

GEOLOGICAL SURVEY OF CANADA

ROBERT BELL, M.D., D.Sc., LL.D., F.R.S.

REPORT

ON THE

ATLIN MINING DISTRICT

BRITISH COLUMBIA

BY

J. C. GWILLIM, B.Sc.



OTTAWA

PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY

1901

No 743

To ROBERT BELL, M.D., LL.D., F.R.S.,
Director, Geological Survey of Canada.

SIR,—I have the honour to submit herewith a report upon the district containing the Atlin gold fields of northern British Columbia.

A contour map of this district compiled from surveys by Mr. W. H. Boyd and myself also accompanies this report.

In connection with the study of the geology of this district I wish to thank Dr. Hoffmann, Dr. Barlow and Dr. Ami of this survey for their assistance and Mr. O. E. Leroy of McGill University for microscopical examination of thin sections of rocks.

I have the honour to be,
Sir,
Your obedient servant,

J. C. GWILLIM.

Ottawa, May 15, 1901.

REPORT

ON THE

ATLIN MINING DISTRICT, BRITISH COLUMBIA

INTRODUCTION.

The examination and topographical survey of the Atlin district was undertaken in 1899, and two seasons were spent in gathering material for a 500-foot contour map geologically coloured, and a report upon the district. In 1900 I was assisted by Mr. W. H. Boyd who undertook the topography of the mountain features. The survey was tied on to Mr. Ogilvie's traverse of the Lewes River in 1887, at Tagish lake.

The methods of survey were by means of boat-log traverses of the lakes and magnetic bearings, also latitude observations for the mountain and inland work. A transit triangulation was made by Mr. Boyd, of all the country between Taku arm and Teslin lake. Pack horses were used as carriers.

Other sources of information have been through Messrs. Brownlee and Lowry of Atlin. Mr. A. St. Cyr, of Ottawa and many others resident in the district showed me courtesy for which I am much obliged.

HISTORY OF THE DISTRICT.

The district to which the following report applies, lies between latitudes 59° and 60° north and extends from longitude 132° to 134° 30' west of Greenwich. This area includes the whole drainage basin of Atlin lake, together with the adjacent country to the east of it, draining into Teslin lake, also the Taku arm basin to the west of Atlin lake, in all some 6,000 square miles of the extreme north-west corner of British Columbia which has recently come into prominence as a placer gold producing district.

Preliminary
map of
district.

A preliminary map of the western portion of the district has been already published in the Summary Report for 1900. A more extensive contoured map accompanies the present report.

Gold
discovered
in 1898.

Atlin became known as a productive placer gold camp early in the year 1898 after the discoveries made by Miller and McLaren. These men approached the district from Skagway over the White Pass, thence by way of Tutshi lake and river and the Taku arm of Tagish lake to Atlin lake. Their first discovery of gold in paying quantities was made on Pine creek in January, 1898. This journey was made with dog sleds in the depth of winter. From this fact it appears probable that the district was known to be gold-bearing prior to their recorded discovery. Such a conclusion is supported by statements of miners and prospectors who winter along the Alaskan coast. There appears to be no evidence to prove that the creeks were formerly worked for gold, although this is commonly believed. A small amount of prospecting may have been done, but nothing more.

Indian
inhabitants.

The presence and influence of Indian inhabitants is marked by portage trails from Tagish Houses to Little Atlin lake and Teslin river, also from Atlin lake at Pike river to the upper waters of Taku river and from Taku river to Teslin lake. Other evidences of a trail are found from Surprise lake to Teslin lake and also to Gladys lake. The intervening country appears to have been rarely visited, nor are the trails above mentioned important highways of Indian travel.

ACCESSIBILITY.

Routes
followed by
prospectors.

During the first rush into Atlin district in the spring of 1898 and 1899, many different routes were followed:—

The 'Fantail route' was a shorter winter trail for dog sleds from Skagway over White Pass. From White Pass the trail strikes south-easterly down a long wide depression leading to Fantail lake, thence across Taku arm to Atlin lake. The 'Taku route' was from Juneau up the Taku river and Nakina river to the mouth of Silver Salmon river, thence up the latter valley and over a low divide at Pike lake to Atlin lake.

Another all overland route was by way of the Telegraph-Teslin trail from Glenora to Teslin lake, thence across the ranges westward to Atlin lake. The present established route follows one of the early approaches by way of Taku arm from Tagish lake which is on the waterway to the Klondike. An all-rail and steamboat service now

connects the district with the Pacific coast at Skagway. This places it within a day's travel of the ocean steamers.

TOPOGRAPHY.

The general elevation of the lower lake and valley system comprising Topography. Lakes Bennett, Tagish, Taku arm and Atlin is about 2,200 feet above sea-level. The highest peaks of the district do not exceed 7,000 feet above sealevel. Generally speaking the mountain tops are from 5,000 to 6,500 feet above the sea. There is also a second system of depressions or upper valleys and plateaux which isolate the mountains into groups having a rounded and worn down appearance. The main lower lake system lies in depressions more or less in a north-and-south direction, following the general trend of range and valley as seen all through the more southern portions of British Columbia. These principal north-and-south valleys are connected by wide depressions.

Contrasted with the rugged granitic barrier of the Coast Range the district offers easy exploration. The upper portions of the mountains above the timber line are grassy and open, without, as a rule, much obstruction to travelling. Extensive slopes and wide valleys are scantily timbered with Banksian pine, spruce and balsam. ^{Exploration not difficult.}

The drainage is in three directions. North and west to the Upper Yukon at Tagish lake by way of Taku arm; north and east to the Yukon by way of Teslin lake and river; and south-westerly by way of the Taku river to the Pacific ocean at Juneau. The central point of dispersion is from the rolling uplands half way between Atlin and Teslin lakes. ^{Drainage.}

LAKES.

The chief lakes of this district are:— Taku arm, Atlin lake, and Teslin lake. These are the lakes of the great north-and-south valleys. Little Atlin lake is a shallow body of water 80 feet higher than Atlin lake, but in the same wide valley to the north of it. The lakes of the upper valleys which drain transversely east or west into these chief lakes are:— Gladys lake, Surprise lake, Tutshi lake, Fantail lake, Edgar lake and Nelson lake. Sloko lake drains south-easterly into Taku river and is the most southerly of these lakes. ^{Important lakes.}

Concerning the depth, soundings were only taken along the northern half of Atlin lake. These soundings showed a fair regularity ^{Soundings taken.}

Little
Atlin lake.

in depth. The depth increasing gradually from 200 feet near the northern end to 550 feet opposite Atlin town. The deepest sounding made was 630 feet. Little Atlin lake, situated on the broad low divide between Atlin lake and Lake Marsh is a shallow body of water with low marshy western shores. Hall lake is an expansion of Gladys river between Gladys lake and Teslin lake. It has many islands and appears to be shallow also.

Sloko lake.

With the above two exceptions, the lakes of this district are deep, with mountain ranges rising directly from their shores. Small deltas exist at the mouths of the streams. Usually a broad low valley connects these lakes with other lakes at a higher or lower level. Sloko lake is almost entirely fed by glacial water; it is of a milky colour and quite opaque even in shallow places. This lake lies one mile south of Atlin lake at a level of 190 feet higher. A low divide, 120 feet higher than Sloko lake separates the waters flowing south-eastward to Taku river and these flowing north-westward to the Yukon.

PRINCIPAL RIVERS.

Principal
rivers.

The chief streams of the district are Atlin river, Gladys river, Nakina river, Sloko river, Sucker river. Of these Gladys, Atlin and Sucker rivers are navigable for small boats and canoes. Pine creek, O'Donnell river, Pike river and Tulloch river are important streams draining into Atlin lake. Tutshi river, Otter river and Hale creek drain into Taku arm from the lakes above them which contain reservoirs of glacial water.

Effect of
glaciers on
streams.

The quantity of water in these streams depends upon their sources. In June and July the glacier-fed streams are low while the others are high. In August and September the reverse is the case. The same principle applies to the lakes. Atlin lake and river appear to be highest in early September. Teslin lake and Teslin river and all their tributaries have high water early in the summer.

Atlin river.

Many creeks or brooks are lateral tributaries of these main streams and of the lakes. Atlin river drains Atlin lake into Taku arm. It is two miles long and falls thirty-eight feet. The current is swift and rough. Boats are poled or tracked up to it. Scows loaded with lumber are taken down this stream at high water. On June 18, 1899, the body of water was estimated at 80 feet wide, and 2 feet deep, with a current flowing at the rate of five miles an hour. On July 31, 1899, the body of water was estimated at 100 feet wide and six feet deep,

Variation in
volume.

with a current flowing at the rate of six miles an hour—nearly five times as great.

Gladys river drains Gladys lake and the district to the south and south-west. It is thirty-three miles long, falls about 700 feet and enters Teslin lake, fourteen miles south-east of Dawson Peaks. This is the largest river draining into Teslin lake from the west. Its volume on August 13, 1900, was estimated as sixty feet wide, two feet deep, with a current of four miles an hour. At that time the water was low since none of the sources are glacial. Strongly built boats can be taken up and down this stream. With the exception of Gladys falls, there is no serious obstacle to small boats. Gladys river.

The Nakina river runs in the district south-west of Calbreath post, at the southern end of Teslin lake. It flows rapidly through a roughly mountainous country along the southern edge of the Atlin district. The chief tributary from the north is the Silver Salmon river. Further to the west the Sloko river, a glacier fed stream of considerable volume and roughness joins the Nakina river. After this junction it becomes the Taku river, which enters the Pacific ocean near Juneau. Sail and row boats can be brought up the Taku river and the Indians appear to have long used it as a highway into the Teslin-Atlin country. It is also a fishing place for salmon as far up as the junction of the Silver Salmon river with the Nakina river and possibly further. An old Indian trail exists from this place to the southern end of Teslin lake, This trail has been replaced by the Taku trail of the miners, which is a rough and mountainous route. Nakina river. Taku river.

The Sucker river is the principal tributary of Gladys lake and river. It flows at an easy grade northwards along a remarkably straight and deep valley which is also the source of the Silver Salmon and of Ruth lake. The Sucker river has many tributaries, chief of which are Zenazie and Terra-heena creeks on the west and Rapid, Roy, Radnor and Brecon creeks on the east. Its length is twenty-nine miles and the fall in this distance about 200 feet. Sucker river. Tributaries of

Lubbock river is an exceedingly crooked stream which drains Little Atlin lake into Atlin lake proper at its northern end. This river is navigable for small boats; its length is nine miles. The current is swift and without rapids. The fall is approximately eighty-one feet from Little Atlin lake to Atlin lake. The whole basin and course being a continuation northwards towards Lake Marsh of the Atlin lake depression or valley. The fall from Little Atlin lake to Lake Marsh is 115 feet. Lubbock river. Length and fall of.

Pike river. Pike river flows into the southern portion of Atlin lake from the east. It had an estimated volume in July, twenty-five feet wide, two feet deep, and a current of three and a half miles an hour. Its length from Pike lake is eleven miles, but its source is in Simpson creek, among the Sloko mountains. This river flows in a great valley with a low divide at Pike lake which leads from Atlin lake to Silver Salmon and Taku rivers. It has been followed part of the way by the Dominion Telegraph line, and has been suggested as a possible all-rail route from Taku river to Atlin.

Possible all-rail route from Taku river to Atlin.

O'Donnel river rises in the high slopes and low mountains south of Surprise lake and drains into the southern part of Atlin lake, three miles north of Pike river. This stream is about thirty miles long. It is a rapid, shallow stream which has many tributaries draining a large district, nearly the whole of which is underlain by quartzites and limestones of Palaeozoic age.

Pine creek. Pine creek is the principal gold-bearing stream east of Atlin lake. It drains Surprise lake, and has a length of eleven miles with a fall of about 830 feet. There are many streams tributary to Surprise lake and Pine creek, the chief ones being Birch, Boulder and Ruby on the north; Wright, Otter and Spruce on the south. All these carry more or less placer gold. The valley of Pine creek is high and broad. It has many terraces. These are for the most part between 300 and 600 feet above the present level of Atlin lake.

Tributaries.

Water power of streams. Concerning the volume and power of the various streams of this district, it is noticeable that there are but few falls, and these are of short descent. Nearly all the streams are rapid and at times torrential. The average fall of the larger streams is from 20 feet to 50 feet per mile, or less than one per cent. The fall of the gold-producing streams is greater. Pine creek falls 830 feet in eleven miles, in some portions of which the grade is four per cent.

Greatest volume in June. The tributary mountain streams have a grade varying from 2.5 per cent to 7 per cent. The greatest volume of water occurs in June, as the result of the melting of the winter's snow. The only exceptions to this are the short glacier-fed rivers entering the southern part of Atlin lake and Taku Arm, which are in greatest volume in July and August. None of these streams receive appreciable freshets from summers or fall rains.

TERRACES.

