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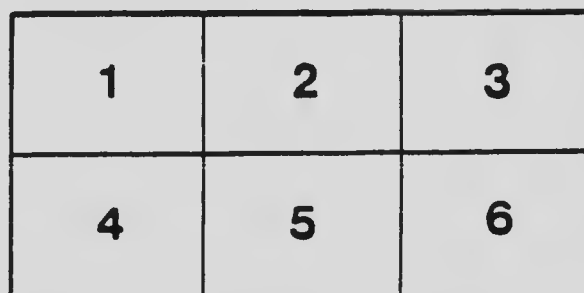
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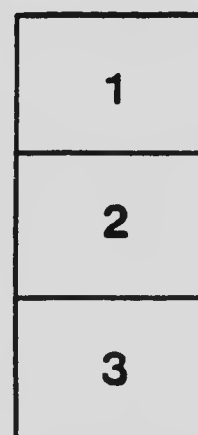
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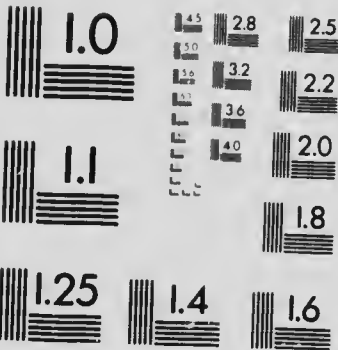
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CANADA
DEPARTMENT OF MINES
GEOLOGICAL SURVEY BRANCH
HON. W. TIMPERMAN, MINISTER, A. P. LAW, DEPUTY MINISTER,
R. W. BROCK, ACTING DIRECTOR

REPORT
ON
A PORTION OF
CONRAD AND WHITEHORSE MINING
DISTRICTS, YUKON.

BY
D. D. CAIRNES



OTTAWA
PRINTED FOR S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1908

No. 942

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CO: 44D CITY, YUKON TERRITORY.

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1908

No. 982

00925438

R. W. BROCK, Esq.

Acting Director of Geological Survey Branch.

SIR,

I beg to submit the following report on a portion of the southern Yukon, mainly included in the Conrad mining district. Contoured topographical and geological maps accompany this report.

I have the honour to be,

Sir,

Your obedient servant,

D. D. CAIRNES.

OTTAWA, MARCH, 1908.

CONTENTS

	PAGE
INTRODUCTION.....	7
DISTRICT SURVEYED.....	7
METHODS OF SURVEY.....	7
TRANSPORTATION.....	8
CLIMATE.....	9
FLORA.....	10
GAME AND FISH.....	10
TOPOGRAPHY.....	10
General.....	10
Windy Arm District.....	11
North of Nares Lake.....	12
Mt. Gray Ridge.....	12
North and West of Mt. Gray Ridge.....	12
Valleys.....	13
ECONOMICS.....	13
General.....	13
Windy Arm Properties.....	14
Watson and Wheaton Rivers Claims.....	18
Union Mines.....	19
Whitehorse Coal.....	20
Tantalus Mine.....	21
Tantalus Butte.....	22
Five Fingers Mine.....	22
GEOLOGY.....	23
General.....	23
Older Schistose Rocks.....	24
Cache Creek Series.....	25
Limestone.....	25
Lower Series.....	26
Granite.....	29
Windy Arm Series.....	29
Tutshi Series.....	31
Granite Porphyry.....	36
Scoria and Basalt.....	37
Superficial Deposits.....	37
MAP.....	38

NOTE.

On the map (No. 999) accompanying this report, the oldest class of rocks—the schists—are marked "Probably Pre-Cambrian"; this should read "Probably Pre-Ordovician."

This has been the opinion of the writer for some time, but, through an oversight, the change has not been made on the map. Full details are given in this report, under "Schists."

D. D. CAIRNES.

INTRODUCTION

During the summer of 1905, Col. J. H. Conrad and others initiated development on Windy Arm, Tagish lake, Yukon, in consequence of which, Mr. R. G. McConnell, of this Department, on his way south from the White River district, made an examination of the properties. A short report of this examination was published under the title "Recent Mineral Discoveries on the Windy Arm of Tagish lake." The properties mentioned in that report having since been rapidly developed, the writer was instructed to make a geological and topographical map of the district and a report on the present aspect of the mineral prospects.

DISTRICT SURVEYED.

Just after the Windy Arm district had been examined, considerable excitement was caused by the finding of quartz carrying free gold and telluride minerals between the Watson and Wheaton rivers, about fourteen miles in a direct line south-west of Robinson; within ninety days over 700 claims were located. It was seen that the district containing these claims, along with the Windy Arm properties and the coal areas south-west of Whitehorse, could be included in one map sheet that would cover the then most interesting portions of the country in this part of the Yukon. The area lies for the greater part in the Conrad mining district, established this season. The south-east corner of the sheet, which accompanies this report, connects with the north-west corner of Mr. J. C. Gwillim's map accompanying his report on the Atlin mining district, B.C., 1901, and from this point the eastern boundary runs in a north-west direction to a point just east of Dun Lake on the W. P. & Y. railway. The western limit of the map runs from a point on the British Columbia and Yukon boundary just west of Lake Bennett to a point about twenty miles west of Dugdale. The British Columbia and Yukon boundary is practically the southern edge of the sheet.

With the exception of a cursory survey, that employed a couple of days, the very interesting and valuable Whitehorse copper deposits which lie to the north of this map were not geologically examined, as detailed work in this locality would have entailed more time than was at the writer's disposal.

METHOD OF SURVEY.

Starting from a measured base on the W. P. & Y. railway, a few miles north of Caribou Crossing, a triangulation was carried through the district, connecting on the south with the Interprovincial Boundary and on the north with two of the stations of H. Dickson, D.L.S., who had determined their position from a point in Whitehorse. Latitudes were obtained with the sextant, and frequent observations were made for azimuth with the transit. The method chiefly adopted for filling in the topography was by transit, and vertical sketches to scale made from triangulation stations and other suitable points; the prismatic compass, micrometer, and aneroid being used for minor details.

Owing to the lack of time in which to make a complete micrometer survey of the rivers and creeks, these have all, with the exception of Watson river, been plotted from sketches. The railway, and the north and south portion of the Watson river, were plotted from the location line of the W. P. & Y. railway.

TRANSPORTATION.

This district is easily accessible. Steamers ply regularly between Seattle and Vancouver, and Skagway, distances respectively of about 1,000 and 867 miles. From Skagway, Whitehorse, which is about 111 miles distant, is reached by the W. P. & Y. railway; thence, steamers run to Dawson, 460 miles. The railway has a general north and south direction, and at 20.4 miles from Skagway the summit of the White pass, which marks the boundary between the "Panhandle" portion of Alaska and British Columbia to the north, is crossed. About thirty-one miles farther is the 60th parallel, the boundary between British Columbia and the Yukon. From the White Pass summit all the waters feed the Yukon river or its tributaries, the river having a general northerly trend for a considerable distance eventually, however, turning toward the west and flowing into Bering sea.

Commencing about ten miles south of the 60th parallel the railway follows the east shore of Lake Bennett to its lower end, where it crosses, at Caribou Crossing, about sixty-seven miles from Skagway, a narrow strip of water connecting Lake Bennett and Nares lake. From this point, for about twenty miles, the railway follows the wide, open valley in which the Watson river flows, and soon approaches the Lewes river, down the west side of which it continues to Whitehorse, affording along the route a very good view of Miles canyon and the Whitehorse rapid.

The ores of the district are conveyed by aerial tramways to the shores of Windy Arm, whence they can be taken in boats up the Arm, and Nares lake to Caribou Crossing on the railway, a distance of about twelve miles. On the south shore of Nares lake, and the west shore of Windy Arm a railway, the building of which presents no more than ordinary engineering difficulties, would eliminate the present necessity of reloading at Caribou Crossing. A good grade for a railway also extends from Log Cabin via Whyton, B.C., to Conrad.

A government wagon road, about twenty miles long with very easy grade, was this season built from Robinson, a point on the railway about eighty-eight miles from Skagway, to Gold hill where the free gold quartz of the Watson and Wheaton Rivers district was first found. A similar road, about twelve miles long, was also built along the beach from Caribou Crossing to Conrad; and a third, built during the previous season, extends from Caribou Crossing to the Klondike. One of the Windy Arm mining properties. Trails, mostly built by the Yukon Government, have been run from the shores of Windy Arm to and between all the most important claims. A road has also been constructed from Dugdale to the Whitehorse coal field, a distance of about twelve miles in a south-west direction, between which points a feasible railway route can also be found.

In fact, taking into consideration the railway already built, the suitability of the topography for further railway construction, the government built roads and trails, and the general natural advantages of the district, including the chain

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of lakes with their fiord-like arms, it may be said that transportation need be no bar to successful mining.

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It is not very long ago that the popular conception of the Yukon was a region almost impossible of access, covered with perpetual snow and ice. Winter photographs, sensational newspaper descriptions of the Chilkoot pass, the building of the W. P. & Y. railway, and stories, generally exaggerated, of the hardships endured by those who joined in the early rush to Klondike, are mainly responsible for those opinions. It is certainly true, that from 1896 to 1898, when the influx to Dawson was at its height, great hardships were endured and many lives were lost, but when it is remembered that the majority of the gold seekers were accustomed neither to a mountainous region nor to encounter difficulties in northern latitudes; that prospectors frequently set out on their quest with only the vaguest notion of the route to be traversed; that the route chosen was often the worst possible in the circumstances, and that a large proportion of the travellers made the trip during the most unfavourable season, it is not amazing that there was loss of life, but that there was so comparatively little.

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Now that the district has become better known, and railway and boat lines have been built, it is seen that the climate of the Yukon, and the southern Yukon in particular, (that dealt with in this report), is similar to that in many districts in British Columbia, and other northerly but prosperous mining camps of the world, and that few more difficulties have to be contended with in actual mining operations.

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During the past season there was a considerable amount of rain on the higher summits, but in the valleys the weather was very pleasant. There was a moderate amount of rain and the temperature was similar to that experienced during other seasons in southern British Columbia. Added to this, however, is the delightful feature of the extreme length of the days; for a month or so there is little or no night, it never becoming completely dark. At least six months are suitable for surface working and for the necessary outside operations contingent on mining, and during many months work can be carried on by night, without artificial light, almost as well as by day. Frost, except in connexion with surface workings, does not interfere with quartz mining.

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The district is very subject to high and long continued winds. On the summits these blow almost continually, and coming off glaciers and snow-capped peaks are exceedingly cold. The length and breadth of the valleys show the winds a great sweep which makes the lakes, particularly Bennett and Forty Arm, very dangerous. Storms of terrific strength cause the almost smooth waters of these lakes to become rougher in a few minutes than, from the nature of the case, could be deemed possible. The wind dies down during the early hours of the day, and remains calm until eleven or twelve o'clock; sometimes, however, the winds continue rough for several days in succession, and as it is on account of their low temperature, to exist in them for a few minutes becomes an exceedingly dangerous matter and has brought disaster to the best canoe men.

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FLORA.

Except in some of the valleys especially along the lower stretches of the Wheaton and on the lower portion of the hillsides, no timber exists: even in the valleys the forest growth is very light. The lodge-pole pine (*Pinus murrayana*), the rough-barked poplar (*Populus balsamifera*), white pine, white spruce, balsam fir, and aspen comprise the existing species, with the exception of a growth of scrubby birch covering the slopes and higher valleys and often so thick as to be difficult to penetrate. The pine is found on the hillsides and in the dry valleys; the spruce in the swampy valleys, and the fir, frequently knotted and dwarfed, on the hillsides, near the timber-line. A saw-mill was in operation for a time on Mill Haven, but it is not now running.

The growing season for wild fruits is very short, but the almost constant daylight effects a continuous growth, so that the development of vegetation is surprisingly rapid. Moss-berries, blueberries, and low-bush cranberries were plentiful; raspberries, gooseberries, and black and red currants were seen.

GAME AND FISH.

Sheep are numerous a few miles west of the railway, and, except where they have been hunted, are not particularly wild or difficult to obtain. Large flocks of a species considerably lighter in colour than the ordinary Rocky Mountain sheep, were often seen feeding on the hillsides.

Caribou and moose were plentiful in the western portion of the district. Black bear are common, and the grizzly bear is found. Beaver dams and beaver cuttings, often quite fresh, were frequently met, chiefly along the Wheaton and Watson rivers. Ptarmigan were seen in large numbers on nearly all the higher ridges and summits, and rabbits were quite numerous. Grouse of different kinds were less often seen, and ducks and geese only occasionally.

