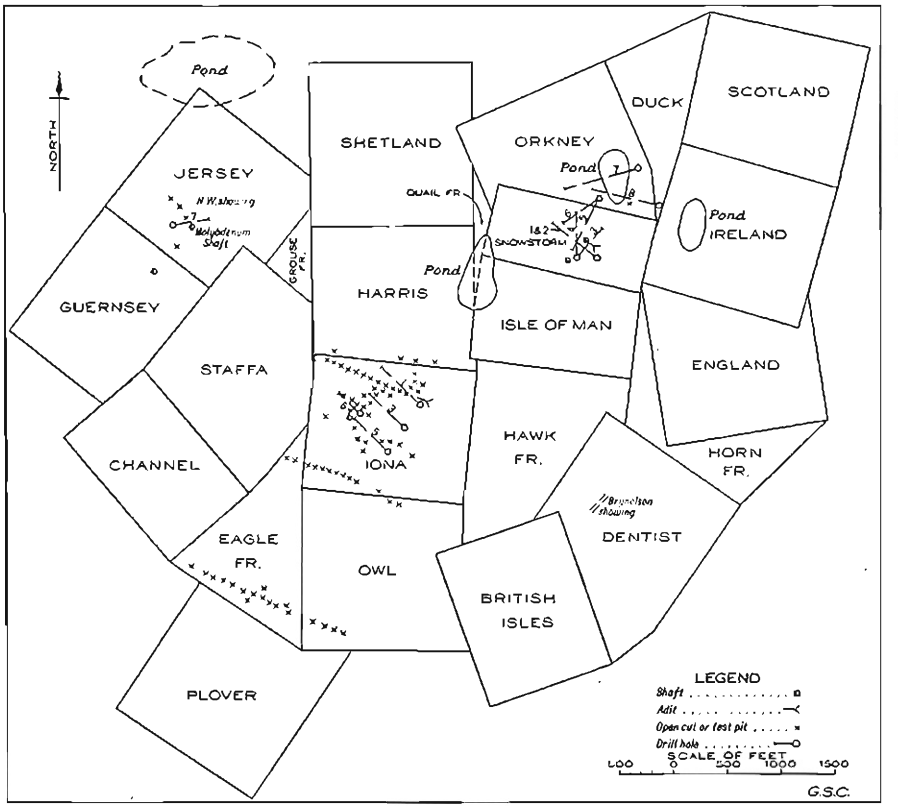


Figure 12. Snowstorm group, Highland Valley, showing claim boundaries, positions of surface workings, and drill-holes.

claim lines, which were surveyed, are shown, and the names of these claims are used in the accompanying description. The new claims in part follow the old claim lines with new names being given, but a new survey has not yet been made.

The claims are situated high on the ridge of Forge Mountain, which lies near the western border of the map-area north of Witches Brook. At the summit of the ridge are a number of rocky knolls separated by draws

covered with drift and holding swamps or small ponds. The claims extend down the southern slope of the ridge where only a small fraction of the area exposes bedrock, the remainder of the slope being covered with glacial debris and rock slides.

The mineral deposits lie within a large mass of granodiorite and quartz diorite that borders Guichon Creek on the west and extends beyond the border of the map-area. They are of two types, namely, fissure veins and large disseminations of copper minerals in the country rock.

The Snowstorm workings (*See* Figure 13) consist of a shaft 50 feet deep sunk on a lode, with an adit driven 70 feet to connect with the bottom of the shaft. Drifts have been run on the lode for about 30 feet northeast and southwest of the adit. In the northeast drift a winze has been sunk on the lode 56 feet. The lode strikes from north 45 to north 65 degrees east, dips 75 degrees southeast, and varies from about 6 inches to nearly 4 feet in width. The better parts of the lode above the drift level have been stoped out. At the southwest face it is 14 inches wide, with stringers along the hanging- and foot-walls and with the intervening rock showing fractures carrying bornite and copper carbonates. At the northeast face the lode is 12 inches wide, with shattered country rock containing copper minerals. The present faces show only low-grade ore. At a depth of 47 feet in the winze, the lode is stated to have pinched to a stringer and at the bottom to be a quartz vein in granitic rock carrying bornite and chalcopyrite. Where intersected on the adit level the lode is in a dark altered rock that has been described as a basaltic dyke, but apparently passes into altered granitic rock. Similar rock is found in the foot-wall of a mineral showing some 560 feet northeast of the shaft. Reference has already been made to the examination of a specimen of this rock. Those occurrences seen by the writer appeared to lack the tabular form of dykes, and the rock is believed to represent alterations of the granitic rock.

At the surface a series of cuts around the shaft have now sloughed. About 300 feet southwest of the shaft approximately along the strike of the lode, a second shaft has been sunk and from it an excavation 10 to 15 feet long has been stoped to the surface. The shaft is about 20 feet deep, but is now partly caved. The main lode is from 15 to 36 inches wide, and consists of a stringer on the hanging-wall and one on the foot-wall with fractured rock carrying copper minerals between, but the richest ore is in these stringers. A vein, with a strike of north 70 degrees west and about 5 inches wide, intersects the lode in the shaft. Drysdale gives the dimensions of the ore shoot from which the ore was mined as a pitch length of 125 feet and a stope length of 75 feet at a point 65 feet below the collar of the shaft, and a reported stope length of 15 to 20 feet at the bottom of the winze.

About 560 feet northeast of the main workings a cut on the Orkney claim exposes a lode striking north 55 degrees east and dipping 50 degrees southeast. The central part of the zone is 40 inches wide, and is heavily mineralized with bornite, chalcopyrite, azurite, and malachite. The wall-rock is fractured and lightly sheared over a width of 10 feet, and carries considerable copper mineral in the narrow fractures. The ore is partly in the altered rock referred to above.

Eight holes were drilled on the Snowstorm and Orkney claims by the British Columbia Department of Mines in 1919. The location of these holes is shown in Figure 13, and the general results are discussed in the Annual Report for 1919. The available records of this drilling were kindly furnished the writer by the provincial department. They show 5,452 feet of drilling. Holes 1 and 2 were put down to test the continuity of the lode in the Snowstorm workings. No positive results were obtained and the writer has no assays available for these holes.

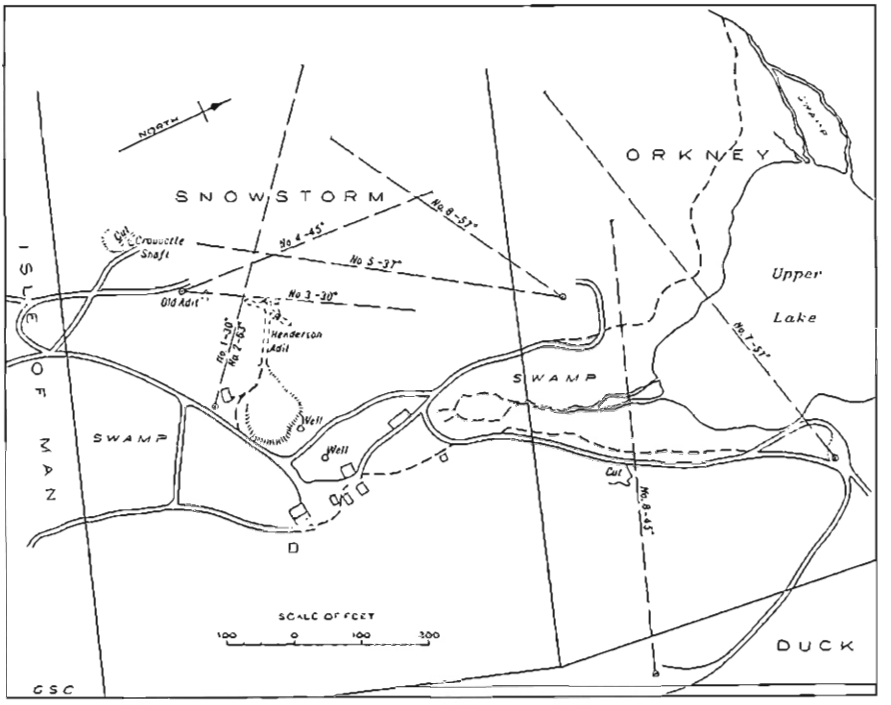


Figure 13. Snowstorm and adjoining claims, Highland Valley, showing workings and drill-holes.

Holes Nos. 3 to 6 were put down to explore the area northwest of this vein, and Nos. 7 and 8 to explore the country northeast of the intersections obtained in holes 3 to 6. The holes encountered three types of rock, namely, the quartz diorite, a rock described by J. A. Dresser as an altered basaltic rock, and a rock described as a hornblende porphyry approaching hornblende porphyrite in composition. It is stated that the latter two rocks are not much in evidence at the surface, and it is probable that they are basic phases of the granitic rock. In nearly every instance copper mineralization is shown in the log to be associated with one or other of these rocks, but the hornblende porphyry is stated not to occur in contact with the "basaltic dykes" in the bore-holes.

The following table gives a condensed log of holes 3 to 8, showing the principal ore intersections:

Footage in bore-hole	Length orebody in drill-hole	Length core recovered	Copper	Remarks
	Feet	Feet	Per cent	
Hole 3–30°				
214–225	11	1·16	0·22	
240–246	6	0·5	1·14	
271–276	5	4·0	0·65	
276–282	6	2·33	Trace to nil	
344–348	4	2·0		
Hole 4–45°				
167–188	21	9·5	0·32	
355–362	7	4·0	1·30	Check 4·2
437–452	15	10·0	0·50	
458–482	24	14	0·10	
515–542	27	14	0·47	Check 0·10
Hole 5–37°				
100–105	5	3·5	0·7	
155·5–160	4·5	4·5	0·3	Check 1·7
464–483	19·0	14	Nil	
511–514	3	3	2·1	
Hole 6–57°				
382–383	1	0·91	0·2	
485–486	1	1·0	1·6	
717–740	23	10	0·57	
Hole 7–51°				
69–80	11	2·75	3·37	
340–358	16	12·5	0·40	
633–651	28	.....	3·05	Check 0·16
1,011–1,014	3	2·0	2·5	
1,035–1,043	8	5·0	0·3	
Hole 8–45°				
199–207	8	3	2·70	
239–241	2	2	2·67	
396–400	4	2	2·40	
472–476	4	4	1·00	
503–521	18	10	1·80	

This table shows that ore of commercial grade was found at a number of points, but the drilling done does not prove the continuity of the veins or zones. If an attempt be made to group these showings in the holes and to include with them the intervening barren rock so that the whole would form areas of low-grade mineralization, it will be seen that the resulting grade is in general too low to be commercial.

Iona Deposit. The Iona deposit is about 2,000 feet southwest of the Snowstorm workings. It consists of scattered mineralization in shattered granitic rock, and is exposed by numerous cuts and trenches, by an adit, and by several shafts (*See* Figure 12).

The area in which the showing occurs is for the most part covered with drift, and many of the cuts and trenches are sloughed, so that little information can be obtained from them. Most of these cuts show copper minerals in the material on the dump. Copper shows in all of the cuts extending on a line northwestward from the Iona adit and in most of the

cuts to the south of these. An average of assays from these cuts, excluding those that cross the southwest corner of the Iona claim and those crossing the Owl and Eagle fraction, for which the writer has no returns, is nearly 1 per cent copper. A shaft sunk 420 feet southwest of the Iona adit to a depth of 40 feet showed an average content of 1·70 per cent copper weighted according to depths represented by the samples. It may be stated that the cuts do not show the outlines of an orebody, but the best mineralized material appears to lie within an area about 800 feet long and some 630 feet wide measured westerly from the 50-foot mark in the Iona adit. In the Iona adit itself, the sampling by the British Columbia Department of Mines gives the following results:

Distance from portal Feet	Copper Average percentage
0–50	0·25
50–105	0·85
105–140	1·32
140–205	0·48
205–225	Trace
225–250	0·8
250–280	0·43
50–250	0·72
0–280	0·64

The rock in the adit is highly fractured, and the ore minerals, chiefly malachite, are deposited along the joint and fracture planes; a little bornite and chalcopyrite are present. One set of fractures runs northeast and dips southeast, another set trends northwest and dips southwest. The northeasterly fractures are parallel with the direction of faulting shown by the lodes of the Snowstorm mine, and the northwesterly fissures are also parallel with a direction of faulting. Both sets of fractures appear to be joint planes with relatively little movement. Along these the rock shows the development of sericite, kaolin, quartz, and epidote, the result of hydrothermal alteration.

