MR-073-02

THE QUICKSILVER RESOURCES OF THE KUSKOKWIM RIVER REGION, ALASKA

INTRODUCTION

The existence of quicksilver ore on the Kuskokwim River was known to the Russians at the time of the building of the fort and settlement at Kolmakofsky in 1838. Cinnabar was seen on the bluff along the north bank of the river three miles below Kolmakofsky. The first mining of quicksilver recorded was done prior to 1900 by a Mr. Lind who made no profit from the enterprise. (1). Later the prospect was staked and held by the late "Cinnabar" McDonald, a well known character on the Kuskokwim. In 1906 Mr. E. W. Parks located two claims known as the Bessie and the Alice eighteen miles above Georgetown. Shortly afterward Fuller & Willis located a property near Parks. Several claims were later staked in these localities.

The largest production in the district is said to be from the Parks prospect with a total reported production of 65 flasks. The next largest production came from the DeCourcey prospect located twenty miles north of the Kuskokwim from the mouth of Crooked Creek below Georgetown. This property was located in 1919 and produced forty-two flasks of quicksilver. This year the Corona, an adjoining property, produced thirty-five flasks. The DeCourcey prospect has been abandoned. There is no definite future ahead for the Corona.

Quicksilver in the Kuskokwim region occurs in the shattered area adjacent to igneous intrusions. It is generally believed that quicksilver ores occur in hot spring deposits and that they are not deep

(Numerals refer to bibliography at end of article)

seated in character. (2). Prospecting an area for a commercial deposit of quicksilver requires some experience and geological knowledge. Much of the development work on the quicksilver deposits of the Kuskokwim region has been misdirected and has accomplished little toward showing the value of the deposit. A large part of the work has been done by placer miners that overflowed into the Kuskokwim district from placer stampedes. The future of quicksilver on the Kuskokwim is then a question which can only be answered as a result of intelligent prospecting.

Stibnite and realgar are the principal ores associated with the cinnabar.

The Yukon-Kuskokwim portage is the accepted route for summer travel. The mail boat, operating twice a month in summer, carries passengers. The fare from Russian Mission to Bethel is $75.

Quicksilver in its occurrence in the Kuskokwim River Region is scattered over a wide area. To one interested in the quicksilver resources and their possible exploitation, they may be considered as a unit. The more specific details relating to the occurrence will be discussed in the description of the individual properties.

LOCATION

The Kuskokwim is the second largest river system in Alaska. The trend of the Kuskokwim River roughly parallels the Yukon River. From the mouth of the Kuskokwim River to the forks that form its upper tributaries the distance is approximately 600 miles. The Kuskokwim River flows southwest, in a general direction, emptying into Kuskokwim

Bay on the east coast of Bering Sea. A range of mountains separates the drainage of the Kuskokwim and Yukon Rivers. The Yukon River lies north of the Kuskokwim and at the nearest point is about 20 miles distant.

The main occurrence of quicksilver in the Kuskokwim Region is located about 18 miles above Georgetown, on the north bank of the Kuskokwim River, in the vicinity of Parks. The first discovery of cinnabar in this locality was made by Mr. E. W. Parks in 1906. This was followed by the discovery and location of the Fuller and Willis prospect about 1 mile below the Parks prospect and on the same side of the river. The Ammiline prospect lies north of and adjacent to the Parks Prospect; it is reported that this prospect has been abandoned and later included in the Parks' holdings. A prospect was located by Mr. Nick Mallick immediately north of the Fuller and Willis Prospect, and later abandoned. The Mallick Prospect was later restaked by Fuller and Willis.

The Parks-Barometer Group of claims is located on the south side of the Kuskokwim River, about 1 mile above Parks, at the foot of Barometer Mountain. The claims are reached by a 1½-mile trail from the bank of the river. Mr. W. J. Cribbee, of Sleitmute, has reported a discovery of cinnabar associated with stibnite east of the Barometer Group.

A discovery of cinnabar has been reported, by Mr. L. N. Wilson of McGrath, 2 miles below the Candle landing on the Kuskokwim

River. Mr. Wilson has located a cinnabar prospect on the south slope of Joaquin Mountain near Takotna. Cinnabar has been reported along the walls of the stibnite veins of Cripple Mountain, Innoko Mining District.

The DeCourcey prospect, located 20 miles north of the Kuskokwim River and 8 miles west of Crooked Creek, was one time operated under the name of the Thrift Mining Company. It was located in 1919. This property may be reached by trail, from Iditarod, or from the mouth of Crooked Creek on the Kuskokwim River. The distance from Iditarod is approximately 67 miles and from the mouth of Crooked Creek 27 miles. It is reported that no assessment work has been done on the DeCourcey Prospect for the past 2 years and that the property is now open for location. A prospect, known as the "Corona", has been located adjoining the DeCourcey.

The old holdings of the late "Cinnabar" McDonald, which mark the location of the first noted occurrence of quicksilver by the Russians, have been restaked by Mr. Gorden Bettles. Many additional claims were included. The Bettles Prospect is located on the north bank of the Kuskokwim River 3 miles below the old Russian settlement at Kolmakofsky.

Mr. Herman Oman, of Akiak, reports an isolated occurrence of cinnabar and realgar on Rainy Creek, a tributary of the upper Eek River, in the lower Kuskokwim District.

Cinnabar is found as float in some of the placer operations in the Iditarod, Innoko, and lower Kuskokwim Mining Districts. The amount recovered has not been commercial.

TRANSPORTATION AND ACCESSIBILITY

The Kuskokwim is navigable by river steamer from Bethel to McGrath, a distance of approximately 500 miles. The Santa Ana Steamship Company operates a steamer from Seattle, connecting with the river steamer at Bethel, semi-annually. The freight rate from Seattle, ship option 2000 pounds or cubic measurement, to various points on the river is as follows: Bethel, $22.50; Akiak, $37; Napamute, $55; McGrath, $65; Takotna Forks, $70; Medfra, $80. Rates are proportional for intermediate distances.

The quicksilver properties along the Kuskokwim may be reached in summer by steamer usually during the months of May and September. Small boats are available at Bethel from May to October depending on the ice in the river. Winter transportation to the Kuskokwim District is by dog team from Nenana via McGrath, Takotna, Iditarod, and the mouth of Crooked Creek.