TOPOGRAPHY.

GENERAL.

This district occupies a position along the western edge of the Central Plateau region, or, more particularly, the Yukon plateau, at least east of the Coast range, which consists of bare granitic mountains. Although in northern British Columbia and southern Yukon there is no sharp line between the plateau and mountain provinces, there is, north of the district here considered, an abrupt change from one to the other.

Viewed from the summits, this Yukon Plateau region appears as a gently undulating plain, broken only by occasional peaks and ridges that have withstood the general erosion. Near the Interprovincial Boundary the plateau has an average altitude of about 5,000 feet near the western edge, slopes gradually towards its centre and, in all probability, rises again towards the east to meet the Rocky Mountain system. It also becomes gradually lower towards the north-west. This upland plateau province is one of erosion and not of constructive deposition, and into it the drainage courses have cut valleys from 1,000 to 4,000

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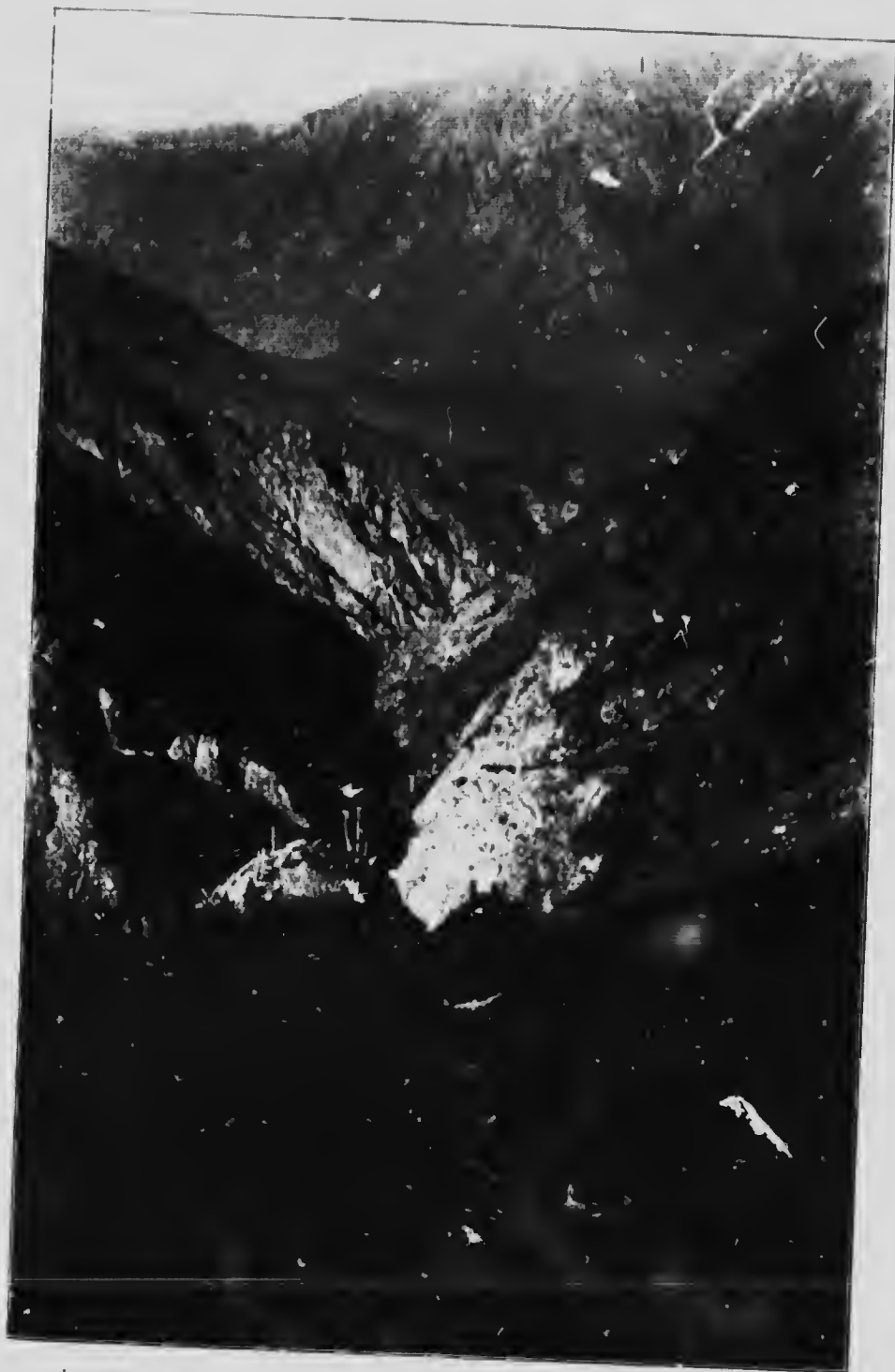
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LOOKING DOWN POOLY CANYON AND ACROSS WINDY ARM, YUKON TERRITORY.

feet deep, the result being a very irregular topography, the summits of the unreduced ridges and mountain masses dividing the different waterways. The valley of the Lewes river, near its source, is cut down to depths of about 3,000 feet below the general level of the plateau (5,000 feet), but as the general gradient of the river is about the same as the general slope to the northward of the plateau, there is little change in the relief to the north of the district included in this report. This plateau was formerly at a lower elevation, and, with the exception of the unreduced portions, which now form the irregular peaks and ridges of its province, was reduced practically to base level, forming a plain sloping towards the north and west. A subsequent uplift gave the rivers and streams renewed life and sufficient activity to begin cutting down their present channels. The flat topped hills and upland separated by these newly-incised valleys, are particularly well developed northward from the West Arm of Lake Bennett.

A broad valley up to seven or eight miles wide, floored with silt deposits, and marking an abandoned waterway, extends from the lower end of Lake Bennett to within a few miles of the Whitehorse rapid, affording a natural pass for the railway.

The Yukon river, the fifth largest on this continent, rises in British Columbia just south of the 60th parallel, and lies, generally speaking, in about the middle of the Yukon plateau. The valleys of the lakes at its source appear to be chiefly formed by glacial action and by being dammed in places by great deposits of drift material. It may be presumed that these lakes, in general, mark the positions of the tongues of the great glacier which, towards the last, disappeared so rapidly that there was not sufficient time for the lake beds to be filled with glacial material. Tagish lake, in particular, is very irregular in outline, being part of a flooded valley system.

The two chief, and, in fact, the only rivers in the district are the Wheaton and Watson, which flow into Lake Bennett. Portions of these, particularly near their mouths, are still cutting channels through the silts and glacial materials of the glacial period, and are, in consequence, characteristically tortuous.

The district may, in a general way, be described as consisting of groups and ridges of mountains separated by wide valleys often occupied by lakes, and running in a north-west and south-east direction, or about parallel to the western edge of the plateau region, which, like the Coast range, follows the coast line not only through the United States and British Columbia, but also into Alaska.

These valleys interlock at times in an intricate fashion. The district here described, although, like the mountains, extending in a north-westerly direction, embraces, in its northern area, a portion of the plateau country, and consequently is here more rolling and less rugged.

WINDY ARM DISTRICT.

The district referred to in this report as the Windy Arm district, which occupies a position at the contact of the plateau and mountain region, consists of a high and rugged group of mountains rising from 4,000 to 5,000 feet above the lake levels, and lies immediately to the north of the British Columbia and Yukon boundary, between Lake Bennett on the west and Windy Arm on the east, and south of Nares and Tagish lakes. The rugged mountains along the southern edge of this district rise, for about five miles north of the 60th parallel, very abruptly

from both sides of Windy Arm. To the north of this, on the west side of the Arm the hills gradually become lower and slope somewhat gently from the beach. The mountains on both sides of Lake Bennett are also high and rugged, becoming more so farther west. This district is surrounded on three sides by deep-cut glacial valleys; on the east and west sides the streams have, in all cases, hanging valleys of varying heights through which they flow with a gentle and even slope until the eroded valley is reached, when they drop abruptly through canyons and gorges, generally over, as in the cases of Pooley, Montana, Dundas and Knol creeks, a succession of falls, to the main valley below.

NORTH OF NAHES LAKE.

These mountains, about eleven miles average width, extending for six or seven miles north of the lake, are high and rugged, having an average altitude of 3,700 feet above the lake itself, though Mt. Caribou rises about 600 feet higher still. The greatest heights are attained some three to four miles east of the railway. Mt. Wounded Bull, four miles east of Robinson, is 4,350 feet above the lake level or 4,000 feet above the railway—but between this mountain and Mt. Caribou the hills are lower and more broken, while to the east they gradually become less and less, and disappear at the banks of the Lewes river.

MT. GRAY RIDGE.

Between the Watson and Wheaton rivers rises a prominent feature in this section, the Mt. Gray ridge, whose summits reach some 4,000 feet above the level of the lakes. This ridge, about seventeen miles long, is characterized by very abrupt slopes and escarpments along its western edge, which is remarkably straight, in a direction somewhat west of north. It affords a particularly striking example of glacial action in the main valleys. The eastern side, though wooded to some extent, is for the most part grass-covered, and slopes gradually to the valley below.

NORTH AND WEST OF THE MT. GRAY RIDGE.

The Wheaton river, for about fourteen miles from its mouth, flows in a direction slightly east of south; above this, however, its course assumes an easterly direction. To the west of the lower portion of the stream the hills in regular relief gradually rise, along their eastern edge, to average heights of nearly 6,000 feet above sea level. Still farther west there opens out a level or undulating plateau of about the same elevation.

This plateau feature continues with varying regularity in a north-west direction to the north of the Wheaton river, in fact to near the northern edge of the map sheet.

North of Robinson and west of the railway the hills are low and rolling, typical of the country of the plateau province. The first mountain of any prominence at all close to the railway is the somewhat cone-shaped and grass-covered Golden Horn, 5,610 feet above level. West and south-west of it the topography is characterized by rolling hills with very gently sloping sides; west of this again,

towards Mt. Granger, 6,850 feet above sea level, the country becomes more rugged and rocky, but the eastern edge of the range proper is here again approached.

VALLEYS.

These different ridges or groups of hills are separated as described above by deep, wide valleys, which probably correspond with the valley systems of the region before the last period of uplift, and which are now, in places, occupied by lakes or rivers, and which in many cases, especially where not occupied by the larger lakes or rivers, contain muskeg. Muskegs are also often found high upon the hillsides and in the high passes between the hills. In the valley between Mt. Needle and Mt. Folle, partially occupied by Annie lake, is a somewhat wide and dangerous swamp. This portion of the valley, a continuation of the Wheaton River valley to the south, has become blocked by glacial material which in time will be carried away, much of the water now being carried to Lake Bennett by the Watson River flowing down the Wheaton.

ECONOMY GEOLOGY.

GEOMIN.

Although numerous claims have been staked in this district, quartz mining, except some development work on the properties just west of Whitehorse, was almost unknown in the Yukon until the latter part of the season of 1905, when Col. J. H. Conrad initiated work on the Windy Arm properties. Since that time a great deal of work has been accomplished.

In other parts of this district where details regarding the actual amount of mining development that has been done, the construction of aerial tramways, and the building of roads, both within and between the different mining properties. The little town of Conrad is coming into existence, and prospectors have been encouraged to make a living, with the result that a number of promising properties have been developed. A great many men have been employed, the mineral resources of the district are in a fair way to being developed, and what promises to be a permanent industry has been established. The commencement of the work on these Windy Arm properties, therefore, marks an important era in the history of the district, although the properties in question are all, as yet, in the development or prospect stage.

The whole southern part of the Yukon was formerly included in the Whitehorse mining district, but this summer became of sufficient mineral importance to warrant sub-division, and the Windy Arm portion, including most of the Watson and Wheaton Rivers district, is now included in the Conrad mining district, with a recorder's office at Conrad.

In opening up these properties a great many difficulties had to be overcome. Most of the claims are situated high on the mountain sides, and all supplies, provisions, and even the wood for fuel and timbering had to be packed up on mules and horses. To haul up machinery of any kind was very expensive. Now, however, most of the timber and supplies are carried up by aerial tramways. The rigours of the winter, and high up on the hills even those of the spring and fall,

have to be considered. Moreover, it was difficult to get men to work who could be called miners. The ordinary wage is \$4.50 per day of eight hours, with board and lodging.

A telephone system connects the different camps with Conrad and Caribou Crossing. A telephone will be found at practically every claim where anyone at all is working. This great convenience is very cheaply installed, and facilitates work in many respects. There are also small gasoline launches on Windy Arm useful for making quick trips around the lake. The Glenora, which is quite a large steamer, runs twice a week between Caribou Crossing, Atlin, B.C., Conrad and Whynnton, B.C. A number of other steamers and small boats are in use on Windy Arm and in the vicinity.

