MINING IN THE FAIRBANKS DISTRICT.

By THEODORE CHAPIN.

GENERAL CONDITIONS.

The mineral production of the Fairbanks district in 1917 included placer gold, valued at $1,310,000; lode gold, valued at $47,781; placer silver, valued at $6,904; lode silver, valued at $1,827; and lead, tungsten, and antimony, valued at $58,257. The total value of the mineral output in 1917 was $1,424,769, as against $2,039,744 in 1916. The decrease was due in large part to a general retrenchment on the part of operators owing to the high cost of supplies, which prevented the working of low-grade ground. Failures were recorded in 1917 on ground which in previous years netted a good profit, and but for the general retrenchment other failures would doubtless have resulted.

Quartz mining showed a slight increase, which in large part was due to the interest in tungsten lodes. Two tungsten mines were in course of development. At one of these mines one unit of a 75-ton mill was in operation, and in the summer of 1917 was turning out several hundred pounds of scheelite a day. On the other property a similar mill was in course of construction during the summer. Development was in progress at both properties. The surface showings indicate the possible presence of large tungsten-bearing deposits.

Five gold quartz mills were in operation during a part of the year, and several other properties not equipped with mills made small outputs. On the whole the gold quartz mining was insignificant.

The production of antimony in 1917 was small. Stibnite was mined at two localities, and at a third some ore was recovered from old tailings.

One silver-lead lode in process of development made several shipments of high-grade argentiferous galena.

GOLD LODES.

FAIRBANKS CREEK.

The Crites & Feldman mine and mill, on Moose Creek, a tributary of Fairbanks Creek, were operated throughout the year. The character of the mineral deposits has been described in previous publications and need not be repeated here.

The Mizpah mine on Fairbanks Creek was operated by a small crew. The mine is developed on an eastward-trending vein that dips

steeply south. An inclined working shaft extends along the vein to a depth of 160 feet, from which drifts extend east and west. On the 80-foot level a slope 170 feet long reaches to the surface. The lode is a quartz vein from a few inches to 3 feet wide. It carries considerable stibnite and in places free gold is abundant and some very rich shoots occur. On the east end of the workings a galena-bearing lode has been encountered, which has been traced on the surface for a long distance. Last year a little scheelite was produced. The mine is equipped with a Huntington mill.

Development work was continued on the Gilmore & Stevens property east of the Mizpah mine. A prospecting adit is being driven northerly into the hill for the purpose of crosscutting the Mizpah and other lodes which have been opened on the surface. In September, 1917, this adit was 800 feet long and presumably is not far from the ore-bearing zone, which on the surface contains a number of lodes. The property is equipped with a 5-stamp mill.

Near the head of Fairbanks Creek development work has been continued on the McCarty property, and some production has been made of both gold and antimony.

SKOOGY GULCH.

The David mine on Skoogy Gulch was in operation during the summer. The property lies west of that of the Rainbow mine and is probably on the same vein that is exposed in the Rainbow workings. The underground workings consist of an adit driven from Skoogy Gulch along the vein for about 100 feet and an overhead stope 65 feet long. The lode is a quartz vein which differs in width from place to place from 6 inches to a gouge seam. The property is equipped with a 2-stamp Hendy mill with two 8-foot plates. A wood-burning boiler furnishes steam for mill, hoist, and compressor. The Rainbow mine is idle on account of litigation.

The Overgard property on Skoogy Gulch made a small production. This property is equipped with a homemade 1-stamp mill.

The Heilig & Creighton property on the divide between Skoogy Gulch and Cleary Creek is now being prospected. A shaft has been sunk 60 feet and crosscuts started which show two parallel veins that strike N. 30° E. and dip 65° NW. The mine is equipped with a Little Giant mill and gasoline engine.

CLEARY CREEK.

Work was continued on the Tony Goessman property on Bedrock Creek tributary to Cleary Creek and a small production was made.

There was no mining in 1917 at the Chatham mine, but the old tailings were picked over and some high-grade ore sorted out for shipment.

ESTER CREEK AND VICINITY.

Considerable development work was done on deposits on the divide between Eva and Ace creeks. Twenty-seven claims covering an ore body known as the Ryan lode and a number of adjacent lodes were bonded by the Alaska Mineral & Development Co., and from October, 1916, to June, 1917, some exploration work was done. The Ryan lode was opened by one adit and five shafts, from which the lode was prospected by nine crosscuts across the lode at depths of 50 to 100 feet. Where examined by the writer the lode is 50 feet or more wide. It is a stringer lode and is composed of veins of quartz that inclose fractured and mineralized schist and seams of gouge. The lode carries considerable stibnite and is highly colored with the stains of antimony oxides. The lode strikes about north and dips east at high angles. Development work was started on the Ryan lode in October, 1916, and was suspended in June, 1917.

On the Combination claim a few shallow pits exposed a quartz vein with arsenopyrite scattered through it and coatings of scorodite and cervantite. The size or extent of the ore body was not evident from the few exposures. The claim is on the slope of Eva Creek near the Ryan lode.

Development work was continued by McGlone & Smith on the Bill Sunday Fraction lode claim. This claim is on the divide between Eva and St. Patrick creeks, northeast of the Fairchance claim, and is probably on the same or a parallel lode. The lode strikes N. 25° E. and dips from 70° SE. to nearly vertical. It has been opened by two shafts 100 feet and 20 feet deep and by surface cuts. At the surface the lode is solid quartz about 3 feet wide, but at depth it widens considerably. At a depth of 50 feet the lode consists of stringers of quartz which cut mineralized schist and carry large seams of gouge. The quartz carries a large amount of stibnite and cervantite and in places free gold. Fine gold is easily obtained by panning either the quartz or schist of the lode.

The St. Paul mine at the head of Eva Creek was operated throughout the year. The property is equipped with a 7-foot roller mill which has a capacity of 20 tons a day.

Roy McQueen is opening an antimony lode on the Jennie C. claim, situated on the divide between Ready Bullion and Nugget creeks. The lode is nearly solid stibnite with a little quartz and occurs in lenses. In places it is 18 to 24 inches wide, and in others it pinches to a seam of gouge matter. The vein strikes N. 45° W. and dips 75° NE. The ore is mined by surface trenching and is hand picked and sacked at the mine.

SILVER-LEAD LODES.

A silver-lead deposit is being developed near the head of Cleary Creek on property leased from the Eldorado Mining & Milling Co. Development work in the fall of 1917 consisted of an inclined shaft 45 feet deep and about 30 feet of drifts and stopes. On the surface the vein was about 3 feet wide, and where the shaft was sunk it was composed principally of stibnite. Below the surface the vein attains a width of 10 to 15 feet. The vein incloses large bunches of pure galena, which is said to be rich in silver. Disseminated pyrite is abundant in parts of the lode. A strong hanging wall strikes N. 45° E. and dips steeply northwest. The footwall is not well defined and is marked by a gradation from lode to country rock. The ore is hand picked and sacked for shipment at the mine.

TUNGSTEN DEPOSITS.