The fare from Seattle to Bethel is $100, Bethel to McGrath $75. Small gas boats are available on the Kuskokwim River from $20 to $25 per day including fuel. The standard rate for guides is $5 per day. Dog teams are available in winter from $15 to $25 per day. The cost of travel with winter mail is approximately $10 per day. The length of time required from Seattle to Bethel in summer is 12 to 14 days; from Bethel to McGrath, 5 days. The length of time required for winter transportation is variable.

Cripple Mountain, Mt. Joaquin, and Candle Creek may be reached from McGrath or Takotna. The DeCourcey Property is accessible by a

rough trail, 40 miles overland, from a point 110 miles from the mouth of the Iditarod River. The usual route followed is by trail from Flat to a point on Crooked Creek, Walsh and Stevens placer mines, 20 miles from the mouth. Rainy Creek, in the Lower Kuskokwim District, is accessible by overland journey from the second fish camp on the Kwithluk River. The second fish camp is approximately 70 miles from the mouth of the river. There are no trails, the approximate overland distance from this point is 90 miles. Rainy Creek may be reached by poling boat on Eek River during high stages of water but, owing to slow progress, this method of travel is impractical.

VEGETATION AND TIMBER

With the exception of Rainy Creek, there is ample timber for mining and camp construction purposes. Spruce, cottonwood, birch, alder, willows and brush were noted. The timber is not large or extremely abundant and decreases in amount toward the mouth of the Kuskokwim River. A small saw-mill is maintained by the Bureau of Education at Akiak. Below Napamute the timber gives way to tundra away from the streams. Trees are found in the tundra areas along the larger streams. The conditions are marshy near the banks of the Rivers and in the Tundra areas. The entire region is covered with moss. Blueberries, cranberries, yellow salmonberries, and forms of moss berries are abundant. The soil is adaptable for the growth of vegetables. The long days in summer seem to promote the growth of vegetation. The tundra areas cannot be utilized for garden unless fertilized. Wheat and oats are grown at Takotna. The ground near the quicksilver occurrences is not frozen.

GAME

Game is abundant in the Kuskokwim River Region. Much fur is obtained by trappers. Animal life noticed included, otter, mink, beaver, muskrat, fox, martin, brown and black bear, ducks, geese, ptarmigan and swan. Fishing is the main native industry along the Kuskokwim River. There are several varieties of salmon. Greyling, trout, and whitefish are caught in the side streams. The natives use fishwheels and nets. The salmon are dried on poles for use as dog feed in the winter. The king salmon is smoked for their own use and is the principal article of native food.

CLIMATE

The Kuskokwim River is a region of wide changes in temperature. The range in temperature is from 60 degrees below zero in winter to 90 degrees above zero in summer. The weather conditions in the summer are ideal. The fall is accompanied by frequent rains. Ice forms in the Kuskokwim River, usually, in October. The break-up occurs in April or May. The warm summer weather is usually accompanied by mosquitoes and other insects.

POPULATION

The postoffices in the Kuskokwim River Region are Akiak, Bethel, and Quinhagak in the Lower Kuskokwim Region; Napamute in the Central Kuskokwim Region; McGrath, Takotna and Medfra in the Upper Kuskokwim Region. The region is sparsely settled, the total population being a few hundred, of which over half are natives. With the exception of a trader near the mouth of Swift River, there is no settlement

between McGrath and Sleitmute. The total white population between McGrath and Akiak is less than 50 with the exception of the men employed at the New York Alaska Gold Dredging Company, Bear Creek, Upper Tuluksak River. The natives above Akiak are Indians. Below Akiak the natives are all of Eskimo stock. Squaw-men are the rule rather than the exception. The towns are more populated during the winter than in summer.

LABOR

The standard rate for day labor in the Kuskokwim River Region is $6 per day and board. There are few men in the district that are experienced in lode mining. The entry of a new industry would attract men from various points in the interior of Alaska. Native labor is available from $75 to $125 per month with board. Board will cost from $1.75 to $3 per man per day, depending on accessibility.

MINERAL RESOURCES

Gold placer operations are located in the vicinity of Takotna and McGrath. The Nixon Fork lode mine, gold-silver-lead-copper, is operated on the Nixon Fork of the Kuskokwim River. Other placer operations are located on Crooked Creek; New York Creek, near Napamute; Marvel Creek, Aniak River tributary; New York Alaska Gold Dredging Company, Bear Creek, upper Tuluksak River; and in the Quinhagak-Goodnews Bay District. Coal is reported on Big Creek, near McGrath; Sou Creek, near Napamute; Aniak River; Eek River; and Nelson Island. Stibnite and realgar are associated with the quicksilver. Arsenic occurs on Rainy Creek, and Quinhag River. There is an occurrence of gold-silver-copper ore in the Russian Mountains near the native settlement of Russian Mission.

Prospecting for placer is carried on, on a small scale, along the tributaries of the Kuskokwim River. Platinum is found in the gold placers of Bear Creek; and Kow Kow Creek, near Quinhagak. A minor occurrence of oil shale is found on Bear Creek, and at Bettles' Prospect.

GENERAL TOPOGRAPHY

The Kuskokwim River flows through a low mountainous region from its upper limits to the Russian Mountains. From this point to the mouth is found the characteristic rolling tundra topography. The river attains no great size above the Tatlawiksuk, Swift, and Stony Rivers. At Parks the river has a width of 1500 feet and an average depth of 12 feet. The elevation of the Kuskokwim River at McGrath is less than 500 feet. The valley of the Kuskokwim is very wide and there are many bends in the river. The channel in the river follows the high cut banks. The mountains are irregular and seldom reach an altitude of 4,000 feet.

The greater part of the area north of the Kuskokwim River is drained by tributaries of the Yukon River. The major part of the Kuskokwim drainage comes from its southern tributaries from the south slope of Mt. McKinley to Eek River. The Tatlawiksuk, Swift, Stony, Aniak, Tuluksak, Kiselalik, Kwithluk and Eek River, southern tributaries of the Kuskokwim, are reported to head in the same general locality and are separated by divides extending in different directions.

