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THE GEOLOGY AND MINERAL RESOURCES of the CARIBOO DISTRICT. British Columbia.

by A. Killin.

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THE GEOLOGY AND MINERAL RESOURCES OF THE CARIBOO DISTRICT, BRITISH COLUMBIA.

Part 1. Introduction.

(1) The scope of the Thesis:-

Although this paper is entitled, "The Geology and Mineral Resources of the Cariboo District, B.C.," it was found, upon examination of the literature by the writer, that the only available material was a reconnaissance report by Amos Bowman,[1] a detailed report on the Barkerville area by Johnston and Uglow,[2] a report by Hanson on the Barkerville Gold Belt,[3] Cockfield and Walker's report on the Quesnel Forks map-area,[4] a report on the Willow River by Hanson,[5] and a preliminary report on the Keithly Creek District by Lang.[6] The material for this thesis has, therefore, been taken from these reports.

1. Geol. of Mining Dist. Cariboo; G.S.C. Ann. Rep't. Vol.III, 1889. Placer & Vein-gold deposits of Barkerville Cariboo District, B.C.
2. Johnston and Uglow. G.S.C. Mem. 149, 1926.
3. Barkerville Gold Belt.-Hanson, G.S.C. Mem. 181, Geol. & Placer Deposits of Quesnel Forks Area, Cariboo Dist.
4. B.C. Cockfield & Walker, G.S.C. Summ. Rept. 1932, Pt. AI. 1933.
5. Willow R. Map-Area. Cariboo Dist., Hanson G.S.C. Sum. Rept., Pt. A. Prelim. Rept. Keithley Cn. Maparea, Cariboo Dist, B.C.
6. Lang G.S.C. Paper 36-115, 1936.

(2) Acknowledgements:

I would like to thank Miss Smith of the University Library staff, and Dr. A.H. Lang of the Geological Survey of Canada, for their kind help in assisting me to assemble the material for this thesis. I would also like to thank Dr. S.J. Schofield for his many helpful suggestions.

(3) Bibliography.

1. Bowman, Amos,- "Report on the Mining District of Cariboo British Columbia." Geological Survey of Canada, Annual Report, Vol. III, 1889.

2. "Placer and Vein Gold Deposits of Barkerville, Cariboo Dist., B.C., Johnston W.A. and Uglow W.L., Geological Survey of Canada, Mem. 149.

3. Hanson, G.- "The Barkerville Gold Belt, Cariboo Dist., B.C., Geological Survey of Canada, Mem. 181.

4. Cockfield, W.E.- Walker, J.F. "Geology and Placer Deposits of Quesnel Forks Map-Area, Cariboo Dist., B.C." Geological Survey of Canada, Sum. Rept. 1932, Part A I.

5. Hanson, G.- "The Willow River Map-Area, Cariboo Dist., B.C.," Geol. Surv. of Canada, Summary Report,1935, Part A.

6. Lang, A.H.- "Preliminary Report on the Keithley Creek Map-Area, Cariboo Dist, B.C.," Geol. Surv. of Canada, Paper 36-15, 1936.

7. Cockfield, W.E.- Lang, A.H. "The Geology and Mineral Developments of Cariboo District, B.C.,"--The Can. Institute of Mining and Metallurgy, Transactions, Vol. XL, 1937, pp. 462-474.

8. Reports of the British Columbia Minister of Mines from 1878 to 1936.

PART II.

A. Location:

The Cariboo District lies in the interior plateau region of British Columbia. The area is bounded in the south by 52° N. latitude and in the north by 54° N. latitude. The northeastern boundary is formed by the British Columbia-Alberta boundary. The southeastern boundary is formed by a line following the drainage divide of the Clearwater and North Thompson Rivers. The area is bounded on the west by the 124° W. longitude.

B. General Characteristics of District.

Topography.

Except for the northeastern part, the Cariboo District exhibits all the land forms of a deeply dissected plateau region. The mountains are smooth, round-topped, with deep valleys. In the northeastern part, we have the Cariboo Mountains. These are rugged and some peaks extend up to 8000 feet or more. As one goes westward, there is a gradual change to the smooth-topped hills of the Barkerville region, these slope gradually to the west until the region of the Mesozoic lavas is reached. Here the topography changes to that of low rounded hills and broad open stream valleys.

Climate.

The region is farily dry in the western district, but there is more rainfall in the east, as one approaches

the higher Cariboo Range. Snow lies on most of the plateau for four months of the year and the winters are quite severe.

(c) Drainage.

The Cariboo District is practically bisected in a north and south line by the Fraser River and most of the main rivers feed into this large one. The drainage pattern of the streams is controlled to a large extent by the structural features of the bed rock, but is complicated in palces by stream piracy, and reversal of drainage. The main valleys were formed by stream erosion in pre-glacial times. There are numerous lakes in the district, the largest being Quesnel and Horsefly Lakes.

(d) Glaciation.

Glacial striae are found in only a few places in the area. Where found, these striae point down stream, and indicate erosion by valley glaciers. These valley glaciers were very active in Pleistocene time. They eroded some valleys and filled others with glacial drift. There is evidence of at least one great ice sheet which covered the whole region. It is thought that this ice sheet was practically stagnant and protected the underlying rocks from great erosion, and that there was an interglacial period during which, great erosion of the drift occurred and some placer gold was concentrated in the valleys.

PART III.

A. General Geology.

(1) Lithology:- The general geology outlined here, is based on the reports mentioned in the introduction.

TABLE OF FORMATIONS.