Tungsten lodes have been discovered at two neighboring localities in the Fairbanks district; one at the divide between the tributaries of Fish and Smallwood creeks, and the other at the heads of First

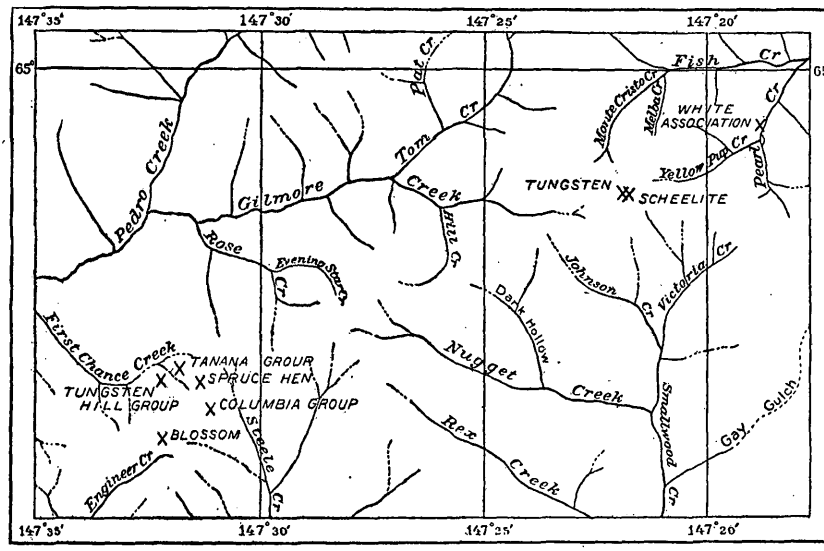

FIGURE 13.—Sketch map showing tungsten lode claims in the Fairbanks district.

Chance, Steele, and Engineer creeks. (See fig. 13.) At the first property one unit of a mill is in operation, and during the summer of 1917 it was producing 500 pounds of scheelite concentrates a day. At the other property a mill was in course of construction and active development work was being carried on. Besides these two mines, a number of claims are located on the scheelite-bearing lodes. The scheelite deposits of the Fairbanks district are believed to be much more extensive than the surface outcrops show and to give promise of a large future production of tungsten.

GEOLOGY.

The tungsten lodes occur in an area of Birch Creek schist, described by Prindle[1] as a series of highly metamorphosed siliceous sediments that consist of massive quartzites, quartzite schists, quartz-mica schists, hornblende schists in part amphibolitic, carbonaceous schists, crystalline limestone, altered calcareous rocks, and associated eclogitic rocks, andalusite hornfels, and a small amount of granitic gneiss derived from intrusive porphyritic granite.

ORE DEPOSITS.

The ore deposits are for the most part replaced portions of the limestone and calcareous beds that occur interbedded with the schists. The deposits as far as noted appear to lie in a more or less continuous zone that strikes about N. 70° E. and parallels the general strike of the schist. The lodes are composed of quartz, calcite pyroxene, hornblende, garnet, epidote, biotite, and scheelite—minerals which are believed to have been formed by the replacement of the limestone and calcareous sediments by the tungsten-bearing solutions. Besides the lodes that represent replaced calcareous sediments there are quartz veins which also carry scheelite. The quartz veins follow the silicification of the limestone beds and in places cut the earlier formed lodes, resulting in an enriched ore body. The known tungsten deposits of this region all occur on the border of a body of porphyritic granite and are believed to be genetically connected with it.

MINES AND PROSPECTS.

ALASKA TUNGSTEN MINES CO.

The Alaska Tungsten Mines Co. has property on Yellow Pup, one of the tributaries of Fish Creek and on the knob between the heads of Gilmore, Smallwood, and Fish creeks. The principal work has been on the Tungsten claim at an elevation of 2,472 feet. The property is reached by a first-class wagon road from Gilmore on Pedro Creek by way of Gilmore Creek. The lode strikes N. 70° E. parallel to the schistosity of the country rock and dips from 20° to 40° NW. The footwall is well defined and follows approximately the bedding planes of the greenstone and quartzite schist. The vein ranges in thickness from 2 to 12 feet and more, but the richest ore is confined to lenses from 2 to 5 feet thick. There is no definite hanging wall to the lode, but back of each is more ore. These are evidently structural planes, either bedding planes or less permeable zones in the original rock along which replacement has taken place. Thin stringers of scheelite-bearing quartz of later origin than the replaced rock follow the bedding planes and cut across them.

[1] Prindle, L. M., Geology of the Fairbanks district, Alaska: U. S. Geol. Survey Bull. 525, pp. 59–131, 1913.

The mine is being developed by an inclined shaft driven along the vein. In September, 1917, this shaft had been extended for 160 feet and dips at an angle of 40° to 18°. In places the shaft widens out to stopes and chambers, and the lower part has been opened to a width of 40 feet.

The Scheelite claim joins the Tungsten on the east, and the ore bodies on the two claims are presumably the same. No mining was in progress in 1917. The development is reported to consist of a 75-foot inclined shaft along an ore shoot 10 feet wide and from 4 to 6 feet high.[1] About 250 tons of ore was shipped from this property in 1915–16.

The mill and camp of the Alaska Tungsten Mines Co. is on Yellow Pup at an elevation of about 1,600 feet. One unit of a Faust concentrating mill was installed during the summer of 1917 and in September was turning out 500 pounds of scheelite concentrates a day.

The Murphy claim, on Yellow Pup just below the mouth of Pearl Creek, is under option to the Tungsten Mines Co., who are developing it. At the time of the writer's visit the workings were inaccessible. Grab samples taken from the dump and crushed and panned appeared to be rich from the amount of concentrate the pannings yielded. The vein is said to be 4 feet wide and to strike N. 75° E.

COLUMBIA MINE.

The Columbia mine is being developed by the Columbia Mining Co. The group of claims now controlled by this company represents the original locations of Jacob Meier and other claims acquired since. The claims are at the head of Steele Creek, about 10 miles from Fairbanks, with which they are connected by a good wagon road.

A number of scheelite-bearing lodes have been located. Location was made on the Columbia claim, where a scheelite lode and quartz vein that is associated with it have been exposed by an open cut and adits. The upper adit has been driven for 80 feet along the vein which follows a granite hanging wall and strikes about N. 20° W. and dips northeast. The lode apparently replaces calcareous beds but is cut by large quartz veins, which also appear to carry scheelite. A lower adit is now being driven to cut this lode.

The Spruce Hen claim, now being developed by the Columbia Mining Co., is on the divide between First Chance and Steele creeks. From appearances several lodes have been opened by crosscuts at intervals for the entire length of the claim. The principal ore body appears to be an iron-stained lode about 4 feet wide. This lode has been opened by one cut to a depth of 8 feet. It strikes N. 50° E. and dips 45° NW. The lode appears to be composed of silicates,

[1] Mertie, J. B., jr., Lode mining in the Fairbanks district, Alaska: U. S. Geol. Survey Bull. 662, p. 421, 1917.

which have replaced limestone beds, and is cut by quartz stringers. Both the silicates and later quartz stringers are rich in scheelite. A little molybdenite also occurs. Seams of gouge occur along both walls of the lode.

The camp and mill were in course of construction in 1917. The camp is at the head of Steele Creek at an elevation of 1,830 feet. The mill is on Steele Creek at an elevation of about 1,200 feet. A Marathon mill was first constructed, but this did not prove satisfactory. The new mill is a Faust concentrating mill.

The Ptarmigan and Franklin claims, on the head of Gilmore Creek, are being developed by J. F. Zimmerman. Surface cuts, made across the claims at a number of places, have disclosed several mineralized zones, one of which appeared to be 15 to 20 feet across. The lodes strike N. 40° E. and dip northwest. The lode material is quartz, and silicate rock has presumably replaced limestone along selective zones. Scheelite occurs in the quartz and silicates.

The Tanana group of five claims occurs at the head of First Chance Creek. On the Tanana No. 1 claim an inclined shaft has been sunk 40 feet along the lode. The ore body is a mineralized zone of schist about 4 feet wide and follows the schistosity of the inclosing quartzite schist. The lode strikes N. 50° E. and dips northwest.

