

CHAPTER IV.

MINERAL RESOURCES.

Placer gold is the only mineral of this area of present economic importance. None of the quartz veins are important when mining conditions are considered. Coal is found within the area, but supplies of a much better grade, where conditions are more favourable, are capable of supplying domestic needs for some time to come.

PLACER GOLD.

The discovery of the Sixtymile gold fields antedates that of the Klondike by four years, and although the discovery of the Fortymile field took place slightly before that of the Sixtymile, the greater part of the Fortymile field was subsequently found to lie in United States territory. In 1892 the Fortymile fields were extended across the divide to certain tributaries of Sixtymile river, C. Miller getting the credit of the discovery. The first real work on Miller creek, however, was performed by a party of four; Nolasque Tremblay, Joe Lemay, Joe Roi (King), and Louis Boucher washed about \$4,000 worth of gold during the summer of 1892; an additional \$2,000 worth was obtained from the rest of the creek. During the same summer the discoveries were extended to Glacier creek and later to Big Gold creek. These three creeks have been the principal producers, although several other creeks were staked. With the discovery of the Klondike, interest in the Sixtymile area waned; and from the year 1896 the production has steadily decreased except during 1915 and 1916, when a dredge, operating on Miller creek, restored production to almost the maximum figure.

The total estimated production of the Sixtymile area, not including a small amount of gold obtained from Matson creek, is \$2,541,600. The following table gives the annual production, estimated for the writer by Mr. Geo. P. Mackenzie, Gold Commissioner, Dawson. These figures, though carefully compiled, are estimates only, for no records were kept in the early days. Since 1906 the amount of royalty is accepted as the basis of production.

Estimated Production of Sixtymile Gold Fields.

Year.	Production in dollars.	Year.	Production in dollars.
1892.	8,000	1905.	70,000
1893.	47,000	1906.	60,000
1894.	200,000	1907.	60,000
1895.	225,000	1908.	57,300
1896.	200,000	1909.	61,500
1897.	150,000	1910.	54,000
1898.	150,000	1911.	33,500
1899.	130,000	1912.	48,000
1900.	120,000	1913.	30,000
1901.	110,000	1914.	35,700
1902.	100,000	1915.	221,500
1903.	90,000	1916.	152,050
1904.	80,000	1917.	50,000

GOLD-BEARING GRAVELS.¹

The gold occurs both in the gravels lying in the present valley bottoms and on the benches or terraces along the streams. Important amounts of gold have been recovered from the bench deposits.

All the gravels are local in origin. The pebbles and boulders are consequently composed mainly of the metamorphic rocks of the Yukon group. The schist pebbles have a very distinctive shape, being usually flat, round-edged disks 1 to 2 inches thick, and from 2 to 6 inches long. They are associated with numerous subangular and angular blocks of quartzite, rounded and subangular pebbles and cobbles of quartz, and pebbles and boulders derived from the late eruptive rocks. These last, in places, make up the bulk of the deposit. The thickness of the creek gravels varies greatly. They are generally covered by black muck, with which layers of sand and gravel are sometimes interbanded.

The bench gravels are in nearly all cases similar to the creek gravels, but show, as a rule, more wear. They present very little sorting or stratification, but are in many places roughly shingled upstream. The bench gravels are usually thin, but are in many places overlain by great thicknesses of talus and other detrital accumulations, and by muck. They differ from the White Channel gravels of the Klondike and other mining districts² not only in character, but in age, being a much more recent development.

The origin of the bench gravels and their gold; their relationship to the creek gravels of the present day; their place in the development of the present drainage of the district; and the influence which they have had in the development of the placer deposits of the creek gravels present interesting and important problems, the solution of which is necessary if a clear idea of the surficial geology, the recent geological history, and the origin of the placer deposits is to be obtained.

The grades of the benches are slightly less than those of the streams. This fact and the frequent shingle-like arrangement of the pebbles show that the benches are stream, and not lake, features, and that they are remnants of the former valley bottoms. Also, since the grades are less than those of the present streams, since the valley floors they represent are wider than the present valley bottoms, and, since the gravels show more wear, the bench gravels represent a relatively longer period of concentration than do the creek gravels. Moreover, if gold was available for concentration at the time of their formation, as it apparently was, the bench gravels should contain gold distributed more uniformly than in the creek gravels, although the total content be no higher. This view appears to be correct, although not definitely proven. The creek gravels are thought to represent, in part at last, a reconcentrate from the bench deposits.

The benches, therefore, represent remnants of the former valley bottoms, and the gravels were formed in circumstances that permitted a long period of concentration under stable conditions. When these conditions were interrupted,

¹ In this report the term "creek gravels" is used for deposits in the present valley bottom, and the term "bench gravels" for the elevated gravels on the benches. The word "gravel" is used in its broad mining sense.