The Lower Kuskokwim is a region of tundra and small lakes. Small deep streams drain the tundra area. Below Bethel the Kuskokwim becomes very wide, extending over a mud flat area. The larger vessels move only at low tide thus enabling them to be freed from any bars that may be encountered.

WATER POWER

The development of a limited water power is possible by the construction of ditches from a point near the source of small streams to the high bank above the Kuskokwim River. The details of such construction can only be obtained by a study of the possibilities near a particular prospect. No large water power sites are recorded.

GEOLOGY

The significant fact regarding the quicksilver occurrences in the Kuskokwim River Region is their association with granitic intrusives. It seems reasonable to assume that the intrusions caused a shattering in the surrounding sediments and that the ore deposition was a result of aqueous emanations from the magma. This opinion is based on the similarity of the intrusives. However, it may be possible that the ore formed as a result of deposition by ascending hot waters subsequent to the intrusion. The occurrence of cinnabar in the intrusive rock in the Fuller & Willis Prospect might be an evidence of the latter theory. However, this occurrence may possibly be accounted for by a minute concentration by surface waters of cinnabar from weathered ore. In all cases noted the quicksilver ore occurred in a shattered zone. Weathering and alteration of the rock accompanying the ore is so marked that it is sometimes difficult, in the field, to differentiate between the igneous rock as a granitic or monzonitic porphyry. (3).

In a discussion of the quicksilver deposits in the vicinity of Parks, Philip S. Smith (4) states, "Lindgren has clearly shown that

he does not restrict the term 'hot springs' to those that derive their water from the surface but includes those which derive their water from hot ascending solutions, possibly of magmatic origin. If the term is used in this broad sense, the quicksilver deposits here described may appropriately be called hot-spring deposits. They are evidently closely associated with the igneous rocks and have derived their mineral content from the emanations of the intrusive masses in the form of solutions. To judge from the geologic occurrence of the ores the depth below the surface at which they were formed apparently was not great. This conclusion is indicated by the number of spaces that are still preserved and the number of open spaces that were in existence when the mineralization took place but are now filled with ore and gangue. It is further supported by the shattered condition of the rock adjacent to the intrusives, for the shattering could have taken place only under slight load, such as is characteristic of the surficial part of the earth's crust. * * * At Barometer Mountain, a few miles south of the Parks prospect, a considerable mass of intrusive granitic rock is exposed. Possibly a similar intrusive mass occurs still nearer the Parks prospect but at so great a depth that only the apophyses from it are exposed on the surface."

Cripple, Joaquin and Barometer Mountains are examples of the larger intrusive bodies. The intrusives in the vicinity of the Fuller & Willis, and Parks prospects are smaller bodies which may be tongues of the larger intrusive masses. The sediments in the vicinity of the

Parks Prospect have been subjected to regional metamorphism which has caused an alteration and a folding of the strata. The sedimentary areas nearer the intrusives have been subjected to an additional contact-metamorphism and shattering.

The ore occurrence may be divided into five types: Cinnabar and stibnite occurring in a series of stringers and lenses with some quartz as at the Parks prospect; narrow stringers of nearly pure cinnabar, Candle Creek, Thrift, and Gordon Bettles; cinnabar and realgar with little stibnite at the Parks Barometer Group and Rainy Creek; massive stibnite with accessory realgar and cinnabar at the Parks Barometer Group; quartz veins with stibnite, and cinnabar in veinlets along the walls at Cripple Mountain; and cinnabar occurring as float and placer at Gordon Bettles', and the various placer districts. As a general rule, the amount of stibnite is greater than the cinnabar. There is an absence of other metallic minerals. Pyrite and marcassite are found but are thought to have formed subsequent to the ore deposition. The gangue minerals are mainly metamorphosed country rock, with some angular fragments; quartz, including chalcedony; and some calcite.

The above photograph shows a sample of quicksilver ore (center) from the Cribbee prospect on Barometer Mountain. The two smaller pieces on either side of the Cribbee ore are broken pebbles of placer cinnabar from the Riley Dredge at Flat, Alaska. The photograph is slightly more than one-half size. The lighter portions of the Cribbee sample are quartz with a small amount of calcite; the darker portions, stibnite; and the red, cinnabar. The yellowish color at the top of the sample represents the wall of the vein. The stibnite predominates. Cinnabar and stibnite are so intermixed in places that the presence of the mineral livingstonite, a sulphide of mercury and antimony, was suspected. In places the cinnabar occurs as veinlets in the stibnite. The stibnite and the cinnabar were undoubtedly deposited at the same time. The back view of this sample gives the impression of a peppering of cinnabar. The crystallization of the stibnite is not as distinct as in some of the other samples where the quartz is not so predominant. The pebbles of placer cinnabar are relatively pure and are a characteristic occurrence in the Iditarod District.

The center sample, in the above photograph, shows quartz with included angular fragments of wall rock. The red portion of the sample is realgar; and the silver, stibnite. There are some fine veinlets of calcite. On the back of the sample realgar is included in the center of a veinlet of calcite. It is difficult to distinguish between the cinnabar and the realgar in the sample though in places it may be recognized in an intergrowth of stibnite crystals. The stibnite occurs in well defined needle-like crystals. There does not appear to be an intermixture of realgar with stibnite or cinnabar suggesting deposition after these two minerals. The smaller samples in the photograph show realgar occurring in small fissures in the vein. There is no quartz in these samples, the gangue being altered country rock. The picture is taken along the mineralization. The realgar occurs in a series of stringers and small lenses. The two smaller samples are taken from the tunnel on the Parks Barometer Group and the center sample from adjacent opencut, described in the discussion of the Parks Barometer Group. Assays from the tunnel show the arsenic content of the samples twice the mercury content. One sample shows the reverse.

The light untouched portions of the above photographs represent crystalline stibnite; the white, calcite occurring in veinlets or vugs; and the red, cinnabar. The dark fragments are included country rock. The brown color represents altered country rock in the vein matter; and the yellowish color stibnite crystals with a coating of iron oxide.

The presence of stibnite crystals in the open vugs indicates their presence at the time of the deposition of the stibnite and the near-surface formation of the ore. Cinnabar is closely associated with the stibnite in these samples. Some quartz is present. The stibnite occurs in well formed crystals and is unaltered. The quartz sample described on page 16 is taken from the same outcrop. No evidences of replacement are seen in any of the quicksilver ores. Stibnite crystals are found in small stringers away from the central point of deposition.