Terraces. Terraced deposits occur above the shores of Taku arm in the valley of Tutshi river. They are also found near Atlin lake, on Pine

creek, Fourth of July creek, Plateau creek and along the lower flanks of Mount Minto and Halcro peak. A very regular terrace runs parallel to the Lubbock river from Atlin lake to Little Atlin lake. The material which composes these terraces is usually fine sandy clay. ^{Composition of.} There appears to be no general horizon at Tutshi river. There are terraces or benches at 10, 20, 40, 50, 80 and 240 feet at Taku arm. On Pine creek the principal terraces are between 200 and 500 feet above Atlin lake.

Terraces, in places where they would naturally be found near the ^{Height of.} mouths of streams are commonly found up to a height of 400 feet above the general level of the Taku arm and Atlin lake. On Fourth-of-July creek well-defined terraces exist at a height of from 1,100 to 1,300 feet above Atlin lake. Such terraces appear to have been formed locally and to be confined to their own valleys or basins.

In many of the wide depressions which lead up to the sloping uplands of this district the terraced deposits give place to more irregular banks and ridges containing much the same material as the terraces. Such irregular deposits were seen on Pine, Spruce, Otter and McKee creeks to a height of 1,800 feet above Atlin lake and on Consolation creek, and the district about Gladys lake at somewhat lower levels.

CLIMATE, FAUNA AND FLORA.

The climate of this district is remarkable for its dryness. The ^{Climate.} summers of 1899 and 1900 were exceptionally wet in southern British Columbia, but the rainfall in the Atlin district during these seasons was very light.

The ice leaves Atlin lake about June 1, after which date night frosts are rare in the low-lying lake district. Cold, prevailing ^{Prevailing winds.} winds come inland from the south-west, over the snow-covered Coast Range. These winds are felt most along the greater valleys immediately east of the Coast Range. The weather in the valleys more inland is bright and warm until the end of September. On June 17, 1899, fresh snow fell on the hills to within 1,000 feet above Taku arm. On September 2 of the same year the first fall of snow covered the mountains above the timber line, but this did not remain. At the same date the first autumn frost, sufficient to kill tender vegetation, was observed in the Teslin valley near Calbreath post.

According to statements made concerning the winter climate, the ^{Snow fall.} following information has been gathered:—Atlin lake does not com-

pletely freeze over before January 1. About two to five feet of snow fall along the level of the main lakes. There is a greater fall in the mountains. The weather is moderately cold, bright and calm. A record of Fahrenheit temperatures was kept during the winter of 1898-99. A summary of these is given below :

	Average.	Maximum.	Minimum.
Last half November.....	6·0	40·0	18·0
First half December.....	28·0	44·0	18·0
Last half December.....	18·0	37·0	20·0
First half January.....	8·0	25·0	23·0
Last half January.....	7·0	31·0	22·0
First half February... ..	17·0	46·9	32·0

The coldest periods correspond with those of the Kootenay district in the same year. The winter of 1900-01 was unusually severe, the same as in other parts of Canada.

The low-lying districts about the lake system of Taku arm, Atlin lake and Teslin lake do not appear to suffer much frost between June 1 and September 1. Garden vegetables of the hardier kinds will grow fairly well. There is not any great extent of fertile valley bottom in the Atlin district. Conditions appear somewhat more favourable in the great valley of Teslin lake where the rainfall is apparently greater and the soil less sandy.

Timber.

The forest growth is rather light. It is principally composed of the White spruce, *Picea alba*, Banksian pine, *Pinus Banksiana* and Balsam, *Abies balsamifera*. White spruce is found in damp valleys and on stream deltas. It is the only source of saw logs. Banksian pine clothes the dry valleys, low slopes and terraces up to 4000 feet above the sea in some places. Balsam fir occupies the rougher rocky ground near the timber line up to 5000 feet above the sea in a few places. Cottonwood occurs commonly at the mouths of streams. White poplar, *Populus tremuloides* is fairly common on flats and low hills. The mountain sides at and above the timber-line are often covered with a thick scrubby growth of dwarf birch *Betula glandulosa*. None of the pine, fir, tamarac, hemlock or cedar trees common to southern British Columbia were seen in the whole of this district. Birch was observed only on the eastern face of Taku mountains and at Nakina river, in small quantities.

Wild fruits

The native fruits, found most abundantly towards Teslin lake are : Raspberry, black and red currant, gooseberry and a dwarf cranberry *Vaccinium Vitis-Idaea*. Cranberry, muskegberry, amalanchior and blueberry are less abundant.

Seventy-nine species of plants were collected during the seasons of 1899 and 1900. These have been determined by Prof. Macoun. Some of them appear to be rare and possibly new to science.

Animal life is somewhat scarce. Moose and caribou are not uncommon. There appears to be two species of mountain sheep; one being the recognized Rocky Mountain variety of the brownish colour and big horns, the other is lighter in colour. These are called Ibex by the hunters. The black bear is common. The silver tip or grizzly bear is also found. Marten is the chief fur. Game and fur-bearing animals.

Partridge and ptarmigan are very abundant. Wild ducks, geese and rabbits were occasionally seen. The common loon is the chief water bird of the deep lakes of the district. There are two species of ptarmigan. One appears to live during the summer altogether above the timber line on the bare mountain sides; this is the rock ptarmigan. It is smaller and grayer in colour than the other species, which spends the summer along the upper limit of the timber and brush. The favorite habitat of this second species is along the upper flats of the mountain streams amongst a low growth of willows and balsam fir. Partridge and ptarmigan abundant.

GLACIATION.

There are distinct evidences of glacial action on rock surfaces at the following places:—

Glaciation.

Golden Gate, Taku arm, north shore;

Taku inlet, and islands of North bay;

Taku portage, south front of the hill 700 feet above the lake.

Half a mile south of Atlin town, on the east shore, and along the western face of Lina range to a height of 600 feet above the lake.

On the southern shore of Teresa island, along the sides of the narrow gaps leading from Atlin lake to the foot of the Llewellyn glacier.

The highest observed eroded rock-surface was on the southern end of the Le Roy range above Ptarmigan flats at a height of about 3,000 feet above Atlin lake or 5,200 feet above sea level. Glacial grooving and polishing was also observed on the limestone of Teslin valley near Calbreath post; eastwards of the divide between Atlin and Teslin lakes, there appears to have been a movement of the ice towards Teslin lake.

The characteristic granites of Surprise lake have been disintegrated and transported north eastward, forming the great slopes and banks of drift about Gladys lake and Consolation creek. A similar movement

Transported granite boulders. appears to have taken place thirty-five miles to the south-eastward, whereby the peculiar hornblendic granite of the mountains west of Hurricane river has been transported across the Le Roy range and Ptarmigan flats to Fisher lake. There was no observed occurrence in situ of this hornblendic granite, east of the Hurricane river. The granite blocks and boulders now scattered over the Le Roy range are separated from the apparent source of supply by a valley over 1,500 feet deep and seven mile across.

Mount Minto. In the drainage basin of Atlin lake itself, there are few evidences of glaciation over a level of 2,000 feet above the lake. Foreign boulders are only occasionally met with, but these are well rounded and usually composed of an acidic or binary granite which, so far as observed, does not exist in the neighbourhood. There are also rounded pebbles of jasper above the 2,000 feet level. The presence of these boulders of totally different material upon peaks composed of porphoritic rocks may point to a regional glaciation. Mount Minto rises directly from Atlin lake and the surrounding flats to a height of 4,650 feet above the lake. Its flanks are composed of a hornblende-biotite-granite. The upper 1,500 feet is a hornblende-porphyrite. Pebbles and boulders of this acidic granite and jasper, very well rounded, are seen right up to the peak. This peak is one of the highest in the district.

Terraced valleys. The tributary valleys which lead up from the great north-and-south lake system into the sloping uplands of the mountains between Atlin and Teslin lakes, are often heavily terraced. Above a level of about 600 feet in Pine creek valley, these terraces give place to ridges and lumpy hills. These appear to be composed almost entirely of local rock material. There is an occasional granite boulder, such as is found on the slopes above. Otherwise it may be said the material is local and glacial. It contains areas of boulder-clay, false bedded gravels, boulders and sands, and rounded irregular ridges and hummocky hills forming a depth of several hundred feet in some places upon the valley bed-rock beneath. The oxidized gravels and bed-rock of a pre glacial representative of Spruce creek may be seen beneath a burden of 100 to 200 feet of drift material from Prams point to Discovery claim.

Probable modern glacial deposits. It seems probable that the glacial deposits of the present valleys and uplands belong to a period more modern than that of the possible regional action which included the highest peaks. Local glaciers of somewhat the same character as the present Coast Range glaciers may have filled these broad valleys, leaving the peaks isolated above the ice-fields as they are to-day on the great Llewellyn glacier south of Atlin lake.

There is, however, little resemblance between the character of the deposits of the present glacier and the deposits of these creeks. The present glacier is discharging large quantities of boulders, gravel and sand from its various tongues into Atlin and Sloko lakes, but without building up terraces or terminal moraines to any great extent. The Llewellyn glacier rises as a great field of ice and snow from near the southern end of Atlin lake. The grade of ascent for the first 2000 feet in altitude is about 4°, after which it becomes more flat and snow-covered.

Prospectors who state they have crossed this ice-field say it took them 9 days and that it stretches from near the Pacific coast at Taku river to Atlin lake, or about 60 miles. Isolated mountains rise from the great snow-field leaving wide stretches of snowy sky-line between them.

During summer the surface of the glacier near its front is hard, smooth and rounded, with occasional crevasses. Many surface streams of clear water run for considerable distances, then descend into crevasses. In places the ice is much split up and is impassible. This appears, to be due to uneven convexities of the floor beneath.

Great masses of rough blocks or rock boulders, pebbles and mud occur as wide medial moraines. This burden of unsorted rock matter gradually descends to the faces of the glacier tongues and is disposed of without leaving adequate terminal moraines. Lateral moraines occur at salient points of the mountains as high as fifty feet above the present surface of the ice. The medial moraines continue as dark sinuous lines far into the wide snow-covered gaps between the peaks.

The issuing streams appear to be in flood at the end of July. They carry much sand, which seems to be filling up the floors of the fiords by which they have entrance into Atlin lake and Sloko lake. There is usually an extensive flat studded with pebbles between the outlet of the river at the glacier front and its sandy entrance into the lakes. The majority of the pebbles and boulders are granite, greenstone, porphyry and quartz, their relative abundance being in the order given.

GENERAL GEOLOGY.

The principal geological formations of the Atlin district have been provisionally classified as follows, in natural sequence, the oldest first.

General geology of Atlin district.

Palæozoic.—A group of rocks containing some schistose varieties. A great mass of crystalline limestone. Wide areas of cherty quartzite, and some slates and magnesium rocks of local distribution, which are called in this report the *Gold Series*.

Mesozoic.—A wide distribution of sandstone and conglomerates, chiefly found about the shores of southern Taku and Atlin lakes. Also mountain masses of andesite and various porphyrites apparently related to the sandstones, which are pyroclastic porphyry and andesite tuffs.

Superficial Deposits.—Both pre-glacial and post-glacial also some volcanic deposits of more recent formation than the present valley system.

Concerning the rocks classed as Palæozoic it may be said that they have the characteristics given by Dr. Dawson to certain formations found under similar conditions in the more southern parts of British Columbia.*

Limestones probably of Carboniferous age.

The great exposures of limestone, forming mountain masses about Taku arm and Little Atlin lake are placed in the Carboniferous system. The peculiar cherty quartzites are also found associated with these limestones in other parts of the province and constitute one of the members of the Cache Creek series of the Kamloops sheet.

The schists occur only as more or less narrow developments near the contact of these older rocks with the coast granites and their isolated representations further inland. The peculiar and local Gold series of slates and magnesian rocks, chiefly confined to the basin of Pine creek, is evidently older than the granites of the district.

Mesozoic rocks.

The Mesozoic rocks were nowhere seen in direct contact with the Palæozoic formations. Their origin is chiefly igneous and they often pass imperceptibly from a sedimentary and stratified form into the mountain masses of porphyrite and andesite. The few fossils found in some of the bedded sandstones appear to belong to the Jurassic period.

The district shows evidence of considerable volcanic activity and some great masses of granite have been formed since Palæozoic times. Fossil evidence is very scarce, so that more can be said of the characteristics of these rocks than of their age, excepting relatively. The valleys contain pre-glacial gravels in some instances. And in many of the higher depressions the drift is also widespread.

Rocks similar to Cache Creek group.

Palæozoic.—The great areas and mountain masses of cherty quartzite and crystalline limestone appear to have much resemblance to the

* Kamloops map sheet p. 47. Part B. Annual Report Vol. VII.

Cache Creek group of the southern interior of British Columbia. The limestone which appears to be conformable with the quartzite and to overlie it, contains Fusulinæ and has been placed in the Carboniferous.