The Tungsten Hill group of claims lies near the head of First Chance Creek. Of these Mertie[1] says:

> Four scheelite lodes had been discovered on these claims by August, 1916, and it is likely that others are present. On the Grand Duke Nikolas claim a scheelite lode in the schist country rock had been exposed in an open cut. This deposit consists of 6 to 8 feet decayed schist, carrying scheelite. Vein quartz containing a little gold is also present, cutting the mineralized zone.
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> On the Tungsten No. 1 claim another open cut had been made in a country rock of mica schist and quartzite schist. A zone mineralized by scheelite is present, but the width of the lode was not apparent from the work done.
>
> On the General Joffre claim a scheelite lode, 14 feet wide, has been exposed. The lode as a whole was considered low-grade ore; but it contains in the central part an 18-inch stringer of decayed schist, which is of considerably higher grade.
>
> These claims certainly deserve further prospecting, for they are as advantageously situated with regard to the granite as other scheelite claims in the district on which workable lodes have been developed.

The Black Bear and Blossom claims are west of the Tungsten Hill group and are apparently in the same mineralized zone. The lodes consist of quartz stringer lodes in schist. Considerable open trenching has been done on these two claims, and several lodes are exposed that apparently extend across the two claims. The scheelite occurs in the quartz stringers that penetrate the schist. These stringers in places are very rich, carrying large crystals of scheelite, and should be further developed.

[1] Mertie, J. B., jr., op. cit., p. 424.

A MOLYBDENITE LODE ON HEALY RIVER.

By THEODORE CHAPIN.

A molybdenite-bearing quartz vein has recently been opened on Healy River. Its location is near the extreme head of the river on the south slope of Rainey Mountain, near the divide between Healy and South Fork of Goodpaster rivers. It is about 160 miles southeast of Fairbanks by trail. This deposit was not visited by the writer and the following description is abstracted from a report made to the owners by Albert Johnson, of Fairbanks.

The ore deposit is described as a quartz fissure vein inclosed in granite. It trends east and dips north. The lode has not been developed to any extent but has been traced by shallow surface openings and float for three claim lengths and is believed to be continuous for this distance. The vein is described as hard white quartz that carries bunches of molybdenite scattered sparingly through the vein and rather evenly distributed.

The deposit is 6,000 to 6,500 feet above sea level and considerably above timber, but timber is said to be available on Healy River within 3 miles of the property, and the water of Healy River is regarded as sufficient for all mining purposes. Supplies are brought up Tanana River, a distance of 130 miles, to the mouth of Healy River, where a trading post has been established. From this place to the molybdenite deposit it is 40 miles. In summer pack horses may be taken along the ridge between Volkmar and Healy rivers and in winter the Healy can easily be traveled by double enders.

MINING IN THE HOT SPRINGS DISTRICT.

By THEODORE CHAPIN.

MINERAL PRODUCTION.

The chief mineral product of the Hot Springs district is placer gold. In a portion of the district a considerable amount of cassiterite (tin oxide) occurs with the gold, but the amount recovered is insignificant in value compared with the gold. There are no independent tin placers, but the tin content of many of the gold placers is sufficient if recovered to add considerably to the total value of the output.

The production of gold in the Hot Springs district for 1917 was $450,000. In 1916 it was $800,000. This decrease was due to several causes. One of the principal causes is that which is common to all placer camps—the depletion of the bonanza ground. One of the immediate causes, however, was the cessation of the large scale operations of Howell & Cleveland, who for the last two years employed a large force of men on Woodchopper Creek. Another important factor in this decline is the high cost of food and mining supplies, which prevented the working of any except the richest ground.

It is not believed, however, that a decline in mining will continue from year to year, for there are large bodies of low-grade placer ground, which, under normal conditions, will be worked profitably for a great many years.

In all about 16 plants operated for all or a part of the season and employed about 150 men. Besides there were a number of men prospecting and working in a small way. Several small outfits were reworking old tailings for the recovery of tin concentrates and whatever placer gold might be recovered by methods more refined than those used when the ground was first worked. At that time the miners seldom used Hungarian riffles in the sluice boxes, and much of the gold was lost in the clay lumps which would go over the pole and bar riffles without breaking up.

Prospecting in 1917 showed that both gold and tin occur in the basin of Sullivan Creek, considerably below the area which has yet been mined. Large bodies of low-grade gravels are being worked on Boulder Creek.

The production of tin in the Hot Springs district in 1917 is estimated at about 25 tons of ore that contained about 30,000 pounds of tin, valued at $14,400. In 1916 about 70 tons of ore that contained about 84,000 pounds of tin, valued at $36,500, was recovered. The decrease was due largely to the shutting down of the large plants on Woodchopper Creek.

TIN ORE.

OCCURRENCE.

Although the stream tin, which occurs with the gold, has proved a considerable source of revenue, it is nowhere concentrated to such an extent that it can at present be mined profitably, except as an accessory to the gold. The bedrock sources of tin, which without much doubt occur somewhere within the drainage basin of Sullivan Creek, may contain workable deposits and will possibly support a more permanent mining industry than the placers.

For a number of years the tin concentrates were thrown aside by the miners as their nature and value were not known, and they were considered a nuisance, as they blocked the riffles and interfered with the recovery of the gold. In 1911 the true nature of the tin ore was pointed out to the miners by H. M. Eakin, of the Geological Survey, during a reconnaissance of this district, and since that time about 173 tons of cassiterite containing 208,000 pounds of tin, worth about $79,000, has been recovered. There was at first little incentive to save the ore, as the miners generally did not know where it could be sold, and the price was not high enough to make its recovery worth while. Speculators at first offered 5 cents a pound for the concentrates, and shipped them to Singapore and Wales for smelting. Since that time the price has advanced until in 1917, 14 and 15 cents a pound was offered at Hot Springs for the concentrates, a price which netted the producer 12 to 13 cents a pound at the mines.

Since the value of the tin became known, most of the operators have recovered as much of it as could be readily won. The tin ore is so much lighter than the gold that by a proper elevation of the sluice boxes the main separation of cassiterite and gold is easily made. The small amount of fine gold that goes over with the tin concentrates is recovered by cyanidation or amalgamation. The most difficult operation, and one which at present entails a considerable waste of high-grade tin ore, is the separation of the cassiterite from other heavy concentrates, principally pyrite and hematite, which are not easily separated from the tin by the ordinary sluicing methods. The tin ore ranges in size from particles the size of beach sand to boulders several inches in diameter and a few pieces nearly

a foot in diameter. The large pieces are easily hand picked, and the ore is then put through a screen of appropriate mesh to remove the pyrite. The pyrite occurs in cubes, the largest of which are one-eighth inch in diameter, and much of the tin ore is in smaller pieces. It is thus obvious that much of the tin is not separable by screening. At present it is not profitable to ship concentrates which contain any pyrite, and a great deal of tin is thus wasted. The fine tin ore contains a much larger proportion of metallic tin than the large pieces, which contain more quartz. The quartz inclusions of the large pieces, however, are reported to carry a considerable amount of gold, which might partly compensate for the smaller content of tin. The separation of the tin ore from the associated heavy concentrates should be easily accomplished by the use of proper machinery. Where no pyrite or other objectionable heavy concentrates are present there is no difficulty in concentrating the cassiterite.

EXTENT AND SOURCE.

The tin ore is practically confined to the basin of Sullivan Creek, and its concentrations in general appear to coincide with the gold placers of that basin. Stream tin has been reported on several streams below the workable gold placers, but naturally the lighter minerals are carried farther downstream. The upper limit of the tin ore on Sullivan Creek and its tributaries appears to be rather well defined. Evidently the bedrock source is somewhere in the present basin of Sullivan Creek and is presumably covered by gravels. Even if the lodes of Moose Mountain contain tin, they are not believed to be the source of the tin of Sullivan Creek, for then the heaviest concentrations of stream-tin ore would normally occur just below the lodes and decrease downhill toward Sullivan Creek. As a matter of fact, little stream tin is found between the lodes of Moose Mountain and a point a short distance above Old Tofty, where the rich concentrations begin very abruptly.