WINDY ARM PROPERTIES.

Beginning with the Windy Arm district, some of the important properties going southward are the Big Thing group, the Montana, Joe Perry, Aurora, Thistle, Francis, M. & M., Vault, Venus No. 1, Venus No. 2, all owned by the Conrad Consolidated; the Ruby Silver, owned by private parties; and the Venus Extension, Bench, Red Deer, and Humper No. 1, owned by the Anglo-American Co.

Big Thing. A wagon road from Caribou Crossing, and trails from Conrad and from the upper terminal of the Montana tramway, have been built to this property, which is situated about five miles in a north-westerly direction from Conrad and differs from all the other properties in this district, having granite for its country rock. The quartz veins of the others are in true fissures in the porphyrite, etc., of the Windy Arm series. The principal vein on the Big Thing was struck this summer at the end of an 80 foot drift. A cross-cut was then run sixty feet on the ore, and a winze was sunk which was about fifty-five feet deep at the time visited last, early in October. The vein, which dips into the hill, was widening rapidly in the bottom and becoming almost flat. It was about ten feet wide and appeared to be of the elongated lense type. The gangue is chiefly quartz and is very porous near the surface, showing the effect of considerable leaching action. The associated minerals are chiefly oxides and carbonates, which should change to the sulphides, etc., at a moderate depth. Stibnite, arsenopyrite, and pyrite were found near the bottom of the shaft. High assays are occasionally obtained in gold and silver, and it is claimed that the ore body will average close to \$30.00 per ton.

The Montana is situated about four miles south of the Big Thing and, like it and most of the Windy Arm properties, is high up on the bleak mountain side. A \$90,000 Riblet aerial double cable tramway runs from the northern extension of the Montana, the Mountain Hero, to Conrad, a distance of 18,697 feet, and has its upper terminal 3,464 feet above the lower. This tramway was built to the mouth of a cross-cut tunnel started on the Mountain Hero, and was intended to tap the Montana vein at a considerable depth, but ore has not as yet been struck in this tunnel. The tramway was commenced about the same time as the tunnel, and it is somewhat unfortunate that it was completed before the most favourable point for its upper terminal was known. During the past summer, however, supplies, timber, and fuel were sent up very cheaply, not only for work in the Montana and Mountain Hero, but also for the Big Thing, Aurora and Thistle, so that a considerable saving was effected. Waste rock from the dump was sent down the greater part of

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LOOKING ACROSS WINDY ARM IN SOUTHEASTERN DIRECTION FROM ABOVE CONRAD CITY, ALASKA TERRITORY.



the time to keep the tram running. The tramway will continue to carry up supplies and to bring down the Montana ore from the Montana workings, and any other claims in the vicinity.

A gasoline engine was installed on the Mountain Hero this summer to operate a compressor to run the machine drills used for a time in the Mountain Hero tunnel. The compressor was placed on a prominent point on the side of Montana creek just below the tunnel, so that water power would be available to run it during certain seasons of the year. Stone houses have been built here as well as on the Big Thing for offices, bunk houses, and cook houses.

A drift was run about 700 feet on the vein, which has a strike of about N. 43° W., and dips to the south-west at 10° to 15°. The gangue of this vein is similar to that of the other properties of this district, i.e., mainly quartz in a fissure in the porphyrite, large interlocking crystals being very characteristic. The vein is from two to five feet in width, with a streak of rich ore, eight inches to eighteen inches wide, next the hanging wall. This richer portion is reported to assay about \$90.00 but the average of the vein is much lower and is said to run \$20.00. An incline is being run on the ore and about the first of October, when last seen, at a depth of 320 feet, the lode was about eight feet from wall to wall with, however, over four feet near the centre of almost barren, leached, and somewhat decomposed porphyrite streaked with quartz stringers.

The values are mainly in silver, the chief mineral being galena. There were also found native silver, lead carbonate, argentite, pyrrargyrite, tetrahedrite, pyrite and arsenopyrite. Some ore shipments have been made to outside smelters.

Trails have been built from this mine to the Big Thing, Conrad city, the Aurora, Thistle, Vault, Uranus, Joe Petty and Venus.

The *Joe Petty* is situated on the north side of Pooley creek about 2,800 feet above Windy Arm, and has a strong vein about six feet wide composed of alternating layers of decomposed iron-stained quartz and mineralized country rock. A shaft has been sunk about fifty feet and drifts have been run each way. A forty-foot tunnel has also been run with drifts at the end. No work was done on the property this season.

The *M. & M.*, to the east of the Joe Petty, has a narrower vein twelve to fifteen inches wide which is high grade ore and can be traced for a considerable distance. The rich silver minerals, argentite, pyrrargyrite, and stephanite, were seen here.

The *Uranus* is situated immediately across Pooley creek from the Joe Petty and just above the upper forks of the stream.*

A tunnel has been run in on the south side of the main creek to cross-cut the vein, which has not been struck as yet. Farther south on the other side of the hill and on the north side of the south branch of the creek a tunnel has been driven 180 feet on the vein, which varies in width from one to four feet. An upper tunnel was also started this summer on the north side of the south branch of the creek where

* On Mr. McCann's sketch map of this district he has named the main branch of the creek Uranus creek, and the canyon below the forks, Pooley canyon. In his report accompanying the map he speaks of this main branch as Pooley creek, Pooley being the older name, the main creek, including the middle branch, or the above mentioned Uranus creek, will be referred to as Pooley creek, and the other two branches the North and South branches respectively.

the vein has a width of three and a half feet, but owing to difficulty in regard to contracts was only driven a short distance.

On the *Thistle* and *Aurora*, higher up the creek, above the Uranus and John Petty, and over 3,000 feet above Windy Arm, prospect work was carried on the greater part of the summer, and some very rich ore was reported. The ore is chiefly quartz, carrying chalcopyrite, zinc blende, malachite, and stephanite.

The *Vault* is situated on the south side of Pooley canyon about 2,000 feet above and about a mile from the beach. When last seen (October) a drift on the vein was in about 325 feet, and a lower tunnel had been started for which a 300 feet contract had been given. This, the same lode, in all probability, as the Venus, can be traced for a considerable distance. It is in places twenty to twenty-three feet in width and is nearly all well mineralized quartz. In places there are four to six feet of almost solid galena. The vein here, as on the Venus, varies greatly in width, and at times is not more than a foot or so broad, but on the Vault so far, except at the entrance to the tunnel, its character and ore values are fairly uniform. An aerial tramway to the beach is under construction, and a shorter one spans the canyon for the transport of wood and supplies.

Situated as this property is, in Pooley canyon, whose walls rise apparently almost perpendicular, for hundreds of feet, work was for a time carried on under many difficulties. Wood and supplies were packed up from the beach to the head of the canyon, and then down to the Vault over a trail cut out along its sides. Even a place large enough for a small tent had to be blasted out of the sides of the canyon. Now, however, the tramway carries over the wood and supplies, and quite comfortable frame bunk and cook houses have been built, in addition to a building at the mouth of the tunnel that serves for blacksmith shop, etc.

Venus No. 1.—On this property, which adjoins the Vault on the south, a shaft has been sunk on the vein for fifty-two feet, and drifts running each way prove the quartz, which was only about ten inches wide at the surface, to have opened out nearly three feet. Several feet of iron-stained, fissured, mineralized rock lie next the quartz. Fifteen tons of ore shipped to an outside smelter, it is stated, have averaged sixty-five dollars per ton in silver.

Venus No. 2 lies south of and adjoining the Venus No. 1. A cross-cut tunnel was put in about one hundred feet to the vein which dips to the west into the mountain, and drifts were run about the same distance each way. Some stoping was done, the lode being eighteen inches to sixteen feet in width. In the stopes there is four to eight feet of good ore which will average over \$20.00 in gold and silver. A lower cross-cut succeeded by drift in each direction, has also been run 544 feet to the vein, which is narrower and leaner than in the upper tunnel, but the narrowing is unlikely to be very extensive as the vein looks well for a few hundred feet both to the north and south.

The chief minerals are galena, lead carbonate, arsenopyrite, chalcopyrite, malachite and pyrite, while a considerable amount of jamesonite and antimony ochre occurs. The ore is chiefly argentiferous galena. Where the vein is wide it consists of alternating bands of quartz, and mineralized country rock. Some ore has been shipped to outside smelters from this property, mostly in the nature of test shipments.

A fifty horse-power gasoline engine operates a compressor here to run the machine drills used on this property, but water-power from Pooley canyon is being installed. An aerial two-bucket tramway 1,525 feet long runs from the lower Venus tunnel to the beach, the upper terminal being 958 feet above the lower. The engine house, bunk, and cook houses, are situated on the beach below the mine workings.

The *Ruby Silver* claim lies to the west of, and adjoins, the Venus No. 2, and has produced some very rich ruby silver ore. The vein is from three to eighteen inches in width.

On the *Venus Extension* adjoining the Venus No. 2 on the south, are two veins about thirty feet apart which can be traced right across the property, and practically up to the upper workings on the Venus No. 2. The upper vein apparently corresponds to the Venus vein; the lower one is probably an off-shoot from it that has not been discovered on the Venus ground. The upper vein contains about four feet of good ore, over half of which was being sacked in October. The sacked ore will probably run \$50.00 to \$60.00 per ton. An incline, sunk on the ore, was down about forty feet. The lower vein contains about two feet of ore, chiefly argentiferous galena with a considerable amount of arsenical iron and pyrite.

The *Beach* claim, lying to the south of the Venus extension and separated from it by the Nipper fraction, is supposed to be on the same vein as the Humper No. 1; it has over ten inches of ore, claimed to average about \$150.00 in silver, and probably \$5.00 in gold. The chief minerals are galena, argentite, zinc blende and pyrite.

The *Red Deer*, lying to the west of and adjoining the Venus Extension, has in places about six inches of almost solid galena, which is reported to run over \$90.00 per ton.

The *Humper No. 1* is a very promising looking property overlooking Windy Arm from a height of about 2,200 feet. It adjoins the Beach claim to the south-west. Only about seventy feet of work in the form of drift had been done. The vein, which strikes almost true east and west, and dips at about 45° to the north, is from eighteen inches to four feet in width and carries argentite, ruby silver, and staphanite, with some native silver, galena and pyrite. About eight inches of the vein are said to average over 300 ounces in silver, and a narrow streak of argentite half an inch to three-quarters of an inch thick, which is quite persistent, is said to give 3,000 ounces of silver. Some small, but high grade shipments of a few tons each have been made from this property and other of the Anglo-American Consolidated Co.

From what could be learned in the examination, all these Windy Arm deposits have the same general characteristics and have been produced by the same causes. They are all mineralized quartz veins in true fissures, the crystals being generally large and interlocking to some extent, but in a general way pointing to the centre, showing the growth of the veins. Ascending thermal waters have probably been chiefly accountable for the deposits. The systems of fissures consist of main lines, with secondary parallel ones, with a certain amount of replacement between the different fissures of country rock by minerals. Some of the walls showed much slickensiding, indicating that the fissures are fault fissures. In these cases the ores are more liable to be persistent, and to continue to greater depths, than if the fissures were merely minor breaks due to cooling or tension, etc., without the walls having

been pushed over one another, and thus generally indicating a more extensive disturbance and consequent fissuring.

Besides these properties some native copper is found on the east side of Win Arm in an augite porphyry, and appears to have been deposited in seams and little patches very similar to the occurrence noted by Mr. J. C. Gwillim in the A district. However, so far, it has not been found in workable quantities.

Some work was done this summer on the Rams Horn on the east side of Win Arm, and very good looking quartz ore carrying galena, zinc blende, chalcopyrite and pyrite was seen there, but the veins examined were too narrow to be profitably worked.

West of Lake Bennett and on the east side of Mt. Gray some work has been done on the College Green. This claim is one of four located along a band of line about fifty feet wide, and running in an easterly direction to the shore of the lake. Copper minerals, chiefly chalcopyrite, are found along this line which occurs in the porphyry formation, and on the College Green, where it probably looks the best. The ore occurs in irregular bunches and veins. Further work here might disclose a workable body of ore.

The ore values given in this report were obtained from a number of samples taken, and also from assay returns kindly shown the writer by mine managers, superintendents, prospectors, and others during the season.

WATSON AND WHEATON RIVERS CLAIMS.