ERA	PERIOD	EPOCH		FORMATION	LITHOLOGY
Cenozoic	Modern	Recent Pleistocene			Sand, gravel, silt, Glacial and interglacial gravel, sand, silt, boulder clay.
	Unconformity				
	Tertiary				Gravel & lava basalt.
Unconformity					
Mesozoic	Jurassic (?)			Mount Murray Intrusives	Dikes & sills of Intermediate to basic composition. Greenish grey & purplish brown volcanics.
Intrusive Contact.					
Paleozoic	Carboniferous	Mississippian.	Slide Mountain Series	Antler	Thinly bedded, white, red and black chert interbedded with greyish-green indurated shale.
				Waverley Greenberry Guyet	Basic volcanics. Crinoidal Limestone. Basal Conglomerates.

Unconformity.					
				Prosperine Intrusives.	Acidic sills and dikes.
Intrusive Contact.					
Precambrian.			Cariboo Series.	Pleasant Valley	Argillite, slate, phyllite, sericite, schist, quarzte.
				Barker-ville.	Limestone, quarzte., argillite, sericite, schist.
				Richfield	Sericite schist, quartzite, argillite, and related types.

The three more northerly map-areas, i.e., The Willow, River, Barkerville and Keithley Creek, areas are to a great extent, underlain by the Cariboo series. The Quesnel Forks Area is underlain largely by the Mesozoic lavas and also by rocks of the Slide Mountain Series.

The Cariboo Series is made up of three main formations. The lowest member is the Richfield Formation. This formation is made up of a great variety of highly altered sedimentary types, quartzites, sericite schists, quartz slates, etc. The middle formation is called the Barkerville Formation, and consists of massive limestone beds and some argillites and quartzites. The upper member, known as the Pleasant Valley formation, is largely composed of argillites, slate and quartzites.

Scattered through the Barkerville and Keithley Creek areas are small acidic dikes and sills called the Prosperine Intrusives. These were not found in the Willow River Area; they are probably present, but not as outcroppings. These dikes and sills cut the Cariboo series, but are not found in the Slide Mountain series. Their exact age is not known, but they are thought to be intermediate in age, between the Cariboo Series and the Slide Mountain Series.

The Slide Mountain Series consists of younger sedimentary rocks. This series is different from the Cariboo Series in several ways. It is generally well bedded and is sheared only locally and to a minor degree. Johnston and Uglow[1] divided this series into four formations.

The Antler formation is at the top and consists mainly of thinly bedded white, black and red cherts, interbedded with greyish green indurated shales.

The Waverley formation is largely made up of baisc volcanic flows and breccias, and lies directly below the Antler formation. The Greenberry formation is made up almost entirely of limestone. Imperfect fossil crinoids were found in this limestone and based upon examination of these fossils, the formation was tentatively placed in the Mississippian age.

The Guyet formation is the base of the Slide Mountain series and is made up of a basal conglomerate.

The Slide Mountain Series was found outcropping in the northeastern parts of the Keithley Creek, Barkerville,

1. Placer and Vein Gold Deposits of Barkerville Area, G.S.C. Memoir 149. --1926.

and Willow River map-areas. It unconformably overlies the Cariboo Series.

Separated from the Slide Mountain Series by an intrusive contact, and overlying this series, is an assemblage of basin sills and dikes which are called the Mount Murray intrusives. These rocks are considered by Johnston and Uglow to be doubtfully Jurassic in age.[1] The sills and dikes vary in composition between diorite, hornblende diorite, diabase, gabbro, and hornblende gabbro. Some of the smaller dikes are very coarse grained, while the larger ones are very fine grained. It is thought that these fine grained rocks may be submarine. Few of these rocks are fresh.

In the Quesnel Forks Area is found an entirely different type of rock formation. In the southwest corner of the map sheet are found conglomerates and arkosic sandstones of undetermined age. Believed to be overlying these rocks, are found limestones, cherts and argillites. These rocks have been tentatively mapped as Mississippian in age, and as such, would be the same age as the Slide Mountain Series of Johnston and Uglow.

There are two distinct types or groups of volcanics in the Quesnel Forks. area. One group consists of greenish-grey, fine-grained porphyritic and brecciated volcanics. This series is similar in mineral composition. Th rocks average about augite andesite porphyry. The other group is one of purplish brown volcanics. This series is similar in mineral

1. G.S.C. Memoir 149.

composition to the greenish volcanics, but contains iron oxides (red-brown) and a prevalense of breccias. These breccias range from fairly fine grained to very coarse explosive breccias. The greenish volcanics are found interbedded with the purplish volcanics and also found with these flows are fossiliferous argillites. These argillites are not so common in the Quesnel Forks area, but in the Swift River Area, adjoining the former sheet, on the north, are quite extensive in the south-western part of this area. They have a northwest trend and are interbedded with the greenish volcanics. In the south-west corner of the Willow River Area, are found black shales which are correlated with the shales and volcanics found in the Quesnel Forks and Swift River Areas. These shales have a north-west strike and are considered to be Mesozoic in age.

The above mentioned Jurassic formations are the youngest consolidated rocks known in the Cariboo. The few known deposi ts of Tertiary age consist of unconsolidated gravels and ancient talus. These deposits are rare and are only found in narrow V-shaped valleys that were not entirely eroded by glaciation. In the Quesnel Forks Area, are found some olivine basalts. These rocks have been tentatively placed in the Miocene. They have been greatly eroded and the remnants left are essentially of a valley-fill occurrence.

Overlying the bed rock of most of the geologically

mapped district, are recent (~~Coast~~ Post Glacial) alluvium, glacial drift, interglacial deposits, and gold-bearing gravels, parts of which are pre-glacial inage,

(2). Structure. Bowman's[1] cross-section, accompanying his report on the Cariboo District, shows the area mostly underlain by the Cariboo Series in the attidude of broad, open folds, with a northwest trend. On the northeastern end of this cross-section, the Cariboo beds outcrop in the Cariboo Mountains. Adjacent to this range on the southwest, (following the line of the sectinn), is the Slide Mountain Series, West of this series, the Cariboo series outcrops agian as a broad anticline which continues to Cariboo Mountain and Keithley Creek where it dips under the Mesozoic beds of the Quesnel Forks area. The only major intrusive shown on Bowman's map, occurs on Mount Stevenson, on Quesnel Lake.

