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GOLD PLACERS OF THE FORTYMILE, EAGLE, AND CIRCLE DISTRICTS ALASKA

BY

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GOLD PLACERS OF THE FORTYMILE, EAGLE, AND CIRCLE DISTRICTS

By J. B. MERTIE, Jr.

ABSTRACT

The Fortymile, Eagle, and Circle districts lie in east-central Alaska, mainly between the Yukon and Tanana Rivers, but closer to the Yukon. Placer gold was discovered in these districts in the last two decades of the nineteenth century, and since that time they have been the sites of continuous gold placer mining. The annual production of gold from these older camps had until recently been slowly decreasing, but the increased price for newly mined gold that became effective in 1933 gave a renewed stimulus to mining, so that the production is now increasing. At the present time the Circle district is the largest producer of placer gold among these three districts, and the Eagle district is the smallest producer.

The geographic and geologic features of the Fortymile, Eagle, and Circle districts have been described in earlier reports, and in the present report only those salient features that have a bearing upon the mining activities are presented. Special emphasis is laid upon the granitic rocks, because they are considered to be the primary source of the gold in this region, and upon the bedded rocks of Tertiary age, which are believed to be a secondary and proximate source of much of the gold found in certain of the placers. The conglomerates of these Tertiary deposits, in fact, are considered to be genetically analogous with those of the Witwatersrand district, of South Africa.

The following report is mainly a description of the mining activities in these three districts in 1936, together with any information and deductions of a general character that such mining operations have revealed. Where the information could be obtained, however, a historical background of the older mining activities has also been presented; and in this connection special attention has been given to the history of older dredging operations. All the larger and most of the smaller mining plants were visited by the writer in 1936, and in the following pages the geologic features of each of these deposits are given, together with brief notes regarding the mining methods that are employed.

INTRODUCTION

LOCATION AND EXTENT

The Fortymile, Eagle, and Circle mining districts are in the northern and eastern parts of the Yukon-Tanana region, of interior Alaska. (See fig. 9.) They have no definite boundaries, but certain geographic limits have been taken to include those areas where min-

ing and active prospecting are now in progress. Thus, the Fortymile district (pl. 2) is considered to lie approximately between latitude 64° and 64°30′ N. and longitude 141° and 142°20′ W. The geographic limits of the Eagle district (pl. 3) are taken between latitude 64°36′ and 65°15′ N. and longitude 141° and 142°40′ W., though this includes a considerable area north of the Yukon where no mining and little prospecting have ever been done. The map has been extended to the west to include Fourth of July Creek, on the south, and the upper valley of Seventymile River, on the north.

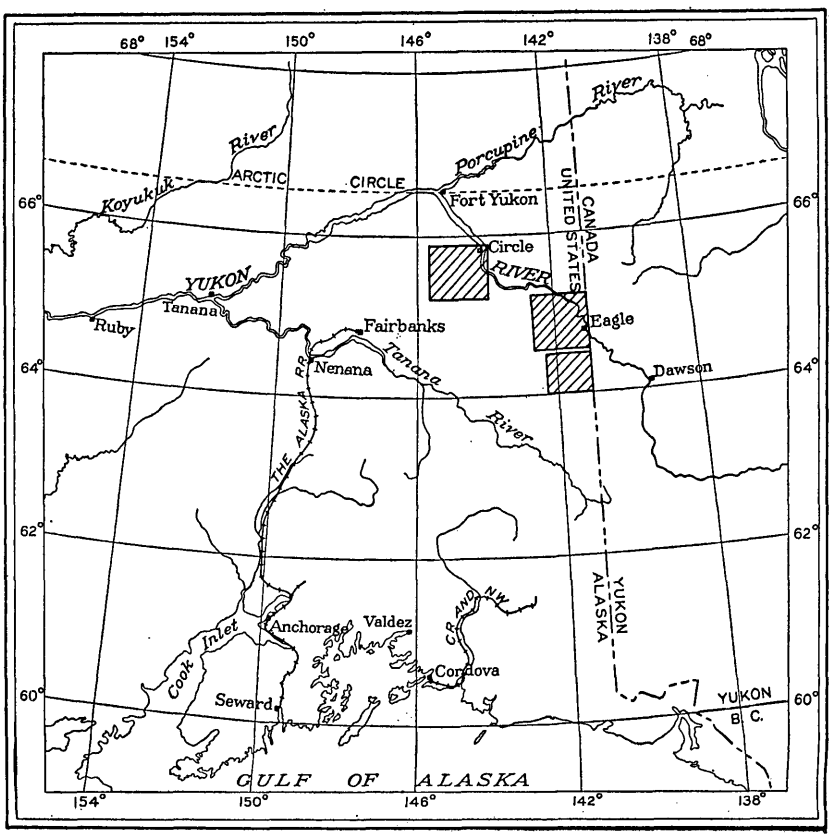

FIGURE 9.—Index map showing location of the Fortymile, Eagle, and Circle districts.

The Circle district (pl. 4) has been taken as an area lying between latitude 65°15′ and 65°51′ N. and longitude 143°53′ and 145°47′ W. This is a larger area than is required to show the site of present mining operations, but the map has been extended to the north and east to include the town of Circle, on the Yukon River. Another area that is considered a part of the Circle mining district lies to the southeast and includes Woodchopper and Coal Creeks, where dredges are now in operation. Only the headwaters of these creeks

have been mapped, and therefore no complete map of their drainage basins can be presented.

Sketch maps of the Fortymile, Eagle, and Circle districts accompany the present report. (See pls. 2–4.) These are drainage maps which have been compiled from two earlier topographic maps, by Prindle,[1] and from a drainage map, by the writer.[2] New roads and other cultural features, however, have been added.

EARLIER WORK

A short sketch of the discovery and early exploration of the Yukon Valley in Alaska has been given in a recent publication,[3] and need not be repeated. It is sufficient to state that the Fortymile and Circle districts are the sites of the oldest mining camps in interior Alaska, the former dating from 1886 and the latter from 1893.

Numerous geologic and mining reports that relate in whole or in part to the three districts under consideration have been published by the Geological Survey, United States Department of the Interior. The more important of these publications are listed below.

Spurr, J. E., Geology of the Yukon gold district, Alaska: Geol. Survey 18th Ann. Rept., pt. 3, pp. 87–392, 1898.

Brooks, A. H., A reconnaissance from Pyramid Harbor to Eagle City, Alaska, including a description of the copper deposits of the upper White and Tanana Rivers: Geol. Survey 21st Ann. Rept., pt. 2, pp. 331–391, 1901.

Collier, A. J., The coal resources of the Yukon, Alaska: Geol. Survey Bull. 218, 1903.

Prindle, L. M., The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska: Geol. Survey Bull. 251, 1905.

Stone, R. W., Reconnaissance from Circle to Fort Hamlin, Alaska: Geol. Survey Bull. 284, pp. 128–131, 1906.

Prindle, L. M., The Yukon-Tanana region, Alaska: Geol. Survey Bull. 295, 1906.

Brooks, A. H., Report on progress of investigations of mineral resources of Alaska: Geol. Survey Bull. 314, pp. 187–204, 1907.

Brooks, A. H., and Kindle, E. M., Paleozoic and associated rocks of the upper Yukon, Alaska: Geol. Soc. America Bull., vol. 19, pp. 255–314, 1908.

Prindle, L. M., Occurrence of gold in the Yukon-Tanana region, Alaska: Geol. Survey Bull. 345, pp. 179–186, 1908.

Prindle, L. M., The Fortymile gold placer district, Alaska: Geol. Survey Bull. 345, pp. 187–197, 1908.

Prindle, L. M., The Fortymile quadrangle, Yukon-Tanana region, Alaska: Geol. Survey Bull. 375, 1909.

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[1] Prindle, L. M., The Fortymile quadrangle, Alaska: Geol. Survey Bull. 375, pl. 4, 1909; A geologic reconnaissance of the Circle quadrangle, Alaska: Geol. Survey Bull. 538, pl. 1, 1913.

[2] Mertie, J. B., Jr., The Tatonduk-Nation district, Alaska: Geol. Survey Bull. 836, pl. 7, 1933.

[3] Mertie, J. B., Jr., The Yukon-Tanana region, Alaska: Geol. Survey Bull. 872, pp. 3–5, 1937.

Ellsworth, C. E., Placer mining in the Yukon-Tanana region, Alaska: Geol. Survey Bull. 442, pp. 230–245, 1910.

Johnson, B. L., Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district, Alaska: Geol. Survey Bull. 442, pp. 246–250, 1910.

Ellsworth, C. E., and Parker, G. L., Placer mining in the Yukon-Tanana region, Alaska: Geol. Survey Bull. 480, pp. 153–172, 1911.

Prindle, L. M., and Mertie, J. B., Jr., Gold placers between Woodchopper and Fourth of July Creeks, upper Yukon River, Alaska: Geol. Survey Bull. 520, pp. 201–210, 1912.

Porter, E. A., Placer mining in the Fortymile, Eagle, and Seventymile River districts, Alaska: Geol. Survey Bull. 520, pp. 211–218, 1912.

Prindle, L. M., A geologic reconnaissance of the Circle quadrangle, Alaska: Geol. Survey Bull. 538, 1913.

Ellsworth, C. E., and Davenport, R. W., Placer mining in the Yukon-Tanana region, Alaska: Geol. Survey Bull. 542, pp. 203–222, 1912.

Chapin, Theodore, Placer mining in the Yukon-Tanana region, Alaska: Geol. Survey Bull. 592, pp. 357–362, 1914.

Ellsworth, C. E., and Davenport, R. W., Surface supply water of the Yukon-Tanana region, Alaska: Geol. Survey Water-Supply Paper 342, 1915.

Waring, G. A., Mineral springs of Alaska: Geol. Survey Water-Supply Paper 418, 1917.

Mertie, J. B., Jr., Geology of the Eagle-Circle district, Alaska: Geol. Survey Bull. 816, 1930.

Mertie, J. B., Jr., Mining in the Fortymile district, Alaska: Geol. Survey Bull. 813, pp. 125–142, 1930.

Mertie, J. B., Jr., A geologic reconnaissance of the Dennison Fork district, Alaska: Geol. Survey Bull. 827, 1931.

Mertie, J. B., Jr., Mining in the Circle district, Alaska: Geol. Survey Bull. 824, pp. 155–172, 1932.

Mertie, J. B., Jr., The Tatonduk-Nation district, Alaska: Geol. Survey Bull. 836, pp. 347–443, 1932.

Mertie, J. B., Jr., The Yukon-Tanana region, Alaska: Geol. Survey Bull. 872, 1937.

PRESENT REPORT

The writer started for Alaska in May 1936, with the intention of preparing a geologic map of the valley of the Porcupine River, in interior Alaska. On the way from Whitehorse, Yukon Territory, to Fort Yukon, Alaska, the steamboat on which he was traveling was wrecked and sunk in the upper Yukon River, and all the instruments and field equipment of the party were lost. The field party was disbanded at Dawson, Yukon Territory, and the writer proceeded thence to Fairbanks, Alaska, where he purchased new clothes and borrowed some instruments from Dr. James H. Hance, of the University of Alaska.

As neither time nor funds were available for replacing the outfit that had been lost, the writer was authorized by the Geological Survey to spend the field season in examining the mining operations in the Fortymile, Eagle, and Circle districts. Returning from Fair-

banks to Eagle, he began field work on July 1 and spent the following 8 weeks on this project. All the important mining plants in these three districts were visited, and as the writer had not visited the Fortymile and Circle districts for 8 and 7 years, respectively, the field season was profitably spent.

In the time available, and with no camp equipment or local transportation other than back packing, no areal geologic mapping was attempted. Therefore, the present report does not supplant the more general reports on this part of the Yukon-Tanana region, in which topographic and geologic maps are published and the areal geology is described. It is mainly a statement of the present status of mining in these three districts though, where available, some of the older records of mining are also given, not only as a historical background but because the increased price for gold is reviving interest in some of the older sites of mining.

ACKNOWLEDGMENTS

The hospitality of the miners and prospectors in Alaska is too well known to require comment. Most of the people whom the writer visited in 1936, however, were old friends, who gave freely of their time and knowledge, as well as in other ways, to help in this field work. Among those to whom acknowledgment is due for their helpful cooperation and hospitality are John Powers, of Eagle; Charles Martin, of Jack Wade; H. D. Cowden, of Walker Fork; Frank Purdy, of Chicken; John Olsen and A. L. Hagen, of the Seventymile River; R. A. Bauer, of Fourth of July Creek; Gen. A. D. McRae and E. N. Patty, of Coal Creek; and A. D. Bush, Frank Miller, Park A. Read, J. T. Clayworth, Alf R. Erickson, Jens Langlow, and Einer Larsen, in the Circle district. The writer also wishes particularly to thank Volney Richmond, president of the Northern Commercial Co., and C. B. Haraden, agent for the same company at Eagle, for financial assistance rendered, on account of the shipwreck in the Yukon River and delays in the receipt of Government funds for this work.

GEOGRAPHY

DRAINAGE AND RELIEF

The three districts discussed in this report are part of the rolling upland country of the Yukon-Tanana region, which has been described in adequate detail in earlier publications. For the purpose of the present report, it suffices to state that this region consists of ridges and rather broad valleys. Within any one district the ridges appear to rise to a rather uniform elevation, but for the whole country this ridge level is variable. Above these ridge levels rise

many conspicuously higher mountains or domes, and in places, particularly along the Yukon-Tanana Divide, the ridges themselves are so high and rugged as to suggest short mountain ranges. A geometric surface produced by joining the ridge tops would yield a flattened though somewhat irregular dome, highest in the east-central part and sloping gently therefrom in all directions, but sloping most westward, toward the confluence of the Yukon and Tanana Rivers. This represents a surface that existed in late Tertiary time and has since been maturely dissected.

The Fortymile district is an area of considerable relief. At the international boundary, according to the map published by the International Boundary Commission, the Fortymile River flows at about 1,100 feet above sea level. The highest mountain in the Fortymile district, referred to the same datum, has an elevation of about 5,700 feet, thus indicating a maximum relief for the district of about 4,600 feet. The average level of the ridge tops, however, is between 3,000 and 4,000 feet, so that the average relief is considerably in excess of 2,000 feet.

The Fortymile River and its tributaries drain practically all of the Fortymile district. The main river is formed by the confluence of the North and South Forks, which join in the central part of the district about 23 miles in an air line west of the international boundary. The North Fork has a general southeasterly course, and about 21 miles northwest of its confluence with the South Fork it receives a large tributary from the west, known as the Middle Fork. The South Fork, on the other hand, is formed by the junction of the Dennison and Mosquito Forks and has an air-line length of only about 13 miles, flowing generally N. 20° E. within the area shown on plate 2. Mosquito Fork drains a large area west and southwest of the Fortymile district, and in a similar way Dennison Fork drains the country to the south. The two largest tributaries of the main Fortymile River, within the Fortymile district, are Canyon Creek and O'Brien Creek. Canyon Creek heads against Walker Fork and flows northward to join the Fortymile River just below Bonanza Bar; but O'Brien Creek flows southward, emptying into the Fortymile River farther upstream. Similarly the South Fork of the Fortymile River has two important tributaries, of which one, known as Walker Fork, heads in Yukon Territory and flows westward. The other large tributary of the South Fork is Buckskin Creek, which lies between the North and Mosquito Forks and flows eastward, emptying into the South Fork downstream from Walker Fork.

The Eagle district lies closer to the Yukon River than the Fortymile district, and therefore many of the ridge tops have a lower mean elevation; but the maximum relief is greater and the average

relief probably little less than in the Fortymile district. The great maximum relief is due to the presence of Glacier Mountain, which rises to an elevation of more than 6,000 feet, and the nearby Yukon River, which in this part of its valley flows at an elevation of about 800 feet. The ridge tops range in elevation from 2,000 feet close to the river to 3,000 or 4,000 feet farther southwest.

That part of the Eagle district which lies southwest of the Yukon River is the area considered in this report. A large part of this area is drained by the Seventymile River and its tributaries. The Seventymile River rises west of the Eagle district, within the Circle quadrangle, and flows in a generally easterly direction for an air-line distance of about 60 miles, joining the Yukon River a short distance downstream from Calico Bluff, a well-known landmark on the river. South of the Seventymile River is a smaller stream, known as Mission Creek, which, together with American Creek, an important tributary, heads against the Fortymile drainage system and flows northeastward toward the Yukon River. Mission Creek empties into the Yukon at Eagle. The southwestern part of the Eagle district is drained by tributaries of the North Fork of the Fortymile River, and the northwestern part by small streams that flow directly into the Yukon. Among the latter are Fourth of July and Washington Creeks, which are described in this report.

The Circle district is northwest of the Eagle district and southwest of the Yukon River. A stretch of low country trends S. 70° E. across this district and divides it into two geographic units. North of this lowland are the Crazy Mountains, which so far have not been proved to contain any commercial gold placers. South of this lowland is the area which in some earlier reports was referred to as the Birch Creek mining district but is here treated as a part of the Circle district. This part of the district is a rolling upland country, similar to the Eagle district. The Yukon River at Circle flows at an elevation of about 600 feet above sea level, and the highest mountain in the district, Porcupine Dome, has an elevation of about 5,000 feet, thus indicating a maximum relief for the district of about 4,400 feet. The mean crest line of the ridge is between 3,000 and 4,000 feet above sea level, as in the other two districts.

That part of the Circle district which lies south of the lowland above mentioned is drained mainly by Birch Creek and its tributaries, though the northwestern part is drained by Willow and Loper Creeks, tributaries of Preacher Creek. The drainage pattern of Birch Creek is rather striking. The main stream heads against one of its own tributaries and flows southwest, then east, then north, and finally, outside of the Circle district, it flows northwest for many miles parallel to the Yukon and joins that river in the Yukon Flats,

downstream from the settlement of Beaver. Crooked Creek, one of the tributaries of Birch Creek, which in its lower course occupies the central part of the lowland area above described has a fan-shaped headwater drainage area, against which the main Birch Creek heads. The headwater tributaries of Crooked Creek include most of the streams on which gold placer mining is now in progress.

CLIMATIC CONDITIONS

The Fortymile, Eagle, and Circle districts are part of the great interior province of Alaska and therefore have a typically sub-Arctic climate. The winters are long and cold, with short days in midwinter, and the summers are short but relatively warm and are characterized by nearly continuous daylight for 3 months. The Circle district is farther north than the Eagle and Fortymile districts, but all three districts lie south of the Arctic Circle, so that the sun never remains below the true horizon at noon, even in late December, though in such hilly country it may at certain localities be invisible for several weeks in midwinter. In summer, on the other hand, the sun shines all day and most of the night, thus favoring the growth of vegetation. Unlike its appearance in the Tropics, the apparent path of the sun at sunrise and sunset makes a small angle with the horizon, so that it is near the horizon long before sunrise and long after sunset. This results in long hours of twilight at all seasons of the year.

Climatic records had been kept at Eagle since 1882, but these observations were discontinued at the end of 1933. The records are not complete for this entire period, as no observations were made during some years, and only partial records in others. From 1909 to 1933, however, the climatic records are essentially complete, and the observations of these 25 years, together with the partial observations of earlier years, give an excellent insight into the mean climatic conditions. The mean temperature, precipitation, and snowfall at Eagle, up to the end of 1933, have been computed from the records of the Weather Bureau and are presented in the following table:

Mean precipitation, snowfall, and temperature at Eagle, Alaska

	Precipitation (inches)	Snowfall (inches)	Temperature (° F.)		Precipitation (inches)	Snowfall (inches)	Temperature (° F.)
January	0.45	8.4	−10.8	August	2.00	0.2	55.1
February	.35	5.4	−.1	September	1.27	1.7	43.5
March	.39	5.5	10.2	October	.79	8.0	26.4
April	.41	3.6	28.5	November	.51	9.2	3.3
May	.84	.5	47.3	December	.45	10.1	−6.2
June	1.50	0	58.5	Annual	10.74	52.6	26.3
July	1.78	0	60.3				

These records have been charted graphically and are thus shown in figure 10. From the tabular and graphic representations several interesting features become clear. First, it will be observed that the summer and early fall constitute the rainy season. The maximum precipitation occurs in August, but 60 percent of the total precipitation occurs in the four months of June, July, August, and September. The total precipitation is such as to classify the region as semiarid, and it is therefore a favorable condition for vegetation that so large a proportion of the precipitation occurs during the growing season. This fact is also a fortunate one for the mining industry, as placer

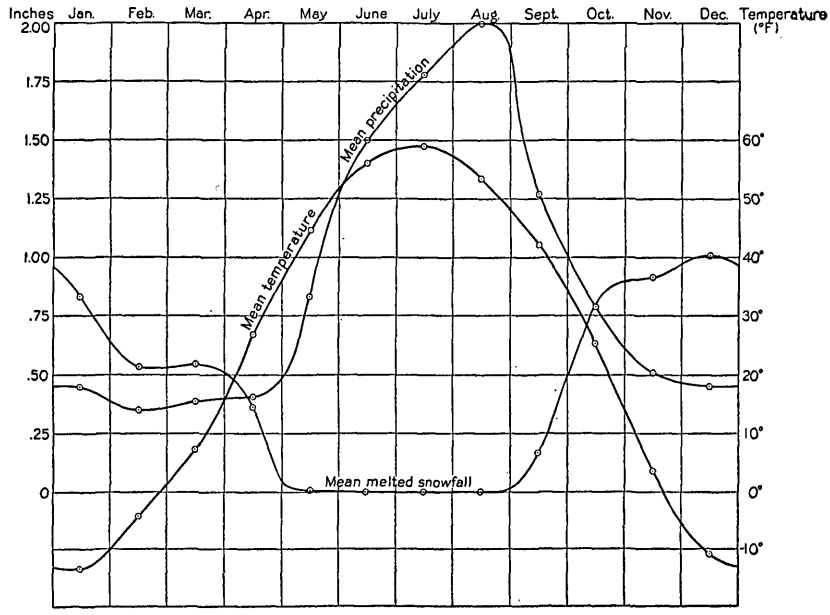


FIGURE 10.—Curves showing mean precipitation, mean snowfall, and mean temperature at Eagle.

mining requires an adequate supply of surface water. It should also be noted that the period of maximum precipitation occurs about a month later than the period of warmest weather.

In computing snowfall into precipitation, it is the conventional practice of the Weather Bureau to regard 10 inches of snow as the equivalent of 1 inch of rain. This procedure has been followed in charting the curve of melted snowfall in figure 10, but the graph shows clearly that local factors, such as temperature and humidity, affect the density of the fallen snow. Thus, in this region it may be assumed that little or no rain falls in the months of November, December, January, February, and March, and therefore for these months the curve of melted snowfall should nearly coincide with the curve of

precipitation. In reality, the graph shows that the two curves diverge differentially, indicating that in February and March from 14 to 15 inches of snow equal 1 inch of water; whereas in November and January 18 inches of snow equal 1 inch of water; and in December 22 inches of snow is required to make 1 inch of water. It therefore appears that the snow of December is fluffier, or less dense, than the snow of other winter months.

The curve of mean temperature is a rather symmetrical one, except for an irregularity in March, during which the mean temperature appears to be about 3° lower than symmetry demands. No such irregularity in the curve is apparent for the corresponding period in the fall. That this irregularity is not accidental is indicated by the fact that temperature curves for other stations in interior Alaska show the same feature. It therefore appears that cold weather persists into March beyond the time when such conditions might be expected. The table also shows that the mean annual temperature is about 6° below freezing. It should be pointed out, however, that the temperature records at Eagle were not taken as a continuous record but are based upon a small number of observations during each day. It is therefore possible that an integrated mean temperature, derived from continuous curves, might show somewhat different monthly and annual means.

A partial record, compiled by the Weather Bureau up to and including the year 1921, also shows that 56 days may be expected at Eagle during which the temperature will rise to 70° or more; that 255 days may be expected when the temperature will fall to 32° or less; and that 120 days may be expected when the temperature will fall to zero or less. Up to 1921 the warmest summer temperature reported at Eagle was 96° and the coldest winter temperature −75°. Similar climatic conditions exist in the Fortymile and Circle districts.

On the basis of 22 observations at Eagle, it has been determined that the average date when the ice starts to move in the Yukon River is about May 10; and on the basis of 19 observations the mean date when the river freezes over in the fall is November 10. The date of the break-up is fairly regular, varying only about a week before or after the mean date; but the date of the freeze-up is more irregular, with possible variations of as much as 2 or 3 weeks. The Yukon River is therefore open for about 6 months in the year, but the presence of ice floes in the spring and fall and the uncertainty regarding the date of the freeze-up limit the period of steamboat navigation to about 4 months.

SETTLEMENTS, TRANSPORTATION, AND COMMUNICATION

Eagle and Circle are the principal towns within the Eagle and Circle districts, but smaller settlements have also been established, not

only in these two districts but also in the Fortymile district. Eagle is an incorporated town on the southwest bank of the Yukon River about 10 miles in an air line downstream from the international boundary. According to the census of 1930 the Eagle district is accredited with a population of 157, of whom 54 lived in the town of Eagle, 78 in the native town of Eagle Village, and the remainder were distributed on nearby creeks where mining is in progress.

Circle is on the southwest bank of the Yukon River about 15 miles northeast of the east end of the Crazy Mountains, at the southeast end of the Yukon Flats. According to the census of 1930 the town of Circle had a population of 50 persons, most of whom were natives. Four other settlements in the Circle district, however, should be mentioned. Central House and Miller House, both of which have fourth-class post offices, are the local supply points for the mining operations that center around Deadwood and Mammoth Creeks, respectively; and Circle Hot Springs, with a fourth-class post office, is the site of a rather popular watering place, which is patronized by many people in interior Alaska, particularly by residents of Fairbanks. Another fourth-class post office, known as Coal Creek, was established in 1936 on the southwest side of the Yukon River at the mouth of Coal Creek.

The Fortymile district includes no large towns but has four small settlements, which have fourth-class post offices and from which supplies and mail are distributed to a population scattered over a considerable area. These post offices are Steel Creek, on the Fortymile River; Jack Wade, on Wade Creek, a tributary of Walker Fork; Franklin, on the South Fork of the Fortymile; and Chicken, on Chicken Creek, a tributary of Mosquito Fork of the Fortymile. The population of the Fortymile district, according to the census of 1930, aggregated 142 persons.

According to local conditions, boats, automobiles, autotrucks, airplanes, horses, and dogs are used for the transportation of people, freight, and mail in the Fortymile, Eagle, and Circle districts. Eagle and Circle are reached in summer by a fortnightly steamboat service on the Yukon River, maintained by the American-Yukon Navigation Co. By this service all the supplies for Eagle and a part of those for Circle are brought downstream from Whitehorse, to which they are delivered by rail from Skagway. Since the completion of the Steese Highway between Fairbanks and Circle, however, a considerable part of the supplies for Circle come overland by autotrucks from Fairbanks. Gasoline launches and small boats are also used on the streams tributary to the Yukon River, particularly on the Fortymile River, where supplies are freighted from the mouth of the Fortymile upstream to Steel Creek.

In winter the Yukon is closed to navigation and the Steese Highway is closed to automotive transportation. Hence most of the supplies required in these three districts are imported during the summer. In winter the mail is distributed by horse sleds from Fairbanks to Circle and from Whitehorse down the Yukon River to Eagle and is then further distributed to outlying areas, including the Fortymile district, either by horse or by dog sleds. It is probable, however, that the mail will soon be delivered to Circle and Eagle in winter by airplane.

A branch road from the Steese Highway leads from Central House to the Circle Hot Springs; and several other local roads have been built in the Circle district, connecting Central House and Miller House with the various mining camps. Coal and Woodchopper Creeks have also been considered to be a part of the Circle district. Under the stimulus of new mining developments now in progress on these two creeks, the construction of an automobile road was begun in 1936, from the Yukon River at the mouth of Coal Creek upstream to the site of the present dredging operations, thence westward over the ridge and down Mineral Creek, a tributary of Woodchopper Creek, and up Woodchopper Creek to the dredging ground in that valley. This road was completed in 1937.

No first-class roads have been built in the Eagle and Fortymile districts, but the summer trail from Eagle to Chicken, which has a length of 85 miles, is sufficiently passable in good weather during the summer for a light wagon to be driven from Eagle to Liberty Creek, a distance of 30 miles. An automobile, however, can be operated from Eagle only 7 miles over this road. No road connects Eagle with the Seventymile district, so that practically all supplies for the Seventymile Valley have to be transported in winter. A poor road, 10 miles long, now little better than a skid road, connects Nation, on the Yukon River, with the mining camp in the upper valley of Fourth of July Creek. No roads have yet been built in the Fortymile district, but the use of tractors is gradually making roads, without any deliberate road building.

Airplanes are rapidly becoming a factor in the transportation of people and freight in this region, particularly in the more remote parts, such as the Fortymile district. Landing fields have been built at Circle, Circle Hot Springs, Eagle, Jack Wade, Franklin, Walker Fork, and Chicken, and others are being projected. Emergency airplane service is also utilized for various purposes, as for example in 1936, when a drilling crew and their equipment were landed on a bar of the Seventymile River. The Yukon River and some of its tributaries also afford landing facilities for hydroplanes and make possible additional service, as for example from Fairbanks to the mouth of Coal Creek.

In the early years of the mining industry in interior Alaska, rapid communication was effected by a network of telegraph lines, operated by the United States Signal Corps. These lines not only served local needs, but also connected the towns of the Yukon Valley with the coast of Alaska, whence messages were relayed by cable to the States. Later the Signal Corps abandoned most of these telegraph wires and substituted radio stations at Eagle, Circle, and other outlying points, from which messages could be sent to Fairbanks and thence to the States. In 1933 most of the radio stations operated by the Signal Corps along the Yukon River were abandoned. In their place small radiophone stations, operated by private concerns, were installed, and communication at Eagle and Circle is now furnished by such facilities. Emergency and amateur radiophones are also being installed in some of the more remote localities, as at the dredge on Wade Creek and at Chicken.

OTHER ECONOMIC FACTORS

One of the most important economic considerations in a mining industry is the transportation of freight. A large part of the supplies and equipment for these three districts comes into Alaska by way of Skagway and the upper Yukon River. The summer freight rates from Seattle to Eagle or Circle by this route vary, according to the types of commodities transported, from $78 to $102 a ton for carload lots, and from $85 to $116 a ton for less-than-carload lots. A different rate, however, applies to commodities that are imported into the Circle district by way of Seward and Fairbanks. The local freight rate from Fairbanks to Circle by autotruck is $40 a ton, but the rate from Fairbanks to Miller House or Central House is about $30 a ton.

The Fortymile district receives its supplies by several routes. Nearly all the heavy equipment and a large part of the other supplies enter the country by way of Skagway and the upper Yukon River, but this freight is unloaded at Dawson, Fortymile, or Eagle, according to its ultimate destination. From Dawson an automobile road has been built westward for a distance of 60 miles to Glacier Creek, in the Sixtymile mining district of Yukon Territory; and from this point tractors are used for the transportation of freight into the Walker Fork area of the Fortymile district. Most of the freight transported from Dawson to Walker Fork is hauled by the Walker Fork Gold Corporation for its own use, so that a local commercial rate cannot be said to exist, but the actual cost is probably about $50 a ton.

The freight unloaded at Fortymile, Yukon Territory, at the mouth of the Fortymile River, is transported up that stream, mainly during the winter, to Steel Creek, Jack Wade, and Chicken, at rates varying

from $70 to $100 a ton, almost double the initial rate from Seattle to Fortymile. Some supplies are also moved up the Fortymile River by boat in the spring and summer. At the present time, however, local tractor haulage in the Fortymile district is tending to reduce the costs of local transportation. Thus, tractors are now operating between Walker Fork and Jack Wade and between Chicken and the dredge on the South Fork of the Fortymile, and equipment has also been hauled from the South Fork to the dredge on Wade Creek.

The freight unloaded at Eagle is used in the Seventymile and Fortymile districts and is transported both winter and summer, but the summer freighting is now restricted almost entirely to the country north of Steel Creek. The winter rates to Steel Creek, Jack Wade, and Chicken range from 5 to 7 cents a pound, but the summer rates to the same localities in earlier years have ranged from 15 to 25 cents a pound. The practical cessation of summer freighting from Eagle to the southern part of the Fortymile district has been caused by the advent of airplane transportation from Fairbanks to Jack Wade and Chicken, at a rate of 10 cents a pound. In 1936 two airplanes were engaged throughout the summer in supplying such services and succeeded in moving some heavy machinery, as well as perishable foodstuffs and other supplies, into the Fortymile district.

Power and fuel are also important economic factors. With the exception of the Fortymile River, there are no potential sites for the development of much hydroelectric power close to these three mining districts, and in the Fortymile district the present development of the mining industry does not appear to warrant the expense incident to such an installation. Spruce timber of small size grows throughout this region and is used locally both for heating and for the generation of power, though at some of the older camps the supply close at hand has become so depleted that such fuel is becoming rather costly. Thus it is estimated that on Walker Fork, where wood is burned under steam boilers aboard a dredge, such fuel costs between $20 and $25 a cord. All three of the dredges now operating in the Fortymile district are using wood to obtain steam power, and although the cost of such fuel is not as great as on Walker Fork, it becomes a very considerable item in production costs. If the Fortymile district continues to develop as an area of low-grade large-scale mining operations, some consideration should be given to the possibility of utilizing the coal deposits of Chicken Creek and vicinity, either as a source of steam power or possibly for the development of electric power, for wire transmission to sites where such power can be utilized.

In the Circle district a great expanse of low-timbered country is present in the valleys of Birch Creek and its tributary, Crooked Creek, so that wood costs only about $10 a cord. The dredge now operating on Mastodon Creek uses wood under steam boilers; but

the dredge on Deadwood Creek and several dragline excavators at other localities utilize fuel oil, burned in Diesel engines. Fuel oil imported into the Circle district costs from 25 to 30 cents a gallon, the price depending upon the extent of local haulage. The dredges on Coal and Woodchopper Creeks also use fuel oil in Diesel engines at 25 cents a gallon.

Most of the foodstuffs used in these three districts have to be imported from the States, but certain local resources help materially. Large herds of caribou roam over this country, and in the autumn during the open season these animals afford an important source of meat, particularly in the Eagle and Fortymile districts, where it is difficult to import meat. Moose, though not as plentiful as caribou, also contribute to the local meat supply. Moreover, by the time the season is opened for killing these animals it has become cold enough to permit the meat to be kept without refrigeration, so that little is wasted.

With the long days of a sub-Arctic summer and a frost-free period of about 3 months, gardens also thrive, and all the more hardy vegetables can be grown. Many people have small gardens, but at some places, as at Eagle and Circle Hot Springs, large gardens are planted, and some of their products are sold locally. Another local source of food is found in the Yukon River, where salmon run during the summer. These salmon are dried and to some extent canned for human use and are also smoked in large numbers for dog feed during the winter. Blueberries, cranberries, and other wild fruits also thrive at favored localities and are much appreciated in a country where fresh fruit from the States is rare and costly. Wild native grasses serve as forage for stock during the summer, and some horse feed is raised locally, but most of the grain used for stock is imported.

GENERAL GEOLOGY

The general geology of the Yukon-Tanana region has recently been described by the writer[4] in as great detail as the information at present available justifies. No general geologic mapping has been done in this region in recent years, so that it will suffice for the purpose of the present report to present an epitomized sketch of the regional geology of the Fortymile, Eagle, and Circle districts, laying emphasis upon particular types of rocks that have a direct bearing upon the occurrence and character of mineralization.

The latest reconnaissance geologic map of the Yukon-Tanana region, including the northern part of the Eagle district, portrays

[4] Mertie, J. B., Jr., The Yukon-Tanana region, Alaska: Geol. Survey Bull. 872, pp. 44–237, 1937.

22 mapped units, which range in age from pre-Cambrian to Recent, or from the oldest recognized geologic formations to the unconsolidated deposits now being laid down. This geologic record not only spans an immense stretch of geologic time but it also is one of the fullest records now available in Alaska. Bedded rocks of every geologic period, except the Jurassic, are present, and a variety of igneous rocks of several ages, both intrusive and extrusive in origin, have also been recognized. Some of the best-substantiated parts of this record have been found in that part of the Eagle district which lies north on the Yukon River, but as that area is not a site of strong mineralization, its geology will not be reviewed here. South of the Yukon River all the rocks appear to have undergone accentuated metamorphism, so that in the mapping so far done formations that may elsewhere be separable into various units have been grouped together and described collectively. It therefore happens that most of the rocks of the Fortymile, Eagle, and Circle districts, except along the Yukon River, must be described under generalized groupings.

The oldest rocks of the region are the Birch Creek schist and associated meta-igneous schists. This group of rocks constitutes the principal country rock in the Fortymile and Circle districts, but in the Eagle district such rocks occur as a narrow border along the northeast and south sides of the granitic rocks of Glacier Mountain and also farther west as a narrow belt, bounded on the north and south by rocks of early Paleozoic age. The Birch Creek schist is defined as a group of recrystallized sedimentary rocks, which include quartzite, quartzite schist, quartz-mica schist, mica schist, feldspathic and chloritic schists, and a minor proportion of carbonaceous and calcareous schist and crystalline limestone. The associated meta-igneous rocks are gneiss, chlorite, albite, and sericite schists, amphibolite, and hornblende schist. The carbonaceous and calcareous schists and limestone of the bedded rocks and the chlorite, albite, and sericite schists of igneous origin are believed to lie near the top of the stratigraphic sequence. The Birch Creek schist and probably most of the meta-igneous rocks associated with it are considered to be of pre-Cambrian age.