The amount of tin ore that can be won under present conditions and costs is not large. As long as the placers of Sullivan Creek valley continue to operate on their present scale, there should be a production of 25 to 50 tons of tin ore a year, or possibly twice that amount if more refined methods of recovery are used. In the old tailings and in the low-grade gravels, however, several thousand tons of tin concentrates could be recovered at a higher cost of production.

MINING OPERATIONS.

The productive area of the Hot Springs district extends from a point near Fish Lake northeastward for about 35 miles to Pioneer Creek, a tributary of Eureka Creek. It comprises the drainage areas of Boulder, American, Sullivan, and Baker creeks.

BAKER CREEK VALLEY.

The principal operators of the Baker Creek valley are Frank & Graham on Pioneer Creek, a large tributary of Eureka Creek that enters from the northeast.

The south side of the valley is steep walled and contains no gravel. North of the stream the valley wall is comparatively flat and extends a long distance to the summit of the ridge. Along the upper part of this slope What Cheer and other bars are partly worked out, but below the bars are extensive deposits of low-grade gravels. The entire creek is now controlled by Frank & Graham, who are working the deposit by hydraulic methods. Two cuts are worked at once, so that they can be sluiced on alternate days, and the ground can be thawed by exposure to the sun and air. The gravel is shallow, and overburden and gravel are easily handled by water from the giants. Streams that cut across this north slope of Pioneer Creek contain much richer concentrations of gold. One of the richest of these tributary streams is Seattle Junior Creek, which is now being worked by hydraulic elevators. Operations here, however, are intermittent, as the elevators can be operated only when there is an ample supply of water.

On Eureka Creek, about 2 miles above the mouth of Pioneer, one company which employs 5 men operated a hydraulic plant, sluicing bench gravels, and also did some prospecting.

On Omega Creek two men drove a drift in the winter of 1916–17 and dug an open cut during the summer of 1917. Water is scarce but the gravels are shallow and very easily worked. A winter dump was also taken out on Chicago Creek. One outfit that employed four men operated on Thanksgiving Creek, and sluicing was also done on Rhode Island Creek and on the bench between Rhode Island and Glen creeks.

SULLIVAN CREEK.

The only active mining on Cache Creek was a little sniping for tin. On the Midnight Sun and Abe Lincoln claims, near Old Tofty, small plants recovered both tin and gold. On Tofty Gulch and the bench to the west three men reworked tailings and recovered several tons of tin ore and considerable gold. One small plant was in operation on Miller Gulch, and between Miller Gulch and Woodchopper there were three outfits that employed from 50 to 60 men.

Extensive deposits were located on Woodchopper Creek in 1914 and for the two years following were actively exploited by a large force of men. These mines were not worked in 1917, and there was little activity on Woodchopper Creek.

AMERICAN CREEK.

American Creek is a comparatively short creek that flows into Fish Lake. Mining is carried on in the upper part of the valley, which is floored with a deposit of shallow gravel from 10 to 18 feet deep. Below the mines the depth of the gravels increases at a steep grade toward Fish Lake. Three plants that employed about 16 men were in operation in 1917, using both open-cut methods and drifting. Gravity water is available for the lower workings, but at one plant it is necessary to pump water to elevated sluice boxes.

BOULDER CREEK.

Boulder Creek is a stream about 25 miles long that flows into the swampy lake area west of Fish Lake. Its main branch heads on the south slope of Moose Mountain, but several large tributaries enter it from the north and head in the main ridge that forms the main divide between Yukon and Tanana rivers. Prospecting has been carried on in Boulder Creek for a number of years, and low-grade deposits were known to exist, but not until recently were there any active mining operations.

Ground was staked on the main fork of Boulder Creek, known locally as Big Boulder, 1½ miles above the main forks, and active development work was started in the spring of 1916, when work was begun on a ditch which brings water 4 miles from a point near the head of Boulder Creek. The company controls 4½ miles of ground. An option was taken on this ground by Cleveland & Howell and worked by them during a part of the season of 1917, but work was stopped in August, and the owners continued to work on a small scale.

The south wall of the creek is steep and contains no gravel. North of the creek the valley wall forms a gentle slope which is floored with shallow alluvium, from 8 to 12 feet deep, that carries gold. The deposits are low grade and spotted but are extensive and easily worked by hydraulic methods. The gold occurs on this bench for a length of several miles, and the workable areas, where explored, have a width of 1,200 feet. Over 200,000 feet of bedrock was cleaned in 1917.

One man was prospecting on Little Boulder, the main tributary of the creek. The stream was diverted from its course and carried for half a mile through the flat at the mouth of the creek. The alluvium is from 6 to 12 feet deep and consists of silt that carries layers and lenses of angular slate fragments.

Trail Creek is the first tributary of Boulder that enters from the north below the main forks. On one of its branches, known as Dry Creek, one plant was operating in 1917. The gravels are shallow and angular. Where exposed by the cut they are from 3 to 6 feet deep and are composed of black slate, graywacke, quartzite, and schist, rocks similar to those exposed on bedrock. Water is not plentiful, but the ground is easily handled.

TIN DEPOSITS OF THE RUBY DISTRICT.

By THEODORE CHAPIN.

The following statement is based on a hasty reconnaissance of the Ruby district in 1917 to determine the possibility of the production of tin. Although stream tin occurs at a number of places in the gold placers, there has been only a slight output. Cassiterite has been noted in the concentrates from Long, Spruce, Short, Tamarack, Midnight, Trail, Monument, Birch, Ruby, Poorman, Flat, and Greenstone creeks. The cassiterite is plentiful at few places, and at no place has enough been found to pay for mining it, except as an accessory to the gold. The gravels on Midnight Creek have been prospected for tin, and 14 sacks of concentrates were shipped to Singapore. This shipment consisted of 1,037 pounds of ore which assayed 52.2 per cent, or 537 pounds, of metallic tin. The net return of $156.22 from ore recovered from 6,000 square feet of bedrock gives a yield of about 2½ cents a square foot. Evidently the amount of tin recovered from even the richest tin placers now known is so small that even the shallow gravels can not be worked profitably for the tin alone. At best it adds but little to the profit derived from the gold. It is also evident that the tin ore is so disseminated that it will be very difficult to recover any large quantity, although a few tons may be saved each year by the placer gold miners.

THE GOLD AND PLATINUM PLACERS OF THE TOLSTOI DISTRICT.

By GEORGE L. HARRINGTON.

INTRODUCTION.

The Tolstoi district as considered in this report includes an area about 12 miles wide by 20 long that lies on the northwest flank of Mount Hurst. The drainage from the district reaches the Innoko mainly through Tolstoi and Dishna rivers.

A time and compass traverse was made of the Dishna River from its mouth to the mouth of the Tolstoi, and thence up the Tolstoi to Madison Creek. Early in July, 1917, two weeks were spent in the vicinity of Tolstoi in collecting the data upon which this report and a portion of the accompanying geologic sketch map (Pl. IX) are based.

TOPOGRAPHY.

Mount Hurst, the highest point in the area, reaches an elevation of nearly 3,000 feet and gives a maximum relief to the district of approximately 2,500 feet. Northeastward from Mount Hurst extends a range of hills which have elevations between 1,200 and 1,800 feet above sea level, becoming lower as they approach the Innoko to the northeast. West of these hills the country presents a much less rugged aspect, and low, broad, flat-topped hills between which stretch wide valleys are the characteristic features, though some of the minor streams are rather sharply incised. Northward toward the Innoko there appears to be a succession of low hills, between which there are wide swampy areas that merge on the west with the lowlands of Innoko and Dishna rivers.

Most of the area under discussion lies within the basin of Tolstoi River, and the high ridge of hills which culminates in Mount Hurst forms the divide between the Tolstoi drainage and that of the upper Innoko.

The trend of the drainage when taken in conjunction with the geologic map, indicates that the northerly course of a number of streams is due to bedrock structure. Modifications, however, have been caused by alluviation or by lateral erosion, the latter in places where the streams flow on bedrock as well as where the banks are of unconsolidated material.