In the folding, the Barkerville limestone beds, the heavily-bedded non-schistose members of the Richfield formation and the Slide Mountain Series and Mount Murray sills act as competent horizons. These horizons are characterized by broad open structures and a general regularity of strike and dip. Between them occur the rocks of the Pleasant Valley formation and the schistose members of the Richfield Formation. These are the incompetent beds and are characterized by pronounced drag folding and changes in dip.

1. Amos Bowman,-Rep't. on Geol. of Mining Dist. of Cariboo, British Columbia. G.S.C. Ann. Rep't. 1887.

The incompetent beds of the Slide Mountain series are not as highly folded as those of the Cariboo series. This suggests two periods of folding, the more intense one being pre-Mississippian, the less intense period being subsequent to the intrusion of the Mount Murray intrusives.

There are three types of faults in the district.

(a) Reverse faults of compression. These are small faults associated with the folding of the Cariboo series.

(b) Strike faults of tension. There is one major fault of this type which is thought to have a downward displacement of about 6000 feet. This fault explains the apparent repetition of the Barkerville and Pleasant Valley Formations.

(c) Cross-range faults of tension. These faults are numerous and cross all formations. They are the effects of the later folding and have in places, horizontal displacements of from 1000 to 4000 feet.

B. Geological History.

(1) Pre-Cambrian:- The Pre-Cambrian era started with a deposition of coarse quartzy sand and sandy clay. The presence of abundant iron oxide as a cement, the great variation in grain size and the enormous thickness of these beds, point to conditions of continental deposition in localities of high relief. These are the Richfield beds.

Following this deposition, came a period of limestone deposition with sandy and clayey beds. This was the formation of the Barkerville Series and indicates lower relief and clearer waters.

The last period of sedimentation in the Cariboo was a time of deposition of calcaceous and carbonaceous clays and volcanic ashes. These form the Pleasant Valley Series.

Following the deposition of the above formations there was a period of orogenic movement, intrusion and erosion. The strata were thrown into broadfolds with a nofthwest trend and recrystallized into quartzites, schists, and slates. Great hinge faults and shear zones were produced and the prosperine sille and dykes were intruded. This intrusion was intermittent and continued throughout the time of deformation.

According to Uglow[1] it was during this intrusion that the shear zones of the Cariboo series were extensively replaced by great lenses, and veins of quartz (A" veins) coming as offshoots from major intrusions which have not been unroofed.

The settling of the country after folding formed the first series of transverse faults. These faults were then healed with quartz and mineralized with auriferous sulphides ("B) veins

(2) Paleozoic-Carboniferous. Following this erosion period, the country was submerged and the rocks of the Slide Mountain Series deposited. The Guyet basal conglomerate was formed from partially-sorted residual material

from the old land surface. Clay and chert and a bed of massive limestone were also deposited at this time.

(3) Mesozoic-Jurassic (?)

Separated from the Slide Mountain series by an intrusive contact, we have the Mount Murray series, consisting of sills and dikes of basic rocks. These rocks have been tentatively placed in the Jurassic period, correlating them with the Coast Range Batholithic intrusion.

There was a large outpouring of lavas in the western part of the area. These lavas are thought to be fissure flows and to be of the same age as the Coast Range intrusion i.e., Jurassic.

This intrusion was followed by a period of progenic movements and the rocks were refolded along the same lines as in the last folding epoch. This folding was less intense and the Slide Mountain and Mount Murray formations were not metamorphosed. The uplift was followed by settling and cross-range fracturing. Following this settling, the country was subjected to great erosion, until the Cretaceous time.

(4) Tertiary.

The Tertiary record is very incomplete. There are a few outcrops of Tertiary gravels and in the northwestern part of the Willow Creek area, there are lava outcrops which are believed to be Tertiary in age. The period,

as a whole, seems to have been one of erosion, with the material being deposited to the west and southwest. It is thought that much of the placer gold was set free and concentrated at this time.

(5) Recent.

In Pleistocene time, there were two types of glaciers. The first type consisted of large, almost stagnant ice sheets. These glaciers did not do much eroding, but the streams formed by their melting had quite an effect. The second type were the valley glaciers. These overdeepened some of the valleys and filled others with glacial drift. There was some reconcentration of the placer gold.

The modern streams have been resorting and removing the glacial drift. There has not been much erosion of bedrock.

PART IV.

LOCAL FEATURES OF THE CARIBOO DISTRICT.

A. Introduction.

In discussing the local features of the Cariboo district, it will be found necessary to confine the discussion to the parts of the district which have been mapped in detail, These consist of the Willow River, Barkerville, Keithley Creek and Quesnel Forks Areas. It is thought, by the writer, that a description of the features of these areas will give a fairly representative picture of the whole Cariboo district.

B. Barkerville Area.

B. Barkerville Area.

(a) Location.

The Barkerville District is approximately in the heart of the Cariboo District. The boundaries of the map-sheet are as follows: on the north, 53° 10' latitude, on the west, 121° 45' longitude, on the south, 53° latitude, and on the east, 121° 15' longitude.

(b) Topography.

Barkerville Area is almost entirely underlain by the Cariboo series. This fact has a direct bearing on the topography. The rocks are highly resistant to erosion. The region has the appearance of being an upraised and deeply dissected peneplain. The rounded and gently rolling summits have nearly accordant levels, with a western or northwestern slope toward the Fraser River. The valleys are deep and sometimes extend to 2000 feet below the level of the uplands. The topographic unconformities between the ridges and the valleys are usually sharp on the northern boundaries of the uplands and less well-defined on the southern boundaries. This abruptness is due to many ~~waves~~ cirques, the headward slopes of which intersect the plateau tops, with almost knife-edge boundaries.