A younger group of little-altered pre-Cambrian and Lower Cambrian (?) rocks are also present in the Eagle district, north of the Yukon River. These are called the Tindir group. Such rocks crop out locally in the country west of Fourth of July Creek but form no important part of the stratigraphic sequence south of the Yukon. In their type locality, in the valley of the Tatonduk River, and at adjacent localities the Tindir group has been subdivided and mapped as several distinct formations.

The next younger group is an undifferentiated complex of pre-Carboniferous Paleozoic sedimentary and intrusive rocks. These rocks occur in the central and eastern parts of the Eagle district as a northwestward-trending belt, which adjoins the Birch Creek schists along its northeast side. At the west side of the Eagle district two belts of such rocks, trending nearly west and separated from one another by Birch Creek schist, lie north of a great granitic batholith. A third belt, likewise trending west, lies farther north and close to the Yukon River. According to Prindle,[5] whose mapping of these rocks is the original source of information, they consist mainly of green and black phyllites, cherty slate, chert, quartzite, and limestone, together with basic and ultrabasic igneous rocks of greenstone habit. Prindle believed that this group of rocks was largely of Devonian age, but it is probable that early Paleozoic rocks of other ages are also represented. In the valley of the Seventymile River, in the Eagle district, some of the ultrabasic and basic intrusives of this group have been separately mapped. These are believed by the writer to be of Upper Devonian (?) age. Basaltic and diabasic lavas of Middle Devonian age, called the Woodchopper volcanics, have also been discriminated and mapped along the Yukon River downstream from the mouth of Coal Creek. North of the Yukon River, in the little-mineralized part of the Eagle district, the pre-Carboniferous Paleozoic rocks have been subdivided and mapped as a number of separate formations.

In the Circle district pre-Carboniferous Paleozoic rocks occur in the Crazy Mountains, north of the more intensely mineralized part of that district. Here the writer has mapped the limestones separately. Greenstones also occur in the Crazy Mountains, particularly along the northern flanks, but these have been considered to be a part of the sequence of Carboniferous volcanics.

In the Eagle district, along and close to both sides of the Yukon River, several formations of Carboniferous rocks have been described by the writer.[6] The oldest of these is a formation of chert, with a smaller proportion of other rocks, which crops out at the north end of Calico Bluff and at several other localities in that vicinity. These rocks lie conformably below upper Mississippian rocks and are considered to be of Mississippian age, but their base is not exposed. Similar rocks, which include zones of chert conglomerate, occur at the base of the Carboniferous sequence in other parts of the Yukon-Tanana region and are correlated tentatively with the cherty rocks

[5] Prindle, L. M., The Fortymile quadrangle, Alaska: Geol. Survey Bull. 375, pp. 18–19, 1909.

[6] Mertie, J. B., Jr., Geology of the Eagle-Circle district, Alaska: Geol. Survey Bull. 816, pp. 84–130, 1930; The Tatonduk-Nation district, Alaska: Geol. Survey Bull. 836, pp. 415–432, 1933.

near Eagle. Such rocks crop out in a narrow belt, trending west, which crosses Coal and Woodchopper Creeks; and they are also present at other localities along the north side of the Yukon River downstream from Woodchopper Creek.

Basic volcanic rocks of greenstone habit occur in the Circle district, along the northeast bank of the Yukon River upstream from Circle. Rocks of the same character lie along the north flanks of the Crazy Mountains. These greenstones were described by the writer [7] under the name "Circle volcanics" but were afterward correlated with the Rampart group, which is considered to be of Mississippian age. These volcanic rocks lie above the Mississippian chert (Livengood chert) in its type locality, but so far as known they are not represented in the Eagle district.

Above the Mississippian chert of the Eagle district lies the Calico Bluff formation, the type locality of which is at Calico Bluff, on the southwest side of the Yukon River just upstream from the mouth of the Seventymile River. This formation also crops out at other nearby localities. The base of the Calico Bluff formation has been defined, but its upper stratigraphic limit has not been determined. It consists essentially of thin-bedded limestone and shale and, on the basis of an abundant marine fauna, has been referred to the upper Mississippian.

A younger formation of Carboniferous age, also exposed at numerous localities along the Yukon River within the Eagle district, has been called the Nation River formation. It is composed mainly of sandstone, conglomerate, and shale, deposited under terrigenous conditions. Both the base and the top of this formation have been recognized, but it lies unconformably on older Carboniferous and Devonian rocks. In view of the undetermined top of the Calico Bluff formations, a considerable sequence of rocks may intervene between it and the Nation River formation.

Above the Nation River formation is the Tahkandit limestone, the youngest formation of Carboniferous age. The type locality of this formation is along the Yukon River just upstream from the mouth of the Nation River, but it has also been recognized and mapped elsewhere in the Yukon Valley, both upstream and downstream from the type locality. The Tahkandit limestone has an abundant marine fauna and is of Permian age.

Upper Triassic rocks have been found only in the Eagle district, along and close to the Yukon River at and above the mouth of the Nation River. These rocks consist of thin-bedded shale and limestone.

[7] Mertie, J. B., Jr., Geology of the Eagle-Circle district, Alaska: Geol. Survey Bull. 816, pp. 85–88, 1930.

They appear to represent only a minor part of the regional stratigraphic section, but they have some additional interest on account of the fact that they contain oil shale.

A widespread group of Mesozoic rocks, known as the Kandik formation, occurs along both sides of the Yukon River in the Eagle and Circle districts. This formation begins about 8 miles from the mouth of the Nation River and continues westward as a broad belt in the Yukon Valley as far as Coal Creek, from which it continues westward as a very narrow belt, crossing both Coal and Woodchopper Creeks. The Kandik formation consists essentially of black slate and quartzose sandstone and is of Lower Cretaceous age. Upper Cretaceous rocks may also be present in this part of the Yukon Valley but have not been definitely recognized and mapped.

The youngest of the consolidated geologic formations of this region is a group of Tertiary rocks, which occur in the Eagle, Circle, and Fortymile districts. These Tertiary rocks contain numerous beds of coal, but they are of particular importance because they are the proximate source of gold for some of the gold placers in the Eagle and Circle districts.

In the Eagle and Circle districts the Tertiary rocks crop out in a belt from 1 to 12 miles wide, which extends along the south side of the Yukon Valley from the international boundary N. 60° W. to and beyond Woodchopper Creek. This belt is widest in the country between Eagle and Fourth of July Creek. These rocks, because they occur fairly close to the Yukon River, occupy for the most part low timbered ridges and have therefore been examined mainly in the valleys of streams tributary to the Yukon Valley, and little is known of them in the interstream stretches. Moreover, no detailed study of this group of rocks has yet been made, though from several points of view more detailed information about them is much needed.

The Tertiary rocks consist of sandstone, shale, and conglomerate and locally include beds of coal, ranging in rank from lignite to subbituminous. According to the intensity of pressure applied at different localities, these rocks show varying degrees of consolidation. They have also been affected by surficial weathering in different degrees, so that at places the shale has reverted locally to clay, and the coarser-grained sediments have broken down to sand and gravel. Thus on some of the ridges veneers of gravel have been formed, which superficially resemble terrace gravel. At most places where the Tertiary rocks have been examined they show a high degree of folding and at numerous localities the dip approaches verticality. This structure, coupled with a lack of detailed work, renders it impossible to state with assurance either the sequence of the beds or their total thickness. Ac-

cording to Prindle,[8] a partial section is exposed in the valley of Bryant Creek, a stream that heads in the granitic rocks of Glacier Mountain and flows northeastward to the Seventymile River. In this section most of the rocks dip at high but varying angles to the north, but it is probable that close folding has caused a repetition of beds at different stratigraphic horizons. Conglomerate crops out at several places along Bryant Creek, but Prindle's evaluation of the exposures at this and other localities led him to believe that about 3,000 feet of sedimentary rocks are present, of which the lower half consists of argillaceous and sandy beds, with lignitic coal, whereas the upper half is composed dominantly of beds of conglomerate. Fossil plants of the same general character have been found in both the lower and upper parts of the formation, and the age of most of these plants has been determined as Eocene.

The conglomeratic portions of this formation are of particular economic interest because they are the proximate source of much of the gold found in certain streams that cut transversely across these rocks. The gravel, which makes up the conglomeratic beds, consists mainly of chert and quartzite, but also includes a smaller amount of vein quartz and other country rock of local origin and at some places decomposed pebbles of granitic rocks. The large percentage of chert and quartzite suggests conditions of residual alteration of the country rock, before and during the time of deposition of these rocks, that differ materially from the surficial conditions of bedrock during most of Pleistocene and Recent times.

The character of these early Tertiary rocks indicates that they are ancient alluvial deposits that have been indurated and folded to produce the present stratigraphic sequence. The distribution of the gold placers on Fourth of July, Coal, and Woodchopper Creeks and on some of the tributaries of the Seventymile River also indicates that some of the conglomerate beds are the source of much of the placer gold in these valleys. These gold-bearing conglomerates are therefore ancient placers, but it should be emphasized that they antedate by tens of millions of years the gold placers found in the present streams. As indurated gold placers, however, they are analogous to the gold-bearing conglomerates of the Witwatersrand district, in the Transvaal region of South Africa. Little prospecting has been done in these ancient placers, and even if gold-bearing deposits that have the tenor of the present ores from the Transvaal could be located, they would hardly be workable under the economic conditions now existing in this part of interior Alaska. The main interest in these conglomerates at the present time is the fact that they are

[8] Prindle, L. M., A geologic reconnaissance of the Circle quadrangle, Alaska: Geol. Survey Bull. 538, pp. 33–34, 1913.

a source of gold in some of the placers found in the valleys of the present streams.

The gold in the Tertiary conglomerates was probably derived from quartz veins and mineralized country rock, which were associated with the granitic intrusives exemplified by the large batholith that lies to the south of this formation. It is possible that the gold occurred mainly in apical zones around the borders of this granitic mass and in its outlying masses and that these gold-bearing zones were first exposed to erosion in early Tertiary time, when the conglomerates and associated rocks were being deposited. Such conditions resulted in the formation of early Tertiary gold placers. The gold in these ancient placers was probably as irregularly distributed as it is in the present stream placers. Moreover, in the millions of years that have elapsed since the ancient placers were formed, the Tertiary rocks have been folded and in part eroded. Consequently, even if gold had been evenly distributed in the original gravel, it would no longer be equally distributed areally. These factors explain why only some instead of all of the streams that drain this belt of Tertiary rocks have developed Recent placers.

Many facts still remain to be learned regarding these Tertiary rocks. Primarily, additional information is needed regarding their thickness and stratigraphic sequence. The position of the beds of conglomerate in the sequence needs to be determined, as these are probably the gold-bearing beds. Samples of the conglomerates should also be assayed, to determine which beds are gold-bearing and what their tenor is. With these facts in hand, prospecting for gold placers might be more intensively carried on, and it is even possible that low-grade gold deposits that would rate as future reserves might be located in the conglomerate bedrock. Some interesting geologic problems which at present are indeterminate might also be solved.

The preceding statements regarding the Tertiary rocks apply mainly in the Eagle and Circle districts. Small areas of these rocks also occur in the Fortymile district, principally in Chicken and Napoleon Creeks. So far as known these rocks have no considerable thickness and contain relatively little conglomerate, so that for this and other reasons they probably have not acted as a bedrock source of gold in the accumulation of the gold placers in the Fortymile district. Their main interest lies in the fact that they contain beds of subbituminous coal, which may sometime be utilized as a local source of power. Basic igneous rocks of Tertiary (?) age, in part of intrusive origin but possibly in part extrusive, also occur in the valley of Chicken Creek, in the Fortymile district.

Besides the principal basic and ultrabasic rocks that are found in these three districts, many masses of granitic intrusive rocks occur throughout the region. In the Eagle district such rocks are present in the vicinity of Glacier Mountain and extend thence westward, forming a great batholith, with a length from west to east of about 70 miles. Smaller intrusive masses are also found in the Eagle district but are particularly prevalent in the Fortymile district, where 20 such bodies have been mapped. The north side of the batholith lies at the head of Coal and Woodchopper Creeks, but smaller areas of granitic rocks occur in the valley of Birch Creek and its tributaries, in the Circle district.

The granitic rocks, like the Tertiary conglomerates, are of importance because they are considered to be a source of gold in the formation of gold placers. The Tertiary conglomerates, however, are only a secondary source of gold, which had to be derived originally from a primary source. The granitic rocks, together with the quartz veins and mineralized country rock along their borders, are believed to constitute such primary sources. The granitic rocks of the Yukon-Tanana region have been described in a recent publication.[9] They range in petrographic character from granite to quartz diorite and in age from Mesozoic to Tertiary. Most of them are equigranular massive rocks, in which the component minerals may be distinguished and generically identified with the unaided eye. They consist essentially of quartz, potash and lime-soda feldspars in varying proportions, mica (commonly biotite), hornblende, and pyroxene, together with a variety of accessory minerals, such as titanite, apatite, zircon, and ilmenite. As a result of alteration, both hydrothermal and surficial, these primary minerals have been altered locally to various secondary minerals. The specialized names applied to the family of granitic rocks, such as granite, monzogranite, quartz monzonite, granodiorite, and quartz diorite, together with corresponding designations for their fine-grained equivalents, are based mainly upon laboratory determinations of the character and proportions of the feldspars. Such distinctions in general cannot be accurately made in the field. Practically all experienced prospectors, however, recognize the granitic rocks when they see them, and as any or all of them may have produced local mineralization, the inability to utilize this specialized nomenclature is no handicap in prospecting.

No intensive study of the granitic rocks of the Yukon-Tanana region has yet been made, though the main areas where such rocks occur have been mapped, and their general petrographic characters have been stated in earlier publications. No detailed statement is therefore

[9] Mertie, J. B., Jr., The Yukon-Tanana region, Alaska: Geol. Survey Bull. 872, pp. 210–216, 219–226, 1937.

warranted regarding the absolute or relative ages of all the granitic rocks, the mechanics of their intrusion, their modes of mineralization, or the paragenesis of their ore and gangue minerals. In a broad way, however, it may be said that some of the granitic masses, particularly the smaller ones, have produced mineralization of varying degrees of intensity in the country rock along their borders, especially in the vicinity of the apexes of such intrusives. The manifestations of such mineralization are usually quartz veining, or alteration and discoloration of the adjoining or nearby country rock, or both. Areas where small bodies of granitic rocks may be found, or areas where quartz veining or hydrothermal alteration of the country rock suggests their presence nearby, are therefore favorable sites for prospecting for lodes of gold, silver, copper, tin, and certain other metals; and the streams draining such areas are favorable sites for prospecting for gold placers.

Emphasis has already been laid upon the size of granitic masses as one of the factors that may bear upon the occurrence or absence of mineralization. The size of a granitic cropping, however, is mainly a function of the depth at which the body has been injected and the amount of subsequent erosion. Most granitic intrusives are pictured as large masses of igneous material, of irregular shape, that are injected into the country rock under a considerable cover of superjacent country rock. As a result of their irregular shape, certain protuberances, as well as radiating dikes, may penetrate upward above the main mass for considerable distances, without reaching or even closely approaching the surface. In the wearing away of the country rock by subsequent erosion and the general lowering of the surface with regard to the underlying granitic rocks, these higher protuberances are the first to be uncovered. The mineral-bearing solutions that accompany the intrusion of granitic rocks work upward along the contacts between the granitic and country rocks and often precipitate their metallic loads at or near the apexes of these protuberances, either along the contacts themselves or in the nearby country rocks. Hence when the granitic rocks are first bared to erosion, it is these smaller protuberances or apophyses that appear and produce small surficial areas of such rocks. It is during this stage of the uncovering of the main granitic mass that the results of mineralization around the borders of granitic rocks are most likely to be visible and effective in producing a metallic source rock. By weathering and erosion this source rock is disintegrated and moved downward into the valleys, to produce placer deposits. Under this hypothesis the importance of small areas of granitic rocks is obvious.

As erosion and general lowering of the surface of the country proceed further, the main intrusive masses are also gradually bared.

This results in the exposure of large masses, such as the great batholith of granitic rocks that extends from Glacier Mountain westward for 70 miles. The exposure of such masses implies that the more highly mineralized apical zones have been worn away, and that the metallic contents of such zones have been distributed into the valleys of the streams that drain the region. Whether these metallic materials, such as gold, are comminuted and dissipated far downstream, even to the ocean, depends upon the length of time involved in the process and upon the character and intensity of geomorphic processes that cannot be described generally but only locally in the light of detailed studies. Fortunately, under the more usual circumstances gold travels no great distance downstream, even when it is repeatedly rehandled by stream action. But there is a downstream vector in its movement, so that if a sufficient time has elapsed since it was first dislodged from its bedrock source, and if the geomorphic conditions are such as to accentuate this downstream vector, gold may and does move far downstream and is finally so disseminated in a large volume of alluvial deposits that the gravel containing it can no longer be considered to form workable placers.

It occasionally happens, where granitic rocks were bared to erosion many millions of years ago, that gold derived from the apical zones of the granitic intrusives was collected or assembled in alluvial deposits at no great distance from the original bedrock sites; and that these gold-bearing alluvial deposits have themselves been preserved from extensive or complete erosion by fortuitous geomorphic conditions. Such alluvial deposits may be so old that, through dynamic processes engendering pressure and heat, they have subsequently been welded into solid rock. This is the conventional interpretation of the origin of the Witwatersrand gold deposits of South Africa, and it is believed to represent the conditions that preserved the gold-bearing Tertiary conglomerates of the Eagle and Circle districts. In other words, it is conceivable and reasonable that the gold which now rests in the Tertiary conglomerates was derived in early Tertiary time from the erosion of upper parts of the granitic rocks to the south.

The youngest geologic formations in this region are the unconsolidated alluvial deposits that form the valley floors of the present streams and extend up the slopes of the valley walls for varying distances. These deposits range in age from Pleistocene to Recent and consist of gravel, sand, and silt, in different proportions at different sites. As the Yukon-Tanana region has not been glaciated, except in very localized areas, the source of most of these deposits is the country rock exposed in the valleys drained by the present streams. But the details of the erosion, transportation, and deposition of these sedi-

ments have not yet been sufficiently deciphered to present any complete sequential statement regarding their geologic history. Many descriptive details regarding these deposits, that apply locally, are given in the following pages, where the character of the gold placer deposits is discussed.

GOLD PLACERS

FORTYMILE DISTRICT

The Fortymile River, known originally as the Shitando River, was given its present name in the early days of the Fortymile district, because it entered the Yukon River 40 miles downstream from the old Hudson Bay post at Fort Reliance. Gold was discovered on the bars of the Fortymile River near its mouth by Howard Franklin, in the fall of 1886, and the gold placers of Franklin Gulch were located about a year later. Gold placer mining has continued in this district from that time without interruption to the present day.

In the spring of 1888 gold placers were located on Davis Creek, a headwater tributary of Walker Fork, and in the following year Poker Creek, another headwater tributary, as well as the main Walker Fork, were found to be the sites of commercial gold placers. Further interest in the Fortymile district was created by the discovery in 1892 of gold placers east of the international boundary, on Miller and Glacier Creeks, which head against Walker Fork and drain southeastward to the Sixtymile River. Largely as a result of this new discovery an influx of prospectors and miners into the Fortymile district began in 1893, and many new placers were soon located. The sequence and dates of discovery of most of the other gold placers of the Fortymile district that have been found and mined cannot be stated, but it is known that mining on Dome Creek dates from 1893, that the placers of Wade Creek were first located in 1895, and that those of Chicken Creek were discovered in the spring of 1896. Apparently most if not all of the valleys where productive placers are now known to exist had been located within 10 years after the stampede of 1893. Evidently the Fortymile district was rather thoroughly prospected in the late nineties, for in the last 40 years few additional pay streaks of any importance have been found.

The fact that all the productive placers of the present day were discovered from 40 to 50 years ago, however, should not be regarded as a deterrent to new prospecting. In the first place, the new price of gold makes it possible now to mine deposits that were unworkable a few years ago. Also, new methods of large-scale mining have been developed in recent years and are being currently improved, so that it will be possible in the future to work not only the low-grade marginal ground of the old placers but also to operate low-grade placers

that have not heretofore been mined. Undoubtedly many placers that were too low in grade to be worked in the early days of the district were known to the prospectors and miners of those days. But most of the men who worked in this district 40 to 50 years ago are now dead, and the results of their prospecting in low-grade placers have not been recorded, so that much of their work will need to be repeated in the light of present economic conditions.

Mining in the Fortymile district now centers about six more or less separated areas—namely, Walker Fork, Wade Creek, Chicken Creek, Franklin Creek, Fortymile River, and Dome Creek. (See pl. 2.) The gold placers and mining operations now in progress in these areas are described in the following pages.

WALKER FORK AREA

Walker Fork and its two headwater tributaries, Davis and Poker Creeks, head in Yukon Territory, in the Bald Hills, which form the divide between Walker Fork and the Sixtymile River. Davis Creek heads against Little Gold Creek, a tributary of the Sixtymile River, and flows southwest; Poker Creek heads against Little Gold and Glacier Creeks and flows west; and Walker Fork heads against Glacier and Miller Creeks and flows northwest. Davis and Poker Creeks and the headwater branch of Walker Fork unite about a mile west of the international boundary. Cherry Creek, another headwater tributary of Walker Fork, enters from the southeast about 5 miles west of the international boundary. The present mining operations on Walker Fork are located in the stretch west of the mouths of Davis and Poker Creeks and east of the mouth of Cherry Creek. The new airplane landing field is located on the low ridge north of the mining camp.

Davis Creek heads in a steep-walled semicircular basin, flows west for about a mile in a narrow valley with a high gradient, and then veers to the southwest, flowing for 2 miles in a broader valley with a moderate gradient to its junction with Walker Fork. Poker Creek heads in a basin similar to that at the head of Davis Creek but with steeper walls; downstream from this basin the valley quickly broadens, and the stream flows westward with a fairly low gradient to Walker Fork. The bedrock on these two streams is quartz-mica schist and quartzite schist, which in places is somewhat carbonaceous. The cleavage of these ancient metamorphic rocks strikes from northeast to east, but the cleavage has been deformed by further folding, so that its dip is inconstant, though dominantly southward. Many quartz veins of varying width appear to follow the cleavage of the rocks; and as no granitic rocks are known either in these two valleys or at their heads, it seems likely that such quartz veins, derived from an underlying body of granitic rock, may be the source of the gold on Walker Fork.

No important mining is now in progress in Davis or Poker Creeks, as the gold placers of these streams have been rather completely mined in earlier years. Apparently the best parts of the pay streaks on these creeks were in their lower valleys, within American territory; and on Davis Creek the Discovery claim was located about half a mile upstream from its mouth. According to Spurr,[10] the alluvial deposits which constituted these placers were shallow, ranging from 6 to 12 feet in thickness, of which the upper 1 or 2 feet consisted of muck. The underlying gravel was subangular, and on Davis Creek, it consisted of fine gravel near bedrock, overlain by coarser gravel. Most of the gold was found in decomposed bedrock and in the gravel just above bedrock. Considerable quartz was found adhering to some of the gold, and in one of the quartz veins exposed on Davis Creek a little free gold was observed. An assay of 35 ounces of gold from Poker Creek, recovered several years ago, shows a fineness of 872 parts of gold and 122 parts of silver in a thousand.

From the junction of its headwater branch with Davis and Poker Creeks, Walker Fork flows westward for about 10 miles, to the mouth of Twelvemile Creek, a small tributary from the north; thence S. 65° W. for about 8 miles, to the mouth of Liberty Creek, a large tributary from the south; and finally in a meandering course N. 50° W. for 8 miles in an air line to its confluence with the South Fork of the Fortymile River. About midway in the last-named stretch Wade Creek enters from the northeast.

In its upper valley, where the course of the stream is west, Walker Fork has an elevation above sea level ranging from 1,600 to 2,200 feet. East of Cherry Creek, where mining operations are in progress, the elevation is about 2,000 feet and the gradient of the stream is about 100 feet to the mile. In this stretch the valley is asymmetric, with a rather steep south wall and gentle slopes and spurs forming the north wall. The valley floor in general is a wide alluvial flat, but it narrows considerably for short stretches. A terrace about 400 feet above the creek level is recognizable on both sides of the creek; and a lower terrace, about 100 feet high, is developed farther downstream, in the vicinity of Twelvemile Creek.

The bedrock of Walker Fork consists essentially of quartzite schist and carbonaceous schist, similar to the bedrock in Davis and Poker Creeks; but between the outlets of Twelvemile and Wade Creeks Prindle [11] reports the presence of garnetiferous hornblende schist and gneiss, as well as granitic and pegmatitic intrusive rocks, presumably

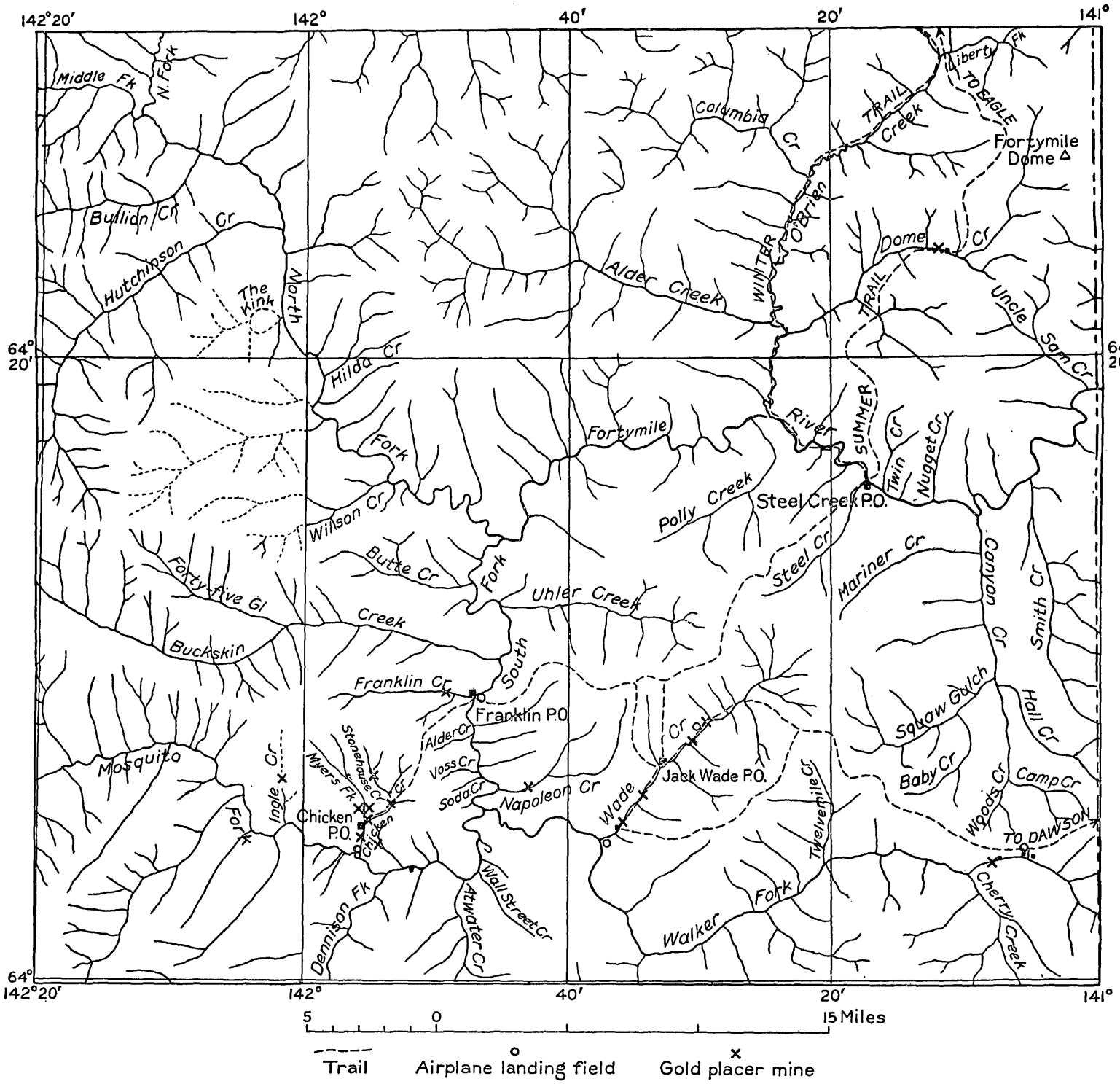
[10] Spurr, J. E., Geology of the Yukon gold district, Alaska: Geol. Survey 18th Ann. Rept., pt. 3, pp. 326–331, 1898.

[11] Prindle, L. M., The Fortymile quadrangle, Alaska: Geol. Survey Bull. 375, p. 35, 1909.

much younger. These intrusive rocks occur both as dikes and sills, and quartz veins are also of common occurrence. The metamorphic rocks have a complex structure, which indicates folding of old cleavage planes. The general strike varies from northeast to east, but the dip of the cleavage planes is inconstant.

Insufficient data have been recorded to give a history of mining operations on Walker Fork, but evidently most of the gold placers were of moderate thickness, for most of the early work was done by hydraulic open-cut methods. The gravel of high grade was small in amount and soon worked out, so that early in the history of this creek mechanical devices operated by power began to be utilized. Thus in 1903 a stream scraper and bucket conveyor were being used on one claim, and a horse scraper was used for stacking tailings on another claim. In 1907 the first dredge was installed on Walker Fork, about a mile about the mouth of Twelvemile Creek, by an Englishman named Russell King. This was an open-connected machine of the bucket type, with a bucket capacity of 5 cubic feet. It was operated on Walker Fork from 1907 to 1909, after which it was moved to the mouth of Uhler Creek, on the South Fork of the Fortymile; and in the ensuing years it worked upstream as far as Franklin. A second dredge was installed on Walker Fork between the mouths of Davis and Poker Creek in the winter of 1907–8, by Robert Mulvane. This was operated during the seasons of 1908 to 1912, and apparently was a success. Its operations were finally terminated on Poker Creek a few hundred feet above the mouth of that stream, where in September 1912 it was dismantled; and during the following winter it was moved across the international boundary to Miller Creek, in the Sixtymile district, where it is still being used. The present company, which holds and operates the placer deposits on Walker Fork, began work in 1923, but during that year and in 1924 only ditching was done. In 1925 it put into operation a Bucyrus steam shovel, with a 50-foot boom, and a bucket with a maximum capacity of 1¼ cubic yards. In this work hydraulic giants were used to move the gravel from the sides of the pay streak toward the center, where it could be picked up by the steam shovel and lifted into the sluice boxes. This machine was used until 1934, but in that year a new stacker-type dredge was built, which began digging late in the summer. This dredge is still in operation.

The pay streak on Walker Fork may be said to start at the mouth of Poker Creek and continues downstream for an undetermined distance. Claims are evidently reckoned from some point at or near the mouth of Davis or Poker Creek, perhaps from the Discovery claim on Davis Creek, about half a mile above its mouth. Mining operations have gradually been extended downstream to the present



SKETCH MAP OF FORTYMILE DISTRICT, SHOWING LOCATION OF GOLD PLACER-MINING OPERATIONS.

site of the dredge, on claim 21 below Discovery, and are being continued downstream. The pay streak on Walker Fork has therefore a known length of at least 5 miles. Its width is variable, depending not only on the distribution of workable placers but also on the definition of what constitutes a workable placer. In the early days of mining on Walker Fork the pay streak was stated to have a width of about 50 feet. This of course applied to the pay streak in that part of the valley near Davis and Poker Creeks, but a greater width than this was afterward worked by the Mulvane dredge. At the site of steam-shovel operations in 1926 and 1927 the pay streak was considered to have a width of 600 feet. Downstream from this point the valley becomes narrower, and at the present site of the dredge and for several claim lengths upstream the workable pay streak has ranged from 250 to 300 feet in width. About 1,500 to 2,000 feet below the present site of the dredge the valley broadens, and here the hydraulic crew is stripping over a width of 600 to 700 feet, though it is not definitely known that this entire width can be worked at a profit.

The alluvial material that lies above bedrock consists of gravel, sand, muck, and a little clay. The stratigraphic thickness is variable. In the upper part of the valley the thickness of this material ranges from 4 to 12 feet, and of the gravel from 4 to 10 feet, with an average of 6 feet. The muck occurs generally as a thin stratum at the surface, but at some places no muck is present, though rarely muck extends downward to bedrock. The gravel consists of subangular pebbles and cobbles as much as a foot in diameter, with a few large boulders. As might be expected, the gravel consists mainly of quartzite schist. In places a thin layer of clay was found between the gravel and bedrock. The lower 2 feet of gravel constitutes the workable part, but gold was also recovered in bedrock to a depth of 1½ feet. Most of this gold occurred as small flat pieces, but nuggets as much as an ounce in weight were recovered. Some of this gold, particularly at the upper end of the pay streak, was rusty or even black in color.

At the site of the steam-shovel operations from 1925 to 1928, in claims 15 to 18 below Discovery, the stratigraphic section of the alluvial material was much the same as farther upstream, as the gravel ranges in thickness from 5 or 6 feet at the edges of the pay streak to 10 feet in the central part, with a cover of muck 1 to 2 feet thick. In this part of the valley the pebbles of the gravel are somewhat smaller in average size, but locally some large boulders, as much as 4 feet in diameter, were uncovered. Such boulders are mainly quartz and are found where quartz ledges cut the bedrock. The bedrock consists of several varieties of blocky schist, into which gold

penetrates to a depth of 2 or 3 feet. Many thin seams and stringers of quartz occur in the bedrock, and at places thick veins or ledges of quartz have been uncovered. The gold placers in this part of the valley, including a width of 300 to 600 feet, are said to have had a value of 15 to 35 cents to the square foot of bedrock, or if the average depth of these placers is taken as 9 feet, the value was from 45 cents to $1.05 a square yard. On claim 21 below Discovery, at the site of the dredge in 1936, conditions of the overburden are essentially similar to those existing on several claims upstream. The gravel has a thickness of 7 to 10 feet and is covered by 2 to 4 feet of muck. The pebbles are subangular to rounded and reach a maximum of 1 foot in diameter but average perhaps 4 to 5 inches. About 1,000 to 1,500 feet downstream, however, where stripping operations were in progress in 1936, the gravel ranges in thickness from 4 to 8 feet and is overlain by 3 to 7 feet of muck.

No assay returns were seen by the writer, but at the present site of mining, the bullion has been reported to have a fineness of about 830 parts of gold in a thousand, though in the ground worked several claims upstream the fineness was reported by the same operators at about 890 parts. If these observations indicate a general condition, there is a suggestion here of local enrichment of the placers from bedrock sources in the vicinity of claims 15 to 18 below Discovery. The heavy concentrates collected with the gold include mainly magnetite, limonite, ilmenite, psilomelane, pyrite, and garnet.

Mining operations on Walker Fork are now being carried on by the Walker Fork Gold Corporation, which holds 14 miles of claims in this valley. The central camp for several years has been located on or near claim 16 below Discovery, about 2 or 3 miles west of the international boundary; but in 1936 the bunk houses and mess house were being moved downstream to a site near the dredging operations. The present dredge is now working downstream, and because the alluvium is shallow it is operating behind temporary dams. This dredge, which was built by the Seattle Iron Works, is of the stacker type and is operated with one spud and two bow and two stern lines. The digging ladder consists of 59 buckets of 3 cubic feet capacity, which can operate at a speed of about 25 buckets a minute, though in 1936 only 19 buckets were being dumped in a minute. The trommel screen is 24 feet long, with holes ranging from half an inch in diameter at the upper end to 3 inches at the lower end. The gravel is washed by five 2-inch nozzles, which are directed at the lower part of the trommel. For power, the dredge uses wood under a boiler rated at 300 horsepower, with 250 pounds of steam, but is operated at less than half capacity, under 190 pounds of steam. About 5 to 6 cords of wood is consumed during each operating day. For motive power, a 2-cylin-

der steam engine is used, which has a maximum speed of 250 revolutions a minute and a 200-horsepower rating, but which is used to deliver about 125 horsepower. A seven-drum winch is used, of which one drum is used for the digging ladder, four for the bow and stern lines, and one for the stacker; the other one is not in use. Three centrifugal pumps, with 10-inch intake and 8-inch delivery, are used, and two of these deliver 4,000 gallons of water a minute to the sluice line. Another centrifugal pump, with a 4-inch intake and 3-inch delivery, as well as three steam injectors, a vacuum pump, boiler-feed pump, make-up pump, and auxiliary boiler, rated at 25 horsepower, are also used. Current for lighting is furnished by a 3-kilowatt direct-current generator. The dredge is operated continuously during the summer, by three shifts. The dredging season in 1935 was from June 24 to October 25, aggregating 122 days, and in 1936 it was probably of about the same duration.

The ground on Walker Fork is frozen, so that it has to be thawed ahead of the dredge. This is done by stripping off the frozen muck by hydraulic operations and allowing the underlying gravel to thaw naturally from the heat of the sun and atmosphere. No steam points are used in thawing, but a quarter of a mile west of the dredge, where thawing operations were in progress in 1936, three 3½-inch giants, with water under a head of 150 feet, were being utilized. For this purpose two ditches have been constructed, but the upper one is now abandoned. The lower ditch has its intake on claim 13 above Discovery and has a maximum capacity of 2,500 miner's inches, or about 62 cubic feet a second, which is adequate for operating 4 giants. The Walker Fork Gold Corporation employs 30 men, of whom 12 in 3 shifts are needed for operating the dredge, and the remainder are used in the ground and hydraulic crews.