Drilling was carried on by Ventures, Limited, beneath the Iona showing. Three holes were drilled on a line running southwest from the Iona adit, and a fourth was drilled somewhat farther west. The results indicated values considerably less than those obtained in the adit and surface cuts. The holes indicated, too, that malachite extended to a depth of more than 300 feet. The drilling reached a vertical depth of about 400 feet, but did not appear to encounter better values below the zone of oxidation.

A zone lying to the northwest of the Iona zone on the Jersey and Guernsey claims has also been investigated. A shaft known as the Molybdenum shaft has been sunk 20 feet on a northwesterly striking and northeasterly dipping vein, and several cuts in the vicinity disclose a shattered zone with molybdenite and chalcopyrite scattered through the rock in fair quantities and also occurring in the fractures. Copper mineralization has been traced northwest for a distance of about 350 feet from the shaft by several open-cuts, and has also been traced southwest for a distance of 550 feet to an old shaft that is caved. The limits of the mineralized area are not, however, outlined by the cuts and by the outcrops of rock occurring in the vicinity. Many of the cuts show only low-grade mineralization. A single drill-hole was run northeasterly under the

Molybdenum shaft and the values obtained were considerably higher than was the case in the Iona deposit. More work is required to outline this showing and arrive at its probable value.

Another showing, known as the Brynelson, lies some 1,800 feet southeast of the Iona adit. Here the zone consists of narrow parallel stringers of bornite along a zone striking north 35 degrees east and dipping 85 degrees southeast. The zone is about 12 feet wide, and has not been traced along the strike.

(55) Aberdeen

References: B.C. Minister of Mines, Ann. Repts.: 1897, p. 615; 1899, p. 734; 1900, p. 892; 1901, p. 1081; 1902, p. 193; 1903, p. 181; 1904, p. 234; 1905, p. 204; 1906, p. 179; 1915, pp. 232-3; 1916, p. 263; 1917, p. 233; 1923, p. 162; 1925, p. 182; 1926, p. 199; 1928, p. 223.

The Aberdeen mine is situated near Broom Creek, a tributary entering Guichon Creek about 10 miles from Nicola River. The showings of this camp were discovered about 1897, and early development was done by the Broomhead Syndicate. Small shipments of ore were made. The property was apparently idle in the period between 1906 and 1916. However, the property is reported to have shipped 1,400 tons of 7 per cent copper ore in 1916 and a "fair tonnage of excellent grade ore" in 1917. The property was closed down in 1917, and was idle until 1925 when it was unwatered and some more ore shipped. In 1928, it was reopened by Aberdeen Mines (1928), Limited, and some development work done. Figures supplied by the British Columbia Department of Mines show that the Aberdeen mine produced 1,809 tons of ore yielding 9 ounces of gold, 761 ounces of silver, and 391,381 pounds of copper.

The mine is opened by a vertical shaft from which levels have been run at depths of 50, 100, 150, and 200 feet. Several of these levels are stated to be 400 feet long. The workings are now inaccessible, and the property was not visited by the writer.

The rocks are not well exposed in the vicinity of the mine, but consist of granitic rocks with abundant inclusions of dark altered rock. The Aberdeen deposit itself is reported to lie along an inclusion of greenstone between two joint planes in granite striking north 60 degrees west. The ore is said to occur in a fracture zone in the greenstone, the deposit being characterized by lenses and pockets of chalcocite to a depth of 100 feet below the surface. According to the 1925 report the bottom level disclosed some lenses and seams of high-grade copper ore, but these are narrow and scattered. The mineralization (1928) is reported to be represented by sporadic inclusions of native copper in a gangue of tourmaline, quartz, and hematite.

(52) Clarke Claims

(Gnawed Mountain)

A group of claims has been staked at the summit of Gnawed Mountain. These were apparently staked by K. W., T. E., and W. S. Clarke, but it seems probable that the claims have lapsed.

The rock in the vicinity is granite with numerous veins of quartz and dykes of aplite, and exhibiting considerable variation in grain size. Associated with it are dark basic "dykes" or inclusions of intruded rock.

A shaft on the property is flooded to within 4 feet of the collar. The dump contains material mineralized with bornite, molybdenite, hematite, chalcopyrite, malachite, azurite, covellite, quartz, and calcite. The minerals are generally in quartz veins in pegmatitic granite or grey quartz diorite, but in some cases molybdenite occurs as stringers of pure mineral in the wall-rock.

About ¼ mile southeast, another shaft, 8 feet deep, has been sunk on a quartz vein 2 to 3 feet wide striking north 80 degrees east and dipping vertically. The chief mineral is molybdenite, associated with some bornite, malachite, limonite, and a yellow molybdite bloom. The country rock is biotite granodiorite.

(65) Eric Claim

The Eric claim, stated to be owned by H. Stumbles, was visited in 1939. Workings on the claim show copper mineralization associated with basic segregations or inclusions in quartz diorite. The relations of these basic rocks are not very well shown in the surface workings.

At the main showing, a deep cut about 10 feet long shows a fault zone striking north 65 to 70 degrees east and dipping 65 degrees northwest. The rock is strongly jointed in a northwesterly direction, and is impregnated with epidote, specular hematite, magnetite, chalcopyrite, and copper carbonates. A cut 250 feet southwest of this showed a stringer of specular hematite in a serpentine inclusion in the diorite. This stringer is 3 inches wide and strikes north 30 degrees east. Several cuts between this and the main showing were sloughed, so that bedrock could not be seen.

North 20 degrees east from the main showing, four cuts have been made within a distance of 200 feet. These have just reached bedrock and do not afford additional information.

Vimy Ridge

References: B.C. Minister of Mines, Ann. Repts.: 1923, pp. 161-2; 1925, p. 183.

The Vimy Ridge property is situated 14 miles up Guichon Creek and about 1½ miles from the Aberdeen mine (55). It was not visited by the writer.

The mineral deposit is stated to be a wide shear zone carrying copper minerals. A shaft has been sunk 155 feet, with a crosscut to the zone at the bottom. This disclosed decomposed, talcose rock with seams and kidneys of bornite. An open-cut about 100 yards north of the shaft shows much copper carbonate.

Black Bluff

Reference: B.C. Minister of Mines, Ann. Rept. 1915, p. 234.

This property, which was not seen by the writer, is situated on Dupuis Creek about 2 miles west of the north end of Mamit Lake. On it a sheared zone in granite carries copper minerals and molybdenite.

Other Copper Properties

A number of other copper properties occur at widely separated parts of the map-area. Many of these are in the volcanic rocks of the Nicola group, and several in younger volcanic rocks. The deposits are grouped for purposes of description.

(67) Copper Belle

Reference: B.C. Minister of Mines, Ann. Rept. 1915, pp. 230-1.

The Copper Belle group consists of four claims, the Copper Belle, Blue Belle, Farewell, and Copper Crown, situated on the south side of Nicola River about 3 miles west of Merritt and about 100 feet in elevation above the river. The workings seen by the writer were sloughed, and the following descriptions are taken from the above reference.

The group is stated to have been worked in 1908, when some shipments were made to the Trail smelter. The property was later acquired by Robert Henderson and partners of Merritt, who made a shipment of 47 tons of sorted ore to Tacoma smelter in 1913. This assayed 7·15 per cent copper.

The orebody is stated to strike nearly east and dip 20 degrees to the south. It consists of quartz mineralized with specular hematite, chalcopyrite, copper carbonates, and calcite. The mineralized outcrops occur as lenses in altered volcanic rocks. The extent of the mineralization is not known, as insufficient work has been done at any one place to determine its continuity to a greater depth than about 20 feet on the slope. The width varies from a few inches to 2 feet, and the length of the various lenses also varies from a few feet to about 30 feet.

All of the development on the Copper Belle has been by open-cuts, some of which have been extended by underhand stoping into shallow shafts from which the ore shipped was mined. More or less ore is exposed in each of these openings and on small dumps, but no systematic development has been carried out.

"One sample was taken from the deepest of these workings, which represents about the grade of shipping ore that could be hand-sorted without much difficulty. This assayed: gold, trace; silver, 1·2 ounces; copper, 6·8 per cent."

On the Farewell and Copper Crown mineral claims, near the eastern end of the group, some attempts have been made to prospect the ground systematically, and an adit has been driven for 30 feet on the Farewell claim. It exposes bunches of specular hematite with a little chalcopyrite and pyrite in an altered volcanic rock.

(67A) Anaconda Group

Reference: B.C. Minister of Mines, Ann. Rept. 1915, p. 231.

The Anaconda group adjoins the Copper Belle group on the east and consists of three claims, the Anaconda, Star, and Sentinel, owned by Robert Henderson and partners, Merritt, B.C. The claims in this group are staked from north to south, with the Anaconda at the north end of the group.

The workings seen by the writer were found to be caved, and the following description is taken from the above reference. The locations were made along a ridge composed of volcanic rocks in which occurs a ledge of specular hematite. A shallow shaft at a depth of about 10 feet exposes specular hematite, with apparently no other mineral content.

About 60 feet below the shaft and at a point about 100 feet east of it, an adit has been driven 30 feet, exposing bunches of specular hematite in altered volcanic rock.

Another adit driven about 50 feet to crosscut the rock formation shows no evidence of any mineralization in the rock.

Iron Mountain

A number of narrow veins occur in the volcanic rocks of the Nicola group near the summit of Iron Mountain southwest of Merritt. These show bunches of specular hematite, chalcopyrite, and pyrite, with some malachite and azurite. Several shallow shafts have been sunk on the showings, but there was no evidence of recent work, and so far as is known the claims had lapsed at the time of the writer's visit.

(54) Dupont, Windsor, and Lost (Bertha and Molly?)

References: B.C. Minister of Mines, Ann. Repts.: 1929, p. 228; 1930, p. 195.

The Dupont, Windsor, and Lost claims are situated near Meadow Creek about 3½ miles south of a point on the Kamloops-Mamit Lake road, distant 35 miles from Kamloops. The property was not seen by the writer, but may be a re-staking of claims formerly known as the Bertha and Molly. The following description of those claims is taken from the above references.

The country rock in this area is traversed by a zone of fracturing trending east. At the western end of the claims a shaft, stated to be 75 feet deep, was sunk many years ago at a point where cuprite appears in the fractures. A Kamloops syndicate, known as Meadow Creek Mines, was formed to continue development at this point, but work was devoted to gouging out some ore around the collar of the shaft for shipping. In the course of this work the shaft was filled to within a few feet of the top. About 5 tons of ore that would stand the cost of shipping was obtained.

At about 1,500 feet west of the shaft, a series of open-cuts has been made on the side of a westerly sloping hill. The same indications of fracturing and sparse mineralization are found.

(53) Ford Group

Reference: B.C. Minister of Mines, Ann. Rept. 1929, p. 228.

The Ford group is situated on Meadow Creek bordering the road from Kamloops to Mamit Lake at a distance of 32 miles from Kamloops. A large open-cut was made in a small bluff of porphyry containing disseminated copper minerals. The property was relocated by Meadow Creek Mines, and some further work was done in an attempt to trace the mineralization shown in the open-cut. Some ore was obtained in these operations, and a shipment of 30 tons was made of this and of the material previously accumulated on the dump. The shipment gave returns of: gold, trace; silver, 0·3 ounce a ton; copper, 2·14 per cent. The claims are now reported to have lapsed.

(16) North Star Group (Maxine)

References: B.C. Minister of Mines, Ann. Repts.: 1910, p. 129; 1913, pp. 194-5; 1915, p. 216; 1918, p. 236.

