MINING IN THE CIRCLE DISTRICT

By J. B. Mertie, Jr.

INTRODUCTION

The term " Circle district," as now used, includes not only the headwater tributaries of Crooked, Birch, and Preacher Creeks but also Coal, Woodchopper, and other near-by gold-bearing streams that drain directly into the Yukon River. The latter creeks, however, have not been visited by the writer since 1925, and the present report deals entirely with the tributaries of Crooked and Birch Creeks, or what was formerly known as the Birch Creek district.

During the summer of 1929 the writer was engaged in geologic investigations in the region north and northwest of the Circle district and terminated his field work at Circle. As no report on this district had been issued by the Geological Survey for a number of years, the opportunity was utilized for making an examination of the mining properties then in operation. This report is therefore intended as an outline of the progress of mining in the Circle district in 1929.

Circle, which is on the Yukon River at the east end of the Yukon Flats, is the nearest supply point for the Circle mining district. Circle has recently been connected with Fairbanks by an automobile road, and the district is therefore served in summer by automobiles and trucks operating on this road from Fairbanks and by the fortnightly steamboat of the American Yukon Navigation Co. on the Yukon River. In winter the mail comes to Circle by horse sleds from Fairbanks and is distributed thence both up and down the Yukon. Quick communication is supplied by a radio station operated by the United States Signal Corps and also by a local telephone system which connects Circle with the outlying mining properties. An airplane landing field assures rapid transit to Fairbanks or elsewhere in the Territory when occasion demands it.

Mining in the Circle district centers in two general localities. One of these is about Deadwood Creek and its tributaries. This area is approached by a wagon road from Central House, a roadhouse on the main automobile road about 35 miles from Circle. A branch automobile road, built in 1929, also leaves the main road at Central

House, to go to Circle Hot Springs, which is now well known in Alaska as a health resort.

The second locality centers about Mammoth Creek and its tributaries, Miller, Mastodon, and Independence Creeks. It also includes Bonanza Creek, which is a tributary of Porcupine Creek, and several headwater tributaries of Birch Creek, principally Eagle Creek. The Circle-Fairbanks automobile road runs directly through this area, following up Mammoth and Miller Creeks, passing close to Eagle Creek and down the northwest side of Birch Creek. Another roadhouse, known as the Miller House, on the automobile road about 50 miles from Circle, serves as a stopping point for this area as Central House does for Deadwood Creek and the Circle Hot Springs. Fourth-class post offices are maintained at Central House and Miller House, and both these roadhouses carry a small stock of general merchandise.

Gold was discovered on Birch Creek in 1893. Placer mining was begun in the summer of 1894 and has continued without interruption to the present day. This is therefore one of the old mining camps of interior Alaska. Mastodon, Miller, and Independence were the first creeks to be worked commercially, and after 36 years they are still producing gold. During 1929 Deadwood Creek and its tributaries, Boulder, Bonanza, and Eagle Creeks, were also worked, and prospecting was done on the North Fork of Harrison Creek and possibly also on other creeks. The summer of 1929 in the Circle district was characterized by more than the usual rainfall, so that ample water was available and placer-mining operations were unusually successful.

GEOGRAPHY AND GEOLOGY

The geography and geology of the Circle quadrangle, which includes the Circle mining district, have been described by Prindle[1] in earlier publications; in this report, which deals primarily with the progress of mining, a concise summary of the geographic and geologic features seems adequate.

The Circle mining district lies in the northwestern part of the Circle quadrangle, between parallels 65° 20′ and 65° 40′ and meridians 144° 40′ and 146°, and embraces an area of about 200 square miles. The index map (fig. 6) shows its location with respect to Alaska as a whole. The area in which mining is now being done is drained entirely by Birch Creek and its tributaries, although a contiguous zone to the northwest, which has been considerably prospected and is regarded as a part of this district, is drained by headwater

[1] Prindle, L. M., The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska: U. S. Geol. Survey Bull. 251, 1905; The Yukon-Tanana region, Alaska: U. S. Geol. Survey Bull. 295, 1906; A geologic reconnaissance of the Circle quadrangle, Alaska: U. S. Geol. Survey Bull. 538, 1913.

tributaries of Preacher Creek. (See pl. 3.) One of the principal lower tributaries of Birch Creek, entering from the west, is Crooked Creek. The four largest tributaries of Crooked Creek are Deadwood, Boulder, Mammoth, and Porcupine Creeks. Deadwood and Boulder Creeks enter Crooked Creek from the south; Mammoth Creek, entering from the southwest, and Porcupine Creek from the west, unite to form the upper part of Crooked Creek. Above the mouth of Crooked Creek Birch Creek cuts back into the hills to the south and drains a large fan-shaped basin. The northwest end of this basin adjoins the Crooked Creek Basin, so that a continuous ridge