WADE CREEK AREA

Wade Creek heads against Steel Creek Dome and flows almost due southwest to join Walker Fork. Its air-line length is about 11 miles. All the tributaries of Wade Creek are short and occupy narrow valleys, but at the head of Wade Creek a number of tributaries, entering from several directions, make a fan-shaped upper basin. One of the larger of these headwater tributaries is Gilliland Creek, which heads against Steel Creek and flows 2½ miles to Wade Creek. At the mouth of Gilliland Creek the elevation of Wade Creek above sea level is 2,000 feet, and at the mouth of Wade Creek the elevation is less than 1,400 feet, so that the gradient of the main valley is about 70 feet to the mile.

Two discovery claims, known as Upper and Lower Discovery, are recognized on Wade Creek, but the claims on the creek are referred

not only to these two discovery claims but also to the mouth of the creek. Thus on ascending the creek, the first 11 claims are called "1 above the mouth," "2 above the mouth," etc. The next claim upstream from "11 above the mouth," is "9 below Lower Discovery," and therefore Lower Discovery claim is 21 claims above the mouth of Wade Creek. Claim 18 above Lower Discovery is called Upper Discovery, and from this point upstream the claims are referred to Upper Discovery. The post office of Jack Wade is located on claim 8 above Lower Discovery.

The valley of Wade Creek is V-shaped and narrow in its upper reaches, with several very narrow constrictions, but broadens at its lower end and merges finally into the broad valley of Walker Fork. One airplane landing field is located at the mouth of Wade Creek, in this alluvial flat; and another is located in the upper valley. The narrowest places in the valley are at Lower Discovery and on claim 3 above Lower Discovery. At these two places the valley floor is so narrow that a dredge could pass only with some difficulty. The valley of Wade Creek is somewhat asymmetric, as the slopes and spurs on the northwest side are more gentle than those on the southeast side. No well-defined low bedrock bench is present in this valley close to the creek, as the bedrock appears for the most part to slope gradually upward from the creek to higher ground. At claim 5 above Lower Discovery, however, and on downstream higher benches appear, and on one of these, about 200 feet above the valley floor, some small-scale mining has been done.

The bedrock in the valley of Wade Creek includes several varieties of schist and some thin-bedded ferruginous limestone, all of which are a part of the Birch Creek schist. Quartzite, mica schist, and hornblende schist are the most common of these metamorphic rocks. The general strike of the cleavage is northeast, about parallel to the creek, but the dip is variable in degree, though dominantly southeastward. A prominent system of jointing strikes N. 30° W. Several small bodies of granitic rocks have been mapped by Prindle[12] in the valley of Wade Creek, and such rocks have probably been an important factor in the mineralization of the country rock from which the placer gold has been derived. Many veins and stringers of quartz, in part pyritiferous, occur in the schist, and some of these are known to carry gold, though no high-grade auriferous quartz has been found. A sample from one quartz vein in the northeastern part of the valley was assayed for the Geological Survey and was found to contain 0.06 ounce of gold to the ton. Such veins and stringers of quartz, which were probably connected genetically with the in-

[12] Prindle, L. M., The Fortymile quadrangle, Alaska: Geol. Survey Bull. 375, pl. 5, 1909.

trusion of the granitic rocks, are doubtless the source of the gold on Wade Creek.

The pay streak on Wade Creek may be said to extend intermittently from Gilliland Creek to Walker Fork, but it is doubtful if large-scale mining can be carried on profitably throughout this distance. Open-cut mining has been done mainly in the upper end of the valley, and drift mining farther downstream, but much of the alluvium of Wade Creek is not completely frozen, so that the drift-mining operations, which were confined to frozen ground, have not served to prospect the creek thoroughly. Therefore, as the valley has not been drilled, little is really known regarding the gold tenor of the pay streak as a whole. It is known, however, that claims 6, 7, 8, and 9 above Lower Discovery were the best claims that were mined on the creek, and gold to the value of $300,000 (referred to the old standard) is reported to have been recovered from claim 8 above and the lower half of claim 9 above Lower Discovery. Such ground is said to have had a tenor of $1 to $1.50 to the square foot of bedrock but probably included only the best part of the pay streak. At the site of mining from claim 14 above Lower Discovery to Upper Discovery, however, the tenor of the ground, including the full width mined, is only about 20 cents to the square foot.

The width and depth of the gravel that constitutes the pay streak are variable. On claim 7 above Lower Discovery the pay streak mined was from 100 to 120 feet wide, and the alluvium was about 12 feet deep. On Upper Discovery claim the pay streak is now being worked over a width of 250 feet, and at the site of the dredge in 1936, on claim 5 above the mouth of Wade Creek, the pay streak was estimated to have a width of 800 feet. For many stretches, however, the pay streak will not exceed 100 or 150 feet in width, and in the narrow places in the valley, above mentioned, it may be as narrow as 50 to 75 feet.

The alluvium forming the valley floor of Wade Creek is composed of partly frozen gravel, overlain by a thin cover of muck. No exact statement can be made regarding the thickness of the gravel, because too little of the creek has yet been mined; but it is believed to range in thickness from a few feet to 10 or 12 feet. The gravel consists mainly of pebbles and cobbles ranging in size from a few inches to 3 feet, though in some parts of the valley very large boulders will undoubtedly be found. The pebbles comprising the gravel were derived from the country rock within the drainage basin of Wade Creek and are therefore mainly schist, but some granitic rocks, as well as a minor amount of vein quartz, are also noticeable. As a rule the pebbles are fairly well worn. The overlying muck varies considerably in thickness, ranging from little or none to as much as

20 feet. The gold occurs mainly on and in bedrock, and where the bedrock is a jointed blocky schist gold is found in the crevices to a depth of several feet. Gold also occurs in the lower 1½ feet of gravel, but in smaller quantity.

The general run of gold on Wade Creek is made up of small flat pieces, but there is little flour gold, so that it may be classified generally as coarse gold. As a rule the gold is bright in color and fairly well worn, but near the head of the creek and at the mouths of gulches the gold is inclined to be iron-stained. Some of this gold that has entered from side gulches, with little transportation, is only slightly worn. Gold with pieces of quartz adhering to it is common, and some large pieces of quartz filled with gold have been recovered. Some large nuggets have also been found, of which the largest known to the writer weighed about 24 ounces. As shown in the following pages, the average fineness of the bullion found in the upper valley of Wade Creek is 830 parts of gold and 165 parts of silver in a thousand; but the fineness for the creek as a whole is believed to be rather variable.

The heavy concentrates recovered with the gold include a variety of minerals, of which nearly half are barite; but magnetite, ilmenite, hematite, and garnet are of common occurrence. Cinnabar, pyrite, and cassiterite are also present in smaller amounts. The cassiterite has been found both in crystalline form and as wood tin.

The placers of Wade Creek are said to have been discovered by Jack Wade in 1895, and since 1898 they have been mined continuously. Insufficient data have been recorded to give any history of these mining operations, but it appears that large-scale open-cut mining has been confined largely to the upper part of the valley. Farther downstream a great deal of shallow drift mining and some open-cut mining have also been done, but as above stated, the partly thawed character of the ground has not favored extensive underground work. During the summer of 1936 one hydraulic plant was operated on Upper Discovery claim (also called claim 18 above Lower Discovery), and some small shoveling-in operations were in progress on claim 4 above Upper Discovery. A dredge was installed during the winter of 1935–36, and this was operated during the later part of the summer of 1936. Small-scale drifting operations were also carried on during the winter.

The hydraulic plant on Upper Discovery is operated by Charles Martin, who holds the 10 claims from 12 above Lower Discovery to claim 3 above Upper Discovery. This hydraulic mining has been in progress since 1921, when work was begun on claim 14 above Lower Discovery. Prior to that time a scraper plant was used on other claims farther downstream, but this work was not successful. On

claim 14 the pay streak was 175 feet wide, but at the present site of mining it has widened to 250 feet and is a little lower in gold tenor. On claim 14 the auriferous gravel had a thickness between 10 and 12 feet, with little or no overlying muck, but at the present site of mining the gravel averages about 9 feet in thickness. In the center of the valley the gravel is overlain by 3 to 4 feet of muck, but along the northwest side, where the pay streak cuts into the valley wall, the muck has a maximum thickness of 20 feet. The gravel ranges in size from pebbles and small cobbles up to boulders 2 feet or more in diameter, but no boulders large enough to require blasting have been encountered. The bedrock here is a mica schist, which is softer and less blocky than that several claim lengths downstream, so that the gold does not work so far down into bedrock. For this reason the cleaning of bedrock by hand is not so necessary.

The operator of this plant kindly submitted a list of assays of the gold that has been mined on this part of Wade Creek from 1926 to 1935. In the following table these assays are arranged chronologically and also in order going upstream. The assays of 1926 refer to gold mined on claim 16 above Lower Discovery, and those of 1935 to gold taken from Upper Discovery.

Fineness of gold from Wade Creek, 1926–35

[Parts per thousand]

Year	Gold	Silver	Year	Gold	Silver
1926	818½	177	1932	830	167
	829¼	164		842½	153
1927	807½	139		835½	161
1928	824	169	1933	840¾	154
	817¼	177½	1934	837½	158
	824¾	168	1935	833¾	161
1929	838½	165		842	148
	833½	159			
1930	835¼	159	Mean	830	165
	828¼	162			
	835	151			
1931	830¼	136			
	823	172			

These assays show a slight but irregular tendency to increase in fineness in going upstream, but they represent a distance in the valley of less than three-quarters of a mile, so that this tendency cannot be said to have much significance. On claim 4 above Upper Discovery, however, the bullion contains 865¼ parts of gold and 129 parts of silver in a thousand, so that there appears to be an increase in the fineness of the gold in going upstream. Unfortunately, no assays from the lower valley of Wade Creek are available, so that no reliable generalization can be drawn. All the gold from claim 14 above Lower Discovery to Upper Discovery is classified as coarse gold. The largest nugget so far found on these four claims weighed 6¼ ounces.

The placer mining on Upper Discovery claim is being done entirely by hydraulic methods. At the present site of mining the pay streak is 250 feet wide. When adequate water is available, three giants are used, one for moving the overburden, one for driving the gravel into the sluice boxes, and one for stacking tailings. The supply of water, however, is often inadequate, particularly in the early summer, and at such times the water is used for whatever job is most necessary at the time. In this work a bedrock drain is first built and then the sluice boxes are set on bedrock at the head of this drain. The gravel is piped against wooden shear boards which are mounted above the sluice boxes upon a hingelike axis parallel with the sluice line. Water is delivered to the cut through a ditch which gives a hydraulic head of 70 feet on bedrock but 60 feet or less at the upper surface of the overburden. During the early part of the summer of 1936 there was little precipitation and therefore little water in Wade Creek and its tributaries, but this condition was improved later in the summer. In addition to the owner of this plant, three men and a cook are employed, so that two men can work at night and two during the day.

On claim 5 above Upper Discovery (23 above Lower Discovery) two men were engaged in open-cut shoveling-in operations during the summer of 1936. These operators hold 16 claims on Wade and Gilliland Creeks. Mining at the locality has revealed an interesting configuration of bedrock. The valley of Gilliland Creek is asymmetric, being markedly steeper on the east side. At the mouth of Gilliland Creek, where the shoveling-in operations are in progress, the stream flows against a steep rock wall along the east side of the valley over a thin stratum of gravel. West of the present stream there is an old channel from which the surface of bedrock rises abruptly both to the east and west. In this channel the surface of bedrock is 3 to 4 feet lower than at the site of the creek. The width of this bedrock depression is about 125 feet. This condition is at variance with the general lack of low bedrock benches on Wade Creek, though a suggestion of the same condition has been uncovered along the west side of the cut on Upper Discovery claim. Such conditions indicate that ancient placers have existed on Wade Creek, as at many other localities in the Fortymile district, but that the straightness of the valley has resulted in the erosion rather than the preservation of such older placers and their reworking and reconcentration in the present valley floor.

Mining on claim 5 above Upper Discovery is being done in this bedrock depression. The upper part of the alluvium consists of 3 to 4 feet of muck. Below this is a thickness of about 5 feet of gravel, which for the most part is coarse and angular to subangular. The cobbles reach a maximum size of 18 inches. The bedrock consists of mica schist, but also includes irregular-shaped masses of metadiorite

and metagabbro. The placers that are being worked are of very high grade, and the gold is coarse. The fineness of the bullion as shown by assays, is 865¼ parts of gold and 129 parts of silver in a thousand. Much of the gold is in the form of nuggets, and two 10-ounce nuggets have recently been recovered. A 13-ounce nugget has also been found at this place.

Mining is being done in parallel cuts about 30 feet wide. A long bedrock drain was being built in 1936, and with the aid of a small dam and gate upstream from the workings the operators plan to continue their shoveling-in operations for several years.

The only other site of any important summer mining in 1936 was on claim 5 above the mouth of Wade Creek, where the newly installed dredge was operating. This work is being done by the Jack Wade Dredging Co., which is controlled by the North American Mines, of Boston. All the claims on which the company will operate in the near future are held by local people, who have mined and prospected on Wade Creek for many years and who will get a royalty on the production of the dredge.

The dredge did not begin to operate until July 11, and little intensive prospecting has yet been done in this part of the valley of Wade Creek; for these reasons not much can be stated regarding the character of the pay streak. Apparently some of the ground is not frozen, and it was in such unfrozen ground that the dredge began to work. The dredge is now working upstream, and it is planned later to groundsluice off the muck ahead of the dredge and allow the frozen ground to thaw naturally. The pay streak at the initial site of the dredge was believed to be about 800 feet wide, and all of this, except a narrow strip for the return trip, will be mined in going upstream. The overburden consists of about 14 feet of gravel, with little or no muck.

This dredge is the old Russell King dredge, which formerly worked in the valley of the South Fork of the Fortymile River as far upstream as Franklin. It was dismantled and moved to its present site in the winter of 1935–36, but it has been modernized and improved by the installation of many new parts. It is now a dredge of the stacker type, with two sluice flumes, and is operated from head and stern lines, but a spud will later be installed. The digging ladder consists of 32 buckets of 4½ cubic feet capacity, but at the time of the writer's visit the digging speed of the ladder could not be observed, on account of a temporary shut-down. The power plant consists of a 150-horsepower boiler which drives three compound steam engines, of which two are rated at 65 horsepower each and the third at 40 horsepower. One of the 65-horsepower engines is used mainly for the pumps; and this engine drives a turbine pump,

with a 14-inch intake and 12-inch delivery, which supplies 2,000 gallons a minute to the sluice line. The second 65-horsepower engine moves the bucket line. The 40-horsepower engine drives the stacker and screen. A fourth engine, rated at 6 horsepower, is used for a 4-kilowatt direct-current generator. The trommel screen is 22 feet long and is built in four sections, of which the upper two have ½-inch holes, and the lower two 3-inch holes. The dredge also has a grizzly upon which droppings from the bucket line fall, and this material feeds into a separate set of riffles, called the "save-all." Two sluice flumes lead from the lower end of the trommel and discharge on opposite sides of the boat. The gravel moving through the trommel is washed by water that issues from a perforated pipe, 8 inches in diameter, which is placed inside and at the top of the trommel. As a temporary expedient, wooden riffles are being used in the sluice line. Bilge water in the hull is elevated by means of a steam siphon.

This dredge is rather favorably situated, because it is fairly close to the airplane landing field at the mouth of Wade Creek. Supplies and equipment can also be obtained in summer by tractor haulage from Dawson, by the Walker Fork route. Thirteen men are used in operating the dredge, but eight or nine others are employed as teamsters, blacksmith, electric welder, and in the mess house. The Jack Wade Dredging Co. also controls a privately owned and operated short-wave radio station, located at the dredge camp.

CHICKEN CREEK AREA

Chicken Creek is a short stream, that heads against a branch of Franklin Creek and flows about S. 30° W. to join the Mosquito Fork of the Fortymile River. Its air-line length is about 4½ miles, and its drainage area about 20 square miles. Chicken Creek has two major tributaries, which enter from the northwest, and several tributary gulches along the east side of its valley. The larger of the two northwestern tributaries is Myers Fork, which enters Chicken Creek about 1½ miles above its mouth. Stonehouse Creek, the smaller of the northwestern tributaries, joins Chicken Creek about 1 mile above the mouth of Myers Fork. The Discovery claim on Chicken Creek is just below the mouth of Stonehouse Creek, and all the placer claims on Chicken Creek, together with those on Stonehouse Creek, are referred to this claim. On Myers Fork, however, the placer claims are referred to the mouth of the creek, and are designated "1 above the mouth," "2 above the mouth," etc.

The valleys of Myers Fork, Stonehouse Creek, and Chicken Creek above Stonehouse Creek converge from the northwest, north, and northeast and produce a broad fan-shaped headwater basin, but the three headwater tributaries have deeply incised narrow valleys

within this basin. Downstream from the mouth of Stonehouse Creek the valley of Chicken Creek widens rapidly, and still farther downstream the valley floor becomes broad and flat, merging finally into the flats of Mosquito Fork. At its mouth Chicken Creek flows at an elevation of about 1,300 feet, and in its extreme head at 2,000 feet, but most of the fall is in that part of the valley upstream from Stonehouse Creek, so that the lower valley has a gradient of less than 80 feet to the mile.

The valley of Chicken Creek is asymmetric in cross section, with the steeper wall along the east side; but opposite the Chicken town site and for a short distance upstream a gravel terrace caps the east wall of the valley and forms the divide between Chicken Creek and a small stream called Lost Chicken Creek, which flows southeastward to Mosquito Fork. This gravel divide lies about 275 feet above the level of Chicken Creek. At the lower end of Chicken Creek the west wall of its valley rises gradually from the creek and merges into a broad spatulate spur on that side. Another stream that is included as a part of the Chicken Creek area is Ingle Creek, a small tributary of the Mosquito Fork, which lies between Mosquito and Dennison Forks. Granitic rocks form the bedrock of Lost Chicken and Ingle Creeks. The bedrock in the central part of the valley of Chicken Creek consists mainly of basic rocks, which include basalt, diabase, and gabbro. Most of these basic rocks appear to be intrusive, but they are probably considerably younger than the adjoining granitic rocks. Southeast of these basic rocks the bedrock of Chicken Creek consists of sandstone, shale, and conglomerate of Tertiary age. These rocks contain some beds of coal, which probably range from lignitic to subbituminous. With so many kinds of rocks in the valley of Chicken Creek, the gravel found in the placers is diverse in character.

Gold placers have been found on Chicken Creek from the mouth of Stonehouse Creek downstream to the point where the valley opens into the flats of Mosquito Fork, but the data on record are not adequate for presenting a history of past mining operations. From Myers Fork downstream placer mining has been done mainly along the west side of the valley, at a distance of 150 to 1,000 feet from the creek. This pay streak, on the basis of past mining, ranges in width from 100 to 200 feet and consists of frozen alluvium, which has been mined both by drifting and by open-cut operations. The gravel lying upon bedrock ranges in thickness from 5 to 15 feet, but the overlying muck ranges from a few feet to 20 feet, thus giving rise to a variable total thickness of alluvium at different localities. As a rule, however, the total thickness ranges from 20 to 35 feet. The configuration of bedrock is also variable. Thus on claim 5½ below Discovery the bedrock is said to be practically level from one

side of the valley to the other, over a distance of about 660 feet, of which 500 feet lies west of the creek. Both upstream and downstream, however, bedrock benches have been recognized. Thus in the narrow part of the valley, at the site of Discovery claim, two bedrock surfaces have been recognized above the level of the bedrock under the creek. Farther downstream, on the west bench claim opposite claim 10 below Discovery, the pay streak lies upon bedrock which is 10 feet above the level of the creek and is about 24 feet above the level of the bedrock below the creek. These two bedrock surfaces are separated from one another by a bedrock rim, at a distance of about 250 feet from the creek. The lower bedrock surface at this locality is reported to be essentially horizontal over a width of about 250 yards; but the alluvial fill upon this lowest bedrock surface is less here than it is farther upstream.

These underground conditions may be variously interpreted. If the general alluviation of the valley took place in a single geomorphic cycle, after the lowest bedrock surface had been established, the pay streak along the west side of the valley may be interpreted merely as representing a subcycle in an intermittent though generally continuous process of lowering by erosion of the bedrock surface of the valley floor. But it is possible that the valley was first alluviated after the formation of the pay streak and before the present valley floor was formed, and that the stream migrated laterally eastward upon such an alluvial fill, and afterward, during a period of rejuvenation, dissected part of the old fill and formed the present valley floor. Under this interpretation, a second stage of alluviation must also be postulated to have produced the unconsolidated material that now covers the lowest bedrock surface in the cross section of the valley. Under the first interpretation the pay streak along the west side of the valley of Chicken Creek may be regarded as a true bench placer; but under the second interpretation, which is believed to apply on many other streams in the Yukon-Tanana region, the pay streak is in reality a buried placer that simulates a bench placer, because the latest erosional activity of the stream has dissected a bedrock surface that in places is lower than the ancient bedrock floor of the valley.

This pay streak along the west side of Chicken Creek has been mined from claim 1 above to claim 11 below Discovery. The best ground is said to have been found on claim 9 below Discovery, but some of the richest spots were found on claim 7 below Discovery. Much of this mining has been done by underground methods, because the ground was fairly deep and frozen and because the lack of an adequate supply of water on Chicken Creek has made large-scale hydraulic mining impracticable. The gradient of the bedrock sur-

face also would have made it necessary to stack tailings, thus demanding an even greater supply of water. Where the bedrock surface lies above the valley floor, however, as for example on claim 10 below Discovery, small-scale hydraulic mining has been done, but the scant supply of water has always been a handicap. Little is known regarding the value of the ground in the deeper part of the valley, near the creek, because much of it is thawed, so that underground prospecting could not be done. The alluvial cover is 40 to 50 feet thick here but is probably thicker at some places. It is likely that in the future the valley of Chicken Creek will be worked by dredging, but a part of it, particularly on "bench" ground, may better be worked by the use of a dragline excavator, on a caterpillar base, with pumping equipment to give an adequate supply of water.

During the summer of 1936 placer mining was done at several localities on and in the vicinity of Chicken Creek. Two open-cut plants were operated on Chicken Creek, and summer drifting was done at a third plant. Some winter drift mining was also reported. Two hydraulic plants were in operation on Myers Fork, and some small-scale open-cut work was done on Stonehouse Creek. On Lost Chicken Creek, east of Chicken Creek, another hydraulic plant worked throughout the summer; and on Ingle Creek, west of Chicken Creek, some small-scale open-cut mining was done. The largest plant in operation in 1936 was the new dredge recently installed on the South Fork of the Fortymile River near the mouth of Lost Chicken Creek. Some details of these activities are given in the following pages.

One small hydraulic plant was operated on Discovery claim of Chicken Creek, at the mouth of Stonehouse Creek. The operator of this plant controls 5 claims in this vicinity, including claims 1 and 2 above Discovery on Chicken Creek and claims 1 and 2 above Discovery on Stonehouse Creek. The plant is working on a well-defined bedrock bench, the eastern rim of which is about 75 feet from the creek. The surface of this bench is about 25 feet above the level of the creek and has a width from east to west of about 65 feet. There is also a lower and narrower bench, about 10 feet above the level of the creek and about 25 feet from it. On the higher bench, where mining is in progress, the alluvial cover consists of 2 to 3 feet of subangular gravel, overlain by 10 to 20 feet of muck, which is thickest farthest from the creek. Most of the gravel consists of material of various sizes up to a foot in diameter, but some boulders as much as 2 feet in diameter have been uncovered. The bedrock is an amygdaloidal basalt. The gold lies mainly on bedrock and in the crevices in bedrock, but it is irregularly distributed. Probably 75 cents to the square foot would be a fair average tenor. Four assays of the gold,

based upon the production in 1935, were given to the writer, and from these it appears that the average fineness of the bullion is 835 parts of gold and 158 parts of silver in a thousand. Water for hydraulic mining is obtained from Stonehouse Creek, through a ditch about half a mile long, which produces a hydraulic head of 100 feet at the cut. Two 2-inch giants, fed by a 6-inch pipe from the ditch, are used for the hydraulic work, but as the ground is frozen the heat of the sun is depended upon largely for thawing. Owing to a scarcity of water at the time of the writer's visit, the two giants could be operated only for about 15 minutes in every 2½ hours.

On claim 5 below Discovery one man was doing summer drifting. The shaft was located on the west side of the valley, about 150 feet from Chicken Creek. The pay streak here is being worked for a width of 85 feet, but present and older work indicate a total width of at least 200 feet in this part of the valley. At the site of present mining the ground has a tenor of 80 cents to $1 to the square foot of bedrock over the width mined, and it may have a tenor of about 50 cents to the square foot over the entire 200-foot width. The shaft at the site of mining shows 7 to 8 feet of gravel on bedrock, overlain by 16 to 17 feet of muck and ice. The gravel is not coarse, cobbles as large as a foot in diameter being scarce. The bedrock is sandstone, of the Tertiary coal measures, and the gold occurs mainly on and in bedrock, though some fine gold is found as high as 4 feet above the bedrock. The coarsest piece of gold so far found at this place weighed half an ounce. The operator of this plant was working alone, wheeling the pay dirt by barrow to the buckets, then climbing the ladder to the surface and hoisting the bucket by means of a small boiler, hoist, and gin pole. Water for sluicing was obtained from a ditch three-eighths of a mile long, with an intake on Myers Fork.

Another man working alone took out a small winter dump on claim 3 below Discovery during the winter of 1935–36. Here the alluvial cover over bedrock was reported to have a thickness of 21 feet and to be completely frozen. This work was done close to Chicken Creek.

A fourth site of placer-mining activity on Chicken Creek was on the bench claim opposite claim 10 below Discovery, where a small hydraulic plant was operated when an adequate supply of water was available. The bedrock rim of this bench is about 250 feet from Chicken Creek. Its bedrock surface is about 10 feet above the level of the creek, and mining operations are being carried on from the bedrock rim westward for a distance of about 100 feet, though the bedrock surface continues westward without any other abrupt rise to the spur between Chicken Creek and Mosquito Fork. The alluvial cover here has a thickness of about 20 feet, most of which is gravel

overlain by 1 or 2 feet of muck and turf. The cobbles of the gravel are mainly small, but some of them have a diameter as great as 15 inches. The bedrock consists of sandstone and shale of the Tertiary coal measures. A single 2-inch giant is used, and the water for this is obtained from a ditch about half a mile long, which gives a head of 25 feet at the cut. Similar open-cut work, both by the hydraulic method and by shoveling into boxes, has been done at this same general site for many years.

On Myers Fork two hydraulic plants, both of which have been operated for years, were working in 1936. This work is being done on both sides of Myers Fork, on bench ground that is well above the creek level, but a line of old shafts located along the northeast side, close to the creek, show the site of the earliest work in this valley. It is reported that this early work, which extended from the mouth of Myers Fork upstream for 1,000 feet or more, was done mainly upon a bedrock surface that is somewhat higher than the bedrock under the creek. Along the northeast side of Myers Fork, opposite claim 2 above the mouth, the bench ground has been worked for many years, so that now a cut is exposed which has a length of 150 yards parallel to the creek. The rear face of this cut is about 175 yards from the creek, but the distance worked from southwest to northeast is about 145 yards. The surface of bedrock within this distance has not been a single horizontal surface, but consists of four fairly well defined bedrock terraces, separated from one another by rises of 6 to 8 feet. Three of these terraces, which have been exposed by mining operations, have widths normal to the creek of 150, 150, and 125 feet, named in order away from the creek. All three slope gently toward the creek. The fourth terrace, of which little has yet been exposed, lies about 10 feet higher than the third one and 40 feet above the level of the creek. No physiographic expression of these terraces was apparent at the surface of the ground prior to mining operations. Recent mining at the northwest end of the cut has uncovered a bedrock spur, which separated the old valley of Chicken Creek from that of Myers Fork; and here the bedrock rises almost to the surface of the ground. Still farther to the northwest, in the old valley of Myers Fork, the bedrock surface drops abruptly, and a short distance from the old bedrock spur the alluvial cover becomes 30 feet thick.

Within the old cut, southeast from the bedrock spur, the average thickness of the alluvial cover has been found by mining operations to be about 15 feet, of which the lower 3 to 4 feet consisted of well-worn gravel in which most of the pebbles are less than a foot in size, though some of them attain a diameter of 2 feet. Above the gravel occur muck and silt to an average thickness of about 11 feet. The

bedrock appears to be mainly a coarse-grained basic intrusive rock close to diabase but in part distinctly gabbroic. This bedrock is cut in at least one place by a light-colored dike rock of granitic affinity. A few inches above the surface of bedrock there is a thin clayey or silty stratum, and most of the gold is found on the upper surface of this material and in the fine gravel just below it. Practically no gold occurs on or in bedrock, and in this respect this placer differs distinctly from most of the others of this region. It is estimated that the average tenor of this gold placer, for the whole cut, has been about 30 cents to the square foot of bedrock. The gold is not very coarse, although one nugget weighing about 1½ ounces was found. Mr. Frank Purdy, one of the two owners of this plant, kindly made available to the writer a series of assays, from which the fineness of the gold is apparent. These are reproduced herewith.

Fineness of gold from bench ground of Myers Fork

[Parts per thousand]

Year	Gold	Silver	Year	Gold	Silver
1925	830½	161½	1931	834	162
	829½	150½		829¾	162
	835½	154½	1932	828¼	167
	842	148		823½	171
1926	838¾	158	1934	835½	159
	835½	156½		835½	159
	837½	152½	1935	838	152
1927	828¾	166	Mean	833	160
1929	827¼	171			
1930	834	162			

The last assay of those above tabulated represents gold that was mined northwest of the bedrock spur separating the old valleys of Chicken Creek and Myers Fork, but it appears to be of about the same grade as the other gold mined southeast of this spur. Moreover, the mean of these assays is not materially different from the fineness of the gold now being mined on Discovery claim of Chicken Creek. The concentrates recovered with the gold at this plant are largely magnetite and ilmenite, but also include garnet, barite, and zircon.

Mining at this plant is done by a combination of ground sluicing and hydraulicking. Water for these operations is obtained from a ditch about 2 miles in length, with an intake on Chicken Creek above the mouth of Stonehouse Creek; and this water is supplied to a 2-inch giant under a head of 70 feet. Sluice water, however, is supplied by a ditch about half a mile in length, with an intake on Myers Fork. On account of the scarcity of water on Chicken Creek during most of the summer, the owners of this plant were engaged in 1936 in excavating a small reservoir on the hillside above the plant, into which the main ditch could be turned, in order to store water and

thereby increase the length of the intervals during which the giant could work.

Another placer-mining plant was operated on the southwest side of Myers Fork, almost opposite the site of the plant above described. This work is also being done on bench ground, but here the bedrock in the cut is 80 feet above the level of Myers Fork. The gravel lying upon bedrock has a thickness of 1½ to 3½ feet and in the present cut is thinnest at the rear face of the cut, at the greatest distance from the creek. Above the gravel is 20 to 25 feet of coarse sand and fine gravel (called "chicken feed"). The gravel is fairly well rounded and includes no large boulders. The bedrock is diabase or gabbro and is deeply weathered and iron-stained to a depth of 3 to 5 feet below its upper surface. One assay of the bullion recovered from this high bench ground shows 819 parts of gold and 176 parts of silver in a thousand; and this is lower-grade gold than any that has been recovered from the lower benches on the opposite side of Myers Fork. This placer is worked by hydraulic methods, the water for which is supplied by a ditch about a mile long, with an intake on Myers Fork. A small monitor is used, under a head of 25 feet, but much dependence is also placed upon natural thawing.

Small-scale mining has also been done on Stonehouse Creek for many years, but no work was in progress at the time of the writer's visit in 1936. Stonehouse Creek has a deeply incised, narrow valley that is nevertheless asymmetric in cross section, with a steep west wall. Most of the mining on this creek has been done along narrow bedrock rims on the east wall of the valley, at varying heights above the creek. At the site of some of the older mining, at about 70 feet above the level of the creek, the bedrock has been well exposed by mining operations. It ranges from a blocky banded argillite to a laminated phyllite that strikes about northwest and dips southwest at a moderate angle. The bedrock is cut by granular intrusives, of which one has a width of 12 feet. Numerous small quartz veins also cut the bedrock. The gravel deposits on these benches are in general from 2 to 8 feet thick and are subangular, with some large boulders. A sample of concentrates collected by the writer in 1928 was found to consist mainly of magnetite, ilmenite, and pyrite, but also included specular hematite and numerous small grains of cinnabar.

On the east side of Chicken Creek, almost opposite the town of Chicken, is a bench about 275 feet above the level of the valley floor. Lost Chicken Creek heads just east of this bench and flows southward to Mosquito Fork, in an asymmetric valley of which the east side is the steeper. Claims were located on the bench at the head of Lost Chicken Creek as early as 1901, and gold was found at a depth of 33 feet. For some years thereafter this bench, then called Lost

Chicken Hill, was worked by drifting operations and eventually was almost completely mined out. But it was subsequently found that the placer found on Lost Chicken Hill was merely the head of a pay streak that continued on down the west side of the valley of Lost Chicken Creek, and therefore the mining operations of later years have been confined to the valley proper. The pay streak on Lost Chicken Creek yields about 75 cents in gold to the square foot of bedrock.

The placer claims on Lost Chicken Creek are named with reference to the mouth of the creek, and the present mining operations are located on Jennie Bench, on the west side of the valley, opposite claim 4 above the mouth. At this general site of mining the placers occur on a bench about 150 feet wide, which lies 300 to 600 feet from the creek. The bedrock on this bench is about 80 feet above the level of the creek and about 120 feet above the level of bedrock under the creek and is said to have a gradient parallel to the creek of only about 1 percent. No benches of intermediate height have been found between this bench and the creek. The alluvial cover on this bench consists on the average of about 20 feet of gravel, "chicken feed," and sand, in alternating beds, overlain by about 4 feet of muck, although at some places muck occurs in the middle of the section. The gravel is not coarse, as cobbles with a diameter of 1 foot are rare. The pebbles and cobbles are also fairly well rounded, though some of them are subangular. The bedrock is a much-decomposed granitic rock. The gold is found in the lower few feet of gravel and on the surface of the bedrock. The gold occurs mainly as small flattened pieces, but cannot be called flaky. Good-sized nuggets are rare, but one weighing nearly 1½ ounces was found some years ago. Seven assays of the gold, based upon the production of 1935 and 1936, are given below.

Fineness of gold from Lost Chicken Creek

[Parts per thousand]

Year	Gold	Silver	Year	Gold	Silver
1935	864½	130	1936	840¼	153
	820¾	121		837¾	155
	845¾	149			
	843¾	151	Mean	842	144
	841¼	152			

The second of these assays shows 58 parts of dross in a thousand and probably represents some gold that contained extraneous impurities, such as lead shot. The average grade of this gold, however, is even higher than that of the gold from Chicken Creek and is considerably higher than that of the gold produced from the comparable high bench on Myers Fork. This difference suggests a local source of the gold on Lost Chicken Creek, perhaps more directly connected

with the granitic intrusive rocks than the source of the vein gold that has been concentrated in Chicken Creek.

A line of old workings along the west side of the valley of Lost Chicken Creek shows the extent of mining done at this site in the last 30 years. During the summer of 1936 mining was in progress at the south end of these workings, where a cut 60 feet wide and 125 feet in a direction parallel to the creek was mined; but this cut represented only a part of the full width of the pay streak. This work was done by hydraulic methods, using a giant with a 2½-inch nozzle. Two ditches are used, of which one 2½ miles long starts from an eastern headwater tributary of Chicken Creek and brings water across Lost Chicken Hill into the valley of Lost Chicken Creek. This ditch leads to a small reservoir, where water is stored, and yields a hydraulic head of 100 feet at the cut. A shorter ditch captures the water from the head of Lost Chicken Creek, giving sluice water for these operations. Two other ditches have been built along the east side of Lost Chicken Creek for the purpose of supplying water for working lower benches farther down the valley, but this work has not yet been begun. Four men, including the two owners, and a cook are employed at this plant.

Ingle Creek, 2 or 3 miles west of Chicken Creek, is a small stream on which small-scale mining has been carried on for many years. It has a length of about 4 miles and empties into Mosquito Fork about 4 miles above the confluence of Mosquito and Dennison Forks. The valley of Ingle Creek is very narrow, and the walls are steep. The pay streak lies in the present valley floor and has been worked mainly by shoveling-in operations, aided by water from small dams which impounded and automatically released creek water. The bedrock in Ingle Creek at the site of mining operations consists chiefly of green schist and quartzite, cut by numerous veinlets of quartz; and in such bedrock the placer gold has penetrated deeply into crevices, thus necessitating much hand quarrying to obtain a high recovery of gold. The gravel is subangular and, besides schist and quartzite, includes granitic rocks that doubtless have been derived from the same type of bedrock farther upstream. Some years ago, when the writer visited Ingle Creek, open-cut mining was in progress on claims 2 and 5 above Discovery, but during the summer of 1936 only claim 2 above Discovery was being worked. The gravel deposits of Ingle Creek are shallow, being usually only 2 to 3 feet thick, but because they include some large boulders the work is slow and laborious. The gold is coarse, and one nugget weighing about 3½ ounces has been found. Three assays of the gold recovered from Ingle Creek have been recorded in the files of the Geological Survey, based upon production in 1919, 1924, and 1929. The weighted mean of these assays shows a fineness of 851 parts of gold and 144 parts of silver in a thousand.

About midway in the valley of Lilliwig Creek, a small tributary of Ingle Creek from the west, there occurs a small intrusive mass of granitic rocks, mainly quartz diorite. Downstream from this intrusive, Lilliwig Creek had workable placers that were mined in earlier years, but no placers were found upstream from the intrusive rocks. Further evidence of the relationship between the gold and the granitic rocks at this locality is supplied by the fact that a body of mineralized quartz diorite was found in this intrusive mass and was prospected as a gold lode. The lode material consists of many parallel stringers of vein quartz and calcite, trending east and cut by another system of discontinuous stringers running north. The lode rock is much sericitized, and both the vein material and the sericitized bedrock contain gold-bearing sulphides, principally pyrite, though some chalcopyrite is also present. One assay of the sulphides taken from the dump was made by E. T. Erickson, of the Geological Survey, and showed 1.87 ounces of gold and 2.05 ounces of silver to the ton. This was of course a picked sample and cannot be considered to represent the average value of the lode material; but such results indicate that lodes of workable grade may be present in this region.