The quartzite is never heavily bedded or sugar-grained. It wears into rounded hills and does not form very important ranges. There is a wide variation in the field aspect of these friable thinly bedded quartzites, from a flinty grayish-white appearance to an almost carbonaceous shale. Irregular patches and bands of a gray crystalline limestone occur in the less chert-like areas. The carbonaceous variety appears to constitute one of the gold-bearing rocks on Wright and other creeks, otherwise it is not of economical importance so far as at present prospected. A microscopic examination of the cherty variety from the O'Donnel river by Mr. O. E. LeRoy, of McGill University, gives the following characteristics :—

Result of
microscopic
examination.

‘A dark-gray flinty rock composed of crypto-crystalline quartz. Running through this fine-grained mass in all directions are small veins of quartz. These often anastomose or enlarge forming pockets of irregular or oval outline. The quartz is generally clear or stained with iron or carbonaceous pigment.’

This is classed as a pyroclastic rock, an acid tuff compacted by secondary silica and is called hälleffinta.

A microscopic section of the Wright creek variety which is more carbonaceous and shale-like in appearance gives as follows :—‘Extremely fine-grained, almost crypto-crystalline groundmass consisting in great part of quartz with a subordinate amount of kaolin through which are seen many veins of quartz. Biotite in considerable amount is in rounded grains and is found all through the mass. Pleochroism is brown and light-yellow. A few grains of pale-green chlorite and yellowish-brown limonite were also noted.’

The distribution of this cherty quartzite, is very wide in the Atlin district between Atlin and Teslin lakes, Consolation creek, the basin of Gladys lake and river, Ptarmigan flats, Hurricane river, Rapid Roy creek and Sucker river. All drain slopes which are for the most part quartzitic. The wide uplands or Arctic moors about the head waters of Terra-heena and O'Donnel rivers are also quartzitic. The granites of Surprise lake, McMaster mountain and Boulder plains are in direct contact with this formation. A few intrusions of greenstone also cut through it about the head of O'Donnel river.

Cherty
quartzites.

Generally speaking these quartzites may be said to floor the whole of the district between Atlin and Teslin lakes excepting where the great areas of later granite have intruded. The small areas of the Gold Series being partly intrusive and of later origin have also disturbed the quartzite at such places as the Lina and Johnson range, and at Chikoida or Merlin mountains.

Mountains of crystalline limestone.

The limestones form conspicuous mountains to the south of Tagish lake and were observed and described in the Yukon report of 1887, by Dr. Dawson as occurring along the east shore of Lake Laberge. They are usually quite crystalline and form solid white mountain ranges on both sides of Taku arm for twenty-five miles southward from Tagish lake. A short distance south of Tutshi lake, on the eastern shore, there is a sharply defined contact with a shaly black rock followed by greenstone. This contact runs north-easterly probably up the wide valley of Tutshi river and south-easterly along the northern flanks of Taku mountains in the vicinity of Atlin lake. The limestone here dips 45° to the north-east. The chief development of this formation strikes off to the east across Little Atlin lake towards Teslin river. Another more or less continuous belt of limestone forms mountain ranges north of O'Donnel river in the Johnson range, thence south-eastwards to the junction of the Silver Salmon and Nakina rivers. It appears that this latter development is also part of the same formation.

Silicious stringers and patches are often present in the limestone, otherwise, with the exception of a few dykes near the southern contact with the greenstones on Taku arm, this limestone is not much diversified or broken up locally.

Fossils.

The only fossil remains collected were some obscure coral and crinoid forms. On the evidence of fusulinæ collected by Dr. Dawson these rocks are placed in the carboniferous, and together with the quartzites and some eruptives show a strong resemblance to the Cache Creek group of southern British Columbia.

THE GOLD SERIES.

Rocks of Gold Series.

Included in the term 'Gold Series' are the characteristic rock-masses which form the basins of the present productive gold-bearing creeks. The chief rocks of this series are certain magnesian forms; a later and partially devitrified greenstone; and two varieties of slate. The magnesian rocks are dunite (peridotite) magnesite and serpentine.

The slates are biotite and actinolite. The age of these rocks is not known. It is probable that the slates are Palæozoic and related to the cherty quartzites. The magnesian rocks represent ancient volcanic intrusives. Some of them may be of Palæozoic age. They are now very much decomposed and altered from their original form and constitution. The greenstones are younger than the other members of the series. They appear to be later than the Surprise Lake granite which has disturbed and broken up these other members.

Ancient intrusives.

In the valley of Pine creek there are numerous dykes and some small areas of diorite associated principally with serpentine and dunite. The diorite may be related in origin to the greenstones, the latter representing the rocks cooled at the surface. This group of rocks in itself, largely, if not entirely of igneous origin, has undergone much fissuring, and mineralization, due to the intrusion of later igneous masses, such as the granite of Surprise lake and the greenstones. There are strong, well-defined fissure veins crossing the actinolite slates and the greenstone. These contain quartz and the sulphides of iron, lead and copper, and are not, as far as observed, of high value in gold or silver. Some large irregular masses of a barren-looking quartz also occur, and another set of mineralized bands or veins which contain mixed quartz and magnesite with gold values therein.

Rocks of igneous origin.

In the magnesian members of the Gold Series there appears to be a resemblance to the rocks of the 'Moosehide series' described by Mr. R. G. McConnel* in the Klondike district. The distribution of the Gold Series beyond the basin of Pine creek is very limited. The typical actinolite slates and magnesian varieties are found in a small area south of Gladys lake at Brown Dome and they also occur in patches on the western shore of Atlin lake near Taku portage at the base of Atlin mountains, and on Taku inlet west of the Taku mountains. Serpentine and greenstones occur about McKee creek and to the south-east in the Chikoida or Merlin mountains.

The characteristic rocks of the Gold Series may be described as follows:—

Actinolite slates.—These occur principally to the north of Pine creek about the basins of Birch, Boulder and Ruby creeks. They are not apparent to the south of Pine creek. Their position appears to be close to the contact of the Gold Series with the granite and they lie between it and the dunite, serpentine, etc. The structure is more or

Actinolite slates.

* Summary Report Geol. Surv. Can., 1899, p. 19.

less banded but is never slatelike, the fracture or jointage giving angular blocks. Above the forks of Birch creek they have a well-defined east-and-west strike and dip to the south.

Microscopic sections of.

On Birch and Boulder creeks these rocks have supplied the coarse gold of the streams. They have some low grade mineral veins and outcrops of quartz, together with some patches of the peculiar granular and friable limestone characteristic of these rocks. A microscopic section of a specimen from Boulder creek is described as follows:— 'The greater part of the rock is made up of a mesh-work of tabular and acicular individuals of pale-green actinolite, between which are small grains of felspar. Included in this matrix are large and rather clear areas of irregular outline. Between crossed nicols these are seen to be made up of a mosaic of felspar grains, twinned according to the albite and pericline laws. The grains vary in size from those easily distinguishable to almost crypto-crystalline. The felspar is albite. A considerable amount of magnetite in small grains is associated with the actinolite and also as very small inclusions together with actinolite needles in the felspar areas.' Several sections of this actinolite slate give somewhat similar results. There is usually a fair amount of magnetite present and in some cases zoisite.

Dunite.

Dunite (Peridotite).—This is another very characteristic rock of the Gold Series. It has a sugar-grained texture and a greenish colour. The weathering is usually brown and rugged like a ferruginous dolomite, but is sometimes smooth and white like serpentine. It is an alteration product of peridotite and is usually more or less serpentinized.

Microscopic section described.

The following is a description of the thin section of the rock from Lina range. 'The constituents are olivine, serpentine, tremolite and magnetite.' This specimen is much altered, containing a large amount of the last three minerals. The olivine individuals remaining are clear and much cracked, the cracks being broadened and filled with light yellow or colourless fibrous serpentine. The magnetite occurs in strings of small grains along the border between the olivine and serpentine or in larger grains throughout the serpentine and tremolite. Tremolite occurs in considerable amount in radiate and sheaf-like aggregates. Its cleavage is well marked and a transverse parting is common.

DISTRIBUTION.

Distribution.

The dunite was observed only within the basin of Pine creek and on Brown Dome, south of Gladys lake. It occurs along the northern

flank of Lina mountains immediately to the south of Atlin town, also in Pine Creek valley associated with serpentine and magnesite. Following a general direction a little north of east, it skirts the southern flank of Munro mountains, thence eastward to Ruby creek near its mouth on the promontory overlooking Surprise lake between Boulder and Ruby creeks. It is also found to the northward along the basins of Boulder, Birch and Ruby creeks. At the head of Ruby creek it forms mountain masses but is here cut off by the Surprise Lake granites. It reappears twelve miles to the eastward on Brown Dome, and its brown-weathering gave the name to that mountain.

MAGNESITE.

Brown-weathering outcrops of this rock occur along the shore of Atlin lake near the mouth of Pine creek, also on Taku inlet west of Taku mountains. It is met with in smaller areas about the head of McKee creek, also on the mountains between Ruby, Boulder and Birch creeks. This rock, when in large masses, is usually affected by the presence of numerous quartz veins and stringers of small size. It is also more or less impregnated with pyrites, as at the Anaconda group of claims near Atlin, where there is a band of this rock over 1,000 feet wide. This band lies between mixed dunite and serpentine which appear to be quite unaffected by any shattering or mineralization. Owing to the presence of gold values in the magnesite of the Anaconda claims some study has been made of its composition. An analysis made for Mr. Bromley of the Nimrod syndicate gives the following results:—

Magnesia	21.70
Protoxide of iron	5.10
Carbonic acid	27.00
Silica	45.68
Combined water and loss	0.52
	100.00

Magnesite.
Mode of occurrence.

Analysis of.

Some of the quartz stringers stained apple-green assayed as follows:—

Copper	traces.
Nickel	15 per cent.
Gold	1 dwt. per ton of 2,240 lbs.

From a series of holes drilled across this wide exposure of magnesite, gold values were always found, some of the more oxidized portions being rich in gold. Beneath the surface oxidation the values are lower. There is an evident concentration in the upper oxidized portions. A green coloration usually present in these ferriferous magnesites is due to the chromiferous mica, fuchsite, not carbonate of nickel as is commonly believed. A purer ivory-like form of magnesite occurs as narrow bands or veins cutting rocks other than those of the Gold Series.

Serpentine.

Serpentine.—This rock forms a portion of the bed-rock of Pine creek from Stephen dyke up to Gold Run. It appears to be the result of the decomposition of the original olivine rocks, now represented by the different magnesian varieties of the Gold Series. Its colour varies from apple-green to almost black. A few thin seams ($\frac{1}{8}$ inch) of asbestos were observed in an occurrence of this serpentine in the Lina range. Patches of this rock occur at the head of Ruby creek, Brown Dome and on Slate creek and the Chikoida mountains, south-west of Atlin. In the Chikoida mountains, it is closely associated with greenstone of the same character as that of McKee and Spruce creeks. No occurrence of chromite or other mineralization or vein-structure was observed in the serpentine.

Greenstone.

Greenstone.—This is a light-green fresh-looking rock. It has a massive dense appearance, sometimes with visible crystal forms and sometimes showing a flow structure in hand specimens. The compact, tough nature of this rock has caused it to form a rounded rather smooth bed-rock on McKee and Spruce creeks. The principal boulders of the present stream-beds and also of the pre-glacial ones, are of this greenstone. Microscopically, this rock gives :

Microscopic description of.

‘A base of brownish isotropic glass, altering to a radiating fibrous product, which, optically, resembles a zeolite, but which does not gelatinize on treatment with hydrochloric acid. ‘Associated with this in small amount is calcite. Pyrite in fair amount is scattered throughout the glass in irregular grains, but the rhombic dodecahedron is quite a common form. ‘This rock appears to be a highly altered glass, and was originally a lava flow.’

Distribution.

The distribution of this greenstone is chiefly to the south of Pine creek in the valleys of McKee and Spruce creeks. It also forms the prominent Spruce mountain, between Pine and Spruce creeks, and is seen along the Atlin lake shore, north of Atlin town. It forms a contact with the granite near Fourth-of-July creek and appears to be

a younger rock, since it penetrates this granite in the form of dykes along the contact.

Greenstone of the same character is found on the western shore opposite Fourth of July creek. Here it is also in contact with granite. Its most westerly exposure is on Taku arm, a few miles south of Tutshi river, near the contact with the Carboniferous limestone. This is, however, less fresh-looking in appearance and may be an older diabase, representing the Gold Series in that locality. Greenstone intrusions of the same age and origin as those of Spruce creek are found to pass through the quartzitic rocks at the head of Bull creek and eastern branch of O'Donnel river. These, under the microscope, are classed as decomposed porphyrites.

Biotite schists.—These form the upper gold-bearing basins of Biotite slates Spruce, Otter and Wright creeks. On Spruce and Otter creeks they appear as ribbed or ribbon-like rocks, gray and flaggy, with bands of softer material, like carbonaceous shales. On Wright creek they are very soft and shaly, and also heavily mineralized with iron pyrites. It may be observed that these slates lie in contact with the Surprise Contacts. Lake granites near Wright creek and in contact with the greenstone of Spruce creek and mountain. Otherwise they do not differ in field appearance from varieties of the quartzite group seen on the upper branches of O'Donnel river, on the tributaries of Sucker river and on Ptarmigan flats. Hence they are found for a distance of fifty miles eastwards, but without the influence of extensive igneous intrusions such as occur where they are at present found to be gold-bearing.