Reference has been made to the excitement caused this season by the discovery made between the Watson and Wheaton rivers by D. Hodnett and J. Stagar, of quartz carrying free gold and telluride minerals. The first claim staked was the Gold Reef on Gold hill on June 21, about fifteen or twenty miles south-west from Robinson, and, as has been said, within the next ninety days over 700 claims were located.

A belt of schists, approximately half a mile wide, out crops in a north-westerly and south-easterly direction near the eastern edge of the granite formation, both schists and granites being cut by dikes of greenish porphyry and porphyryite. It is in this disturbed belt that the quartz veins occur, either in true fissures in the granite or between the planes of schistosity of the schists. These veins are often well mineralized, the chief minerals being galena with occasional grey copper, chalcopyrite, and pyrite. Outcrops of quartz, very much resembling each other, are seen in almost parallel lines, at short intervals, and with the same general strike from the Watson river to about eight or ten miles south of the Wheaton river—a distance of about twenty miles. Although most of the veins found were in this belt, only about two miles wide, Mr. Porter and others discovered towards the end of the season, some large deposits of pure stibnite and other minerals at a considerable distance west of the belt. Details regarding the geology of these deposits are included in the geological portion of this report.

The first discoveries were made on Gold hill, Mt. Hodnett, and Mineral hill, all in the line of strike of this belt and just south of the Watson river. One vein of solid quartz is, for long distances, ten to fourteen feet wide and, in places, is fairly well mineralized with galena, argentite, chalcopyrite, malachite, and pyrite. In the vein traversing the Gold Reef, which is in the schists, is well defined on the surface

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LOWER TERMINAL OF MONTANA TRAMWAY AT CONRAD CITY, YUKON TERRITORY.

and which appears to be four or five feet wide, a pocket or streak of very rich ore was found carrying coarse free gold and the rich telluride minerals sylvanite, hessite and telluric ochre. Further work on this claim, however, failed to disclose any more of the rich ore.

A group of claims, the Custer, Alice M. and Ramon, staked just south of the Gold Reef on a grey copper vein, looked somewhat promising, although no work had been done when seen. The width of the vein was difficult to determine, on account of wash and slide rock, but it is probably about six feet and appears to be well mineralized.

The *Legal Tender*, staked by J. Perkins, lies to the north-west of this group and is on a very steep, rugged, side hill on the south bank of the Watson river. The vein is, in a fissure in the granite, where exposed, three to three and a half feet in width, and consists of quartz carrying argentiferous galena with some chalcopyrite, malachite and pyrite. The values are chiefly in silver and are claimed to average about \$40.00 per ton.

On the Big Bend mountain, to the south of the Wheaton river and seven or eight miles south-west of Gold hill, and in the line of strike of the mineral belt, a number of claims were staked by L. Behner, O. Dickson, J. Perkins, and others on well defined quartz veins in the granite; they carry galena, chalcopyrite, pyrite, etc. South-west of this, in the same direction, on Mt. Stevens, the veins in the granite were again found and most of the outcrop was staked. Messrs. Stevens, Hogan and partners doing the first staking. On the hill to the west a number of similar looking locations were made by Messrs. Gilliam and partners on quartz veins in the schist carrying galena and chalcopyrite. In fact this whole belt, from one-half to two miles wide, was practically staked from north of the Watson river to west of the north end of Mill Haven—a distance of about twenty miles—and naturally a great many valueless locations were made, though several have good surface indications.

Assays running as high as \$300.00 or over were occasionally obtained, as also a number of fairly average assays from \$20.00 to \$60.00, but with the exception of a small amount of work performed on the Gold Reef, no real development has been attempted.

But there is a large amount of mineralized quartz in this section of the country and, considering the little prospecting accomplished, the results are very encouraging, and should stimulate both prospectors and capitalists to investigate this belt more closely, following it to the north-west and prospecting on its western limits.

Coal was found about two miles to the east of Gold hill, at the same horizon as that in the Whitehorse coal fields to the north, but whether it is in sufficient quantities to be of economic value remains to be seen.

UNION MINES.

A group of four claims, known as the Union Mines, is situated on the hills just to the west of Annie lake, about nine miles due west of Lons Bayne siding and about three or four miles east of Gold hill. These claims were first staked by W. F. Schmadel in 1898, and are supposed to cover the ground known as the Lost Mine. Some work has been done on the properties and preparations are being made to continue development during the winter. A ten ton shipment of ore, Mr. Schmadel informed the writer, gave returns of over \$20.00 per ton. The values are chiefly in silver and a little gold.

As these claims are, in all probability, the first staked in the southern Yukon, their history is somewhat interesting. The writer obtained the following information, chiefly from Mr. Schmabel.

In 1893 Thomas Kerwin and two others staked claims in this vicinity, and took out ore which assayed \$1,200.00 and over to the ton. Kerwin died and, later on, while lying on his death-bed in Juneau, Alaska, Kerwin told the Catholic sister of his discovery and willed his interests to them. He described approximately the place, maintained that his old camp would be found on a creek near which a piece of driftwood, driven into a tree, had hanging on it, a shovel and coffee pot. After considerable searching Mr. Schmabel and others coming in by Lake Bennett and the Wheaton river found this old camp, as described, but could not find the ore. However, the veins of the present Union mines were found on the hill just to the north of the camp and were staked in 1898. They were held more or less continuously until 1900 when the four claims now held were staked and have since been the property of Messrs. Schmabel, Follé and partners. Mr. Schmabel showed the writer an original location notice signed by Kerwin and partners, which was wrapped up in a piece of oil cloth and was found in a crack in an old post on the ground of the present mines. The owners who have built cabins and cut trails, besides doing considerable prospecting in the vicinity, still expect to find the rich ore of this La Mine on their ground.

WHITEHORSE COAL.

Several seams of anthracite coal, on which a number of claims known as the Whitehorse coal claims have been staked, outcrop along the north side of the plateau (2,000 feet above the railway at Dugdale) at the head of Coal creek, about twelve or fourteen miles in a southerly direction from Dugdale. A tunnel about six hundred feet long has been run on one of these seams and a few open cuts have been made, otherwise the coal is entirely undeveloped. The strike at the tunnel is true north 63° west with 42° dip to the north-east. The general strike of the measures which were traced over twelve miles is about north 71° west. The seams measured were nine feet eight inches, ten feet four inches, and two feet six inches respectively. Numbers of other seams may exist and probably do, and as the measures are very favourably situated for working and prospecting, a small amount of work should give much definite information. The measures appear to be quite regular and are easily accessible. There is a very good grade from the W. P. & N. railway, into these claims, and considering their proximity to the Whitehorse copper deposits, the town of Whitehorse and the Watson and Wheaton River claims, this coal, which should make a good fuel, should prove of considerable value in the near future. No seams of coking coal were found.

Four samples of the coal were taken, and have been analysed by Dr. Hermann of this Department with the following results:

A is an average sample of the nine foot eight inch seam at the end of the six hundred foot tunnel.

B is an average outcrop sample of the two foot six inch seam.

C is an average outcrop of the ten foot four inch seam.

D is an average sample of an outcrop found in the creek just below the tunnel that were occupied when the claims were worked. This may be the same seam as one of the others.

	A	B	C	D
Water	2.15	3.76	1.78	2.35
Volatile combustible matter	6.91	8.34	10.06	6.65
Fixed carbon	69.86	62.50	48.38	42.25
Ash	21.98	25.40	47.78	48.74
	100.00	100.00	100.00	100.00

A trip was made at the end of the season down the Lewes river in order to examine the coal measures in the vicinity of the Tantalus and Five Fingers mines, and at Tantalus Butte.

TANTALUS MINE.

This mine is situated on the left limit of the Lewes river, about one hundred and ninety miles down the river from Whitehorse. The coal outcrops on the river banks, and is naturally well situated for economic working. The cars are loaded out of the tunnels by mules, and by cable up an incline, at the top of which the coal is dumped into bunkers ready for loading. Most of the river steamers burn the coal, and about 7,000 tons will be loaded this season.

There are three seams opened up, only the lower two of which are being worked at present; others may be found, as the formation is, in most places, heavily covered. The coal is worked by the stall and pillar system from two tunnels, which, when visited in October, were in 692 and 708 feet respectively on the bottom and middle seams. From the bottom seam nine rooms had been or were being worked, and were up from 50 to 115 feet, No. 1 having been run up 160 feet to the surface for air. From the middle seam there were ten rooms up from 70 to 150 feet. Although the seams are dirty, the coal could easily be sorted; but as wages are \$5.00 and board, for underground, and \$1.00 and board, for surface work, no sorting has yet been attempted.

The following section was measured near the end of the tunnels:

	Coal	2 feet,	4 inches,
Bottom seam, . . .	Shale, . . .	0 "	7 "
	Coal, . . .	2 "	0 "
	Shale, . . .	0 "	8 "
	Coal, . . .	2 "	14 "
	Shale, . . .	4 "	0 "
	Coal, . . .	2 "	3 "
Middle seam, . . .	Shale, . . .	0 "	2 "
	Coal, . . .	0 "	7 "
	Shale, . . .	0 "	2 "
	Coal, . . .	2 "	0 "
	Shale, . . .	0 "	2 "
	Coal, . . .	1 "	8 "
Top seam, . . .	Shale, . . .	7 "	0 "
	Coal, . . .	3 "	0 "
	Shale, . . .		

The measures are quite regular and can be traced over twenty miles down the Nordenskiöld river to the south and for over ten miles to the north, from which it may be inferred what an enormous amount of coal this district contains. When the measures have been prospected they may be found to extend much farther. Only coal near the river is at present of economic value. The dips are to the east and vary in the tunnels from 21° to 40°. Three average samples, L, E, and G, were taken respectively from the breasts of the bottom and lower seams and from the top seam where cross-cut from the middle seam, probably about 300 feet in. These samples analysed by Dr. Hoffman gave:

	L.	E.	G.
Water	0.75	0.76	0.82
Volatile combustible matter	25.61	24.74	25.13
Fixed carbon	55.24	58.60	66.05
Ash	20.45	15.90	8.02
	100.00	100.00	100.00
Coke per cent	75.43	71.50	71.00

These results show that the coals in the laboratory make a good coke, and it is hoped that they can be used when the copper deposits of Whitehorse, and the minerals in the other parts of the Yukon, become further developed. It is also hoped that these coals may be found much nearer Whitehorse.

TANTALUS BUTTE.

At Tantalus Butte, across the river from the Tantalus mine, the same measure again outcrops, but dip to the west, showing the presence of an intervening synclinal fold. The coal outcrops are near the top of the Butte, about four hundred feet above the river, wash and terrace material covering the formation lower down. The best seam seen contained five feet of good, firm, clean looking coal with one foot of coal and shale on the bottom. Other seams were dirty and narrow, but good ones may be here obscured by drift, etc., as practically no work has been done except small surface cuttings. Altogether, the general conditions of the measures including dip, strike, etc., are similar to those at the Tantalus mine, and the property will probably be worked in the near future. The surface samples obtained did not give a firm coke, but possibly fresh coal would give a different result. The following is the result of an analysis, by Dr. Hoffmann, of an average outcrop sample from the best seam.

Water	9.48%
Volatile combustible matter	32.28%
Fixed carbon	53.51%
Ash	4.73%

FIVE FINGERS MINE.

This is situated on the east side of the river about ten miles north of the Tantalus mine. A considerable amount of coal has been shipped from here, but the

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old workings are closed now on account of being dangerously situated on the steep clay and sand bank of the river, subject to mud slides. The old slope was down about 350 feet with rooms run off it, the seam in the lower rooms being 21 in. and a half to four feet wide. The new slope now being sunk is to the north and in safe ground, and at the time visited was down about 525 feet, dipping to the east at 16°. This seam, which is not the same as that mined in the old workings, was at this depth about two feet wide, and was apparently becoming wider. It had previously narrowed to about six inches. An average sample of the two feet, analysed by Dr. Hoffmann, gave:

Water,	4.26%
Volatile combustible matter	10.26%
Ash,	10.81%
Fixed carbon	71.67%
Coke per cent.	55.52%

The coke is a firm coherent coke.

These measures are not the same as those at the Tantalus mine which appear in the valley about three and a half miles to the east of the Five Fingers mine, and also up a small creek about three or four miles to the east from the Five Fingers rapid.

GEOLOGY

GENERAL

In studying this portion of the Yukon, as it extends from British Columbia to the south, a striking similarity in the geology is noticeable in a north-west and south-east direction, all the main horizons extending parallel to the Pacific coast line.

The principal geological formations have been placed in the following divisions, beginning with the oldest:

Schists.—Lying next the granites along the western edge of this district, in places, are some schists, chiefly chloritic, sericitic and hornblende, and sericitic and schistose quartzites, which are probably the oldest rocks observed this season.