The largest-scale mining now in progress in the Chicken Creek area is the dredging on Mosquito Fork, which is being done by the Alaska Gold Dredging Corporation. A new dredge was installed in the spring of 1936 at a point about 800 feet downstream from Gibraltar Rock, a prominent bluff on the north side of the river about three-quarters of a mile below the mouth of Lost Chicken Creek. Up to July 20 the dredge had worked 1,700 feet upstream, taking a cut 150 feet wide, most of which was in the river, as only a narrow strip of unfrozen ground was found along the south bank. Shortly after that date the dredge crossed to the north side of the river and began a series of parallel cuts about 200 feet wide, which were to be worked northward as far as practicable.

The pay streak at the site of these dredging operations was not blocked out in advance by prospecting, so that no statement of the area that will be worked can now be given. The limits of unfrozen ground are also unknown, thus adding further uncertainty to the workable limits of the pay streak. The dredge crossed from the south to the north side of Mosquito Fork largely because it was thought that the large bar below the mouth of Lost Chicken Creek might contain considerable gold that had issued from the valley of Lost Chicken Creek and also because a considerable part of this bar was thought to be unfrozen. In the coming years the limits of the workable pay streak and of unfrozen ground will have to be accurately determined, and frozen ground of workable grade will have to be thawed ahead of the dredge, either by stripping or by hydraulic methods, if these operations are to be successfully continued.

Coming upstream along the south bank of the South Fork, the dredge found a rather small amount of gravel in the river bed, ranging in thickness from 2 to 6 feet, but the dredge also crossed riffles where only a veneer of gravel lay upon bedrock. On the bar along the north side of the river, where the dredge operated in the late summer, the thickness of the gravel was about 8 feet. The gold recovered along this 1,700-foot stretch was very fine grained and light and was said to have a fineness of 0.900. A moderate amount of fine black sand was also recovered with the gold.

This dredge is of the pontoon type, manufactured by the Washington Iron Works. The hull is composed of 31 sections of sheet steel, and the superstructure is also steel. The dredge has 64 buckets, of 4 cubic feet capacity each, which dig at the rate of 24 a minute. The digging ladder can operate to a depth of 16 feet below the water level. One spud, two headlines, and two stem lines are used in operating the dredge. The trommel screen is 22 feet long and is built in six sections, with holes ranging in size from 3 inches to half an inch. The gravel is reached by five nozzles at the lower end of the screen and by a sprinkler at the upper end. From the trommel, the gold and fine gravel go to a sluice line and flume. A seven-drum hoist is used, of which six drums are utilized for the two head lines, two stem lines, spud, and digging ladder. For power, wood is burned under a 200-horsepower boiler, which carries 200 pounds of steam. The daily consumption of wood is about 7 cords. Two 100-horsepower compound steam engines are used, one of which drives the screen and pumps, and the other is used for the digging ladder and stacker. A smaller engine operates the winch. For the sluice line and trommel, two pumps with a capacity of 1,500 and 2,000 gallons a minute are used. Electric power for lighting is supplied by a 2-kilowatt direct-current generator.

The Alaska Gold Dredging Corporation began digging with the dredge on June 5 and continued until October. Twenty men were employed in this work, of whom 13 were required to operate the dredge, in three shifts of 8 hours each. The camp is on the south side of the South Fork, at the site where the dredge was constructed.

FRANKLIN CREEK AREA

Franklin Creek is the oldest producing creek in the Fortymile district, having now produced gold for more than 50 years. This creek is about 6 miles in length, flows almost due east, and enters the South Fork of the Fortymile River about 10 miles in an air line upstream from the confluence of the North and South Forks. The western or headwater portion of the valley of Franklin Creek is fairly open, but the eastern part of the valley, where placer mining

has been carried on, is very narrow, with steep walls. The valley is also asymmetric in cross section, the steeper wall being on the south side. The stream gradient in the lower 2 or 3 miles of the valley is high, approximately 140 feet to the mile, but in the upper valley the gradient is much lower. These conditions suggest that Franklin Creek is still in process of adjustment to a new and lower base level of erosion, produced by the late rejuvenation of the Fortymile River. Under normal conditions little water flows in Franklin Creek, but in May 1935 a disastrous flood occurred, taking out all dams and filling in the old mining cuts so completely that little mining has been done since that time.

The bedrock of Franklin Gulch consists of several varieties of schistose rocks, of the Birch Creek schist, including mainly mica and quartz-mica schist, in part garnetiferous, hornblende schist, and some crystalline limestone. The head of the valley and the headwater portions of some of the tributary valleys from the south lie in granitic rocks; and the schistose rocks of the main valley are also cut here and there by dikes of granitic and basic rocks. The bedrock is cut by quartz veins. Hence the creek gravel is diverse in character and includes schistose rocks of the Birch Creek schist, granitic rock, basalt, and vein quartz, most of which are more or less angular in outline.

The pay streak of Franklin Creek extended from the mouth of the creek upstream for about 3 or 4 miles, though mining claims are held to the head of the valley. Discovery claim was located about 3½ miles from the mouth of the creek. The pay gravel occupied the present valley floor of Franklin Creek, and the best part of the pay streak extended over a width of about 50 feet. In the earlier days of mining in Franklin Creek, some high-grade placers were located, and some of the gravel carried as much as $5 in gold (on the old gold valuation) to the cubic yard. All the best ground, however, has now been mined out, and present operations are confined to working the leaner and deeper gravel along the edges of the main pay streak. All mining has been of the shoveling-in type, though dams have also been used for ground sluicing.

The gravel deposits of the main pay streak were fairly shallow, ranging from 2 to 12 feet in thickness, but the gold was found mainly on and in bedrock and to a lesser extent in the 2 feet of gravel overlying bedrock. The gold is coarse and angular, and some of it is found with adhering particles of vein quartz. Small nuggets are common, and in the early days some large nuggets were found. One of these, according to Spurr,[13] weighed 30 ounces and was found

[13] Spurr, J. E., Geology of the Yukon gold district, Alaska: Geol. Survey 18th Ann. Rept., pp. 332–335, 1898.

at the mouth of the creek by Conrad Dahl in 1894. Another nugget weighing about 14 ounces was taken from the mouth of a small gully on the south side of Franklin Creek. The fineness of the gold recovered from Franklin Creek is not known to the writer, but a quotation of $17 an ounce was mentioned by Spurr, based upon the old price of gold. This was probably only a commercial or exchange rate, but it shows that the fineness was at least as great as 820 parts of gold in a thousand. Probably the fineness is not essentially different from that of the gold recovered from Chicken Creek. The concentrates taken with the gold on Franklin Creek are 50 percent magnetite but also include considerable ilmenite, garnet, some limonite, and small amounts of barite and cinnabar. One piece of galena and pyrite was also observed in the concentrates.

Another locality that may be considered a part of the Franklin Creek area is the valley of Napoleon Creek, a tributary of the South Fork of the Fortymile River, entering that stream about 4 miles in an air line above Franklin. A trail along the east side of the South Fork connects Franklin with Napoleon Creek, and the miners on Napoleon Creek get their mail and supplies from Franklin.

Napoleon Creek is formed by two headwater tributaries, which rise in the ridge northwest of Wade Creek and flow in a general southwesterly direction, uniting to form Napoleon Creek proper, which then flows westward for about 2 miles in an air line to its mouth. The headwater forks of Napoleon Creek are steep, narrow gulches, but from the forks downstream the valley is wider and more open, though asymmetric in cross section. The steeper wall of the lower valley is on the south side, and originally the creek flowed mainly against this south wall, but it has now been diverted by mining operations. The valley floor below the forks ranges in width from 100 to 200 yards. At the mouth the valley floor is 90 yards wide and the walls on both sides are steep bluffs composed of conglomerate.

Placer gold was found on Napoleon Creek as early as 1893, but systematic placer mining is thought to have begun about 1898 and has continued to the present time. Discovery claim is located at the mouth of Napoleon Creek, and the stream gravel has been worked intermittently for seven claims upstream. Discovery claim and claims 1 and 2 above Discovery had high-grade placers, but little was found on claims 3 and 4 above Discovery. Considerable gold was recovered from claim 5 above Discovery, and a little from claim 6 above Discovery, but farther upstream no mining has been done, either in the valley floor or on the benches. It is reported that gold to the value of $200,000 has been recovered from the placers of Napoleon Creek.

The bedrock in the valley of Napoleon Creek consists of several types and ages of rocks. At the mouth of the creek the country rock

is a Tertiary conglomerate, which strikes N. 15°–25° E. and dips eastward at a steep angle. This is succeeded upstream by other Tertiary rocks consisting of fine conglomerate or grit, sandstone, and salty shale, with which are interbedded some seams of coal. These rocks follow up the north side of the valley for about 1½ miles, but on the south side basic rocks, similar to those on Chicken Creek, begin about three-quarters of a mile from the mouth and continue upstream for about half a mile. Upstream from the Tertiary sedimentary rocks and the basic igneous rocks are found some early Paleozoic rocks, which include greenstone and limestone. Above the forks of Napoleon Creek, however, the country rock consists of schistose rocks of the Birch Creek schist, which are cut by dikes of granitic rocks. The extreme heads of the two forks reach into a good-sized intrusive mass of granitic rocks, which form much of the bedrock on the ridge northwest of Wade Creek.

The early mining on Napoleon Creek was done entirely in the stream placers of the present valley floor. The gravel and muck overlying bedrock is said to have ranged in thickness from 8 to 18 feet, and on claims 1 and 2 above Discovery, where some of the highest-grade placers were found, the pay streak appears to have been worked by shoveling-in operations in parallel cuts over a width of about 150 feet. The gravel is naturally diverse in character but also shows considerable variation in size and shape, ranging from pebbles to heavy boulders and from subangular to well-rounded detritus. The gold was found to occur mainly on and in the crevices of bedrock, below the gravel.

The present work on Napoleon Creek consists of small-scale mining operations on the benches along the north wall of the valley. These benches are scarcely visible as surface features, but prospecting and mining have shown that fairly well defined bedrock terraces exist under the surficial material along this north wall. Thus on claim 1 above Discovery two rock-cut terraces have been exposed by mining, of which the lower one is 25 to 30 feet above the level of the creek, and the higher one about 60 feet above the creek level. Both these bedrock terraces are about 30 feet wide. The alluvium above these terraces consists of 2 to 10 feet of gravel and muck. The gravel is fairly well rounded and contains considerable granitic detritus. The bedrock, which here strikes about northeast and dips 60° SE., consists of sandstone, shale, grit, and conglomerate, containing much carbonaceous material and imperfect plant remains. The surface of the bedrock is very irregular. Gold is found mainly at the bedrock surface, both on the terraces and to a lesser extent on the bedrock slope between them. The fineness is reported to be 860 parts of gold in a thousand, but no assay sheets were seen.

At this site one man was operating a small plant by the hydraulic method, but the supply of water was inadequate, as it was obtained not from the main creek but from two or three dams in a small side gulch close to the workings. The east ends of some older cuts were being mined. A giant with a 3-inch nozzle is used for this work, and when water is available, mainly during periods of rainy weather, a head of 100 feet could be obtained. Two other men were also engaged in shoveling into sluice boxes on a low bench along the north wall of the valley on Discovery claim.

No other mining operations are now in progress in the Franklin Creek area, but one man has recently been doing considerable prospecting on Fortyfive Gulch, a tributary of Buckskin Creek, with the idea of proving the ground to be suitable for dredging. Fortyfive Gulch is a stream about 7 miles long, which flows about S. 60° E. and joins Buckskin Creek about 9 miles above its mouth. The man who is prospecting at this locality claims to have 5 miles of dredging ground on Fortyfive Gulch and 2 miles on Buckskin Creek below the mouth of Fortyfive Gulch. The pay streak is said to be from 200 to 300 feet wide, and the overburden from 12 to 16 feet thick. The gold, however, is known to have a fineness of only 0.620 and is therefore 25 percent lower in grade than that on most of the other creeks in the Fortymile district. This means that the pay streak will have to contain a third more gold than any other dredging ground in order to yield comparable profits.

In earlier years attempts were made to install dredges at various places in the Fortymile Valley, and some of these dredges were operated successfully for several years. A small dredge, called the Little Dipper dredge, was built at Pump Bar, about 2½ miles downstream from Franklin, on the South Fork of the Fortymile River, in 1907, but it was wrecked by the spring freshets of the following spring. Two other dredges were also installed in the Fortymile Valley in 1907, one of which was located at the international boundary, and the other in Yukon Territory about 4 miles above the mouth of the Fortymile River. Both of these dredges appear to have been operated successfully for several years, as reference is made by Ellsworth and Davenport[14] to two Canadian dredges that were being operated by the Canadian Securities Co., Ltd., on the lower Fortymile River, as late as 1912. One of these two Canadian dredges was afterward dismantled and moved, by a Mr. Blankman, to the "kink" of the North Fork of the Fortymile River, about 12 miles in an air line from its confluence with the South Fork. It was not a success at this site and still remains there.

[14] Ellsworth, C. E., and Davenport, R. W., Placer mining in the Yukon-Tanana region, Alaska: Geol. Survey Bull. 542, p. 218, 1913.

Reference has already been made to the Russell King dredge, which was installed on Walker Fork in 1907 and was operated during the seasons of 1907, 1908, and 1909. In the winter of 1910 this dredge was moved by Robert Mulvane to the South Fork of Fortymile River, where on June 20, 1911, it began again to operate at Pump Bar, at practically the same site where the Little Dipper dredge had been worked in 1908. Whether this dredge worked continuously upstream to Franklin, or whether it was subsequently moved there is not known to the writer, but it is definitely known that it was operated a short distance upstream from Franklin during the season of 1917 and that it was not operated at that site after 1917. In 1936 its machinery was moved to Wade Creek and installed in a new hull by the Jack Wade Dredging Co. Another dredge which is on record in this area is the so-called Atwater dredge. The writer does not know when or where this dredge was installed, but it is a matter of record that it passed the mouth of Buckskin Creek, working up the South Fork of the Fortymile River, in 1912; and that it continued to operate upstream on the South Fork in 1913. It is possible that the designations "Mulvane" and "Atwater" refer to a single dredge that operated on the South Fork for a number of years, beginning in 1911. At the present time only one dredge, owned by the Alaska Gold Dredging Corporation, is being operated on the South Fork.

FORTYMILE RIVER AREA

The post office of Steel Creek is located at the mouth of Steel Creek, a tributary of the Fortymile River which enters from the south about 5 miles downstream from the mouth of O'Brien Creek. This post office is the distributing point for a considerable number of placer miners along the Fortymile River, from the mouth of the North Fork to the international boundary.

The Fortymile River in this stretch follows a meandering course in a steep-walled, narrow valley that is deeply intrenched in a wider and more open older valley. A pronounced terrace about 600 feet above the present surface of the river indicates the level at which an ancient stream once flowed. Farther upstream, however, the difference in elevation between this terrace and the river decreases, and in the headwaters of the larger forks of the Fortymile River, as for example on Dennison Fork, this terrace gradually merges into the present valley floor. This relation shows that the ancient stream had a lower gradient than that of the present stream. There are also other terraces higher than 600 feet above the present stream that are prominent at many places in the Fortymile Valley. Such higher terraces indicate still higher valley floors over which the ancient river flowed. It is possible that the 600-foot terrace is as old as Pliocene, and the highest terraces may date back to the Miocene.

It is evident, therefore, that the valley of the Fortymile River exemplifies rejuvenated stream action, produced by a lowering of the base level of erosion in this area. The terraces, however, indicate that the lowering of the base level was neither constant nor continuous but was characterized by long periods during which little or no change occurred and also by periods of accelerated change.

The bedrock in the main Fortymile Valley consists of metamorphic rocks, including several varieties of schist and crystalline limestone. The general trend of the cleavage of these rocks is obliquely transverse to the course of the Fortymile River, and as the rock cleavage also dips at higher angles, approaching verticality at many places, the bedrock surfaces in the valley floor have acted as natural riffles, to hold and concentrate gold. Bedrock is exposed at many places in the bed of the Fortymile River, but even on the bars and low-sloping benches close to the river the cover of gravel is thin. Hence the bars and low benches of the Fortymile have for many years been sites for small-scale mining, and at some localities larger hydraulic plants and dredges have been installed. Also, so far as small-scale mining is concerned, these low bars are perennial sites, because after being worked, they may again be enriched by flood waters that remove old alluvium and deposit new gravel and gold from points farther upstream. During the season of 1936 about 15 men were thus engaged in small-scale mining along or near the Fortymile River between the mouth of the North Fork and the international boundary. Various methods of mining were employed in this work, but most of it was done by shoveling into boxes, by the use of a rocker, and by small-scale hydraulic mining.

Within this stretch along the Fortymile are also a number of tributary streams, which have been worked in the past and some of which are still being worked in a small way. Among the better known of such streams are Canyon Creek and its tributaries, of which the one that has the most numerous placers is Squaw Gulch. Canyon Creek is a deeply incised stream, which has a rather open lower valley, with a valley floor nearly half a mile in width. The headwater tributaries, however, are markedly V-shaped and canyonlike. From the older records it appears that much work has been done in the main valley of Canyon Creek and also in Squaw Creek, but little mining is now in progress at these localities, though many claims are held, and considerable prospecting is going on. One of the interesting results of recent prospecting has been the discovery of high auriferous gravel along a west bench of Canyon Creek. The value and extent of this deposit have not yet been entirely demonstrated.

To one looking at the Fortymile Valley from a physiographer's point of view, it would seem that the gravel deposits lying upon the high terraces might possibly be worth some intensive prospecting as

possible sites for low-grade placers that might be worked on a large scale. The size and gradient of the ancient stream were certainly favorable for the deposition and retention of gold, and although a large part of the old valley floor has been destroyed in the sculpturing of the present gorge, yet large uneroded areas still remain at these higher levels, which are bedrock surfaces covered by a moderate thickness of gravel. The development of such high-level placers by hydraulic methods would of course be handicapped by a scarcity of water, as at Idaho Bar, in the Rampart district. But in the Fortymile Valley conditions are more favorable than in the Rampart district, because the ridge tops rise 2,000 feet or more above the 600-foot terrace, so that some water could be obtained from nearby side streams. If low-grade placers of considerable extent could be located on these higher terraces, it is possible that they might be worked by the use of some of the various types of mechanical excavators, supplemented by pumping.

DOME CREEK AREA

Dome Creek is a stream about 15 miles in length, which rises northwest of Fortymile Dome and flows in a general southwesterly direction to join O'Brien Creek about 3 miles from the mouth of that stream. The upper two-thirds of the valley has an asymmetric cross-section, being steeper on the southeast side, with long, gentle spurs descending on the northwest side from the ridge top to the valley floor. The gradient of Dome Creek in the central part of its valley, in the vicinity of the mining operations, appears to be lower than it is either upstream or downstream from this stretch. The gradient of the bedrock on the bench along the northwest side of the valley appears to be even lower. Dome Creek has several tributaries from both sides of its valley, but the only one on which mining activities have been carried on is Little Miller Creek, a small stream, which has a total length of less than 1½ miles, and flows south, entering Dome Creek about midway between its source and mouth.

The original discovery of gold on Dome Creek was made at the mouth of Little Miller Creek in 1893, and the earliest mining was done at this site. The stream placers mined on the two lower claims of Little Miller Creek are said to have been of very high grade, and the two discoverers quickly accumulated a competence and left the country. Later it was realized that the stream placers of Little Miller Creek had been reconcentrated from high-level gravel that formed a bench along the northwest side of Dome Creek, and mining of these bench placers then began. To date the bench placers have been traced on Dome Creek for 4 miles upstream and 2 miles or more downstream from Little Miller Creek; but most of the bench mining has been

done downstream from Little Miller Creek, chiefly because the gravel increases in thickness upstream.

The pay streak in the vicinity of and downstream from Little Miller Creek is a true bench placer, which here trends about due east. The bedrock terrace and overlying gravel have a width, from north to south, of about 300 feet, and the south edge of the pay streak is about 1,200 feet from the creek and about 125 feet vertically above it. The bedrock at the south edge of the pay streak forms a definite rim, from which the bedrock surface slopes gently northward for some distance.

Where Little Miller Creek cuts through this bench channel, the gravel has a maximum thickness of 80 feet at the north end of the cut, and one clean-up from the high gravel along the east side of Little Miller Creek is said to have yielded $27,000 at an average value of 35 cents to the square foot of bedrock, or about 14 cents to the cubic yard; but these figures should be increased by about 75 percent to conform with the present value of gold. Downstream from Little Miller Creek several old cuts show the progress of mining since 1922, when the bench mining began to be extended westward from Little Miller Creek. The present mining operations are being carried on about a quarter of a mile downstream from Little Miller Creek.

At the site of present mining the gravel ranges in thickness from 60 feet at the north side of the cut to only a few feet at the south side. It appears to be nearly uniform in character and size throughout the section, and the pebbles are rather subangular, with an average diameter of 3 to 4 inches and few of them exceeding 12 inches. As the bedrock of Dome Creek lies entirely within the area of Birch Creek schist, the gravel includes numerous varieties of crystalline rocks, together with considerable vein quartz. Except in a few places there is practically no overburden of muck or silt, but where such deposits occur they have been found to contain remains of mammoth, bison, and other ancient vertebrates, thus dating the top of the section at least as old as the Pleistocene. Among the crystalline rocks observed in the present cut are quartzite schists, which include some ancient dikes or sills of serpentinized greenstone, and some thin beds of limestone; and one observation of a dominant structure suggestive of original bedding indicates a general trend about N. 20° W., with a low dip to the west. Another observation of cleavage, however, shows a trend of N. 30° E., with a low dip to the northwest. Where exposed by mining the bedrock shows numerous shear zones, filled with greenish gouge, some of which consists of granulated vein quartz mineralized by pyrite. The bedrock under the placers is weathered but not to any unusual depth.

The gold occurs mainly on or near bedrock, but careful tests have also shown the presence of some fine gold throughout the gravel sec-

tion. This relation suggests that at least some of the gold may have traveled a considerable distance from its bedrock sources. No gold has been observed in place in the bedrock, but some of the gold has been found to have quartz adhering to it. The gold is bright yellow, and for the most part fine-grained. Some of the large pieces are porous, and these contain the largest amount of vein quartz. The largest piece that has been found by the present operator weighed about 7 grains. The mean of two assays on recent production gives a fineness of 885 parts of gold and 107 parts of silver in a thousand, thus indicating a high-grade product. Considerable pyrite occurs in the concentrates, but some galena and cinnabar have also been observed.

This deposit is worked by hydraulic methods. A ditch about 8 miles in length, with an intake about 4 miles in an air line upstream, furnishes water with a head of 100 to 125 feet, depending upon the point of application. The rated capacity of this ditch is 1,000 miner's inches, but during the early summer only a quarter or less of that amount may be available. As this deposit lies upon a bench, well above the level of the valley floor, the disposal of tailings presents no problem, but in order to obtain the necessary gradient for the sluice boxes, a bedrock drain and sluiceway about 500 feet long has been constructed, to join the south face of the cut with the northern slope of the valley wall. Similar sluiceways have been built in working the older cuts farther to the east. The present sluiceway penetrates 10 feet into bedrock, to obtain the necessary gradient.

EAGLE DISTRICT

Gold placer mining is carried on in three separated areas in the vicinity of Eagle, which in earlier years have been designated as individual districts but are here treated collectively under the general name "Eagle district." (See pl. 3.) The most productive of these is the area along the Seventymile River, on which and its tributaries placer mining has been in progress for many years. The second area is on American Creek and its tributaries. Some earlier mining has also been done on Mission, Boundary, and perhaps other nearby creeks, which are considered to be a part of the American Creek area. The third area centers about Fourth of July Creek but would also include the older mining that was done on Washington Creek and contiguous streams. About 12 miles west of Washington Creek is a large stream known as the Charley River. The basins of the Charley River and those tributaries of the Yukon lying between the Charley River and Circle are now included as a part of the Circle district.

Gold was first found in the basin of American Creek in 1895, but it was not until the following year that a few claims began to be worked

systematically. The placers in the basin of the Seventymile River were probably discovered at about the same time, as the original discovery on Barney Creek is known to have been made in 1895. Gold was first discovered on Fourth of July Creek in 1898, and since 1902 there is a record of systematic mining on this and most of the other creeks of this district now known to be productive. Hence it may be said, as in the Fortymile district, that few new discoveries of gold have been made in the Eagle district during the last 35 or 40 years.

SEVENTYMILE RIVER AREA

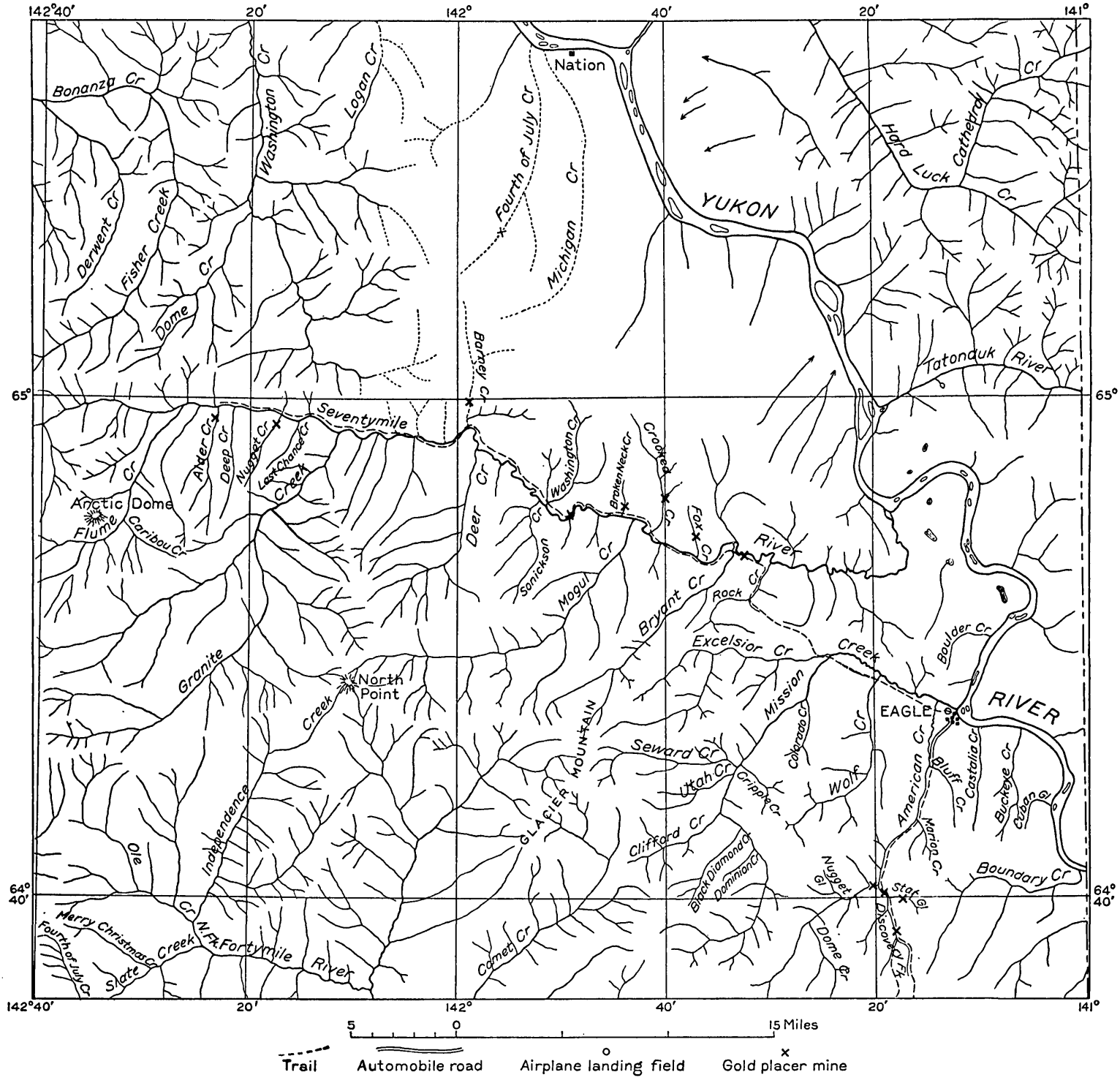
The Seventymile River heads against several large eastern tributaries of the Charley River and flows in a general easterly direction for about 60 miles in an air line, to the Yukon River. Many tributaries join the Seventymile River, but it is a noteworthy fact that all the larger tributaries enter from the south. The number of tributaries, however, on which placer gold has been found and mined is about equally distributed on the north and south sides of the valley. The principal southern tributaries that have produced placer gold, named in order downstream, are Flume, Alder, and Nugget Creeks, all of which are located in the upper valley of the Seventymile, though not in the extreme headwaters. On the north side of the valley the chief producing streams, named in order downstream, are Barney, Broken Neck, Crooked, and Fox Creeks, all of which lie in the lower or east end of the valley. Some small-scale mining has also been done on other of the northern and southern tributaries. Considerable mining has likewise been done in earlier years in the main valley of the Seventymile River. At the present time little mining is in progress in the Seventymile Basin, as the only good-sized plant now being operated is on Crooked Creek. Mining on a smaller scale, however, is also being done on Broken Neck and Fox Creeks. Still other mining activities, which rank little above prospecting, are in progress in the main valley of the Seventymile and on Alder, Nugget, and Barney Creeks.

A variety of rocks are exposed in the valley of the Seventymile River. In the headwater area the country rock consists of various granitic rocks, which form the northern border of the great batholith that extends westward from Glacier Mountain. The larger southern tributaries of the Seventymile River, such as Diamond Fork, Flume Creek, and Granite Fork, also head in the area occupied by granitic rocks. The main valley of the Seventymile River, however, from the mouth of Diamond Fork downstream as far as the "Falls" of the Seventymile, is carved mainly in metamorphic and semimetamorphic rocks of pre-Cambrian and early Paleozoic age. These rocks are intruded by some small masses of granitic rocks, and there is every

reason to believe that they are underlain at no great depth by a northward continuation of the batholith of the Charley River. From the "Falls of the Seventymile River" downstream for about 12 miles the bedrock in the main valley consists of the Tertiary rocks, which cross obliquely in a belt from 4 to 6 miles wide that trends about N. 50° W. Still farther downstream the bedrock consists mainly of undifferentiated Carboniferous rocks.

The gold placers of the Seventymile Valley occur both in the area occupied by the metamorphic and semimetamorphic rocks and in the area occupied by the Tertiary rocks. With little doubt the gold in the older rocks has been derived directly from quartz veins and other mineralized sources in bedrock, which are genetically related to the adjacent and subjacent granitic rocks above mentioned. The granitic batholith that lies south of the Seventymile Valley is believed to be of Mesozoic age, though this belief is based upon rather fragmental evidence. The crystallinity and size of this batholith and the contact-metamorphic effects that are noticeable along its periphery lead to the belief that it was intruded at a considerable depth below the surface of the country as it existed at the time of this volcanism. It is therefore probable that a long period intervened between the emplacement of the granitic rocks and their exposure at the surface as a result of regional erosion. Possibly it was not until early Tertiary time that these granitic rocks began to be bared at the surface; and it was at this time that there began the disintegration of the quartz veins and other mineralized bedrock zones from which the gold was derived. At about the same time, or perhaps a little later, granitic rocks may again have been injected on a smaller scale. The evidence for this postulate consists of the presence of cinnabar at a few localities in the Seventymile Valley and the belief that most of the cinnabar so far found in Alaska is a result of Tertiary mineralization. The net result of these geologic activities is that gold placers have probably been in process of formation in the Seventymile Valley for perhaps 50 millions of years, though the gravel deposits that now contain the gold are of Quaternary age, so that the oldest of them are not likely to have been deposited more than a million years ago. In other words, much of the gold in this region has been handled and rehandled many times, with relatively little movement downstream, before it was finally deposited in the present gold placers.

The accumulation of gold into commercial placers over so long a period of time implies that the older or pre-Quaternary gravel deposits were subsequently eroded, reworked, and in large part moved downstream, leaving the gold behind. This condition is probably true in many if not in most of the gold placer fields of interior Alaska. But under certain particularly favorable circumstances the old pre-



SKETCH MAP OF EAGLE DISTRICT, SHOWING LOCATION OF GOLD PLACER-MINING OPERATIONS.

Quaternary gravel may be in part shielded from active erosion and thus preserved. This is the condition that exists in the valley of the Seventymile River and in contiguous drainage basins, where terrigenous Tertiary deposits occur. The character and extent of these Tertiary rocks have been set forth elsewhere (see pp. 151–153); and it has also been shown that these deposits contain gold that was derived originally from quartz veins and mineralized bedrock. Such deposits must therefore be a proximate source of gold, from which some of the Quaternary placers have been derived. This is true on the Seventymile River and on its tributaries from the "Falls" downstream to the northeastern limit of the Tertiary rocks. Hence the gold placers of Barney, Crooked, Broken Neck, and Fox Creeks are to be regarded as Quaternary reconcentrations of the gold imprisoned in these Tertiary rocks; and such placers therefore have had a somewhat different history from those farther upstream in the Seventymile Valley.

If these conditions had been known many years ago, when prospecting and mining were actively in progress on the upper tributaries of the Seventymile River, such as Flume, Alder, and Nugget Creeks, some interesting comparative studies might have been made relative to the history of gold concentration over a long period of time. It might have been possible, for example, to show that the gold of these creeks, having been in process of more or less continuous rehandling over so great a length of time, would show perceptible differences from the gold of the lower valley, which has been stored and held immobile in the Tertiary deposits over a considerable part of this long period. With bedrock sources of the same general sort, the gold of some and perhaps of all these upper tributaries might be expected to have a higher fineness and to have different physical characters of size and shape. Unfortunately, such comparisons cannot now be made, as these upper tributaries, to judge from the past and present activities, are about worked out.

At the present time one man is prospecting on Alder Creek and one is mining in a very small way at the mouth of Nugget Creek; and no one is known to be working on Flume Creek, so that few data are available regarding these placers. According to Prindle,[15] the bedrock of Flume Creek, for about a mile above its mouth, is greenstone, which is intruded by basic dikes and is also at places mineralized by quartz veins carrying pyrite. Upstream from the greenstone for 7 miles the bedrock consists of Paleozoic schists of several types, but granitic rocks form the bedrock of the headwater tributaries. Some coarse gold has been found on Flume Creek, and some good-sized

[15] Prindle, L. M., The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska: Geol. Survey Bull. 251, pp. 56–57, 1905.

nuggets have been recovered. The fineness of the gold is not known to the writer.

Nugget Creek is a small stream, only one-fourth as long as Flume Creek and with a drainage basin only a tenth the size of that of Flume Creek. The gold placers were found mainly in the lower mile of the valley, where the bedrock is a gneissoid granite, regarded as one of the meta-igneous rocks associated with the Birch Creek schist. The original pay streak was considered to be about 20 feet wide in the stream gravel of the present valley floor, but undoubtedly a greater width of auriferous gravel was worked in later years. The fineness of the gold is not known to the writer.

Alder Creek is a small tributary of the Seventymile River about the size of Nugget Creek, which enters from the south about 3½ miles upstream from Nugget Creek. A hydraulic plant was operated on Alder Creek for several years, but this work was discontinued about 10 years ago. No other data are available.

On the Seventymile River just upstream from the contact between the Tertiary rocks and the metamorphic rocks of the Birch Creek schist, the river for a short distance flows in a rapids which is known locally as the "Falls." Directly upstream from the Falls and for some distance farther upstream small-scale mining has been carried on for many years in the gravel of the low benches, particularly along the north side of the river, and such work still continues intermittently, though none was in progress at the time of the writer's visit in 1936. The bedrock at and above the Falls consists of quartzite schist, quartz-mica schist, amphibolite, and basic igneous rocks of greenstone habit, though at one place along the river bank a small block of Tertiary conglomerate was observed to be downfaulted into the schistose rocks. In this stretch of the river, above the Falls, well-developed benches occur on both sides of the valley, though the low benches are best developed on the north side. One low bench, about 12 feet high, shows well on the north side and slightly on the south side. About 4 or 5 feet higher, on the north side, another bench extends for a considerable distance back from the river. On the south side another prominent bench occurs about 125 feet above the level of the river. All these benches have been prospected, but only the gravel deposits of the lower ones have been worked as gold placers. During the summer of 1936 a drilling crew was sent into the area by Gold Placers, Inc., to prospect these low benches. A hundred holes were drilled along the north side of the Seventymile River from the Falls upstream to a point within a mile of Barney Creek and showed an average depth to bedrock of about 19 feet and a maximum depth of about 27 feet. This work was begun on April 8 and continued for 3½ months, but when the drilling crew ceased its operations it was generally reported

that the results of the drilling were not as encouraging as had been expected.

The bars of the Seventymile River have been worked in a small way, in the same way as the bars of the Fortymile River, though to a much smaller extent. Two or three men were engaged in this work in 1936 along the south bank of the river about 3 or 4 miles downstream from the mouth of Crooked Creek. This work was done by shoveling the gravel into boxes, a short ditch being used for sluice water. If the results of this work were favorable, the operator in charge planned to continue the work on a larger scale, using a Diesel pump to obtain water for hydraulicking.