SANDSTONES, CONGLOMERATES, ETC.

For twenty-five miles southwards of Tagish lake the Carboniferous Cache Creek limestone is found on each side of Taku arm. The low Cache creek limestone. broad valley of Tutshi river appears to be the southern limit of the limestone on the western side. Two miles further south, on the eastern shore, this limestone is succeeded by a narrow belt of greenstone and porphyrite. This belt of rocks extends in a north-westerly and south-easterly direction, and separates the limestone from the great area of sandstones, conglomerates and so-called argillites which form the shore and islands of southern Taku arm, excepting the western bay, which enters the Coast Range granites. These sandstones also extend in places across the mountains from Sandstones. Taku arm into Atlin lake. They surround the southern portion of

Atlin lake, but are not seen to the north of the southern flanks of Atlin mountain on the west shore, or north of the great O'Donnell and Pike river valley, on the eastern shore of Atlin lake. They probably occur further to the south-east in the direction of the Nakina river.

The prevailing variety of this sandstone series is of a greenish-gray colour. It is usually in heavy beds. There are occasional bands of a darker and more argillaceous-looking material, also some thick deposits of thinly-bedded fine grained black and gray material. Conglomerates occur somewhat rarely. Such beds usually contain very coarse boulders, as large as three feet in diameter. These boulders are principally granite, with sometimes a considerable number consisting of crystalline limestone and porphyrite.

Good section of.

A very good section of this sandstone formation is found on the west side of Tory inlet on Atlin lake. An anticline occurs at this point. The northern slope of the beds forms the abrupt eastern face of Section mountain. This section shows over 5,000 feet of thickly bedded sandstone of the greenish-gray false-bedded variety inter-banded with some finer-grained beds of darker material. The upper portion of these beds is without conglomerate. The lower beds contain some narrow bands of which the boulders are usually small and consist principally of granite and porphyrites (hornblende and andesite porphyrite).

Rocks of pyroclastic origin.

From microscopic examination of several specimens of this series, they appear to be of pyroclastic origin. One of these from the southern part of Taku arm is termed a prophyry tuff, and its appearance under the microscope is thus described :—

Microscopic description of a porphyry Stuff.

'A fine grained rock made up principally of individuals of a rather clear glassy striated feldspar, with a subordinate amount of milky quartz, in a dark-gray base. This base is crypto-crystalline and in comparatively small amount. The feldspar individuals are closely crowded together. There are many good forms with the angles slightly rounded, but the principal form is the angular or sub-angular one. They are twinned according to the albite law, many having in addition the pericline twinning. A few feldspar individuals are fresh, but the greater number are more or less turbid along the cleavage or twinning planes. The quartz occurs in clear angular or sub-angular grains with a few opaque inclusions. Strain shadows are common. A few individuals of a pale-brown biotite occur bent or twisted in between the feldspar grains, the former is altering to a very pale-green

almost isotropic chlorite. Calcite occurs as grains in the base and also fills in cracks in it and in the feldspars, due to infiltrating waters. In places it is stained by hydrated oxide of iron.' A small well-rounded pebble taken out of specimen 18 was also sliced and found to be like specimen 99, a hälléfinta.

The general strike of the sandstones is south-easterly. They usually occupy the low-lying shores of the greater lakes, but occur on Birch mountains to a height of 3,000 feet above Atlin lake; and between Taku arm and Atlin lake they form mountain masses to a height of over 2,000 feet above the lakes. They are nowhere observed in direct contact with any rocks other than the porphyrite and granite porphyry mountain areas common about the southern portion of Atlin lake. The transition from these bedded porphyrite and andesite tuffs to the porphyrites, andesites and basalts of Cameron and McCallum mountains is indefinite. Usually a very fine-grained andesite tuff intervenes.

The beds are inclined generally at low angles. An anticline appears to pass from Section creek across the southern part of Teresa island; thence across Griffith island to a place near Moose creek. Along the range south of Taku inlet, near Golden Gate, there are several great foldings of the strata forming truncated anticlines which have their axes in a south-easterly direction.

A few fossil forms were found in some of the darker fine-grained beds of this series of rocks. These were obtained from the west shore of Tory inlet, the south-eastern shore of Teresa island, and the eastern shore of Atlin lake south of Griffith island. From field conditions and lithological resemblance, this series of rocks was at first believed to be Cretaceous in age. The examination of the few fossil forms appears to place them in the Jurassic. No evidence of the occurrence of coal was obtained. Organic remains of any kind are rare in these pyroclastic rocks. The following is a note on the specimens of fossils collected on Atlin lake during the season of 1900 and submitted to Dr. H. M. Ami for examination:

'The fossils are preserved for the most part in a rather imperfect manner in a dark, at times streaky, gray, fine-grained calcareous rock, which, when examined in thin sections under the microscope reveals the structure of a porphyrite or andesite tuff * * * The fossils are for the most part fragmentary, and were no doubt rather difficult to obtain in the hard andesite and tufaceous strata, but they represent several small collections made in different portions of Atlin lake and possibly different horizons in the Mesozoic.

Strike of sandstone

Anticlines.

Fossils probably of Jurassic age.

Examined microscopically by Dr. H. M. Ami.

It is very difficult to state precisely what is the age of the strata from which the organic remains were obtained, both on account of the condition in which the fossils are themselves preserved and on account of the fact that the fauna represented is practically a new and hitherto unrecognized one in that portion of North America. * * *

Ammonites.

The presence of a few ammonites, which had the general outward appearance of *Arniotites* not unlike *A. Vancouverensis* seemed to indicate a similar horizon to that of the Triassic system of the Cordilleran belt, but as none of these ammonites show any of the sutures, it is impossible to state precisely in what section or division to place them.'

Examined
by Dr. T. W.
Stanton.

Some of the most typical of these fossils were sent to Dr. Timothy W. Stanton, of Washington. He found it difficult to determine the ammonites even generically since they showed no sutures. He says :

'These may possibly be Triassic, but I think it more probable that they are early Jurassic. They are certainly not as late as the Cretaceous. There seem to be three or four species and perhaps nearly as many genera of ammonites.

'There are also a smooth species of *Pecten*, and two or three other simple forms of Pelecypoda, but these are of types having a wide range and do not aid in close correlation.' Besides the three or four species of ammonites referred to by Dr. Stanton, in the collection, the following may be mentioned :

1. A smooth species of *Pecten*, probably belonging to the subgenus *Pseudamusium*, and apparently an undescribed form.
2. A small shell-like *Trigonodus*.
3. A bivalve like *Tancredia*.
4. A fragment apparently of a species of *Inoceramus*, with conspicuous rather regular raised concentric folds or lines of growth.
5. A number of branching fucoid-like and carbonaceous markings on slabs, appear to indicate the presence of algae.

GRANITES.

Large granite
areas.

There are several very large areas of granite in the district between Atlin and Teslin lakes. This granite appear to belong to the same period as that of the Coast Range granite. It is usually hornblendic, with variations in the quantity of biotite. Its greatest development

extends almost unbrokenly from Atlin lake to the flats west of Teslin lake, a distance of fifty miles. It forms the shores of the northern portion of Atlin lake; thence in an eastern direction it constitutes the high rugged ranges about Surprise lake and Zenazie creek. The great valley of Sucker river intervenes, and the granite reappears in the Snowdon range to the east of it.

About Surprise lake the granite is almost without bisilicates. It consists of quartz and felspar, which form an easily disintegrated rock. The *debris* of this granite has gone towards the formation of the heavily drift-covered slopes to the south and west of Gladys lake. The yellow pre-glacial gravel of Pine creek also contains much of it as a coarse sand. The granite of Zenazie creek and Snowdon mountains is more hornblendic in character. It will be noticed that the longer axis of this granite area is nearly east and west. The adjacent rocks are the regional quartzites, with the exception of the actinolite slate of the Gold Series in Pine creek basin. The granite is evidently younger than any of these rocks, with the exception of the greenstone and the scoria and basalt of Ruby creek. Twenty miles south of the Surprise Lake granite, there are two other great mountain masses of granite. These are again separated by the valley of the upper Silver Salmon river, which is a continuation of the Sucker River valley.

Source of drift material.

Palaeozoic quartzite flanks these ranges on the north-east and west. The most easterly of these masses occupies the high Boulder plains between the Nakina river, Hurricane river and Ruth lake. It is a great barren Alpine upland, strewn with boulders and draining gently southward to the Nakina river. It is built of hornblende granite, often porphyritic. It resembles the granite of the White pass in the Coast Range.

The western area forms McMaster mountain. It lies between the upper Silver Salmon and O'Donnel rivers. The texture of this granite is more even-grained, and made up of small crystals of hornblende, biotite, much felspar and a little quartz. It weathers into a very massive, smoothly rounded range unlike the Surprise Lake granites. Dykes, veins and all foreign intrusions, variations or segregations are noticeably absent in this granite. It appears to be barren, both in placer and in lode minerals.

McMaster mountain.

PORPHYRITES, ANDESITES AND BASALTS.

Eruptives.

This group appears to be closely connected with the origin of the sandstones of which they may be the non-fragmental representatives. They form the Taku, Cameron, McCallum and Sloko mountains. Each of these groups of mountains is isolated from the other, excepting McCallum and Sloko, which are divided by a deep valley. The group lies in a nearly north-and-south direction, parallel to the Coast Ranges. Excepting these occurrences there is no further development of the same set of rocks in the Atlin district. It is probable that they represent one of the localities of later igneous activity just east of the Coast Range. Rocks of a somewhat similar character have been brought from the Nordenskjold and Nisling rivers north of this district.

Form high mountain ranges.

These eruptives, as a rule, form high-pointed or smoothly-curved mountain ranges, resulting from the material weathering into small fragments. Many very steep and symmetrical cirques occur. The smooth grassy mountain tops over 5,000 feet above the sea-level are favourite feeding grounds of the Rocky Mountain sheep. All these eruptive areas, with the exception of Cameron mountain, lie outside, or at the edge of the sandstone series. Cameron mountain is almost completely surrounded by the sandstones. The change from tufaceous fragmental rocks to the porphyrites and andesites of this mountain is gradual and indefinite.

Taku mountain.

Taku mountain forms a mass about 2,000 feet above the level of the lakes. The eastern portion is very flat-topped, giving a basaltic appearance. The structure of its rock is also prismatic in places and microscopic sections show it to be a porphyrite. There are also large areas of a greenish-reddish augite-porphyrity, which is found more extensively along the low hills between Llewellyn glacier and Atlin lake.

The low hill on Taku portage and the rocks about the outlet of Atlin river are andesites. Fine-grained andesite tuffs occur in the cirques and banks of Cameron and McCallum mountains. In hand specimens this much resembles the banded basalt of Sloko mountain.

Augite porphyrite.

On the southern portion of Copper island in Atlin lake there is an area of augite porphyrite, a dark-green rock which sometimes weathers down into a sand of augite crystals. This rock appears to carry seams along which native copper has been deposited. Such an occurrence is found at the 'Noel' claim on Copper island. Sloko lake lies entirely

within mountain ranges of eruptives of this period. The arrangement of the various flows has resulted in a tabular appearance, due principally to almost horizontal bands of a flinty dark-coloured basalt at different horizons.

On Glacier inlet, which leads through a fiord-like channel from Atlin lake to the Llewellyn glacier and Coast Range granites, a natural section shows the transition from the sandstones to the lake basin. Passing southwards down the east shore of this deep inlet, the rocks are seen to strike south-easterly, dipping from 50° to vertical to the north-east. The section is roughly as follows :

Gray-brown rather coarse hard-weathering sandstone, 1,800 feet.

Very regular thickly bedded greenish-gray sandstone, 5,000 feet.

Greenish-reddish stratified and somewhat twisted rock, 2,500 feet. (This is probably augite andesite.)

Yellowish-brown conglomerate, of which the principal boulders are acidic granite, greenstone and a dark porphyrite, 2,500 feet.

Greenish-reddish twisted augite-andesite strike SSE., dip 85° ENE. This appears to be conformable.

Specimen 54.—Augite-andesite, Sloko inlet.

Composition
of augite
andesite.

‘A massive compact tough rock, dull green in colour with brown and reddish-brown patches. It consists of a large number of finely twinned phenocrysts of felspar and a few rounded augites in a base which is partly crystalline and partly glassy. The felspar occurs in both large and small individuals, many of which have good crystalline form. They are nearly all turbid from alteration. Products, yellowish epidote and greenish zoisite, the latter in considerable amount. The augite is colourless, in rounded grains and rather decomposed. Magnetite in considerable amount and some biotite is present. The base is not in large amount, but the transition from ordinary glass to cryptocrystalline base is well seen.’

GRANITE PORPHYRY.