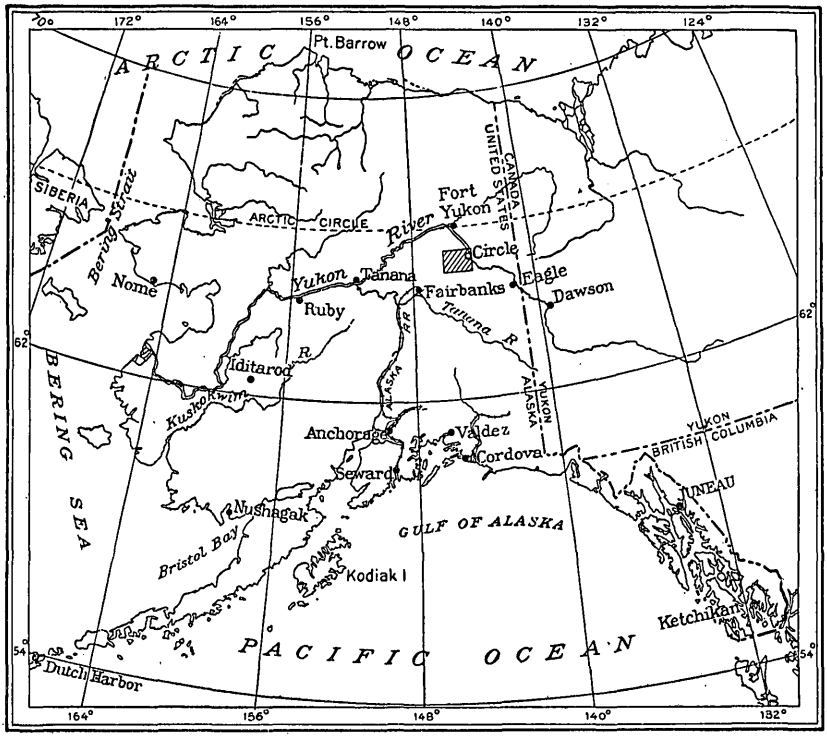


FIGURE 6.—Index map showing location of Circle district

of considerable height trending southeast is drained on the northeast by tributaries of Crooked Creek and on the southwest by headwater tributaries of Birch Creek.

The three tributaries of Mammoth Creek, named from east to west, are Independence, Mastodon, and Miller Creeks. Bonanza Creek, to the northwest of Miller Creek, flows parallel with it, but drains into Porcupine Creek. Ptarmigan, Eagle, and Golddust Creeks, headwater tributaries of Birch Creek, and Harrison Creek, which enters Birch Creek farther downstream, are the principal streams within the Circle mining district draining the southwest slope of the ridge previously noted.

Central House is situated at an altitude of somewhat less than 1,000 feet. Mastodon and Porcupine Domes, two prominent points on the main ridge southwest of Crooked Creek, have altitudes of 4,400 and 4,810 feet, respectively, so that the maximum relief in this district is close to 3,000 feet. North of the Circle mining district is an isolated group of hills known as the Crazy Mountains, the highest point of which is 3,690 feet above sea level, and between this point and Circle, on the Yukon, there is likewise a difference in altitude of nearly 3,000 feet. These upland areas represent a maturely dissected land surface drained by streams which at the end of the Pliocene epoch had been adjusted in their lower courses to a base-level 600 to 800 feet above the present level of the Yukon. The subsequent lowering of this base-level of erosion to the present one has caused rejuvenation of all the tributaries of the Yukon. In the longer tributaries fall lines far upstream show that the process of adjustment has not yet been completed. Another of the evidences of this post-Pliocene lowering of the base-level of erosion is the presence of rock-cut terraces, as may be seen along the Yukon above Circle.

Another interesting physiographic feature of this district is a wide alluvium-filled depression that separates the Circle mining district from the Crazy Mountains. This depression is now drained by two sluggish, incompetent streams, one flowing southeastward to Crooked Creek and the other flowing northwestward to Preacher Creek. It is believed that this wide valley represents the site of an ancient river channel through which the Yukon flowed, perhaps during a part of the Pleistocene epoch.

Six hard-rock geologic formations have been distinguished and mapped in this district, including the Crazy Mountains. These are:

Granitic rocks. Mesozoic.
Chert formation. Mississippian.
Rampart group. Lower Mississippian.
Limestone. Devonian or Silurian.
Noncalcareous sedimentary rocks and greenstone. Devonian to Ordovician.
Birch Creek schist. Pre-Cambrian.

The oldest of these formations, the Birch Creek schist, includes a group of metamorphosed sedimentary rocks, which consist mainly of quartzite schist, quartz-mica schist, quartzite, and mica schist. By definition, metamorphic rocks of igneous origin are excluded from the Birch Creek schist, but in reconnaissance areal mapping such rocks are not actually distinguished as separate cartographic units. One of the most distinctive of such units is a group of granitic gneisses, known in Yukon Territory as the Pelly gneiss, which will eventually be separately mapped. Other rocks sometimes included with the Birch Creek schist are phyllite, chlorite and sericite schists,

amphibolite, hornblende schist, and various types of greenstones. Some of these are certainly younger than pre-Cambrian, but in areal mapping they are often included because time does not permit their separate delineation. The Circle district is considered the type locality of the Birch Creek schist.

The next younger rocks, often called the lower Paleozoic metamorphic rocks, are a group composed of sheared arkose and graywacke, quartzite, purple and green phyllite, and green, red, and black slate, together with some limestone and chert. This group includes rocks which are the equivalent of the Tatalina group, described by Prindle [2] as probably of Ordovician age, and also other pre-Carboniferous metamorphic sedimentary rocks. Where possible the Silurian and Devonian rocks of this complex have been mapped separately.

Bands of crystalline and semicrystalline limestone trending east are found in the Crazy Mountains. These appear to be different from the Silurian limestone that is found to the west, in the White Mountains, and they are certainly not to be correlated with the siliceous limestones of the Carboniferous. They resemble more than anything else the Middle Devonian limestones of the Woodchopper volcanics, which are exposed along the Yukon River about 50 miles above Circle. But as the limestones of the Crazy Mountains have yielded no determinable fossils, they are designated Silurian or Devonian.

The Rampart group is an assemblage of basic igneous rocks, mainly lava flows, with some interbedded sediments. The type locality is along the Yukon River between Fort Hamlin and Rampart. A similar formation, believed to be equivalent to the Rampart group, is exposed along the Yukon River just above Circle. Because the exact equivalence of these two formations had not been proved, the latter was called by the writer [3] the Circle volcanics. The Rampart group has now been traced intermittently eastward from Fort Hamlin to the Crazy Mountains, within 30 miles of Circle, and the belief in the equivalence of the two formations, which was based originally on lithologic and petrographic similarities, is now further strengthened by areal distribution. The sediments interbedded with these volcanic rocks are mainly chert, but in the Rampart district one small lens of limestone and several beds of calcareous tuff have yielded Mississippian fossils. The next two overlying formations along the Yukon are also of Mississippian age, so that the Rampart group and the Circle volcanics are referred by the writer to the basal Mississippian.