² McConnell, R. G., "Report on the Klondike gold fields," Geol. Surv., Can., Ann. Rept. vol. XIV, 1901, p. 31B.

Cairnes, D. D., Geol. Surv., Can., Sum. Rept., 1915, pp. 14-16.

a rejuvenation of the streams permitted a rapid cutting through the older and wider valley bottoms to the present constricted channels, leaving portions of the old valley bottoms as benches. The gorge-like character of the valley bottoms shows that this cutting was rapid.

This cutting has been ascribed to an uplift or upward,¹ but it is now generally recognized that profound changes have taken place in the drainage systems of Yukon and Alaska, and that these changes may account for the formation of the benches.² Large portions of these territories remain unexplored, or only cursorily examined, but certain of these changes are fairly well proven, and causes may be assigned for them.

The valley of the Lewes-Yukon river being much younger below than above Rink rapids, it is probable that the Lewes formerly turned sharply near these rapids to the east and flowed to the east of the present Yukon, cutting across the present drainage channels diagonally. This valley thus formed has been described by McConnell in the following passage³:

"The principal feeders of the Macmillan below the forks are Kalzas river, Moose river, and Russel creek. These streams are all northern tributaries, no important feeders entering the river from the south. Kalzas river, which joins the Macmillan 27 miles above its mouth, is a large rapid stream about 60 feet in width. It forks a short distance above its mouth, the principal branch occupying a wide, terraced valley, which extends in a northeasterly direction for a distance of 40 miles. The northwesterly branch empties Kalzas lake, a sheet of water about 6 miles in length, lying behind the Macmillan mountains. This branch follows part of an old valley, which has been traced from the Pelly in a northwesterly direction to the Klondike and beyond. This valley is occupied in different portions of its course by the Pelly, a branch of Kalzas river, Crooked creek, a portion of Stewart river, Clear creek, Flat creek, and the lower portion of the North Fork of the Klondike river. This ancient drainage channel is an important topographic feature of the country, and may prove to be of economic importance, as gold may be concentrated along portions of its course. It runs in a northwesterly direction, crossing the present drainage channels diagonally, and has a width of from 2 to 10 miles or more. In the glaciated area, it is bordered by wide terraces, built up of silts, sands, gravels, and boulder clay, and in the unglaciated area, north of Stewart river, it is filled to a depth of at least 600 feet with sand and gravel."

Wide terraces of silt, sand, and gravel line the valley of the Lewes upstream from near Rink rapids, but do not occur below that point. It is significant that these terraces are found along the ancient drainage channel described above, and that this channel was, probably, blocked by the extension of valley glaciers during the Pleistocene. Below these terraces, the Lewes flows in a steep, rock-walled valley, a distinctly new cutting. Below the mouth of Stewart river, this valley is lined by a bench or terrace that has a totally different origin. It is rock-cut, supporting beds of gravel, and its grade is less than that of the river. At Stewart city it is only a few feet in elevation above the Yukon, at Dawson it

¹ McConnell, R. G., op. cit., p. 31B.

² Cairnes, D. D., "Scroggie, Barker, Thistle, and Kirkman creeks," Geol. Surv., Can., Mem. 97, 1917, pp. 14-16.

³ McConnell, R. G., and Keele, J., Geol. Surv., Ann. Rept., vol. XV, p. 24A. See also Map 805.

is 300 feet, and at Fortymile 700 feet¹. This bench is the remnant of a former valley bottom through which the river has cut, apparently rapidly.

Moreover, the studies of Alaskan geologists have recently established the fact that a large river formerly occupied a portion of the present valley of the Yukon, lying below Yukon flats, and that this stream flowed in the opposite direction to the present stream. This older stream probably drained to the Arctic ocean, possibly following up the valley of Porcupine river for a considerable distance, and possibly also receiving the waters of the river lying to the east of the present Yukon, the course of which has been previously outlined. Very extensive drainage reversal is postulated by Eakin² for the lower Yukon region, and the cause assigned for these changes was the extension of glaciers in the Pleistocene epoch. It is known for example that a lobe of the Keewatin ice-sheet extended along the Arctic coast as far as Mackenzie bay, and possibly as far as the 141st meridian. Such an extension would effectually block any drainage to the Arctic.