‘This rock consists of large individuals of a finely twinned felspar in a micro-granitic groundmass composed of quartz with magnetite, hornblende, biotite, chlorite and felspar. This groundmass is principally quartz and felspar. There seems to have been a movement subsequent to the formation of the individual crystals of felspar, as

Granite
porphyry.

they all show strain shadows and many are broken, bent or cracked. Crenulate borders are common which would indicate a further growth, the new material being in optical continuity with the parent grain.'

Forms
conspicuous
mountain
peaks.

This rock forms the conspicuous peaks of Birch, Atlin and Cathedral mountains, all three groups being isolated from one another and on the south-west side of Atlin lake. These are distinct intrusions, probably of somewhat later age than the sandstones and porphyrites. This granite porphyry breaks up into broad plates of a few inches thick. The weathering down on Atlin mountains has resulted in a great rock slide from a basin on the eastern face.

RECENT ERUPTIVES.

Recent
eruptives

The most recently formed eruptive rocks of this district occur on the west side of Ruby creek and at the head of Volcanic creek, sixteen miles north-east of Atlin. These deposits, consisting of scoria and basalt, have partly filled in pre-existing valleys. No evidence of glacial action or presence of foreign boulders was seen on these areas. The eruptions have taken place near the contact of the actinolite slates with the Surprise lake granite. On the west side of Ruby creek a mountain slope of brown and black scoria terminates in a crater-like summit 2,000 feet above the valley and 6,360 feet above the sea. The crater-like depression at the summit of this conical pile of scoria and basalt is about 300 yards in diameter. The central depression is ten feet below the lowest gaps in the rugged rim which surrounds it and 170 feet below the river at its highest point.

Area of
Ruby creek
eruptive.

The valley of Ruby creek 2,000 feet below is floored with a gray basalt through which the present stream has cut a narrow cañon. The area of this eruptive rock is about four square miles. Another and similar but smaller area lies at the head of Volcanic creek, at the northern base of Mount Barham. There is evidence of a crater of which the built-up rim is scoria. A flow of basalt has crossed the head of the creek northward in the direction of the present drainage; pieces of scoria were noticed amongst the broken-down material of Mount Barham. The area of this eruption is less than one square mile.

Sandstones
and conglom-
erates.

The only cemented beds of later origin than the sandstone series was an occurrence of horizontally bedded sandstones and conglomerates, near the entrance to Sloko inlet, at the southern end of Atlin lake. These are soft friable sandstones of a brown colour, containing pebbles

of mica-schist and a peculiar quartzite not seen elsewhere except in the vicinity of the Coast Range and as loose material in the glacier moraines. Some cemented conglomerate of wholly local origin was also seen on the western face of McCallum mountains.

Mr. A. Saint-Cyr, D.L.S., in the course of establishing the northern boundary of British Columbia, collected a set of specimens from the prevailing and characteristic exposures along the line, from Windy arm to Teslin lake. Specimens collected by Mr. A. Saint-Cyr.

Specimen No. 13, from White-Fraser mountain, one mile east of Windy arm, is a dark cleaved rock, apparently a hornblende schist and probably allied to the iron-stained band of Palæozoic hornblende schists and quartzites seen on Lake Bennett and elsewhere, as occupying a position in contact with and east of the Coast granites. Description of.

No. 10, from Patterson mountain, 3.5 miles east of Windy arm. Three specimens, obsidian, jasper and a hornblende porphyry.

No. 9, from White mountains, six miles east of Windy arm. A light coloured fresh-looking greenstone with quartz and calcite stringers.

No. 11, from the same place, is a brown granular rock, a very much decomposed dyke rock. Both of these specimens belong to igneous intrusions in the main mass of the mountain, which is formed of the crystalline palæozoic limestone.

No. 8 is from Morin mountain, two miles west of Taku arm. This is a white plated rock of fine texture. It resembles a variety seen on Sloko inlet of Atlin lake, an acid tuff of the porphyrite and andesite series, so largely developed along the first belt east of the Coast Range granite. Other specimens of greenstone and crystalline limestone taken from the district between Taku arm and Windy arm, show north-western extension of rocks similar to some in the Atlin district. The limestones appear, however, to be more broken into by igneous rocks of the newer series of porphyrites, greenstones and basalts. The specimens taken along this boundary line between Atlin and Teslin lakes show that the granite of the northern part of Atlin lake gives place, on going eastward, to the regional cherty quartzites. These quartzites form the floor of the great sloping flats of this district until the western flanks of Dawson peaks are reached. On the western and southern flanks of Dawson peaks there are crystalline limestones. The Dawson peaks themselves are made up principally of eruptives, probably porphyrites, some of which are dark fine-grained rocks, resembling basalt. These isolated mountains are apparently not the Other specimens.
Dawson peaks.

result of denudation, but of a volcanic uplift through the Palæozoic floor of limestone and quartzite.

PRE-GLACIAL GRAVELS.

Pre-glacial
gravels.

These are yellow, much decomposed gravels, usually found beneath gravel and clay of a much darker appearance, and probably of glacial origin. Such gravels in the district are easily recognized. They are often of a deep yellow lustrous appearance. On being broken the fractures will be found to be also yellowish with oxide of iron. This will often decide between the genuine ancient gravels and the gravels which are simply coated with iron oxide from a spring or water course.

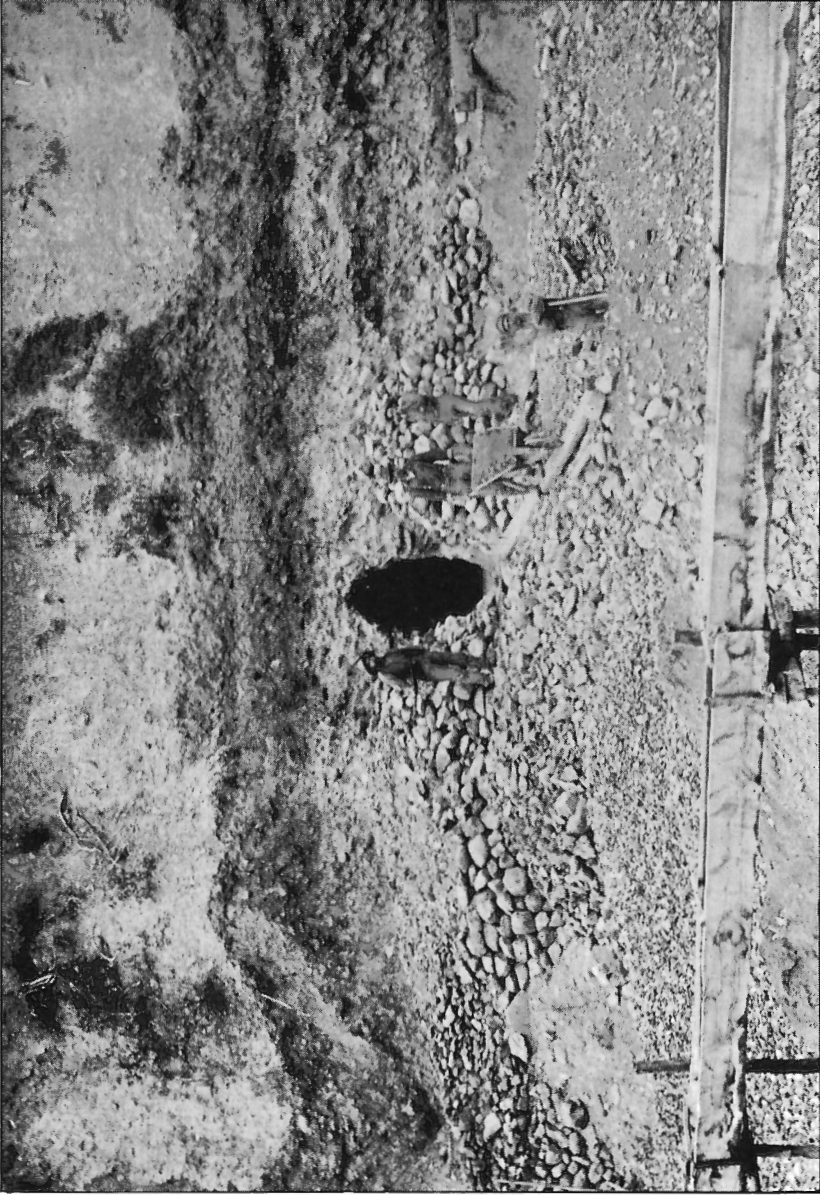
Such gravels exist in the broad valleys of Pine and Spruce creeks. They pass, at times, beneath 200 feet of drift or superficial material of more recent origin. This drift was spread over the old valley and streams completely burying them at one time, but since that time the drainage has again cut down to its former level through this overlying drift and at some points the new or post-glacial stream has followed very closely in the course of the older pre-glacial one, and has also rewashed its gravels and cut down to the old bed-rock.

Spruce
creek yellow
gravels.

On Spruce creek these yellow gravels, as part of a pre-glacial stream, were traced from Prouses tunnel at about 100 below Discovery claim up to the bed-rock of the south bench at Discovery. They also extend for a short distance up the western bank of Spruce creek above Discovery claim, but are soon lost sight of beneath the moraine material so plentifully represented at the upper portion of Spruce creek. From Prouses tunnel to Discovery claim, a distance of nearly two miles, the course of this old channel appears to have been almost straight in a course of 97° (magnetic.) The present stream is more crooked. It has cut down to the level of the old stream bed in places and, in its windings exposes the yellow gravels, first on one side, then on the other, but the greater portion of the yellow gravels appears to be on the western side of the present stream. Into this, many tunnels have been driven, exposing a rather deep and wide deposit of the yellow gravel.

Gold contents
of gravel
from Prouses
tunnel.

The gravel taken out of Prouses tunnel is said to have carried \$6 to the cubic yard. At 93 below Discovery, on the eastern bank, active work and sluicing of these gravels was carried on during last summer. Several men were preparing to drive tunnels into this deposit during the ensuing winter. The grade of the pre-glacial stream bed on



Atlin Gold Field

CLAIM 93, BELOW DISCOVERY, ON SPRUCE CREEK
Illustrating the pre-glacial gravels beneath glacial drift.

Spruce creek is somewhat steeper than that of the present stream. It is about 140 feet per mile. No evidence of pre-glacial gravels was seen lower than Prouses tunnel excepting some gravels stained with iron oxide, which may have been derived from the older channel near by.

On Pine creek yellow gravels of a less conspicuous character were traced from Stephen dyke to the junction of Gold Run with Pine creek, a distance of about two miles. They appear to exist above this point on the north bank of Pine creek. Shafts sunk into the post-glacial channel of Gold Run, also pass through a brownish-white and yellow gravel, which is decomposed along lines of fracture. Much of the gravel here is of granitic origin, being derived from the Surprise Lake granites. Such gravels would not collect in the valley of Pine creek under present conditions. The present course of Pine creek from Gold Run down to Stephen dyke follows closely the course of the older stream, but appears to have cut somewhat deeper from Willow creek down to Stephen dyke.

Pine creek
yellow
gravels.

Gravel
of granitic
origin.

Between Gold Run and Willow creek the yellow gravels occur on both the north and south banks at times together and sometimes as far as shown, on only one bank. Usually the ancient stream bed appears to have been quite wide, and some of the work done may be far from the chief channel of gold concentration. The fall in the present stream and that of the older one appears to have been about the same, for nearly a mile below Gold Run. About Willow creek it has been cut down more deeply, leaving a little rocky ridge between Willow and Pine creeks, which ridge appears to have been either bed-rock or rim-rock of the yellow gravel. This bench, twenty feet above the channel of Pine creek, and nearly as much above the earlier channel, Willow creek, has a whitish-yellow rock surface, with a thin deposit of yellow gravel and boulders, containing some gold. Below Willow creek the somewhat oxidized rocky benches down as far as Stephen dyke, are at present the only evidence of the older channel. There is also a deposit of yellow gravel in the south bank, opposite Pine town. Below the junction of Pine and Willow creeks it seems probable that most of the yellow gravel has been re-washed and its gold contents re-concentrated in the present stream-bed, which is fairly rich along this portion.

Evidence of
older channel.

In the case of the Pine creek yellow gravels, there is at present no indication of glacial deposits overlying them. The very deep drift-deposits of Spruce Creek valley are absent in the upper valley of Pine creek. Boulder clay occurs at Willow creek and between Willow creek

Moranic
ridges.

and Stephen Dyke creek, also morainic ridges, but not overlying the ancient stream deposits, so far as observed by the writer. There is some evidence to show that ice action may have cleared or kept clear this upper portion of Pine creek. The tracing of these ancient stream gravels of Pine and Spruce creeks depends almost entirely upon work done in shafts, excavations and tunnels, which have exposed the conspicuously coloured gravels.

Concentration
of gold in
pre-glacial
streams.

The present surface of these valleys, covered with drift and terrace-deposits, affords little information concerning the courses of pre-glacial streams. Hence these deposits have been found along those portions of the present streams which have been most actively developed. What may exist above or below those limits of present exposure is more or less conjectural. It appears largely due to this coincidence of the past and present streams that pay-gravel is found along such portions. Where such is not the case, the yellow gravels may be found intact and in a different channel, but such a condition of things will not be revealed by surface indications to any great extent.