[2] Prindle, L. M., A geologic reconnaissance of the Fairbanks quadrangle, Alaska: U. S. Geol. Survey Bull. 525, pp. 37–39, 1913.

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

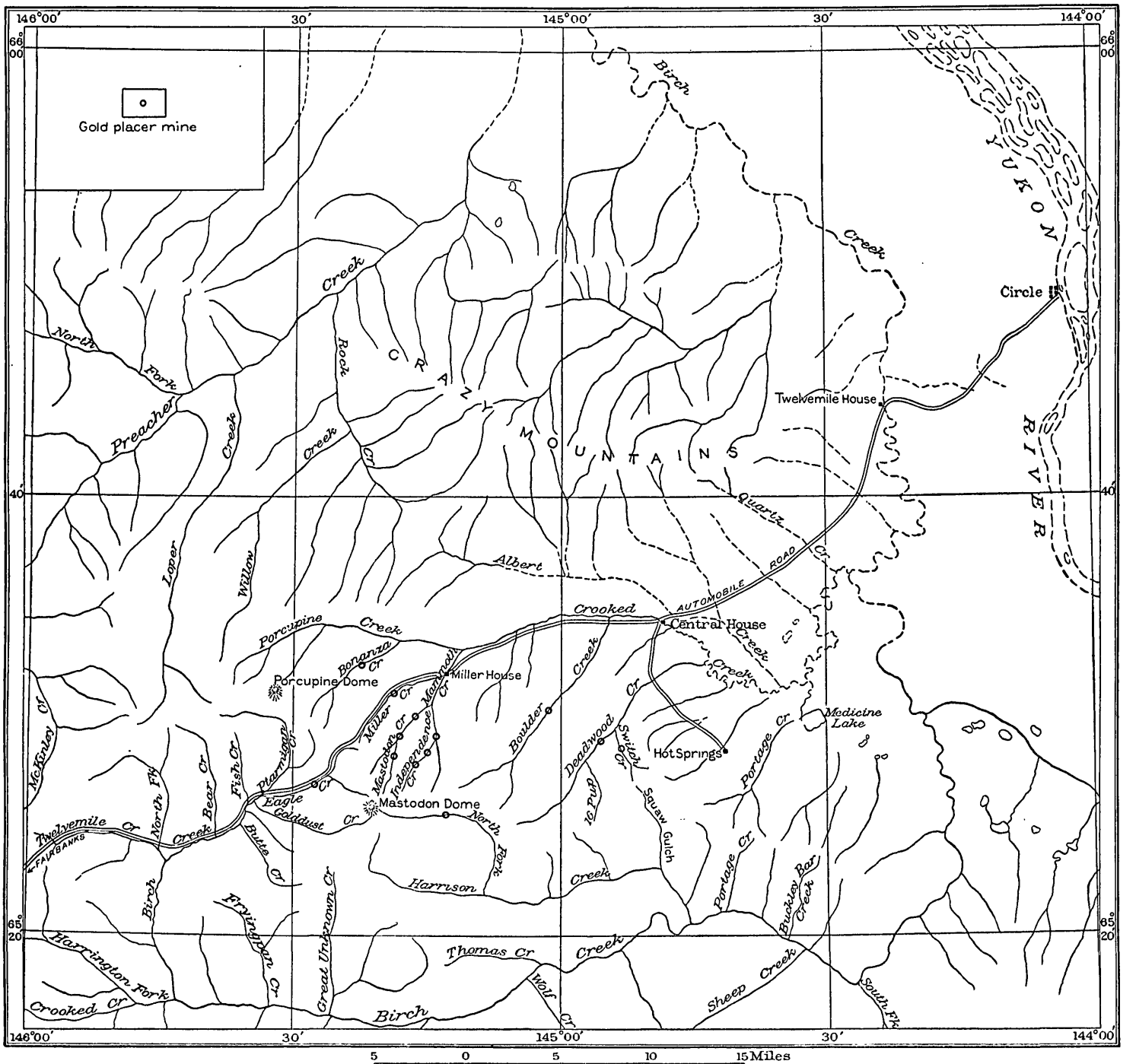
Above the Rampart group lies a chert formation, of which the type locality is in the valley of Livengood Creek and vicinity, about 60 miles west of the Circle district. This formation has been traced intermittently eastward into the Crazy Mountains, and it has also been found on Woodchopper and Coal Creeks, southeast of the Circle district. The chert formation, to which a formal name has not yet been applied, is a distinctive lithologic unit, composed essentially of thin beds of chert, with a massive basal chert conglomerate. Interbedded with the chert are also some beds of slate and limestone, in minor proportion, as well as some basic igneous rocks, partly extrusive and partly intrusive. The interbedded limestones are particularly easy to distinguish, in that they are rather cherty, resembling in this respect the Lisburne formation of northern Alaska. The basal chert conglomerate is the most distinctive part of the formation; it is composed of rounded to angular pebbles of chert set in a chert matrix and so firmly cemented together that the rock commonly fractures across the pebbles. At some localities the fragmental character of the rocks is apparent only by the weathering. The chert formation was described by the writer[4] in 1916, and the genesis of the chert conglomerate has been considered at greater length in a subsequent publication.[5] Fossils found in this formation by R. M. Overbeck in 1918 have been determined to be of Mississippian age.