Numerous lakes are a characteristic feature of the poorly drained lowlands. They are usually small in area and occupy slight depressions in unconsolidated sediments rather than depressions in bedrock. They lie at higher elevations than the oxbow lakes that are formed by changes in stream channels, and they are probably the composite result of a number of factors which include soil flow, the damming of sluggish streams by the growth of vegetation, and the thawing of lenses of ground ice.

CLIMATE.

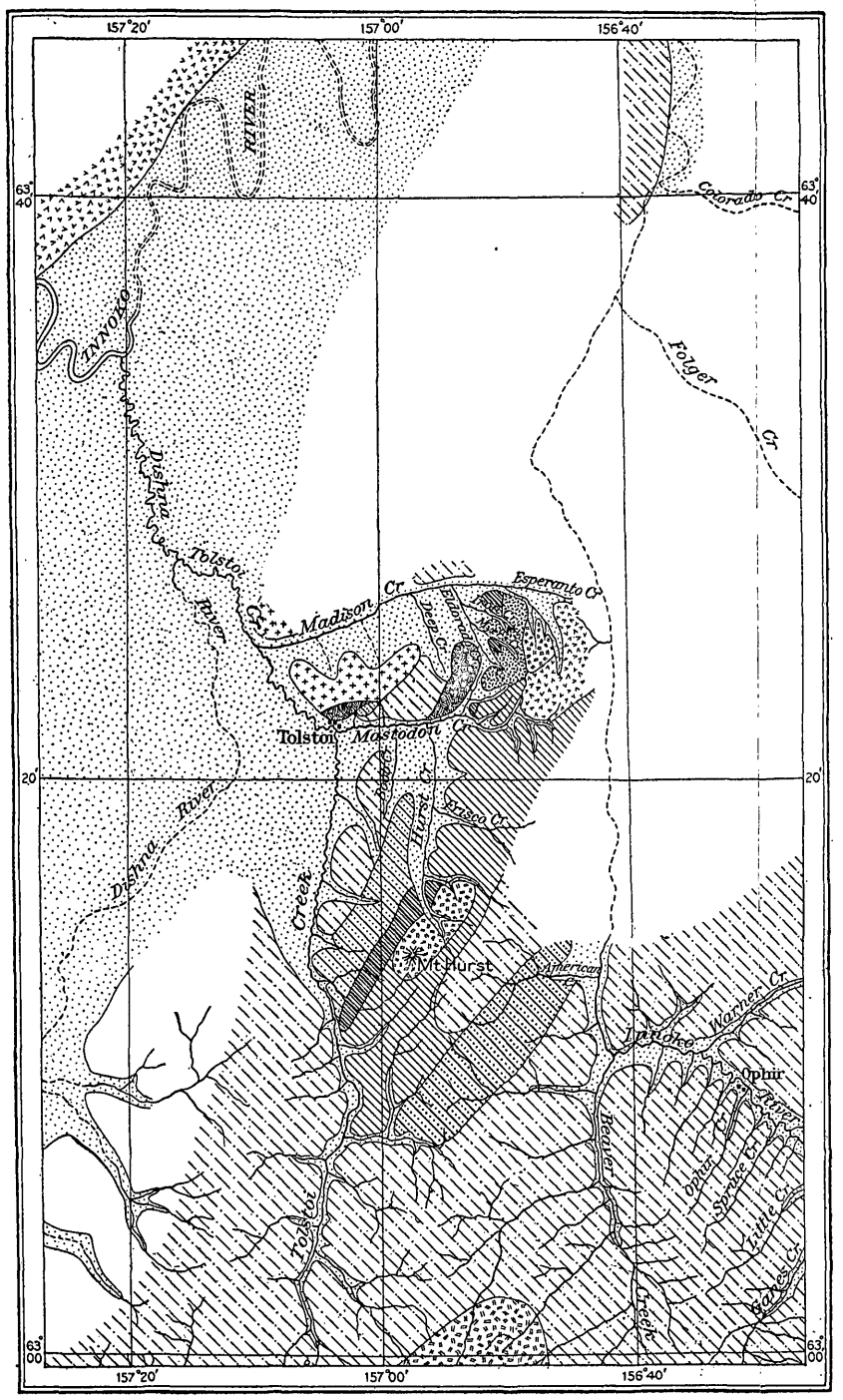
Climatic conditions in this district are essentially the same as those found elsewhere within the lower Yukon drainage basin. Winters are somewhat more moderate than in the Upper Yukon, although they are both long and cold.

Fair days in summer are usually very pleasant, but their number varies from year to year, as do the number of rainy days and the amount of rainfall. Usually, however, the later part of the summer has the greater precipitation. During July, 1917, the rains were unusually heavy and frequent, so that the Tolstoi reached and maintained a stage of water for about 10 days comparable with that of the normal spring high water. In one rain during this period there was a precipitation of more than 2 inches in a few hours. In the high hills near Mount Hurst, the rainfall is apparently greater than in the low areas along the lower courses of Tolstoi and Dishna rivers, as these hills were frequently hidden in clouds when the sky was fairly clear over the valleys.

VEGETATION.

A heavy carpet of sphagnum mosses covers all but the highest peaks and steep slopes or heavily timbered areas. Where conditions are favorable, in areas with good drainage, grasses make up a greater proportion of the vegetal covering. Alders, willows, and dwarf birch form the low growth of minor stream valleys and of the hillsides, and the larger species of willows, together with spruce, tamarack, cottonwood, and some birch, make up the major growth along the Dishna and Tolstoi and their larger tributaries, where thawed and drained ground present conditions most favorable for their best development. The poorly drained interstream areas are occupied by a scattered and stunted growth of spruce. Tamarack may occasionally be found associated with it. Good timber occurs on the flanks of Mount Hurst up to 1,800 or 2,000 feet. Though this timber is mostly spruce, there are some patches of tamarack and a few birches.

At Tolstoi there were gardens where the more rapidly maturing vegetables were raised. The amount so produced, however, was only a small proportion of the total quantities consumed, with the exception of radishes and lettuce, of which practically the entire consumption was of local production.



Scale 1/500,000
5 0 5 10 MILES

GEOLOGIC SKETCH MAP OF THE TOLSTOI DISTRICT.

EXPLANATION

SEDIMENTARY ROCKS

- Unconsolidated silt, sand, and gravel *(of fluvial, lacustrine or marine, and littoral origin)* — QUATERNARY
- Sandstone, slate, phyllite, and conglomerate — CRETACEOUS
- Chert and tuff *(may include some Cretaceous sediments)* — EARLY MESOZOIC OR LATE PALEOZOIC
- Limestone, including some slate and phyllite — CARBONIFEROUS?
- Slate, phyllite, tuff, chert, greenstone, diorite, and quartz monzonite — UNDIFFERENTIATED, MAINLY LATE MESOZOIC AND PALEOZOIC

IGNEOUS ROCKS

- Soda rhyolite — LATE TERTIARY
- Andesite — LATE TERTIARY
- Diorite — TERTIARY
- Quartz monzonite — TERTIARY
- Greenstones *(mainly metamorphosed andesite flows and tuffs)* — EARLY MESOZOIC OR LATE PALEOZOIC

ANIMAL LIFE.

Black bear are said to be fairly common in this region, and one was seen on the Dishna. Caribou are only occasionally seen. Smaller animals are numerous.

Geese and ducks were seen along the streams, and the swampy areas afford ideal breeding places for them. Ptarmigan are found on the higher hills in small flocks, though in lesser numbers than in former years.

Grayling and trout are found in the streams and may be taken with a fly. King salmon ascend the Dishna and sometimes ascend the Tolstoi also. The smaller species of salmon were taken in nets in considerable number at the mouth of Mastodon Creek.

ECONOMIC FACTORS AFFECTING MINING.