Figures 1, and 2, are the back and front views of the same sample. This sample was taken as characteristic of the ore in the Fuller and Willis crosscut. The number of open spaces may be observed in the ore partly filled with calcite. The white mineral is calcite and the red cinnabar. The remainder of the sample is altered country rock. The cinnabar fills small cavities and fissures in the ore accompanied by a smaller amount of stibnite which is usually closely intermixed with the cinnabar. Other samples from the same locality present a banded appearance with a mineralization of stibnite and cinnabar in small stringers and lenses.

The calcite is regarded as secondary and apparently has formed along fissures caused by movement after the deposition of cinnabar. A more detailed description of the occurrence is given under the discussion of the Fuller and Willis prospect.

The accompanying photographs show the general nature of the quicksilver ore in the vicinity of Parks. The photographs are all slightly over one-half size. It is interesting to note the predominance of quartz in some of the samples and its absence in others. It is also interesting to speculate on the nature of the mineralizing solutions that deposited silica, cinnabar, and stibnite. It is suggested that the quartz was deposited in the main fissures and that the more volatile stibnite and cinnabar penetrated the finer breaks in the sediments. The realgar may have followed as a subsequent deposition as its occurrence is not general and has not been reported prior to the present examination.

The age of the sediments along the Kuskokwim River from Parks to Kolmakof, in which the main quicksilver occurrences are located, is described as Cretaceous. (6).

The occurrence of metacinnabar, the black sulphide of mercury, is reported in the Parks prospect (4), but was not observed during the visit to the property. Small amounts of native mercury may be observed in the creeks. Smith and Maddren (6) suggest that this may be caused as a result of previous wood fires in the locality.

Future development work on the quicksilver deposits of the Kuskokwim River Region should be done under the direction of a geologist. Intelligent prospecting only can determine the commercial value of the known occurrences, and the details of the geology of the district. There is a lack of surface outcrops. Smaller igneous bodies do not make an appreciable break in the topography. Prospecting should be carried on in the shattered area adjacent to the igneous intrusives.

SAMPLING

Special precautions should be taken in sampling a deposit of quicksilver. Care must be taken to include all of the sample taken, and an even amount of sample should be taken across the vein. Cinnabar tends to break in finer particles than the accompanying rock and a loss of fines in the sample would represent a loss of quicksilver. The walls of the mineralization are often not well defined. The sample should be taken at right angles to the walls; mistakes are often made in the measurement of the true width of an occurrence through disregarding this point.

Samples taken locally, by the owners, are assayed by retorting in a small improvised retort. The mercury content is calculated by the recovery from a known weight of sample. This method of assay is very practical for their operation.

QUICKSILVER PROPERTIES

THE N. L. WILSON PROSPECT 13-37

The following details of quicksilver occurrence were furnished by Mr. N. L. Wilson of McGrath. As no time was available, the property was not visited. The Wilson prospect is located on the south slope of Joaquin Mountain near the upper limit of the middle of three streams flowing from Joaquin Mountain into Tatalina River. The prospect is about 15 miles from Takotna.

Cinnabar was first found as float in the stream. The largest amount of float occurred as concentrate in the pot-holes of the stream bed. There is some quartz float showing gold. Two veins are reported occurring near a contact between a granitic intrusive and the sediments. The two veins are at right angles, the smallest having a general northwest strike. The dip of both veins is nearly vertical. The width of the small vein varies from 12 to 20 inches. Stringers of pure cinnabar are said to occur in the small vein. The larger vein is from 15 to 20 feet wide; cinnabar is observed by panning the larger vein. The outcrop is located just above timber line.

The only development work has been the facing of the smaller vein for a drift. Sluicing will be employed to remove the overburden. Water sufficient for this purpose flows, at a grade of 25 degrees, past the portal of this drift.

U. S. Geological Survey Bulletin 754, (5) discusses the general geology of this area. Joaquin Mountain is described as a quartz monzonite intrusion in sandstone, shale, grit, and conglomerate of Cretaceous and Tertiary age.

CANDLE CREEK

Mr. N. L. Wilson also reports the occurrence of cinnabar on Candle Creek, near McGrath, as a stringer of solid cinnabar, 2 to 3 inches wide, crossing the gulch near the upper limit of the dredging ground, and about one-half mile from the starting point of the Candle Creek dredge.

THE W. J. CRIBBEE PROSPECT

The discovery of cinnabar and stibnite, by Mr. W. J. Cribbee east of the Parks prospect and near the base of Barometer Mountain, has been previously mentioned. The prospect was not visited as it was impossible to obtain the exact location from Mr. Cribbee.

THE PARKS PROSPECT KA-82-10

The Parks prospect is the best known of the quicksilver prospects in the Kuskokwim River Region. The prospect was located by the present owner, Mr. E. W. Parks, in 1906 and has operated inter-

mittently since that time. Very little work has been done the past few years, which fact is due partly to the decrease in local demand for quicksilver. Details of the occurrences at the Parks prospect have been described by Smith and Maddren (2). The geology and main workings are described with detail. There has been little new development work. The old workings are, for the most part, inaccessible. This lack of interest is due to the attempt to interest outside capital in the enterprise, marketing difficulties, and the discovery of the Barometer Group of claims. Recent work has been confined to the Barometer Group.

Mr. Parks was absent from the property at the time of visit. Observations were made with the aid of Mr. Willis who was not entirely familiar with the prospect. A bench of Johnson-McKay retorts were constructed, and later dismantled, near the main tunnel entrance on the bank of the river. The retorts were set up very poorly. The location was thought too close to the bank of the river. The condensing end of the retorts were set within a few inches of the wall along the hillside. There could be no room for efficient condensation of the mercury vapor. Mr. Parks had evidently confined his retorting operation to the winter season and depended on the cold weather for condensation.

Present retorting of ore on the Parks prospect is done in a large sheet-iron gasoline container. Cordwood is used for fuel. As observed, the retort rested on a fire-box built of brick taken from the Johnson-McKay retorts. The gasoline-container retort stood on end. A charge of ore was placed in the retort and the mercury vapor condensed in iron pipes leading from the top of the retort.