The youngest mappable unit, except the alluvial deposits, consists of a variety of granitic rocks, of which the most common are biotite and hornblende granites. Other varieties of granite, however, are found, as well as quartz monzonite, quartz diorite, diorite, gabbro, and ultrabasic igneous rocks. Several small intrusive bodies of granitic rocks are found in the Circle district, particularly in the area where gold placer mining is in progress. The hot waters of the Circle Hot Springs issue from rocks of this type. The granitic rocks originated later than the youngest of the Paleozoic sedimentary formations of this district, but as no Mesozoic rocks are present in the near vicinity, their age can not be stated with assurance. Similar granitic rocks of Jurassic, Cretaceous, and Tertiary age are known elsewhere in Alaska, and as the granitic rocks are believed to have had an important influence in the processes of mineralization, the position, size, and shape of their outcrops are considered to be matters of economic interest.

Unconsolidated deposits ranging in age from Pleistocene to Recent are found in nearly all the stream valleys of this district. As this part of Alaska has not been glaciated, the older alluvial deposits, as

[4] Mertie, J. B., jr., The gold placers of the Tolovana district, Alaska: U. S. Geol. Survey Bull. 662, pp. 239–244, 1918.

[5] Mertie, J. B., jr., Geology of the Eagle-Circle district, Alaska: U. S. Geol. Survey Bull. 816, pp. 88–95, 1930.



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

well as the later deposits, are mainly of fluviatile origin, though at some localities lacustrine deposits also are known. The older gravel deposits, usually found in ancient bench channels, are for the most part covered with black muck composed of silt and peaty material, with a few beds of sand or gravel. The later gravel deposits conform more closely with the general run of fluviatile deposits found elsewhere. Commonly the older deposits are frozen, but the later deposits, particularly close to running streams, are thawed. Some of the fluviatile deposits were formed by ancient or present streams that drained areas mineralized with gold; these deposits also contain gold, and where the auriferous content is sufficiently high they constitute commercial gold placers.

GOLD PLACERS

DEADWOOD CREEK

Deadwood Creek is about 20 miles in length. It heads in the high ridge that forms the divide between the Birch Creek and Crooked Creek drainage areas and flows in a northeasterly direction to Crooked Creek. In the upper 12 miles the valley is narrow, but in the lower 8 miles it widens gradually as it merges into the flats of Crooked Creek. A bench follows down the west side of the lower valley. The stream gradient is about 150 feet to the mile in the upper part of the valley, but becomes appreciably less in the lower part.

Deadwood Creek has a number of small tributaries, of which the two largest ones enter from the southeast side. The lower of these is known as Switch Creek and the upper as "16 Pup." About halfway between Switch Creek and 16 Pup, on the opposite side of the valley, a small gulch known as Discovery Gulch enters Deadwood Creek. Switch Creek is about 3 miles long and enters Deadwood Creek in a narrow gorge.

The bedrock of Deadwood Creek, including also Switch Creek, is composed mainly of massive quartzite schist and quartz-mica schist, but small intrusive bodies of granitic rocks constitute a considerable part of the bedrock at several localities, particularly on lower Deadwood Creek, where such rocks crop out on both sides of the valley for several miles below the mouth of Switch Creek. Some carbonaceous and chloritic schists are also present, and dikes of basic igneous rocks occur at intervals. In places, particularly near the granitic rocks, the schists are garnetiferous. Where seen by the writer on upper Deadwood and Switch Creeks, the cleavage of the schists dips at a moderate angle northeastward. The stream gravel is derived from the bedrock of the various types exposed in Deadwood Creek and therefore embraces a considerable number of types of schist and intrusive rocks. As a rule the stream boulders do not exceed a foot in

diameter, and the deposit includes much fine material, but at the site of present mining operations on Switch Creek boulders as much as 2 feet in diameter were noted. The depth of the stream gravel on Deadwood Creek ranges from 3 to 14 feet, but a somewhat greater thickness is reported on the west bench. At some places gold has been found rather evenly distributed throughout the gravel, but as a rule most of the gold is found close to and in the bedrock. Where the bedrock is massive and much jointed the gold penetrates deeply into the joint crevices, and the recovery of this gold involves much labor in removing and cleaning by hand large slabs of bedrock. The pay streak on Deadwood Creek is said by Prindle [6] to range from 25 to 300 feet, and the average tenor of the developed pay streak is stated to have been 25 cents to the square foot of bedrock, although ground with a gold content as high as $1 to the square foot has been mined. The gold of the creek placers is inclined to be flat in shape, and at the lower end of the creek it is flaky. The largest nugget so far reported was worth $122. It was formerly thought that the gold of Deadwood Creek was of lower grade than that of the other creeks in the Circle district, but the average from the two plants operated in 1929 was $15.96 an ounce, as compared with $15.58 an ounce from the three plants operated on Mastodon Creek.

The concentrates recovered with the gold on Deadwood Creek and its tributaries are particularly interesting. According to Johnson,[7] they include wolframite, cassiterite, magnetite, ilmenite, arsenopyrite, pyrite, galena, limonite, garnet, tourmaline, and quartz. In the concentrates from Switch Creek wolframite was not detected, and magnetite was scarce, but the arsenopyrite, pyrite, and galena were found principally on this stream. Cassiterite was found in all the concentrates from Deadwood Creek and its tributaries. Wolframite was not found above Discovery Gulch, but it occurs in all the stream placers for at least 4 miles below Discovery Gulch. Both wolframite and cassiterite occur most abundantly in the zone between Discovery Gulch and Switch Creek, and Johnson states that they were coarsest and most plentiful on Deadwood Creek a short distance below Discovery claim. The largest piece of wolframite there seen measured 1.7 by 1.8 by 1.8 inches, and the largest piece of cassiterite was 1 by ¾ by ½ inch; pieces even larger have been reported. A light-colored porphyritic granite that was observed by Johnson in the vicinity of the heaviest tungsten concentrates is believed by him to be related genetically to the wolframite. During 1916, when the price of tungsten was high, some of the wolframite concentrates from Deadwood Creek were saved and shipped.