Lower Cûche Creek series. This series consists of cherty quartzites, slates, argillites, altered diabases and basic andesites, some serpentines, and some thin beds of limestone, and is probably Lower Carboniferous or Upper Devonian.

Limestone. Overlying the slates, cherts, etc., of the above class is a considerable thickness of limestones forming a range of hills along the eastern edge of this district. It is probably Carboniferous, and perhaps belongs to Dr. Dawson's Upper Cûche Creek series.

Granite. Cutting the above formations are the granites of the Coast range, which are now generally considered to be Jurassic.

Windy Arm series. This consists chiefly of fine-grained, greenish, fresh-looking porphyrites, but includes some diorites, gabbros, andesites, basalts, tuffs, etc.

Tutshi series. This name has been given by Mr. McConnell to a series of bedded rocks, chiefly tuffs, tuffaceous sandstones, conglomerates, etc., which have

been found to overlie the Windy Arm rocks conformably and, in fact, to pass gradually down into them. Both appear to belong to Dr. Dawson's Porphyrite series.

Granite porphyry. Cutting all the above formations are some dikes and masses, generally quite small, of granite and syenite porphyry.

Scoria and basalt. Overlying all are some recent lavas of Tertiary age.

OLDER SCHISTOSE ROCKS.

These rocks occupy altogether but a small area, chiefly in the form of a narrow disconnected belt, with occasional small outlying areas adjoining the granites. They can be traced almost continuously, with an average width of about one-half mile, from the West Arm of Lake Bennett, north to the Watson river. They vary greatly in appearance and mineralogical composition, and probably represent rocks of different origins and different ages. Their occurrence and general description corresponds somewhat closely with those found by Mr. J. C. Gwillim in the Atlin district, and placed in division IX in his table of formations, and considered by him to be Lower Paleozoic. They also all probably belong to Mr. McConnell's "Older Schistose rocks," including the Klondike series, Moosehide group, and Nasina series of the Klondike gold fields. Mr. Brooks⁽¹⁾ considers the Nasina series to be Lower Paleozoic or Pre-Cambrian, and Mr. McConnell⁽²⁾ considers a portion of the Klondike series, and probably the whole series, to be referable to the age of the Pelly gneisses⁽³⁾, and to be probably nearly contemporaneous with the Moosehide group⁽⁴⁾. So the probability is that these rocks are all Pre-Cambrian.

Some fine-grained, light-coloured, finely schistose, chloritic and sericitic schists, which break up readily into very thin schists, and are generally somewhat glossy in appearance, are found along the eastern edge of Mt. Stevens, somewhat to the east of the main belt. These are evidently very old, and correspond lithologically to Mr. McConnell's Klondike schists found to the north, and described in his report on the Klondike gold fields. No other rocks at all closely resembling these were seen in the district. A number of quartz veins, frequently several feet in width, outcropping for several hundred feet, and often carrying copper minerals and occasionally galena, were noticed in these schists. The veins occur generally along the foliation planes of the schists, and seldom in true fissures.

On the hills just to the west of Mt. Stevens the schists are wider than elsewhere observed. Towards their western margin they are generally quite coarse, presenting the appearance of extremely crushed hornblende-granites, breaking readily along the planes of schistosity, and present a coarsely mottled appearance due to the occurrence of large altered feldspar crystals. These probably correspond to the Pelly gneisses. Farther east are some greenish, chloritic, as well as some fine grained and more quartzitic schists. These are all somewhat closely foliated though they do not, as a rule, cleave along the planes of schistosity, but break

1. Twenty-first Annual Report of the United States Geological Survey, part II.

2. Report on the Klondike Gold Fields, p. 17 B.

3. Described by Mr. Brooks in the Twentieth Annual Report of the United States Geological Survey, part VII, pp. 160-163, and by Mr. R. G. McConnell in the American Geologist, Vol. XXX July, 1902.

4. Report on the Klondike Gold Fields, p. 23 B.

into more block-like pieces; have not, to nearly the same extent, the glossy sericitic or chloritic appearance of the Mt. Stevens rocks, and are generally more compact. Quite a number of quartz veins, generally parallel to the schistosity, and often well mineralized with pyrite, copper minerals and galena, and carrying gold values, occur in these schists.

The schists, having a width of about a third of a mile, are again seen on Gold hill, where they are very similar to the eastern portion of the belt west of Mt. Stevens. From here they can be traced for some distance towards the Wheaton river to the south, through Mt. Hodner, and towards the Watson river to the north. These are greenish, generally dark-coloured, fine grained and closely foliated, but only occasionally cleave along their planes of schistosity. An examination of their sections and specimens of the Gold Hill schists shows them to be generally sericitic or schistose quartzites grading into silicified slates, or rocks originally containing much argillaceous material, but which have by shearing received their slaty or even schistose structure. The specimens examined are all decidedly of sedimentary origin and the banding, in some cases, appears to be due to bedding rather than to shearing. The rocks are, however, very much altered, and the original minerals are to a great extent replaced by secondary ones. These schists closely correspond lithologically with Mr. McConnell's Nasina series in the Klondike district, and probably belong to it. Quartz veins several feet wide, and quite persistent, are found in these schists, and it is in one of these on Gold hill that the rich free gold quartz carrying the telluride mineral, hessite, sylvanite, and telluric ochre, was found this summer. Other veins also carry copper minerals, such as chalcopyrite, grey copper, malachite, malconite, pyrite, galena, etc.

Very similar schists to those on Gold hill were found on Mt. Stony extending south to the north shore of West Arm, and north as shown on the accompanying map. No economic deposits were seen here.

As only a hurried examination was made of these rocks no more definite information concerning them could be obtained. All the schists above described have, therefore, been given the same geological colour on the map, and, though not necessarily of the same age, are probably for the most part detached portions of older schist series which have been included in the Coast granites, and are to some extent covered again by the more recent rocks.

CACHE CREEK SERIES.

Limestone. Extending along the eastern edge of the district is a somewhat straight, prominent ridge of white limestone hills particularly noticeable on the eastern side of the mouth of Windy Arm. The limestone is usually fine-grained and is often in the state of marble. Some beds contain much quartz and often weather very rough; others are mainly composed of cherty matter. A similar limestone is shown on Mr. Gwillim's Atlin map, in the north-west corner, which practically joins the north-east corner of the district covered by this report. He considered this limestone to be probably of Carboniferous age, and Dr. Dawson states in the Report of Progress for 1887 that parts of the rock, thin sections of which he examined, proved to be largely composed of the remains of Fusulina, which are so typically Carboniferous and even Lower Carboniferous. He consid-

ered these beds to belong to his Upper C  che Creek series, described in his report on the Kamloops map sheet and in other reports, and which is found in the interior of British Columbia practically from the north to the south, and to maintain many of its characteristics over the entire area.

A few small outcrops of the upper portions are seen projecting through the higher series of rocks to the west of the main range, especially just east of Mt. Needle, west of the railway; along the railway on the east side; just north of Lansdowne, and at the north-east corner of Mill Haven, at which last place, however, on account of the surrounding deep glacial wash, the contact with the other formations is not exposed.

No fossils of much importance were found in these limestones. The following imperfect specimens were obtained, and have been examined by Dr. J. F. Whiteaves, of this Department. He says:—

“One fragment of a Cyathophylloid coral.” This was found in the limestone range east of Whitehorse.

From the limestone hills about three miles west of De Witte were found: “A few specimens of a small, smooth compressed Athyroid or Terebratuloid shell, which do not show the characters of the interior nor those of the beak and area of either valve.” Also a “fragment of a bivalve shell with sculpture like that of *Rafinesque alternata*.” “These are Paleozoic or possibly Triassic.”

Lower Series.—Underlying the limestones is a series of cherty quartzites, cherts, slate, metamorphosed argillites and sandstones, serpentines, altered diabases and andesites, which, with the exception of the schists farther west, are the oldest rocks in the district and underlie particularly the eastern portions, being invaded by the granitic intrusions to the west. Lying, as these rocks do, under the limestones, they are naturally found along both sides of the range above referred to, where the erosion and folding have been sufficient to expose the rocks beneath it, the limestone appearing to lie in a shallow, almost flat, synclinal fold with the older rocks exposed on both sides. Mr. Gwillim found these rocks in the Atlin district, where they outcrop in a similar manner to those seen along both shores of Windy Arm and elsewhere to the east.

The rocks here placed in the Lower C  che Creek series closely correspond lithologically with those of this series described by Dr. Dawson,* and underlie the Fusulina limestones above mentioned.

They also correspond with Division VIII on Mr. Gwillim's Atlin map which includes “cherty quartzites, black slates, biotite slates, and limestones.” The cherty quartzites, slates, and cherts are the most characteristic rocks of this series and the ones most easily identified. The altered igneous rocks are, especially where the outcrops are few and small, somewhat difficult to distinguish from the also somewhat altered igneous rocks of the Windy Arm series, which overlies the limestone.

The best exposures observed of these old sediments outcrop on Copper gulch (on the east side of Windy arm), and about a mile and a half up a gulch on the west side of Windy Arm about two miles below Conrad. These outcrops are very similar except that the exposures on the west side of the Arm consist mostly of cherts and the cherty quartzites, whereas up Copper gulch quite a variety of rocks are seen,

* Report on Explorations in British Columbia; Report of Progress 1876-77, and Pt. B, Vol. VII Annual Report.

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Vol. VII



LOOKING UP WEST ARM OF LAKE BENNETT, YUKON TERRITORY.



from finely bedded, and often highly folded and twisted slates, to very fine-grained, black compact altered argillites, and to the cherts and cherty quartzites which vary in colour from grey to black and in structure from finely bedded to massive.

The cherty quartzites are very noticeable and somewhat peculiar in character. They generally occur in well defined beds only a few inches thick, are always line-grained, resembling chert, and are usually grey or light-coloured except where iron stained, when they very often present a red appearance on their weathered surfaces. They occasionally become nearly black, and at times are greenish or nearly white in colour. The argillites are line-grained and generally black, ranging, however, from dark grey to black. They are often massive, but at times are somewhat slaty, finely bedded and quite siliceous, having a tendency to pass into cherty quartzites.

The slates are generally finely bedded and possess the typical slaty structure, cleaving quite readily along the foliation planes, and are occasionally very much folded and disturbed. They are in places more massive, however, and become very siliceous and grade into quartzites that vary from line-bedded to massive.

Owing to these exposures being greatly disturbed, and of a very imperfect nature, no idea could be obtained—without much detailed work—as to the relative ages of the various members of the series. A somewhat continuous but narrow outcrop of these slates and cherts is to be seen along the west side of Windy Arm for about two miles south from the limestone exposure at its mouth. Also, west of this, and connecting with the outcrops just above the Indian village across from Caribon Crossing, the same slates prevail and are often quite quartzitic. Up a small creek that heads just east of Mt. Escarpment signal, and runs into Windy Arm about two miles above the mouth of the Arm, the typically red, iron-stained cherts and cherty quartzite outcrop in the canyon in which the creek runs. Some outcrops of slate were also noticed in the south bank of the creek and above the cherts, while up from the mouth of a small creek running into the lower end of Nares lake, from the north, are typical slates and quartzites. Small exposures of these rocks were noticed immediately south of the limestone, half a mile east of Windy Arm, and another exposure about half a mile wide, of dark finely-bedded slaty rocks, often possessing quite a schistose structure, occurs about a mile above Conrad.

A series of metamorphosed sandstones, alternating with beds of limestone, outcrops along the north side of McDonald creek on the east side of Lake Bennett. This outcrop is approximately one mile wide along the lake shore, and extends nearly to the head of the creek. This series consists of highly metamorphosed, well-bedded, generally fine-grained, hard, dark grey to reddish brown sandstones, which are somewhat calcareous throughout and decompose readily. They alternate with beds of limestone from fifty to one hundred feet in thickness, which are generally well-bedded, but are sometimes more massive. Numerous granite dikes one to four feet in width cut these beds in all directions. The series differs from any other seen during the season, but lithologically resembles part of the Cache Creek series. It is calcareous, contains limestone bands and is older than the granite; it has, therefore, been assigned to the Lower Cache Creek series.

Apparently associated with the slate and slaty rocks along Windy Arm are some schistose rocks, altered diabases, basic andesites, and serpentines, which are older than the granites and which are also here included in this Lower Cache Creek series. These rocks in places closely resemble the somewhat altered porphyrites and tuffs of the Windy Arm series, and, where the outcrops are small and the

characteristic appearance of the rocks in the field is not pronounced, it is difficult to distinguish them. In fact, as the work done this season was necessarily of a somewhat preliminary nature on account of the large area covered, it is quite possible that some of the region mapped as the Windy Arm series properly belongs to this Lower Cache Creek series, or that the latter should be subdivided. The altered igneous rocks included in this series are, in most cases at least, somewhat newer than the cherts and slates, but more detailed work is needed to accurately map them separately.