Other main drainage channels of Yukon have been similarly affected. Brooks³ claims that the waters of the Upper White and Upper Tanana rivers formerly drained to the Pacific. He states that these rivers joined to form a stream which followed the valleys of Mirror, Snag, and Beaver creeks to the valley of the present White, thence turned up White River valley to Koidern river, and continuing up this stream crossed the Donjek and found its way to Kluane lake. From the southern end of that lake the stream followed Schwack valley, a depression skirting the base of the St. Elias range, and the valley of Creadon river to Tatshenshini river and thence to the Alsek. Cairnes⁴ combats this view, and outlines a course for the ancient stream as follows. The White followed its present course to the Boundary, but there swung to the north and joined the Beaver. The Genere persisted on its present course and was joined by the Koidern and the waters of the Upper White and possibly the Tanana. These combined streams may have flowed down the Tanana to the Yukon, or followed the valley of the White as far as the mouth of the Donjek. In any case the valley of the White from the mouth of the Donjek to the Yukon is a distinctly new cutting. Cairnes points out that these changes probably took place owing to the blocking of the valley of the White by glacial, and glaciofluvial accumulations.

These changes support a theory of drainage diversion to account for the rock-cut benches that exist on some of the present streams. A large stream diverted to a lower outlet, or given a greater grade, will cut rapidly to establish an equilibrium of conditions, and when so cutting, benches, representing portions of the former valley bottom, will appear. These changes also affect the tributaries, which have to adjust themselves to the new conditions. Owing to the recency of these changes, many of the smaller and more sluggish streams have not yet cut to the head of their valleys.

¹ McConnell, R. G., "Report on the Klondike gold fields," *Geol. Surv., Can.*, vol. XIV, 1901, p. 8B.

² Eakin, H. M., "The Yukon-Koyukuk region," *U.S. Geol. Surv., Bull.* 631, 1916, pp. 70-74.

³ Brooks, A. H., "A reconnaissance from Pyramid Harbor to Eagle City, Alaska," *U.S. Geol. Surv., 21st Ann. Rept.*, 1899-1900, pt. II, pp. 354-55.

⁴ Cairnes, D. D., "Upper White River district," *Geol. Surv., Can., Mem.* 50, pp. 61-62.

These widespread changes of drainage are due to the extension of the Pleistocene glaciers. All the older valleys mentioned in this connexion have suffered glaciation alone sufficient to effect the changes; and it is significant that the Yukon today occupies a valley which was not glaciated. With the retreat of the glaciers, many minor changes linked the drainage system into a unit, but the rivers were too firmly established in their new courses, and the older channels too much obstructed by glacial accumulations, to permit of the streams resuming their former courses.

Either the theory of an uplift or the theory of diverted drainage will account for the benches. The uplift theory has little evidence to support it other than the benches themselves. That those portions of the continent subjected to the action of continental ice-sheets were uplifted subsequent to the retreat of the ice is common knowledge, but of the behaviour of those portions lying towards the margins of the ice-sheets very little is known.

It remains to be established whether the diverted drainage was due to glaciation or to uplift.

METHODS OF MINING.

Mining methods in Sixtymile district are almost identical with those employed in the Klondike¹ and other mining districts in the Yukon.

In only one case is an hydraulic monitor used on the creek gravels in Sixtymile district. This is done on J. P. Miller's group on Sixtymile river near the mouth of Miller creek. Here the gravels are dislodged by means of water thrown from the nozzle and washed towards the sluice boxes, where they are elevated by means of an hydraulic elevator and passed through the boxes. This arrangement is necessary in order to get sufficient grade to dispose of the tailings (Plate V A).

The tailings on some of the creek claims are got rid of by self-dumping scrapers or other conveyors operated by steam. The gravels and boulders are carried to the top of the waste pile and dumped automatically. Such an arrangement has been installed on Claim No. 1 below Discovery on Glacier creek.

DESCRIPTION OF CREEKS.

MILLER CREEK.

Miller creek, rising in a steep-walled gulch near the Boundary, flows into Sixtymile river. Its length is $6\frac{1}{2}$ miles, and its width, in the lower reaches, where its grade is about 100 feet per mile, is about 200 yards. The depression has been cut in the floor of an older valley, but the cutting has not been symmetrical, having taken place along the western wall. One slope is, therefore, broken by a plain of irregular outline, the other is continuously steep.

The larger portion of the valley is underlain by rocks of the Nasina series (See page 14), which in the lower portion of the valley have been invaded and covered by andesites of the Newer Volcanics.

¹ Geol. Surv., Can., Ann. Rept., vol. XIV, pt. B, pp. 66-61.
Geol. Surv., Can., Mem. 97, pp. 16-19.

The gravels contain pebbles and boulders of all these rocks, but are composed chiefly of flat pebbles of quartzite and schist.