The North Star group of eight claims is in part at least a re-staking of the former Maxine group, which had reverted to the Crown. The present owners are Messrs. N. Smith, Louis Pelezon, W. J. Moffatt, and Mrs. Moffatt of Kamloops. The group is situated on the north side of Kamloops Lake in the vicinity of Frederick siding about 14 miles west of Kamloops. A branch road from the Kamloops-Red Lake road makes it possible to drive to the property. The mineral showings are roughly ¼ mile back from the lake shore and about 500 feet above it.

Showings of native copper, chalcocite, bornite, and carbonates occur disseminated in the country rock, chiefly along northerly trending lodes. Some of the lodes carry calcite, but quartz is not abundant. The Maxine has produced 1 ounce of gold, 37 ounces of silver, and 6,705 pounds of copper from 33 tons of ore. The principal showings are along a gulch that descends to the lake, and the workings comprise three adits and several open-cuts. A quarter of a mile farther east are two short adits and some cuts, and about 1,000 feet west from the principal showings a shaft, now caved, has been sunk.

At the uppermost of the three adits, an open-cut 50 feet long communicates with the adit, which was driven north 15 degrees east for 55 feet. The adit follows a lode striking north 10 degrees east and dipping 85 degrees southeast. Along this lode the rock is shattered and carries copper minerals across a width of 5 to 6 feet. The most heavily mineralized streak is along the main fracture and is 3 inches to 1 foot wide. Its contacts on either side are indefinite.

The second adit is 100 feet southwest of the upper adit and about 30 feet lower. It has been driven 40 feet easterly to intersect a lode along which drifts have been run 10 feet to the south and 50 feet to the north. At the north face is a 10-foot crosscut to the east. The lode averages 8 to 10 inches wide, but narrows to 2 inches at the face. It dips 85 degrees west, and may be the lode disclosed in the upper adit.

The third adit is 75 feet southwest of the second and about 70 feet lower. It is run easterly 90 feet and then northerly along a lode. A winze has been sunk 22 feet at the intersection, but is full of water. Good ore has been reported from this winze. South of it, a drift has been run on the lode but this is blocked with debris. North of the winze a stope 8 feet long and 4 feet wide was driven into the back at a low angle. The walls of the orebody, at this stope, are not well defined. About 40 feet north of the winze, a second winze has been sunk 16 feet. This is also full of water. At this point a crosscut has been driven easterly, but is full of debris. The drift continues 10 feet beyond the winze, but is also full of debris. Here the lode is about 16 inches wide, with copper minerals occurring in the walls as well. Chalcocite is reported from this showing, but was not seen underground, although abundant in a pile of ore on the dump. The ore minerals consist of pyrite, chalcopyrite, bornite, chalcocite, azurite and malachite, and native copper, associated with a little calcite and quartz.

About 75 feet northwest of the third adit, an open-cut has been started on a sheared zone in the volcanic rocks. No defined walls were observed. The zone is heavily stained with hematite and a little copper carbonate.

About 1,000 feet northwest of the upper adit is a shaft, now caved at the collar, but apparently sunk on a fracture zone striking north 20 degrees west and dipping steeply southwest. The zone shows considerable copper carbonate.

About 1,500 feet slightly south of east from the upper adit, there is an open-cut now largely sloughed. The rock carries small masses of bornite and pyrite disseminated through it. One hundred feet southeast of this cut an adit 5 feet long has been driven on a lode striking north 60 degrees northeast. This shows a stringer about 1 inch wide containing copper minerals. Other stringers nearly parallel in direction, but dipping at different angles, carry calcite and occasional small bunches of copper minerals. Fifty feet southeast of the adit, a second adit has been driven 15 feet to meet a lode striking north 35 degrees west and dipping nearly vertically. This shows considerable gouge, with thin stringers of calcite and malachite.

Between these workings and the main group is a group of cuts now largely sloughed. These show considerable alteration of the rock to epidote with thin stringers of quartz, calcite, and malachite.

(13) Tenderfoot Claim

References: B.C. Minister of Mines, Ann. Repts.: 1895, p. 696; 1898, p. 1105; 1899, p. 738; 1901, p. 891; 1902, p. 191; 1909, p. 141; 1910, p. 129; 1913, p. 192; 1918, p. 236; 1919, p. 179; 1920, pp. 193-4. Dawson, G. M.: Report on the Area of the Kamloops Map-sheet; Geol. Surv., Canada, Ann. Rept. 1894, vol. VII, p. 343B.

The Tenderfoot Crown-granted claim, owned by K. R. Rosseau of Vancouver, is situated on the east side of Carabine Creek about half a mile north of Kamloops Lake and about 500 feet above the lake. On it are mineral occurrences consisting of veins and disseminations of copper minerals in shattered zones in volcanic rocks.

The lowest working seen is an incline shaft about 15 feet deep with three irregular crosscuts from it. One of these was driven south 20 degrees east for 10 feet. The second runs south 50 degrees west for 10 feet and then north 40 degrees west for 50 feet. The third extends northeast for an unknown distance, as it is filled nearly to the back with mud washed in from the surface. Both the crosscuts examined show a number of narrow quartz stringers running in various directions. These carry copper minerals, chiefly bornite with oxidation products. A large number of short calcite stringers also intersect the rock, which is impregnated with bornite, and in places heavily stained with malachite.

The main adit lies 250 feet north 70 degrees west of the lowest working. It is caved within 5 feet of the portal, but is stated to have been driven about 75 feet. The ore extracted is augite porphyrite carrying stringers of calcite, bornite, quartz, and considerable malachite. The bornite forms veinlets and disseminations in the rock, and is not necessarily associated with calcite or quartz.

A second short adit is situated 150 feet northeast of the last. It is 34 feet long and is driven northwesterly on a fractured zone about 4 feet wide at the portal and narrowing to 12 inches. Veins of calcite traverse the rock in different directions. This zone carries bornite and malachite.

An incline shaft has been driven about 25 feet southwest of the second short adit on a vein striking northwest and dipping nearly vertically. This vein is 20 inches wide at the shaft and widens to 4 feet 50 feet beyond. The incline heads down the strike of the vein at 35 degrees, and breaks into a stope from a working below. From this stope there is reported to be a drift and a crosscut to the main adit, which was caved, with a winze 50 to 60 feet deep but now full of water at the intersection. The stope itself is 15 to 20 feet long, 4 to 5 feet wide, and about 15 feet high. The remainder of the working was not examined.

About 150 feet northwest of this incline, a shallow shaft has been sunk with a 25-foot drift on a mineralized shear zone running northwest. This carries small stringers of calcite and of copper minerals. Near the shaft a small stope has been run to the surface and later filled. Copper minerals appear across a width of about 3 feet. Near the shaft the shear appears to split into two diverging branches. Mineralization is not entirely confined to the shear zones, as copper occurs in the unsheared rock.

About 1,000 feet southeast of the shallow shaft, a long adit has been driven northwesterly. At 171 feet it was found to be caved, with water backed up behind the cave, so that it could not be examined. That part of the adit seen was in overburden. At a further distance of 550 feet southeast there is a group of sloughed cuts and an adit caved at the portal. It is not known if these are on the Tenderfoot claim.

(12) Copper Prospect Near Copper Creek

A group of showings on the hillside between the workings of the Tenderfoot claim and Carabine Creek is, according to information received, on claims that have lapsed. The first showing is on a bearing of north 50 degrees east from Copper Creek station, near the summit of a prominent ridge. It is a mineralized shear zone in augite porphyrite tuff, striking north 65 degrees east with a vertical dip. The zone is 30 inches wide, narrowing to 12 inches in the face of a 20-foot adit that has been driven on it. A second zone 14 inches wide parallel with the first and 3 feet from it narrows to a point along the adit. These shear zones carry stringers of quartz $\frac{1}{8}$ to $\frac{1}{2}$ inch wide, mineralized with tetrahedrite, azurite, and malachite.

Between this and the lower Tenderfoot workings on the opposite side of the ridge is a group of cuts and a short adit. The upper working is an open-cut on a shear zone about 3 inches wide, carrying two stringers of quartz about 1 inch and $\frac{1}{2}$ inch wide, respectively, mineralized with chalcopyrite and malachite. The next cut, about 50 feet southeast and 25 feet lower, is sloughed, but numerous stringers of quartz intersect the rock in various directions. The adit is 150 feet southeast from this cut. It is caved at the portal, but is reported to be 50 feet long, and, apparently, follows a shear zone striking northwest and dipping steeply southwest. The dump indicates that the zone carries stringers and bunches of quartz with bornite, chalcopyrite, and calcite. The copper minerals occur in the rock dissociated from the quartz and calcite as well as in these gangue minerals.

(66) Peacock Group (Hunter Group)

References: B.C. Minister of Mines, Ann. Repts.: 1900, p. 892; 1903, p. 182; 1904, pp. 298, 300; 1906, p. 179; 1907, p. 138; 1915, p. 231; 1916, p. 518.

The Peacock group is situated in the canyon of Clapperton Creek about 5 miles from Nicola. The workings have been flooded and part of the original showings covered with debris by flooding of the creek.

The showings occur in a dark-coloured phase of a granitic rock, which is here a coarse-grained, in part gneissic hornblende-biotite granodiorite, near the contact of rocks of the Nicola group. Also at the same locality is a light-coloured acidic granite that is possibly intrusive into the granodiorite, but the age relations are not clear. Clapperton Creek here follows in part a fault plane with quartz veins and aplite dykes running in to the fault. Numerous fault planes in the granitic rocks strike about north 30 degrees east and dip from 50 degrees northwest to nearly vertical.

The main showing is a body of quartz 40 feet wide, exposed for a length of about 40 feet in the floor of the canyon. The quartz carries sericite, and is mineralized with streaks of bornite, chalcopyrite, azurite, and malachite. The average mineral content of the quartz was judged to be low.

According to Robertson (B.C. Rept., 1907, p. 138) several large bodies of quartz were connected by a rather indefinite quartz vein that, presumably, followed the fault in the creek bottom. On the Peacock claim a shaft is stated to have been sunk 50 feet and a drift run 20 feet north with the intention of intersecting the large body of quartz exposed in the creek bed. These workings encounter several small stringers but not the main body, and there is some doubt as to whether it was driven far enough.

On the opposite side of the creek from this shaft and 100 feet farther upstream another shaft was sunk 10 feet on a fissure in the country rock in which were seen a number of narrow quartz veins with chalcopyrite. Still farther up the creek is another shaft sunk 20 feet on a showing of quartz that carries copper sulphides.

Turlight Claim

Reference: B.C. Minister of Mines, Ann. Rept. 1929, p. 246.

This Crown-granted claim is situated at an elevation of approximately 3,000 feet on the hill between Clapperton Creek and Nicola Lake. Its location is not indicated on the accompanying map, but the claim lies about 5 miles northeast of the village of Nicola, with which it is connected by road.

The claim was worked in 1929 by Turlight Mines, Limited, when a considerable amount of prospecting was done on a copper showing. Work was then suspended apparently until 1947 when Guichon Mine, Limited, secured an option on the property and proceeded to test it. In consequence a considerable number of claims have been staked surrounding the Turlight.

The work by Turlight Mines, Limited, included the sinking of a shaft 60 feet deep on a copper showing and the excavation of several open pits along the course of the vein. In the summer of 1947 Guichon Mine, Limited, drilled a hole directed to intersecting the deposit at a depth of 100 feet some 50 feet northwest of the shaft. Drilling of this hole had barely started at the time the writer visited the property, but it has since

been completed and it is reported that the vein was encountered and disclosed good copper ore. The shaft was subsequently pumped out and a carload of ore was shipped.

The deposit occurs in a gneissic granodiorite, with the foliation at the shaft striking north 40 degrees west and dipping 45 degrees northeast. Except in the immediate vicinity of the shaft outcrops are scarce, and very little stripping or trenching has been done. The vein at the shaft is 5 feet wide with well-defined walls, strikes north 30 degrees west, and dips 65 degrees northeast. It is composed of quartz mineralized with chalcopyrite, bornite, and some malachite. A sample taken by Nichols of the British Columbia Department of Mines assayed 0·02 ounce gold a ton; 2·6 ounces silver a ton, and 11·7 per cent copper. The shaft was full of water at the time of the writer's visit, and, consequently, very little of the vein could be seen.