The stream valleys are narrow and steep-sided, but locally show the V-shape characteristics of glacially eroded valleys.

(c) Drainage.

The main drainage of the region is to the

northeast by way of the Willow River. Due to the deep dissection, the streams of the area show a marked irregularity. The drainage pattern is controlled to a great extent by the structure of the bed-rock, some streams following the axis of folding of the rocks and others following the ~~mass~~ cross fracturing. There are many lakes in the district, the largest being Jack of Clubs Lake, which has a maximum depth of 175 feet.

(d) Geology.

The Barkerville area has been of interest in the mining worls for many years and the geology has been studied in some detail.

The district contains most of the rocks listed in the Table of Formations given in part III, The Mesozoic lavas are missing; also the lavas of Tertiary age, which were noted in the Willow River Area.

The area is underlain to a great extent, by the rocks of the Cariboo series. It was in this area that Johnston and Uglow[1] divided this series into three main divisions, the Richfield, the Barkerville, and Pleasant Valley.

In this area, the Richfield consists of metamorphosed quartzose sediments. Some of these are : quartzites, quartz slates, quartz sericite schists,carbonaceous clays and slates with minor intercalations

1. Johnston and Uglow,-G.S.C. Memoir 149.

of limestone, calcareous argillite and silicified tuff.

The Barkerville formation is poorly exposed in the Barkerville area. The rocks which were found to belong to this formation are composed chiefly of massive limestone. There are also minor amounts of thinly bedded sericitic quartzite, quartz, slate, and quartz-sericite, schist.

The Pleasant Valley formation was found conformably overlying the Barkerville formation. The members of the Pleasant Valley Formation in this area, consist in the main of argillaceous sediments. The most dominant type is a clay slate with well-developed cleavage. There are also small amounts of schistose volcanic rocks. Veinlets and lenses of quartz occur abundantly throughout the formation. Some of these veins contain disseminated pyrite.

Cutting the Cariboo series, there are a number of acidic sills and dikes, consisting mostly of quartz-porphyry, felsite, aplite, and quartz latite. These rocks have been called the Prosperine Sills and Dykes, These dykes were not found cutting the Slide Mountain Series.

In the northeastern part of the area, is found a series of sedimentary rocks unconformably overlying the Cariboo series. This series is made up of conglomerate, limestone, chert, argillites, and some basic volcanic flows and flow breccias and is known as the Slide Mountain series. This series has been divided into four formations. Aththe base is the Guyet conglomerate. This formation grades from

a somewhat decomposed schistose conglomerate at the base, into a massive, heavily bedded, bouldery deposit towards the middle part, and a coarse-grained, gritty, quartzite near the top. Conformably, overlying the Guyet basal conglomerate, is found the Greenberry formation. The main rock is a medium-grained grey limestone, veined with dark colored chert. The overlying formation, the Waverly Formation, was poorly exposed, and it was found impossible to locate the horizon of this formation accurately. The rocks of this group consist partly of andesitic and basaltic lava, with prominent pillow structure, and partly of schistose, amygdaloidal, andesitic and basaltic flow breccias.

The northeastern corner of the map sheet is largely underlain by the Antler formation. It unconformably overlies the Greenberry formation of limestone. The rock types are greyis-green argillites and white chert, with minor amounts of red, indurated shale and jasper and some silicified quartzite.

Separtaed fromthe Slide Mountain Series by an intrusive contact, we find the Mount Murray Sills and intrusives. They have been correlated with the Coast Range (Jurassic) period of intrusion and are made up of diorite, horneblende diorite, diabase, gabbro and horneblende gabbro.

Very few Tertiary deposits have been found in the area. Where found, they consist of very poorly consolidated gravels. These gravels are found to contain placer gold in many places.

The unconsolidated deposits overlying the bedrock consist of Recent (post-glacial) alluvium, glacial drift formed during the Ice Age, interglacial deposits, and gold-bearing gravels.

The major structural feature of the Barkerville Area is a broad open anticlinorium whose axis tends north-west. The anticlinorium pitches a few degrees to the south-east.

C. The Willow River Area.

(a) Location. The Willow River Area bounds the Barkerville Area on two sides, the northern and western. Officially it lies between latitudes 53° and 53° 15' and longitudes 121° 30' and 122°. The western boundary of the area is 30 miles east of Quesnel. There is an automobile road joining Quesnel and Barkerville.

(b) Topography. The topography is very similar to that of the Barkerville Area. The general level of the mountain summits have a gentle south-westerly slope. On the western border of the sheet, the general level falls rapidly to the level of the low-lying ground, adjacent to the Fraser River. This drop in elevation is coincident to passing from the more resistant metamorphosed sediments of the Cariboo series in the east, to the softer Mesozoic lavas in the west.

(c) Geology. The greater part of the area is underlain by the Cariboo series. It was found imposs-

possible to subdivide the Cariboo series, into definite lithological formations in this area. The Cariboo Series crosses the area from northwest to southeast in a band 15 miles wide and occupies 80 per cent of the area. It is made up principally of grey to dark grey quartzites, grey quartz-sericite schists, sericite schists, argillaceous schists, sheared conglomerates and partly or wholly converted into marble,--limestone. These are the country rocks of the gold-quartz veins of the area.

Overlying the Cariboo Series in the eastern part of the area are sediments and volcanics believed to be of late Paleozoic or Mesozoic age.