[6] Prindle, L. M., A geologic reconnaissance of the Circle district, Alaska: U. S. Geol. Survey Bull. 538, pp. 60–62, 1913.

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

Deadwood Creek and Switch Creek have been worked for many years by shallow drifting operations in winter and by open cuts in summer, but of late years only summer mining has been done. Nearly all this work has been done by small-scale mining methods, including shallow drifting, shoveling-in operations, or small hydraulic plants. Brooks[8] stated in an early report that many of those who worked ground on Deadwood Creek in the early days never attempted to gain more than a living wage and that the creek might well be called a stronghold of conservatism. He suggested the desirability of consolidation of some or all of the 106 claims on Deadwood Creek, so that large-scale operations might be undertaken. He also predicted the presence of shallow-thawed ground in the lower valley. These predictions and recommendations now seem about to bear fruit. Two men have acquired possession or control of the creek claims from 22 below to 59 below Discovery and are attempting to interest capitalists in placing a dredge upon this ground. These claims, like most of the other claims on Deadwood Creek, were staked 500 feet in length under the old mining law. Drill holes and shafts indicate that the ground between claims 22 below and 36 below Discovery is largely unfrozen and that the pay streak on claim 30 below Discovery is 250 feet wide. At the lower end of this group of claims the ground is said to be but 14 feet deep to bedrock.

Claim 3 above Discovery was worked by a hydraulic plant during the summer of 1929. Four persons, including the cook, were engaged in this work, and the plant was operated about 95 days. The gravel in this property is about 10 feet thick, with little or no overburden, and consists mainly of schist with a little granite. No boulders larger than 2 feet in diameter were noticed in the gravel. The bedrock is schist and dips downstream. Contrary to what might be expected, little or no gold is here found on bedrock, but instead the gold is distributed rather evenly in the lower 4 feet of gravel. A cut about 370 by 130 feet, or about 48,000 square feet in all, was worked; with an average depth of 10 feet this amounts to 18,000 cubic yards handled. The hydraulic plant consists of two nozzles, one being used for moving gravel into the sluice boxes and one for stacking tailings. Water is supplied by a ditch with an intake 1 mile upstream from the plant and is delivered to the nozzles under a head of 125 feet. A line of 12 sluice boxes is used, with a vertically placed sheet-iron shear board, which is mounted on the sluice boxes on the side opposite to that from which the gravel is being piped in. The gold recovered at this plant has a fineness of $16.22 an ounce but passes commercially at about $15.50 an ounce.

Another hydraulic plant was worked on Switch Creek, on claim 6 above Discovery, about a mile above its mouth. Two men were

[8] Brooks, A. H., The Circle district, Alaska: U. S. Geol. Survey Bull. 314, p. 192, 1907.

engaged in this work. The gravel here is about 5 feet thick, and the bedrock is a greenish quartzite that weathers brown. The gold penetrates deeply into the joints of this bedrock, and about 5 feet of rock has to be removed and hand cleaned in order to recover all the gold. Two cuts were worked, one 170 by 45 feet and another 70 by 30 feet, or about 9,750 square feet in all. With an average depth of 5 feet of gravel, this amounts to about 1,800 cubic yards. The largest nugget recovered in these operations was worth about $7. The gold was said by the operators to assay $15.71 an ounce.

In addition to these two hydraulic plants prospecting and small-scale open-cut operations were in progress on upper Deadwood Creek during 1929, but no mining was being done at the time of the writer's visit in late August.

BOULDER CREEK

Boulder Creek is a stream of about the same length as Deadwood Creek and flows parallel to it to join Crooked Creek. The bedrock is schist, and in all probability it is intruded by granitic rocks, as on Deadwood Creek. As Boulder Creek drains part of a mineralized area, it might be expected to yield commercial placers, but so far little mining has been done. Years ago workable placer ground was located on a small tributary of Boulder Creek known as Greenhorn Creek. This ground was shallow and easily worked, but lack of water was the principal handicap to mining.

During the season of 1929 one man was engaged in hydraulic mining on a bench on the southeast side of Boulder Creek. The depth to bedrock here is 8 feet, of which the lower 3½ feet of gravel is considered to carry gold in paying quantity. About 1,500 square feet of ground was worked, and this at an average depth of 8 feet gives a total of about 450 cubic yards. The gold is said to assay $18.15 an ounce. This plant was operated about 95 days.

INDEPENDENCE CREEK

Independence and Mastodon Creeks unite to form Mammoth Creek. Independence Creek is about 6 miles long and is markedly asymmetric, as it receives a number of small tributaries from the east and southeast but none from the west. At its mouth the valley floor is 100 yards or more in width, but the valley becomes rather narrow upstream. At its head the valley opens out somewhat into a steep basin that lies on the north flank of Mastodon Dome.

Independence is one of the earliest-producing creeks of the Circle district. Apparently it has not been the site of any large-scale mining operations but has produced steadily on a small scale for many years. Some well-defined benches occur in the valley, but so far as can be learned mining has been done only in the creek placers. The

gravel is from 3 to 9 feet thick, and the pay streak extends as a narrow strip, cutting first to one side and then to the other side of the present creek valley. This ground, which is being worked by open-cut methods, ranges in gold content from 30 to 90 cents a square foot of bedrock.

Three small open cuts were worked during 1929. The farthest downstream, on Discovery claim, about a mile above the mouth of the creek, was worked for 85 days, and 960 square feet of bedrock was cleaned. The cubic yardage given by the owner indicates a depth of 8 feet of material mined, but some of this thickness is probably bedrock that had to be removed. The gold assays $16.83 an ounce. This plant was not in operation at the time of the writer's visit.