The development work at the Parks prospect has not been planned to determine the extent of the quicksilver mineralization. No computation of the amount of ore is possible. It is difficult, therefore, to accurately predict the future of the Parks prospect, or to determine the size of plant that might be warranted by more development. At the present time the Parks prospect may be regarded as a small mine; capable of producing a small amount of quicksilver governed by the market for the product and the initiative of the owner. It is reported that there would be some question of title, if any outside capital were brought in to develop the Parks prospect, resulting from family misunderstandings. Too, Mr. Parks gives the impression of placing an unreasonable value on his holdings.

In the adit, locally called the main tunnel, only the probable trend of the ore can be determined. Drifting in either direction to determine probable ore reserves would be a logical course for further work. The retorts are located a few hundred feet down-stream from the adit. At the retorts the bank is about 100 feet high. Near the top of the bank a shaft has been sunk on the ore. The ore occurs near the contact of the intrusive and the sediments. The rock is

highly altered and shattered. For the purpose of getting some indication of the value of the ore, surface alteration making accurate sampling impossible, the side wall was cleaned near the bottom of the shaft and a 9-foot channel sample taken. Assay by Mr. Paul Hopkins: Gold...trace; silver...trace; mercury...1.21%. A further point to be guarded against in sampling is to avoid taking a sample which may possibly be salted by a concentration of cinnabar, by surface waters, in small fissures and open spaces in the ore. Cinnabar is not soluble in water but the alteration of the gangue material releases particles of cinnabar which may lodge in spaces along the course of surface water.

The main occurrence at the Parks prospect is located on claims known as the Bessie and the Alice. The other claim notices have been burned. There are few outcrops away from the river bank on the Parks prospect. The color of the cinnabar is somewhat obscured, in surface outcrops, by a coating of iron oxide. The discovery at Parks resulted from the observation of float in the creek bed and along the river bank.

A ditch line has been constructed, mainly for the purpose of sluicing at the retorts, that might possibly be used for a small development of water power.

THE AMMILINE PROSPECT

The Ammiline prospect lies north of and adjacent to the Parks prospect. Traces of cinnabar are seen in the shattered shale near a probable continuation of the Parks intrusive. Development work

consists of a shaft and a 60-foot adit. No ore is visible in the adit which was obviously driven to tap a possible continuation of the mineralization in the shaft. The shaft was inaccessible. The adit is located near the top of the bank on Parks Creek, approximately 40 feet below the collar of the shaft; and 100 feet, horizontal distance, from the shaft. Evidently the amount of cinnabar found was discouraging. It is reported that the prospect was abandoned and later included in the Parks' holdings.

THE PARKS BAROMETER GROUP PROSPECT

The Parks Barometer Group prospect is located on the south side of the Kuskokwim River, about 1 mile above the Parks prospect, and 1½ miles by trail from the river bank. Location notices, as in the Parks prospect, were destroyed by tundra fire. The main workings lie near the base of Barometer Mountain at the head of a small stream. There are several open-cuts, and an adit about 150 feet in length. From the adit there is a moderate slope toward the summit of Barometer Mountain. Between the adit and the river bank the land is flat and swampy.

The accompanying sketch gives an impression of the relationships at the workings. The first discovery of cinnabar, or perhaps realgar, was made by natives and communicated to Mr. Parks. The discovery was the finding of float in the stream bed, and subsequent open cuts located the ore in place. The adit, again locally called the tunnel, was driven 40 feet below the discovery in the open-cuts and near the foot of the slope. The ore found showed realgar and cinnabar, with a

small amount of stibnite occurring in a shattered and brecciated shale. The core of Barometer Mountain is classed as a monzonite by Martie (7). The location of igneous bodies near the Barometer ore is obscured by lack of surface exposures. The mineralization may be related to the main Barometer Mountain intrusive or to an off-shoot from this intrusive.

The walls of the mineralization are not well defined. The extent of the development work in the adit is not sufficient to determine whether the adit may be termed a crosscut or drift. The surrounding rock is highly altered and fractured. Minerals recognized were realgar, cinnabar, and stibnite in a gangue of country rock with some calcite and a small amount of quartz. The predominant mineral is realgar occurring in lenses, stringers along fracture planes, and radiating hairlike aggregates. It is difficult to distinguish between the realgar and the cinnabar, assays shown on the sketch indicating the arsenic content to be double the mercury content of the ore. No previous record of the occurrence of arsenic in the quicksilver ores of the Kuskokwim River Region is known.

The accompanying sketch shows the nature of mineralization in the adit, and the results of sampling. The ore apparently occurs in a zone of deposition determined by the extent of shattering from the intrusive.

About 200 feet from the portal of the adit an outcrop of ore has been uncovered which is different in nature from that in the adit. The surface shows massive crystalline stibnite with minor amounts of cinnabar. There is an abundance of realgar in the outcrop.

The gangue minerals consist of quartz with included angular fragments of argillite, calcite and country rock. Stibnite predominates. Surface prospecting does not show the connection of this ore with the ore in the adit. A suggestion as to the possible relationship is that the ore in this outcrop is in the form of a fissure vein or a filling in a larger break in the sediments. The less volatile products in the mineralizing solution, or those less soluble, as silica deposited in the major breaks in the rock and the more volatile, or more soluble, minerals penetrated the outer limits of the zone of shattering. With this hypothesis the ore in the adit may be explained as deposition toward the outer limits of the shattered zone.

Open spaces in the rock and ore has been given as evidence of near-surface deposition. There is abundant evidence of post-mineral movement; this factor should also be taken into consideration to account for the open spaces in the rock. Calcite has been deposited in some of these post-mineral fractures. This evidence does not necessarily point to other than near-surface deposition but is a fact for record.

The statement that the development work done has not been sufficient for a detailed examination of the geologic conditions is becoming oft repeated. In respect to the Barometer prospect only the observable facts concerning the ore occurrence can be recorded and inferences drawn as to the details of the occurrence. An example is the determination of the relationship of the ore in the stibnite outcrop with the ore in the adit. A logical course for further prospecting would be to drift in the adit and to trench between the two outcrops.