Forty-five feet northwest of the shaft the vein is poorly exposed in an open-cut that has partly caved, but the occurrence of mineralized material here indicates the presence of the vein. Farther northwest three trenches have been dug at intervals of about 50 feet, but none of these penetrated to bedrock. Beyond these a slough and heavy timber indicate that the overburden may be thick.

Forty feet to the southeast of the shaft an open-cut has been dug, but is now caved.

Guichon Mine

Guichon Mine, Limited, holds seven Crown-granted claims and seventeen claims held by location near the mouth of Quilchena Creek. This property was inactive at the time geological work was done in the district by the writer, and the mineral deposits were not seen, so the property is not shown on the accompanying map. Recently, however, a considerable amount of development work has been done, and the writer has seen some of the mineral showings but was unable to make an examination of the property.

The mine workings are situated less than a mile south of the Merritt-Kamloops highway, and southwest of the mouth of Quilchena Creek.

Several narrow quartz veins carrying copper minerals and in places yielding high assays in gold and silver occur intersecting the rocks of the Nicola group. The surveying of the different showings had not been done at the time of the writer's visit and, consequently, it is difficult to relate the individual exposures. In the earlier work done on the property several veins had been followed by short adits and open-cuts. Guichon Mine, Limited, has since driven a long crosscut adit and has done a considerable amount of drilling.

An old adit at an elevation of 3,380 feet (barometric) is 63 feet long and very crooked, the vein showing only in places. The vein is 12 to 15 inches wide, strikes northwest, and dips steeply northeast. It is composed of quartz mineralized with bornite and malachite. Sampling has indicated a content ranging up to $90 a ton in gold, silver, and copper.

A second adit has been driven on the vein about 30 feet above the first and is 25 feet long. In this distance the vein maintains a width of 8 to 12 inches.

Beyond these adits the vein has been traced on the surface by open-cuts for about 300 feet and is about a foot wide. At the farthest showing from the adit, however, no regular vein appears, the cut showing a lode consisting of fractured country rock with irregular stringers of quartz and thin streaks of hematite. Very high assays in gold are reported from this showing.

Some 200 feet southeast, but offset from the projected position of this vein, is a vein known as No. 6, which may be the same vein displaced by faulting. An adit 200 feet long has been driven on this, but because of water near the portal could not be examined.

Northeast of these showings and some 300 feet lower, a crosscut adit has been driven 1,400 feet towards them, but is still short of its objective. Drilling from the face is reported to have disclosed veins ahead of the drift.

Approximately 1,400 feet northwest of this adit another has been driven 55 feet on a vein known as No. 1. This strikes northwest and dips 45 to 60 degrees southwest. It is about 30 inches wide, and is well mineralized with bornite. Near the portal of the adit the vein is crossed by a second vein, 4 to 12 inches wide. Silver assays ranging up to 60 ounces a ton are reported from this showing.

Similar veins are stated to occur at other points on the property.

Sunny Boy (71), Lakeshore Deep (72), and Nicola Lake Groups (70)

The showings on these groups were not seen by the writer, several of them having been prospected after the geological work in that part of the area was done.

IRON DEPOSITS

Deposits of iron minerals occur at a number of points within the map-area and are of several different types. Vein deposits of magnetite with apatite occur with the rocks of the Iron Mask batholith; a deposit of limonite occurs in a gulch south of Nicola Lake; small bodies of specular hematite are found at scattered localities in the Nicola greenstones; and a contact metamorphic deposit of magnetite occurs near Heffley Lake.

Magnetite Deposits in the rocks of the Iron Mask Batholith

Veins of magnetite, some of them of considerable size, occur at several places in the rocks of the Iron Mask batholith. Apatite is associated locally with the magnetite. The walls of the veins are in many places sharply defined. The veins individually tend to extend for distances of some hundreds of yards and locally may widen to several times their breadth elsewhere. The relationship of these veins to the copper deposits occurring in these plutonic rocks has already been pointed out.

(26) Glen Iron Mine

References: B.C. Minister of Mines, Ann. Repts.: 1890, p. 377; 1891, p. 574; 1892, p. 540; 1893, p. 1068; 1894, p. 751; 1895, p. 696; 1896, p. 567; 1897, p. 614; 1898, p. 1104; 1899, p. 733; 1900, p. 890; 1901, p. 1079; 1902, p. 191; 1903, p. 181; 1913, pp. 184-5; 1918, pp. 236-7; 1922, p. 49. Dawson, G. M.: Geol. Surv., Canada, Rept. of Prog. 1877-8, pt. B, pp. 117-8; Ann. Rept. 1894, pt. B, pp. 158, 341-3. McEvoy, J.: Geol. Surv., Canada, Sum. Rept. 1898, pp. 9-10. Lindeman, E., and Bolton, L. L.: Iron Ore Occurrences in Canada; Mines Branch, Dept. of Mines, Canada, vol. I (1917), pp. 30-1. Young, G. A., and Uglow, W. L.: Iron Ores of Canada, vol. I; Geol. Surv., Canada, Econ. Geol. Ser. No. 3, 1926, pp. 109-115.

A detailed description of this property has been given in Young and Uglow's report. As this report is still available it is unnecessary to repeat the description, but some of the salient facts with regard to the deposits are summarized from that report.

The property is situated close to the south shore of Kamloops Lake near Cherry Creek station, which lies 13 miles west of Kamloops on the Canadian Pacific Railway. The ore exposures and the mine workings lie on a steep hillside that rises directly from Kamloops Lake. The iron ore deposits are veins that lie within the area of plutonic rocks referred to in this report as the Iron Mask batholith. In the vicinity of the deposits the rock is dark, medium grained, and rich in dark-coloured minerals, which include pyroxene, biotite, and magnetite. This rock near the magnetite veins shows considerable alteration to epidote accompanied by either tremolite or serpentine. The veins vary from considerably less than a foot to nearly 35 feet wide, and have been traced for distances ranging up to 650 feet. They are confined to an area extending 1,600 feet south from the lake shore and with a width increasing from 300 to 1,300 feet southward. The veins follow curving courses trending generally east. Locally they swell and branch and in some cases terminate abruptly. The ore consists essentially of magnetite with varying amounts of apatite.

Young and Uglow have described veins at fifteen localities on the property. Of these veins No. 3 and No. 8 appear to be the more important, and are described as follows:

"Vein No. 3 . . . is exposed at intervals over a length of 370 feet, sends off several branches and possibly is continued westward by veins Nos. 4 and 5, in which case the total exposed length would be 770 feet. At the easternmost exposure the vein is less than an inch wide and appears to end . . . seventy feet west the vein is one foot wide. Eighty feet farther west . . . the vein is 5 feet wide, and is only several feet south of a body of magnetite 10 feet wide tapering to a foot in an easterly direction. This . . . presumably represents the eastern end . . . of the main vein; and from it a branch runs eastward for 60 feet . . . where it seems to end. The main vein is exposed 75 feet to the west with a thickness of 5 feet . . . . Farther west along the vein the magnetite . . . has an exposed width of 20 feet and . . . one or more narrow branch veins are exposed to the south of it . . . . Apparently at the places where the vein forks the ore mass notably increases in width, forming, it is estimated, one lenticular body 120 feet long and 25 feet wide and a second body 100 feet long with a thickness gradually increasing from 5 to 10 feet."

Veins 4, 5, and 6 are possibly continuations or branches of vein No. 3.

"Vein No. 8 is the vein on which the deep open-cut has been made and along which the 150 foot tunnel has been driven. The vein is exposed by the open-cut for a length of 360 feet and intermittently for a farther length of 290 feet. The eastern end of the vein is not exposed, but it presumably lies somewhere between the tunnel mouth and the east side of the gully into which the open-cut opens, for the vein almost certainly does not continue eastward across the gully. At the tunnel mouth the vein is about 15 feet wide, much of it is rich in apatite, but a zone about 5 feet thick is nearly pure magnetite. At the face of the tunnel, 150 feet in, the vein is fully 15 feet wide, but forward of the tunnel end in one place contracts or holds a horse of country rock. At the surface a 3-foot vein lies a few feet north of the main vein and underground the main vein appears to split and to be paralleled by another vein. The western part of the cut is wider than the eastern part and presumably the vein is wider in the west. About midway along the open-cut where it makes a right-angle turn, the vein has a width of 35 feet and . . . consists of band-like, comparatively pure masses of magnetite striking parallel with the vein and alternating with zones very rich in magnetite and with bands or horses of country rock. This point in the open-cut is 140 feet above and nearly vertically over the tunnel face. Towards the west end of the cut (in) the floor . . . country rock is exposed for a width of 5 feet with, on the north side, a vein of magnetite 5 feet wide and apparently increasing in width westward. On the south side of the rock parting is a wider vein, which appears to narrow westward . . . and . . . gradually diverges from the north vein. At the west end of the open-cut there is a vertical rock face about 20 feet high. The north 5-foot vein continues to this point . . . and extends upwards for 12 feet on the end rock face but there abruptly ends and is succeeded upwards by a zone of much fractured rock. The south vein at the west end of the cut lies about 15 feet south of the north vein. Beyond the end of the cut the south vein is exposed in two places with widths of 3 to 4 feet and at a third place 290 feet west of the end of the cut it varies from 2 feet to an inch or so in width. Two hundred feet farther along the strike there are indications (vein No. 8A) of a possible continuation of this vein."

The remaining veins are similar in character but on the whole narrower than those described above.

The principal workings are the open-cut and tunnel referred to in the description of No. 8 vein. The open-cut is 430 feet long, varies from 10 to 20 feet wide, and in places is more than 40 feet deep. It extends westerly uphill from a gully and near its lower easterly end an adit has been driven 150 feet into the hill. The ore is partly stoped out above this tunnel. Young and Uglow give a total production of about 15,000 tons made prior to 1902 and used as a flux in copper smelters.

Of the veins only four are wide enough to be of value, but some of the narrower ones may widen in depth and others may exist but not extend to the surface.

(30) Moose, Magnet, Signal, and Anvil Claims

Reference: Young, G. A., and Uglow, W. L.: op. cit., pp. 115-128.

The Moose, Magnet, Signal, and Anvil claims are situated close to the Trans-Canada Highway about 7 miles west of Kamloops. They do not appear among those in good standing at the Records Office, but it is possible that some of them have been re-staked under other names.

Young and Uglow give a full description of the mineral showings, from which the following account is taken.

Within the area of the claims the bedrock is largely concealed by drift, but a considerable amount of stripping and trenching has been done. Several shallow trenches and an incline pit have been sunk on outcrops on the Moose claim, and on the Magnet a shaft was sunk some years ago in search for copper ore. The ore occurrences are veins lying within the plutonic mass referred to in this report as the Iron Mask batholith.

On the Signal and Anvil claims the outcrops of magnetite are confined to an area about 300 feet broad and 1,000 feet long; elsewhere rock outcrops are scarce in all directions. Within this area exposures are small and widely scattered, so that neither the full extent of the mineral deposit nor its trend is apparent. It is probable that several individual zones are represented.

The exposures on the Moose claim lie about 2,000 feet northeast of those of the Signal and Anvil claims. In the western part of this claim there are indications of five veins ranging from 1 foot to 5 feet in width. The most important exposures, however, lie about 200 feet northeast of these, where several trenches reveal the presence of considerable magnetite for a length of 250 feet. Here the most westerly exposures are in a trench 60 feet long that shows magnetite in a series of well-defined veins striking east and dipping south at 45 degrees. The individual veins are separated from one another by fractured and weathered country rock. Along the south side of the trench one vein of nearly pure magnetite from 1 foot to 2 feet wide continues the entire distance (60 feet) with minor veins splitting off from the main body. At one point a section shows five bands of magnetite with a total thickness of 35 inches (including the continuous vein referred to above) separated by bands of rock with a total thickness of 13 inches. There are indications of two other larger veins beneath, one of which is at least 3 feet thick. Thus, in a thickness of some 20 feet there appear to be four major veins, the uppermost of which is continuous for a length of 60 feet whereas the others probably disappear or break up into groups of thin divergent veins. At the east end of the cut all the veins are terminated by a fault.