Mining has been carried on since 1892 and nearly all the paying portions have been worked over once, and sometimes twice. The lower 3 miles, from Discovery to the mouth, form the Healy Hydraulic Concession, leased by the North American Trading and Transportation Company. The creek gravels on this stretch have been dredged, and no further payable production can be expected. Above the concession claims yield wages or sometimes better, but future production from this source must be small.

On the eastern side of the creek, a short distance above Discovery, an old channel has yielded important amounts of gold, and, as large portions remain untouched, should continue to do so for a number of years.

Discovery claim is situated on a small gulch known as Discovery pup, on the western side of the creek. On claim No. 1 above, the bench gravels have a thickness of 4 feet, but this thickness increases greatly as the hillside is approached. A shaft sunk on the adjoining claim 64 feet back from the rim shows that the deposit at this point is 64 feet thick, but the greater part of this section is made up of detrital material from the hillside. The gold is distributed through 4 feet of gravel overlying bedrock, and extends as much as 2 feet into the bedrock. The paystreak¹ has thus a maximum thickness of 6 feet, and its width is not definitely known. The distribution of the gold is fairly uniform. Rich spots, of course, occur, but a general average of \$100 to the box length² is claimed. The gold is coarse and shotty. Panning showed little or no fine flaky gold.

Claim No. 2 above, was staked in 1898 and has been largely worked over. There are portions of virgin ground where the depth to bedrock is 10 feet. The section consists of 2 or 3 feet of muck and 6 to 7 feet of gravel. Pay is found through a vertical range of 6 feet, including 2 feet of bedrock. Galena is common amongst the concentrates. Insufficient work has as yet been done on the bench deposits to prove their value, but results already obtained are satisfactory.

On claim No. 5 the chief work is where a shaft, 55 feet deep, has been sunk to bedrock. The section in this shaft may be taken as follows: slide rock, 19 feet; gravel, 30 feet; slide rock, 9 feet; gravel, 7 feet. The paystreak had an average width of 25 feet, and a thickness of 5 feet, including 2 feet of bedrock. The average value of the gravels was \$125 per box length, but in some spots a very much higher content was found.

On claim No. 7 above, the paystreak is about 40 feet wide and most of the values lie in bedrock, penetrating to a depth of from 12 to 18 inches. The gold is coarse, and reckoning as nuggets all pieces over 25 cents in value, the percentage of nuggets would be about 50. Nuggets as high as \$8 in value have been found.

On claim No. 11 coarse gold was obtained at the lower end and the average value was \$20 per box length, but towards the upper end the values decrease 50 per cent and the gold is fine and pockety. Mining above this claim would prove costly, owing to the small supply of water.

¹ Although the term "paystreak" is used when describing these properties, the term is only relative. Frequently so irregular is the distribution of the gold, that there can hardly be said to be a paystreak at all.

² It is the custom of miners in Yukon to estimate values per square foot of bedrock or per box length, 12 feet square, rather than in terms of cubic yards.

GLACIER, DAKOTA.

Gold was discovered on Glacier creek a short time after the discovery of Miller creek, and the stream has been producing steadily ever since. Though the creek was washed over in the early days, many of the claims are still yielding wages or better. The benches on the left limit have been shown to contain important amounts of gold. The existence of an older channel has been demonstrated at a number of points. Benches also exist on the right limit of the creek some distance below Discovery, but these are not being worked. Large volumes of these untouched deposits should contribute to the production of the creek.

Discovery claim is situated about 3 miles from the mouth of the creek, at the end of the wagon road from West Dawson.

Claims Nos. 17, 18, 19, and 20 below are fairly close to the mouth of the creek. The depth to bedrock varies greatly from the rim of the bench back towards the hillside, but the bed of gravel overlying bedrock, where exposed by mining, is about 6 feet thick. The gravels are composed mainly of schist pebbles, and bedrock is an andesite, in many places deeply weathered, and in others quite fresh. The width of the paystreak had not been ascertained, and the content was stated to be from 60 cents to \$1 per square foot.

No mining is in progress from claim No. 17 to claim No. 1 below. On the latter the depth to bedrock is 20 feet, and the section exposed consists of from 3 to 12 feet of muck, and about the same thickness of gravel. The paystreak is about 200 feet wide and the values are fairly uniform across it, an average of about \$100 per box length being claimed.

On Discovery and Nos. 1 and 2 above, the depth to bedrock is 10 feet and the section consists entirely of gravel. The values lie right through the gravel and extend 6 to 8 inches into the bedrock. The paystreak is 100 to 125 feet wide and the average content from \$50 to \$75 per box length.