The discovery of ore at the Cribbee prospect and at the Parks Barometer prospect opens the possibilities of future discoveries along the contact of the Barometer Mountain intrusive and the sediments. Parks may be regarded as a center of quicksilver mineralization in the prospect stage of development.

Cinnabar and stibnite were, perhaps without question, deposited contemporaneously. The realgar may have been a result of contemporaneous, or later deposition by hot spring action. The realgar is observed as enclosing the stibnite, a factor that points to later deposition. The deposition of realgar in hair-like aggregates, and along some fracture planes, is, so far as observed, unaccompanied by stibnite. The occurrence of realgar is not general and has not been reported from the north bank of the Kuskokwim or any other occurrence of cinnabar with the exception of Rainy Creek. The fact suggests itself that realgar, as near Barometer Mountain, is deposited nearer the main intrusive yet there is no reported occurrence of realgar at Cripple Mountain. Little alteration of the realgar was noticed.

Local attempts to retort ore containing realgar are reported unsuccessful. The effect of arsenic in the metallurgy of quicksilver will be subsequently discussed.

THE FULLER AND WILLIS PROSPECT

The Fuller and Willis quicksilver prospect is located about a mile below the Parks prospect on the north bank of the Kuskokwim River. A well constructed trail leads from a cabin on the bank of the

river to the prospect, 1½ miles distant. At the prospect 2 cabins have been constructed to serve for prospecting the deposit at the foot and near the top of the hill.

The occurrence of the ore has the same general characteristics as the Parks prospect. The Fuller and Willis prospect is located on the west side of a probable continuation of the Parks intrusive. The surrounding rock is much shattered and slickensided; the cinnabar, with some stibnite, occurs in the shattered area near the intrusive. It is possible that the Fuller and Willis intrusive is not a continuation of the Parks intrusive but an apophysis of the same igneous body.

Cinnabar was first discovered on the Fuller and Willis prospect by the partners, Fuller and Willis, in the fall of 1907. Cinnabar, as float, was found in a stream bed and followed back to the site of the present prospect. The discovery resulted from interest created in quicksilver by the discovery of the Parks prospect. The Fuller and Willis prospect was first staked in 1907; lay idle and was restaked in 1910.

The ore occurs on a hillside on the east side of the creek about 500 feet above the level of the Kuskokwim River. The float, found along the bed of the creek and the hillside, indicated that the ore has a general north-south trend. A series of open-cuts and trenches disclosed the ore in place occurring in narrow veinlets, stringers and isolated particles in the accompanying rock. The ore minerals consisted of cinnabar and stibnite in a gangue of country rock, some calcite, and little quartz. The vein matter was heavily altered. The

zone of ore deposition has undergone intense surface alteration as well as the metamorphic action of the intrusive. The open-cuts have caved and the nature of the ore can be observed only by an examination of the dumps surrounding them. An adit, 80 feet in length, attempted to crosscut the ore at a depth of 40 feet below the surface outcrops. As the ore lacked defination no success was met with in the operation. There was no sign of igneous rock in the adit which throughout showed the shattered and brecciated shale with no cinnabar. Ore in a later crosscut showed it to be dipping toward the hill, east, at an angle of 30 degrees. Dip and strike can only be determined approximately due to the contortion of the sediments. On the other side of the creek valley some float was found but subsequent open-outs failed to disclose any ore in place.

The only ore in place exposed at the present time is in the Fuller and Willis crosscut. The sketch and photograph on page 37 shows the nature of the occurrence. There is evidence, in the form of slickensides, of movement after ore deposition. The ore lies on top of an altered igneous rock and narrows from 24 to 3 inches in width. The face of the crosscut, and the right wall, are totally slickensided and, according to Mr. Gordon Bettles who did work on the property after the examination, the ore does not extend beyond these slickensided faces.

Sampling in the crosscut indicated that cinnabar existed in the igneous rock as well as in the vein. This locality is heavily altered and this occurrence may be accounted for by a concentration of cinnabar

in the small fissures in the igneous rock, by surface waters, from the weathered vein above. It is also possible that the igneous rock may be a pre-mineral sill. The nature of the alteration of the igneous rock, from the outside toward the center, is shown in the photograph; the cleavage indicates movement. Surface outcrops are not exposed to trace this rock in its extent. Mr. Paul Hopkins identifies the igneous rock as follows: "The sample may be monzonite as you suggest. Prof. Patty (Alaska Agricultural College and School of Mines) would classify it as trachyte. There is little or no quartz present but I could not classify the feldspar."

The igneous rock weathers to a yellow color and resembles sandstone (arkose). A similar rock outcrops near Sleitmute. Between the Fuller and Willis and the Parks prospect an outcrop resembling the Parks intrusive is noted. It is thought that this latter rock is the mineralizing agent and that possibly the rock in the crosscut is a sill or flow of another age.

Seven claims comprise the Fuller and Willis holdings, the worldly possessions of two very old prospectors. The future of the Fuller and Willis prospect cannot be controlled by the present owners as they are unable to do any great amount of further work on their property. If a future quicksilver industry is established on the Kuskokwim River the Fuller and Willis prospect will be included in the field of general prospecting.

NICK MALLICK PROSPECT

The Nick Mallick prospect lies north of and adjoins the Fuller and Willis prospect. Development work consists of several opencuts, now caved, on a sparse scattered occurrence of cinnabar in brecciated shale. An adit was driven below the open-cuts but showed no ore. The prospect was abandoned by the owner, Mr. Nick Mallick, and restaked by Fuller and Willis. The Mallick prospect indicates a north south trend of the Fuller and Willis ore.

THE THRIFT (DECOURCEY), AND CORONA PROSPECTS

During the visit to the placer camp on Crooked Creek Mr. A. E. Kirk, of the Corona quicksilver prospect, was interviewed concerning the Corona prospect and the Thrift Mine. As no one was at the Corona prospect, the time being limited, and according to Mr. Kirk no ore was exposed on either prospect, these properties were not visited. The information concerning the occurrence was obtained from Mr. Kirk.