A few feet to the east and north of these exposures a second trench extends 20 feet east. It exposes much magnetite, with the same general relations as exhibited in the first trench. At the east end of this cut the magnetite veins are 19, 2½, 45, and 8 inches wide, respectively, and westward along the cut the 19- and 45-inch veins coalesce to form a body of magnetite 8 feet wide, which then decreases in width to 3 feet within a distance of 8 feet.

A third pit 30 feet eastward has largely caved, but the amount of ore seemed to decrease eastward and the zone appears to be represented by thin seams of magnetite across a width of 12 feet.

About 200 feet north of this is a fourth pit, which shows a mass of magnetite 5 feet wide terminated abruptly to the west by a fault.

A fifth trench slightly to the west and south of the last shows at its east end two veins of magnetite each 3 feet wide, but one of which splits into several narrow veins. It is possible that the veins visible in these trenches are all parts of one zone broken into short segments by faulting.

The Magnet claim lies 1,500 feet west-northwest of the Signal and Anvil claims. The showings probably indicate several curving veins striking generally southeastwards, but three of them appear to strike northeast. The more important of these veins are described below.

Vein No. 3 is represented by a series of outcrops for a length of 1,300 feet. At its northwestern end the vein is traceable by nearly continuous exposures to the top of a small ridge. It has a minimum width of 10 feet in this section and is nearly pure magnetite. On top of the ridge two outcrops indicate the vein is not less than 20 feet wide. From the top of this ridge eastward for 500 feet the exposures are poor, the vein being exposed only at three places in this distance. At the first of these exposures the vein is 15 feet wide, the width is not shown at the second, and at the third it is 19 feet wide, but here encloses several narrow bodies of country rock. A little farther east the vein is exposed continuously for 200 feet with a width ranging between 15 and 20 feet. At the last exposure, 130 feet farther east, the vein is much narrower.

Vein No. 4 is roughly parallel with No. 3 and at distances of 50 to 100 feet north of it. It has been traced for 1,400 feet, and near its northwestern end is represented by two outcrops of magnetite 70 feet apart. Easterly from these no exposures occur for 600 feet. Beyond this covered area the vein is exposed on a small ridge, and is 30 feet wide. From this ridge exposures are continuous for 300 feet, with the width gradually decreasing until it is less than 8 feet. In this stretch the vein includes long sheets of country rock and the quality of the ore is further decreased by the presence of zones rich in apatite. Beyond this stretch of continuous exposures outcrops are lacking for 200 feet to where the vein is exposed in several outcrops for a length of 30 feet.

Vein No. 5 lies 50 to 80 feet north of No. 4, and the exposures indicate a vein 600 feet long and generally 1 to 2 feet wide.

Vein No. 6 is 75 to 100 feet north of No. 5. At its western exposures it is 2 to 5 feet wide; at the extreme eastern exposure the ore shows a width of 15 feet, with only one wall uncovered.

Veins 8, 9, and 10 strike nearly at right angles to those described above. Vein No. 8 is exposed at only one locality. Vein No. 9 appears to be a vein zone composed of three parallel veins. On the east side two outcrops indicate a vein between 5 and 10 feet wide. Ten feet northeast, a body of magnetite is visible for a length of 30 feet and a width of 5 feet. A third body shows to the west with an exposed length of 65 feet and a width of 10 feet, with country rock along its eastern side. Eighty feet southwest an exposure, presumably of this third vein, shows ore having a breadth of at least 15 feet.

The showings of No. 10 vein, or vein zone, lie 300 feet west of those of No. 9 vein, and indicate two parallel veins 5 to 10 feet apart. The more northerly is exposed for 35 feet with a width varying from 5 to 10 feet. The second has about the same dimensions.

(69) Iron King and Iron Queen

Reference: Young, G. A., and Uglow, W. L.: Iron Ores of Canada, Vol. I.; Geol. Surv., Canada, Econ. Geol. Ser. No. 3, 1926, pp. 129-30.

This limonite deposit is situated in a deep gulch in the range of hills that lie on the south side of Nicola Lake, about 3 miles easterly from the village of Nicola. The deposit is fully described in Young and Uglow's report cited above and the description need not be repeated here.

Hematite Deposits

Reference has been made to the occurrence of deposits of specular hematite with the volcanic rocks of the Nicola group, and several are mentioned in connection with the copper deposits with which they are associated. These appear to be in general concentrations in the greenstone of insufficient size to be of interest as iron orebodies.

Contact Metamorphic Deposits

Two deposits of the pyrometasomatic type have been discovered in the area. One of these is a copper-tungsten deposit in a gangue of skarn rock, situated near the other mineral deposits, previously described, on Swakum Mountain. The second is a deposit of magnetite in altered limestone near Heffley Lake. Both appear to be of the type situated at some distance from bodies of plutonic rocks, for in neither case is there evidence of such rocks occurring in the immediate vicinity of the ore. A test shipment was made from the Swakum Mountain deposit. Otherwise, neither property has been productive.

(57) Last Chance Group

(Swakum Mountain)

References: B.C. Minister of Mines, Ann. Repts.: 1917, pp. 233, 450; 1918, p. 239; 1924, p. 136; 1927, p. 213.

The Last Chance group, consisting of thirteen claims, is located on the northern slope of Swakum Mountain, 13 miles by road north of Nicola. The property is in part a re-staking of the former Lucky Mike group, which had lapsed. The Lucky Mike claim was staked in 1916 as a copper prospect. A number of cuts were run on copper showings and a shipment of 22 tons of ore averaging 4·6 per cent copper was made from the surface showings in 1917. Granby Consolidated Mining, Smelting and Power Company, Limited, did a limited amount of diamond drilling on the claim that year, but dropped the option held on the property. The same year an option was taken by Northwestern Mines, Limited, of Spokane, and a 50-foot shaft was sunk. The property subsequently lapsed, but was re-staked as a tungsten prospect in 1942, six claims, including the showings on the former Lucky Mike claim, being recorded by R. McD. Reid of Penticton. The property was optioned to W. B. Milner of Toronto in

1942 and additional claims were staked in 1942 and 1943 and registered in his name. The property was prospected by Mr. Milner, and some stripping was done and several cuts excavated. Fair values in tungsten were obtained at some points in the surface cuts, but as the surface material was oxidized a limited amount of drilling was undertaken for the Metals Controller in 1943 and in order to sample the showings. The claims have recently lapsed.

The mineral deposits are situated on a small knoll that drops off sharply to the east, north, and west, but the area surrounding the knoll is only about 50 feet lower than the knoll itself. Most of this surrounding area is covered with drift.

The deposit lies in a band of limestone that is included in the greenstones of the Nicola group. The contact of these rocks strikes northerly and dips steeply easterly. As pointed out elsewhere, Swakum Mountain is probably the locus of an anticline with the limestone bands at the Last Chance located on the eastern limb of the fold. The limestone bands appear to be discontinuous and to consist of a series of lenses that outcrop at intervals for several miles to the south. The size of the limestone lens at the Lucky Mike is not known.

The deposit is of the contact metamorphic type, being situated at the contact of the limestone and the greenstone and consisting of a gangue of lime-silicate minerals, chiefly garnet and epidote, carrying pyrite, chalcopyrite, and scheelite. The hanging-wall contact between the comparatively unaltered and altered limestone is quite irregular, and the deposit ranges from about 25 to about 75 feet in width (Figures 14, 15). In the greenstone foot-wall are bands of calcareous material that are largely altered to epidote and garnet and that carry scheelite and copper minerals. These are believed to represent calcareous pods, now largely altered, within the greenstone. Granitic rocks are not known in the immediate vicinity of the deposit, nor were they encountered by drilling, which was carried to a maximum depth of 193 feet below the outcrop. A large batholith of granitic rocks outcrops between 2 and 3 miles east of the property, and isolated exposures of granitic rock occur in a drift-covered area on the north slope of the mountain some considerable distance from the mineral deposits. A number of quartz porphyry dykes cut the greenstones to the west of the mineral deposits, but the nearest is several hundred feet from the mineral deposits themselves.

The deposit has an exposed length of 350 feet, but its extensions along strike are concealed by overburden at both ends. In the early trenching work the hanging-wall of the ore zone was not disclosed in the southern section owing to heavy drift cover, but it would appear from the drilling that the deposit is widest a short distance from its northern end and that it tapers rapidly from its central section towards the fault exposed in the trench near the southern end of the knoll; beyond this fault only one hole was drilled and the mineral zone appeared to widen again. The zone is thus from 25 to 75 feet wide, with an average width of about 40 feet. These figures then indicate a mineral zone of approximately 1,400 tons per foot of depth, and the deposit showed no change in character to a depth of 190 feet.

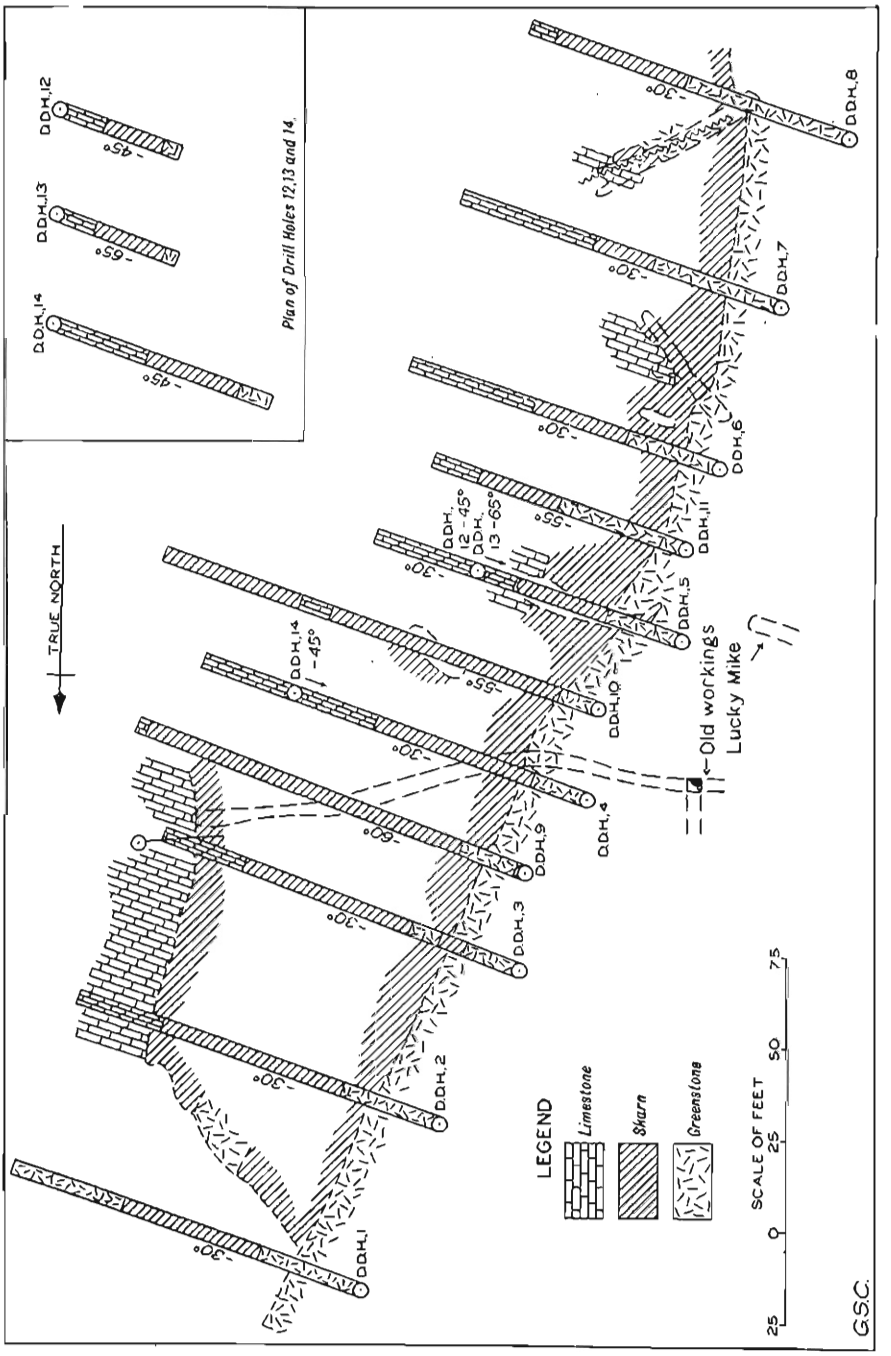


Figure 14. Last Chance group, Swakum Mountain, showing surface workings, drill-holes, and main geological contacts.