Neither Pine or Spruce creek yellow gravels were seen at a lower level than about 500 feet above Atlin lake. Their existence above Gold Run, on Pine and Discovery claim on Spruce creek is probable, but it is also not unlikely that portions of them have been removed by the local glacial action. On the upper part of Pine creek the deposit is wide and almost level, as far as observed. Such a condition affects the concentration of the gold into pay-channels. It is evident that the drainage conditions of pre-glacial times was much the same as at present. How much the upper valleys have been affected by the ice and the lower portions by the lake system, is not apparent.

ORIGIN AND OUTPUT OF PLACER GOLD.

Production of
placer gold.

The placer gold production of the years 1898-99 and 1900 since the discovery of this district, has been practically confined to the basin of Pine creek and McKee creek, seven miles southward. The basins of these producing creeks lie within an area of rocks which have been given the name 'Gold Series', on account of their association with the gold-bearing gravels. The superficial material which now covers the broad valleys of Pine and Spruce creeks, whether the result of pre-glacial, glacial or post-glacial action, is almost entirely of local origin. The narrower V-shaped tributaries of Pine creek contain practically nothing but the ordinary mountain slope, débris or wash, and a stream-bed of coarse boulders of local origin.

It follows from these conditions that the gold concentrated along these past and present watercourses is also of local origin, whether derived from the veins, stringers or the more or less mineralized country-rock. There are many strong veins of quartz mineralized with the sulphides of iron, lead and copper within these basins. Some also contain free gold, but none of exceptional richness were observed. Some bands of rock, such as the wide magnesite exposure of the 'Anaconda' group, are found to be traversed by innumerable stringers of quartz and calcite. The whole mass of the rock carries small values in gold.

The biotite slates of Wright creek are in places much impregnated with iron-pyrites and show other evidences of mineralization, while microscopic sections of all these rocks of the Gold Series show the presence of magnetite and pyrite. It seems therefore probable that the gold has been derived originally from the wearing away of great masses of the country-rock together with its contained veins and mineralized zones. The existence of a rich and extensive 'mother lode', workable as a quartz or lode mine is unlikely.

Within the valleys of Spruce and Pine creeks very little has been done by the present post-glacial streams towards enlarging or cutting down of these valleys. These creeks have done little beyond re-washing and re-concentrating the gold already collected in the drift and pre-glacial channels. Any local richness in placer gold will be found to be due to the presence of earlier concentrations in pre-glacial gravels, or from the drift and post-glacial channels, into which the present stream has cut its way.

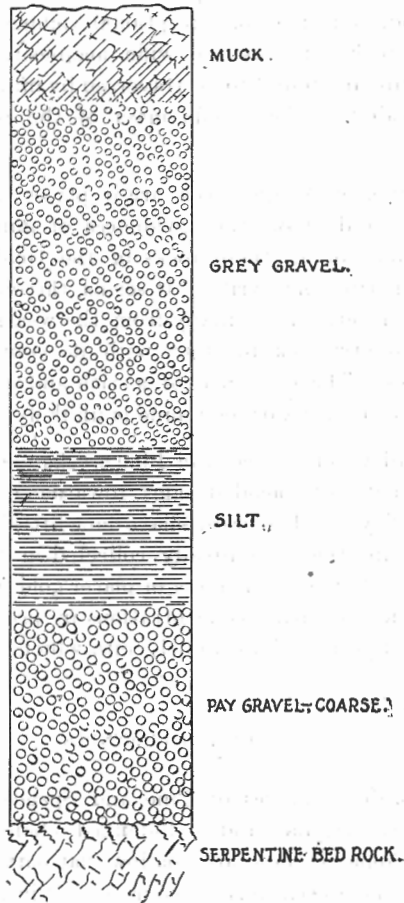
POST GLACIAL CHANNELS.

Besides the present courses of Pine and Spruce creeks, there are other more or less regular and well-defined channels within these broad valleys. Some of these are shallow, flat-bottomed depressions, which appear to have been former courses of Pine creek. Such are Gold Run and Willow creek.

Thron gulch appears to have been an earlier course, not unlikely followed by a stream during the period at which the great terrace deposits were laid down. There is no evidence of a large volume of water having passed over this course for a long period of time. Several short feeders or low ravines lead into Pine creek from the south above Discovery claim. These are simply excavations in the drift made by small streams during freshets, but they appear to have

Gold Run
creek.

concentrated some gold and to have enriched the Pine Creek gravels near the points of their junction with that stream. Gold Run creek is a low regular course about half a mile long on the south side of Pine



SECTION OF STREAM GRAVEL ON WILLOW CREEK

SCALE 3 FT = 1 INCH.

creek, one mile and a quarter above Pine city. This watercourse is separated from Pine creek by a low ridge of gabbro-diorite. Its surface is about fifteen feet above Pine creek. A shaft sunk to a depth of

thirty-five feet passes through a covering of dark muck, then into gray and finally yellowish-gray gravels, which are largely composed of granitic material, such as might be derived from the Surprise Lake granites. This gravel may be of pre-glacial origin. The depth to bed, or rim-rock on the 'Deadwood group,' indicates that a channel moraine, deeply cut than Pine creek exists at this point. Gold values at this place are said to be good. As far as known there is no pay gravel due to the later stream which cuts the existing shallow channel. The fall in the ancient stream beneath Gold Run must have been very slight, certainly less than 1 per cent.

WILLOW CREEK.

This is a well-defined channel on the north side of Pine creek just Willow creek. above Pine city. Its length is about half a mile and it is separated from Pine creek by a low bench or ridge of serpentine, together with some dyke rocks of a dioritic character. This little ridge has a thin covering of yellow gravel, but no yellow gravel was seen in Willow creek itself. If such at any time existed it has been re-sorted and broken down into the material given in the following section, in ascending order.

Three and a half feet of coarse black and red-stained gravel on serpentine bed-rock.

Two and a half feet of fine silt or sand, sometimes stained brownish red.

Five and a half feet of mixed gray gravel.

One and a half feet of black surface muck.

The gravel below the silt on bed-rock carries the chief values. In this former stream-bed there is some evidence of glacial action, such as the pressure of some deposits of unassorted clay and boulders, and some striated boulders. Evidence of glacial action.

THRON GULCH.

This is not a gulch in the usual sense of the term, but a shallow fairly well-defined depression, sometimes constricted by rocky outcrops of serpentine between Pine city and Spruce junction. Between Spruce junction and the western end of Munro mountain it is a shallow wide depression, only a few feet lower than the surrounding terrace

flats. There are no rocky outcrops to be seen between Spruce junction and the gap at Munro mountain. After passing this gap, which is about 400 feet above the level of Atlin lake, a little stream has cut deeply into the terrace deposits and so continues this channel on to Fourth-of-July creek.

Bed-rock not reached.

Bed-rock, as far as known, has not been reached at any point between Spruce junction and Fourth-of-July creek. It is probable that deep deposits of terrace material overlie this portion. A shaft sunk in the gap near Munro mountain for about 50 feet shows a dark gravel rather even in size. Gravels of much the same character have been thrown up from pits sunk along the upper portion between Spruce junction and Pine city. There are said to be fair prospects from this development, but the prospecting of this stream or creek is not sufficient as yet.

No pre-glacial gravels seen.

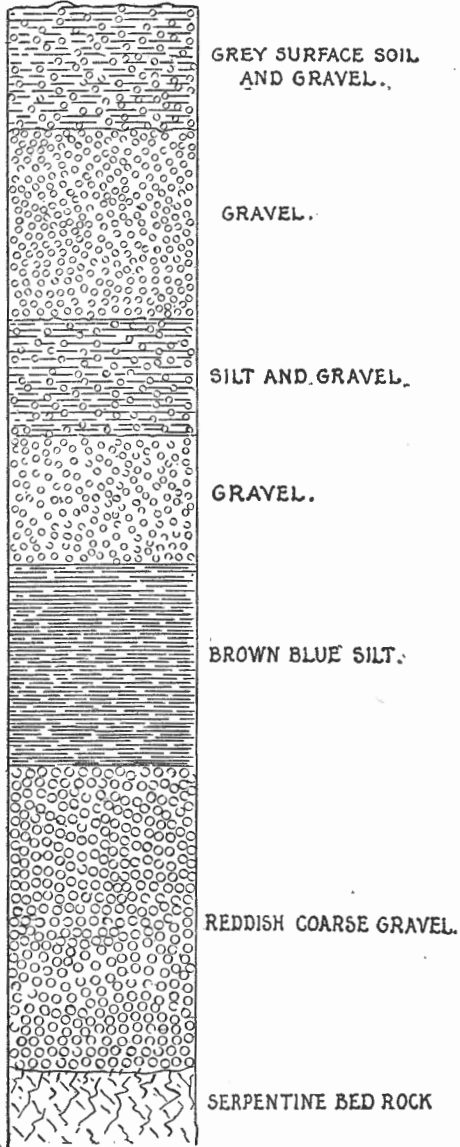
No evidence of pre-glacial or yellow gravel deposits was seen along this course. They are not likely to occur, although it is a common supposition that Pine creek once followed this course in its way to Atlin lake. The fall from Pine city to Spruce junction, 1.5 miles, is about 150 feet. From Spruce junction to Munro mountain, 2.5 miles, it is about 100 feet; and from Munro mountain to Atlin lake 2.5 miles by way of the deeply cut little gulch and Fourth-of-July creek, the fall is 400 feet.

STEPHEN DYKE.

Stephen dyke. The only important tributary from the south is Stephen Dyke creek, a small stream which heads in the morainic hills on the north side of Spruce creek. It has cut down or re-occupied a rather deep, narrow valley, at times between the moraines and drift, and at others between steep rocky walls of greenstone. A shaft sunk for 40 feet on this course has not reached bed-rock. The present stream seems inadequate to the formation of such a deep and narrow valley. No evidence of this being a pre-glacial channel of Spruce creek was observed. It is more likely to have been a temporary channel during the reunion of the local glacier at the head of Spruce creek, and as such has assisted in a concentration of placer gold. This also accounts for the presence of Spruce creek gold on the Stephen dyke benches.

Pine creek.

Pine creek, the principal gold-bearing stream of Atlin district, drains Surprise lake, eleven miles east of Atlin. For the first five miles after leaving Surprise lake it passes over a flat broad valley, with little exposure of rock along its course. The fall of the stream in this dis-



SECTION OF PINE CREEK GRAVELS AT DISCOVERY CLAIM

SCALE 3 FT = 1 INCH.

tance is about 130 feet. The remaining six miles of its course is more rapid, with a fall of about 700 feet. It passes through several rocky cañons below Pine city and many terraced flats composed of more or less assorted material, also some deposits of stiff boulder-clay.

Varieties of
bed-rock.

The principal varieties of bed-rock are diorite and serpentine, also some porphyrite and dyke material. The cañons at Halfway house and Stephen Dyke creek are a decomposed porphyrite and diorite. Below these cañons and above Pine city, serpentine is the prevailing bed-rock. The greater portion of the gold is moderately coarse, being about the size and shape of flax-seed. Nuggets up to a weight of several ounces are not uncommon. This gold is usually well-rounded or flattened; it occurs principally near bed-rock, usually in a rather coarse gravel, and is often somewhat stained with iron oxide.

Section,
at Discovery.

A section of the gravels at Discovery claim is as follows, in ascending order:—

- 5 feet, brown-red coarse gravels on serpentine bed-rock.
- 3 “ brown-blue silt.
- 2 “ gravel.
- 2 “ silt and gravel.
- 3 “ fine gravel.
- 2 “ surface gray gravel, clay and muck.

On Harrigan's claim one face of the excavation shows 10 feet of very fine and even-grained bluish silt overlying about one foot of gray mixed gravel. This is the pay-gravel and lies on a serpentine bed-rock. Gold in paying quantities is also found on some of the thinly covered rocky benches 20 to 60 feet above the stream.

Placer mining
on Pine creek.

Also on certain horizons, pay gravel is found by drifting into the banks on the south side of Pine creek below Discovery claim. These appear to be earlier post-glacial levels of Pine creek, before it had cut down to its present level. Placer mining on Pine creek during 1900 was practically confined to that portion which lies between Gold Run and Stephen dyke. The best results appear to have been obtained from the vicinity of Discovery claim and for about 30 claims below it.

The Sunrise Hydraulic Company has fitted up its appliances and commenced piping on the north bank of Pine creek, near the head of Willow creek. Bracketts Hydraulic Company has taken over much of Willow creek. During the season of 1900 they appear to have done effective and successful work.

pruce creek,

Spruce creek is the largest tributary of Pine creek. It rises thirteen miles to the south-east, and falls in its course to the junction with

Pine creek, some 1700 feet. The upper portion is simply a low grassy coulie leading over into Father creek and O'Donnel river. Low wide slopes and some local morainic material characterize the heads of this creek and also Otter and McKee creeks, all of which have their sources from the same wide uplands or Alpine moors. The upper seven miles of the stream flow through a flat-bottomed valley, between banks of drift material 75 to 100 feet high, and it falls in this distance about 400 feet.