The fact that coarse syenitic and granitic dikes invariably cut these igneous rocks, and do not cut the Windy Arm rocks, is a helpful feature in distinguishing them, as is also the fact that the Cache Creek igneous rocks are much altered.

On the east side of Sugar Loaf hill some splendid specimens are found of old, very basic eruptives which are in places almost entirely altered to serpentine. Another small area of similar basic rocks, although not so extensively altered, occurs on a small rounded hill about two miles to the south of Mt. Escarpment signal, and another at about the head of the south branch of Copper gulch, one mile south-west of this summit. In these two localities the rocks present a very rough, red, iron-stained appearance. On the east side of Windy Arm, and south of Rams Horn creek, is a ridge rising with a continuous high rugged escarpment facing the Arm, which, practically as far as the British Columbia and Yukon boundary, is composed chiefly of rather fine-grained, greenish, chloritic, schistose rocks which have been much altered, and are traversed everywhere, and in all directions, by a network of fine quartz veinlets, and which are also frequently cut by granitic dikes from one to six inches wide. These same rocks outcrop on the west side of Windy Arm north of Pooley canyon, as shown on the map; also at Conrad and to the north for some distance, and on the eastern side of the Arm below Conrad, extending to near the limestone. Here they are, as in some other places, heavily impregnated with pyrite. In all cases these rocks present the same general altered appearance, the granite dikes are numerous, and the quartz veinlets are always present.

On the west side of Sugar Loaf hill, and next the granites are some very basic, dark, altered, schistose rocks in which actinolite has been extensively developed. To the east of this hill, and extending to the north and south ridge about three miles away, are some rocks which have been much altered and broken and which weather very roughly and are generally quite basic, and often are heavily iron-stained on weathered surfaces. Thin sections of these rocks show them to be much altered basic andesites grading, in some cases, towards basalts. Similar rocks also outcrop on some small hills about one and a half miles to the north of the summit of the Montana tramway, which is somewhat over half way between the lower and upper terminals, and also along the tramway below this point, and to the north. On the hills to the south of Mt. Nares station are similar outcrops.

From the above descriptions it will be seen that although the rocks of this Lower Cache Creek series cover only a very small portion of the area surveyed, they are of a somewhat varied character. In fact it is the intention to place all these older rocks (*i.e.*, older than the Coast granites), except the schist series, in this Cache Creek series. Dr. Dawson has stated that the age of the Lower Cache Creek rocks may be older than Lower Carboniferous, and that the series may include

portions of Devonian age. The rocks placed in this series this season are probably of the same age.

GRANITES.

The Coast granites which were intruded originally as a great batholithic mass in Jurassic times, and which extend along the western edge of this district, are mostly fresh and unaltered in appearance, and are often granite and granitoid rocks, generally grey in colour, and rich in hornblende, and are, for the most part, considered to be grano-diorites. They are as a rule coarse-grained and, towards the edges of the intrusive mass, often become porphyritic and, from the abundance of pink orthoclase, in places, assume a pinkish appearance.

Along the west side of Mill Haven, and extending some distance to the north and west, is a much crushed and altered belt of these granites from which a section was examined microscopically by Dr. G. A. Young of this Department, who says: "Grano-diorite, composed essentially of quartz and plagioclase feldspar. The rock has been subjected to pressure which has fractured and deformed the quartz; in some cases the individuals have yielded entirely to the pressure and involved the feldspars in their ruin." These rocks outcrop along the western side of the Wheaton River valley. A few small hills of the granite occur in this belt, as would be expected, but for some reason have escaped this crushing action.

The granites that outcrop along Lake Bennett near Caribou Crossing, and cut the Mt. Gray ridge, are generally coarse-grained and hornblendic, containing, at times, black mica, and are in all probability of the same age as the granites to the west. Wherever these granites could be found in contact with the porphyrites of the Windy Arm series, dikes of the porphyrites were seen cutting the granites.

WINDY ARM SERIES.

Newer than these Coast granites is a series chiefly consisting of porphyrites, diabases, andesites, tuffs, and basalts which cut through and overlies them, by far the greater part of the rocks being porphyrites which are generally fine-grained and greenish in colour and present a fresh, unaltered appearance. So predominant is this porphyrite that it might be considered a porphyrite series, but as the ores of the Windy Arm district occur in it, the writer has called it the Windy Arm series. Thin sections of specimens of these porphyrites from various parts of the district possess a strong similarity, and consist chiefly of phenocrysts of plagioclase which at times consist of interlocking individuals either somewhat broad or of lath-like habit, or of minute laths, or the plagioclase individuals may be more tabular in outline. Sometimes augite is abundant in the ground mass, and in a few places specimens were found containing augite phenocrysts. Pyrite is often found and in places hematite and magnetite are present in considerable quantities. When the rocks have been much altered, secondary minerals, as chlorite, are abundant. In places these porphyrites grade into diabases, andesites, &c., and true diorites and even gabbros have been found, but these are quite exceptional, and are probably due to cooling under different conditions. Tuffs and ash rocks are very plentiful in this series and vary considerably in appearance and composition. The porphyrites apparently grade into basalts with the typical prismatic jointing and also into the tuffs and ash rocks, and these into true sediments.

The porphyrites have broken through their overlying beds and have flowed through and over them mostly in the form, apparently, of great laccoliths, sheets, etc., the flow structure being frequently well marked. Where the porphyrites come in contact with the Coast granites, dikes of them fill the latter, and there are numerous cases where the porphyrites fill inequalities in the surface of the granites. Violent explosions accompanied the eruption or eruptions, causing the formation of tuffs, which are often very coarse. These are very characteristic, and are met frequently over the entire district. Often they present on weathered surfaces the appearance of conglomerates due to particles, lumps, &c., either quite fine or several inches in diameter, of one porphyry or porphyrite in a ground mass of a somewhat different looking porphyry or porphyrite. There have been great showers of ashes and finer material which have consolidated into generally fine-grained, greenish rocks showing bedding structure which is often quite pronounced, giving the rocks the appearance of fine-grained sandstones and shales. In places these particles have fallen into water, and show to some extent water sorting action, and are mixed with argillaceous and other sedimentary materials. These rocks seem to grade into true sediments as shales, conglomerates, bedded cherts, cherty quartzites, &c., which carry coal seams. It is somewhat difficult to draw any decided line between the true sediments and the bedded tuffs and ash rocks which seem to lie conformably on one another. However, it has been decided to attempt this for economic reasons, and the true sediments with some of the upper bedded ash rocks and tuffs are included in the Tutshi series described below. The rest are included in the Windy Arm series. The whole series appears to correspond to Dr. Dawson's Porphyritic series found to be so extensive in British Columbia, and which he described somewhat in detail in the Report of Progress of this Department for 1876-77. This Windy Arm series also corresponds, in all probability, to the rocks of Division IV on Mr. Gwillim's Atlin map above referred to, and includes the corresponding representatives of the greenstones of his Gold Series Division VI, which are newer than the granites. The corresponding representatives of the other members of Division VI, which are older than the granites, have been included in this report, and on the map in the Lower Cache Creek series. In the writer's summary report on this district mention was made of some altered sediments newer than the limestones. These upon examination proved to be mostly tuffs, and have been also included in the Windy Arm series.

The whole series is somewhat calcareous, and the porphyrites generally contain enough lime—due chiefly to the alteration of the feldspars—to cause effervescence with acid. Bands of limestone, locally spoken of as limestone "dikes," occur in a number of places, up to fifty feet in width. Probably the most noticeable instance, generally about fifteen feet wide, extends along the west side of the Mt. Gray ridge from the north end of the ridge to south of west of Mt. Pyramid station. On Mt. Needle it is seen about three-fourths of the way to the top where it dips into the hill at low angles and extends almost in a straight line to about three-fourths of a mile west of Mt. Pyramid station, where it outcrops along the top edge of the main part of the ridge and has been in places staked off as mineral claims. A somewhat similar occurrence, from five to fifty feet wide, has been described above as being on the east side of Mt. Gray, and running at about right angles to the shore of Lake Bennett, and along which the College Green and other claims have been staked, copper minerals having been deposited along the contact of the lime and porphyry.



LOOKING EAST ACROSS WINDY ARM FROM NEAR THE MONTANA MINE, YUKON TERRITORY

Typical porphyrites of this series outcrop around the Windy Arm mining properties, and practically the whole of Mt. Gray, Mt. Ptarmigan and Mt. Twin consist of these rocks. The coarse tuffs are well seen along the top of the Mt. Gray ridge, particularly the top of Mt. Needle and Mt. Gilliam. They are also seen around the station at Mt. Twin and just south of the Thistle mine up to towards Mt. Matheson, and at other places.

Along the ridge from Dails peak towards Mt. Matheson, and along the high ridge south of the Big Thing group, are typical basalts.

The rocks along the western edge of Mt. Needle, which are chiefly ash rocks and tuffs, as seen in the distance, show distinct bedding, the beds being generally from one to four feet wide or even wider. On approaching them the bedding is not so evident and probably would not be recognized. This same feature was noticed in other places.

In the Windy Arm district, in particular, red belts or zones of rock from a few feet up to several hundred feet wide occasionally occur, and are often spoken of as porphyry dikes. These in most cases are only portions of the porphyrite that are particularly rich in iron, oxidation having given the red colour to the rock which, if broken, will be found to be red only on the weathered surfaces and as far as the weathering extends. At one place, however, on the west side of Lake Bennett, below the mouth of the Wheaton river, a belt of these porphyrites contains a considerable amount of hematite as well as pyrite and magnetite, and seems to be permeated throughout by the red coloring. On the east side of Lake Bennett is a somewhat sharp ridge of red iron-stained hills about two miles from the lake and extending south from McDonald creek three or four miles, the rocks of which upon being examined microscopically proved to be tufaceous sandstones which lie between porphyrites.

The rocks of the narrow belt extending along the eastern face of Mt. Stony, and lying between the schists on the west and the badly sheared granites on the east, are generally fine-grained and greenish in appearance, and in places have an apparent schistose structure. Under the microscope they prove to be highly altered basic volcanics almost entirely changed to zoisite, epidote and actinolite. These have therefore been included in the Windy Arm series, the same force which has so broken and crushed the granites to the east probably having also altered these.

The whole of Mt. Lakeview is composed of light-coloured rocks showing apparent bedding in places, but a number of thin sections were examined which, under the microscope, proved to be typical Porphyrites very similar to the others of the Windy Arm series. Along the foot of the mountain, however, and just north of the signal, some exposures of dark, finely bedded tuffs were seen.

TUTSHI SERIES.

This name was given by Mr. McConnell to include the "Argillites, tufaceous sandstones, conglomerates, &c.," of the Windy Arm district, and the writer has adopted the name for all rocks in the area that appear to belong to this same series. These Tutshi rocks, which in all probability, as mentioned above, correspond to the rocks of Mr. Gwillim's division III on his Atlin map, belong, as well as the Windy Arm series, to Dr. Dawson's Porphyrite series and correspond lithologically and stratigraphically with his Jackass Mountain series (Report of Progress for

1871-72), which he has decided over the conformably the rocks described in the report of 1875 as belonging to the Porphyrite series. This latter consists chiefly of igneous products, and the Jackass Mountain series resembles rocks of ordinary aqueous origin; but as rocks which were originally flows are very difficult to distinguish from those of the same chemical composition though of fragmental origin, as ashes, sands, &c., they have all been placed under the same name, and in his report of 1876-77 all are included in the Porphyrite series. As this Porphyrite series covers such a large portion of the district, and as coal occurs in some of the beds, it has now been decided to distinguish them on the map as far as possible, although it is to be understood that no sharp lines are drawn between them. All rocks, therefore, which are of aqueous origin, and all those associated and interbedded with them, are placed in this Tutshi series, as water action has had more or less effect on all of them and has not affected the rocks of the Windy Arm series. Dr. Dawson considered the Porphyrite series to be probably a link between the Jurassic and Cretaceous, making the Jackass Mountain beds Lower Cretaceous. The fossils found this season in these Tutshi beds, being all typically Lower Cretaceous, further bear out this correlation.