On claims Nos. 6 and 7 above (Plate IV B), the depth to bedrock varies from 8 to 12 feet, with a section composed of from 4 to 6 feet of gravel, overlain by various thicknesses of muck. The pebbles of the gravel are small and possess a shingle-like overlap, due to current action. They are embedded in a loose micaceous sand. The paystreak averages 25 feet wide and the distribution of the gold is patchy. In some places it lies almost entirely on the surface, in others it is found practically throughout the gravel.

On claims Nos. 8, 10A, 13, and 15 rich deposits were found on the benches lying on the left limit of the creek. The depth to bedrock varies greatly. On claim 10A it is 20 feet; on claim 13, 30 feet; and on claim 15, 7 feet. On claim 10A the section consisted of 10 feet of gravel and 20 feet of gravel. The old channel here had an elevation of 75 feet above the creek level, and was separated from the creek by a rock ridge 27 feet high and 200 feet wide. The paystreak averaged 50 feet in width and about 5 feet in thickness, including 1 foot to 1 1/2 inches of bedrock. The gold averaged from \$125 to \$150 per box length, and was coarse, about 15 per cent of it being nuggets. The bench deposits are by no means exhausted.

On claims Nos. 14, 16, and 18 above, the depth to bedrock averages 12, 14, and 18 feet respectively. On No. 14 the section is composed entirely of gravel, but on the other two claims a layer of 1 to 6 feet of muck overlies the gravel.

The average width of the paystreak is 70 feet and its average thickness 3 feet, including 1 foot of bedrock. Within the 70 feet of the paystreak an average of \$100 to the box length is claimed.

From claims Nos. 17, 18, 19, 20, 23, 24, 25, and 26 above, the results so far obtained are very encouraging. All the work has been done on the bench lying on the left limit of claim No. 18. On the rim, the depth to bedrock was 3 to 4 feet, and 50 feet back from the rim the depth was 7 feet, with about 5 feet of gravel and 2 feet of muck exposed in the cut. The paystreak is known to be 150 feet wide, but the work done is not sufficient to justify an estimate of its value.

On claims Nos. 21 and 22 above, the depth to bedrock is from 8 to 12 feet in the creek bottom and 21 feet on the bench. The pay is concentrated in a narrow streak less than 80 feet wide, and from 4 to 6 feet thick. The gold is coarse, round, and solid.

BIG GOLD CREEK.

The only part of Big Gold creek now worked lies in a broad, flat-bottomed valley from the mouth of Glacier creek to Sixtymile river. Rocks along this stretch are mainly andesites belonging to the Newer Volcanics. Remnants of the older channels in the form of benches are found along this part, occurring chiefly on the right side (looking downstream). Some portions of the former valley bottom still exist on the left limit, but are not so marked in their development.

The gold has a much more spotty distribution than is usual in this district.

Discovery claim is situated at the mouth of Glacier creek, and its width of 2,000 feet embraces not only the valley of Big Gold creek, but parts of the valley of Glacier creek. Mining is being carried on in the angle formed by the junction of the two creeks, a bench at this point being worked. The workings include an open-cut and drift into the gravels from the hillside facing Big Gold creek, and a shaft and ventilation drift near the extreme southern portion of the bench. The depth to bedrock in the shaft is 30 feet showing the following section: muck 7 feet, gravel 10 feet, muck 6 feet, gravel 7 feet. The pay is irregular and scattered. It is distributed through 6 feet of gravel, and in places extends as much as 2 feet into the bedrock, a weathered andesite. No accurate estimate of the average value can be given, but very rich spots have been struck.

On claim No. 6 below Discovery, two shafts near the right bank of the creek have been sunk to bedrock. The depth to bedrock was 24 and 25 feet; in the first the section showed 21 feet of muck and 3 feet of gravel; in the second, no gravel was found, the muck extending to bedrock, a deeply weathered andesite pitching towards the eastern side of the valley. The distribution of the gold is erratic and values range from 30 to 75 cents per square foot.

On claim No. 7 below, the depth to bedrock varies from 18 to 30 feet at this point. On the left limit of the creek the section consisted of from 6 to 8 feet of muck and 18 feet or more of gravel, and on the right limit of 20 feet of muck and 8 feet of gravel. No decided paystreak has as yet been found, the value being somewhat irregularly distributed. Insufficient work has been done to prove the value of this property.

On claims Nos. 8, 83, 9, 10, 11, and 12 below, the most recent work has been done on the bench gravels lying on the right limit of Big Gold creek on

claim 8. The depth to bedrock on this claim is 16 feet, the upper 2 feet being muck and the remainder gravel. The paystreak, which has not been crosscut at this point, is claimed to average \$100 per box length. On the creek gravels a drift 60 feet long showed values of from 30 cents to \$100 per square foot.