In the vicinity of the creeks, where there has been more or less prospecting, a scattered growth of stunted spruce has afforded fuel for the small plants used for thawing. With an increase in magnitude of operations, however, this type of fuel is unsatisfactory and uneconomical. In addition, it is necessary to have larger timber for use in mining. For the operations on Boob Creek cordwood and timber were hauled a distance of 2 to 4 miles from Tolstoi River and from Mastodon Creek. On other creeks, except those directly tributary to Tolstoi River, where mining may be carried on, even greater difficulty in obtaining fuel will be found, and it is probable that for large operations it will be necessary to use liquid fuels.

Such fuels can be carried by gasoline scows up Tolstoi River as far as Tolstoi and possibly still farther under favorable conditions of high water. Winter transportation from Tolstoi River would probably prove most economical. Under present conditions even winter transportation to the upper portion of Madison Creek costs about 5 cents a pound from Tolstoi River. Supplies can be brought by water from Holy Cross to the mouth of the Tolstoi for 2 or 3 cents a pound.

Navigation to this point is comparatively free from difficulties except in unusually low stages of water on Innoko and Dishna rivers. On Tolstoi River navigation is not practicable for power boats at low stages.

Wages during the summer of 1917 were about the same as at other Alaskan camps, $5 a day of 8 hours with board being paid for underground work and $6 a day of 10 hours with board for surface work. No natives were employed in mining but some worked at the sawmill at the mouth of Tolstoi River.

The early summer of 1917 was unusually wet, yet on many of the smaller streams where prospecting was being carried on there was but little surplus of water over that required for sluicing. In normal

seasons it would appear that there will be a scarcity of water unless ditches are built to bring in water from two or more streams, or dependence must be placed either on the water supply furnished by the melting snow in spring or on that afforded intermittently by rains during the summer. An intermittent supply may be obtained by damming and "splashing."

As the creek gradients are low in the lower courses, some difficulty may be experienced in securing dump room and grade for sluice boxes without building trestles.

GEOLOGY.

The geology of the region in general is simple, though its interpretation is at first somewhat difficult because outcrops of the formations are not everywhere common, especially on the lower hills and gentler slopes. Vegetation covers these areas, and the nature of the underlying rocks is revealed only by the material taken from prospect holes, by isolated projecting rocks, or by exposures here and there along stream courses. The trend of the structural features, however, affords considerable help in geologic mapping and was relied on where other data were lacking.

PALEOZOIC ROCKS.

The most conspicuous of the Paleozoic rocks is a limestone, which forms the high conical hills on the northwest and west flanks of Mount Hurst and extends southwestward nearly to Tolstoi River.[1] It crosses Hurst Creek and appears at the base of the hills on the east side of this stream a short distance below the now abandoned Jap Roadhouse. A small outcrop lies between the forks of Mastodon and Mammoth creeks, and another appears on the south side of Myers Creek. Limestone pebbles are found in the gravels of Iron Creek, and this rock is said to crop out on the north side of the creek. It is not known whether or not it extends north of Madison Creek.

Schistose and siliceous phases of the limestone appear in the vicinity of Mount Hurst, and the siliceous rock is finely crystalline. Elsewhere the rock appears to show but slight effects of crystallization.

Areas of phyllites or schistose argillitic rocks are associated with the schistose limestone, but they are comparatively small, and on account of their similarity in composition can not everywhere be readily separated from some of the Cretaceous argillitic rocks which have been metamorphosed. As fossils have not been found, it is not possible to make a definite statement of the age of the limestone. Because of their lithologic similarities the limestone and associated rocks are considered to be of late Carboniferous age and to be correlated with similar rocks on the lower Kuskokwim and on the lower Yukon near Marshall.

[1] Maddren, A. G., oral communication.

PALEOZOIC OR MESOZOIC ROCKS.

GREENSTONES, GREENSTONE TUFFS, AND CHERTS.

Although the rocks of this group are of widely diverse types they are believed to be of like origin and to be closely related in age. They have been separated, however, in mapping, the tuffs and cherts being grouped together and the greenstones shown separately.

They occur chiefly on the northwest flank of Mount Hurst and along the divide between Tolstoi and upper Innoko rivers, at the heads of Mastodon and Madison creeks, and probably also between Hurst Creek and upper Innoko River, south of the head of Mastodon Creek, in the area mapped as undifferentiated. Small areas are also known from other parts of the district, and cherts appear on the north side of Mastodon Creek about a mile northeast of Tolstoi. As considerable faulting and folding were produced by the intrusions which form Mount Hurst and by the monzonite between Mastodon and Madison creeks, numerous other small patches of these rocks representing fault blocks will probably be found elsewhere in the district.

Andesite rocks constitute a large portion of the greenstones, including most of the dense fine-grained dark-greenish tuffs between Hurst Creek and Tolstoi River and the more schistose phases, which probably represent altered flows, at the head of Mastodon Creek.

In addition to these two types other igneous rocks, including basaltic flows and the even more basic intrusives, which are probably the source of platinum in this district, occur in a number of small areas in the vicinity of Mount Hurst as well as to the north of Mastodon Creek. Their areal extent is not known, for they are not conspicuous in places where they are associated with the greenstones and, as has already been pointed out, an additional difficulty in mapping is caused by the widespread distribution of the Quaternary deposits, which effectually conceals the underlying bedrock. Pyroxenites occur in close association with the greenstones. They are dark, coarsely granular, nonporphyritic rocks that consist mainly of augite and lesser amounts of diallage. In some platiniferous placer areas the source of the platinum has been found in rocks of this type.

The cherts occur north of Mastodon Creek and along the ridge leading to Mount Hurst west of Hurst Creek. They may be either light or dark, ranging from light horn-colored to dark greenish gray, and may resemble some of the phases of the tuffs with which they are closely associated.

No definite age determination has yet been made of these rocks, but they overlie limestones which have been tentatively assigned to the Carboniferous. Chert cobbles and pebbles are found in a conglomerate which overlies the greenstones and which marks the base of the Cretaceous in this district. The age of the group is therefore very late Paleozoic or early Mesozoic. It is not certain whether the basic intrusive rocks are of this age or younger.

CRETACEOUS ROCKS.

In the Tolstoi district Cretaceous rocks have considerable extent, appearing on both sides of Tolstoi River and on the north side of both Mastodon and Madison creeks. Small patches of those rocks also appear along the lower part of the ridge west of Hurst Creek, and they probably form the bedrock of Boob Creek and of the area between Boob Creek and Tolstoi River.

The lithology shows considerable variation. Wherever the base of these rocks was observed, as along the ridge between Hurst and Ledge creeks and also north of Mastodon Creek, it is a conglomerate composed of chert pebbles that rests on the irregular surface of the underlying cherts. The sandstones show a greater diversity of materials, including quartz, feldspar, fragments of carbonaceous rocks, and minerals of probably secondary origin, such as chlorite and calcite. If ferromagnesian minerals, such as hornblende, augite, or olivine, were originally present, they have now been so completely altered to secondary minerals as to be unrecognizable. The feldspars are also undeterminable on account of kaolinization.

A considerable proportion of the Cretaceous sediments are of the fine-grained argillaceous type and have been metamorphosed to form slates. Intrusion by the dioritic mass of Mount Hurst as well as by the diorites on the headwaters of Madison Creek, has produced phyllitic phases of some of these rocks, so that they are not readily distinguishable from the older phyllites that are associated with the Paleozoic limestone. Both the slates and phyllites are cut by numerous small quartz veins, which are probably the source of the gold. Some of the veined slates show pyritization.

No fossils were found in the Tolstoi district, so that correlations must be based on stratigraphic and lithologic features. These rocks are essentially similar to the slates and sandstones in near-by regions which are of known [1] Cretaceous age and are therefore considered as belonging to that period.

TERTIARY IGNEOUS ROCKS.