The next plant upstream is on claim 10 above Discovery, although the operator owns other claims above and below the plant. Here mining was continued over a period of 112 days, and 1,100 square feet of bedrock was shoveled in. The bedrock at this place is a greatly jointed, blocky quartzite schist, into which the gold penetrates deeply. The gravel is about 5 feet thick, but the character of the bedrock makes it necessary at places to take up 5 feet of bedrock also.

The third plant, which is being operated on claim 14 above Discovery, was worked for 126 days and opened up 1,800 square feet of bedrock. Here 5 to 8 feet of gravel is present, and usually 3 feet and sometimes 5 feet of bedrock also must be removed in order to recover a high percentage of the gold.

MASTODON CREEK

Mastodon Creek, like Independence Creek, is about 6 miles long, heads in the north flank of Mastodon Dome, and runs about north-northeast. The valley is bounded on both sides by even-topped spurs that rise to a height of 1,200 feet or more above the creek and slope gradually at their northeast ends to the valley floor. Like that of Independence Creek, the valley is asymmetric in outline, but the steeper wall is on the southeast instead of the northwest side. At its mouth the valley floor 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 still farther upstream it widens out again. The gradient of the stream ranges from 100 to 150 feet to the mile.

The bedrock consists essentially of quartzite schist and mica schist, which are cut at many places by quartz veins. The cleavage of these rocks strikes about N. 60° W. and has been observed by the writer dipping both upstream and downstream, although the usual direction of dip has been considered to be upstream. Other varieties

of bedrock also occur in minor proportions, as, for example, certain greenish feldspathic schists mentioned by Prindle [9] and some thin-bedded impure closely folded limestone that crops out near the mouth of the creek. Dikes and small intrusive bodies of granitic rock are also found in the valley of Mastodon Creek.

The stream detritus is similar to that found on Deadwood Creek and consists of subangular to rounded material, ranging from sand and clay up to cobbles and boulders 2 feet in diameter and in the upper valley still larger. The gravel deposit ranges in thickness from 8 to 20 feet and averages perhaps 10 to 12 feet. Usually several feet of muck overlies the gravel. As on Deadwood Creek, the gold is not localized at any one horizon in the gravel but is found at some places on or near bedrock and at others rather evenly distributed through the lower half of the gravel. The pay streak is variable in width, ranging from 85 feet in the upper valley to 200 feet in the lower valley. The ground first worked on Mastodon Creek yielded as high as $2 to $3 a cubic yard, but the ground now being worked on lower Mastodon Creek yields about 75 cents a cubic yard.

The gold in the upper valley is fairly coarse and light in color, but farther downstream the usual run of the gold is fine and flaky. According to Prindle,[10] the gold recovered 20 years ago from Mastodon Creek assayed about $17.35 an ounce and passed commercially at $17 an ounce; but the gold from the plants operated on Mastodon Creek in 1929 ranged from $15.25 to $16.15 an ounce, with an average value of $15.58. The gold appears to become progressively higher in grade downstream.

Mastodon Creek was from the beginning and still is the largest producer of placer gold in the Circle district and in the aggregate has probably produced between $2,000,000 and $3,000,000. During the season of 1929 three plants were operated on this creek. The largest was the hydraulic plant of the C. J. Berry Dredging Co., on claim 3 below Discovery, just above the mouth of Independence Creek. The gravel, which is composed almost entirely of schist, is about 7 feet thick, but several feet of overlying muck is ground-sluiced off prior to hydraulicking. The bedrock is a blocky quartzite, the cleavage of which dips upstream. Into the joints of this schist the gold penetrates deeply, so that from 5 to 7 feet of bedrock must be removed. Large slabs of the bedrock are pried loose with crowbars, but inasmuch as the boulders in the gravel do not exceed 1 foot in diameter, these slabs are the only heavy material to be handled. The gold is fine and flaky and assays $16.15 an ounce after melting. The largest piece so far found on this property

[9] Prindle, L. M., The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska: U. S. Geol. Survey Bull. 251, p. 62, 1905.

[10] Prindle, L. M., The Circle district, Alaska: U. S. Geol. Survey Bull. 538, p. 63, 1913.

weighed 1 ounce, but three-quarters of this by volume was vein quartz. In late August, 1929, a cut measuring about 165 by 700 feet, or about 115,500 square feet, had been opened up at this property. Just below this cut, on the west side of the valley, a slight elevation of the bedrock gives rise to a well-defined low bench, covered by gravel. This has been prospected for 125 feet from the rim and showed a good tenor, and it was expected that this ground would be mined in 1930. The present hydraulic plant utilizes three nozzles—4 inches in diameter when water is plentiful and smaller when water is scarce. Two of these nozzles are used for hydraulicking the gravel, and one is used for stacking tailings. Water is supplied through hydraulic pipe, with a penstock about three-quarters of a mile upstream, and the water is delivered to the hydraulicking nozzles under a head of 80 feet. A line of 10 sluice boxes is used, with overhead sheet-iron shear boards, pivoted to swing to either side of the boxes. Six men, including the cook, were engaged in these operations.

The next plant upstream is on claim 24 above Discovery. This likewise is a hydraulic plant, and the mining methods and local conditions are very similar to the plant on claim 3, above described. The gravel here is said by the owner to be 10 feet thick, but along the east side of the cut the gravel and overlying muck together appeared to be nearly 20 feet thick. This plant was operated 143 days during the season of 1929, and a cut about 300 by 175 feet was opened up.