At Eagle point, two miles from the head, there is a little cañon formed by a barrier of rocks, which are a more quartzitic form of the biotite slates of Wright creek. At this place a few miners have been employed during the seasons of 1899-1900. Portions of the rocky bench, thinly covered with gravel, gave good returns in gold. Pay gravel is also being washed from the valley. This is not on bed-rock, but above a stratum of silt or clay, below which gold has been also found at some points. Canon at
Eagle point.

Seven miles from its head the character of the stream valley changes. It here enters a broad low barrier of greenstone, similar to that of McKee creek and Spruce mountain. The stream falls more rapidly through a series of deep cañons. Lower down, it cuts deeply into the drift, forming a ditch-like channel from 200 to 400 feet deep and 500 to 800 feet across from brink to brink of the banks. The material exposed by this deep cutting is a more or less assorted and false-bedded drift, with some deposits of stiff boulder-clay, containing striated boulders. There is little bed-rock exposed in all this upper portion. The yellow gravels are cut into here and there by the present stream, which falls about 1,300 feet in the lower six miles on a grade of from 2.5 to 3 per cent. Character of
valley
changes.

Drift and
boulder-clay
exposed in
cutting.

No hydraulic mining of importance has been carried on upon this creek. Placer mining has been active for the past two seasons on that portion of the creek from 138 below to 80 below Discovery, also at a few places higher up, and at the benches near Discovery claim, also at Eagle point. The greater portion of this stream, though proved to be gold-bearing at points widely apart, has not been worked by placer mining, on account of the depth to bed-rock. The supply of water is fully utilized at present by the placer miners for their water-wheels and sluices. The gold is usually coarse. Some nuggets, up to 40 ounces in weight, have been taken out. This gold runs somewhat finer than that of Pine creek. Placer mining
not general.

Ruby creek lies fourteen and a half miles east of Atlin lake. It is the most easterly of the gold-bearing creeks, tributary to Pine creek,

from the north side. Its source, seven miles back from Surprise lake is from a number of remarkably deep, rather flat-bottomed valleys, which penetrate some of the diorite, actinolite slates and serpentine of the Gold Series. The valley downward from these upper tributaries has not an even grade. It has been filled in to some extent by a basalt flow, through which the present creek has cut a deep narrow cañon.

Middle portion should contain placer gold.

From analogy with Birch and Boulder creeks, which also drain basins in rocks of the Gold Series, the middle portion of Ruby creek should have paying placers. This portion of the creek is overlain by the basalt. A mountain of scoria, evidently an old volcano, lies on the western range of this valley, and the Surprise granites occupy the eastern range near the mouth, but the upper portion has been deeply eroded in rocks of the Gold Series.

Boulder creek.

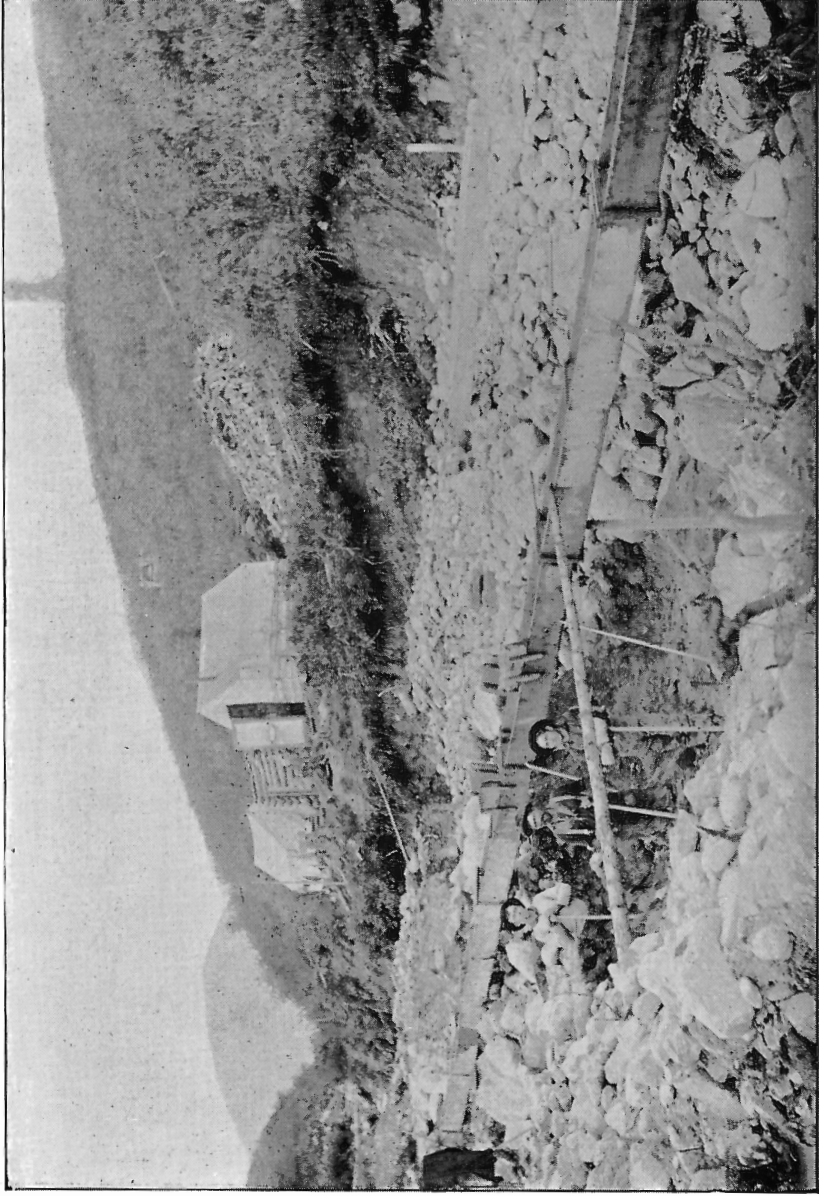
Boulder creek is $12\frac{1}{2}$ miles east of Atlin and parallel to Ruby creek, Its length is about six miles. The sources are in steep ravines leading up into the granite ranges at its head. Granite is also found as bed-rock as far down the stream as Discovery claim. The valley of the creek is of the common V-shaped kind, and is heavily filled in with boulders. There is a fall of about 1,400 feet between the second forks and Surprise lake. The volume of water is sufficient for present needs.

Pay gravel on granite bed-rock.

Placer mining has been carried on with success during the seasons of 1899—1900. The gold is coarse. One nugget of 50 ounces was found on Discovery claim. Pay gravel is found above Discovery claim on a granite bed-rock, the only instance observed in the district. This may be accounted for by the fact that the upper portion of the valley was originally occupied by actinolite slates of the Gold Series. These have been worn down and the contained gold concentrated on the granite which underlies them. Upon the lower part of this stream The De Lamare Hydraulic Syndicate has a lease. A flume has been built and some piping done during the season of 1900. The upper portions of the productive ground being still in the hands of placer miners.

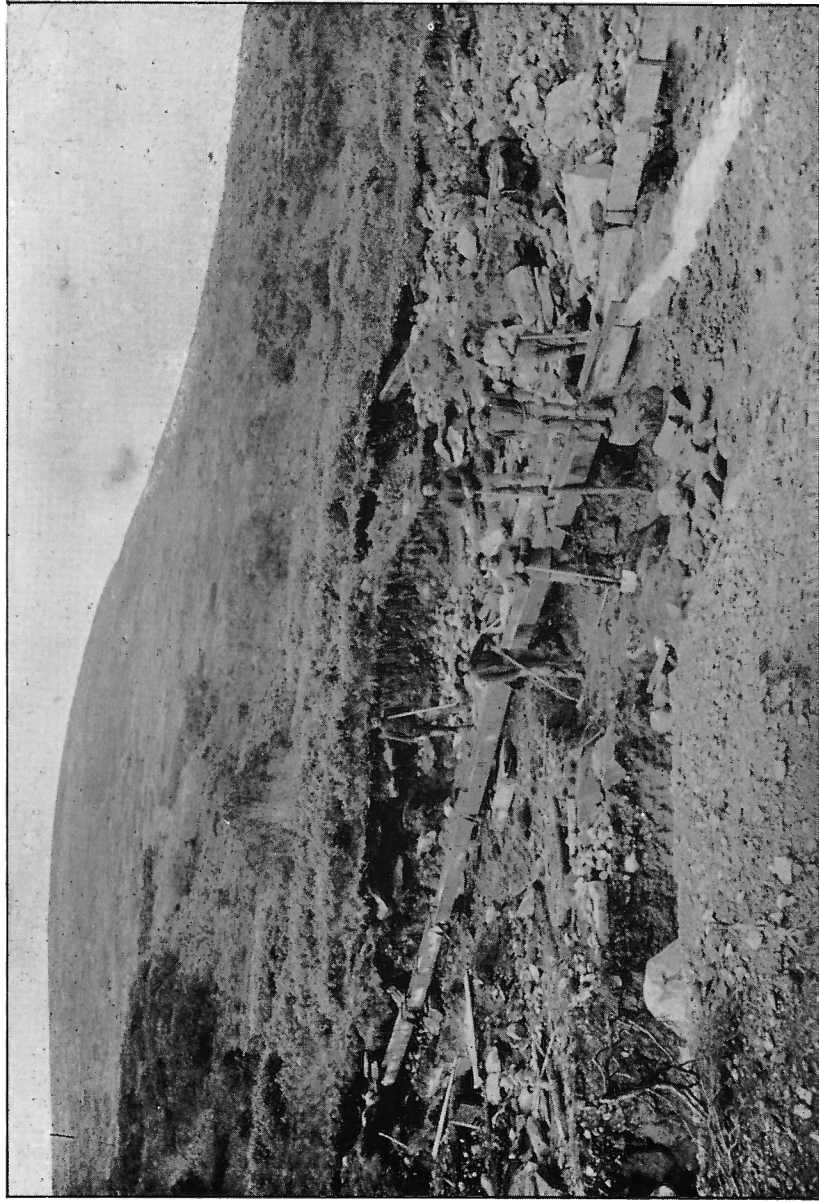
Atlin lake hydraulic Company.

Birch creek is nine miles east of Atlin. It is parallel to Boulder creek and is much the same in form and character, with a smaller flow of water. Actinolite slates, together with some magnesite, dunite and limestone form the adjacent ranges. These rocks are traversed by some vein-filled fissures, and they also contain large bodies of a white barren looking quartz. This stream returned fair pay to placer miners during 1899. It has since been taken over almost entirely by the Atlin Lake Hydraulic Company, which has built a flume and begun operations near Discovery claim at the lower end of the creek-



Atlin Gold Field

CLAIMS 2 AND 3, BELOW DISCOVERY, BOULDER CREEK.
Methods of working 100 foot claims.



Alton's Gold Field

CLAIM 37, ABOVE DISCOVERY, WRIGHT CREEK.

Illustrates shallow bed-rock and the mountains above timber line, about 4,500 ft. over sea level.

Ruby, Boulder and Birch creeks are the three chief northern tributaries of Pine creek. They are alike in physical features but differ from the other gold-bearing streams. They appear to be simply the V-shaped valleys and basins, due to water and snow erosion, and now contain no evidence of glacial origin or deposits.

Wright creek flows into Surprise lake from the south. It is the most easterly of the productive creeks south of Pine valley. The length of this stream is six and a half miles. Its sources are like those of Spruce and McKee creeks upon the Alpine uplands of this district. The upper portion is above timber line. The stream flows over a rather soft biotite slate which wears down without leaving boulders. It is this upper exposed portion of the stream bed which has so far proved productive. The gold values appear in some places to be found deep in the decomposed slate and in the banks at some distance from the stream. The rock is heavily impregnated with pyrites. Free mercury, cinnabar and native copper are said to be found also, but no certain evidence was obtained. The lower three miles of this valley are covered too deeply with drift to afford placer diggings. The Pendugwig Hydraulic Company has operated to some extent on this portion of the stream.

Wright creek.

Gold found in biotite slates.

The quality and colour of the gold found on this stream are somewhat different from that of Pine creek and its northern tributaries. A more than usual amount of black sand and pyrites is concentrated along with the gold in washing. The slate of this creek resembles very much that seen in many places to the south-westward. At this point, however, it is in contact with the Surprise granites to the north, and may have derived some of its value from that circumstance.

Otter creek drains the slopes between Spruce and Wright creeks. It enters Pine creek close to its outlet from Surprise lake. Like Wright creek it rises in the great uplands 1,700 feet above Surprise lake. Its length is about ten miles. Six miles from the mouth there is a little cañon, much like the one at Eagle point on Spruce creek and in the same rocks. Placer mining has been successful at this point. Below this upper cañon the valley has a flat-bottomed, filled-in appearance and no productive work has yet been done. Near the mouth, there is another cañon, composed of quartzites, limestone and a talcose rock, containing large patches of a barren-looking quartz. This stream much resembles Spruce creek. It has the same drift deposits and little morainic hills. From the upper cañon to Pine creek there is a fall of about 900 feet, The volume of water is greater than that of Wright, Boulder or Birch creeks.