LITTLE GOLD CREEK.

Little Gold creek rises about 2 miles east of the Boundary and about the same distance north of Glacier creek. Its length is about 6 miles, but it is of slightly larger volume than Glacier creek. It rises in a number of steep-walled, narrow gulches, and near its head the grade is steep, but in the lower reaches approximates 75 feet per mile.

The rocks exposed belong chiefly to the Yukon group of metamorphic rocks. Gneissoid quartzites, quartz-mica schists, sericitic schists, and granite gneisses are most abundant. Near its junction with Big Gold creek, these rocks are invaded by an extensive area of andesitic rocks, and some Tertiary sediments (Kenai series) containing lignite occur.

Little Gold creek was very extensively prospected in the early days, but was generally considered too poor to work. The gold is distributed uniformly in a narrow and continuous streak, which is nowhere very rich. Heavy boulders make successful mining here difficult.

On Discovery claim an open-cut has a width of 75 to 100 feet and a length of 800 feet. The width of the paystreak is the same as that given for the cut, and the depth to bedrock is about 8 feet, the ground on the left side being slightly deeper than that on the right. The gold occurs in the gravel, or, much less frequently, in bedrock. The values are very uniform and average from 8 to 9 cents per square foot, the higher values being obtained in the gravels on the left limit.

On claim No. 2 below, the depth to bedrock is from 4 to 6 feet. Bedrock consists of the gneissoid quartzites and quartz-mica schists of the Nasina series. The paystreak has a width of 100 feet and the gold is usually found in the gravel lying immediately above bedrock, rarely extending upwards more than 7 inches, and the greater part of the values lie within 1 inch of bedrock. The average value is about 5 cents per square foot.

BEDROCK CREEK.

Bedrock creek rises in Alaska and flows east and southeast to Sixtymile river. Its length is less than 7 miles and the volume of water is very small. It rises in a series of narrow gulches, but opens out slightly, though it is narrow throughout its entire length.

Bedrock creek forms for a part of its length the contact between the quartzites, quartz-mica schists of the Nasina series, and the sericitic schists which are tentatively correlated with the Klondike series. Near the mouth a small area of andesites and similar rocks, and, towards the head, numerous bodies of rhyolite and rhyolitic tuffs, occur.

Some prospecting, but very little mining, has been done. There is no geological reason why gold should not be found along certain parts of this creek.

The depth to bedrock is very variable; reefs of rock are exposed in the creek bottom, and at other points the rock is covered by superficial deposits of varying thickness.

On claims Nos. 25 and 26 above, the depth to bedrock is 5 feet on the rim of the bench, and bedrock consists of broken and decomposed sericitic schists of the Klondike series, striking across the direction of flow of the former channel, and offering excellent riffles to catch and retain the gold. The bedrock on the bench is 50 feet above the creek. The gravels are coarse and boulders 12 inches or more in diameter are the rule. Pay has been found on the bench extending back 200 feet from the creek, and also extending along the right side of the creek. The values obtained during prospecting work were encouraging, and there is little doubt these claims will be producing in the near future.

On claim No. 2 below, the depth to bedrock is 20 feet, and there are two paystreaks, one 30 feet wide and the other of unknown width. The thickness of the paystreak is about 4 feet, including 2 feet of bedrock. The values across the paystreak so far prospected run about 20 cents per square foot of bedrock.

SIXTYMILE RIVER.

In the upper portion of its course the Sixtymile (See page 10) is a small, rapid stream, with numerous shallow riffles or bars. It receives many large tributaries and below the mouth of California creek is quite practicable for poling boats.

The gravels, both of the river itself and of its benches, have yielded important amounts of gold, but only the short stretch from the mouth of Miller creek to near the mouth of Big Gold creek has been prospected thoroughly. It seems probable, however, that some parts as yet almost untouched may prove productive.

The rocks occurring along Sixtymile river, where mining operations are in progress, belong to both the Yukon group and to the Newer Volcanics (See pages 12 and 31).

The first gravels to be worked at all thoroughly on the Sixtymile were the bench gravels lying between the mouth of Miller creek and the mouth of Big Gold creek, but more recently the creek gravels have received some attention. Discovery claim may be taken as lying near the mouth of Big Gold creek, as the claims are numbered up and down stream from this point.