The third hydraulic plant on Mastodon Creek is on claim 36 above Discovery. At this point the valley is narrow and the pay streak is about 85 feet wide. The bedrock consists of quartzite and quartzite schist, which dip downstream. The overburden consists of 12 feet of heavy gravel, of which the upper 7 feet is particularly coarse, containing boulders as much as 4 feet in diameter. Above this gravel lies 7 to 8 feet of muck and gravel, which has to be groundsluiced off in advance of hydraulicking operations. The gold lies mostly in the lower 5 feet of gravel and the upper 2 or 3 feet of bedrock. The gold is fairly coarse, not well worn, and light yellow. It is of rather low grade and is said to assay on the average about $15.25 an ounce after melting. The largest piece of gold so far found on this property was worth $20. Heavy sand concentrates are said to be scarce. For hydraulicking, a ditch 1 mile long has been built along the west side of the valley, which supplies water at a head of 100 feet. Another ditch on the east side has just been completed to supply water under a head of 300 feet, but as the intake is much farther upstream the supply of water may be inadequate. A small dam a short distance above the cut is used for sluice water. Six sluice boxes are used in washing the gravel. In late August, 1929, a cut measuring

about 140 by 85 feet, or nearly 12,000 square feet, had been mined out, and the plant probably continued in operation for another two or three weeks.

MILLER CREEK

Miller Creek is about 7 miles long and flows into Mammoth Creek about 2 miles below the junction of Independence and Mastodon Creeks. It heads against Eagle Creek and flows in a general northeasterly direction. Like Mastodon Creek, it has an asymmetric valley, with a much steeper southeast than northwest wall. The northwest side of the valley is benched, and the new automobile road follows up this side from Miller House over the ridge to Eagle Creek. This divide, known as Eagle Summit, is the highest point along the automobile road, and the depth of snow on it determines how early in the spring and how late in the fall the road may be traversed by automobiles. The grade of Miller Creek is said to be from 150 to 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 groundsluicing. In the upper valley the gravel is but 4 or 5 feet thick. At some places, according to Prindle,[11] 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. This gold is reported to be about the same in character and grade as that obtained on Mastodon Creek, but in view of the lower-grade gold now being produced from Mastodon Creek and the high-grade gold in Eagle Creek, just across the divide, the writer would expect that the gold of Miller Creek should be of higher grade than that of Mastodon Creek, though not so high as that of Eagle Creek. As no recent assays from Miller Creek are available, this question can not be decided. As a rule, the gold is rather fine, but pieces weighing as much as an ounce have been found.

Miller Creek has never been a large producer of gold but has been worked intermittently since 1895. No mining was in progress here

[11] Prindle, L. M., The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska: U. S. Geol. Survey Bull. 251, p. 64, 1905.

at the time of the writer's visit, but two men were engaged in constructing a ditch along the northwest side of the valley about 3 miles above Miller House with the expectation that they would begin hydraulic mining on claim 8 above Discovery in 1930.

BONANZA CREEK

Bonanza Creek heads in the ridge just southeast of Porcupine Dome, is about 8 miles in length, and empties into Porcupine Creek. The lower valley of the creek is sharply incised, but the upper valley opens out into several tributary valleys. A long nearly horizontal spur separates Bonanza Creek from Miller Creek.

Little is known of the general condition of bedrock, gravel, and pay streak on Bonanza Creek, for although some prospecting was done on both Bonanza and Porcupine Creeks in the early days of the camp, commercial mining was not begun until a few years ago. The site of present mining operations on Bonanza Creek is about 4 miles above its mouth, on a group of five 40-acre claims known as the Bonanza Association. The bedrock here is schist 6 feet thick, with about 2 feet of overlying vegetation and muck. The pay streak is from 60 to 80 feet wide. Some fine gold is found in the lower part of the gravel, but the coarse gold, which constitutes most of the output, is found on and in bedrock. At places 5 feet of bedrock must be taken up to obtain this gold. During the summer of 1929 a nugget worth $160 was found. One sample of gold weighing 2.5 ounces, taken from a prospect hole, was assayed and found to have a fineness of 0.811 in gold and 0.178 in silver; this, at the current price for silver, shows a value of $16.88 an ounce after melting. A sample of the heavy sands recovered with the gold was found to contain zircon, garnet, ilmenite, limonite, magnetite, pyrolusite, pyrite, pyrrhotite, and galena.

Three men operate this hydraulic plant on Bonanza Creek. Some work was done five or six years ago, but owing to illness and ditch trouble active mining was not begun until 1927. Water is obtained from the upper end of a long ditch, which was originally built by the Mammoth Dredging Co. to deliver Porcupine and Bonanza water on Mastodon and Mammoth Creeks. By means of the upper 2 miles of this ditch, water under a head of 200 feet is delivered to the nozzles in the cut. A 16-inch hydraulic pipe at the intake is reduced to 8 inches at the cut, and the water is fed to a 3¼-inch nozzle. A cut measuring 60 by 350 feet, or about 21,000 square feet, was mined out during the 118 days of operation in 1929.

EAGLE CREEK

Eagle Creek is formed by the junction of two creeks known as Miller and Mastodon Forks, so called because they head, respectively,

against Miller and Mastodon Creeks. Eagle Creek, from the junction of these forks, is 4 miles long and flows southwestward to Birch Creek. Mastodon Fork heads to the east in Mastodon Dome and flows for 3 miles through a narrow valley to its junction with Miller Fork. Miller Fork has a somewhat more open valley.

The pay streak on Eagle Creek continues on up Mastodon Fork. Miller Fork is barren. The bedrock on Mastodon Fork is mainly quartzite schist, and the gravel is composed mainly of the same material. According to Prindle,[12] the depth to bedrock ranges from 8 to 10 feet, and the pay streak is said to be irregular and spotted. Some very good ground has been found and worked on Mastodon Fork, and much of the gold is coarse. No mining was in progress on Mastodon Fork in 1929.

The valley of Eagle Creek proper widens rapidly below the forks and opens gradually downstream into the valley of Birch Creek. Beginning in 1901 the pay streak on Mastodon Fork and Eagle Creek was worked by open cuts and drifts for 2 miles below the forks, but much of this ground is now being worked by hydraulic methods. The bedrock and gravel on Eagle Creek are the same as those on Mastodon Fork, but the depth to bedrock is greater, ranging from 14 to 20 feet. The lower 6 feet was said to carry most of the gold, and the pay streak was considered to be from 30 to 80 feet in width. Much coarse gold was found, and one piece worth $74 was recovered. This gold was of high grade.