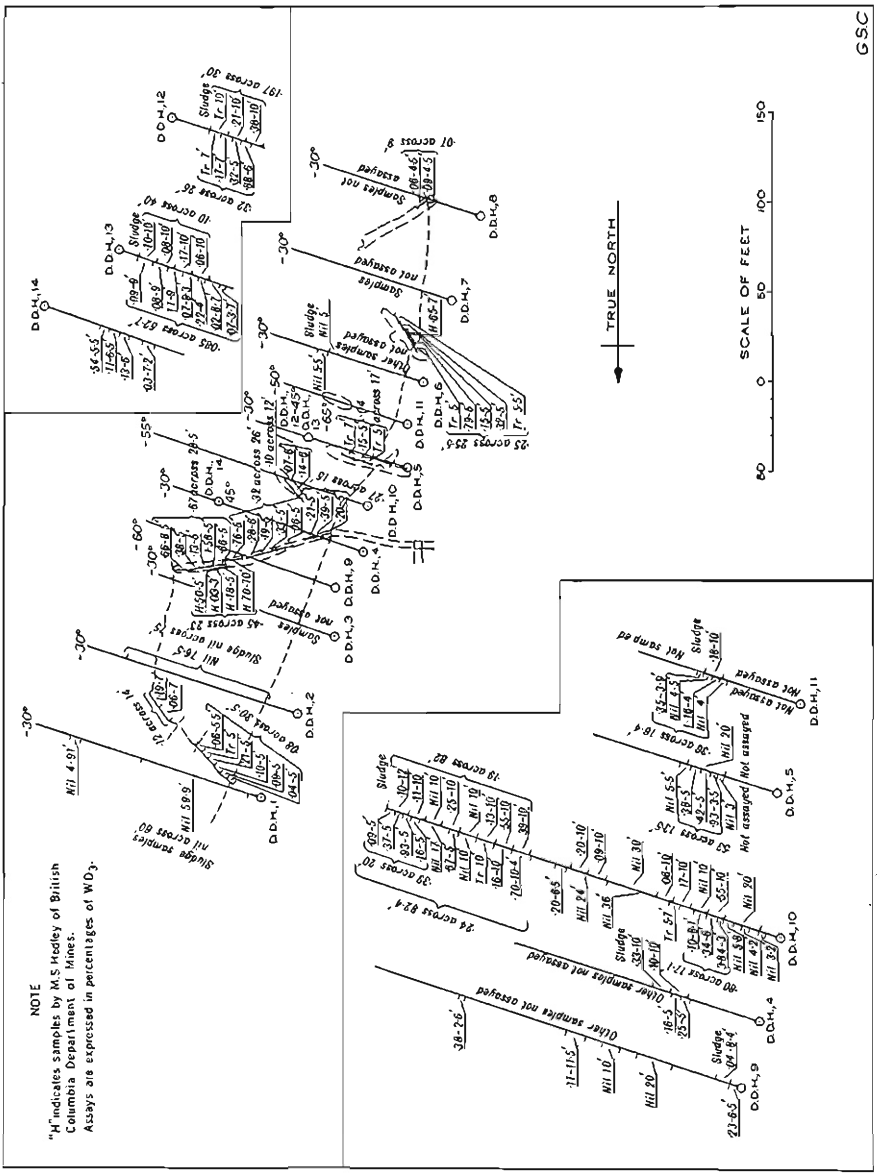


Figure 15. Assay plan, Last Chance group, Swakum Mountain.

The mineral zone consists of skarn rock composed very largely of garnet. Calcite and epidote are abundant, and chlorite and pyroxene occur. Locally quartz is present in irregular masses. Hematite is visible in much of the deposit, and is plentiful along fracture planes and joints in the skarn and in the greenstone. Chalcopyrite, pyrrhotite, and pyrite are present and in some places the chalcopyrite forms small masses that make up most of the drill core for short sections. The pyrrhotite and pyrite are generally disseminated through the rock. None of these sulphide minerals is confined to the skarn, and all may be found in the adjacent greenstones, where, however, they are most abundant in calcareous bands associated with abundant epidote. Scheelite occurs in grains, ranging from pin-point size to crystals about $\frac{1}{4}$ inch long. It is not confined to the main body of skarn rock, but occurs also in the limy bands within the greenstone foot-wall referred to above, and was observed in the old workings driven to explore the property for copper many years ago (*See* Figure 14). It was also observed in the greenstones on several surrounding properties, generally in calcareous bands, but not in amounts that would justify sampling.

Development work done on the property in the winter of 1942-43 consisted of a number of open-cuts and trenches (Figures 14, 15) that partly outline the orebody. The southernmost cut does not expose the southern end of the orebody that is shown by drilling to extend beyond the fault in that cut, but the overburden in this direction was considered too thick to trace the body farther by means of trenches. Similarly, at the northern end the orebody is exposed in a working that is for the most part a face blasted from a rock outcrop. It consists of two bands of lime-silicate rock separated by a horse of greenstone. The other cuts show the orebody to be at its widest towards the northern end, tapering towards the fault in the southernmost cut. Assays by the operators and by Buffam and Hedley[1] are shown on Figure 15. The writer took no samples of the surface showings. The average of the surface samples taken by the operators and by W. S. B. Buffam indicates a value of 0·25 per cent WO_3 across an average width of 34 feet, or, including Hedley's samples, which are obviously character samples taken at some of the better showings, 0·28 per cent WO_3 when weighted for the widths across which the samples were cut.

It was felt by Dr. Buffam that this figure did not necessarily represent the true value of the deposit, because some of the trenches did not reach the hanging-wall and because the shattered and oxidized character of the surface rock made it difficult to secure satisfactory samples. A program of drilling was recommended by him to consist of eight holes spaced at intervals of 50 feet along the strike of the deposit and drilled at angles of minus 30 degrees. These holes were drilled from the foot-wall side, because of better set-ups for the drill on that side of the deposit and because, owing to the steep dip of the formation, the holes would not be lengthened greatly (*See* Figures 14, 15).

The drilling was done under the writer's supervision, and samples were taken of the core across the entire ore zone. The cores were examined with an ultraviolet light, but after the first few holes were drilled and complete assays made it was found unnecessary to assay sections of the core that did not show a fair amount of scheelite. Complete assays were made for holes 1, 2, 10, 12, 13, and 14 (*See* Figure 15). For the remaining holes

[1] Hedley, M. S.: British Columbia Department of Mines, unpublished report.

a number of samples were picked for assay, chiefly at those points where the ultraviolet light showed most tungsten in the cores. Hole 1 encountered a narrow band of skarn rock consisting largely of calcite, epidote, and limonite, and then continued in alternating bands of greenstone and calcareous rock carrying considerable epidote. At 65 feet the drill entered greenstone with comparatively few calcareous bands to 122 feet where drilling was stopped. A limestone hanging-wall was not found, although limestone occurs at the surface a few feet from the hole. It is believed that the limestone lens is pinching out in this direction, possibly to be replaced by another lens slightly farther to the east. The hole showed no scheelite. The other seven holes of this set, Nos. 2 to 8, showed the normal succession of greenstone, mineralized skarn rock, and then limestone. A number of soft porphyry dykes were encountered in the skarn rock. Hole 2 also showed nil across the ore zone, although the zone was massive garnetite. Holes 4 and 5 showed rather more scheelite than the other holes, and holes 9, 10, and 11 were drilled at steeper angles to test the possibility of an ore shoot occupying this part of the body. Holes 12, 13, and 14 were short holes drilled from the hanging-wall towards the foot-wall along the lines of holes 4 and 5 to test the orebody below the zone penetrated by these holes (*See* Figures 14, 15). The average of all samples assayed from the cores of the holes, properly weighted for the widths over which the samples were taken, is 0·15 per cent WO_3. If, however, those parts of the zone of which the samples were not assayed be included, and if it be assumed that these samples would show nil upon assay, the average content would become 0·095 per cent WO_3. The average content of Wo_3 can, therefore, be assumed to lie between these two figures and probably closer to the lower than to the higher figure. The average of the sludge assays from all holes except No. 14, from which no sludge was recovered, was 0·046 per cent WO_3. However, the average values of those assays made from holes 4, 5, 9, 10, 11, 12, 13, and 14 was 0·217 per cent WO_3 across an average width of 25 feet, a figure approximating the average obtained in the surface cuts. If the same assumption be made as before, that those samples which were not assayed would yield nil upon assay, the average for this area would become 0·147 per cent WO_3. The average for this part of the deposit, therefore, lies between these two figures, probably more closely approximating the latter than the former. No samples were assayed for gold or for copper. The conclusion reached is that the average of this part of the zone is too low grade to be considered commercial, and that although streaks of good scheelite mineralization occur they cannot be related into ore shoots.

Genesis. The ore deposit is so typical of the contact-metamorphic or pyrometasomatic type that little need be said with regard to its genesis. The alteration of limestone to skarn is commonly accepted as forming the type example of this class. In this particular case the deposit appears to be situated at some distance from the intrusive rock responsible for the metamorphism. Although the ore zone is situated at the contact between greenstone and limestone it is not thought that the greenstone is in any way genetically associated with the formation of the ore, although the contact may have had a structural effect in localizing the mineralization. The greenstone is itself metamorphosed and carries some of the ore minerals. It is thought that the ore-bearing solutions emanated from an

intrusive body that is not exposed at the surface, either because it lies in the drift-covered area or has not been bared by erosion. Although isolated outcrops of granitic rock appear in a drift-covered area several thousand feet to the north of the property and aplite dykes occur in the vicinity of the showings, it is believed that the intrusion responsible for the mineralization lies below the deposit, in which case the limiting factor might be the size of the limestone lens rather than the position of the granitic rocks.

(23) Iron Range Group

The Iron Range group, situated on the north side of Heffley Lake, is owned by H. Stephens of Kamloops. The claims are situated about 9 miles by road from Heffley station on the Canadian National Railway, and the Heffley Lake road passes within a few hundred yards of the showings.

The showings have the characteristics of contact metamorphic deposits, although no body of plutonic rock is known to occur in the immediate vicinity. The area to the south is, however, covered by drift. The deposits consist of disseminated or massive magnetite with garnet and epidote in a fine-grained dense rock that is undoubtedly an altered limestone. A large body of crystalline limestone outcropping on a steep hillside above is cut by numerous dykes of greenish grey hornblende porphyry. Many rusty altered zones occur in the limestone, and cuts have been made near the base of the hill on several of these found to contain magnetite. Accompanying the magnetite is pyrite and pyrrhotite.

The lowest cut is situated near the bottom of the steep hillside, and is about 25 feet long. At the western edge of the cut there is 1 foot of porphyry, then 1 foot of altered limestone with epidote and magnetite, followed by 4½ feet of altered limestone carrying thin streaks of magnetite along joint planes. This is followed by 3 feet of altered limestone carrying disseminated magnetite and pyrite, 3 feet with comparatively little magnetite, 8 feet with disseminated magnetite, and 2 feet with no magnetite, the remainder of the cut being sloughed. About one ton of magnetite has been sorted out and piled on the dump.

The next cut is 500 feet northeast and about 150 feet higher. It shows small remnants of crystalline limestone in fine-grained, green, lime-silicate rock. This cut also is about 25 feet long and shows narrow veins of magnetite along joints in the altered limestone. Disseminations of magnetite and garnet with pyrite occur towards the western end of the cut.

The next cut is 50 feet northwest and 25 feet higher. It is more than 70 feet long, showing limestone at both edges. At the eastern edge is 6 feet of altered limestone with disseminated garnet, magnetite, and pyrite, followed by 6 feet of hornblende porphyry, then by 10 feet of altered limestone with disseminations of garnet, magnetite, and pyrite. In this section are irregular bodies of massive magnetite carrying pyrrhotite. The remaining 20 feet of the cut is in altered limestone with small bunches of magnetite. The area intervening between the cuts is largely drift covered.