On claims Nos. 1a and 2a below, a considerable amount of prospecting has been done. Seven drill holes and fifteen shafts have been sunk to bedrock, but as yet no drifting has been undertaken. The depth to bedrock varies from 5 to 14 feet, the average being about 12 feet. The section consists almost entirely of gravel, and the bedrock is an andesite, having a fairly flat surface, with no decided pitch towards either side of the valley. A paystreak 300 feet wide is claimed with values ranging from 60 to 80 cents a cubic yard. The thickness of the paystreak is 5 feet, the gold lying entirely in the gravel. Coarse gold in addition to fine gold is present; nuggets ranging as high as \$8 in value have been found.

On claim No. 1 below, a little prospecting work has been done, both on the bench on the left limit, and on the creek gravels. On the bench, the depth to bedrock was 30 feet, of which 5 feet was muck and the remainder gravel. The

results obtained in the shaft on the bench indicate a value of from 20 to 60 cents per square foot of bedrock. On the creek, the depth of bedrock is 17 feet, 4 feet of gravel overlying the bedrock, the remainder being muck. The values ran from 12 cents to \$1 per square foot of bedrock.

Claims Nos. 3 to 10 above are owned by the North American Trading and Transportation Company who leased them for dredging. Preliminary prospecting, however, failed to show satisfactory results, and in consequence dredging was abandoned.

The gold is almost invariably fine. Portions of the benches on this group of claims have been worked, and considerable amounts of gold have been recovered from them, but large volumes of these gravels still remain, and should prove a source of future production.

On claim No. 10a above, the depth to bedrock was 16 feet, and the section was composed of 3 feet of muck and 13 feet of gravel. The paystreak was found to be 150 to 200 feet wide and most of the gold lay within 2 feet of bedrock. The average value claimed was 50 cents per square foot of bedrock, and the gold recovered was nearly all fine. A second paystreak is presumed to enter this property from the claim above, but thawed ground prevented work.

The bench gravels of claims Nos. 11 to 19 above have been worked extensively. From the bench gravels much gold was recovered. The bench is situated on the left side of the stream 50 feet above river bed. The gravels range from 20 to 50 feet in thickness, the deposit getting rapidly thicker towards the hillside. These gravels are similar in many respects to the creek gravels, and show little or no sorting or stratification, coarse and fine being found together, mingled with sand. The finer gravels possess a shingle-like overlap, indicative of stream action. Stumps and trunks of trees, and the bones of various extinct animals were found in the top of the gravels, and in the muck overlying them. L. M. Lambe determined these to be: the posterior part of cranium of a bison; a large splinter of the shaft of limb bone of mammoth; a fragment of mammoth tusk and bones of horse as follows, left femur, left tibia, right radius with part of shaft of ulna. The horse represented stands somewhat lower than *Equus Scotti* Sidley of the Pleistocene of Texas and is of much lighter build. The gravels on the rim of the bench are 20 feet in thickness and, several hundred feet back towards the hillside, a shaft 90 feet deep failed to reach bedrock. The section in this shaft is as follows: muck 65 feet, gravel 15 feet, muck, moss, tree remains, and volcanic ash 5 feet, ground-ice 5 feet. The width and value of the paystreak are not known, but those portions worked were profitable.

The creek claims have been prospected by borings, which show that there are two paystreaks, 200 and 400 feet wide. The depth to bedrock is 16 feet and most of the pay lies within 2 feet of the rock. The average content would be slightly over 50 cents per square foot. The gold is prevalingly coarse. The workings at present lie on claims 15 and 16. Amongst the concentrates galena and cinnabar are common.

MATSON CREEK.

Matson creek, sometimes known as the South Fork of Sixtymile river, is a large stream, draining the country lying in the southern portion of the region. It rises within 10 miles of the Boundary and flows southeast for a distance of 8

miles where it is joined by Marion creek, the combined streams flowing in a northeasterly direction to Sixtymile river. The volume of water in Matson creek is greater than in any of the other tributaries to the Sixtymile and it approaches the parent stream itself in size.

Matson creek¹ and all its tributaries were staked from end to end in 1911. Notwithstanding this, very little prospecting work has been done, and most of the claims have been abandoned. Above the mouth of Marion creek, the valley of Matson creek is floored largely by the metamorphic rocks of the Yukon group. Granite gneiss predominates, but smaller areas of both igneous and sedimentary schists and gneisses are to be found. Below the forks the valley is underlain largely by Tertiary volcanics and sediments. Andesites, diabases, rhyolites, and quartz porphyries are all to be found.