The Thrift Mine was located by DeCourcey in 1919. Ore was mined from an open-cut 60 feet long and 12 feet deep. The total amount of quicksilver recovered was 42 flasks. It is reported that the ore pinched out in the open-cut. Mr. C. P. Lindfors took a lease on the property and cleaned up all of the ore on the Thrift dump, and open-cut, as well as all of the float on the hill. This ore was retorted at the Corona prospect this spring with a recovery of 35 flasks. The country rock is a shattered sandstone near an intrusive. Many faults are reported. Moss and vegetation obscures outcrops in the vicinity. As no assessment work has been done on the Thrift property for the past 2 years, it is presumably open to location.

The Corona prospect, owned by C. P. Lindfors and Mrs. Fullerton of Flat, lies adjacent to the Thrift Mine. A. E. Kirk and C. P. Lindfors are working under a lease and option from Mrs. Fullerton. There is some question regarding the title. The Brink brothers of Flat state that they will contest the ownership if any ore is discovered.

Equipment, including 6 wood burning Johnson-McKay retorts, was moved from the Thrift Mine to the Corona prospect. There is plenty of wood available for retorting purposes, and timbering if needed. The charge for each retort is 300 pounds, this charge being changed every 12 hours, total retorting capacity is 3600 pounds per 24 hours. Ore retorted this spring on the Corona prospect, by C. P. Lindfors and A. E. Kirk, had a recoverable value of 1.6%. Approximately 60 tons of ore was treated to recover 35 flasks of quicksilver. The quicksilver was shipped, via Bethel, to Seattle for disposal. Returns received are to be used to pay outstanding debts on the property.

Several small stringers of cinnabar, dipping at 70 degrees, were exposed on the Corona prospect by open-cut. An adit is being driven from the hillside to reach a possible continuation of these stringers at a depth of 300 feet. The owners express the hope of finishing the adit by spring and that the result will "make or break" the property. It was advised that they confine their efforts to ore in place, or along the strike of the ore near the surface. The advice came too late, 150 feet of adit having been completed. There is no water power available in the locality.

Mr. Thomas Golby (8), formerly owner of the Marfa, and Mariposa quicksilver mine, Terlingua County, Texas, examined the Thrift Mine in 1924. He states, "On getting on the ground I found that there was no ore blocked out and none on the dumps. In the open-cut on the King and Queen claims a vein was exposed some 2'4" wide including a narrow ribbon of rich cinnabar. It was from this ore that the 43-1/3 flasks were obtained. * * * On other claims the showings were not encouraging."

As the Thrift and the Corona properties were not visited, an accurate speculation as to their future cannot be given.

THE GORDON BETTLES PROSPECT

Gordon Bettles' cinnabar prospect is located on the north bank of the Kuskokwim River about 3 miles below the now abandoned town of Kolmakofsky. This point marks the site of the original discovery of cinnabar, by the Russians, in 1838. The ore was exposed in a lens on a high bluff above the river. Prior to 1900 a Mr. Lind (1) sent a shipment of this ore to the States. Later this prospect was held by the late "Cinnabar McDonald. Mr. McDonald built a scaffolding on the bluff and removed all of the ore in sight. This ore was retorted in a small oil-barrel retort and 2 flasks of quicksilver obtained and sold locally to placer miners. After the death of Mr. McDonald the prospect lay idle until staked by Mr. Gordon Bettles and his associates. It is reported that their holdings comprise over 100 claims.

No ore was observed in place on the property. Large quantities of well worn float has been found along the top of the bank above the Kuskokwim. Development work has been carried on according to local opinion of procedure. The surface rock is highly fractured and slickensided. Shafts were started in the region where float was the most abundant. Working on the theory that the ore had "blown up from below somewhere," wherever float was observed they endeavored to follow fracture planes defining them as walls along which the supposed "blowout" had taken place. No ore was found in the shafts. As the construction of the shafts reached the limits of the shattered zone, water was encountered which froze in the shafts. The shaft-sinking operation was abandoned.

An adit was driven, for 160 feet from the river bank, in the general direction of the shafts. After passing through the surface rock the adit passed through arkose, or graywacke. The rock is not appreciably fractured and no indication of ore was encountered. Mr. Hopkins states in regard to the rock in the adit, "The sample may be arkose. Prof. Patty states that it appears to be a graywacke. Under the microscope the fragments are difficult to identify but may be altered feldspars. There are small dark inclusions which are probably oxides of iron and manganese. The sample gives a distinct test for manganese in the wet way." Dall (9), in a record of early explorations on the Kuskokwim, records the existence of manganese ore but fails to state the locality. The above is the only present indication of manganese noted. A band of black mineral from the face of the adit was identified by Mr. Hopkins as bony coal or oil shale.

The point of the original discovery of cinnabar, in place, was not touched in the recent development work. A detailed description of this occurrence is given by Maddren (10). The adit is located several hundred feet upstream from this point.

Cinnabar float as found is well rounded and occurs over a wide area. Money and efforts would have been better expended in prospecting for the original lead. The creek has sufficient water for a sluice-head which would enable the sluicing of the overburden along the strike of the ore-bearing formation. Cinnabar would be recovered in a sluice box and its recovery might be an aid in caring for the expense of the operation. The future would then be a matter of direct prospecting. The occurrence of the unshattered rock in the adit may be an indication of limited extent to the deposit. The general strike of the formation is NE. The adit is more in the nature of a drift than a crosscut.

Assays, high in mercury content, were obtained from the float found on the property and stimulated interest in the development.

The work on the prospect has been financed by capital raised in Ketchikan by Mr. E. C. Howard. It is reported that $10,000 was raised and expended. A great deal of work has been accomplished for this amount but nothing has been accomplished toward showing the nature or extent of the ore-bearing rock, or toward the future of the prospect unless the adit is used as a basis for direct future exploration warranted by surface showing. Matters have been complicated by the death of Mr. Howard. It is recommended that, as the property represents an investment, the water be utilized from the creek for sluicing to un-

cover the rock along the strike of the discovery, at the least possible expenditure.

RAINY CREEK

Rainy Creek is a tributary of the north fork of the upper Eek River. Mr. Herman Oman, of Akiak, reports the occurrence of a small vein of cinnabar associated with a larger deposit of realgar. Some interest was taken in arsenic in this locality by Mr. Frank Joaquin of Takotna. Mr. Joaquin made no mention of the cinnabar content of the ore.