Barney Creek is a small stream that enters the Seventymile River from the north, about 6 miles in an air line upstream from the Falls. It is formed by two tributaries, one from the north and one from the east, and the main stream flows in a narrow canyon to the Seventymile River. The bedrock of Barney Creek consists entirely of Tertiary rocks, and the gold in its placers is believed to have been derived from the disintegration and erosion of these rocks. The placers of Barney Creek were worked by open-cut shoveling-in methods years ago, though it is possible that some of the marginal areas of the old pay streak might now be worked at a profit. In recent years small-scale mining has been confined to a bench along the west side of the creek, particularly on claim 4 above Discovery. Discovery claim is located at the mouth of Barney Creek. The present operator has a small ditch, which gives a head of about 20 feet, but water under this pressure has little value for hydraulic work and is used mainly for ground sluicing and for sluice water in the boxes.

About 3 miles downstream from the Falls a small stream, hardly more than a gulch, enters the Seventymile River from the north. This stream, which is known as Broken Neck Creek, has been a site of small-scale mining for many years. The valley of Broken Neck Creek is bounded by precipitous walls, and where the stream debouches into the flats of the Seventymile River its valley floor is only 120 feet wide. The bedrock in the valley of Broken Neck Creek consists of Tertiary rocks, and at the mouth of its canyon prominent bluffs of Tertiary conglomerate appear on both sides of the valley.

The placers of Broken Neck Creek were originally worked for a distance of half a mile or more upstream from the place where its steep valley opens into the flats of the Seventymile River. The pay streak is said to have been 20 to 50 feet wide at the mouth of the canyon, but much narrower farther upstream. The stream gravel that was worked is reported to have had a thickness of 3 to 5 feet. Recent work has been confined to a bench along the west side of the creek, the eastern bedrock rim of which is about 100 feet from the

creek and about 20 feet above it. This old bench is not apparent at the surface and slopes gently upward to the west. Recent work has uncovered another bedrock bench, still farther west and about 10 feet higher. The total thickness of alluvium at the east side of the lower bench, where mining is now in progress, is about 8 feet, but at the west side of the cut it increases to 30 feet or more. The gravel directly overlying bedrock has a thickness ranging from 1 to 8 feet and is likewise thickest at the rear or west side of the cut. The gravel is well washed and fairly well rounded, with few cobbles exceeding a foot in diameter. The alluvial material that lies above the gravel is a curious mixture of muck and rounded eluvial debris, which, however, includes no large boulders. This material was doubtless derived from disintegrated conglomerate of the Tertiary series, which also forms the bedrock in the cut. Most of the gold occurs in the gravel close to bedrock and also on bedrock, but some fine gold may also be panned from higher levels in the gravel. No coarse gold is recovered on this bench, as the present operators say that the largest piece so far found weighed only about 15 grains. Four assays of the gold, based on production in earlier years, are given below:

Fineness of gold from Broken Neck Creek

[Parts per thousand]

Year	Gold	Silver
1929	832¼	161
1933	834	161
1934	826	169
1935	825½	169
Mean	829	165

No assays are available of the gold recovered in earlier years from the creek placers, but one of the present operators, who formerly worked these placers, states that the creek gold was of distinctly higher grade, comparable with the gold now being recovered from the stream placers of Crooked Creek.

The alluvial material on the bench is frozen, but by ground sluicing, aided by the heat of the air and the sun's rays, most of the muck and slide is removed. The gravel is moved by the hydraulic method, for which water is obtained from a ditch 2,300 feet long, which gives a pressure of 45 to 55 feet, depending upon the point of application of the water. A monitor with a 2-inch nozzle is used for hydraulicking. The present operators plan to continue their operations downstream, working on this lower bench.

Crooked Creek is the site of the largest placer-mining plant now being operated in the valley of the Seventymile River. It is about 7

miles long, flows a little east of south, and enters the Seventymile River about 4½ miles downstream from the Falls. For about 3 miles above its mouth the bedrock of Crooked Creek consists of conglomerate, sandstone, and shale of Tertiary age. Above this point the bedrock changes, but as this area to the north has not been mapped, the exact nature and age of the bedrock are not well known. Present and past mining operations have been confined to that stretch of the valley where the bedrock consists of Tertiary rocks, and much or all the gold found in the placers of the present valley floor has probably been reconcentrated from the conglomeratic members of this group of rocks.

Gold placer mining is now in progress on Crooked Creek on claim 1 above Discovery, about 2 miles upstream from the mouth of the creek. The older mining on Crooked Creek was done farther downstream, and hence the present work is being done progressively upstream. The gold is found in stream placers which form the present valley floor, and the pay streak is about 270 feet wide. At the site of mining on Discovery claim, in 1925, the pay streak was 240 feet wide, so that it is apparent that a large body of auriferous gravel was deposited in the valley of Crooked Creek. At this older site of mining the tenor of the pay streak was about 13 cents to the square foot of bedrock. The bedrock at the present cut consists of sandstone, shale, and conglomerate, which strike nearly east and dip 50° N.; but a short distance upstream a body of coarse conglomerate crosses the valley. The alluvium of the placers consists of 5 to 6 feet, or locally as much as 8 feet, of well-rounded cobbles that are rather uniform in size but contain some boulders with a diameter as great as 2 feet. Above the gravel is 3 to 4 feet of muck. Contrary to the usual condition found in the placers of this part of Alaska, the gold is not concentrated on or near bedrock but occurs throughout the body of gravel. The gold is rather fine grained, as the largest pieces recovered by the present operators weighed only 30 grains, and the largest piece recovered by the earlier operators weighed about 80 grains. Some small silver nuggets have also been recovered with the gold. Three assays of the gold were submitted to the writer and are given herewith. They represent the highest grade of gold that has been recorded from the Seventymile area.

Fineness of gold from Crooked Creek

[Parts per thousand]

Year	Gold	Silver
1934	910¼	84
1935	892¾	102
1935	903¼	91
Mean	902	92

Mining on Crooked Creek is done by hydraulic methods, which involve the use of hydraulic monitors for moving the gravel to the sluice boxes and also for stacking tailings downstream from the cut. In the older mining operations water was obtained from a ditch with an intake on Crooked Creek, but as the work progressed upstream the available pressure from this ditch became too small, so that its water is now used only for ground sluicing. Recently a new and higher ditch about a mile long has been built, which takes water from Eldorado Creek, an eastern tributary of Crooked Creek. This gives a pressure in the cut of 120 feet, but as the drainage basin of Eldorado Creek is small the supply of water is often inadequate for mining operations. On account of the width of the pay streak, the ground is worked in parallel cuts. Two monitors with 3-inch nozzles are used, one for moving the gravel laterally into the sluice boxes and the other for stacking tailings. A line of eight sluice boxes are used, over which are mounted center boards, against which the gravel is driven from the sides of the cut. The operator of this plant employs two men and a cook.

Fox Creek is a short stream that flows parallel to Crooked Creek and enters the Seventymile River about 2½ miles downstream from the mouth of Crooked Creek. A small western tributary of Fox Creek, known as Lucky Gulch, heads against Eldorado Creek, the eastern tributary of Crooked Creek, and joins Fox Creek about 2 miles from its mouth. Fox Creek and Lucky Gulch have been the sites of mining for many years. From the positions of old tailings it appears that the gold placers of the valley floor and of the lower benches have been worked on Fox Creek for some distance downstream from the mouth of Lucky Gulch and for a comparable distance up Lucky Gulch. No gold placers have been formed on Fox Creek upstream from Lucky Gulch, and it appears certain that the gold has come out of Lucky Gulch. The bedrock throughout the basin of Fox Creek consists of Tertiary rocks, and it is probable that some auriferous conglomerate that crosses Lucky Gulch has been the source of the gold in the valley of Fox Creek.

Placer mining is now being done on a high bench along the east side of Fox Creek just below the mouth of Lucky Gulch, on what is thought by the present operators to be Discovery claim. The bedrock surface of this bench is 70 feet above the creek, and its more or less level surface extends about 100 feet eastward from its rim. The bedrock is a Tertiary conglomerate, which is overlain by about 4 feet of well-rounded gravel with an average diameter of less than 1 foot. Above this is a mixture of muck and fine gravel, which extends to the surface. Mammoth tusks have been found in this upper alluvial cover. The total thickness of the alluvium is 8 feet at the rim and 15 feet at the rear or east end of the cut. The gold is fine-grained

and high-grade, but no assays of the gold recovered from this bench were seen. Two assays, however, are available of gold that was recovered in 1933 and 1934 from a low bench along the east side of Fox Creek, about 15 feet above the level of the creek. The average of these two assays shows 884 parts of gold and 110 parts of silver in a thousand.

The present cut on Fox Creek has an area of about 3,000 square feet. Mining is done by hydraulic methods, water being supplied by a ditch three-quarters of a mile long, which gives a hydraulic head at the cut of about 40 feet. When sufficient water is available two monitors, with 2¼-inch and 3-inch nozzles, are used.

AMERICAN CREEK AREA

American Creek is one of the several tributaries of Mission Creek, a stream that enters the Yukon River at Eagle. Mission Creek has a remarkably asymmetric valley. The main stream runs a little south of east, but all its tributaries of any size flow northward from the south side of the valley. The first tributary of Mission Creek above its mouth, and the largest one, is American Creek.

American Creek has two headwater forks which join about 9 miles in an air line from Mission Creek. The larger fork, which is regarded as the main creek, flows northeastward for about 7 miles in an air line; the smaller fork, which is called Discovery Fork, flows northward for an air-line distance of about 4 miles. Both the main stream and its tributaries flow in narrow V-shaped valleys, and the main stream shows a fall of 3,000 feet from its head to its mouth. The gradient of American Creek at the forks is said to be 100 to 120 feet to the mile.

For about 5 miles above its mouth the bedrock of American Creek consists of rocks of Tertiary age. Upstream from the southern limit of the Tertiary rocks and southward to the heads of both forks of American Creek the bedrock is a complex assemblage of recrystallized and partly recrystallized sedimentary rocks and greenstones of several types, all of which are considered to be of Paleozoic age. Much of the bedrock below the forks of American Creek and for a mile up the main fork consists of serpentine, cut by basic dikes. Placer mining has been done both in the lower valley of American Creek, where the bedrock consists of Tertiary rocks, and also about 7 miles farther up the valley, where the bedrock is part of the Paleozoic sequence, but little or no work has been done in the intervening stretch. It is therefore probable that the placers of the lower valley had a secondary source in the Tertiary rocks, though originally all the gold was doubtless derived from veins and mineralized zones in the Paleozoic rocks.

The sequential history of placer mining on American Creek and its tributaries has not been recorded in the earlier publications of the Geological Survey and therefore cannot be given here. No mining is now in progress in the northern part of the valley, where the Tertiary rocks occur. In the upper valley mining has apparently centered about the forks. On Discovery Fork the placers of the present valley floor have been worked for many years, by manual methods, and a little shoveling in is still in progress. On the main fork of American Creek the present stream placers are still being shoveled into boxes, but evidently in earlier years one or more attempts were made to work some bench placers on the west side of the valley.

Discovery claim on American Creek is at the mouth of Discovery Fork and serves as the reference point for numbering claims on both forks. The present operator on the main creek has been working on this stream since 1925 and controls claims 9 below to 14 above Discovery on American Creek and claim 2 above Discovery on Discovery Fork. All these claims except 8 above Discovery have been worked in part by earlier miners. At the forks the valley floor of American Creek has a width of about 30 yards, and in recent years two men have shoveled into boxes the auriferous gravel over an area about 100 yards long and 30 yards wide, just upstream from the mouth of Discovery Fork. This ground is said to have averaged about 65 cents to the square foot of bedrock. The average depth of the overburden in this area was about 14 feet. During the early summer of 1936 these two men were shoveling in another cut on American Creek, just below the mouth of Discovery Fork. This cut, which is 15 feet wide and 72 feet long, is located along the east side of the valley floor. At this place the bedrock consists of foliated green schist, quartzite schist, and carbonaceous schist, which contain many small veins and stringers of quartz. The cleavage of the green schist strikes S. 80° E., and dips 35° N. Above the bedrock is a body of gravel about 12 feet thick, the cobbles of which average about 5 inches in diameter, though a few large boulders are also uncovered. The gold is rather coarse, and some large nuggets are found. It is a matter of record that a nugget weighing about 11 ounces was found on American Creek in 1899. The fineness of the gold was not ascertained, but it is said to sell commercially for about $28 an ounce, at present prices.

The same two operators are also preparing to shovel in a cut 600 feet long and 10 feet wide on claim 2 above Discovery, on Discovery Fork, if and when the water supply is adequate. In this work a small dam upstream from the cut will be utilized to supply water for ground sluicing, by means of which most of the upper and barren gravel will be removed prior to the shoveling-in operations. At this

site the depth to bedrock is from 7 to 9 feet, and the cobbles of the gravel subangular and larger, averaging perhaps 10 to 12 inches in diameter. Some boulders as large as 3 or 4 feet in diameter occur in the gravel. Just above bedrock there is a stratum, about 6 inches thick, of very fine gravel, and the gold lies below this, on and in bedrock. The largest piece of gold so far found at this cut weighed 48 grains, but a 19-ounce nugget is reported to have been recovered from Discovery Fork in earlier years.

Two other small cuts were being worked on Discovery Fork in 1936, by the method of shoveling into sluice boxes. One of these cuts, worked by one man, was on the upper end of claim 7 and the lower end of claim 8 above Discovery. Here the gravel is 5 to 7 feet thick, and the gold is coarse-grained and lies entirely on or in bedrock. The operator planned to work a cut 12 feet wide and 72 to 96 feet long. Another small open cut, which was not visited by the writer, was being worked by two men on Star Gulch, an eastern tributary of Discovery Fork.

No other mining is now in progress in the American Creek area, but it is a matter of record that some mining has been done on other streams in this general area in earlier years. In 1902, for example, some mining was done on Boundary Creek, a stream which heads against Discovery Fork and flows eastward to the Yukon River. In the same year a little mining was done on Colorado Creek, a headwater tributary of Mission Creek. Some mining has also been done on Mission Creek, and one man plans to begin mining operations on this stream in 1937.

FOURTH OF JULY CREEK AREA

Fourth of July Creek is about 12 miles in length, flows somewhat east of north, and enters the Yukon River about 4 miles downstream from the mouth of the Nation River. The valley of Fourth of July Creek is asymmetric in cross section, with the steeper wall on the east side, yet the larger tributaries of the creek enter from the east side of the valley. These eastern tributaries, named in order upstream, are Lucky Gulch, Independence Gulch, Crowley Creek, Union Gulch, Seventeen Gulch, and Ruby Gulch. Crowley Creek is the largest. The principal tributaries on the west side of the valley, named in order upstream, are Seven, Eight, Ten, Thirteen, and Owl Gulches. The numerical nomenclature arises from the fact that certain of these streams enter the main valley opposite mining claims so numbered. The gradient of the creek at a point about 10 miles from the mouth, where mining is now in progress, is said to be about 125 feet to the mile, but in the lower valley the gradient is appreciably higher.

In the upper part of its valley the bedrock on Fourth of July Creek consists of Tertiary rocks, and at the site of mining it is largely conglomerate. These Tertiary rocks continue downstream to a point about 2½ miles above the mouth of Crowley Creek, where massive limestone begins and continues downstream to the point where the valley opens out into alluvial flats. This limestone is believed to be of Permian age. The gold placers occur in the upper valley, north of the limestone, and are thought to have been reconcentrated from ancient placers in the Tertiary conglomerate.

Discovery claim on Fourth of July Creek is located at the mouth of Crowley Creek, and the contact between the Tertiary rocks and the limestone crosses the valley at about the middle of claim 10 above Discovery. The owner of the mining plant now being operated on Fourth of July Creek holds claims 7 to 20 above Discovery, and the mining in 1936 was being done on claim 12 above Discovery. The placers on this creek were discovered in 1898 and have been worked for many years, as there is a record of systematic mining operations as early as 1902. At the time of the writer's visit to Fourth of July Creek in 1925 mining operations were being conducted by the July Creek Placer Co., but a few years later that concern sold out to the present operator, who has continued to mine to the present time. The mining on Fourth of July Creek for the last 15 years or more has been carried upstream, but an inadequate supply of water has rendered the progress slow.

The pay streak that has been worked in the last 12 years or more is a rather wide stream placer, aggregating at most places from 400 to 500 feet, and has averaged about 25 cents to the square foot of bedrock. The alluvial cover over bedrock has consisted of 6 to 15 feet of gravel, overlain by 2 to 7 feet of muck. The bedrock is conglomerate. The gravel comprising the placers consists of conglomerate, sandstone, and the cobbles of other rocks which have disintegrated from the conglomerate. All the pebbles are well rounded and of moderate size, ranging from 2 to 10 inches in diameter, though some boulders as large as 2½ feet are found. At the present site of mining, the alluvial cover consists of 6 feet of gravel, overlain by 5 feet of muck. The conglomeratic bedrock consists largely of pebbles of chert and quartzite, with some vein quartz and rarely a piece of greenstone. The pebbles in the conglomerate at the present site of mining are small, rarely exceeding 3 inches in diameter. The gold occurs mainly on and in bedrock, so that it is necessary at places to take up 2 feet of bedrock in order to obtain a high recovery of gold. Some gold, however, also occurs in the lower 2 to 3 feet of the gravel. Most of the gold is fine-grained, but some nuggets are found, of which the largest known to the present operator weighed about half an

ounce. The average fineness of the gold is closely known, as 22 assays are available, which refer to production from 1918 to 1935. These assays are presented below.

Fineness of gold from Fourth of July Creek

[Parts per thousand]

Year	Gold	Silver	Year	Gold	Silver
1918	896½	99	1932	892¼	98
1923	891¾	103		880½	113
1929	894	101		896¾	97
	894	101	1933	912½	83
	880½	114		916¼	78
1930	888½	106		915½	78
	885¾	107	1934	914¾	80
	890	106		900¼	94
	886¼	101	1935	848¾	109
1931	888¼	106		868¼	103
	897	96			
	893½	101	Mean	892	99

The average fineness, as given above, is 892 parts of gold and 99 parts of silver in a thousand, but five assays, based on production in 1933 and 1934, show an average fineness of 912 parts of gold and 83 parts of silver in a thousand. This higher-grade gold was recovered from the east half of the pay streak, on claims 11 and 12 above Discovery, which were worked in 1933 and 1934. The west half of the same stretch of the pay streak, worked from 1929 to 1932 and in 1935, yielded lower-grade gold, as may be seen by the assays above presented. This distribution of higher- and lower-grade gold is hard to explain, but it suggests that the gold in the ancient Tertiary placers was of unequal grade at different localities. It furthermore indicates that the gold has not moved a great distance from the original conglomeratic source rock, as otherwise there would have been a general mixing, resulting in a more uniform grade of gold throughout this part of the creek.

A matter of further interest on Fourth of July Creek is the discovery in recent years of a bench placer about opposite the site of present mining, along the west side of the valley. A 29-foot shaft, which was sunk on this bench, revealed 14 feet of gravel overlying a bedrock surface, which is about 12 feet above the level of the creek and extends for 100 feet west of its eastern rim. No mining has yet been done on this bench channel, but the placers are reported to have a tenor at least as great as that of the placers now being worked in the present valley floor.

On account of the width of the pay streak on Fourth of July Creek, it is worked in two parallel cuts, from 225 to 250 feet wide. Mining is done by hydraulic methods, the water for which is obtained from a ditch about 2½ miles long, along the east side of the valley.

This gives a pressure of 165 feet at the present site of mining, but the intake of the ditch is so far upstream that the supply of water is often inadequate during the early summer. The placers are frozen, so that the muck is first stripped off by ground sluicing, thus allowing the underlying gravel to thaw naturally from the heat of the air and sun. When the supply of water permits, four monitors with 2½-inch nozzles are used, one of which is required for stacking tailings downstream from the cut. A line of eight sluice boxes is set at the upper end of a bedrock drain, and over these are mounted metal boards, against which the gravel is piped from both sides of the cut.

Another stream in the Fourth of July Creek area on which some placer mining has been done is Washington Creek. There are two streams in this area called Washington Creek, one of which is a tributary of the Seventymile River, and the other lies 10 to 15 miles west of Fourth of July Creek and flows directly into the Yukon. The second stream, which is the one to which reference is here made, is the larger one, having an air-line length of about 25 miles. Washington Creek heads against the Seventymile River and flows in a general northerly direction. According to Brooks,[16] placer gold has been found at two localities on this creek. One of these was on a small tributary called Nugget Creek, about 6 miles from the Yukon River; and the other was on Surprise and Eagle Creeks, two tributaries that enter Washington Creek about 13 miles from its mouth. The gold placers on Nugget Creek are said to have been much localized accumulations of coarse gold on the Lower Cretaceous bedrock. The placers of Surprise and Eagle Creeks occurred in or just north of the area where the bedrock consists of rocks of Tertiary age, from which the gold was presumably derived. The placers of Surprise Creek are said to have been discovered in 1907 by a Dr. Pratt, and for several years thereafter they were worked intermittently by other men. A third locality where some mining is known to have been done on Washington Creek is at the head of a large headwater tributary from the southwest, known as Dome Creek. No placer mining is now in progress in the valley of Washington Creek.

CIRCLE DISTRICT

Placer mining in the Circle district centers at the present time around three general areas, which are here designated the Mammoth Creek area, the Deadwood Creek area, and the Coal Creek area. (See pl. 4.) The Mammoth Creek area and the Deadwood Creek area are close to one another, and both obtain their supplies and equipment by way of the Steese Highway, either from Fairbanks or from Circle.

[16] Brooks, A. H., The Circle precinct, Alaska: Geol. Survey Bull. 314, pp. 200–201, 1907.

The Mammoth Creek area centers about Miller House, on the Steese Highway, in that all the creeks considered to belong in this area are connected with Miller House by roads or trails. The streams of the Deadwood Creek area are connected by roads and trails with Central House, on the Steese Highway. The Coal Creek area lies about 45 miles east-southeast of the Deadwood Creek area and obtains its supplies and equipment by way of the upper Yukon River.

Mammoth and Porcupine Creeks are the two principal headwater tributaries of Crooked Creek, which is a tributary of Birch Creek. Placer mining has been in progress for many years on Mammoth Creek and on its three tributaries, Independence, Mastodon, and Miller Creeks; also on Porcupine Creek and one of its tributaries called Bonanza Creek. Placer mining is also being done on three other streams, which head against the tributaries of Mammoth Creek and flow to Birch Creek. These are Eagle Creek, Butte Creek, and the North Fork of Harrison Creek, which are included as a part of the Mammoth Creek area. There are many other nearby streams which belong in this area, and prospecting is in progress on some of them, but the nine streams above named are the principal sites of placer mining at the present time in the Mammoth Creek area.

Deadwood Creek is another tributary of Crooked Creek, which joins that stream about 11 miles below the junction of Mammoth and Porcupine Creeks. The principal mining now in progress in the Deadwood Creek area is on Deadwood Creek itself and on one of its tributaries called Switch Creek. Placer mining is also being done on Ketchem Creek, which lies southeast of Deadwood Creek, and on some other streams in the same vicinity.

In the Coal Creek area placer mining is now in progress on Coal and Woodchopper Creeks, and prospecting is being done on other streams farther to the southeast, principally on Sam Creek and on certain tributaries of the Charley River. A new post office has recently been established at the mouth of Coal Creek, known as Coal Creek post office; and the post office that was formerly located at the mouth of Woodchopper Creek has been abandoned. Supplies and equipment for Coal and Woodchopper Creeks are now freighted from Coal Creek post office up Coal Creek and thence westward over the ridge to Woodchopper Creek.

Gold was first found in the Circle district in 1893 by two Russian halfbreeds, named Pitka and Sorresca, who made the initial discovery somewhere on Birch Creek. The news of the discovery started an influx of prospectors into this district, and in the spring of 1894 the placers of Mastodon Creek were discovered. This was quickly followed by the discovery of gold on Independence, Miller, Dead-

wood, and Boulder Creeks. Gold was found on Eagle Creek in 1895, and discoveries were made on Harrison and Porcupine Creeks during the winter of 1895–96, so that by the year 1896 all the principal streams of the Circle district that are now producing gold had been located and were being mined. Many other gold deposits have subsequently been located in the Circle district, and some of these have been mined as commercial placers, but it is an interesting fact that all the more productive placers in the Mammoth Creek and Deadwood Creek areas were discovered 40 years ago.

MAMMOTH CREEK AREA

The streams that are considered to be a part of the Mammoth Creek area are Mammoth Creek and its three tributaries, Independence, Mastodon, and Miller Creeks; Porcupine Creek and its tributary, Bonanza Creek; Ptarmigan, Eagle, Golddust and Butte Creeks, which together form the headwaters of Birch Creek; and the North Fork of Harrison Creek and nearby tributaries of Harrison Creek.

The post office, road house, and general store at Miller House, at the mouth of Miller Creek, form the local supply point for the mining camps on these various streams. The Steese Highway connects Eagle Creek and the adjoining headwater streams of Birch Creek and the workings on Mammoth Creek with Miller House. An automobile road also leads from Miller House up Mammoth Creek to the junction of Mastodon and Independence Creeks, thence up Independence Creek and southward across the ridge and down into the North Fork of Harrison Creek. A branch from this road goes to the head of Mastodon Creek. A road was also surveyed in 1936 and built in 1937, to connect Miller House with Bonanza and Porcupine Creeks.

MASTODON AND MAMMOTH CREEKS

Mammoth Creek is formed by the junction of Independence and Mastodon Creeks and flows northeastward for about 4 miles to its confluence with Porcupine Creek. Mastodon Creek, however, which has a length of 6 miles from its source to its mouth, may be considered the headwater part of Mammoth Creek, so that the Mastodon-Mammoth Valley may be described as a unit.

Mastodon Creek heads in a high mountain, known as Mastodon Dome, which has an elevation of 4,400 feet above sea level. The main valley of Mastodon Creek may be said to begin at the junction of its two small headwater branches, the more easterly of which is known as Fortytwo Gulch. The elevation at this point in the valley is about 2,600 feet, and at the mouth of Mammoth Creek about 1,600 feet, so that the average gradient of the Mastodon-Mammoth Valley is about 2 percent, though the gradient of Mammoth Creek is con-

siderably less than that amount, and the gradient of Mastodon Creek is considerably greater, ranging perhaps between 3 and 4 percent. About 2 miles below the mouth of Fortytwo Gulch, Bakers Gulch, another tributary of Mastodon Creek, enters from the southwest, but Mastodon Creek has no other tributaries farther downstream.

The valley of Mastodon Creek is steep-walled but asymmetric in cross section, with the steeper wall forming the east side of the valley. This asymmetry, while noticeable even in the extreme headwaters, becomes progressively accentuated downstream, and it is evident that in the erosion of its valley the creek has migrated laterally eastward. It is for this reason that although no prominent terraces show along the west side of the valley, there are remnants of old erosion channels, and these are gradually being uncovered by mining in the lower valley. At its mouth the valley floor of Mastodon Creek is about 400 yards wide, but within 2 miles upstream it narrows to half that width, and about 3 miles above its mouth it becomes still narrower, but farther upstream it widens somewhat. Mammoth Creek, which may be considered the lower valley of Mastodon Creek, has a broad valley floor, which widens downstream from 100 to 500 yards, and the creek itself meanders over a broad gravelly flood plain. It also has a valley with an asymmetric cross section, with the steeper wall along its southeast side.

The bedrock on Mastodon and Mammoth Creeks consists essentially of quartzite schist and mica schist, the cleavage of which strikes about N. 60° W. The usual dip of the cleavage is upstream, toward the southwest, but numerous dips to the northeast have also been observed. Other varieties of bedrock are present, such as feldspathic schists and also some thin-bedded impure and closely folded limestone that crops out near the mouth of Mastodon Creek. One good-sized body of granitic rocks invades the schists along the east side of Mammoth Creek, opposite the mouth of Miller Creek, and dikes and small intrusive bodies of the same kind of rock are found at other localities. The bedrock is cut by many veins of quartz, which are doubtless of different ages. Some of these quartz veins, as well as mineralized zones in bedrock, are the source of the gold in the Mastodon-Mammoth Valley. The quartz veins become more plentiful toward the head of the creek.

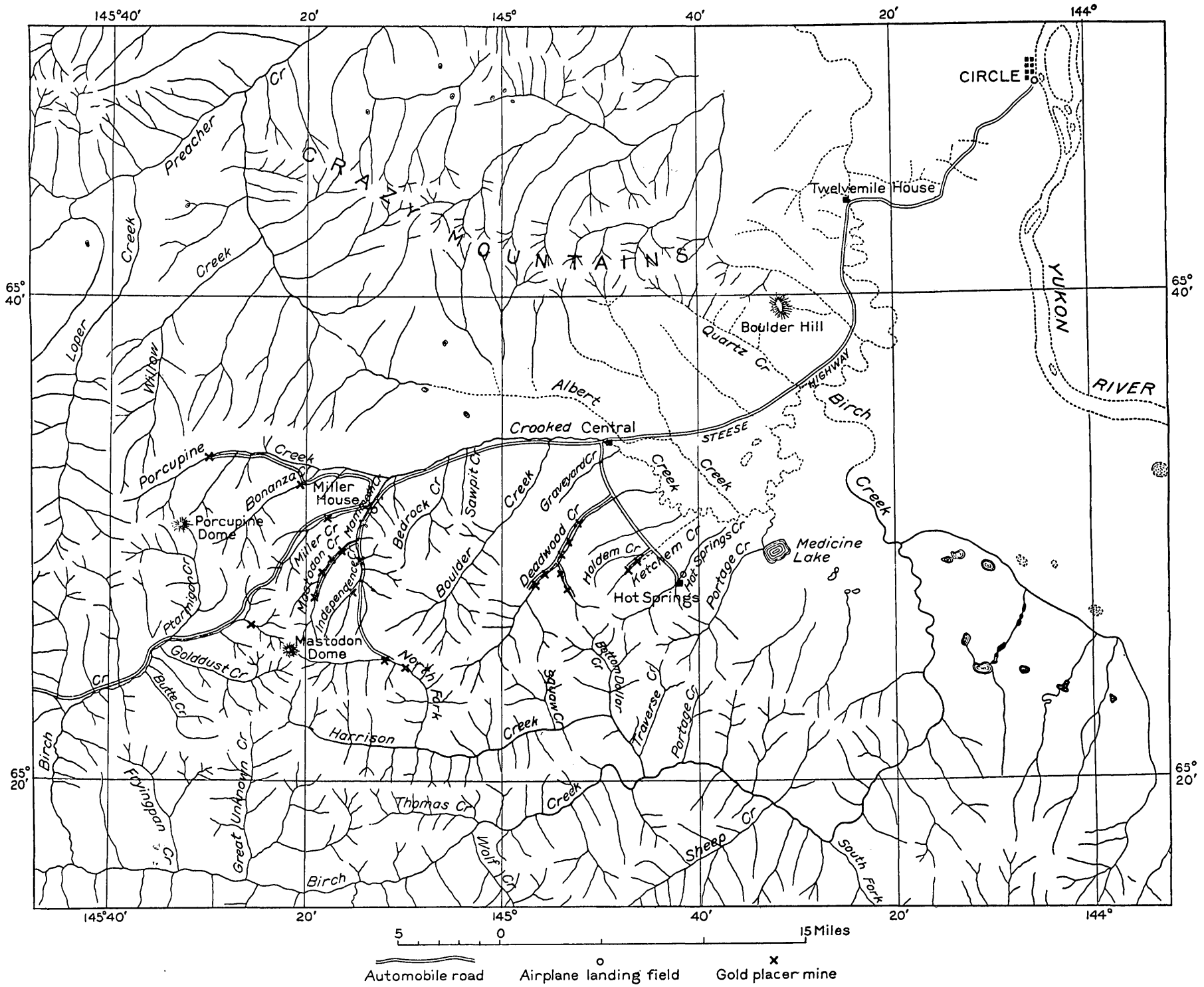
As the bedrock is mainly schist, not only on Mastodon and Mammoth Creeks but also on their tributaries, the gravel found in the Mastodon-Mammoth Valley consists largely of several varieties of schist, though at the mouth of Miller Creek and from that point downstream granitic rocks are also prominent. The size and shape of the gravel depend upon the location on the creek, but in general the pebbles become smaller and more rounded downstream, except in

the vicinity of the granitic rocks above mentioned, where large boulders are common. Details regarding conditions at individual properties are given below.

The gold in the upper valley is fairly coarse and light-colored, but farther downstream it is fine and flaky. At the head of the valley on claim 37 above Discovery the fineness is about 740 parts of gold in a thousand; on claims 28 to 30 above Discovery, it is about 746 parts of gold in a thousand; and far downstream, on claim 3 below Discovery, about 1,000 feet upstream from the mouth of Independence Creek, it ranges between 803 and 811 parts of gold in a thousand. It thus appears that the gold on Mastodon Creek increases gradually in fineness downstream.

The variation in the fineness of the gold, or percentage of gold in a placer alloy, is susceptible of sundry interpretations. The ratio of gold to silver in some placers changes progressively downstream, with a gradual enrichment of the alloy in gold, and it has been assumed by many geologists that such enrichment is due chiefly to progressive solution of silver in the course of progressive downstream movement. This process, of course, is accentuated by the increased comminution of the gold, as the surface available for chemical action is thereby greatly increased. The usual hypothesis, then, is that gold which has been moved farthest downstream has been subjected to the greatest degree of chemical action through repeated rehandling by the streams and through increased comminution. Therefore, the fineness of the gold should increase progressively downstream. There can be little doubt that this process is effective, but it is equally certain that other significant factors must be evaluated.

In most small streams much of the alluvial material is in course of progressive movement from the headwaters downstream. In the uppermost stretches all this alluvium, from the surface to bedrock, at times of flood is moved downstream, and redeposited. But in most small streams there is a zone in the valley downstream from which the alluvial material on or near bedrock will not be further disturbed, even at the highest flood stages, unless the stream is rejuvenated by a lowering of its base level of erosion. The position and length of this critical zone varies with the strength of the current, the size and specific gravity of the alluvial materials, and with several other factors; yet its existence is fairly well substantiated. If a gold lode occurs at or near the head of a valley, the gold on being liberated by the process of weathering migrates downstream with the other stream detritus, gradually working its way toward bedrock. Somewhere in the critical zone, however, most of this gold, and all the coarse gold, finally comes to rest; and from this zone downstream the current of the stream is slower, and the detritus



SKETCH MAP OF CIRCLE DISTRICT, SHOWING LOCATION OF GOLD PLACER-MINING OPERATIONS.

becomes thicker, so that the stream can no longer erode to bedrock. This critical zone, which lies between the headwater stretch of intermittent movement of all debris and the downstream stretch of no movement of the debris near bedrock, marks the downstream terminus of the pay streak; but gold in process of downstream migration may also be present upstream from the critical zone. Such gold may or may not constitute a pay streak, depending upon various factors. But stream erosion is a continuous process, in the course of which the valley is either extended backward into its divide or, if another headwater stream is flowing in the opposite direction, the divide between the two streams will be lowered. In either case, the net result is a change in the longitudinal profile of the stream bed, so that the critical zone of deposition migrates slowly upstream. Hence that stretch of gold placers, no longer subject to downstream movement, is lengthened, and a pay streak is deposited progressivly upstream. The concept thus results that the part of a placer farthest downstream was deposited first and that the formation of the pay streak took place progressively upstream. This mode of pay streak formation is particularly applicable in areas where the concentration of the gold into a pay streak has been in progress for a great duration of time, such as throughout the Pleistocene and Recent epochs, or perhaps for a much greater span of time. This condition applies to most of the commercial placers of interior Alaska.

It is probably the usual, rather than the unusual, condition for the fineness of gold to vary in different parts of a lode. Moreover, where such variation occurs, the percentage of gold in free-gold ore will likely be greatest in the higher or apical portions of a lode, and the percentage of silver will probably increase with depth. Evidence of such a vertical distribution of fineness has recently been shown by the writer [17] to exist in the Medfra area, in central Alaska, where the fineness of the ores now being mined ranges from 735 to 812 parts of gold in a thousand, whereas the placer gold derived therefrom has a fineness of 928. Under such conditions in the lode, and under the physiographic conditions above outlined, the highest-grade gold would be deposited farthest downstream in the pay streak. Later accretions of gold to the pay streak would be of lower grade, and would be deposited progressively farther upstream. The final result of this process would be the development of a pay streak in which the fineness of the placer gold would increase downstream. It thus appears that the fineness of gold in a pay streak may increase progressively downstream without the solution of any silver from the placer gold.

[17] Mertie, J. B., Jr., Mineral deposits of the Ruby-Kuskokwim region, Alaska: Geol. Survey Bull. 864, p. 236, 1936.

Two distinct processes may thus account for an increase in the fineness of gold downstream, and doubtless both act concurrently under favorable conditions. Yet in many valleys where placer gold is found, the variation in fineness of the placer gold is practically nil, or erratic, or in some places actually opposite to that predicated by both these processes. Many causes account for this nonconformity with the theoretical distribution. In the leaching of silver by surface waters a long span of time is required to make the process effective. Hence in placers of Recent origin the effect may be of small magnitude. Again, the ratio of the time when placer gold is moving to the time when it is not moving is very small, so that most of the solvent effect must be laid to the action of circulating ground water. In central Alaska most of the alluvial material of the placers has been frozen throughout the Pleistocene and Recent epochs, and even where the alluvium is thawed the low temperature of the circulating water diminishes greatly its dissolving power. Uncertainty also exists as to the degree and trend of the variation in the fineness of gold at various levels in the lodes from which the placers were derived. Under certain conditions it is indeed possible that the fineness of the gold in a lode may actually increase with depth, at least within a small vertical range. Again, the placers may be, and often are, derived from a number of small lodes, separated from one another by considerable distances. If the gold in each of these lodes possesses different characteristics, or if the lodes show a vertical range in the fineness of the gold and are bared to erosion at different times, erratic effects may be expected. Finally, it must be recognized that weathering, erosion, and transportation and deposition of alluvial debris are exceedingly complex processes. Gold has not necessarily moved progressively downstream from its bedrock source to its present resting place in the pay streak. In the various cycles of erosion, it may have been deposited as an ancient pay streak which later became a gravel terrace, and the gold from this terrace pay streak may later have been reworked and mingled with other gold that may have been transported directly and more rapidly from an entirely different source rock. Again the result is an erratic distribution of fineness in a pay streak. The distribution of fineness in a pay streak is therefore of little value as an aid in deducing the character and source of the antecedent lodes, unless a variety of contributory evidence is also available.