The present hydraulic operations on Eagle Creek are being carried on by the Berry Holding Co. Work was begun a number of years ago on claim 8 above Discovery and has progressed upstream to claim 15 above Discovery, the site of mining in 1929. The bedrock at this place is a slabby schist striking N. 60° E. and dipping 30°–40° NW., and several feet of this rock must be pried up with crowbars after the gravel is removed in order to recover a high percentage of the gold. It contains some very irregular stringers and kidneys of quartz. The gravel is about 20 feet thick and ranges in size from very fine material up to subangular slabs 3 feet in diameter. Overlying the gravel is from 2 to 5 feet of muck, which is groundsluiced off before hydraulic operations are begun. The best pay is a streak about 60 feet wide which was worked years ago, but in the present type of mining the pay streak is considered to be 200 feet in width. The gold is rather coarse, the largest pieces so far found in these hydraulic operations being worth $58. This gold is worth $18.46 an ounce after melting and is therefore the highest-grade gold recovered in the Circle district.

[12] Prindle, L. M., The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska: U. S. Geol. Survey Bull. 251, pp. 64–65, 1905.

This hydraulic plant gets its water from a ditch that taps Mastodon and Miller Forks and also a small stream known as Cripple Pup on the southeast side of the valley below the forks. This ditch supplies water at a head of 70 feet at the top of the gravel and at 90 feet in the bottom of the cut for stacking tailings. Five sluice boxes are used for washing the gravel. The present ditch does not permit the work to be continued much farther up Eagle Creek, and the owners feel doubtful whether a higher ditch would supply sufficient water. Seven men were employed at this plant, and two cuts aggregating about 50,000 square feet were worked during the season of 1929.

NORTH FORK OF HARRISON CREEK

Harrison Creek is fed from two forks, of which only one, the North Fork, has been proved to contain gold placers. The North Fork of Harrison Creek heads in the south side of Mastodon Dome, against Mastodon Fork of Eagle Creek, and flows east for about 7 miles and thence south for 4 miles to join the main Harrison Creek. In the upper 7-mile stretch most of the tributaries enter from the south side of the valley.

According to Spurr,[13] the first discovery of gold in the Birch Creek district was made in 1893 on Pitkas Bar, at the junction of the North Fork with the main Harrison Creek; but the first gold found on the North Fork is said to have been discovered a mile below Mastodon Dome in 1895. No very high-grade placers were found on Harrison Creek, and until lately its lower-grade placers have been neglected. A number of people, however, have retained their interest in the North Fork, and prospecting and assessment work continue to be done.

According to Brooks,[14] the valley floor in the upper North Fork is from 300 to 400 yards wide, with a steep south valley wall. Farther downstream the valley becomes constricted, and the creek passes through a steep-walled canyon before joining the main Harrison Creek. The bedrock is said to be mainly quartz-mica schist, but some granite pebbles in the gravel show the presence of granitic rocks farther upstream, probably around Mastodon Dome. Much vein quartz is found cutting the schist, and Spurr states that one such specimen of vein quartz was observed to contain gold.

At Discovery claim, 6 or 7 miles above the canyon, the depth to bedrock is said by Brooks to be from 8 to 9 feet on the north side of the valley but only 3 to 4 feet on the south side. Here the bedrock grade is 75 to 100 feet to the mile. The valley floor at Discovery

[13] Spurr, J. E., Geology of the Yukon gold district, Alaska: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, pp. 351–354, 1898.

[14] Brooks, A. H., The Circle precinct, Alaska: U. S. Geol. Survey Bull. 314, pp. 195–197, 1907.

claim is about 300 feet wide. The gold is found mainly in the lower part of the gravel and in the decayed schist bedrock to a depth of 1 or 2 feet. The gold is fine, flaky, and bright colored. A recent assay of some gold recovered by one operator somewhere above Discovery claim shows 807 parts gold and 183 parts silver per 1,000, worth, at the current price for silver, $16.77 an ounce after melting. No very coarse gold has been found, the largest nugget so far reported being worth but $4. Garnet and pyrite occur among the heavy sands.

One small hydraulic plant was operated for a short time during 1929 at the head of the North Fork of Harrison Creek, probably several claims above Discovery. No information is available about the results of this work. Prospecting and assessment work on the North Fork were also continued on the Clayworth Association and other claims.

PRODUCTION

The following table gives the value of gold bullion produced in the Circle district, by years, from 1894 to 1929. As will be seen from these figures, the total production is about $7,500,000.

At the conventional value of 1 per cent of dross in the bullion, the fineness of the gold from the Circle district is 804 parts per thousand, with 186 parts of silver. As this production, however, includes gold from other districts during 10 years, these values can only be regarded as approximations.

Gold production of Circle district, 1894–1929

1894	$10,000	1913	$176,000
1895	151,000	1914	216,000
1896	[a] 706,000	1915	231,000
1897	[b] 464,000	1916	301,000
1898	[b] 403,000	1917	201,000
1899	[a] 252,000	1918	177,000
1900	[a] 253,000	1919	136,000
1901	[a] 202,000	1920	56,000
1902	[a] 201,000	1921	61,000
1903	[a] 202,000	1922	122,000
1904	[c] 202,000	1923	115,000
1905	[c] 202,000	1924	91,000
1906	303,000	1925	151,000
1907	202,000	1926	163,000
1908	176,000	1927	72,000
1909	226,000	1928	81,000
1910	227,000	1929	110,000
1911	352,000		
1912	326,000		7,520,000

[a] Includes production from Eagle and Rampart districts.
[b] Includes production from Fortymile, Eagle, and Rampart districts.
[c] Includes production from Rampart district.