Outcrops of the Prosperine Sills and Dikes found in the Barkerville Area are not found in this area, probably due to the extensive covering of drift which mantles the whole area. The Slide Mountain Series is identified in the eastern part of the map area. These younger rocks hold no known ore deposits of commercial value. They are generally well bedded and the shearing found was local. In this area, due to insufficient outcrops, only the Guyet, Antler, and Greenberry formations were identified. The Guyet consisted of gritty quartzites and is only found in the eastern part of the area. The Greenberry limestone is also found in the eastern part of the area. Much of the northeastern part of the map area is underlain by the Antler formation. It consists of grey to white cherts and greenish grey shales.

In the extreme north-east corner of the map-sheet are found numerous outcrops of basalts and gabbros. The Antler formation dips east under these rocks. Whether these rocks are intrusive or extrusive, has not definitely been decided, but they are thought to be Mesozoic in age.

The south western part of the Willow River map is underlain by Mesozoic rocks. These rocks have the same strike and are of the same type as those occurring inthe Quesnel Forks Area. In the Willow River,area, however, there are more sedimentary and less igneous rocks than in the Quesnel Forks Sheet. In Willow River Area, the rocks are mainly black-shales which strike west-northwest and dip steeply. These rocks are folded into light anticline and synclines. Only a few basic dikes or sills were seen in the area. These rocks have been placed by Cockfield and Walker[1] in the Jurassic,

Throughout the area are found rare deposits of gravel, sand, talus, etc., in various stages of concentration. These deposits have been placed in the Tertiary.

Pleistocene accumulations of boulder clay, morainal debris, stratified gravel, sand and silt and Recent deposits of gravel, sand and silt are found extensively throughout the area.

The Cariboo series lies in a broad, northwesterly plunging anticline. On the eastern flank occur the rocks of the Slide Mountain Series. On the western

1. Geol. Sur. Can. Sum. Rept., 1932 Part 1-A pp. 79-84.

flank the rocks of the Mesozoic age occur.

(d) Drainage.

In the eastern part, the drainage is northeast to the Bowron River. In the northern part, it is north to the Fraser, by means of Willow River. Lightning Creek, flowing westward, drains the south-western part of the area, and joins the Swift River, forming the Cottonwood River which flows northwest to join the Fraser.

D. The Keithley Creek Area.

(a) Location.

The Keithley Creek Area is in the southern part of the Cariboo District. Its north-south boundaries are latitudes 53° and 52° 45'. Its east-west boundaries are longitudes 121° and 121° 30'. The northern part of the area can be reached by road from Barkerville. The southern part can be reached by a road from the 158-mile house on the Cariboo Highway, to Keithley Creek.

(b) Topography.

The topography of the region is very similar to that of the Barkerville area. The eastern part is a little more rugged because this map-sheet is in an intermontane belt, forming the transition zone between the Interior Plateau and the more rugged Cariboo Mountains. The mountains in the area are generally flat-topped with steep northern slopes and more gentle slopes on the southern sides.

(c) Drainage.

The master valley of the region is that of Cariboo (Swamp) River, which was cut during Tertiary time, and deepened by glacial action in the Pleistocene. This river flows southwest to join in the Quesnel River, Except for the northwest corner of the area, the drainage is all tributary to the Quesnel River. The northwest corner is drained by means of Antler Creek, northwest to the Fraser River.

The drainage pattern follows two general directions. Some streams flow northwest and southeast, parallel to the strike. Other streams flow northeast of southwest and follow the trend of the cross-range faulting.

(d) Geology.

Except for a small territory where the Slide Mountain series has been found, the area is underlain by the Cariboo series.

The Richfield is found in the western part of the area. The formation is largely made up of altered impure quartzites and argillites. These are found interbedded with one another and with minor quantities of conglomerate, slate, graphite schist and limestone.

The Barkerville formation occurs in two parallel belts, in the eastern part of the area. The belts are separated by the Pleasant Valley formation. Limestone

is the chief rock of the formation.

The Pleasant Valley formation also occurs in two separate belts. One belt separates the two parts of the Barkerville formation. The rocks of this formation are essestially argillites. The characteristic rocks are fissile, black argillites, slates, and phyllites, with minor interbeds of quartzite, schist and limestone.

A few narrow, soft, buff-weathering sills and dikes were found cutting the Cariboo Series in the Keithley Creek area. They are thought to correspond to the Prosperine Intrusives of the Barkerville Area.

Only afew outcrops have been tentatively correlated with the Slide Mountain Series. One of these is a large outcrop of conglomerate containimg mostly limestone pebbles which outcrops in the canyon of Cariboo River near the mouth of Limestone Creek.

There is a large diabase dike outcropping at the head of Lost Creek which is believed to be related to the Mount Murray Intrusives of the Barkerville Area. It is about 100 feet wide and strikes north 27 degrees east.

The major structure in the area is similar to that in the Barkerville Area and consists of a broad anticlinorium whose axis strikes northwest. The sediments of the axis are staggered successively to the southwest, apparantly due to ~~the~~ some type of faulting.

Pleistocene and Recent deposits of the area consist essentially of gravels, sands, and silts.

E. The Quesnel Forks Area.

(a) Location.

The Quesnel Forks Area lies astride the Quesnel River. Its northern boundary is six miles north of Quesnel River. The area extends westerly from near the lower end of Quesnel River to a short distance below the mouth of Berrell Creek. Officially, the area lies between latitudes 52° 30' and 52° 45' and the longitudes 121° 30' and the longitudes 122°.

The area lies about forty miles by road from Williams Lake. The road from the Cariboo Highway to Keithley Creek passes through the central part of the area.

(b) Topography.

The area is relatively low with subdued relief. The streams flow in narrow, deep valleys. The general level is about 3000 feet above sea-level, and the maximum relief is not over 2800 feet. The hills seldom rise higher than 4000 feet and the general aspect of the area is that of a gently rolling terrain with rounded hills.

(c) Drainage.