PLACER CINNABAR

Cinnabar has been recognized in the placer clean-up in the Long, Innoko, Iditarod, and Lower Kuskokwim placer districts, and on Seward Peninsula. The amount recovered was not commercial. The significance of cinnabar in the placer districts is the occurrence in regions of granitic intrusives.

METALLURGY

There is ample wood fuel available for retorting the quicksilver ores of the Kuskokwim River Region. It is not improbable that the coal resources of the region will be available, at some future time, for this purpose. Wood is perhaps the most practical fuel as it is available in the immediate vicinity of the prospects and may be secured with little expense.

Bulletin 222, United States Bureau of Mines, "The Metallurgy of Quicksilver," by L. H. Duschak and C. N. Schuette, 1925, gives a comprehensive discussion of quicksilver metallurgy. Quicksilver ores of the Kuskokwim River Region are adaptable to direct-furnace roasting. Stibnite and realgar are liable to influence the treatment of the ores containing them. Duschak and Schuette state (pp. 16-17), "Compounds of arsenic and antimony are about the only volatile materials other than sulphur and bituminous matter that are liable to influence the metallurgical behavior of the ore. Of the two metals, arsenic is the more liable to cause complications, as vapor-pressure curves of arsenic trioxide and mercury are not widely different. * * * The boiling point of mercury is about 357° C., and that of arsenic trioxide * * * 355° C. Evidently when arsenical quicksilver ore is roasted in the presence of oxygen, the arsenic trioxide will distill over and condense with the mercury in the condenser system." The bulletin further mentions an attempt to treat an ore, containing arsenic, in Oregon. "The condenser product consisted of a grey soot, containing little free-running mercury and as much as 70 per cent arsenic trioxide. Attempts to recover the mercury by treating this soot in a retort were not successful, which might have been foreseen from the vapor pressure relationship * * * . Some experiments * * * indicated that separation was possible by pulping the soot with 5 to 10 parts by weight of water, and gently agitating the mixture. The free mercury gradually coalesced and settled to the bottom, the arsenic trioxide remaining in suspension."

The suggestion is made that a part separation of these products could be made in a tile-pipe condenser by suitably controlled condensing.

Stibnite has a lower vapor pressure than arsenic of mercury so a separation in the condenser should be possible. The quicksilver ores of the Kuskokwim River Region, containing appreciable quantities of stibnite or realgar, present a metallurgical problem that would necessarily be solved by experimentation before the establishment of a large plant in the district. Usually these ores have stibnite as the predominant mineral and the arsenic content in the realgar appears to be twice the mercury content. The important part of the metallurgical plant would be the condenser system. There are several types of furnaces or retorts that might be used. Some of the ore would give no trouble in treatment.

MARKET-USES

The uses of mercury are: As a detonator for explosives, medicine, paints and pigments, electrical apparatus, mercury boiler, chemical manufacture, storage batteries, and amalgamation of gold and silver ores. From a previous investigation it is thought that market for quicksilver, produced in the Kuskokwim River region, would be in the manufacture of explosives in the state of Washington. However, the question of market for this product is one to be answered in the future and under the then existing conditions. At the present time the market is steady, the last market quotation; Engineering and Mining Journal, November 27, 1926; was $99 per 75 pound flask. San Francisco, $98.67. San Francisco is the primary quicksilver market in the United States (11).

CONCLUSION

The quicksilver resources of the Kuskokwim River region have not been sufficiently prospected and developed to indicate the extent and possible commercial value of the deposits, or to warrant the establishment of a large plant for treatment of the ore. An examination of this resource, at the present time, is not likely to interest outside capital in its development for the following reasons: Immediate production is not possible, except on a small scale by make-shift retorts. The installation of a plant would necessarily be preceded by extensive prospecting, and development work, to block out sufficient tonnage to warrant its construction. There is no appreciable tonnage of quicksilver ore blocked out on any of the properties. A storage of quicksilver would be necessary as the steamer runs only during the summer season twice yearly. The isolation of the district and consequent difficulty in shipping the product and receiving supplies increases the expense of operation. Mining activity, in an isolated district, has a fascination for the operator but the returns to be received by the investor must show real possibilities.

In many respects the region is ideal for the industry. The climatic conditions, supply of timber, ease of mining, and location near water transportation would be an aid to the operation.

A prediction of the future of the quicksilver industry in the Kuskokwim River region can be given. The exhausting of the domestic supply of quicksilver in the United States, or an increased demand for the metal, or investigation of the resource as a war-mineral, will

turn attention to undeveloped resources. It is probable that a large part of the attention will be turned to the ores of the Kuskokwim River region and a thorough investigation follow. There is another possibility. The occurrence warrants further development work and prospecting. The industry, for a one or two man operation, is already established. It is possible that sufficient ore may be discovered to warrant the attention of outside interests. A small-scale operation might, under efficient management, grow in size if the deposits prove to be extensive.

It has been the aim of this report to present the observable facts concerning the occurrence of quicksilver ores in the Kuskokwim River Region, Alaska. In closing a word of acknowledgment and appreciation must be given to the owners and to other inhabitants of the district for courtesies extended during the visit to their country.

ESTIMATED TOTAL PRODUCTION OF QUICKSILVER FROM THE KUSKOKWIM RIVER REGION

Parks Prospect: 6 flasks produced in 1925. 2 flasks produced in 1926. Total production 65 flasks. Authority--letter from E. W. Parks.

Fuller & Willis: Total production 2 flasks. Authority--Mr. Willis.

DeCourcey Mine: Total production 43-1/3 flasks. Authority--letter from Thos. Golby. M+ 13-11

Corona Prospect: Total production 35 flasks. Authority--A. E. Kirk.

Cinnabar McDonald: Total production 2 flasks. Authority--Mr. Ezra Rabideau, former partner of McDonald. Prior to Mr. McDonald's ownership a Mr. Lind is reported to have spent 2,000 dollars in shipping some of the ore to the States, but lost on the enterprise. (Spurr, J. E. in U. S. Geological Survey Twentieth Annual Report, pp. 261-262, 1898.

SUMMARY

	Flasks
Parks Prospect.....	65
Fuller & Willis.....	2
DeCourcey.....	43-1/3 (Thrift)
Corona.....	35
Cinnabar McDonald.....	2
Total.....	147-1/3

In addition to this is added the output of Mr. Lind.

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