In the vicinity of the Union mines, and on the eastern slope of Mt. Follé, are some fine-grained, very hard, brittle, often cherty, well and often thinly bedded rocks, generally red with iron stain. They break up into sharp angular pieces and prove, when examined petrographically, to be for the most part cherty quartzites, and banded cherts, containing much pyrite, and the base chiefly a chemical precipitate. Numerous specimens of a type of fossil were found and have been examined by Dr. Whiteaves of this Department, who says: "*Proconygelus woolqari* (Mantell). Several crushed specimens of an Ammonite that are possibly very young individuals of this species. In the Upper Missouli country, and elsewhere in the United States, *P. woolqari* is regarded as a characteristic fossil of the Fort Benton group. In Canada a few good specimens of it were collected by Mr. McCannell in 1880, in the lower 200 feet of the La Riche shales, at two localities on the Athabaska." This band of reddish weathering rocks is seen outcropping for some distance in a north westerly direction, passing just to the east of Mt. Perkins signal and forming the central part of Red ridge for some distance on both sides of the signal, where there are porphyrites, tuffs, &c., of the Windy Arm series.

Just to the west of this belt, and outcropping on the ridge running west from the Union Mines and about midway to Pugh peak, are some shales, conglomerates, cherts, and cherty quartzites, carrying some coal seams. These rocks are of the same horizon as the coal measures which have been opened up about seventeen miles in a south-westerly direction from Whitehorse. The chief horizon marker consists of a number of heavy beds of a peculiar looking conglomerate, made up almost entirely of hard, well-rounded, generally small pebbles of slates, cherts, quartzites, &c., in a siliceous matrix, giving the rock a very cherty, hard appearance. Some black shales both finely and coarsely bedded were found next the coal seams. Also, adjoining them and the conglomerates are a number of beds of hard, fine-grained, often brightly coloured bedded cherts which are banded, the bands being generally narrow, about a quarter of an inch or less, and prettily coloured, the colours varying from greys to reds and blacks. There are, too, some light coloured, thinly bedded, and also some more coarsely bedded shales and light

coloured sandstone. The rocks here are very much bedded. In an attempt to measure a section was made. Three or four beds, apparently only a few inches in width, were seen, but their actual thicknesses were not determined. The area of these measures here is somewhat small.

Just west of the granite on Mosquito hill, and extending to the west of the two shown on the top of the ridge, appear the red, iron-stained, fine-grained, hard, brittle, cherty quartzites, &c., as seen on Mt. Follé. West of the main part of Mt. Goat, outcrops are very scarce, but those seen are tuffaceous sandstones, tuffs and porphyrites. The main part of the mountain, however, is composed of bedded rocks, as tuffaceous sandstones, tuffs, cherts, &c., similar to those of Mt. Mosquito, and some coarse irregular conglomerates differing considerably from the conglomerates of the coal measures, in not having the cherty, slaty pebbles, and being much less uniform in composition. There are here some finely-bedded grey and greenish, and some almost black fine-grained tuffs and ash rocks, looking like shales, and some coarser ones that on account of being bedded might be mistaken for sandstone. Some fossils from this mountain have been examined by Dr. Whittrave who says:

"*Triopina*, small, areolate, and beeked species. Two other *Pelecypoda*, imperfect and undetermined. Shales with numerous valves of an *Estheria* or of very young specimens of *Inoceramus*. Also two crushed fragments of a small *Ammonoite* apparently referable to *Prionocyclus woolgari*." These are all placed under the head "Cretaceous" and are probably lower Cretaceous as described above.

A low ridge, the Watson ridge running just west of the Watson river, seems to have been caused by a heavy bed or beds of conglomerate which, being harder and more difficult to weather than the surrounding rocks, have been left above the level of the wide valley in which they are situated. The conglomerate appear to be the same as those on Mt. Goat, Mt. Caribou, and Mt. Granger, being light coloured, and consisting of generally well-rounded pebbles of granite, porphyry, porphyrite, &c., varying in size from small up to four or five inches in diameter. In addition to these conglomerates—which do not resemble the conglomerate found in the coal measures, the ridge consists chiefly of fine-grained, well-bedded, dark, cherty, shale-like rocks and quartzites, and some lighter coloured, coarser bedded tuffs. Just across the railway from here is a parallel, but lower and less prominent, ridge of similar conglomerates which extends along the western side of Mt. Caribou, and has in places a reddish appearance due to iron-stain.

The western side of Mt. Caribou consists of conglomerates, similar to those on the ridge across the railway, the so-called argillites, tuffs, &c., all having a general strike of about true N. 13° E. Overlying the conglomerates are some thinly bedded, dark, somewhat soft, argillite-looking rocks composed chiefly of volcanic material. Overlying these again are some more coarsely bedded, fine-grained, almost black, very hard, slate-like rocks which prove, however, when examined under the microscope, to be tuffs. Besides these are some lighter coloured tuffs generally fairly well-bedded, and varying in texture from fine-grained to about that of an average sandstone. The bedded fragmental rocks, which are mostly pyroclastics, extend along the ridge to the north of Mt. Caribou and south of the signal for some distance, but as the deep draw is approached dividing this mountain from Mt. Nares the rocks become nearly all greyish and greenish porphyritic looking tuffs and tuffaceous sandstones, and grade into true porphyrites. It is, therefore, difficult to draw a line here between this and the Windy Arm series.

The top of Mt. Wounded Bull, to the north of here and east of Robinson, is chiefly composed of the red weathering, fine-grained, hard, cherty quartzites, banded cherts, &c.

The southern part of Mt. Golden Horn, and the low ridge of hills to the south-east of it running north from Mt. Mosquito, are also composed almost entirely of the reddish, weathering hard rocks almost identical in appearance with those at Red Ridge signal, and in the vicinity of the Union mines and elsewhere. Thin sections of these rocks examined microscopically prove them to be the same, and to be bedded and banded cherts and cherty quartzites containing pyrite, the base being chiefly a chemical precipitate.

The wide valley in which the railway runs west of Caribou and Mt. Wounded Bull, and which, particularly in the vicinity of Lewes lake, is floored with heavy silt deposits, is probably underlaid by these Tutshi rocks. They outcrop along both sides of the valley, there is coarse float in a number of places, and one outcrop was found along the railway about two miles south of Robinson.

The outcrops seen on Mt. Double from the east side of Coal lake on the west, and including the long ridge extending from it in an easterly direction, are chiefly light coloured, fairly well-bedded, generally coarse-grained tuffaceous sandstones and massive beds of conglomerates, the latter being generally quite coarse and composed of well-rounded, very irregularly sized pebbles and boulders up to five or six inches in diameter, of granites, porphyrites, and the general types of the other rocks of the district, which are often only very loosely cemented together. Outcrops, except on the summits of the mountains and ridges, are very scarce and it would seem that these sandstones and conglomerates, which weather less readily than some of the finer-grained and softer, more shaly rocks with which these are associated in other places, are accountable for the summits and ridges, and that the lower portions of the hills, which have weathered to a greater extent, are composed of these softer rocks. Dips and strikes are very irregular and of little value here. These sandstones and conglomerates are very similar to those seen on Mt. Caribou, Mt. Granger, and elsewhere. Just west of the Mt. Double signal are also some of the harder, reddish-weathering cherty quartzites, as seen to the south-east of Golden Horn, on Red ridge, and elsewhere as mentioned above.

Coal ridge, which extends along the western side of Coal lake and just across from Mt. Double, is also composed of rocks resembling those to the east of it, the conglomerate being very noticeable, and also the red, cherty beds which form the northern end of the main part of the ridge.

On Mt. Granger, farther to the west, the same beds continue as were seen on Coal ridge and Mt. Double, these being all in the general line of strike. Commencing a short distance to the south of the summit of this mountain, and extending over the northern edge to the granite contact, are the red, hard, fine-grained, cherty quartzitic rocks described above. The strikes here as elsewhere are very irregular. One near the granite contact was true N. 28° E. with a dip of 70° to the north-west. The general strike is here more nearly east and west. Underlying these beds is a great thickness of hard, coarse, light-coloured sandstones and conglomerates similar to those on Mt. Double, with a few intercalated, finer, darker, and softer beds, most of them probably pyroclastics. These extend to nearly the foot of the mountain, *i.e.*, on its south side, the conglomerate beds being of great thickness, in some instances several hundred feet, and apparently overlying the coal measures which



LOOKING SOUTH FROM TOP OF WINDY ARM MOUNTAINS NEAR MONTANA MINE, YUKON TERRITORY.

outcrop in the valley to the south of Mt. Granger. This was the only place seen this season where anything approaching a complete section of this Tutshi series could be measured, and even here it would be somewhat difficult to arrive at anything like accurate results, the coal measures being to a great extent covered with glacial wash material, and the higher rocks being considerably disturbed. Moreover, it was very late in the season when this district was examined, and recent heavy falls of snow, covering considerable portions of the formation, made these somewhat rugged hills dangerous to traverse. However, this series here has a considerable thickness, probably between three and four thousand feet at least.

As mentioned above, only a partial section of the measures was seen, as they outcrop along the valley having approximately the same general strike, and are mostly heavily covered with drift. Descriptions of the coal are given in the economic portion of this report. The general strike of the measures is about true N. 74° W. At the tunnel the strike is true N. 63° W, with a 42° dip to the north-east. The most noticeable beds in these measures are the conglomerates which are similar to those seen between the Union mines and Gold hill, and are readily distinguishable from other conglomerates in this district. They are generally much finer and of more even size, and all the beds not only present a very similar appearance but are quite uniform throughout. They are composed of pebbles of cherts, slates, and quartzites, and are generally somewhat dark in colour and very hard, and usually cherty in appearance, the pebbles being well cemented together with a siliceous material. There are at least six of these beds here, generally from seventy-five to one hundred feet in thickness, but some narrow beds of only a few feet were observed. These cherty conglomerates have evidently been derived from the cherts and slates of the Lower Cache Creek series, and are probably the lowest true sediments above them in this district. The rest of the measures consist mostly of somewhat coarse, light-coloured sandstones, some beds of finer and darker shales being also seen. The conglomerates, sandstones, &c., of Mt. Double extend to the south to a point about midway between the station and the north branch of the Watson river, as shown on the map, where the Windy Arm rocks commence. Near the contact the coal measures from the south of Mt. Granger strike across this ridge, and were traced to the deep valley separating it from Mt. Lakeview.

In the Windy Arm district, to the south and on the north-east side, particularly, of Mt. Brute, are some peculiar fragmental rocks. These, very irregular in texture, are composed chiefly of volcanic ashes, lapilli, and quite coarse materials that have fallen into the sea and have been cemented together, often by clays. These rocks, not noticeably bedded and showing very little sorting action, have the general appearance of conglomerates. To the south, and running in a southerly direction to the head of McDonald creek, keeping to the west of it, is a rather narrow exposure of the reddish weathering cherty quartzites, etc.

There is also the belt of these Tutshi rocks noted by Mr. McConnell in the southern portion of the Windy Arm district. Outcropping along the shore of the Arm above Whynton, B.C., and extending in a north-westerly direction to the north of Mt. Dundalk, keeping south of Knob hill, they consist chiefly of conglomerates, tufaceous sandstones, tuffs, etc. The conglomerates are somewhat coarse and similar to those described above as occurring on Mt. Granger, etc. The sandstones are generally light-coloured, hard, somewhat coarse, massive, and usually in very thick beds. There are also some much finer, darker coloured

thinly bedded tuffs, which are particularly noticeable for some distance along Windy Arm, where they appear as fine-grained, dark argillites. All these rocks appear to be pyroclastics, and thin sections of the so-called argillites, examined under the microscope, are seen to be tuffs. The only fossils found here are imprints of some valves of young specimens of a species of *Inoceramus* which were examined by Dr. Whiteaves, and which he considers the same as the species found on Mt. Goat, and probably Lower Cretaceous.

These Tutshi rocks are frequently cut by porphyry dikes, generally fine-grained and greenish in colour; in a few places light-coloured pink porphyry dikes were observed to cut both the Windy Arm and Tutshi rocks. These dikes, which probably belong to some period of volcanic activity in Tertiary times, are in all cases too narrow to be shown on the accompanying map.