The main valleys of the area are the Quesnel River, its tributaries, the North and South Forks, and Beaver Creek. These main rivers flow in deeply cut, narrow trenches, in the upland surface. The smaller streams in the

area are all tributary to these three and flow in canyons cut in the bedrock or in unconsolidated deposits. The drainage pattern so formed has a northwest-southeast trend, following the bedrock structure, with a subsidiary pattern at right angles to this.

(d) Geology.

Bedrock relationships between the various lithologic formations were seldom found because of an extensive mantle of unconsolidated materials throughout the area.

In the southwestern corner of the sheet, to the west of Beaver Creek, occur extensive deposits of conglomerate and snadstone. The formation has a general northwest-southeast trend. The conglomerate beds grade from a cobble to a pebble conglomerate and through arkosic grits to arkosic sandstone. The cobbles and pebbles are chiefly quart zite.

Outcrops of limestone, cherty argillite, and greenstone also occur in the southwestern part of the afea. The greater part of the exposures consists of finely crystallized limestone which has been fractured and filled with calcite veinlets. The cherty argillites are intruded by light greenish-grey greenstone. These rocks have been mapped as Mississippian but Cockfield and Walker[1] think that they may be younger than the conglomerate beds and might be Jurassic (?) in age.

The greater part of the area is covered by

1. Cockfield and Walker,-Geol. of Quesnel Forks Area, G.S.C. Summary Rept. 1932, Pt. A1.

volcanics. There are two types of volcanics.

Type one is the greenish-grey volcanics. Under this heading are grouped a variety of intrusives and extrusives, chiefly augite, andesite porphyry and volcanic breccia along with some sediments. These rocks are generally dark grey to greenish grey, fine grained, and porphyritic. The ground mass is fine grained and dense and the phenocrysts are small crystals of augite, dark green in color.

The second type is the purplish brown volcanics. These rocks occur in a wide belt which has a northwest trend across the center of the area and have a purplish to red-brown color. These volcanics vary in appearance and character from massive flows to coarse breccias. When examined microscopically, these rocks were found to be similar to those of the greenish grey volcanics group.

A band of limestone is found within the beds of volcanics and several outcrops of argillite have been found interbedded with the volcanics. It is thought that there was a nearly continuous period of volcanic activity with one short period of sedimentation. From fossils found in one of the argillite beds, the formation is tentatively placed in the Jurassic.

Igneous rocks, some of which are known to be intrusives, and others which are thought to be, outcrop in a number of small scattered exposures throughout the area. They vary from syenite to monzonite and pyrozenite.

Olivéne Basalts occur in flat-lying flows of dense, columnar and vesicular basalt, some with smooth surfaces and others with rough, ropy surfaces. These lavas have been g reatly eroded and the remnants left are essentially of valley fill occurrence. They are thought to be late Miocene in age.

The structure of the area is tentatively described as a large syncline, but lack of sufficient outcrops has prevented actual determination of the structure.

PART V.

MINERAL DEPOSITS.

A. Introduction.

The Cariboo district has been known from the 1860's as a gold producer. For its area it was one of the richest placer grounds in the world. Strangely enough it was not until early 1930-31 that any successful lode gold operations appeared in the area. Lode gold operations had been carried on from the early 1870's but none of them were successful, until better transportation routes facilitated the bringing in of modern mining machinery.

B. Placer Deposits.

(a) History. Prior to 1858, placer gold was known to exist in the province and when news of the dis-

covery of gold reached the United State s, there was an immediate rush to the new field. The trail of the gold was followed up the Fraser to the Quesnel, up the Quesnel to Keithley Creek. It was not long until the gold had been followed into what is now the Barkerville Area. Here the richest ground of all was discovered about 1860, on Williams and Lightning Creeks. The yield of placer gold began to diminish in 1875 and 1876 but the Cariboo is still producing a fair amount of placer gold.

(b) Occurrence.

According to Johnston and Uglow[1], there are five ways in which the ~~grey~~ pay streaks occur:

(1) They occur in ancient gravels lying on bedrock and covered by great or small thicknesses of glacial drift. It was in these gravels that the rich pay-streaks were first found and they are the most important sources of placer gold in the area. These gravels average five to six feet in thickness. Where the gravels have little clay and are porous, the gold is found mostly in the cracks and crevices of the bedrock; but where the gravels contain much clay, and contain partly disintegrated fragments of country rock, the gold is apt to be scattered through them.

The gravels consist of water-worn, but somewhat angular fragments of the country rock, and ancient talus or slide rock is generally present. They are called

1. Johnston and Uglow,-Geol. Surv. of Canada, Mem. 149.

"Flat-wash", by the miners and are found mostly in the narrow deep parts of the creek valleys, where the effects of glaciation have not been pronounced. The gold is a mixture of coarse and moderately fine gold and is referred to by the miners as "Lead Gold".

(2) The second type of placer gold occurrence is on the bedrock benches at various heights above the creeks and in a few places in abandoned or partly abandoned stream channels. The gravels on these benches are mostly glacial drift. Gold occurs on the bedrock and scattered throughout the gravel. This gold is nearly uniform in size and is flattened and worn as if it had been transported by powerful streams.

(3) Type three is interglacial pay streaks; that is, they are pay streaks underlain and overlain by glacial drift. These deposits occur on a false bedrock of boulder clay well above the level of the bedrock in the creek bottom. The gold is thought to have been derived from stream erosion of glacial drift in which the gold has been included.

(4) No appreciable pay streaks have been found in the boulder clay nor in the larger gravel ridges and irregular hills, nor in the moraines formed by the valley glaciers. Small amounts of gold are probably scattered throughout these deposits.

(5) Placer gold also occurs in the post-glacial gravels. This gold is very fine and is called "Flood" gold. The deposits are not extensive and have not paid for the mining of them.

They are used as an indication by the placer prospectors who consider this gold to be transported and unless there is coarse gold with it, there is little chance for finding gold on bedrock below the bars.