Otter creek.

McKee creek. McKee creek is the principal productive creek outside the drainage basin of Pine creek. It rises in the low slopes near the head of Spruce creek, seven miles east of Atlin lake, and empties into that lake seven miles south of Pine creek. The upper portion of its valley is deeply covered with drift, through which an occasional point of rock projects. From the upper flats the stream falls rapidly about 1,500 feet in a distance of four miles. The bed-rock consisting of a greenstone similar to that of Spruce creek is often exposed, on this portion of the creek which has been profitably worked from the junction of Little Eldorado down to Discovery. A bench or terrace of fine material lies along the north bank, otherwise the lower part of the valley resembles that of the creeks north of Pine creek.

Rock principally greenstones and quartzes.

The principal rocks found within the basin of McKee creek are the andesitic greenstones, some limestone and cherty quartzite. At the head of the valley there is some magnesite.

Hydraulic work by Nimrod Syndicate.

A fair supply of water and a good fall are points of advantage in this stream, which has now been producing for two seasons. The Nimrod Syndicate has purchased a large portion of the ground already worked and will operate thereon with hydraulic machinery.

Magnetic separator.

The production in placer gold of the Atlin district during the two seasons 1899 and 1900, amounted approximately to somewhat less than a million and a half dollars. Experiments and determinations made in connection with the black sand residues or concentrations of these creeks, show the efficiency of the Wetherill magnetic separator, and the presence of platinum and other metals of the same group.*

QUARTZ AND LODE MINING.

Lode mining not established.

Up to the present time not much has been done in establishing productive lode mining. Several mineral discoveries within the valley of Pine creek have been prospected and to some extent developed by the Nimrod Syndicate. These for different reasons are not now being actively worked. Some of the mineral deposits show signs of strength and probable permanence. The cost of development at present is heavy. Transportation rates added to this, make a heavy total for the production of refractory or smelting ores. Such ores are found to some extent in this district, more especially to the north of Pine valley in the actinolite slates, and in one instance in granite on Crater

Cost of production too great.

* Summary Report Geol. Surv. Can., 1900, p. 11

creek, a tributary of Fourth-of-July, there are veins of gold-bearing quartz. Some of these deposits are strong, well defined lodes, usually with a gangue of quartz. Sulphides of iron, lead and copper are present. As far as determined these are not of high enough value in the precious metals, to encourage their development during present conditions of heavy costs.

Other deposits of more or less free-milling gold-quartz offer better returns for development. In some cases very rich assays are given. The result of mill tests made by the Nimrod Syndicate people with their small five-stamp mill at Atlin go to show that general averages are moderately low. Mill tests of the Anaconda rock, an auriferous magnesite deposit of great extent, show it to be of too low grade in gold to pay under present conditions. A mill-run continued for several weeks upon the ore of the 'Paris Exhibition' on Munro peak gave, according to published report, a little over \$10.00 per ton in gold. High values in gold are reported from the 'Ivy May', a quartz vein on the Tina mountains; also from the 'Yellow Jacket' which crosses Pine creek half a mile above Discovery claim. Some free gold and argentite were seen in the vein matter of the 'Lakeview' claim, near Surprise lake, and a solid but undefined deposit of galena and pyrites occurs on the 'Sunset,' at the summit between Keely and Consolation creeks.

Free milling
gold-quartz.

High values
reported.

Near the head of the east fork of Birch creek there is a strong and regular vein, the 'Little Edna.' This is well mineralized with iron-pyrites and some chalcopyrite in a quartz gangue. This carries some values in gold and silver. Other veins and mineralized bodies are found principally within the rocks already defined as the Gold Series. It seems probable that some of these will become productive in time, especially those which are more or less free-milling. Under present conditions as to cost, ores of a smelting character will necessarily have to be of high grade. The presence of coking coal in this or some neighbouring district may, if discovered, cause an active development of the refractory ore bodies.

'Little Edna'
vein.

Discovery of
coking coal
needed.

The Engineer Mining Company is developing the 'Hope' claim on Taku arm, eight miles south of Golden Gate. The ore-body is composed of quartz and has an extensive outcrop at the lake shore. It carries values in free gold, also some stibnite. Telluride of gold is said to be found but it was not detected in specimens examined in the laboratory of the Survey. The country-rock is a dark twisted slate, almost a shale in places. Quartz stringers and iron-pyrites are found throughout it. This is the only observed occurrence of precious metals

Native copper. in the rocks of the Sandstone series. Some light coloured dykes occur in this locality. The occurrence of native copper was seen on the "Noel" claim near the southern shore of Copper island in the southern part of Atlin lake. At this place there is an occurrence of augite-porphyrite, a greenish coloured rock full of little crystals of pyroxene. Mode of occurrence. This rock has been fissured and along the fissure there is an occurrence of quartz and calcite as thin seams, together with some flakes and plates of native copper. On each side of this seam the country-rock is lightly impregnated with specks of native copper. The largest piece of copper taken from this place weighed about 40 pounds. Copper, both native and as a sulphide, appears to be common through this belt of rocks, which is a part of the porphyrite series not far from the contact with the sandstone.

WATER ANALYSIS.

Water analysis.

Samples of water were taken from three springs in the district and these were examined qualitatively in the laboratory of the Survey.

No. 1. Taken from a warm spring near the eastern shore of Atlin lake, ten miles south of Atlin. This water, when filtered was clear and bright, devoid of odour or any marked taste. Its total dissolved saline matter was 16.53 grains per imperial gallon. A qualitative analysis showed the presence of :

Soda, very small quantities ;
 Lime, small quantity ;
 Magnesia, very small quantity ;
 Sulphuric acid, very small quantity ;
 Carbonic acid, small quantity ;
 Chlorine, very small quantity ;
 Silica, trace ;
 Organic matter, trace.

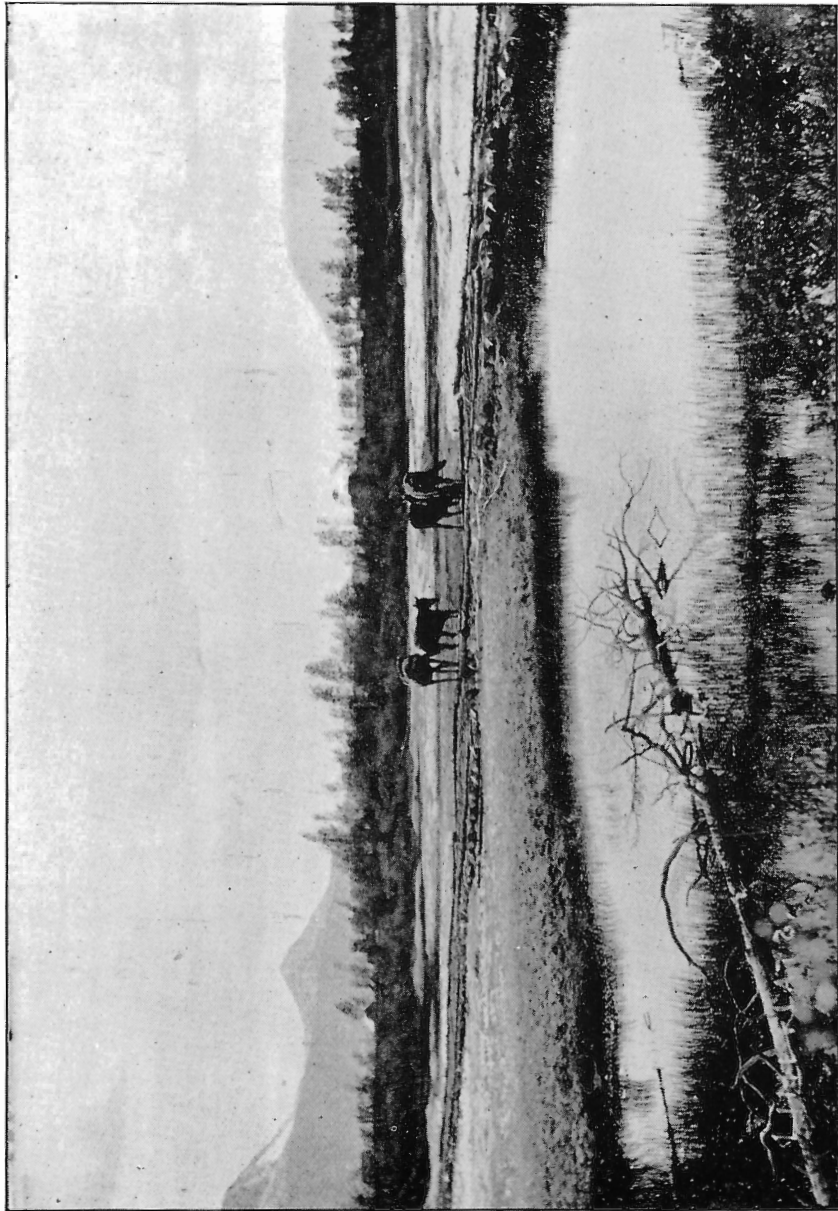
Boiling produced a slight precipitate consisting of carbonate of lime with some carbonate of magnesia.

Spring lukewarm.

This spring is lukewarm. It has built up a raised channel and mound of calcareous sinter or tufa and appears to issue from near the contact of the O'Donnel River limestones with the quartzites. It was the only warm spring noted in the district.

Analysis of so-called 'soda-water'.

No. 2. An examination was also made of the so-called 'soda water' found issuing into the bed of McKee creek a little way above Discovery claim. It is described as a clear bright and colourless water, devoid



Altin Gold Field

EAST OF ALTIN TOWNSITE.

Beds of hydro-magnesite deposited from mineral springs.

of odour or any marked taste. The total dissolved saline matter was 103 grains per imperial gallon. A qualitative analysis showed the presence of ;

Soda, very small quantity ;
 Lime, rather small quantity ;
 Magnesia, rather small quantity ;
 Sulphuric acid, trace ;
 Carbonic acid, somewhat large quantity ;
 Chlorine, trace ;
 Silica, trace ;
 Organic matter, faint trace.

Boiling produced a rather small precipitate, consisting of carbonates of lime and magnesia.

This water, when fresh, is sharp and pleasant to the taste. There appears to be considerable free carbonic acid. The only deposit it leaves on the gravels is a stain of iron.

No. 3. A sample of water was collected from a mineral spring at the north end of the town of Atlin, in order to prove, if possible, the relation of such waters to the hydro-magnesite deposits in the vicinity. This water has been examined in the laboratory of the Survey, and is reported upon as follows by Dr. Hoffmann :—

Examination
of water from
mineral spring
at Atlin.

This water was found to contain :

Potassa, traces.
 Soda, very small quantity.
 Lime, very small quantity.
 Magnesia, somewhat large quantity.
 Ferrous oxide, trace.
 Sulphuric acid, very small quantity.
 Carbonic acid, large quantity.
 Chlorine, very small quantity.
 Silica, trace.
 Organic matter, faint traces.

The magnesia amounted approximately to 1·834 parts in 1,000, an amount which would correspond to 3·851 of magnesium carbonate, or 5·869 of magnesium bi-carbonate. It is more than probable that it is to the water of this and similar springs in the vicinity, that the deposits of hydro-magnesite, occurring near Atlin townsite, owe their origin. This spring is surrounded by a deposit of hydro-magnesite, with some iron oxide cementing this material. Along a

Probable
source of
hydro-
magnesite
deposits.

Description
of beds.

shallow depression which passes immediately behind the town of Atlin, there are several patches of this white hydro-magnesite occurring as beds, raised to a height of some two or three feet above the surrounding flat or marsh. These are quite dry during the summer season, but in spring, it is said, springs issue all along this course. The total area of these deposits is some two or three acres, but the patches are isolated by the intervening marsh or bottom land, which has no trace of such material.

Pits sunk
in beds.

Pits have been sunk in these beds for a few feet disclosing material which is described in the laboratory of the Survey as 'a pure white, more or less firmly compacted, yet readily friable mass of hydro-magnesite.' The rocks underlying this portion of Pine valley are magnesite serpentine and dunite, all magnesian rocks. These meet the granite near the western end of Munro peak. The deposits of hydro-magnesite occur to some extent along a line of depression leading nearly up to this contact-line at Lake Como.

Underlying
rocks.

MAP OF THE ATLIN DISTRICT.

Map of
district.

In connection with the Atlin map it has been found difficult to define closely the many variations of rock formation. The age and sequence given is only provisional. Fossil remains are rare and the stratigraphical relations much disturbed. Excepting the limestones the principal formations appear to be of igneous, eruptive, or pyroclastic origin. Very careful work and much time would be necessary to trace out all the geological boundaries, and the classification of the formations will depend upon further work in the districts to the south-east and north-west, where similar conditions are likely to prevail.

Geological
boundaries
difficult
to define.

The present map indicates closely enough for present needs, the main features of the geology of the district.