The gold on Mastodon Creek, as already shown, increases gradually in fineness downstream. The cause of this variation may be due to either or both of the two processes above described. But in either event, it seems likely that gold mineralization was sharply localized in the extreme headwaters of Mastodon and Independence Creeks,

for it is very unlikely that the fineness would increase uniformly downstream if gold had been added to the pay streak from local sources, such as the valley floor, or from tributary gulches. In fact, the improbable assumption would have to be made not only that these bedrock sources contained gold of progressively higher grade to the south but also that the rate of this southward change in the lode material corresponded to the rate of change in the alluvial gold of the pay streak. Therefore, the known distribution of fineness in the pay streak may at least be said to harmonize with a localized source for the gold in the extreme headwaters of Mastodon Creek.

Certain other facts regarding the character and distribution of the gold on Mastodon Creek should also be recorded. Nuggets of gold are fairly common in the head of the valley and are almost unknown in the lower or north end of the valley. Hence the gold becomes progressively finer grained downstream. The prevalence of quartz veining toward the head of the valley has already been mentioned, but it should also be added that more quartz adheres to the gold in the headwater part of the valley than farther downstream. Moreover, as shown in the detailed descriptions given below, the gold of Mastodon Creek occurs not only on and in the crevices of bedrock but also in the lower 4 or 5 feet of well-worn gravel that directly overlies the bedrock. This distribution is at variance with the condition that prevails generally in the Yukon Valley, as most of the placer gold in other streams is concentrated on or close to the surface of bedrock. This vertical distribution of the gold suggests conditions of stream erosion differing from those mentioned above for an ideal stream, but in addition it also suggests that no considerable part of the placer gold has originated from local sources, such as the bedrock in the present valley floor, as such gold is unlikely to have migrated downstream to have been deposited high in the alluvial section. Finally, the localization of the pay streak itself is significant. No commercial gold placers have been found on Bakers Gulch, the west headwater tributary of Mastodon Creek, yet the pay streak continues up the main Mastodon Creek to the extreme head of the valley. Similarly, on Independence Creek, the next tributary of Mammoth Creek east of Mastodon Creek, the pay streak goes to the head of the main creek but does not follow up the east headwater branch.

All these facts taken together indicate that most of the gold in the valley of Mastodon Creek has come from one or more sharply localized sources along the north flank of Mastodon Dome at the heads of Mastodon and Independence Creeks. No intrusive granitic rocks crop out at the surface of Mastodon Dome but it is a fair presumption that such rocks may lie at no great distance below the surface and may have produced the mineralization localized in that vicinity. It

does not follow, however, that commercial gold lodes will necessarily be found around the flanks of Mastodon Dome, for the gold of the present placers has been in process of accumulation for many millions of years, during which millions of tons of country rock has been eroded and comminuted. Given a sufficiently long span of time and erosion, gold lodes of exceedingly low grade may produce very rich placers, and such may be the case in this area. Moreover, it is possible that most or all of the original lode material may already have been eroded. But if prospecting for lodes is justified anywhere in this area it should be justified at the head of Mastodon Creek, not primarily because of the large amount of gold that has been washed into the valley of Mastodon Creek, but more particularly because there is evidence that the original bedrock source of the gold was rather sharply localized.

Mastodon Creek alone, without including Mammoth Creek, has been the largest producer of placer gold in the Circle district, and its placers are still being mined. It is estimated that Mastodon Creek has produced in the aggregate between $2,000,000 and $3,000,000 in gold. Both large- and small-scale mining has been done in the Mastodon-Mammoth Valley, but large mechanical and hydraulic mining plants have been used for many years. Thus in 1905 a steam-shovel plant of an experimental type was used in the upper valley of Mastodon Creek, and in 1906 a small steam shovel was installed on Mammoth Creek, about halfway in its course. In 1908 a ditch 6 miles long was built to bring water from Bonanza Creek down the southeast side of that stream and the south side of Porcupine Creek and around into Mammoth Creek. The lower end of this ditch was on the hillside northwest of Miller House. In 1909 the ditch was extended 4 miles farther around the spur between Bonanza and Porcupine Creeks, to take water from the latter stream. This ditch had a width of 7 feet on its bottom and a gradient of 5 percent, and its water was used for a few years by a hydraulic plant on Mammoth Creek. Only the part of it that extends upstream from the placer workings on Bonanza Creek is now in use, but it is of interest at the present time because it was surveyed in 1936 as the site of a new road from Miller House into the Porcupine Valley, the construction of which was completed in 1937.

Dredging has had a long history in the Circle district. The first dredge in Yukon Territory was built on Stewart River in 1898; and in 1901 it was moved to Bonanza Creek, a tributary of the Klondike River. In the fall of 1912 this dredge was floated down the Yukon River to Circle, where it was dismantled, and during the following winter it was hauled to Mastodon Creek, where it was rebuilt on claim 10 above Discovery. This was called the Elmer dredge, after

its owner, J. M. Elmer. It was a machine of the Risdon type, with a hull 32 by 70 feet and buckets of 3½ cubic feet capacity. This dredge was operated during the summers of 1912 and 1913 on claims 10 and 11 above Discovery, but proved to be an unprofitable venture, as it was too small to dig to bedrock. It was therefore abandoned on claim 11 above Discovery, where it still remains.

In 1915 a new dredge was installed by the Berry Dredging Co. on Mammoth Creek, about halfway between Miller House and the mouth of Independence Creek; and this was operated in the 12 years from 1915 to 1926. During that period the dredge worked up Mammoth Creek into Mastodon Creek, up the west side of Mastodon Creek to Independence Creek, and on up Mastodon Creek for about 1½ miles above the mouth of Independence Creek. In 1920 it was dismantled and rebuilt on Mammoth Creek, about half a mile downstream from Miller House and again worked up Mammoth and Mastodon Creeks along the east side of its old tailings to the mouth of Independence Creek and up Independence Creek for about a quarter of a mile, where operations ceased at the end of the season of 1926. In 1936 this dredge was again dismantled, and its machinery was moved to Mammoth Creek, where it was reassembled in a new hull. The present site of the dredge is in the flats of Mammoth Creek, about 2 miles downstream from Miller House. Further details regarding its machinery and operations are given below.

During the season of 1936 two hydraulic plants were operated on Mastodon Creek, and two men were engaged in some small shoveling-in operations. Another large hydraulic plant, which had worked in earlier years on Mastodon Creek, was idle in 1936 but will again be operated in 1937. Finally, the dredge lately rebuilt on Mammoth Creek began to work on September 16 and continued until October 22. In the ensuing descriptions of the mining operations in the Mastodon-Mammoth and other valleys, it should be remembered that most of the claims referred to were staked under the old law of years ago and therefore have a length of only 500 feet.

In the headwaters of Mastodon Creek a hydraulic plant was operated throughout the summer of 1936 on claim 37 above Discovery. The operator at this site held all the claims from about 35 above Discovery to the extreme head of the creek and had been working these placers progressively upstream for the last 8 or 9 years. At the site of mining in 1936 the pay streak is about 150 feet wide, but only a width of about 80 feet, east of the original course of the creek, was being mined. The placers consist of alluvium of the present valley floor, comprising about 10 to 12 feet of subangular gravel overlain by several feet of muck and vegetation. The gravel is rather coarse, and many boulders are uncovered, some of which are

as large as 3 feet in diameter. The bedrock is a mica schist, the cleavage of which strikes N. 10° E. and dips 5°–20° W. Quartz veins are common in the bedrock in this headwater part of the valley. The gold occurs not only on and in bedrock but also to some extent throughout the gravel. At places it penetrates into bedrock to a depth of 3 or 4 feet, so that much hand cleaning to the bedrock is necessary in order to obtain a high recovery of gold. The gold is fairly coarse, yet few very large nuggets are found, the largest so far discovered by the present operator having weighed about 3 ounces. Two assays of gold mined at this place in 1925 and 1931 show a mean fineness of 740 parts of gold and 252 parts of silver in a thousand. Water for the hydraulic plant was obtained from a ditch about a mile in length, with an intake on Fortytwo Gulch. This ditch supplied water under a head of 200 feet, and when the supply of water was adequate, three No. 2 giants, equipped with 3-inch nozzles, were used. One of these giants was used for stacking tailings downstream from the cut. Six sluice boxes, 32 inches wide, with block riffles, were used, and in piping into the boxes, boards were used on the opposite side from which the stream of water is directed. The cut was about 80 feet wide and 100 feet long, and the tenor is said to have been about $1 to the square foot of bedrock, which indicates higher-grade ground than is now available farther downstream.

In 1937 a new organization, called the Mastodon Mining Co., began mining on this ground in the headwaters of Mastodon Creek. For this work, a drag-line excavator was installed at the site of the hydraulic operations above described, and mining was continued upstream. At a point 60 feet upstream from the old hydraulic cut, where the excavator was working in the fall of 1937, the workable pay streak was 160 feet wide, but it was known to narrow to 120 feet at a point three-quarters of a mile upstream. The section of the alluvium is about the same as in the old cut downstream, with 12 to 15 feet of gravel overlain by 4 or 5 feet of silty muck. The gravels have an average diameter of about 12 inches, but many boulders as large as 4 feet in diameter are uncovered. The gold occurs not only on and in the crevices of bedrock but also in the lower 5 to 6 feet of gravel, and at some places considerable gold occurs as high as 9 feet above bedrock. About 1½ feet of bedrock is removed by the excavator, to obtain a high recovery of the placer gold.

The Mastodon Mining Co. is operating a Bucyrus-Erie 34–B dragline excavator, mounted on a tractor, together with a washing plant, the design of which is somewhat different from most plants of this type. The excavator consists of a boom 55 feet long, with a bucket having a capacity of 1¼ cubic yards. Power is furnished by a 6-

cylinder caterpillar Diesel engine, rated at 120 horsepower. The washing plant is of the elevated type and consists of a dump box and sluice line built on two skids; the whole unit weighs about 30 tons and is completely enclosed, so that the sluice line resembles a covered belt-stacker on a dredge. A square dump box is used, at the lower end of which eight iron rails are laid slantwise, sloping to the left to an opening in the side of the house and acting as a grizzly to divert the large boulders outside, where they drop to the ground. From three sides of the dump box there issue fourteen 4-inch streams of water, not under pressure, which serve to wash the material in the dump box, and also as sluice water. A giant with a 4-inch nozzle also plays upon the gravel in the sluice box. The sluice line is about 80 feet long, and consists of steel sluice boxes, 30 inches wide, which are lined with wood. Iron rails, set right side up and one-half inch apart at their bases, are laid crosswise in the boxes to serve as riffles, but undercurrent riffles are also used in the last few box lengths. The boxes are set at a gradient of 13½ inches in 12 feet. On account of the size and number of boulders, a bulldozer is also used to push the gravels from the marginal part of the cut in toward the bucket. This bulldozer and a similar one, used for general purposes, are of the RD–8 caterpillar type. Water for the giant and sluice line is pumped from a small dam in the valley, downstream from the excavator. For this purpose an Allis-Chalmers pump is used, with an intake of 14 inches and an outlet of 12 inches, which delivers 4,200 gallons a minute to the giant under a head of 100 feet. The pump is driven by a V-8 caterpillar Diesel engine, rated at 160 horsepower. Under favorable conditions this plant will handle 1,000 cubic yards of gravel in a day. A 1,500-watt direct-current Kohler plant is used on the excavator, and an Owens 2,000-watt alternating-current light plant is used for general purposes around the camp. About 15 men were employed at this plant.

Beginning on the upper end of claim 11 above Discovery, where the old Elmer dredge ceased its operations, there is a continuous line of tailings that extends upstream to claim 35 above Discovery, or in other words for eight claim lengths above the mouth of Baker's Gulch. These tailings lie on 24 or 25 claims and some fractional claims, and have a length of about 2½ miles. Most of them represent hydraulic mining that was done by one concern from 1911 to 1935, though some earlier work was done at the lower end of this stretch by a steam-scraper in the years 1904 to 1911. This is the plant, above mentioned, that was not in operation during the season of 1936. This operator, however, began work again in 1937 on claim 28 above Discovery, just upstream from Baker's Gulch, and will work upstream, at least as far as claim 30 above Discovery, in marginal ground along the edge of the

old tailings. This marginal ground, however, is not considered a bench placer, because there is no appreciable rise in the surface of bedrock, though the overburden is thicker. In the work so far done the pay streak of the placers in the present valley floor has ranged in width from 150 to 230 feet and is believed to have averaged 200 feet. The gravel has varied in thickness from 16 feet at some places at the north end of the old workings to 8 feet at the last site of mining, with an average thickness of about 10 feet. In a reverse manner, the muck above the gravel has increased in coming upstream from 4 feet to as much as 8 feet in some places. Where the gravel has been the thickest, there has been a tendency for the gold to occur both in the gravel and in bedrock, and at some of these places gold has been found to occur in the gravel to a height of 5 or 6 feet above the bedrock surface. Most of the gold, however, has been found on and in bedrock. The bedrock consists of quartz-mica and quartzite schist, in which mining has uncovered many veins of quartz ranging in thickness from 6 to 18 inches. These quartz veins are more numerous at the upper or south end of these old workings, thus again suggesting accentuated mineralization in the direction of the headwaters of Mastodon Creek. Most of the gold is fine-grained, and little of it has adhering quartz. The largest nugget found in this long line of workings weighed about 2 ounces. Two assays of the gold that was mined in recent years show an average fineness of 749 parts of gold and 236 parts of silver in a thousand. All this work has been done by hydraulic methods, and in the course of it four ditches have been built as the work progressed upstream.

Farther downstream, on claim 8 above Discovery, one man was engaged in shoveling into sluice boxes during the season of 1936. This work was being done in marginal ground along the east side of some old tailings. Here about 6 feet of gravel is overlain by 5 to 6 feet of muck and vegetation. The gold occurs not only on and in bedrock, but in places in the gravel for a distance of 4 or 5 feet above the bedrock surface. Another man was shoveling into sluice boxes in a small way farther downstream, on Discovery claim.

On Mastodon Creek about 1,000 feet upstream from the mouth of Independence Creek another large hydraulic plant was operated during the summer of 1936 by the Berry Holding Co., which holds the ground from claim 5 above Discovery downstream to the mouth of the creek. From 1927 to 1931 this company operated this plant along the northwest side of the old dredge tailings, working progressively upstream. In 1932 it began a parallel line of cuts farther to the northwest. It is still carrying this work upstream, and all indications point to the possibility of mining a fourth line of parallel cuts, still farther to the northwest. The width of all these cuts is

not known, but to judge from the width of the present excavations the pay streak in this part of the valley must be about 1,000 feet wide. For the most part there has been no appreciable rise in the surface of bedrock in these successive cuts northwest of the creek, though the thickness of the overburden has increased materially. But at the present site of mining, at the south end of the third line of cuts, a low bedrock bench is now being exposed, which rises about 12 feet above the general level of bedrock. This bedrock bench veers to the north farther downstream in this third line of cuts but will probably be exposed in the next or fourth line of cuts to the northwest. At the site of operations in 1936 the body of gravel ranges in thickness from 8 to 15 feet and is overlain by a fairly uniform stratum of muck about 10 feet thick, but farther downstream in this third line of cuts the thickness of the muck in places was as much as 18 feet, with a corresponding diminution in the thickness of the underlying gravel. The gravel, being composed mainly of slabby schist, is not well rounded and is particularly subangular on the higher bedrock surface above noted. Some large boulders are uncovered, but they are not very plentiful. The bedrock is mainly a slabby quartzite schist, which at this locality strikes N. 10° E. and dips 20° W., but some softer, dark-colored, more micaceous schist has also been exposed by mining. Granitic dikes are fairly plentiful in the bedrock, and at such places large boulders of granitic material occur in the gravel near bedrock. The slabby, schistose bedrock is hard to clean, and the giants have to be arranged in such a manner that the stream of water drives parallel to the strike, toward the sluice boxes; and at least 18 inches of bedrock has to be removed in order to recover most of the gold. Here as at most other places on Mastodon Creek, the gold occurs not only on and in bedrock but also in the gravel. In fact, all the gravel with the exception of the upper 5 feet contains some gold. It is believed that the tenor of these placers is about 25 cents to the square foot of bedrock. The gold is very fine grained, and practically no nuggets are found. Five assays of gold that was mined in this third line of cuts, which represents a production of about 2,400 ounces, were obtained from the records of the Geological Survey. The weighted mean of these five assays shows a fineness of 806 parts of gold and 184 parts of silver in a thousand. The variation from this mean is small, not exceeding 5 parts.

Mining at the plant of the Berry Dredging Co. on Mastodon Creek is done by hydraulic methods, the water for which is obtained from a pipe that has an intake about a mile upstream. The hydraulic head is from 150 to 175 feet, but swales in the pipe and friction probably reduce the pressure to the equivalent of 110 or 115 feet.

At the intake the pipe has a diameter of 26 inches, which is reduced to 18 inches in the length of 1 mile; and the water is fed to the giants through an 11-inch field pipe. Five giants are used in the cut; one of them is required for stacking tailings. The other four are not used simultaneously but are placed at advantageous positions around the cut and are used as needed to obtain the best thrust of the gravel toward the sluice boxes. Eight people, including a foreman and cook, are employed at this plant.

In 1937 the Berry Holding Co. started a new cut on Mastodon Creek just above the mouth of Independence Creek and farther downstream than their work of 1936. This cut is farther northwest than the work of 1936 and earlier years and indicates evidently that a fourth line of parallel cuts at this site will be worked.

Reference has already been made to the dredge that was built during 1936 on Mammoth Creek, about 2 miles downstream from Miller House. The ground in this part of the valley has been rather thoroughly prospected, and it is estimated that from a point half a mile below Miller House there is at least 2 miles of available dredging ground, extending downstream perhaps to the mouth of Porcupine Creek. It is probable that the mining of all this ground will take from 5 to 10 years. As the dredge had not yet been assembled at the time of the writer's visit, little could be learned regarding the section of the alluvium in this part of the valley, but it is known that at the initial site of the dredge the gravel ranges in thickness from 7 to 16 feet, with an average of about 13 feet. It is overlain by a stratum of muck, which along the northwest side of the valley has a thickness as great as 6 feet, but very little muck occurs along the southeast side of the pay streak. The total thickness of alluvium is also less on the southeast side. One assay, which probably represents gold recovered by this dredge in 1936, shows a fineness of 828¼ parts of gold and 163½ parts of silver in a thousand. It is estimated from drill-hole prospecting that the workable part of the pay streak has a width of 600 to 800 feet.

This dredge is of the Yuba type, with a new wooden hull, and is said to be similar in some respects to the old Greenstone dredge that was first built on Greenstone Creek, in the Ruby district, and is now operating on Ganes Creek, in the Ophir district. It is a stacker-type dredge, equipped with 58 buckets of 3½ cubic feet capacity, which dig at the rate of 23 buckets a minute, and its rated capacity is 3,000 cubic yards a day. Its best record, however, over a whole season was made on Independence Creek, where it handled an average load of 2,300 cubic yards a day. The dredge has a six-drum winch and is operated from two spuds, together with head and stern lines. For power, wood is burned under two Wulf boilers, rated at 75 horsepower each, and the steam is utilized to drive two compound steam

engines at high and low pressures of 180 and 80 pounds per square inch. From 4 to 5 cords of wood a day is required. Two centrifugal pumps are used, one of which, with a 12-inch inlet and 14-inch outlet, delivers low-pressure sluice water. The other, with a 10-inch inlet and an 8-inch outlet, delivers water at a head of 70 pounds per square inch, for use in the nozzles inside the trommel. The trommel-screen is built in two 5-foot sections and has 3-inch holes throughout. Two flumes project from the stem of the dredge, and these also serve as sluice boxes, as they are lined with 30-inch Hungarian iron riffles. A save-all, or small sluiceway, is also built under the well, below where the buckets dump. A small direct-current plant is utilized for lighting.

This dredge began work on September 15, 1936, and operated until October 23, and in 1937 it operated successfully throughout the summer. At the time of the writer's visit in 1937 the dredge was digging 10 feet below the water line, and was carrying a 4-foot face above the water line. It was digging about 2 feet of bedrock, so that the total thickness of the alluvium was therefore about 12 feet. At the site of operations in September 1937 the pay streak as determined by drilling, was 550 feet wide, and the dredge was working upstream and back and forth across the southern 440 feet of the pay streak, leaving a cut 110 feet wide for the return trip downstream.

INDEPENDENCE CREEK

Independence Creek lies from 1 to 2 miles east-southeast of Mastodon Creek, to which it is roughly parallel. The two streams are about of the same length, and their confluence is the source of Mammoth Creek. As both streams head close together along the north flanks of Mastodon Dome and join downstream, their bedrock gradients are very similar. The valley of Independence Creek, though sharply incised, is asymmetric in cross section, but this asymmetry is less marked in the valley walls close to the creek than in the valley of Mastodon Creek and also differs in that the northwest side of the valley is the steeper. Independence Creek also differs from Mastodon Creek in the fact that it has a considerable number of small tributaries from its headwaters to its mouth. All these tributaries enter from the southeast side of the valley, and some of the spurs between these tributaries are more or less benchlike in character. At its mouth the valley floor of Independence Creek is 100 yards or more in width, but farther upstream the valley becomes narrow.

Independence Creek has been worked since 1894 or 1895 and has been a steady producer of placer gold, though its pay streak was not nearly so high in grade as the best part of the pay streak on Mastodon Creek. The ground that is now being worked, however, will

probably average 30 to 50 cents to the square foot of bedrock and therefore compares favorably with some of the ground being mined at the present time on Mastodon Creek. During the summer of 1936 two hydraulic plants were operated on Independence Creek, but mechanical methods were also utilized for stacking tailings.

One mining plant is on Independence Creek about 2½ miles upstream from the mouth of the creek and about half a mile downstream from Harrison Fork, which is a headwater tributary of Independence Creek. The owners of this plant control the ground for about 1,000 feet downstream from the present site of mining and thence upstream to Harrison Fork. They also control 1½ miles of placer ground up Independence Creek above Harrison Fork. This plant began operations in 1932 and to date has worked upstream for a distance of about 800 feet.

At the present site of mining the workable part of the pay streak is 130 feet wide and consists of about 8 feet of poorly rounded gravel, with practically no overlying muck, though at places the thickness of the gravel decreases to 4 feet, and that of the muck increases to 8 feet. The gravel is rather coarse and tightly packed with little interstitial material, and boulders as large as 3 feet in diameter are occasionally uncovered. The bedrock has varied in the workings of the last 4 years from mica schist to quartz-mica schist and quartzite schist, and the strike of the cleavage has ranged from north to N. 30° W., with a dip of about 20° W., or upstream. One iron-stained quartz vein, 18 inches thick, was uncovered in the present cut, and at least one such vein is said to have been uncovered in every cut so far mined. The gold lies mainly on or in bedrock, but for some distance along the east side of the cut it was also found in the gravel for about 3 feet above bedrock. The gold is fine-grained and therefore penetrates deeply into crevices in the bedrock, so that about 3 feet of bedrock is removed to obtain a high recovery of gold, but this is done largely by hydraulic methods. Eight assays of the gold recovered in the 800 feet of earlier workings show a mean fineness of 787 parts of gold and 201 parts of silver in a thousand. These assays are given below.

Fineness of gold from Independence Creek

[Parts per thousand]

Year	Gold	Silver	Year	Gold	Silver
1933	792	198	1935	795½	195
	791	199		778½	212
	794	196		788	202
	779	211	1936	781	198
			Mean	787	201

The cut being worked at this plant at the time of the writer's visit was 130 feet wide and 130 feet long. A ditch 5,100 feet long, which takes water from both forks of Independence Creek, supplies water for the hydraulic operations at a head of 200 feet. Two giants are used, by means of which most of the gravel is moved downstream, where it is stacked, and the lower few feet of gravel is then piped to the sluice boxes. Six sluice boxes 30 inches wide and 12 feet long constitute the sluice line. In earlier years the tailings were stacked with a giant, but in 1936 the operator of this plant purchased a 40-horsepower Diesel caterpillar and bulldozer, with which it was planned to stack tailings in succeeding years. As a result of overflows from the frozen creek, much ice accumulates in this part of the valley during the winter, thus retarding the start of mining in the spring. During the winter of 1935–36, 17 feet of ice accumulated in the cut, so that work was not begun until June 20. The season for hydraulic mining usually ends here, as elsewhere in the Circle district, in the later part of September. Including the owner, nine persons are employed at this plant.

The second mining plant on Independence Creek is about 3,500 feet upstream from the mouth of the creek and about 1½ miles downstream from the plant above described. Discovery claim on Independence Creek is about 1 mile upstream from the mouth of the creek. An earlier hydraulic plant started 2,000 feet from the mouth of the creek and worked upstream for 700 feet. The present plant began at this point and has worked upstream for 800 feet farther and will continue to work upstream, probably for a distance of 1½ miles. In this part of the valley the pay streak is wider than farther upstream, attaining a width of 300 feet, so that it is worked in parallel cuts, 125 to 175 feet wide. At the time of the writer's visit a cut 175 feet wide and 175 feet long, along the east side of the pay streak, had just been completed, and another cut, 125 feet wide and 175 feet long, was being worked along the west side. In both of these cuts the gravel was found to have a general thickness of about 7 feet, overlain by about 2 feet of muck and vegetation; but at the west side of the west cut the section, from the base upward, was found to consist of 9 feet of gravel, 2 feet of muck, 5 feet of gravel, 6 feet of muck, and 3 feet of a mixture of muck and gravel. The pebbles of the gravel are smaller than at the plant farther upstream, averaging perhaps 6 to 8 inches in diameter, but some as large as 2 feet in diameter are uncovered. They are not well rounded. The bedrock is a blocky quartz-mica schist, the cleavage of which strikes about north and dips 15°–20° W., or upstream. In the east cut the gold lies almost entirely on and in bedrock, so that from 2 to 3 feet of bedrock is removed and hand cleaned. In the west cut, however, the lower few feet of gravel also carries gold. The gold is fine grained,

though some nuggets as large as 5 pennyweights have been recovered. No assays of the gold were seen, but from the records of the Geological Survey, 5 assays representing about 1,500 ounces of gold that was mined from Discovery claim to claim 7 above Discovery show a weighted mean fineness of 810 parts of gold and 175 parts of silver in a thousand.

At this plant the water for hydraulic operations is supplied by a ditch with an intake about 1½ miles upstream, which gives a head of 160 feet. Two giants with 2- and 3½-inch nozzles are used, and all the gravel is driven through the sluice boxes. For the sluice line seven 12-foot boxes 36 inches wide, equipped with iron rails for riffles, are used. The tailings, however, are elevated by a steam scraper, with a bucket having a capacity of 1 cubic yard; and by means of a gin pole and overhead trolley they are dumped high on the west side of the cut. For this work a 50-horsepower boiler and hoist are used. Including the foreman, nine persons are employed at this plant.

A third mining plant began work still farther upstream on Independence Creek in 1937, on claim 4 below Discovery. The site of these operations is a short distance upstream from the southern limit of the ground worked by the Berry dredge in 1926. At this point is an old open cut, from 15 to 30 feet wide, which the Berry Dredging Co. worked after the dredging operations on Independence Creek had been discontinued. The present operator has located workable placers on both sides of this old cut, so that the total width of the pay streak is now considered to be about 425 feet. In 1937 a strip 250 feet wide, along the east side of the old cut, was being mined. Here the gravel has a thickness of 5 to 6 feet and is overlain by 6 to 7 feet of muck, but along the west side of the old cut the thickness of the alluvium aggregates 17 to 18 feet, of which about 10 feet is muck. In the present work from 2 to 3 feet of bedrock is also removed to obtain a high recovery of the placer gold. Directly upstream from this plant the stream placers were more or less worked in earlier days by hand methods, with little success, but this ground can probably now be profitably worked under present conditions and by modern methods.

This mining is being done mainly by hydraulic methods, but an Isaacson tracdozer, rated at 60 horsepower, is also utilized for moving gravel from the edges of the cut inward to the head of a line of five sluice boxes into which it is driven by water from a giant, with a 3-inch nozzle. A pipe line, 3,000 feet in length, supplies water to the giant under a head of 100 feet.

MILLER CREEK

Miller Creek lies northwest of Mastodon Creek, to which it is roughly parallel. It heads against Miller Fork of Eagle Creek

and has a length of about 7 miles, discharging into Mammoth Creek about 2 miles below the junction of Mastodon and Independence Creeks. Like that of Mastodon Creek, the valley of Miller Creek is asymmetric in cross section, with the steeper wall on the southeast side. The northwest wall of the valley is benched, and between Miller House and Eagle Creek the automobile road from Circle to Fairbanks follows this side of the valley, high above the creek. The gradient of Miller Creek is said to be between 150 and 200 feet to the mile.

The bedrock on Miller Creek consists of quartzite and quartzite schist veined with quartz. Granitic dikes occur along the ridge between Miller and Eagle Creeks, but no intrusive bodies of granite of any size have been noticed in the valley of Miller Creek. The gravel is therefore composed mainly of different varieties of schist, with a little granite, and is similar in size and arrangement to that of Mastodon Creek. The thickness of the gravel in the lower valley of Miller Creek ranges from 8 to 16 feet, averaging perhaps 12 feet, of which about 4 feet is an overburden of muck and gravel that can be removed by ground sluicing. In the upper valley the gravel is but 4 or 5 feet thick. At some places clay as much as 3 feet thick lies between the gravel and bedrock and contains most of the gold. At most places, however, the gold is said to be found in the lower few feet of gravel, which occurs as a pay streak with a maximum width of 50 feet.

In an earlier report the writer[18] stated that although no assays of the gold from Miller Creek were at that time available, the gold was probably of lower grade than that of Eagle Creek and of higher grade than that of Mastodon Creek. From a large number of assays recently contributed by Mr. Jay F. Kelly, who formerly mined on Miller Creek, and from assays taken from the old files of the Geological Survey, this statement has proved to be correct. The records made available by Mr. Kelly are given below:

Fineness of gold from Miller Creek

[Parts per thousand]

Year	Gold	Silver	Year	Gold	Silver
1929	862¼	132	1934 (continued)	839	156
1931	831½	160		837	158
1932	834¾	161		837½	157
	836¾	159		826½	159
	827	168	1935	825½	159
1934	822½	172		831¼	163
	835	160	1936	804¼	157
	844	151	Mean	838	153
	920	75			

[18] Mertie, J. B., Jr., Mining in the Circle district, Alaska: Geol. Survey Bull. 824, p. 168, 1932.

From the records of the Geological Survey a weighted mean was also made from seven assays based on production in 1919, 1920, 1923, 1924, and 1928, together representing 965 ounces of gold. By this method, the fineness was found to be 832 parts of gold and 162 parts of silver in a thousand. These two determinations, based on different methods of computation and upon entirely different sets of assays, agree remarkably well and leave little doubt as to the average value of the gold from Miller Creek. Insufficient data are available, however, for stating the character and rate of change of the gold in different parts of the valley.

Miller Creek has not been a large producer of placer gold, but has nevertheless been worked intermittently since 1895. Most of the creek, from a point about 2 miles above Miller House upstream for 2 miles, has been worked in earlier years by hydraulic plants, and before that to some extent by drifting. During the summer of 1936 a hydraulic plant was in operation at a point about 2½ miles from the mouth of the creek. At this site there is a block of ground about 130 feet wide and 200 feet long, which was partly worked by underground methods years ago but had not previously been hydraulicked. Here the gravel is about 12 feet thick, with little or no overlying muck. The upper part of this gravel contains practically no gold and is therefore piped off to each side of the cut. The lower 3 to 4 feet of gravel is then driven by giants into the sluice boxes. The gravel is in part subangular and in part fairly well rounded, and some boulders as large as 2 or 3 feet in diameter are uncovered. The bedrock is a blocky schist, on and in which much of the gold occurs. The gold is said to be rather fine grained.

Water for these operations is obtained from a ditch about 1½ miles long, which is said to give a head of about 150 feet or more. A line of six sluice boxes are used. Tailings are stacked by one giant, but a 40-horsepower Isaacson tractor and bulldozer was purchased in 1936, which may be used either for stacking tailings or for aiding the giants in moving the gravel toward the sluice boxes, but probably for the latter purpose. After the block of ground is worked, the present operator plans to move his plant 1½ miles farther upstream, where another block of drifted ground will be worked. For this work an old ditch will be repaired and used as a source of water for the giants.

PORCUPINE AND BONANZA CREEKS

Porcupine Creek heads in the ridge country west of Porcupine Dome and flows east for 15 miles to the point where it joins Mammoth Creek, to form Crooked Creek. According to the topographic map published by the Geological Survey,[19] the gradient of Porcupine

[19] Prindle, L. M., A geologic reconnaissance of the Circle quadrangle, Alaska: Geol. Survey Bull. 538, pl. 1, 1913.

Creek is low, averaging about 60 feet to the mile for the lower 11 miles of its course. At its mouth, Porcupine Creek flows at an elevation of about 1,750 feet above sea level. The walls of the valley of Porcupine Creek differ little in their degree of steepness, but in a more general sense the valley is asymmetric in cross section, as no tributaries of any size enter from the north side of the valley, and the bounding ridge on that side of the valley is only a mile or two distant from the main stream, whereas on the south side of the valley there are several tributaries, and the bounding ridge lies from 3 to 6 miles to the south. The largest of these southern tributaries is Bonanza Creek, which enters Porcupine Creek from the southwest about 3½ miles from its mouth. About 4 miles above the mouth of Bonanza Creek a smaller tributary known as Yankee Creek enters from the southwest, and a mile farther upstream is a headwater fork from the southwest called Dome Creek. There are two other small southern tributaries of Porcupine Creek, one between Bonanza and Yankee Creeks, and the other east of Bonanza Creek, but these are not large enough to require a name. Between Yankee and Dome Creeks, two terraces exist along the north side of the valley, and there may be other bedrock benches of which there is no surficial expression.

Gold was found on Porcupine Creek and its tributaries in the early days of the Circle camp, but little mining has been done in the main valley of the creek until recent years, though some mining was done on Yankee Creek near its mouth years ago. Claim 2 below Discovery on Porcupine Creek is at the mouth of Yankee Creek, and claim 2 above Discovery is at the mouth of Dome Creek, so that Discovery claim lies about midway between the mouths of these two tributaries. The site of present mining on Porcupine Creek is on claim 2 above Discovery, just downstream from the mouth of Dome Creek and about half a mile upstream from the highest timber on Porcupine Creek. The operators have been working at this general site since 1933, but the work of the first year was largely of a preparatory nature, such as ditch building, so that the first production of placer gold was in 1934. Mining was begun 400 feet upstream from the lower end of claim 1 above Discovery and has now progressed upstream for a distance of about 1,000 feet. The operators do not plan to continue their work upstream beyond the work done in 1936, as the ground in that direction appears to be of lower grade. Instead, they intend to move the plant downstream to the mouth of Yankee Creek and to work upstream to the lower end of the workings of 1934. A gold lode prospect has recently been found along the ridge west of Porcupine Dome, at the head of Dome Creek, and it is therefore possible that some of the gold now found

in the placer of Porcupine Creek may have come from that general direction.

Within the stretch of 1,000 feet so far mined in the valley of Porcupine Creek the placers consist of stream gravel lying in the present valley floor, and the pay streak has had an average width of about 100 feet. The section of the alluvium consists of about 13 feet of gravel overlain by about 2 feet of muck. As the bedrock throughout the valley of Porcupine Creek is the Birch Creek schist, the gravel consists entirely of types of rock found in that formation. At the site of mining the gravel is rather subangular and slabby, being composed of slabby varieties of schistose rocks, mainly quartzite schist and quartz-mica schist. Most of the pebbles do not exceed a foot in diameter, and they have an average size much less than this, though some boulders as large as 3 feet in diameter have been uncovered by mining operations. In the present cut the bedrock was not exposed at the time of the writer's visit, but in the bedrock drain below the cut the bedrock was seen to consist of a thin-cleaving mica schist, the cleavage of which stands nearly vertical and strikes about north. Only the lower 5 feet of gravel is put through the sluice boxes, and even this contains little gold, as the gold is found mainly on and in bedrock. The gold has sunk deeply into the crevices of the bedrock, and therefore it is necessary to remove several feet of bedrock and at places to clean bedrock with the giant repeatedly, in order to obtain a high recovery. The gold is coarse, ragged, and shotty, and numerous nuggets are found. Several nuggets weighing between 2 and 3 ounces have been recovered, but all of these contained considerable intergrown quartz. A weighted mean of the gold mined in 1934 and 1935 shows a fineness of 822 parts of gold and 168 parts of silver in a thousand; but an assay of some of the gold produced in 1936 shows a fineness of 818 parts of gold and 172 parts of silver in a thousand. A little cassiterite is found in the concentrates.