(c) Development.

Placer mining is still being carried on in the Cariboo to-day. The rich pay-streaks have been mostly worked out and the modern development has turned to hydraulicking. There are a few large scale hydraulic operations in the district and many small scale operations. Development in many cases is retarded through lack of water. There are a few properties operating by drifting, the largest of which is at Wingdam.

The Boullion Mine is on e of the largest of the hydraulic properties in operation in the district. The property includes a number of leases which are believed to cover 8,500 feet of an old, high channel of the South Fork of Quesnel River, separated in part from the present stream by a high rock rim known as French Bar Bluff. In the old China pit, the channel is 400 feet deep, 200 to 300 feet wide, at the bottom and from 1000 to 1500 feet wide at the top. This gorge lies in altered greenstone or diabase with syenite intrusions in it. Bedrock is covered by roughly stratified gravels consisting of coarse, rounded cobbles and boulders with slide rock from the canyon walls ~~with~~ and a considerable amount of clayey sand and gravel. Above these lower gravels

is a deposit of boulder clay consisting mostly of firm clay with few boulders. Well stratified sands and gravels overlie this boulder clay. The top formation consists of a normal stoney boulder clay.

It is thought that the bulk of the values lie in the lower gravels, below the lower boulder clay, but the upper gravels also contain some values. The gold is generally fine, well worn and flattened, varying in size from fine colours to flax or mellon seeds but pieces up to $4 and $5 in value, have been found. A small amount of platinum is reported in the sluice concentrates.

The property is essentially a large low-grade proposition. The water system is extensive, water being brought from Bootjack and Morehead Lakes by way of Jawbone Creek. The amount of gravel remaining is extensive and the property has prospects of operating for some time.

The Wingdam property is on Lightning Creek. Work has been carried on on this property since 1898, but it was not until recently that the property has started serious production. A large amount of money has been expended on sinking shafts, drilling and installing pumping plants. Until modern equipment was installed, the water pressure has forced the cessation of operations. A large modern plant has been built and operations are going ahead. The material mined is believed to be from a deep channel along Keithley Creek. The gold is flattened and varies from coarse to fine.

Although no placer deposits as rich as those found in the '60's have been found in the Cariboo in recent years, it is the opinion of the writer that placer mining will continue to produce gold in profitable quantities. The introduction of modern methods of mining and prospecting has placed many lower grade properties on a profitable operating basis.

The completion of the geological mapping in the district should provide a foundation for the exploration and prospecting of the area in a systematic manner.

B. LODE DEPOSITS.

(a) History.

Since placer mining commenced in the district, in the 1860's, the abundance of quartz veins in the district was noticed. No interest was taken in these exposures until the supply of placer gold began to diminish. In 1875 and '76, some development work was carried out on the veins in the area. The development was not extensive and was carried out in spurts. No really rich discoveries were made and interest in the deposits lagged from 1906 to the 1920's. Improved transportation facilities allowed the importation into the area of modern machinery and the perserverence of the miners brought a reward with the strike of rich ore in the Cariboo Gold Quartz Mine in the early 1930's. The rise in the price

of gold coupled with the news of this strike, has occasioned a boom in prospecting and developing the quartz veins in the Barkerville and adjacent areas.

(b) Occurrence.

There appears to be a definite relationship between the Cariboo Series and the rich gold deposits in the area. The limits of the placer deposits are the limits of the areas underlain by the Cariboo series and all the known lode gold deposits are in this series. The metalliferous veins in the Cariboo are closely related to the bedrock geology.

Hanson[1] states that most of the valuable quartz veins in the district occur in the upper part of the Richfield formation, the lowest member of the Cariboo series. In the Barkerville district, he was able to subdivide this series into five members, these being from top to bottom:

Baker member, mainly fissile, grey calcareous quartzite.

Rainbow member, partly fissile, interbedded argillite, and quartzite.

B.C. member, black argillite.

Lowhee member, mainly fissile quartzite.

Basal member, black argillite.

In the Barkerville area, it would appear that the richest veins occur at the bottom of the Baker member and throughout the Rainbow member.

1. G.Hanson,-Barkerville Gold Belt, Cariboo Dist't. B.C. Geol. Surv. Can. Memoir 181.

B.C. member contains very few important veins,

Insufficient exploration and development work has been carried on in the rest of the Cariboo district, to enable the subdivisions of the Richfield formation to be recognized.

The rocks of the Richfield formation are traversed by numerous pre-mineral fractures, many of which contain quartzveins. In the gold belt, the fractures are most numerous in the Rainbow members. Some of the fractures parallel the strike of the formations, some are at right angles to the formations, and others are diagonal to the strike. Many of the fractures at right angles to the formations, hold no quartz, but some contain veins from one half inch to several feet wide. All the fractures diagonally crossing the strata, and so far as is known, all those parallelling the strata, contain quartz veins. The transverse and diagonal fractures are not faults while those paralleling the strata are faults.

The mineral deposits of the area consist of quartz veins and pyritic replacements. Many of these deposits are valuable for their gold content.

Veins.

A great many of the pre-mineral fractures are occupied by quartz veins that are strikingly related to the rocks and to the geological structure.

When stresses are brought to bear on the rocks, different rock types react in different ways. Limestone and the limey clastic sediments do not fracture readily, being only cut by the stronger fractures. The quartzites and argillites fractured readily but the argillaceous quartzites appear to have been the most favourable rocks for fractures. A characteristic of most of the transverse fractures and veins is that they do not continue across rocks of dissimilar type.

The Baker member is a fairly homogeneous unit consisting mainly of fissile calcareous quartzite containing few veins relatively. Veins are very numerous in the Rainbow member but rarely cross the whole member. The B. C. member is a homogeneous unit, contianing relatively few quartz veins, which, however, seem to be more persistent than those in the Rainbow member. The Lowhee member contains many veins of ~~unicular~~ similar character to those in the Rainbow member. The basal member is very poorly fractured and contains only a few fairly persistent veins.