No gold values have been reported.

INDUSTRIAL MINERAL DEPOSITS

GYPSUM

References: B.C. Minister of Mines, Ann. Repts.: 1911, p. 185; 1913, p. 225; 1915, pp. 232-3; 1922, p. 153. Johnston, R. A. A.: A List of Canadian Mineral Occurrences; Geol. Surv., Canada, Mem. 74, p. 112 (1915). Cole, L. H.: Gypsum in Canada; Mines Branch, Dept. of Mines, Ottawa, Report 245, 1913, pp. 97-98; Investigations of Mineral Resources and the Mining Industry, 1926; Mines Branch, Dept. of Mines, Report No. 687, 1928, p. 28; Gypsum Industry of Canada; Mines Branch, Dept. of Mines, Report No. 714, 1930, p. 69.

(13) Merritt Gypsum Deposit

On the benches of the hill north of Merritt and about a mile from that city, a deposit of gypsum is spread over the hillside in irregular patches. In places it is quite pure, and in others contaminated with calcite, sand, and vegetable matter. It is thickest on little knolls and hogbacks, where in places it is reported to reach a thickness of 10 feet. At one time it was probably extensive, but erosion has removed much of the deposit (1913, p. 225). In colour it is light brown, and, therefore, cannot be used where fine or finished work is required, but forms an excellent plaster.

The development work consists of a number of holes and pits scattered over the hillside, but many of these were more or less filled with debris (1916). Shipments of 500 tons are stated to have been made in 1911, chiefly for use as fertilizer in Fraser Valley.

(8) Knutsford Gypsum Deposit

Deposits of gypsite occur on a small bench on the hill slope west of Knutsford. One of these, worked by G. J. Rogers and S. Little of Knutsford, has been excavated by a trench 85 feet long, 45 feet wide, and from 1 foot to 5 feet deep. Eighty feet west, another pit 4 feet deep, but now largely sloughed, has been excavated in the same material. The bench on which the deposit occurs is 100 to 150 feet wide, and it is probable that the gypsite extends 600 feet southeast of the large cut. Although no exposures occur other than in the cuts mentioned, it is believed that the limits can be traced to some extent by the character of the vegetation on the areas underlain by the gypsite. The gypsite is a greyish cream colour, due, apparently, to the presence of organic matter. It is contaminated with some sand and carries occasional small pebbles.

A second deposit, located on a ranch owned by Dr. R. W. Irving, occurs northwest of Knutsford and about 150 feet above the road on what is apparently a continuation of the same bench. The bench at this point is about 200 feet long and 50 feet wide. The gypsite also extends in a narrow band on a gentle slope below the bench running towards the road. A number of short holes put in with an auger showed the gypsite to be 4 to 8 feet thick and in places probably thicker. Samples were tested but not analysed. The samples were all coloured, the colour apparently being due to organic matter, but a little iron was present in some of the samples. An analysis of a sample reported to the writer was as follows:

	Per cent
Fe_2O_3 and Al_2O_3	0·6
CaO	31·0
MgO	Trace
SO_3	42·1
Insoluble	4·5
Loss on ignition	21·6

(2) Carabine Creek Gypsum Deposit

A deposit of gypsum occurs on a bench known as Kelly flat on the east side of Carabine Creek. Showings occur in several pits and cuttings along the road leading to the Hardie Mountain cinnabar property; and gypsum apparently occurs at several points near the cinnabar property. Apparently at one time deposits of gypsum were mined from this locality, but little information could be secured as to the amount shipped or the extent of the deposits. It is believed that the gypsum may not be continuous between the various exposures.

A general sample combined from samples taken at the different exposures was partly analysed. It showed 43·1 per cent lime and 15 per cent sulphur. This would indicate the presence of some calcium carbonate.

HYDROMAGNESITE

Reference: Cummings, J. M.: B.C. Minister of Mines, Bull. No. 4, 1940, p. 115.

(12) Buce Lake Hydromagnesite Deposit

A deposit of hydromagnesite occurs near the eastern edge of the map-area east of Buce Lake, about ¼ mile south of the Vernon road and about 17 miles east of Kamloops. Here several holes were put down with an auger in a depression about ¼ mile long and from 200 to 400 feet wide. Most of the holes showed hydromagnesite with a thickness of from 1 foot to 2½ feet overlain by from 10 to 30 inches of drift. Of samples taken at this point, only one was partly analysed. It gave the following results:

	Per cent
Insoluble in HCl (including any silicate)	20·74
Fe, Al group	3·91
CaO	1·76
MgO	34·20
MnO	0·07
SO_3	0·05
H_2O	6·56
Loss on ignition	38·45

On the basis of the MgO content, the sample would contain approximately 77·90 per cent hydromagnesite. It is probable that in taking samples with the auger some foreign material was included. No thorough sampling of the occurrence was undertaken, and no calculation of the amount of hydromagnesite present can be made.

(10) Barnhart Vale Hydromagnesite Deposit

A second deposit of hydromagnesite occurs in a depression or dry lake on the road to Campbell Range, about 2 miles east of Barnhart Vale, 12 miles east of Kamloops.

The depression is roughly 600 feet long and 500 feet wide. A second depression about the same size lying ¼ mile east is reported to have shown hydromagnesite. This, however, was not tested. Two short holes with an

auger showed the hydromagnesite to extend to depths of 6 feet with 6 inches of overburden. A partial analysis of the sample from one of these holes gave the following:

	Per cent
Insoluble in HCl (silica)	23·28
Fe, Al group	3·56
CaO	5·71
MgO	27·44
MnO_2	0·05
Loss on ignition	not determined

On the basis of the MgO content the sample would contain 62·50 per cent hydromagnesite. As before, there may have been some contamination of the sample due to the method used in obtaining it.

(9) Campbell Range Hydromagnesite Deposit

A small depression west of the road to Campbell Range, 13 miles southeast of Kamloops, is roughly 250 feet in diameter, and contains irregular patches of white hydromagnesite. An auger hole sunk in this material showed white hydromagnesite to a depth of nearly 3 feet. It is reported that a hole sunk a few feet away showed nearly 20 feet of this material. Three other auger holes sunk in the depression showed only sand and gravel. It is believed that the deposit is quite irregular. A partial analysis of the material obtained in the first hole showed:

	Per cent
Insoluble in HCl	7·37
Fe, Al group	0·93
CaO	0·66
MgO	37·44
Loss on ignition	not determined

Using the percentage of MgO to calculate the amount of hydromagnesite, this is found to be 85·28 per cent.

SODIUM SULPHATE

References: B.C. Minister of Mines, Ann. Repts.: 1922, p. 154; 1930, p. 191; 1931, p. 109; 1932, p. 147; 1933, p. 195; 1934, p. D29; 1935, p. D16. Cummings, J. M.: Industrial Minerals in British Columbia; Bull., Can. Inst. Min. Met., Nov. 1938, p. 565. Saline and Hydromagnesite Deposits of British Columbia; Bull. No. 4, 1940, B.C. Minister of Mines, pp. 34-40.

One lake (6), controlled by the B.C. Sodium Syndicate, lies 1½ to 2 miles north of the Kamloops-Savona highway, about 12 miles westerly from Kamloops. The lake has an area of about 7½ acres. According to Cummings "in the autumn of 1937 it was covered by a winter crystal about an inch thick. Towards the southeast end of the lake, the deposit was formed of circular areas separated by mud.... The mud forming the remainder of the surface and surrounding shore-line was heavily encrusted with a white efflorescence of dried salts. About 6 inches of soft black mud occurring beneath the surface layer contained tiny disseminated crystals.... Underlying this over at least three-quarters of the lake, was a deposit of hard massive permanent crystals." Cummings did not investigate the depth or extent of the crystal bed, but, from figures given in an earlier report

(1930) showing 7 feet of crystal near the edge and 19 feet near the centre, estimated a probable tonnage of from 100,000 to 200,000 of crystal. Previous analyses from borings showed sodium sulphate, 83·8 per cent; magnesia, 0·9 per cent; and insoluble, 15·1 per cent, calculated on a water-free basis. Cummings' samples on the same basis showed sodium sulphate, 79·2 per cent; magnesium sulphate, 7·2 per cent; calcium sulphate, 2·8 per cent; and insoluble, 10·8 per cent.

Iron Mask Lake (7) is the easternmost and largest of a chain of four lakes lying along the Kamloops-Savona highway, starting at a point about 6 miles west of Kamloops and extending nearly 4 miles west. The lake is half a mile long and 300 to 500 feet wide, with the eastern end covered by tailings from the mill of the Iron Mask mine, formerly operated on the hill to the south.

According to Cummings, the surface of the lake in October 1937 was encrusted with a white efflorescence of dried salts, but no permanent layer of crystal was observed. Beneath the encrustation was soft black mud containing sparsely disseminated mirabilite crystals. Cummings put down some test pits, but these were restricted to near the shore. Solid crystal, the thickness of which was not determined, was encountered beneath 3 to 4 feet of mud near the margin of the tailings dump.

It is stated that the lake was drilled some years before and that an estimated area of 5 acres was found to be underlain by a crystal bed 5 to 12 feet thick containing about 50,000 tons. The depth of cover ranged from 3 to 5 feet. Samples showed the brine to carry 27·63 per cent solids, composed of: sodium sulphate, 35·8 per cent; magnesium sulphate, 61·8 per cent; sodium carbonate, 2·0 per cent; and sodium chloride, 0·4 per cent. Surface crystals collected from the lake later in the year showed 94·2 per cent sodium sulphate; 5·1 per cent magnesium sulphate; and 0·5 per cent sodium carbonate.

The next lake west lies in the same depression, is about 4½ acres in area, and roughly circular in outline. Cummings found the brine contained 11·67 per cent solids with the following composition: sodium sulphate, 32·8 per cent; magnesium sulphate, 62·0 per cent; sodium chloride, 1·6 per cent; sodium carbonate, 1·4 per cent; and calcium sulphate, 2·1 per cent. Cummings estimated that the lake contained probably in excess of 3,000 tons of mixed salts.

The next lake west lies in the same general depression as the two preceding ones and was dry when examined by Cummings in October 1937. It carried a heavy crust of dried salts over an area of 4 acres, below which was soft mud. Drilling was restricted because of conditions, but no permanent crystal was encountered in the holes drilled. Former drilling is reported to have encountered a bed of crystal beneath 5 feet of mud, but its thickness and extent were not determined. The crystal was composed of: sodium sulphate, 48·6 per cent; magnesium sulphate, 19·8 per cent; sodium carbonate, 1·9 per cent; magnesium carbonate, 2·5 per cent; calcium carbonate, 2·7 per cent; and insoluble, 21·6 per cent.

Other, small, undrained lakes occur farther west and were drilled by Cummings, but no beds of permanent crystal were encountered. The brines in general were more dilute than those described.

Dilute brines containing sodium sulphate and magnesium sulphate occur at Wallender and Inks Lakes, about 1½ miles and 2½ miles respectively south of the Iron Mask mine on the road from Kamloops to Meadow Creek.

On the high bench south of Red Plateau, about 2 miles westerly from Tranquille River road and about ¾ mile north of Kamloops Lake, there is a lake (3) less than ¼ mile long that contains brine together with crystals on the shore of the lake and a deposit of crystal on the lake bottom. No estimate could be made of the amount of crystal available, and no samples of the crystal have been submitted for analysis. However, the writer made qualitative tests and found the material to be largely sodium sulphate, probably with minor amounts of sodium carbonate and magnesium sulphate.

Crystal deposits were noted around other lakes in the district, but no attempt was made to sample the deposits.

SODIUM CARBONATE

References: B.C. Minister of Mines, Ann. Repts.: 1922, p. 154; 1930, p. 196; 1931, p. 109; 1932, p. 147; 1933, p. 195; 1934, p. D27; 1935, p. D16; Saline and Hydromagnesite Deposits of British Columbia, Bull. No. 4, 1940, pp. 26-30. Cummings, J. M.: Can. Inst. Min. Met. Bull., Nov. 1938, p. 562.