Mining is done by hydraulic methods. A ditch has been constructed, with an intake 1½ miles upstream, which takes water from both Porcupine and Dome Creeks and delivers it at a head of about 175 feet. The supply of water is often inadequate in midsummer, but when a sufficient supply is available three giants with 4-inch nozzles are utilized, of which one is required for stacking tailings. The sluice line consists of five boxes 30 inches wide. Besides the three owners of this plant, four other men are employed.

In 1937, a drag-line excavator plant was installed on this ground, but so far it has been used only for handling the tailings.

Bonanza Creek, the principal tributary of Porcupine Creek, has a length of about 7 miles and a gradient said to be as much as 3 per-

cent, though the topographic map indicates that the gradient in the main valley, except in the headwater gulches, is about 2 percent. In either case the gradient is considerably higher than that of Porcupine Creek. The valley is nearly symmetrical in cross section, though most of the headwater tributaries enter from the southeast side. There are no important tributaries from either side in the lower half of the valley.

The valley of Bonanza Creek, like that of Porcupine Creek, was discovered many years ago to be the site of gold placers, but little mining was done in the early days of the Circle camp, though the valley was doubtless well prospected. Except for the higher stream gradient, local conditions, such as the character of bedrock and gravel, are much the same as on Porcupine Creek. The present operators began work on Bonanza Creek about a quarter of a mile above its mouth in 1927 and since that time have worked upstream for a distance of about 3,000 feet. Within this stretch the pay streak has ranged in width from 75 to 150 feet and at the present site of mining has a width of 115 feet. About 1½ miles upstream from the present cut coarse gold has been found at the mouth of a small gulch entering Bonanza Creek from the northwest, and it is believed that the pay streak may extend this far upstream. The average tenor of the pay streak thus far mined is believed to be about 15 to 20 cents to the square foot of bedrock.

The gravel within the stretch of 3,000 feet so far mined has ranged in thickness from 3 to 6 feet, and the overlying muck from 2 to 8 feet. In the cut being worked in 1936 the alluvium consisted of 4 feet of gravel overlain by 3 feet of muck. The surface of bedrock rises about 1 foot from the center of the pay streak northwest and southeast to the limits of the ground that has been worked, but the placers are considered to be a part of the Recent deposits of the valley, though here as at most other places in the Yukon Valley the gold has probably been handled and rehandled by streams that date back into the Tertiary period. The gravel of the pay streak is well rounded and of moderate size, though some boulders as large as 2 feet in diameter are uncovered. The pebbles are different varieties of schist, and at the present site of mining the bedrock is a blocky, much-jointed quartzite schist, into the crevices of which the gold penetrates deeply. Very little gold occurs in the gravel, most of it being found on and in the bedrock, and for this reason 4 to 5 feet of bedrock is removed and cleaned.

The gold is rather coarse, but varies considerably in this respect in different cuts. Some good-sized nuggets have been recovered, two of which weighed 10½ and 8½ ounces, though the latter was almost half quartz. In the present cut considerable quartz is found intergrown

with or adhering to the gold, and several quartz veins have been uncovered in the bedrock, though none of these are known to have been gold bearing. Within the range of mining in the last 10 years there appears to have been little variation in the fineness of the gold. A weighted mean of gold produced in the years 1930 to 1934 shows a fineness of 853 parts of gold and 137 parts of silver in a thousand. A longer list of assays, given below, shows a fineness little different from the weighted mean.

Fineness of gold from Bonanza Creek

[Parts per thousand]

Year	Gold	Silver	Year	Gold	Silver
1925	811½	178	1933	854½	135
1928	850½	144		869	121
1929	845	145	1934	857	133
	851½	138		864½	130
1930	855	135	1935	847¼	147
	853	138		853½	127
1931	852	138			
1932	841	149	Mean	850	140
	850	140			

The mining on Bonanza Creek is done by hydraulic methods. The old ditch that was built in 1908 to bring water from Bonanza Creek around the spur into the valley of Mammoth Creek has been abandoned, except for that part from the intake on Bonanza Creek to the site of present mining, which serves now as a source of water for the hydraulicking. This part of the ditch is about 1¼ miles long and gives a pressure at the present cut of 140 feet. When the supply of water permits, two giants with 3-inch nozzles are used, one of which is needed for stacking tailings. Six to eight sluice boxes, 29 inches wide, form the sluice line, and block riffles are used. The gravel is driven diagonally downstream into the head of the sluice line. In addition to the two operators of this plant, three other men are employed. In 1937 a bulldozer was added to the equipment at this plant, for use in the disposition of tailings.

EAGLE CREEK

Eagle Creek is one of the headwater branches of Birch Creek. It is formed by two forks, known as Miller and Mastodon Forks, which are so designated because they head respectively against Miller and Mastodon Creeks. Miller Fork flows about south, except in its extreme headwaters; Mastodon Fork flows west-northwest; and Eagle Creek, from the junction of these two forks to its mouth, flows west-southwest. A small tributary of Eagle Creek, called Cripple Creek, enters from the southeast about 2 miles below the junction of Miller and Mastodon Forks. Both Miller and Mastodon Forks have lengths of 2 to 3 miles, and Eagle Creek has a length of about 4 miles. The

gradient of Eagle Creek is about 2 percent, but Miller and Mastodon Forks have higher gradients. The valley of Mastodon Fork is narrow and V-shaped, but the valley of Miller Fork is somewhat more open. At the junction of these two forks the valley of Eagle Creek is also narrow, with steep walls, but it opens and broadens gradually downstream into the wide valley of Birch Creek.

Gold was discovered on Eagle Creek at about the same time as on the other principal creeks of the Circle district, probably about 1895, but little intensive mining was done for several years thereafter. Beginning about 1901, however, the pay streak on Eagle Creek and Mastodon Fork was worked for several years by open cuts and by drifting, and this work was extended downstream for 2 miles below the forks. No mining has ever been done on Miller Fork, as no commercial placers have been found in this part of the valley. In 1906 the Berry Holding Co. took over most of the workable ground on Eagle Creek, and from 1907 to 1936, with the exception of the season of 1933, this company has worked the placers of Eagle Creek and Mastodon Fork by means of hydraulic plants. Work was begun on Eagle Creek on claim 8 above Discovery and by 1929 had progressed up to claim 15 above Discovery. In 1936 the Berry Holding Co. was operating its hydraulic plant on Mastodon Fork, on claim 4 above Discovery claim of that fork. There are some old workings about three-quarters of a mile downstream from the site where the Berry Holding Co. started its work, but in 1907 it was not considered that the commercial placers extended that far downstream. Another possible site of mining in future years is on a bench along the south side of Eagle Creek west of the mouth of Cripple Creek, but this will require some prospecting before any mining is begun.

The pay streak in the valley of Eagle Creek and Mastodon Fork appears to begin 1 mile above the mouth of Mastodon Fork and to extend downstream about 3 miles, of which 2 miles is in Eagle Creek. There is some evidence for the belief that a part of the gold in Mastodon Fork has come from the northeasterly of its two headwater forks. The history of mining in the valley of Eagle Creek has not been consecutively recorded, but apparently the richest part of the pay streak, and that part of it which was originally worked by drifting, had a width of 30 to 80 feet, but this width at places comprised several narrow parallel pay streaks, 4 to 8 feet wide, with intermediate zones of lower grade. In the hydraulic mining operations that succeeded the early drift mining the ground that could be worked was considered to have a width of 150 to 200 feet. On claim 4 above Discovery, on Mastodon Fork, the pay streak is now being worked over a width of 170 feet. The alluvial material of the placers has been found to be rather variable in thickness, ranging from 5 to 20 feet of gravel, overlain by a stratum of muck 2 to 15 feet thick. On claim 15 above Discovery

claim on Eagle Creek, where mining was in progress in 1929, the gravel was 20 feet thick and ranged in size from small cobbles up to subangular slabs of rock 3 feet in diameter. Above this was 2 to 5 feet of muck. At the site of operations on claim 4 above Discovery, on Mastodon Fork, in 1936 the section consisted of 12 feet of subangular gravel, averaging perhaps 6 inches in diameter but including some large boulders that had to be removed from the cut by steam power. At this place there was only about 1 foot of muck above the gravel. The principal bedrock, both on Mastodon Fork and on Eagle Creek, is a quartzite schist, the cleavage of which strikes N. 60° E. and dips about 30°–40° NW. At the present site of mining on Mastodon Fork, the gold occurs in the crevices of the upper 2 feet of bedrock and in the 3 to 5 feet of overlying gravel. Considerable quartz is found adhering to and intergrown with the gold, and it is a noticeable fact that the proportion of quartz with the gold and also the number of quartz veins and stringers found in the bedrock have increased upstream. One quartz vein about 18 inches thick was uncovered at the time of the writer's visit, in August 1936. The gold recovered on Eagle Creek and Mastodon Fork is of the highest grade that occurs in the Mammoth Creek and Deadwood Creek areas, though some of the gold from the extreme headwaters of Deadwood Creek is reported to be of nearly or quite as high grade. Three assays of the gold, based on the production in 1918, 1934, and 1935, are given below:

Fineness of gold from Eagle Creek and Mastodon Fork

[Parts per thousand]

Year	Gold	Silver
1918	892	102
1934	871½	115¼
1935	864¾	120

The mean fineness of these assays is 876 parts of gold and 112 parts of silver in a thousand; but the weighted mean, taking into account the weight of the three lots, shows a fineness of 883 parts of gold and 108 parts of silver in a thousand. So far as these data go, they indicate a gradual increase in fineness in going downstream. The gold recovered at the present site of mining is said to be rather coarse-grained. One nugget weighing about 3¼ ounces has been recovered from the placers of Eagle Creek.

The hydraulic plant of the Berry Holding Co. on Mastodon Fork is taking cuts 150 feet long and 170 feet wide. Water for the giants is obtained from a pipe line, with an intake at the forks of Mastodon Fork, and is delivered at the cut at a head of about 160 feet. The old ditch, which takes water from Mastodon and Miller Forks, became

useless for hydraulicking as the work progressed upstream, and the water from it is now used only for ground sluicing and stripping. A third ditch brings the water from Cripple Creek into Mastodon Fork, and this is used as a supply of sluice water. The sluice line consists of 16 boxes, 12 feet long and 3 feet wide, equipped with iron riffles. Steel center boards are mounted above the sluice boxes, and the gravel is driven into the boxes from both sides of the cut by three No. 2 giants equipped with 3-inch nozzles. By means of a gin pole and a steam scraper, the tailings are elevated and dumped to one side of the cut. For this purpose a bucket with a capacity of three-quarters of a cubic yard is used, and the steam scraping plant is driven by a two-cylinder steam engine, with a 40-horsepower boiler. Including the foreman, about 10 men are employed at this plant.

South of Eagle Creek is a stream known as Golddust Creek, which heads somewhat south of Mastodon Dome and flows nearly west for 7 or 8 miles, joining Birch Creek about a mile below the mouth of Eagle Creek. The gravel of Golddust Creek was being prospected by drilling during the summer of 1936, with the idea of installing a mining plant if commercial placer ground could be located.

The next tributary of Birch Creek southwest of Golddust Creek is Butte Creek. This stream has two headwater forks, from the junction of which it flows northwest for 3 miles to its mouth. A dragline excavator plant was installed and operated on Butte Creek in 1937. A weighted mean of the gold so far mined on Butte Creek shows a fineness of 900 parts of gold and 88 parts of silver in a thousand.

NORTH FORK OF HARRISON CREEK

Harrison Creek is a large tributary of Birch Creek, which heads southeast of Eagle Creek and flows in a general easterly direction for 20 miles or more. The North Fork, a large branch of Harrison Creek, heads on the east flanks of Mastodon Dome and flows east for about 5 miles and then south for about 4 miles, to its junction with Harrison Creek. The headwater part of Harrison Creek, west of the mouth of the North Fork, is known locally as the "South Fork," though it flows almost due east. Harrison Creek between the mouth of the North Fork and Birch Creek receives three good-sized tributaries from the north, which in order downstream are called Squaw, Bottom Dollar, and Traverse Creeks. Some prospecting and mining has been done on these three streams.

The valley of the North Fork of Harrison Creek is distinctly asymmetric in cross section, particularly in the western or upper half. In this stretch no tributaries enter from the north, and the boundary ridge on that side is only a mile or two from the creek, whereas on the

south side the ridge is farther away, and there are numerous equally spaced tributary streams. Notwithstanding this general configuration, the south wall of the valley, close to the valley floor, is decidedly the steeper of the two bounding walls, so that close to the creek the aspect of the asymmetry may be said to be reversed from that which prevails in the valley as a whole. In this headwater stretch the valley of the North Fork is 200 to 300 yards wide, but farther downstream it contracts, and before reaching the main valley of Harrison Creek the stream flows through a steep-walled canyon. The gradient of the North Fork, in that part of the valley where mining is in progress, is said to be between 2 and 2½ percent. The valley of the "South Fork" is said to be broader and more symmetrical in cross section than that of the North Fork. From the junction of these two forks the valley gradually broadens and finally merges into the lower valley of Birch Creek.

The bedrock throughout the valley of Harrison Creek and its tributaries consists of schistose rocks belonging to the Birch Creek schist. At the site of mining on the North Fork quartz-mica schist and mica schist are the more common varieties; and at one locality the cleavage of the schist was observed to strike about N. 60° W., with a high dip to the southwest. Quartz veins in the bedrock are said to be of common occurrence, and Spurr has recorded one specimen of such vein quartz in which free gold was observed.

The gravel deposits in the valley of the North Fork range in thickness from 4 to 12 feet and have an average thickness of about 7 feet, but little or no muck overlies them. They are also in large part unfrozen, thus favoring placer mining. Most of the pebbles are of moderate size, though some good-sized boulders are occasionally uncovered. At places strata of sand are interbedded with the gravel. As the country rock is mainly schist, the gravel also consists chiefly of different varieties of schist, but the presence of some pebbles and cobbles of granitic rocks indicates that small unmapped bodies of such rocks are also present in the headwaters of the valley of the North Fork. Gold occurs not only on and in bedrock but also in the lower 3 feet of the gravel stratum.

The original discovery of gold in the Circle district is said to have been made in 1893 on Pitka Bar, at the mouth of the North Fork of Harrison Creek. Gold was subsequently found on the North Fork and on Harrison Creek above and below the mouth of the North Fork; but gold placers have been worked commercially mainly on the North Fork. The commercial placers of the North Fork of Harrison Creek are now controlled largely by two operators. One man holds the ground from the mouth of the North Fork upstream for 4½ miles; and the same man holds 5½ miles of ground in the

main valley of Harrison Creek, of which 2 miles extends upstream from the mouth of the North Fork. The second operator holds a stretch of ground on the North Fork, from 4½ to 7 miles above the mouth. Hydraulic plants were worked by both of these operators in 1936, but the smaller plant was the one farther downstream.

A hydraulic plant was installed in 1931 about 1½ miles downstream from the western limit of the lower block of ground, and mining was carried upstream for a distance of about 1,400 feet. In this stretch the pay streak is reported to have been 150 feet wide, but at the present site of mining the ground was being worked in 1936 over a width of only 40 feet. The gravel here has a thickness of about 7 feet and is fairly well rounded, with little or no overlying muck. A few boulders as large as 18 inches in diameter were seen, but most of the pebbles are small, averaging perhaps 6 inches or less in diameter. The bedrock is a soft, much-decomposed mica schist, the cleavage of which strikes about N. 60° W. and dips variably but steeply southwest. The gold is found in the lower 2½ to 3 feet of gravel and also on and in the bedrock, but as a rule it does not penetrate deeply into bedrock of this sort. In mining, however, from 1½ to 2 feet of bedrock is usually removed, to make sure that no considerable part of the gold is unrecovered. The gold on and near bedrock is fairly coarse, and one nugget weighing a little more than half an ounce has been recovered. The gold found in the gravel, however, is fine-grained, flaky, and bright yellow. No assays of the gold recovered at this plant were seen.

Water for the hydraulic mining at this plant is obtained by a ditch about 1½ miles in length, which furnishes a head of 130 feet at the cut. Three giants equipped with 3-inch nozzles are used, one of which is required for stacking tailings. The sluice line consists of five boxes having a width of 34 inches. The owner of the ground and two laymen were working at the plant.

A little more than 1½ miles upstream from the plant above described and 500 feet upstream from the eastern limit of the upper block of ground, another hydraulic plant was operated in 1936. About 1,000 feet upstream from this plant, and extending therefrom another 1,000 feet upstream, are old tailings where the present operators worked during the seasons of 1932 to 1934. It is planned to work progressively upstream from the site of present mining to the lower end of these old tailings. Work in this lower cut was begun in 1935 and has now been carried upstream for a distance of 300 feet. At the site of present mining the pay streak is 200 feet wide, but farther upstream it was worked to a width of 240 feet. The gravel has a thickness of 5 to 6 feet, with practically no overlying muck,

but in the ground farther upstream it was 12 feet thick. Here, as at the plant 1½ miles downstream, the pebbles of the gravel are of moderate size and are well rounded. The bedrock includes mica schist and quartz-mica schist, both of which are much decomposed. The gold occurs mainly on and in bedrock, but a considerable part of it is recovered from the lower 2 feet of the gravel. Two 1-ounce nuggets have been recovered. About 2 to 3 feet of bedrock is removed in the mining operations, to get a good recovery of the gold. Assays of the gold are presented below.

Fineness of gold from North Fork of Harrison Creek

[Parts per thousand]

Year	Gold	Silver	Year	Gold	Silver
1930	816	169	1936	826½	164
1931	822	165		818	172
1932	819½	170		853	137
1933	839	158	Mean	837	154
	832	158			
1934	827½	162			
1935	873	117	Upper ground (mean)	826	164
	867	123	Upper ground (weighted mean)	822	166
	832¾	162	Lower ground (mean)	846	145
	851½	139			

Production data in the files of the Geological Survey make possible the figures showing a weighted mean for the upper ground, but the weighted mean differs little from the arithmetical mean. From these figures it appears that the gold recovered from the ground worked in 1935 and 1936 has an average fineness somewhat greater than that of the gold worked farther upstream in earlier years; but the table also shows much irregularity in the distribution of gold of varying grades, so that it cannot be said that the gold increases regularly in fineness downstream. In fact, the distribution of values suggests that gold from diverse local sources has accumulated to form the pay streak. This conclusion is fortified by the facts that much quartz is found adhering to and intergrown with the gold, and that the amount of this quartz is as great in the gold recovered from the lower ground as in that recovered from the upper ground, if not greater.

Mining is done by hydraulic methods. A ditch three-quarters of a mile long gives a head of 110 feet at the penstock, but the present cut is 1,800 feet downstream from the penstock, and the water is piped downstream for this distance, giving a head at the cut of about 140 feet. Four No. 2 giants with 3-inch nozzles are used, but one of these is required for stacking tailings. The sluice line consists of six boxes of standard length, 28 inches wide, and the gravel is driven into the head of this sluice line. At the time of the writer's

visit the supply of water was inadequate, and only two giants were being operated. Including the two owners of this plant, five persons are engaged in this work.

In addition to the mining operations on the North Fork of Harrison Creek, two men and another concern were engaged in small-scale mining and prospecting on Bottom Dollar Creek during the summer of 1936. The second concern was engaged in drilling operations. It is reported that the fineness of the bullion from Bottom Dollar Creek is 702 parts of gold and 285 parts of silver in a thousand at one locality, but 797 parts of gold and 195 parts of silver at another locality.

DEADWOOD CREEK AREA

The principal streams that are considered to be a part of the Deadwood Creek area are Deadwood Creek and its tributaries, including Switch Creek; Ketchem Creek, the next large stream east of Deadwood Creek; and several other nearby streams.

Central House is on the Steese Highway along the north side of Crooked Creek, between the mouths of Boulder and Deadwood Creeks. It is a post office and the site of a roadhouse and general store. From Central House a branch of the Steese Highway leads southeastward to the Circle Hot Springs; and a branch of this road goes up Deadwood Creek to and beyond the mouth of Switch Creek, and also up Switch Creek. Another branch of the road between Central House and Circle Hot Springs leads up Ketchem Creek.

DEADWOOD CREEK

Deadwood Creek has an air-line length of about 15 miles. It heads in the high ridge that forms the divide between the Birch Creek and Crooked Creek Basins and flows in a northeasterly direction to Crooked Creek. In the upper 10 miles of its course Deadwood Creek flows in a valley bounded by hills, but in the lower 5 miles it meanders across the wide valley floor of Crooked Creek. In the uppermost 5 miles Deadwood Creek receives several small tributaries from both the northwest and the southeast sides of its valley. The most easterly and largest of these tributaries, entering from the southeast side of the valley, is Sixteen Gulch, so named because it enters Deadwood Creek on claim 16 above Discovery. From this point downstream Deadwood Creek receives no tributaries of any size from the northwest side of its valley; but on the southeast side an important tributary, known as Switch Creek, enters about 2½ miles downstream from Sixteen Gulch. Discovery claim on Deadwood Creek is about 5,000 feet upstream from the mouth of Switch Creek; but all the claims in this part of the valley of Deadwood

Creek were staked years ago under the old placer laws and are therefore only 500 feet in length.

The valley of Deadwood Creek from the mouth of Switch Creek upstream is narrow, with steep bounding walls and a cross section of nearly symmetrical shape. From Switch Creek to the flats of Crooked Creek, however, the valley becomes progressively asymmetric in cross section, with a steep southeast wall and a gentle northwest wall. In the lower or northeastern part of this stretch the northwest wall is a wide sloping bench, which, however, is known from mining development to consist of several bedrock surfaces rising in low steps above one another. The valley of Switch Creek, though steep and narrow, also has an asymmetric cross section, with a steep bounding wall along its northeast side and a gentler wall, characterized by visible and concealed bedrock benches, along its southwest side.

The valley floor of Deadwood Creek and the benches along its northwest side are covered with shallow deposits of gravel, which constitute the gold placers of this valley. But at the point where Deadwood Creek flows out of the hills and into the valley floor of Crooked Creek, the distance from the surface to bedrock increases suddenly to a great and as yet undetermined depth. Thus on Deadwood Creek, about a mile upstream from the crossing of the Central House and Circle Hot Springs road, a shaft 100 feet deep did not penetrate to bedrock. Similarly, at the exit of Boulder Creek from the hills a shaft 60 feet deep did not reach bedrock. A similar sudden northward dip in the surface of bedrock is also reported to exist where Mammoth and Birch Creeks emerge from the hills. It is therefore evident that the bedrock floor of Crooked Creek is buried by a great thickness of alluvial deposits, which probably are genetically related to the alluvial deposits that constitute the Yukon Flats.

The principal bedrock in the valley of Deadwood Creek, including most of the valley of Switch Creek, consists of massive quartzite schist and quartz-mica schist, but some carbonaceous and chloritic schists are also present. The schists are intruded at places by granitic rocks and their fine-grained equivalents, but dikes of basic igneous rocks are also found. The largest mass of granitic rocks is one that crops out on Deadwood Creek, from a point about a quarter of a mile above the mouth of Switch Creek downstream for a distance of about 1¼ miles. This same intrusive mass extends 500 feet up the valley of Switch Creek. Smaller intrusive masses of granitic rocks are also known at other places, as on Sixteen Gulch and at the head of Switch Creek, as well as at localities where they have been uncovered by mining operations. Along the contacts with the granitic rocks the schists are locally garnetiferous. The general strike of the

cleavage of the schists is probably about east-northeast, but the dip of the cleavage appears to be rather variable, both in amount and in direction. In the vicinity of granitic intrusives, as on Deadwood Creek above and below the mouth of Switch Creek, both strike and dip of the schistose cleavage are variable to a high degree.

The gold found in the valley of Deadwood Creek and its tributaries is believed to have been derived from quartz veins, which are connected genetically with the intrusion of the granitic rocks. As no sedimentary rocks younger than the Birch Creek schist are exposed in this valley or in any nearby area, the age of the granitic rocks and their associated auriferous quartz veins cannot be determined upon any stratigraphic basis; but they are believed to be very much younger than the ancient schists and are likely to be either of Mesozoic or Tertiary age, and possibly of both. The available data regarding bedrock mineralization on Deadwood Creek have been summarized by Johnson [20] in the following statement.

> Numerous quartz veins are found in the metamorphic rocks. These veins vary considerably in size, ranging from a fraction of an inch to several feet in width, though most of them are but a few inches wide. A few small quartz veins were seen which were closely folded with the enclosing schists. Most of the veins, however, cut across the foliation of the schists, are not folded, and are therefore younger than the regional metamorphism which produced the schists. They were probably formed during the final stages of the consolidation of the intrusive granitic mass. The rusty appearance of a few of these later quartz veins indicates the former presence of sulphides, but the greater number of the veins show no surface signs of mineralization. Numerous boulders showing feldspar-bearing quartz veins cutting schist can be seen in the creek gravels. Arsenopyrite occurs in association with these quartz-feldspar veins, especially on Switch Creek. On Deadwood Creek wolframite pebbles with mica and quartz attached have been found in the placers. Fragments of schist containing gold-bearing quartz veins have been found in the Birch Creek region, and gold nuggets with attached vein quartz have been found on many of the claims on Deadwood and Switch Creeks. Mineralized fracture zones permeated by quartz stringers carrying pyrite and galena have been found in the schists on the upper part of Deadwood Creek.

One of the interesting features connected with the mineralization in the valley of Deadwood Creek is the occurrence of a large amount of wolframite and cassiterite in the concentrates that are recovered with the gold placers. It was reported to Brooks [21] that a small vein of wolframite was found on Deadwood Creek in 1908; and Johnson,[22] apparently referring to the same discovery, states that this vein was uncovered at the base of a prospect hole sunk in the

[20] Johnson, B. L., Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district, Alaska: Geol. Survey Bull. 442, pp. 247–248, 1910.

[21] Brooks, A. H., The mining industry in 1908, Alaska: Geol. Survey Bull. 379, p. 29, 1909.

[22] Johnson, B. L., op. cit., p. 248.

high bench gravel along the west side of Deadwood Creek near Discovery Gulch. This would be about 1 mile upstream from the mouth of Switch Creek. This vein, however, was not seen by any member of the Geological Survey, and there is no other record of the finding of wolframite or cassiterite in place on Deadwood Creek. The distribution of wolframite and cassiterite in the placers, however, gives a clue to its original bedrock source. Both these minerals occur in greatest abundance in the placer concentrates on Discovery claim, about a mile upstream from the mouth of Switch Creek, and they are fairly plentiful in the placer concentrates for a mile downstream from this point. Still farther downstream they become progressively more scarce, and on Switch Creek neither of these minerals was detected by Johnson in the concentrates. These data suggest that the principal site of tin and tungsten mineralization is south of the southern periphery of the granitic mass that crops out in Deadwood Creek.

Deadwood Creek was staked originally in 500-foot claims from about 55 above Discovery to 50 below Discovery, a distance of about 10 miles; and in recent years at least 9 other claims, each 1,320 feet in length, have been staked downstream from claim 50 below Discovery. Old tailing piles and other indications of mining activity show that the placers have been worked by various methods throughout a distance of 10 miles, from claim 55 above Discovery downstream. The history of these older operations is not sufficiently well known to make any very definite statements regarding the width, depth, tenor, or continuity of the pay streak. In the stretch from half a mile above Switch Creek downstream for 5 miles, however, the workable pay streak, in terms of present hydraulic operations, is known to have ranged in width from 100 feet or less to 400 feet; and in the stretch of the creek between claims 22 and 32 below Discovery, where the valley floor is 800 feet wide, the pay streak, in terms of modern mining methods, may prove to be wider than 400 feet. The thickness of the alluvial deposits that form the valley floor is naturally variable, but in general all the stream placers are of shallow depth, from 5 to 20 feet. The gravel stratum ranges from 3 to 14 feet in thickness, and the overlying muck from a few inches to 8 feet or more. The gold occurs both in the gravel and on bedrock, but in different degrees at different places. It is probably true that most of the gold occurs on and in the crevices of bedrock, but at no place visited by the writer was it said that less than 15 percent of the total recovery was found in the lower part of the gravel body, at heights of 2 to 6 feet above the bedrock surface. The data above given, however, apply only to the placers of the present valley floor. In the lower part of the valley of Deadwood Creek the bench gravel is also being worked for a distance of 250 feet northwest of the creek placers,

and still higher bedrock benches are known to exist, which may ultimately extend the total width of the pay streak in this part of the valley to 1,000 feet or more. Details regarding these bench placers and the bench placers of Switch Creek are given below.

Considering the scope of mining operations on Deadwood Creek in earlier years, relatively few data are available regarding the fineness of the gold. The following assays, based on production in recent years, were obtained mainly from the records of Alf R. Erickson, postmaster at Central House:

Fineness of gold from Deadwood Creek

[Parts per thousand]

Claim	Year	Gold	Silver
30-A	1934	817¾	177
25-A	1935	801	194
5-A	1934	778¼	216
4-B	1933	791¼	203
11-B	1934	800½	194
22-B	1935	779	216
44-B (bench)	1936	805	185
Mean		796	198

From these records it will be seen that there is no progressive increase or decrease in the fineness of gold on Deadwood Creek from Switch Creek downstream. There is said, however, to be a progressive increase in the fineness of the gold on Deadwood Creek from claim 5 above Discovery upstream to claim 42 above Discovery, on which some of the highest-grade gold of the Deadwood Creek area has been found. The gold of Switch Creek is definitely of lower grade than the average grade of the gold from Deadwood Creek, and therefore an anomalous distribution of fineness is to be expected below the mouth of Switch Creek. But the reported increase in fineness upstream on Deadwood Creek above the mouth of Switch Creek is also unusual. All these facts suggest a complex history of gold accumulation on Deadwood Creek, in which the gold of the present stream placers has been derived from diverse and widely separated bedrock sources, as well as from bench deposits.

The gold placers of Deadwood Creek were discovered in 1894, and mining has continued from that time to the present day. In the early years the placers were worked by drifting and when possible by shallow open cuts, and even as late as 1909, there had been no hydraulic mining downstream from Switch Creek, but this kind of mining began shortly thereafter, and now, large-scale mining by the use of mechanical excavators is beginning. It is probable that by means of such large-scale methods, capable of working low-grade deposits, the placers of Deadwood Creek will still be worked steadily

for many years. In 1936 mining was in progress at six places on Deadwood Creek. Two of these were hydraulic plants, two were small open-cut operations, one consisted of small-scale drifting, and the last was a mechanical excavator that operated on lower Deadwood Creek. These mining plants are described below.

On claim 20 above Discovery one man was working a small open cut in 1936. This work was being done along the northwest side of the creek and about 75 feet from it, on a low bedrock bench. The bedrock at this cut is at about the same level as the creek, but it is about 9 feet higher than the bedrock under the creek and in this sense is therefore bench ground. The overburden here consists of 2 to 3 feet of fairly well rounded gravel, overlain by 3 feet of muck and hillside slide. The bedrock is a blocky light-gray quartzite, into the crevices of which the gold penetrates for 2 or 3 feet, thus necessitating the removal and cleaning of that much bedrock. This is marginal ground, along the edge of the old pay streak, which consisted of the present stream gravel. Old tailing piles that extend 2 miles or more upstream and for a considerable distance downstream below Switch Creek show the scope of the old mining operations in this part of the valley. Much of this work was done by open cutting and shoveling into boxes.

On claim 5 above Discovery a hydraulic plant was being operated. The work of this plant was begun in 1917 on claim 1 below Discovery and since that time has been carried progressively upstream to the present site. The present owner of this plant has been working here for 5 years and now controls all the placer ground from claim 5 above Discovery upstream to the head of Deadwood Creek. The paystreak in the seven claims so far worked has ranged in width from 100 feet on claim 1 below Discovery to 260 feet at the site of present operations, on claim 5 above Discovery. The ground on Discovery claim and on several claims downstream from Discovery is said to have been of high tenor, but claims 1, 2, and 3 above Discovery had low-grade deposits, which probably yielded 20 cents or less to the square foot of bedrock. Claims 4 and 5 above Discovery and the other claims farther upstream had placers of higher grade. Some of these, for a narrow strip in the medial part of the pay streak, yielded from $1 to $3 to the square foot of bedrock. Within the stretch from claim 1 below to claim 5 above Discovery the alluvium on the southeast side of the creek, which is bounded by the steeper wall, has ranged in thickness from 5 to 8 feet, practically all of which has been gravel. On the northwest side of the pay streak, however, the total thickness of alluvial deposits has ranged from 10 to 18 feet, of which the upper 6 to 8 feet consisted of muck. The pebbles of the gravel are of moderate size, seldom

exceeding a foot in diameter, but are not well rounded. They consist mainly of several varieties of schist, but some cobbles of granitic rocks show the presence of small bodies of such rocks farther upstream. Vein quartz is also of common occurrence among the gravel, and the larger boulders are usually either vein quartz or granitic rocks. The bedrock is mainly quartz-mica schist and quartzite schist, the cleavage of which strikes N. 50° E., and dips 20° NW. Numerous veins of quartz from 6 inches to 2 feet thick cut the bedrock, and along the southeast wall of Deadwood Creek, opposite these workings, three large quartz veins are clearly visible.

In the stretch from claim 1 below to claim 5 above Discovery the gold was found both on bedrock and in the overlying gravel. Not uncommonly half the gold occurred in the gravel, and at some places as much as two-thirds of it was found in the gravel. Generally some gold was found from the top of the gravel stratum to its base, but most of it was localized in the lower 2 to 4 feet of gravel. At one locality, however, it was noticed that the lower 2 feet of auriferous gravel was overlain by 1 foot of barren gravel, which in turn was overlain by auriferous gravel. Such conditions indicate much transportation of the gold downstream, with the consequent mixing of gold of several grades. According to the present operator, the grade of the gold changed little in this stretch of seven claims, nor did it change much from claim 1 below Discovery down to the mouth of Switch Creek. Upstream from claim 5 above Discovery, however, the gold is said to have increased progressively in grade. At the site of present mining, on claim 5 above Discovery, one assay shows a fineness of 778¼ parts of gold and 203 parts of silver in a thousand. Most of the gold found on these seven claims has been fine-grained, with relatively few nuggets. The largest nugget so far recovered by the present operator weighed half an ounce.

Mining from claim 1 below to claim 5 above Discovery has been done by hydraulic methods. The ditch that supplies water for these operations has a total length of about 1½ miles, but now, on account of the progress of mining upstream, it has an effective length of only 4,000 feet and supplies water at a head of 80 feet. Four No. 1 giants with 3-inch nozzles are utilized in this work, but only two are used simultaneously, and one of these is required for stacking tailings. The sluice line consists of six 34-inch boxes equipped with block riffles.

One man was mining in a small way on claim 4 below Discovery. This work was being done by hand, open cutting and shoveling into boxes.

On claim 15 below Discovery a second hydraulic plant was in operation. The two operators of this plant hold claims 1 to 12

below Discovery and have leased claims 13 to 15 below Discovery. Much of the ground on these 15 claims has been worked in earlier years by open cutting and by drifting, but it has not been worked on any large scale, so that the present operators have many years of work ahead of them. They also control the bench claims along the northwest side of Deadwood Creek from claims 1 to 21 below Discovery. The pay streak on claim 15 below Discovery is considered to be about 300 feet wide. On the northwest side the stream placers are bounded by a pronounced rise in the surface of bedrock, which may lead upward to a higher bedrock surface overlain by bench placers. Late in the summer of 1936 a cut 80 feet wide and 150 feet long was being worked along the southeast side of the pay streak. At this place the operators had not been able to get a drain to bedrock, so that they were unable to clean bedrock, but this difficulty will be obviated as the work progresses upstream. The alluvial section consists of 10 to 12 feet of gravel, overlain by 3 to 5 feet of muck. The gravel is rather coarse, many of the cobbles being a foot or more in diameter, with also some larger boulders, mainly of granitic rocks, that reach 3 feet in diameter. This plant is located in the area of granitic rocks that crosses Deadwood Creek below the mouth of Switch Creek, and the bedrock is therefore composed entirely of such rock. The granite is greatly fractured, and the gold penetrates deeply into the crevices. Gold occurs throughout the gravel and also on and in bedrock, but because the mining has not been carried to bedrock in this particular cut, the proportion of the gold in gravel and on bedrock is not known. Two kinds of gold are recovered. One, which is dark in color and of the higher grade, represents the run of gold from upper Deadwood Creek. The other, which is brighter and of lower grade, is the gold that has come out of Switch Creek. All the gold is said to be fairly coarse grained, and one nugget weighing 3¼ ounces has been recovered. No assays were available to the writer.

Mining on claim 15 below Discovery is done by hydraulic methods, for which water is supplied by a ditch with an intake about a mile upstream on Deadwood Creek. This ditch supplies water at the cut under a head of 120 feet. Three No. 1 giants equipped with 3-inch nozzles are used, one of which is required for stacking tailings. Owing to the difficulty of gradient in the present cut, only three sluice boxes are used, which are set to a minimum grade of 8 inches to the box length. Even with these precautions, the operators found it necessary to blast through a reef of granitic bedrock, for a distance of 80 feet, in order to work the present cut.

Farther downstream, on claim 19 below Discovery, one man was engaged in small-scale drift mining during the winter of 1935–36.

The largest-scale mining in progress on Deadwood Creek in 1936 was the work that was done by the Deadwood Mining Co. on claim 44 below Discovery. The owners of this concern took over from previous holders the control of claims 22 to 59 below Discovery, representing a linear distance of 7 miles along the creek. They have also taken an option on claims 7 to 22 above Discovery. Mining was begun in 1936 but was confined entirely to bench placers along the northwest side of the valley.