The transverse veins seem to fill fractures which have been formed by compressive stresses. The fractures are numerous but are not all filled with quartz. The diagonal fractures are stronger than the transverse fractures and frequently cut across several units of a member. They are nearly all filled with quartz and form

a great number of thelarger and most consistnet veins. The largest diagonal vein is 300 feet long and five feet wide. The above types of veins tend to occur in zones and persist throughout the Rainbow member.

The last type of fracture is that roughly paralleling the strike and dip of the strata. The veins formed in these fractures occur as quartz replacing and filling a fault zone. Veins of this type are not numerous but tend to be large. Small lenticular veins have been found which parallel the strike and dip of the strata.

The transverse and diagonal veins contain pyrite and arsenopyrite, and many have small amounts of gold, galena, sphalerite, bismuth-lead, sulphide, marcasite, telluride, and scheelite in a gangue of quartz, commonly with some ankerite. The quantity of pyrite in the veins is valuable and the gold values vary with the amount of pyrite, but the amounts of the two minerals are not in direct proportion. Veins with 50 per cent pyrite are not always richer than those with 25 per cent pyrite, and veins with with very little pyrite are not commercial. Arsenopyrite occurs in nearly all veins, with the pyrite, but as a minor constituent. Galena, sphalerite, and marcasite occur locally in only a few veins. A small quantity of telluride is associated with the lead-bismuth sulphide which occurs in many veins as nests but is very rare. The pyrite in the veins is very coarse and this is a

characterisitc of the transverse and diagonal veins. Gold is scattered free in the veins, and varies in fineness, pieces ranging from a quarter ounce to one tenthousandth of an inch speck in diameter, being found.

The strike fault veins and the bed veins are poorly exposed and not enough work has been done on them to prove their commercial value. The strike fault veins are mineralized with pyrite but the few bed-veins appear to be barren.

REPLACEMENT DEPOSITS.

The replacement type of deposit was discovered in the Cariboo in 1933, the largest known body being in the Island Mountain Mine. The ore is generally higher grade than the vein ore and commonly assays two ounces of gold to the ton. The best ore consists of massive, fine-grained pyrite with free gold. Where replacement is less intense the ore consists of silicified limestone, with streaks of minute pyrite crystals and local bunches of ankerite and dolomite. Several bodies of this type have been found in the Cariboo Gold Quartz Mine.

Origin.

It is believed by Johnston and Uglow[1] and also by Hanson[2] that the materials for the fracture fillings came from the quartz porphyry intrusives which were injected before late Paleozoic time.

The mineralizers for the replacement

1. Johnston and Uglow,-Placer & Vein Gold Dep. of Barkerville Dist. B.C. Mem. 149-G.S.C.
2. Hanson-Barker ville Gold Belt, G.S.C. Memoir 181.

deposits are believed to be the veins themselves, as there seems to be a direct relationship between the deposits and the veins.

(c) Development.

As mentioned in the short history of the lode gold deposits, development has been carried on since about 1875. This development was never extensive and no important production was made until 1932, when rich ore was struck in the Cariboo Gold Quartz Mine. The news of this strike and the rise in the price of gold, focussed the attention of the mining world on the Cariboo District. Several properties were opened up and a prospecting boom lasted for about two years.

The two most important mines in the district are the Cariboo Gold Quartz and the Island Mountain Mine.

The Cariboo Gold Quartz mine is southeast of Jack of Clubs Lake on the northern slope of Cow Mountain. The present owners began exploration in 1927 and began milling on a 50-ton basis in 1933. In 1934 the rate of milling was increased to 100 tons a day. The gold is removed by cyanidation. There were over four miles of underground levels in 1933. The ore occurs in veins and also in pyritic replacement deposits.

The Island Mountain Mine is northwest of Jack of Clubs Lake. Development began in 1876 but the property has been idle until the present company took it over in 1930. The undergroun development has been steady

since 1932 and production on a 50-ton basis began in 1934, the ore being treated in a cyanidation mill. The ore occurs in two types of deposits, a quartz-pyrite vein type and a pyrite replacement type. The replacement deposit is higher grade than the vein type and constitutes the main ore of the mine at this time.

There are many smaller properties and claims being developed in the area, but space does not permit a description of them here.

CONCLUSION.

A. RESUMÉ

The Cariboo District lies in the Interior Plateau of British Columbia, its eastern boundary being the Cariboo Range and its western boundary, the Coast Range. Although it was impossible to cover the whole Cariboo District, the parts discussed give a fairly representative idea of the geology and mineral prospects of the district.

The northeastern part of the area, is underlain by the older Cariboo series which is thought to be Pre-Cambrian in age. These older rocks are overlain to the south and west by younger Mesozoic and Tertiary lavas. The contact between the two series has

a general northwest trend. It is notable that all the placer and lode gold deposits in the Cariboo ore in the areas underlain by the older Pre-Cambrian Cariboo Series and no deposits of any value are known to occur outside these areas.

B. POSSIBILITIES.

Although the Cariboo district has been prospected for nearly 78 years, its possibilities are not yet exhausted. This is strikingly shown by the discovery of commercial ore in the Cariboo Gold Quartz and Island Mine Mountain, Mines.

The day of the extremely rich placer deposits is probably gone for ever, but it is being followed by modern methods of systematic mining and there are still great opportunities for finding and successfully working lower grade placer deposits.

Successful lode mining is coming into prominence in the Cariboo to-day and when more information and experience has been obtained, the lode deposits will probably last as long--if not longer--than the placer deposits.

The completion of the geological mapping of the whole Cariboo district will provide a basis for systematic prospecting which, it is hoped, will lead the way to the development of many successful mines.

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