From the coal seams at the Tantalus mine, which are of the same horizon as those south-west of Whitehorse, and to the east of Pugh peak, as described above, some fossil plants have been examined by Dr. Penhallow, who says:— "All the material appears to be the same as the specimen of *Thyrsopteris elliptica*, Fontaine, as figured by Ward in the 'Status of the Mesozoic Floras of the United States,' vol. XLVIII, pl. LXXI, figs. 12 and 13; and to this the present specimens are provisionally referred. It is to be observed, however, that there seems to be some question as to the correctness of Ward's reference, since the specimen cited is quite distinct from the original type of *Thyrsopteris elliptica* as described by Fontaine (in 'Potomac Flora, vol. XV, p. 133, pl. XXIV, figs. 3, 3a'), and it is quite possible that further and more complete specimens may show this to be an entirely new species. A somewhat related flora was described by me in 1898 as obtained by Mr. J. B. Tyrrell from the Nordenskiöld river. All the specimens shown, however, were specimens of *Cladopicheis*, and they indicated Cretaceous age. "The specimens from the Tantalus mine present a flora with the same facies as those from the Nordenskiöld river, and the whole conform to the flora of Kootenai age. (Lower Cretaceous,—sometimes assigned to the Jurassic-Cretaceous period, near the close of the Jurassic and at the beginning of the Cretaceous)."

This further evidence bears on the correlation of the Tutshi series as made above.

GRANITE PORPHYRY.

In a number of places intrusive dikes, and masses of granite and syenite porphyry were seen cutting all the other rocks except the Tertiary basalts, etc. The areas of these are as a rule too small to show on the accompanying map, being generally dikes less than five hundred feet wide, but occasionally wider.

One of the most noticeable was a typical syenite porphyry, cutting Red ridge about one-half mile west of the signal, and continuing through Mt. Perkin to the eastern edge of Pugh peak, about one-half mile from the summit, being from nearly a half mile wide on Red ridge to about eight hundred feet wide east of Pugh peak.

Just west of Mt. Double summit is a similar dike about two hundred feet wide. This, however, on account of scarcity of outcrops of any kind, could only be traced a short distance.

On the south-east portion of the ridge forming the eastern portion of Mt. Lakeview is an exposure of these syenite porphyries, cutting through the Windy Arm porphyrites, which are here somewhat lighter coloured than usual. Outcrops were also seen forming portions of the summits of Caribou and Minto mountains and elsewhere.

SCORIA AND BASALT.

The newest rocks in this district are some recent dark basic lavas, which are of Tertiary age, and which are only seen in the northern portions. It is these lavas that have flowed across the valley of the Lewes river and caused the Whiteshorse rapid and Miles canyon. Along the sides of the latter these basalts show particularly well the prismatic jointing peculiar to these rocks, causing them to appear as vertical pillars. These rocks also extend to the west some distance, and are seen occasionally to the west of the railway along Johnson creek. The western portion of Black ridge, to the west of the Golden Horn, is composed of these lavas.

Boulders of scoria, often several feet in diameter, are thickly strewn over the surface along the north and north-west sides of Mt. Double, and to the west of Golden Horn. These, like the lavas, in most places are quite vesicular, the cavities not as a rule being yet filled with secondary minerals.

These Tertiary lavas somewhat resemble those of the Windy Arm series, but the latter are more disturbed and have the cavities of their originally vesicular rocks almost invariably filled with secondary minerals, while those of the former are commonly open and are much fresher looking.

For the greater part of the work of microscopically examining the rocks mentioned in this report I am indebted to Dr. G. A. Young, of this Department, and to Dr. R. A. Daly.

SUPERFICIAL DEPOSITS.

Filling the wide valleys of this district are, in most places, considerable thicknesses of gravels, clays, silts, etc., which completely obscure the rock formations. All such valley deposits have been mapped under one geological colour.

They were not studied in detail, but the silts which fill a considerable portion of the wide valley bottoms, particularly of the valley in which the railway runs to the north of Caribou Crossing, and are often thick, were very noticeable. These silts are the overwash of the glacial epoch, and are now being trenched by the different rivers and streams. Particularly in the vicinity of Lewes lake, which was partially drained during the construction of the railway, these are well seen and are very typical. They were evidently deposited in sluggish water, and at a considerable distance from the source of the material. Nearer the edge of glaciation the materials are more heavily bedded, much coarser, are cross-bedded to a greater extent, and show every evidence of being fluvial deposits, and of having been deposited in swiftly running water.

A noticeable feature in this district is a widespread layer of volcanic ash or pumiceous sand, which forms a single layer and is evidently due to one period of eruption. It is much more recent than the silts and other glacial deposits,

having been deposited in the river valleys, etc., after they had been cut down to about their present levels. In fact this ash is almost at the very surface, the grass roots being often in it. The layer is very even, except where it has been washed down from the hillsides into the valleys, and it evidently fell very gently, as snow might. It has an average thickness of from three to six inches, increasing to the north-west.

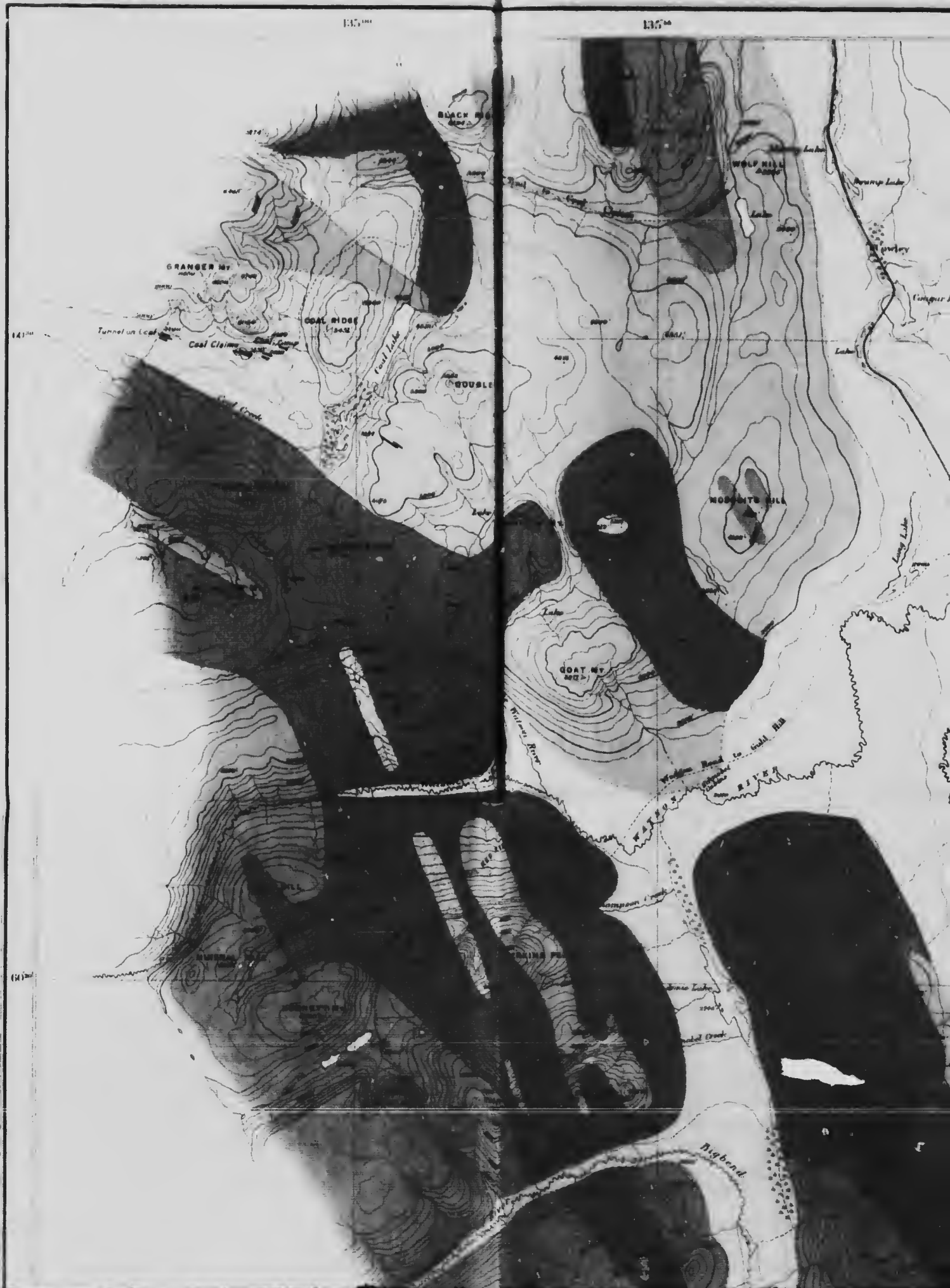
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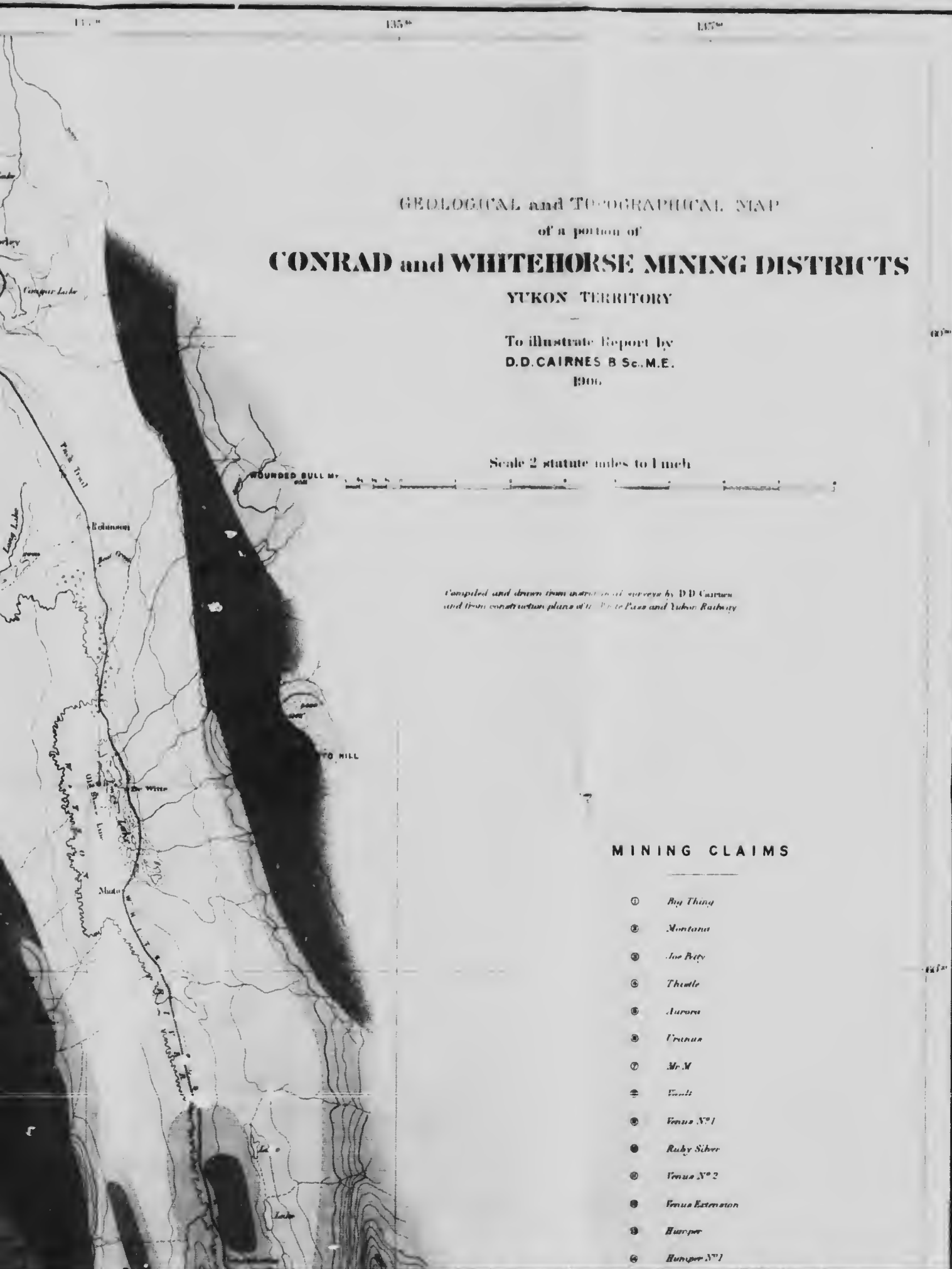
In connexion with the map of this district, it should be said that, as the work was somewhat rapidly done, no attempt at elaborate detail has been made. To accurately differentiate and map the various formations would require a great amount of work. Towards the north, outcrops are very scarce, hence it was difficult to assign exact geological boundaries to the different formations. However, the map probably indicates the different geological horizons accurately enough for the present needs of the district.

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GEOLOGICAL SURVEY





Explanation of Colours and Signs

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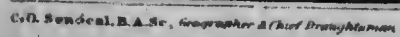
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