QUARTZ MONZONITE.

Pinkish quartz monzonite, which is locally known as granite, occurs along the ridge between the Madison and the Mastodon drainage at the head of Eldorado Creek, between Myers and Iron creeks, and also between Iron and Madison creeks. The areas mapped as monzonite may also contain some sedimentary rocks, as between Iron and Madison creeks, where limestones occur.

[1] Mertie, J. B., jr., and Harrington, G. L., Mineral resources of the Ruby-Kuskokwim region, Alaska: U. S. Geol. Survey Bull. 642, p. 233, 1916.

It has been pointed out in a previous bulletin [1] that elsewhere in the Ruby-Kuskokwim region there is a close genetic connection between the auriferous mineralization and the monzonitic rocks. In the Tolstoi district this relation also probably holds, and the occurrence of gold placers is to be attributed to these intrusives. There is said to be some residual placer gold on the slopes of gills made up of the monzonite, and the auriferous quartz veins, which occur in the near-by areas of sedimentary rocks, are believed to be derived from the monzonite intrusion.

The quartz monzonite is made up of quartz, orthoclase, and plagioclase in about equal amounts, together with hornblende and biotite. Apatite and magnetite are present as minor accessory minerals.

A correlation with similar rocks elsewhere in the Ruby-Kuskokwim region [2] would establish a Tertiary age for the quartz monzonite.

DIORITE.

Diorites are perhaps more widely spread than the geologic map indicates, for it is extremely likely that in the area of undifferentiated rocks east of Hurst Creek a number of the higher peaks are composed of this type of rock. There are also numerous small outcrops in the greenstone areas, which are too small to represent on the map. These outcrops represent dikes from the larger batholithic intrusives which form Mount Hurst and appear on Joffre Creek. From the relations of the diorite and greenstone at the head of Joffre Creek, it appears likely that even where the diorite is not exposed it lies below the greenstone where that rock appears between Mount Hurst and Madison Creek. There are also dikelike intrusions of considerable extent in the Cretaceous sediments, in the limestones, and in the greenstones and greenstone tuffs. In the greenstones especially, the similarity of appearance on weathered surfaces makes a determination of the extent of these intrusions difficult.

Some differences in the appearance of the diorite are due partly to the amount of weathering that the rock has undergone and partly to differences in composition. Weathering gives the rock a much darker and greener color than it has when unaltered, owing to the formation of secondary silicates and ferromagnesian minerals, such as zoisite, chlorite, and hornblende, as well as hydrous iron minerals.

Where the rock is unaltered its constituents are plagioclase feldspar, biotite, and augite, together with a minor and varying amount of quartz. Apatite and magnetite are everywhere present, the magnetite varying considerably in amount. In some places ilmenite appears to take the place of some of the magnetite and occurs in somewhat larger grains. The feldspars range from albite oligoclase to labradorite, but the mean appears to be oligoclase andesine.

[1] Mertie, J. B., jr., and Harrington, G. L., op. cit., pp. 235, 264, 1916.
[2] Idem, p. 235.

Possibly the basic granular rocks that are associated with the greenstones, and from which the platinum is derived, are differentiates from the dioritic magma, but confirmatory evidence on this point is lacking, although the diorites in the greenstones are somewhat more basic than either the main mass of Mount Hurst or the intrusive mass on Joffre Creek.

Although gold has been found on Joffre and Madison creeks, in the diorite, the gold may not have been derived from deposits which owe their origin to the intrusion of the monzonite.

Age determinations are only possible where relations to both younger and older rocks are known. The diorite cuts Cretaceous rocks and therefore is post-Cretaceous and probably early Tertiary. Its age with relation to the monzonite is not known but both are assumed to have been introduced during the same period of igneous activity.

SODA RHYOLITE AND ANDESITE.

North and northwest of Mount Hurst low flat-topped hills appear to merge into the lowlands of the Dishna and the Innoko. So far as is known, these hills are made up of rhyolite flows and tuffs, though andesite is present in dikes and flows and possibly also in tuffs. They are mapped separately, but the rhyolite areas may include some andesite, and the area mapped as andesite may contain some rhyolite.

The rhyolites are light-colored rocks and at a distance present an appearance like that of limestones with a slight buff tinge. In thin section they are seen to be fine-grained porphyritic rocks, the phenocrysts being quartz and the plagioclase feldspar. The quartz is usually of the smoky variety. Albite is the principal plagioclase, but the feldspars range between albite and oligoclase. Biotite is usually present in a few foils, which are also sometimes apparent in the hand specimen. Less commonly hornblende may be seen in the section. Magnetite may also be present. For the most part the groundmass is very fine grained and almost glassy in appearance. The flow or tuffaceous character of the rock is apparent from the typical texture seen in thin section.

In the hand specimen the andesites are light to dark greenish gray and can be readily distinguished from the rhyolites on account of their color. Where the andesites are in the field they are also much darker, and they are usually more completely covered by vegetation than the rhyolites. Associated with the flows or dikes are minor areas of dense fine-grained rocks which resemble argillites in appearance but which are probably fine-grained tuffs or volcanic muds. The rhyolites appear to make up the entire hilltop and in many places the steep slope to the flat of Tolstoi River, but the andesites north of Tolstoi appear at an elevation below the crest of the main ridge in small subsidiary ridges which trend northeastward in conformity with the

general structural trend. Between Eldorado and Mastodon creeks the andesites occupy higher positions on the ridges, which correspond to those occupied by the rhyolites farther west.

In thin section andesine feldspar appears to be the chief constituent of the rock, making up the phenocrysts as well as a considerable amount of the very fine grained groundmass. Phenocrysts of augite are also present in places. Magnetite occurs in small grains in widely varying amount. Much of the groundmass is altered and indeterminable and has been converted in part to secondary hydrous iron oxides, which give a general brown appearance to the section.

It is not possible to make exact age determinations of these rocks, although some generalization may be made. There is a suggestion as to the relative ages of the andesite and rhyolite afforded by the form of the outcrops of the andesite and by the relative position of the two series. The ridges north of Tolstoi may represent the upturned eroded edges of flows the source of which lay eastward, although this is by no means proved. If this supposition is correct the rhyolites which lie to the west of the andesites flowed out over and are younger than the andesites.

In other areas in western Alaska rocks of one or the other type are rather widely distributed. The exact lithologic equivalent of the rhyolite was seen on the north bank of the Innoko about halfway between Shageluk Slough and the mouth of Iditarod River. Collier[1] reports that both andesites and rhyolites cut the Cretaceous rocks between Ruby and Holy Cross. Andesitic and dacitic dikes, tuffs, and flows were found by the writer[2] to have a considerable extent along Anvik, Stuyahok, and Bonsila rivers, as well as in places along the Yukon between Anvik and Andreafski. At these occurrences they are younger than the Cretaceous rocks with which they are sometimes associated and are older than the late Tertiary or Quaternary basalts of the lower Yukon. In other portions of the Ruby-Kuskokwim region both rhyolites and andesites have been found[3] which are of late Cretaceous or Tertiary age, and these are to be correlated with the corresponding rock types in the Tolstoi area.

QUATERNARY DEPOSITS.

Unconsolidated material which is mainly of Quaternary age covers much of the lowland area of the Tolstoi district and extends nearly to the heads of many of the smaller streams and occupies the interstream ridges. This material is in part alluvial but probably is also in part of marine or lacustrine origin, and the flat-topped hills at

[1] Collier, A. J., unpublished notes.

[2] Harrington, G. L., The Anvik-Andreafski region, Alaska (including the Marshall district): U. S. Geol. Survey Bull. 683, pl. 2, 1919.