A small lake (5) containing sodium carbonate is located a mile from the Kamloops-Savona highway, 12 miles west of Kamloops. It lies about ¾ mile south of the Canadian Pacific Railway.

The deposit lies at the contact between granitic rocks and volcanic rocks of the Kamloops group. It is reported to cover an area of about 3 acres, and to be overlain by a few feet of mud below which the crystal, containing 63 per cent water and from 1 to 5 per cent mud, has been penetrated to depths ranging from 18 to 36 feet without reaching bottom. An analysis of 92 per cent sodium carbonate and 8 per cent sodium sulphate is given for the crystal. The proportion of these two compounds is, however, stated to vary, and Cummings (1940) shows that it is probable that the amount of sulphate in the quoted analysis is too low to be representative. Cummings estimates on the basis of the figure previously given about 100,000 tons of permanent crystal.

The deposit was worked by the B.C. Sodium Syndicate, and between 1931 and 1935 about 1,000 tons of impure sal soda was shipped to Vancouver and Calgary.

Buce Lake (11) on the Kamloops-Vernon highway, 14 miles from Kamloops, contains brine with 2·37 per cent solids. This carries 75 per cent sodium carbonate, 3 per cent sodium chloride, 20 per cent sodium sulphate, and 2·3 per cent magnesium sulphate.

MAGNESIUM SULPHATE

Reference: Cummings, J. M.: B.C. Minister of Mines, Bull. No. 4, 1940, pp. 50-51.

Several small lakes (4) occur on the plateau north of Kamloops and west of North Thompson River. Cummings reports that one of these, about 6 miles from Kamloops, contained brine with 20·8 per cent solids. The composition of the solids was: magnesium sulphate, 84·0 per cent; sodium sulphate, 14·7 per cent; sodium carbonate, 1·0 per cent; and

sodium chloride, 0·4 per cent. The lake is about 2 acres in area, and the depth of the brine at the centre probably exceeds 5 feet. The quantity of salts in solution is estimated at 800 tons per foot of depth.

A second small lake 1½ miles south carried brine with 6·0 per cent solids. These carried: magnesium sulphate, 65·0 per cent; sodium sulphate, 31·0 per cent; sodium carbonate, 1·4 per cent; and calcium sulphate, 2·4 per cent.

DIATOMITE

(1) Red Lake Deposit

Reference: Eardley-Wilmot, V. L.: Mines Branch, Dept. of Mines, Canada, Bull. No. 691, 1928, pp. 44-45.

A deposit of diatomite occurs on the farm of B. Chester about a mile northwest of Red Lake post office and some 10 miles by road north of Copper Creek station on the Canadian National Railway.

The deposit is shown by a few open-cuts, which have now largely caved, and similar material is reported to have been encountered during the sinking of several wells on this farm.

According to Eardley-Wilmot the material is "an impure diatomite mixed with volcanic silts . . . . The material which is compact and buff in colour, has an average thickness of 13 feet over at least 25 acres, and there are strong indications that it is also present in other localities on the summit of the divide between Tranquille and Criss Creeks. The predominating diatom is *Melosira granulata* which is typical of the high level Tertiary deposits of Quesnel . . . and the Red Lake material may have washed down from some large undiscovered deposits to the north, and redeposited in its present site.

"Samples tested . . . at the Mines Branch, Ottawa, showed that in its crude state it possesses bleaching qualities for mineral oils equal to standard *fuller's earth.* It also bleaches lard almost as well as the best Pike's Peak earth . . . ."

From the open-cuts the writer obtained a few fossil plants similar to those obtained from the Tertiary beds elsewhere.

BENTONITE

(16) Quilchena

References: B.C. Minister of Mines, Ann. Rept. 1920, p. 169. Cummings, J. M.: Industrial Minerals of British Columbia; Can. Inst. Min. Met., Bull., Nov. 1938, pp. 562-3. Ries, H., and Keele, J.: Clay and Shale Deposits of the Western Provinces; Geol. Surv., Canada, Mem. 25, 1913, pp. 73-4. Spence, H. S.: Bentonite; Mines Branch, Dept. of Mines, 1924, pp. 7-8; Mines Branch, Dept. of Mines, Sum. Repts.: 1918, p. 160; 1921, pp. 73-77.

Bentonite is reported to occur in an outcrop of the Tertiary (Coldwater) rocks on the Triangle ranch near Quilchena with outcrops of coaly shale. According to Ries and Keele, the coal measures at this point strike north 10 degrees east and dip 30 degrees southeast, and the bentonite is

found where a part of the section was exposed by an opening made in the search for coal. The section given is as follows:

	Feet
Coaly shale	
Concealed	10
Bentonite	3
White clay, probably dried bentonite	6
Coaly shale	6
Concealed	

The deposit is a dense, buff-coloured, fine-grained rock with conchoidal fracture. It is stated to have strong absorbent properties. Analyses are given in the Mines Branch report for 1921.

So far as is known this material has not been tested on a commercial scale. Somewhat similar material from Princeton has, however, been tested, and is stated to be inferior in certain qualities to imported bentonites.

Another deposit has been reported from Deadman River, a short distance above the mouth of Gorge Creek, a tributary joining that river about 5 miles above Criss Creek. The clay is deposited in a flat at the base of outcrops of volcanic rocks, and is evidently composed of the products of weathering of these rocks.

COAL

Coal seams outcrop at many places in the map-area, and a considerable production has been made from the basin of Coldwater rocks near Merritt. The areal limits of the coal-bearing rocks in this basin are conjectural, due to the extensive drift cover that, in places, attains thicknesses ranging from 40 to 175 feet; one drill-hole is reported to have penetrated 600 feet of glacial and alluvial material. Although a considerable number of boreholes have been drilled, few of the results appear to be available except those that have already been published[1]. Owing to the lack of complete sections it is difficult to relate the coal seams in different parts of the basin. The number of seams present has been estimated as high as ten, but this figure is based on correlations made from place to place within the basin. The following section, furnished from the records of the British Columbia Department of Mines, shows seven seams in the area worked by the Middlesboro Collieries, with the intervening thicknesses of strata from the base of one seam to the base of the next. The thicknesses given for the seams is approximate only and includes partings in the seams.

		Top of section Feet
No. 2 seam		6
Interval	70	
No. 3 seam		2.5
Interval	50	
No. 6 seam		7
Interval	210	
No. 8 seam		8
Interval	160	
No. 4 seam		28
Interval	120	
No. 5 seam		5
Interval	160	
No. 1 seam		30

[1] Ells, R. W.: Nicola Coal Basin, B.C.; Geol. Surv., Canada, Ann. Rept. 1904, vol. XVI, pp. 52A-74A and map.

From the information available to the writer the seams being developed on the property of the Diamond Vale Colliery could not be correlated with the above seams with any degree of assurance.

Near the western margin of the basin where work was being carried on by Middlesboro Collieries at the time the writer was in the field, the beds lie in tight folds with axes trending northwest and plunging southeast. The dip of the measures is in places 70 degrees or more.

In the central part of the basin the dips are more moderate, the strata generally striking northwest and dipping southwest at angles up to 30 degrees. Drill-holes have established the presence of the coal measures at some points, but the drilling has not been sufficient to present a complete section of the basin. The records of some holes are not available and their location is a matter of some doubt. One hole near the junction of Coldwater and Nicola Rivers is reported to have penetrated into the underlying volcanic rocks without encountering the coal measures, after having passed through 600 feet of glacial and alluvial material. Others were abandoned after penetrating several hundred feet of superficial deposits without reaching bedrock. The data appear to indicate that near the northern margin of the basin the measures may have been completely removed by erosion in places.

One point of importance is that a nearly horizontal flow of vesicular basalt forms a bench on the south side of Nicola River. This was shown in an earlier report[1] as a tongue of Triassic volcanic rocks dividing the coal basin in two parts at this point. The writer's interpretation is that these basalts are younger than the coal measures, and that the latter would pass beneath the volcanic rocks unless, of course, they were removed by erosion prior to the extrusion of the lava flows.

The chief coal producer of the area was the Middlesboro Collieries (14). The mines of this company operated for about 38 years, and finally closed down early in 1944, the machinery and properties being offered for sale.[2] Other groups have made a limited production. Some of the workings of Diamond Vale Collieries (15), lying in the Nicola Valley flat east of the Middlesboro property, were reopened in 1943 after having been idle since 1917, but closed down again in 1945.

On Quilchena Creek (17) drilling done many years ago by Diamond Vale Collieries disclosed several seams of coal. As this locality is some considerable distance from railway transportation little progress has been made with mining. Some coal has been mined for local use.

Similar rocks occur in the valley of Guichon Creek, where, however, only isolated outcrops could be found. Some drilling has been done, but the results are not known to the writer.

Thin seams of coal were discovered, in 1888, in the area of Tertiary rocks on Guerin Creek 3 miles southwest of Kamloops. These rocks belong to the Tranquille beds and are possibly younger than those of the Coldwater group. A small amount of coal was mined for local consumption, but the occurrence was not found to be economic. Boring was undertaken in the beds of the same group farther to the northwest where there is a thicker accumulation of these rocks, but failed to disclose coal.

---

[1] Ells, R. W.: op. cit., Map.

[2] The land of Middlesboro Collieries and part of the Diamond Vale land has since been acquired by a new company. The work being done is largely the rehabilitation of the old No. 2 slope.

86446
A. View across Coldwater River towards Iron Mountain, showing sparsely timbered lower slopes, heavily timbered upper slopes, and, in the middle distance, a high bank of glacial deposits. (Page 2.)

86426
B. View westerly across the open valley of Stump Lake Creek towards the heavily timbered Nicola Plateau. (Page 2.)

A. Bedding and crossbedding in the augite-porphyrite tuff. Painted Bluffs.
(Pages 2, 25, 28.)

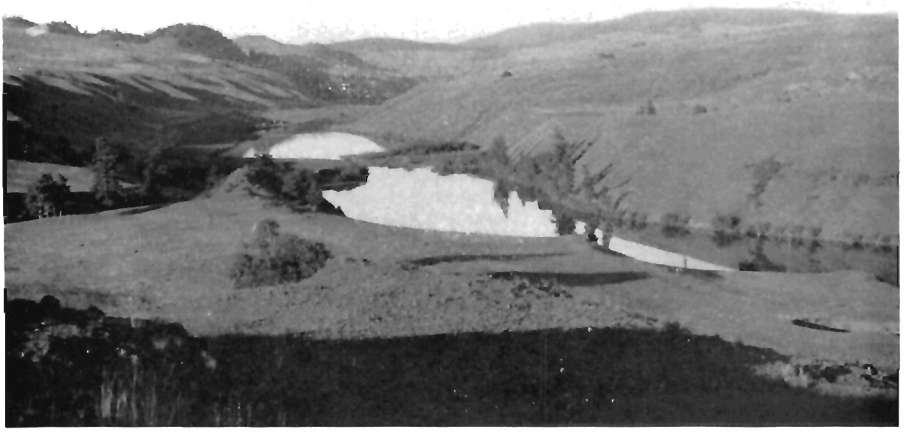
B. Erosion of the serpentine and augite-porphyrite tuff. Painted Bluffs.
(Pages 2, 26.)

58295

A. Columnar jointing in basalt, near Tranquille. (Page 38.)

86415

B. Nearly horizontal vesicular basalt overlying unconsolidated material, which is talus of greenstone. The lower few inches of the lava has included fragments of the greenstone. Quilchena Creek. (Page 41.)



86444
A. Looking north across Napier and Ritchie Lakes, showing terraces of glacial materials. (Page 41.)

88267
B. White silt terraces, South Thompson River east of Kamloops. (Page 42.)

86445
A. Mineral Hill and part of the camp of Consolidated Nicola Goldfields, Limited. The plant is the surface plant at the adit level of the Enterprise-King William workings. (Page 47.)

88273
B. Shaft at the Mercury group, Tunkwa Lake. The cinnabar showings occur on the mound of carbonate rock back of the shaft. A line of open-cuts can be seen on the right side of the mound: other cuts from which recent production was made lie to the left of the mound. (Page 83.)

INDEX