On Discovery claim situated near the mouth of Weide gulch, about 5 miles above the forks of the creek, the depth to bedrock varies from the rim back towards the hillside. The maximum thickness exposed is 7 feet, the section being as follows: muck, 14 inches; gravel, 2 inches; sand, 9 inches; gravel, 5 feet. The bedrock consists of the broken and decomposed schists of the Yukon group (Plate VI). A cut has been made across the bench 115 feet in length, and the paystreak has been found to extend for the whole of this distance. The total width of the paystreak is, therefore, unknown, but it probably does not extend much farther as the bedrock rises sharply towards the end of the cut, and this rise, if continued, would entirely pinch out the bed of gravel underlying the muck. Values range from 18 cents to \$1.00 per square foot. The values lie entirely in the rock, and extend into it to a depth of 4 feet. The production for 1917 averaged about \$400 per month. Both coarse and fine gold are found, and the former shows scarcely any signs of wear, but is rough and flat. Pay has also been found in the creek gravels at this point. The depth to bedrock here is 20 feet, and the gold appears to be even more irregularly distributed than on the bench.

OTHER CREEKS.

Parts of some of the creeks tributary to Fortymile river lie within the area mapped, but the stretches at present worked are all in United States territory.

Some prospecting has been done on Boucher and California creeks and good values are claimed at certain points, but no mining has, so far, been done. On Rice creek, Deep creek, Otter creek, and at other points within Ladue valley desultory prospecting has been carried on, but though a little gold has been found at several points, no important deposits have been discovered. Gold may yet be found in paying quantities on some of these creeks.

SOURCE AND ORIGIN OF THE PLACER GOLD.

It is now almost universally accepted that placer gold is detrital in origin. The nuggets of the Sixtymile field frequently contain particles of vein quartz, or are contained in quartz derived from veins. Some evidence as to solution and redeposition of the gold in the Klondike and Sixtymile regions has been

¹ In Yukon, when gold is found on a creek and claims are located on it, the creek is said to be discovered.

offered. McConnell¹ described a boulder found in the workings on Miller creek "the upper surface of which was partially covered with specks and scales of crystalline gold. The crystals were arranged in dendritic forms, and while some of them were firmly attached to the rock, others separated quite easily from it. The angles of the crystals were sharp and showed no wear of any kind, while the boulder itself, an autoclastic quartz-mica schist, was well rounded. The gold evidently did not belong to the rock originally, and the only explanation of its occurrence under the conditions stated, seems to be that it was taken up by some solvent, and redeposited on the surface of the boulder in the position in which it was found." McConnell mentions similar occurrences on other Klondike creeks. This process is, however, to be assigned only a very subsidiary place in the formation of the placers.

Quartz veins are abundant in the metamorphic rocks of the Yukon group. These veins are nearly always small, and non-persistent, and in the majority of cases of lenticular form. They follow very closely the planes of foliation of the schists, and in the majority of cases are apparently barren of mineral, but in some cases, iron minerals, galena, and zinc blende are found. Gold is sometimes visible to the naked eye but more frequently is not. McConnell² shows that the bulk of the Klondike gold is derived from rocks of the Klondike series, but this does not hold outside that district, for in Sixtymile region the producing creeks are floored by the older sedimentary gneisses of the Nasina, and in Stewart River district the same is true to some extent.³ Consequently, any of the members of the Yukon group may contribute to the formation of the placers.

It seems likely that veins of more than one age are present. The creeks producing in Sixtymile region are near points where the metamorphic rocks are invaded by Tertiary greenstones, but this may be accidental. Many of the veins, probably, owe their origin to the injection of the Pelly gneisses, which were later metamorphosed along with the containing rocks; but veins, though repeatedly faulted, are decidedly later than the foliation of the enclosing rocks. The part played by the Mesozoic granites is not clear, but in any case they are too small to have affected the formation of these veins, unless it be conceded that they are the peaks of a huge batholith underlying the whole region.

The fact that no payable veins have been found does not disprove these statements. To show the great concentration which has taken place, and the amount of material removed to form the placer deposits, McConnell⁴ has made some interesting calculations, and he concludes that to form the abnormally rich Klondike placers, the original quartz veins need have carried values of only a few cents per ton. That this view is correct is shown by the sampling carried out by McLean.⁵

The absence of glaciation is also of great importance, since it means that wherever gold has been concentrated in the steam gravels, it remains

¹ McConnell, R. G., Geol. Surv., Can., Ann. Rept., vol. XIV, 1901, p. 85A.

² McConnell, R. G., "Report on the Klondike gold fields," Geol. Surv., Can., Ann. Rept., vol. XIV, 1901, pt. B.

³ Cairnes, D. D., Geol. Surv., Can., Sum. Rept., 1915, p. 13.

⁴ McConnell, R. G., "Report on the Klondike gold fields," Geol. Surv., Can., Ann. Rept., vol. XIV, 1901, p. 61B.

⁵ McLean, T. A., "Lode mining in Yukon," Dept. of Mines, Mines Branch, 1914, pp. 17-61.