[3] Mertie, J. B., jr., and Harrington, G. L., Mineral resources of the Ruby-Kuskokwim region, Alaska: U. S. Geol. Survey Bull. 642, p. 236, 1916.

elevations of 800 to 1,000 feet may be wave-cut terraces upon which these sediments were deposited. For the most part, the sediments are thin and in large measure have been removed or have been left in only small areas. In the lowlands the former stream courses were filled with gravels, sands, and silts, but upon the reestablishment of drainage systems after the period of inundation a large amount of the unconsolidated material was removed. Between Tolstoi and Boob Creek prospect holes which have been sunk to a depth of 125 feet pass through about 60 feet of muck and ice which overlies an equal thickness of silts, sands, and gravels.

In the silts there are large amounts of ice, in sheets rather than in wedges. These ice sheets appear to contain different amounts of silt and bands of clear ice from an inch or less to several feet in thickness, alternating with bands of frozen siltlike material, which show variations in thickness equally great. Possibly some of the numerous small lakes in the flatter, low-lying areas are due to depressions caused by the melting of ice layers underneath.

The gold and platinum content of the gravels has been concentrated by either the action of waves on beaches or by the current of streams, or there may have been a reconcentration by streams from older deposits formed along beaches or streams.

A somewhat unusual feature in connection with the placer gravels is that a short distance above the gravels there are fragments of vegetation and tufts of grass which resemble the niggerheads on the present surface. Their presence is easily explained. There is a covering of silts and sheet ice over practically all the gentler lower slopes, and when a small or intermittent stream has cut through the surface mat of vegetation it rapidly erodes the silt and ice to the gravels or to bedrock. By sloughing of the steep sides vegetation may reach the bottom of the cut, 20 feet or more in depth. By continuous sloughing, or by repeated freezing and thawing in fall and winter, the crevice is completely filled with ice and muck, and the following year the stream may follow a different course.

The occurrence of tusks, teeth, and other bones of Pleistocene mammals in the placer gravels indicates the age of the deposits, although it is possible that later reworking has taken place and that some of the placers are later than the Pleistocene.

The Quaternary history of this region has not been completely worked out, so that it is not possible to differentiate between the Pleistocene and Recent deposits on account of their similarity and the grading upward of one into the other.

The deposits which are definitely of Recent age embrace stream alluvium, talus, and other detritus produced through the action of frost and other processes of weathering and the vegetal accumulations which cover large areas throughout the interior of Alaska.

MINERAL RESOURCES.

HISTORY OF MINING DEVELOPMENT.

The earlier history of the region has been given in the report of Maddren[1] on the mining developments in the Innoko basin to the time of his investigations in 1908. Some additional notes have been contributed by Eakin[2] as the result of a reconnaissance trip from Ruby to Iditarod in 1912.

Incident to the stampede to the Innoko, in the vicinity of Ophir, many claims were staked on streams in the Dishna drainage. A few men prospected their claims faithfully, although the high cost of supplies and the difficulty of getting them at any price necessarily made prospecting difficult. Many claims were held by other men, however, and upon them only sufficient work was done to maintain titles or not even the amount of work required by law. Title to most of these claims had been permitted to lapse by 1915, and when a rush during the spring and summer of 1916 followed the discovery of gold during the previous winter most of the ground along the creeks lay open for restaking. Prospecting was carried on quite extensively during the summer of 1916, but Boob Creek alone made any production and that small. Preparations for mining on a larger scale were made, however, and during the winter and spring of 1916–17, a considerable production was made by the plant which operated on claim No. 2 below Discovery and the adjoining fraction above this claim. During the winter of 1916–17 there was a stampede from Ruby, Ophir, and Iditarod, which brought the population of the district up to about 450, most of whom staked claims. This stampede was followed during the winter by active prospecting on a large number of the creeks tributary to Tolstoi River, but for the most part this work failed to develop workable placer ground. As a result the population dwindled, until in July, 1917, there were only about 50 left in the district. About $50,000 in gold was taken out in 1917, the result of the operations of about 25 men on five plants, most of the production being on Boob Creek. Boob Creek is the only creek in the district that produced platinum. The platinum was not separated from the gold but was sold with it to the bank in Iditarod. The platinum in the gold was said to amount to about 1 per cent, so that about 30 ounces of platinum was produced in 1917.

GOLD PLACERS.

The only plant which made any considerable production up to July, 1917, is located on Boob Creek. Extensive mining operations have been confined to that creek, where one plant was in operation,

[1] Maddren, A. G., The Innoko gold placer district, Alaska: U. S. Geol. Survey Bull. 410, pp. 19–24, 1910.
[2] Eakin, H. M., The Iditarod-Ruby region, Alaska: U. S. Geol. Survey Bull. 578, p. 39, 1914.

and several outfits were engaged in prospecting during the spring and summer.

The deposits are worked by underground methods for the auriferous gravels, 2 to 4 feet thick, lie beneath 25 to 35 feet of muck and ice. The surface gradient of the stream is low, not over 50 feet to the mile.

Besides gold and platinum other minerals which may have economic importance are cinnabar and cassiterite, which are found in small amounts. Cinnabar occurs in small pebbles up to half an inch in diameter of a characteristic red color. Cassiterite in the form known as wood tin occurs in the typical botryoidal form, showing radiate structures when cracked open. The pebbles are somewhat darker than those seen in the Ruby district, being nearly black. The crushed mineral gives a very light brown powder.

A small sample of the platinum from Boob Creek was presented to the Survey by Mr. J. S. Pitcher, of Tolstoi. It was analyzed by R. C. Wells in the chemical laboratory of the Survey and found to have the following composition:

Analysis of specimen of platinum from Boob Creek, Tolstoi district.

Platinum	83.4
Iridium	.4
Palladium	.3
Copper	None.
Rhodium	.3
Iron	9.8
Osmiridium, silica, and undetermined	.6
Nickel	None.
	94.8

Pyrite, magnetite, garnet, feldspar, and quartz also occur in the concentrates. The quartz is found in small brilliant transparent crystals as well as in the milky white form from veins. A considerable number of grains of nearly opaque, brownish-black grains of obsidian or volcanic glass were also noted.

Some of the tributaries of Tolstoi River, which head against Mount Hurst or its spurs, were prospected during the spring and summer. Up to July none had made any production. Considerable prospecting had also been done on tributaries of Mastodon Creek other than Boob, but without result.

On Madison Creek and several of the streams flowing into it, including Esperanto, Joffre, and Eldorado creeks and their tributaries, considerable prospecting has been done. On Iron Creek, which empties into Eldorado, there were at one time seven or eight outfits, but in July only one of these was working about 2 miles from the head of the creek. Mining was being done in an open cut

by three men who were shoveling into the boxes. The gravels were largely composed of phyllitic rocks and granite but included some pebbles of limestone. Sections show from 2 to 4 feet of gravel overlain by about 4 feet of muck. A considerable amount of stripping had been done, and it was planned to work during the summer. No platinum was found on this creek. A considerable amount of prospecting had been done on a number of claims near the head of Madison Creek, but work during July was confined to two claims. On claim No. 5 above Discovery three men were working. At this locality 4 feet of muck overlies about 8 feet of gravel, and the gold is found in the lower 4 feet. The gold from this claim is flaky, fine, and worn. No platinum was seen in pannings, which in addition to the gold contained magnetite, ilmenite, augite, hornblende, garnet, and zircon, none of which have economic value under these conditions of occurrence. The creek valley is about 150 to 200 feet wide on this claim. The ground in the center is said to be thawed, although it is frozen on either side. Operations were largely carried on with the purpose of ascertaining the extent and richness of the stream gravels. A small production was made from this and adjoining claims under the same ownership.

One man was working on claim No. 7 above Discovery. A number of prospect holes had been sunk and the dirt from these holes and some short crosscuts had been rocked out. The gold, although somewhat worn, is considerably coarser than that found on claims lying farther down the creek and is described as "shotty" rather than flaky. An association of minerals similar to that on the lower claims is found in the concentrates.