A general picture of the mining operations of the Deadwood Mining Co. can best be given by describing the valley of Deadwood Creek at claim 44 below Discovery. At this site the cross section of the valley is asymmetric, with a steep wall on the southeast side and a long gentle slope on the northwest side. The valley floor, which is the site of the present stream placers, is about 400 feet wide, and the bedrock surface is covered by about 8 feet of gravel overlain by 5 to 6 feet of muck. The northwest side of the valley floor is bounded by a bedrock rim that rises 14 feet to a nearby flat bedrock surface, which extends northwestward for about 250 feet. The bedrock surface of this first bench is covered by about 3 feet of gravel, overlain by 5 feet of muck. At the northwestern limit of this bench the bedrock again rises 8 to 10 feet to a second bedrock surface, which likewise has a width of 250 feet and is covered by 6 feet of gravel, overlain by 5 feet of muck. This second bench was the site of mining in 1936. At the northwest end of the second bench the bedrock again rises 10 to 15 feet to a third surface, which continues northwestward as a nearly level bench, forming the bedrock surface of the spur between Deadwood and Boulder Creeks. These benches are bedrock surfaces, which do not appear as such at the surface of the ground. Moreover, the section here given does not apply in detail for any great distance northeast and southwest. In the present valley floor, for example, the width of 400 feet above given continues upstream to the "basin," which is a much wider part of the valley floor, between claims 32 and 22 below Discovery, where the width increases to a maximum of 800 feet. Downstream from claim 44 below Discovery the valley floor increases gradually to a maximum width of 800 feet.

On the second bench, where mining was in progress in 1936, the section has already been given. The pebbles of the gravel here are rather small, being mostly less than 10 inches in diameter and averaging perhaps half that size. A small pile of boulders, the largest 2 feet in diameter, represented the amount uncovered in mining an area of about 130,000 square feet. All the gravel is fairly well rounded. Gold is found mainly in the lower 2 or 3 feet of the ground and in the upper 2 to 4 feet of fractured bedrock, which is removed with the scraping equipment. About 85 percent of the gold is said

to occur on or in bedrock. The gold is rather fine grained, with an average weight of 5 to 6 milligrams, and is rather flaky, but some nuggets weigh as much as half an ounce. One assay showed a fineness of 805 parts of gold and 105 parts of silver in a thousand.

Mining on this bench was done by means of a No. 6 Northwestern dragline Diesel excavator, mounted on a caterpillar base, used in conjunction with a 90-horsepower R. D.–8 Diesel caterpillar bulldozer. The bulldozer is used to scrape gravel and bedrock from the edge of the cut inward to a point where it can be reached by the excavator. The excavator has a 55-foot boom and swings a bucket with a capacity of 1½ cubic yards. The dump box and sluice boxes are built as an elevated rigid unit, which is mounted on skids so that it can be moved readily from one place to another, without the necessity of dismantling and reassembling this equipment. A dump box 7 feet wide and 34 feet long, equipped with block riffles, forms the head of the sluice line, which is followed by 50 feet of steel sluice boxes 34½ inches wide. The sluice boxes are equipped with manganese-steel cross riffles and are set to a grade of 14 inches to 10 feet. A No. 1 giant with a 4-inch nozzle is used to wash the gravel into the dump box. The elevated sluice line obviates the necessity of stacking tailings. Sluice water is obtained from a short ditch, which, however, is useless for washing the gravel; but another ditch 2½ miles long is being constructed, which will give a hydraulic head of 200 feet at the dump box. In the meanwhile, the water issuing from the sluice boxes is impounded and is pumped back to the giant with an adequate pressure by means of a 97-horsepower caterpillar 6-cylinder Diesel engine, which drives a centrifugal pump with a 12-inch intake, a 10-inch outlet, and a capacity of 4,000 gallons a minute. This pumping equipment will also be used at times after the new ditch is built, because the supply of water on Deadwood Creek is often inadequate for full-time mining operations. For lighting, a 9-horsepower Fairbanks-Morse Diesel engine is used, which delivers 7,500 watts at 110 volts. Some idea of the efficiency with which this mining is being done is indicated by the fact that for the month preceding the writer's visit to this plant, the average area mined per day had been 3,000 square feet. The plant includes a variety of other features, such as a mess house, bunkhouses, and much accessory equipment. Seventeen men were employed.

As this bench mining was continued upstream in 1936 and 1937, the pay streak ended, and about 200 feet downstream from the place where this mining was begun the depth to bedrock suddenly increased greatly, just as it is known to do in the main valley floor. This bench mining was therefore discontinued, and in 1937 the Deadwood Mining Co. moved its dragline plant upstream on Deadwood

Creek to claim 5 above Discovery, above the mouth of Switch Creek, where it operated throughout the summer. The general conditions of the placer ground at this site are stated above.

At the general site of its operations in 1936, but in the present valley floor, the Deadwood Mining Co. built a dredge during the spring of 1937, which began to operate on August 8. The pay streak here was found to be about 300 feet wide. The total thickness of the alluvium is about 12 feet, of which the upper 4 feet of muck is stripped off with a bulldozer ahead of the dredge. The dredge is digging 10 feet below the water level and is therefore taking up about 2 feet of the hard quartzitic bedrock. The gravel is coarse, averaging perhaps 10 inches in diameter, but boulders as large as 3 feet in diameter are present. The dredge was built on claim 43 below Discovery, close to the east wall of the valley, and worked upstream for 710 feet, then turned, and in September 1937 was working downstream, taking a parallel cut 175 feet wide.

The hull of this dredge is made of steel pontoons, assembled from 20 sections, but the upper part is constructed of wood and fiber, covered on the outside with sheet iron. It has a bucket line of 60 buckets, of 4 cubic feet capacity, and is operated at the rate of 27 buckets a minute. It can dig 15 to 16 feet below the water line. It is operated by one spud, two stern lines, and a single continuous head line, which stretches across the bow of the dredge. Power is supplied by two 4-cylinder Atlas-Imperial Diesel engines, rated at 125 and 90 horsepower. The larger engine drives the digging ladder and winch, and the smaller one operates the pumps. A seven-drum winch is used. The pumping equipment consists of two centrifugal pumps, of which the larger delivers 3,000 gallons and the smaller 1,800 gallons a minute. The dredge is equipped with a trommel, 5½ feet in diameter and 25 feet long, of which four sections have ⅜-inch holes, and one section has 1-inch holes. Iron riffles are used in the zigzag sluiceway under the trommel, but the six boxes on each side of the boat are equipped with wooden riffles. The gravel in the trommel is washed by water issuing from a perforated pipe, which is mounted inside the trommel, just above its center. A small sluiceway or save-all is also used in the well, below the dumping buckets.

SWITCH CREEK

Switch Creek, a small stream about 3 miles in length, flows N. 20° W. and enters Deadwood Creek about 5,000 feet downstream from Discovery claim, or on claim 10 below Discovery of Deadwood Creek. The valley of Switch Creek is asymmetric in cross section and in the same sense as Deadwood Creek, in that the east wall is the steeper. The stream gradient is steep and is said to be as much as 5½ percent

in the lower end of the valley. The claims on Switch Creek are referred to the mouth of the creek, and are designated "1 above the mouth," "2 above the mouth," etc. The first nine claims above the mouth have lengths of 500 feet each; but from claim 10 above the mouth upstream each claim has a length of 1,320 feet.

The pay streak on Switch Creek consists of both stream and bench placers, and in the lower valley the higher channels show as topographic features along the west wall. One of these benches, whose underlying bedrock surface is about 45 feet above the level of the creek at its mouth, follows the west wall upstream, becoming narrower; and about 1,000 feet from the mouth, on account of its relatively low gradient compared with that of the present stream, this bench merges into the present valley floor. Farther upstream remnants of higher benches are also visible, and old tailing piles on all these benches show the sites of former drifting operations. In addition to the benches that have a topographic expression, there are other bedrock surfaces along the west side of the valley which lie above the level of the creek but are not visible until they have been bared by mining operations. The bedrock in the valley of Switch Creek consists mainly of different varieties of schist, but at the lower end of the valley granitic rocks crop out for a distance of about 500 feet upstream from the mouth. A small intrusive mass of granitic rocks also crops out in the eastern headwater fork of Switch Creek, so that some granitic rocks appear in the dominantly schistose gravel.

Switch Creek has been mined for many years, at first by small open-cut operations and by drifting and in later years by hydraulic plants. In 1936 two hydraulic plants were working on Switch Creek, of which the upper one was located on claim 10 above the mouth. The two operators of this plant control the ground from claim 7 above the mouth to the head of Switch Creek. They began working on Switch Creek in 1917 but did not install their hydraulic plant until 1922. Since that time they have worked upstream from claim 7 to claim 10 above the mouth, a distance of more than half a mile. Most of this work was done in the present stream placers, but some of the placers on low bedrock surfaces above the level of the creek were also worked. At the site of present mining, on claim 10 above the mouth, the work is being done on a bedrock surface along the west wall of the valley, about 30 feet above the level of the creek. The alluvial section on this bench consists of 3 to 5 feet of gravel, overlain by a mixture of slide rock and muck, which near the eastern rim of the bench has a thickness of only a few feet. This bedrock surface, however, extends into the wall of the valley for a distance of about 50 yards, and at this west end of the cut, the depth of the slide and muck is as much as 14 or 15 feet. Most of this gravel is of moderate size,

whereas in the mining of nearby stream placers the gravel was found to be coarser and to contain a considerable number of large boulders. This difference, noticeable here and elsewhere in this valley, is undoubtedly due to the fact that the present stream has a much higher gradient than the stream which once flowed on the higher bedrock surfaces. The bedrock here is a blocky quartzite, striking N. 70° E. and dipping 70° S. Quartz veins and stringers are of common occurrence in the bedrock. The gold occurs largely on bedrock and in the crevices of bedrock to a depth of 2 or 3 feet, but considerable gold is also recovered from the lower 2 to 3 feet of gravel. In the nearby old workings of the stream placers a larger proportion of the gold was found to occur in the gravel. The placers on the bench at the present site of mining have a gold tenor about three to four times as great as that of the nearby stream placers. Other old bedrock erosion surfaces, which do not show at the surface, lie both above and below the one here described.

The gold found at this upper plant on Switch Creek is rather coarse, with many pieces weighing from 10 to 30 grains. The largest nugget so far recovered weighed 4 ounces. Some of the larger nuggets have considerable adhering quartz, but there is no noticeable increase in the amount of quartz upstream. The following data on the fineness of the gold refer largely to gold recovered from the creek placers, as the operators have done little bench mining. Unfortunately no assays referring to work in the period 1922 to 1927 are available. The assay of 1936, however, refers to bench gold at the present site of mining.

Fineness of gold from Switch Creek, claims 9 and 10 above mouth

[Parts per thousand]

Year	Gold	Silver	Year	Gold	Silver
1928	773½	215	1935	765¼	232
1931	767	220		750¼	242
1934	753½	241	1936 (bench gold)	760½	227
	752	236			
	760	235	Mean	760	231

Mining at the upper plant on Switch Creek is done by hydraulic methods. In all the work to the present time, water was supplied by a ditch with an intake about 200 feet downstream from the lower line of claim 11 above the mouth, which at the present site of mining now gives a head of only 75 feet. A new ditch is being constructed, however, with an intake a claim length farther upstream, which will give a head of 140 feet at the present cut. Except in periods of rainy weather, the supply of water is inadequate for efficient mining, but when a satisfactory supply is available two No. 1 giants with 3-inch

nozzles are used. The sluice line consists of seven sluice boxes 24 inches wide, equipped with block riffles, and is placed at the lower or east end of the cut. The gravel is driven against shear boards into the head of the sluice line, and the tailings are spread down the slope of the valley wall toward and into the bed of the creek.

A second plant was operated in 1936 on the west side of Switch Creek, close to its mouth. The operator of this plant holds the first six claims above the mouth of the creek and has been mining at this general site for 4 years, though some of this work has been done on creek placers. The present site of mining is on a bench, the bedrock surface of which is about 45 feet above the level of the creek and about 100 yards from it. This bedrock surface, as shown by prospecting, extends westward into the hillside for nearly 50 yards, with a gradual rise in that direction. The pebbles of the gravel at this place are subangular but rather small, and the bedrock is granite. At one place in the cut there is next to the bedrock a stratum of gravel from 1 to 2 feet thick, which is brick red and so firmly cemented by iron hydroxides as to be a solid conglomerate. This stratum cannot be disintegrated by the giants, and where present it causes much loss of gold, in that it is not only itself auriferous but also shields the auriferous bedrock from hydraulic operations. These iron deposits probably represent the site of an ancient spring whose water contained a high percentage of dissolved iron salts. The gold occurs in the gravel for 3 or 4 feet above the bedrock and also on the surface of bedrock and in its fracture crevices. It is somewhat coarser than that found in the nearby stream placers, and nuggets weighing as much as 2 ounces have been found. It is also said to be a little lower in grade than the gold of the stream placers, but no assays were seen of either.

These placers are mined by hydraulic methods. Water is obtained from a ditch 4,000 feet long and is delivered at a head of 140 feet at the present site of mining. At the time of the writer's visit a cut 35 feet wide (parallel to the creek) and 100 feet long was being worked. One No. 1 giant with a 3-inch nozzle was being used, but only one splash was being obtained every 25 minutes. The sluice line, consisting of five sluice boxes with block riffles, was set normal to the creek, and the gravel was piped into its head. Ample room for tailings was available.

KETCHEM CREEK

About 5 or 6 miles east of Deadwood Creek is another tributary of Crooked Creek, called Ketchem Creek. Unlike Deadwood Creek, less than a half of the valley of Ketchem Creek lies within the hilly country south of the Crooked Creek Flats, but this part has an asymmetric cross section, with the steeper wall forming the east side of the valley. An intrusive mass of granitic rocks, about 1 mile wide, crosses the headwater part of the valley of Ketchem Creek. Mining has been in

progress in Ketchem Creek only in recent years, and little is known by the writer regarding local conditions in this valley.

Two placer-mining plants were operated on Ketchem Creek in 1936. The operator of the upper one of these plants controls the ground on this creek from claim 1 below to claim 5 above Discovery, also some association claims, making in all a stretch of 2½ miles along the valley floor. He was operating a small open cut on claim 2 above Discovery and had been drifting during the winter of 1935–36. On claim 2 above Discovery the width of ground worked in the present small-scale operations is 30 feet, but this does not represent the width of the pay streak that could be worked by larger-scale methods. The depth from the surface to bedrock is 11 feet, of which 4 to 6 feet represents gravel. No large boulders are uncovered, and the pebbles in general appear to be of moderate size. The southern contact of the granitic intrusive rock that crosses Ketchem Creek is about a claim length downstream, on claim 1 above Discovery. The bedrock at this plant is schist, but of a variety apparently hardened by its proximity to the granitic rocks. The gold is rather fine grained, but numerous pieces weighing from 7 to 10 grains have been found. Some of the gold has considerable quartz adhering to it. The fineness is reported to be 783 parts of gold and 207 parts of silver in a thousand.

The second plant on Ketchem Creek was located on the upper end of claim 5 below Discovery, in that part of the creek where the bedrock is granite. The operators of this plant, however, control the ground from claims 2 to 7 below Discovery, or for a distance of about 1½ miles along the valley floor. This plant had just been installed and was beginning to operate in August, at the time of the writer's visit, so that little information was at that time available regarding local conditions. The pay streak, however, was thought to be 150 feet wide, though only a width of 100 feet was being worked. The alluvial section consists of 11 to 17 feet of gravel, overlain by 3 to 4 feet of muck. The average run of pebbles in the gravel are small, but occasional large boulders of granite are to be expected. From prospecting, the gold has been found to occur in the lower 2 to 3½ feet of bedrock and in a fine arkosic sand which covers the bedrock surface. Farther upstream, however, the gold is said also to occur in bedrock. The fineness of the bullion is 783 parts of gold and 207 parts of silver in a thousand.

Mining is being done by means of a small Marion dragline excavator, with a 30-foot boom and a bucket with a capacity of three-quarters of a cubic yard. A 20-horsepower steam boiler is being used as the power plant.

In 1937 another dragline excavator plant was installed on Ketchem Creek, on claim 8 below Discovery, and about 1½ miles upstream from the point where Ketchem Creek is crossed by the Deadwood-

Circle Springs road. The operators of this plant control 16 association claims, and by drilling have proved the existence of about a mile of workable ground, which extends 2,500 feet upstream and 3,000 feet downstream from the site where the excavator was installed.

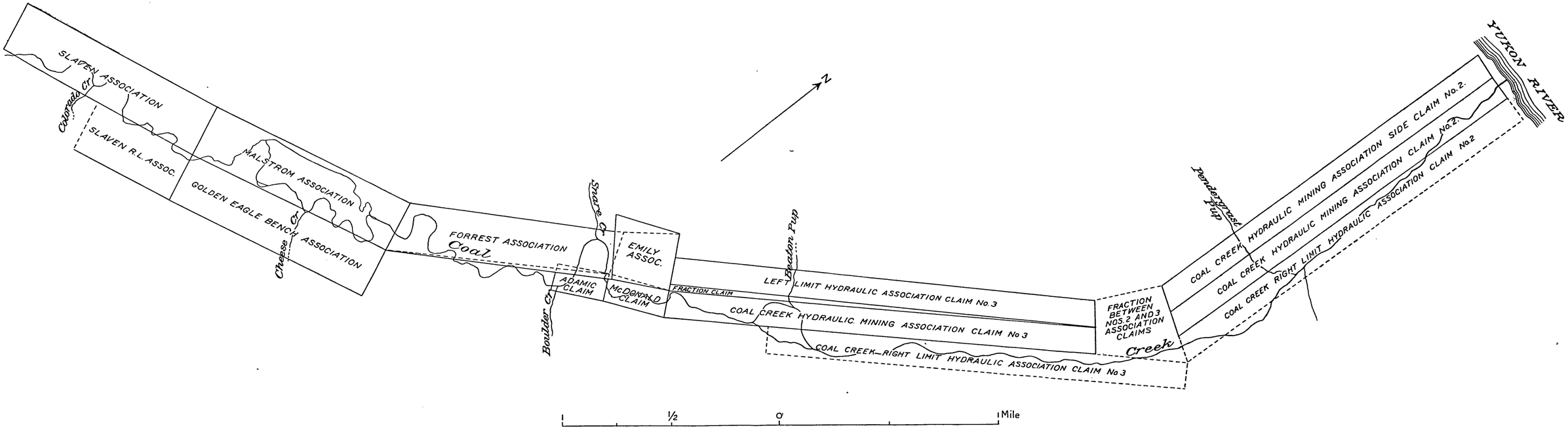
The pay streak here averages from 350 to 400 feet wide but in places is as wide as 600 feet, and this workable ground lies mainly along the northwest side of the creek bed. The bedrock is an arkosic granite, the surface of which is uneven, rising in places within 5 or 6 feet of the surface. It is also characteristic of the configuration of bedrock that it rises rather abruptly on both sides of the pay streak. The alluvium has a thickness of 16 feet, of which an upper stratum, ranging from 1 to 5 feet, is muck and sand. The underlying gravels have an average size of 7 or 8 inches, but boulders, mainly quartzite, as much as 2½ feet in diameter are present. The gold is rather coarse but in flattened pieces, and the largest piece so far recovered weighed one-half ounce. The fineness of the product is said to be about 780 parts gold in a thousand.

Mining is accomplished by a dragline excavator, on a tractor base, driven by a four-cylinder Atlas Diesel engine, rated at 80 horsepower. A 50-foot boom is used, which swings a bucket with a capacity of 1 cubic yard. The washing plant is the usual type of elevated dump box and sluice boxes, mounted on skids. Water for washing and sluicing the gravel is pumped from a small dam in the creek by a Fairbanks-Morse centrifugal pump, with a 10-inch intake and an 8-inch outlet, which delivers 3,500 gallons a minute. This pump is driven by an International Diesel four-cylinder engine, rated at 120 horsepower.

BOULDER AND PORTAGE CREEKS

Boulder Creek is a large stream, about 13 miles in length, which flows parallel with and about 4 miles west of Deadwood Creek. Two streams called Portage Creek are located in the Circle district. They head against one another, one flowing north-northeast to Crooked Creek and the other flowing south-southwest to Birch Creek. The one flowing to Crooked Creek has a length of about 9 miles.

Both Boulder Creek and the Portage Creek that empties into Crooked Creek have been the site of small-scale mining for many years, but neither of these streams has been visited by the writer. One headwater tributary of Boulder Creek, in which some work was done in earlier years, is known as Greenhorn Creek. In the headwater part of the valley of Portage Creek two men were reported to have worked in 1936. One of these was drifting, and the other was prospecting in a shaft, using wood fires for thawing the ground. In 1937, two men shoveled in an open cut on Portage Creek, cleaning



SKETCH MAP SHOWING LOCATION OF PLACER-MINING CLAIMS ON COAL CREEK, CIRCLE DISTRICT.

an area of 20 by 300 feet, which is reported to have had a tenor of 30 cents to the square foot of bedrock.

COAL CREEK AREA

The Coal Creek area comprises principally the two streams known as Coal and Woodchopper Creeks, which enter the Yukon River about 40 miles southeast of the town of Circle. A short distance east of Coal Creek is a smaller stream known as Sam Creek, on which some small-scale mining is in progress; and still farther east is the Charley River, a large stream on some of whose tributaries placer mining has also been done. All these localities are considered to be a part of the Coal Creek area, which in turn is now considered to be a part of the Circle mining district.

A fourth-class post office, known as Woodchopper, was formerly located at the mouth of Woodchopper Creek, but in 1936 this was discontinued, and a new post office called Coal Creek was established at the mouth of Coal Creek. This change in the site of the post office was brought about by the initiation of large-scale placer mining on Coal Creek. For the same reason an automobile road was constructed in 1936 from the mouth of Coal Creek upstream for 6 miles to the site of these mining operations, and thence westward across the ridge into the valley of Woodchopper Creek, where similar large-scale mining operations were being started. This road will therefore serve all the principal mining plants on Coal and Woodchopper Creeks, and the post office of Coal Creek will be the future distributing point for mail and supplies for this area.

COAL CREEK

Coal Creek heads against a western tributary of the Charley River and flows in a general northeasterly direction to the Yukon River. Its airline length is about 20 miles. No topographic maps of the valleys of Coal and Woodchopper Creeks have been made by the Geological Survey, but their approximate positions have been shown by Prindle [23] on the topographic and geologic maps of the Circle quadrangle. The sketches of these two drainage basins there shown are not sufficiently accurate to warrant their reproduction, and therefore no complete drainage map of these two valleys is given with the present report. A surveyed map, however, has been made by Gold Placers, Inc., of the drainage of Coal Creek, in the lower 7 miles of its course, and of the mining claims in this part of the valley. Mr. Ernest N. Patty, resident engineer for Gold Placers, Inc., kindly made this map available to the writer, and it is reproduced herewith. (See pl. 5.)

[23] Prindle, L. M., A geologic reconnaissance of the Circle quadrangle, Alaska: Geol. Survey Bull. 538, pls. 1, 2, 1913.

All of the valley of Coal Creek has not been seen by the writer, and therefore no complete description of it can be given. Within the limits of the area shown on plate 5 Coal Creek has several tributaries from both sides of its valley. About 4½ miles from its mouth Boulder Creek enters from the southeast side of the valley. Some small-scale drift mining was done on this stream in the winter of 1935–36. Another tributary of Coal Creek is Colorado Creek, which enters from the southeast side about 7 miles from its mouth. Colorado Creek was formerly the site of some small-scale mining. From the mouth of Coal Creek upstream for a distance of 1½ miles the southeast wall is the steeper side of the valley, but farther upstream, at least as far as the southwestern limit of the Tertiary rocks, the valley is asymmetric in cross section, with the steeper wall along the northwest side. In this stretch there is a fairly well defined bench along the southeast side of the valley, at an elevation estimated to be about 100 feet above the level of the creek. High on this same side of the valley, however, there are remnants of a much higher level of erosion, which is probably correlative with the Pliocene (?) terraces that are found along the Yukon River at elevations of 500 to 600 feet above the present valley floor. The gradient of Coal Creek is reported to be only about 1 percent.

Six general types of bedrock are known to exist on Coal Creek. From the mouth upstream to a point close to Boulder Creek the bedrock consists dominantly of black slate, of Lower Cretaceous age. For the next 3 miles upstream the bedrock consists of chert and chert conglomerate, which are believed to represent the basal part of the Mississippian sequence of this region. For the next 3 or 4 miles upstream the bedrock consists of conglomerate, grit, sandstone, and shale, which constitute the terrigenous formation of Tertiary age that has been described in some detail in preceding pages. This formation is considered to be a proximate source of most of the gold now found on Coal Creek. Upstream from the Tertiary rocks undifferentiated Paleozoic rocks and the Birch Creek schist form the country rock almost to the head of Coal Creek; but in the extreme headwater area are the granitic rocks that form the northern edge of the great batholith previously described.

The placers of Coal Creek were mined by small-scale open-cut and drifting operations for many years. In 1925, when the writer first visited Coal Creek, most of the more promising ground had already been consolidated into two groups of claims, held by two men. The upper group of claims lay mainly in that part of the valley where Tertiary rocks formed the bedrock. The lower group of claims lay in the area of Lower Cretaceous rocks. Recently these and all the other claims on Coal Creek were taken over by Gold Placers,

Inc., which now controls all the ground that is likely to be mined in this valley. In the fall of 1935 the materials for the construction of a dredge were landed at Coal Creek by this company, and early in July 1936 the dredge was put into operation.

The pay streak on Coal Creek has been thoroughly prospected by drilling, and within the stretch covered by this prospecting the width, depth, and tenor of the placers are accurately known. The tenor of the placers, being confidential information, cannot be stated in this publication. It may be stated, however, that at least 2 miles of ground on Coal Creek is considered to be suitable for dredging. The dredge began its operations in the middle of this 2-mile stretch, on the northeastern third of the Malstrom Association, working upstream. At this point the pay streak is considered to have a width of 600 feet, though a cut only 300 to 400 feet wide was being taken by the dredge, in order to leave dredging ground for the return trip downstream. The results of drilling also show that the pay streak ranges in width from 400 to 800 feet.

At the initial site of the dredge the alluvial section consists of about 10 feet of gravel, overlain by 7 feet of muck, but the dredge also digs up about 2 feet of bedrock. This is also close to the average thickness of the overburden, but the drilling records show that the gravel ranges in thickness from 5 to 18 feet, and the overlying muck from 5 to 10 feet. The gold is said to occur not only on the bedrock and in its crevices, but also more or less throughout the overlying gravel. No assays of the bullion had been made at the time of the writer's visit, but it is generally believed to have a fineness of about 875 parts of gold in a thousand.

The dredge on Coal Creek is of the pontoon type, with a covered-belt stacker and a hull consisting of 15 sections. It is operated from one spud, two bow lines, and two stern lines. A seven-drum winch is used. The digging ladder consists of 62 buckets of 4 cubic feet capacity, but it is handling about 3,000 cubic yards to the 24-hour day. With this ladder the dredge can dig 14 feet below the surface of the water, and hence for handling some of the deeper ground on Coal Creek an extension to the present ladder may be needed. The trommel screen is 20 feet long and 5 feet wide, with holes grading from half an inch to 1½ inches, and the gravel is washed by water from two nozzles at the head of the screen and five nozzles at the lower end of the screen. A grizzly is also used, with two small tables below it, dumping into the well. Under the trommel is a Holmes distributor, feeding into six tables and two flumes on the starboard side and into five tables and two flumes on the port side. The power plant consists of two Atlas Imperial four-cylinder Diesel engines, of 135 and 90 horsepower, and the fuel consumption ranges from

100 to 130 gallons a day, depending upon the speed at which the engines are operated. The larger engine is used to supply power for the main belt drive, which operates the digging ladder and the trommel screen. The smaller engine drives the belt stacker and two water pumps, which are operated by a chain drive. One of the pumps provides water at high pressure for the seven nozzles, and the other provides sluice water. A small auxiliary gasoline engine is used to operate a small centrifugal pump, which is used in the process of cleaning up. A 5-kilowatt direct-current generator, which is used for lighting the dredge, is ordinarily run off the main belt drive, but during the clean-ups it is run by the auxiliary gasoline engine. A 40-horsepower boiler is used in the fall, for thawing the pond.

The alluvium on Coal Creek is frozen and therefore has to be thawed ahead of the dredge. For this purpose a hydraulic crew were working upstream from the dredge, stripping and thawing. For stripping off the muck, water is used from a ditch 2 miles in length, which gives a head of 85 feet at the present site of operations. In this work two giants with 3-inch nozzles are used. The gravel is thawed by cold water and circulated under pressure through pipes driven into the ground after the muck has been stripped off. These pipes are set in 16-foot squares, with one in each corner and one in the center. Water is supplied at pressures ranging from 20 to 45 pounds to the square inch, depending upon the available supply.

This dredge was installed before a road had been built up Coal Creek, and therefore all transportation from the river was effected by means of caterpillars and trailers. Three Diesel caterpillars are now owned and operated by Gold Placers, Inc., and by its affiliate, Alluvial Gold, Inc., which operates on Woodchopper Creek. On Coal Creek a substantial camp was built at the initial site of the dredge. Other improvements consist of a radio station (K7EMS) equipped with a small Collins transmitter and a professional operator, for sending and receiving code messages. A 32-volt Kohler plant supplies electric power for the radio station and for lighting the camp. A telephone line has been built from Coal Creek post office to the camp, and this is now being extended westward to the plant of Alluvial Gold, Inc., on Woodchopper Creek. About 30 men were employed on Coal Creek in 1936.

WOODCHOPPER CREEK

Woodchopper Creek heads against the South Fork of Birch Creek and flows northeast to the Yukon River, parallel with and 4 to 5 miles west of Coal Creek. The valley of Woodchopper Creek has not been mapped by the Geological Survey, but the accompanying sketch (pl. 6) shows the drainage system of that part of the Woodchopper

Creek Valley where large-scale mining is now in progress. The drainage and claim lines shown in this sketch were supplied by Alluvial Gold, Inc., through the kindness of Mr. Ernest N. Patty, resident engineer. The road that leads up Coal Creek runs westward across the ridge into the valley of Mineral Creek, down that stream to Woodchopper Creek, and thence up that stream to the new mining camp.

The valley of Woodchopper Creek, at least in its lower or northeastern end, is asymmetric in cross section, with a steep wall forming the southeast side. The gradient of the stream is said to be about 2 percent. Woodchopper Creek has several small tributaries, of which the most important so far as mining is concerned is Mineral Creek, which enters from the southeast side of the valley about 5 miles in an air line from the Yukon River. Another tributary of Woodchopper Creek, on which some mining has been done, is Iron Creek, which enters from the same side of the valley about 1½ miles upstream from the mouth of Mineral Creek. Remnants of high benches are visible at many localities on Woodchopper Creek, from the mouth of Mineral Creek downstream.

The bedrock formations of Woodchopper Creek are more or less similar to those which occur on Coal Creek, but they differ in some respects. The bedrock at the mouth of Woodchopper Creek consists of lava flows of Middle Devonian age, and upstream from these occur black slates of Lower Cretaceous age. Unlike their occurrence on Coal Creek, these Lower Cretaceous rocks crop out for only about a mile. Southeast of them is a wedge of crystalline limestone, of undetermined age, which, however, resembles some of the limestones found in the Mississippian sequence at other places in the Yukon-Tanana region. Upstream from this limestone the bedrock for about a mile consists of chert and chert conglomerate, of lower Mississippian age. Upstream from the Mississippian rocks there occur the Tertiary conglomerates and related rocks, which here as on Coal Creek are the proximate source of much of the placer gold. The contact between the Mississippian and the Tertiary rocks crosses Mineral Creek about half a mile above its mouth and crosses Woodchopper Creek about a mile above the mouth of Mineral Creek. The gold placers of Mineral Creek, therefore, lie in the zone of and downstream from the Tertiary rocks; and the same is true of that part of the valley of Woodchopper Creek, where Alluvial Gold, Inc., is operating. Upstream from the Tertiary rocks the sequence of rocks is much the same as on Coal Creek except that the widths of the several bands are different.

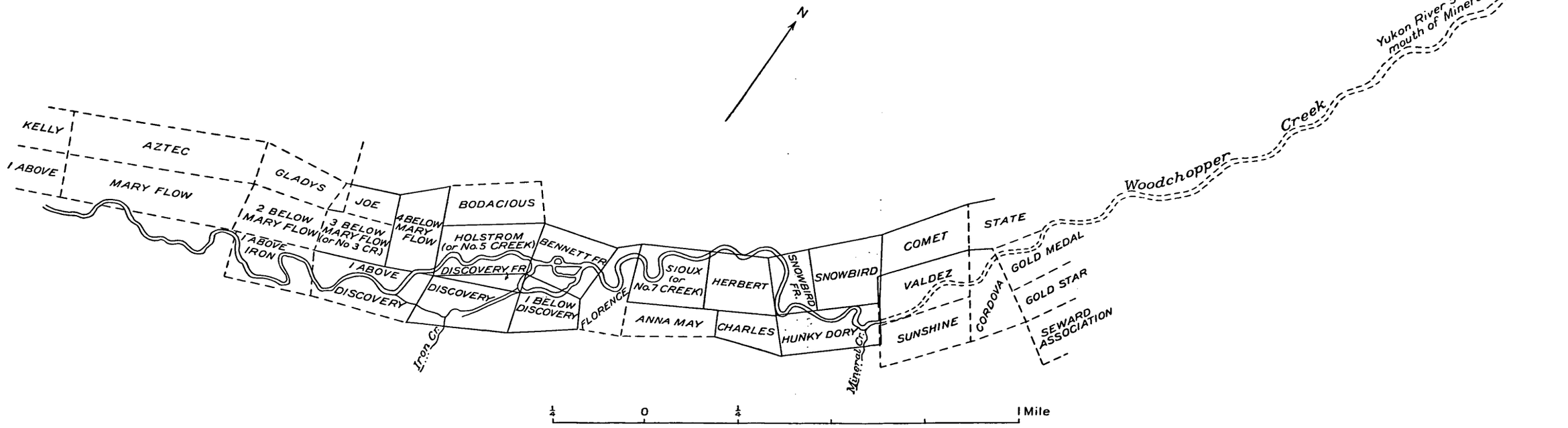
Some mining has been done on Woodchopper Creek since 1898, but this stream has never been a large producer. In fact, most of the

gold from the valley of Woodchopper Creek has come from Mineral Creek. About 1½ miles above the mouth of Mineral Creek, however, the valley floor is half a mile or more wide. Here, at the mouth of Iron Creek, the Discovery claim is located, and in this general vicinity, as well as on Iron Creek, small-scale mining has been carried on intermittently for many years. It is in this general area that Alluvial Gold, Inc., is now operating, and for this work the company has obtained control of all the claims in the valley floor for 1½ miles upstream and downstream from the mouth of Iron Creek.

A dredge was built during the winter of 1936–37 for operation at this site, beginning in 1937. At the time of the writer's visit in 1936 the work then in progress consisted in clearing the ground for a camp and in building a ditch for hydraulic operations. This ditch is 3 miles long and will deliver water under a head of 157 feet at the initial site of the dredge. At least 2 miles of dredging ground is known to be available upstream from the place where the dredge will begin to dig. The width of the pay streak is probably wider than on Coal Creek, but the alluvium is considerably deeper, and for that reason this dredge will be equipped to dig 25 feet below the water line. The gravel is said to range in thickness from 11 to 30 feet, and the overlying muck from 5 to 20 feet. The deepest hole sunk during the drilling of this dredging ground had a depth of 54 feet. The methods of work will be the same as on Coal Creek, and all supplies and equipment will be freighted by way of the new automobile road that comes up Coal Creek. About 22 men were employed at this camp in August 1936.

In 1937 the dredge on Woodchopper Creek was completed, and began to operate sometime during the first week in July. At the site where the dredge was built the pay streak is 600 to 700 feet wide but in places is said to be as much as 1,000 feet wide. The dredge began to operate along the southeast side of the pay streak, working upstream and taking a cut 400 feet wide, thus allowing a cut 200 to 300 feet wide for the return trip. The drilling so far done in the pay streak of Woodchopper Creek indicates that the ground is somewhat higher in grade than on Coal Creek. The gold is of exceptionally high grade, as the first returns on the placer product show a fineness of 933 parts gold in a thousand. Both this dredge and the dredge on Coal Creek handled about 2,700 cubic yards of gravel a day, during the seaeson of 1937.

Mineral Creek is a tributary of Woodchopper Creek, about 2 miles in length. In the lower reaches its valley is a narrow gorge, with a floor about 75 feet wide; but about a mile upstream the valley becomes more open and the width of the floor increases to 75



SKETCH MAP SHOWING LOCATION OF PLACER-MINING CLAIMS ON WOODCHOPPER CREEK, CIRCLE DISTRICT.

yards. Several benches occur in the valley of Mineral Creek, but some of these are bedrock surfaces that do not show in the present valley walls. Most of the mining on Mineral Creek has been done about half a mile from its mouth, close to the mouth of a small tributary called Alice Gulch, which enters from the southwest.

Mineral Creek was staked in 1898, but mining did not begin until some years later. Little work is now in progress, and the creek has not been visited by the writer since 1925. At that time a pay streak 100 feet wide, in the present valley floor, was being worked by hydraulic methods; but gold in paying quantity had also been discovered on a low bedrock bench along the northeast side of the present creek and about 20 feet vertically above it. At the site of mining in the creek the alluvial section consisted of about 10 feet of gravel and muck. One of the features of interest at this locality was the uncovering, by mining operations, of the contact between the chert conglomerate of Mississippian age and the overlying Tertiary conglomerate. Another feature of interest is the high grade of the gold recovered from this creek. Three assays of the bullion produced in 1919, 1921, and 1926 show a weighted mean fineness of 925 parts of gold and 73 parts of silver in a thousand.

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