THE SHUNGNAK REGION, KOBUK VALLEY.

By Philip S. Smith and Henry M. Eakin.

INTRODUCTION.

In the central part of the Kobuk River basin there is a mineralized area in which placer gold has been mined and copper, gold, lead-silver, and asbestos deposits prospected. These deposits had not been studied by members of the Survey before 1910. The region was the scene of a stampede of gold seekers in 1898, but although a few thousand dollars in gold was produced annually for several years, in 1910 the district was nearly deserted. Many problems of importance both to the prospector and to the geologist still remain to be solved by more careful examination, but until such studies are made it has seemed expedient to set forth the general geologic observations and to point out some of the important subjects that require further investigation.

The region considered in this report lies north of the Arctic Circle, adjacent to the 157th meridian. Particular attention is given to the region between Kogoluktuk River on the east, Shungnak River on the north and west, and the Kobuk on the south. Although this small area is the place where minerals of economic importance have been found and is directly the subject of this report, a somewhat larger region is described in order to show the setting or general relation of this field to the geology and geography of the central part of the Kobuk Valley. A still broader and more comprehensive account of the features of northwestern Alaska is in preparation and will serve to extend the area covered by this more detailed report.[1]

GEOGRAPHY AND TOPOGRAPHY.

Figure 19 shows the general location of the area, which for convenience will be called the Shungnak region. The settlement from which this name is taken is about 250 miles from the mouth of the Kobuk, measured along the crooked course of the river. Measured

[1] Smith, P. S., Geology and mineral resources of northwestern Alaska; in preparation.

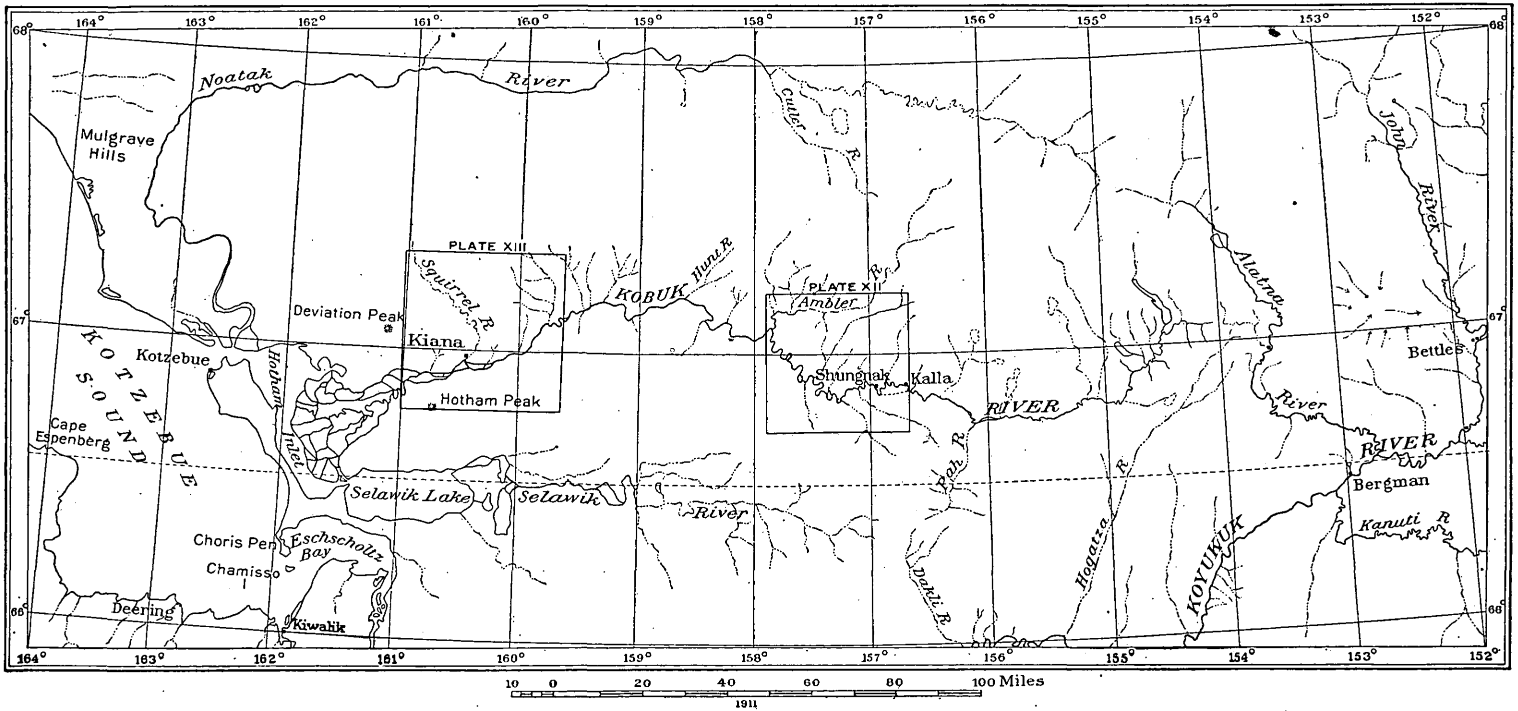


FIGURE 19.—Sketch map of part of northwestern Alaska, showing location of Shungnak and Squirrel River regions.

in a straight line, however, it is only a little more than half that distance. Throughout this distance the stream is navigable for boats drawing as much as 3 feet, and an even greater draft could be carried if it were not for shallow bars at the mouth of the river and the crooked, shifting course of the channel farther upstream. The best approach to this region is by way of Kotzebue Sound and Kobuk River, for a mail boat from Nome touches at Kotzebue three times a month, and launches and barges can be taken there for points up the river. A description of the method of reaching Kiana, at the mouth of Squirrel River, is given on pages 306–309 and applies to reaching Shungnak as well, but the river trip continues for another 175 miles and consequently takes from 5 to 10 days longer. In 1901 Mendenhall reached this region by way of Koyukuk and Alatna rivers, and this route has been traveled by natives and prospectors for many years. This is, however, a roundabout way of reaching Shungnak and is not suitable for bringing in supplies, etc. In 1910 the writers reached the region by going overland from the Koyukuk near the mouth of the Hogatza, but this is not a direct route and is not a feasible way of reaching the Kobuk except during the winter months.

RELIEF.

The larger-scale map (Pl. XII) shows more details of the Shungnak region than are given on the sketch map (fig. 19). Although the topography of the map shown on Plate XII is in a measure obscured by the patterns used to denote the several geologic formations and groups, the major features of the relief are evident. From this map it will be seen that there are five more or less distinct belts of relief. The most southern of these belts is a range of hills, averaging about 2,000 feet in elevation, succeeded toward the north by the Kobuk Valley Flats. These are in turn succeeded by a narrow range of hills reaching heights of about 3,000 feet in the eastern part and gradually decreasing in altitude toward the west. North of these hills is a lowland 3 to 4 miles wide which is succeeded toward the north by rugged mountains.

The southern hills, called by Mendenhall in 1900 the Sheklukshuk Range, form only a narrow highland between the Kobuk lowland and the Selawik lowland on the south. These hills have been only slightly explored, but they are probably not more than 10 to 15 miles wide and trend in a general east-west direction. The higher points reach elevations of 4,000 feet, but the average elevation is only about half as great.

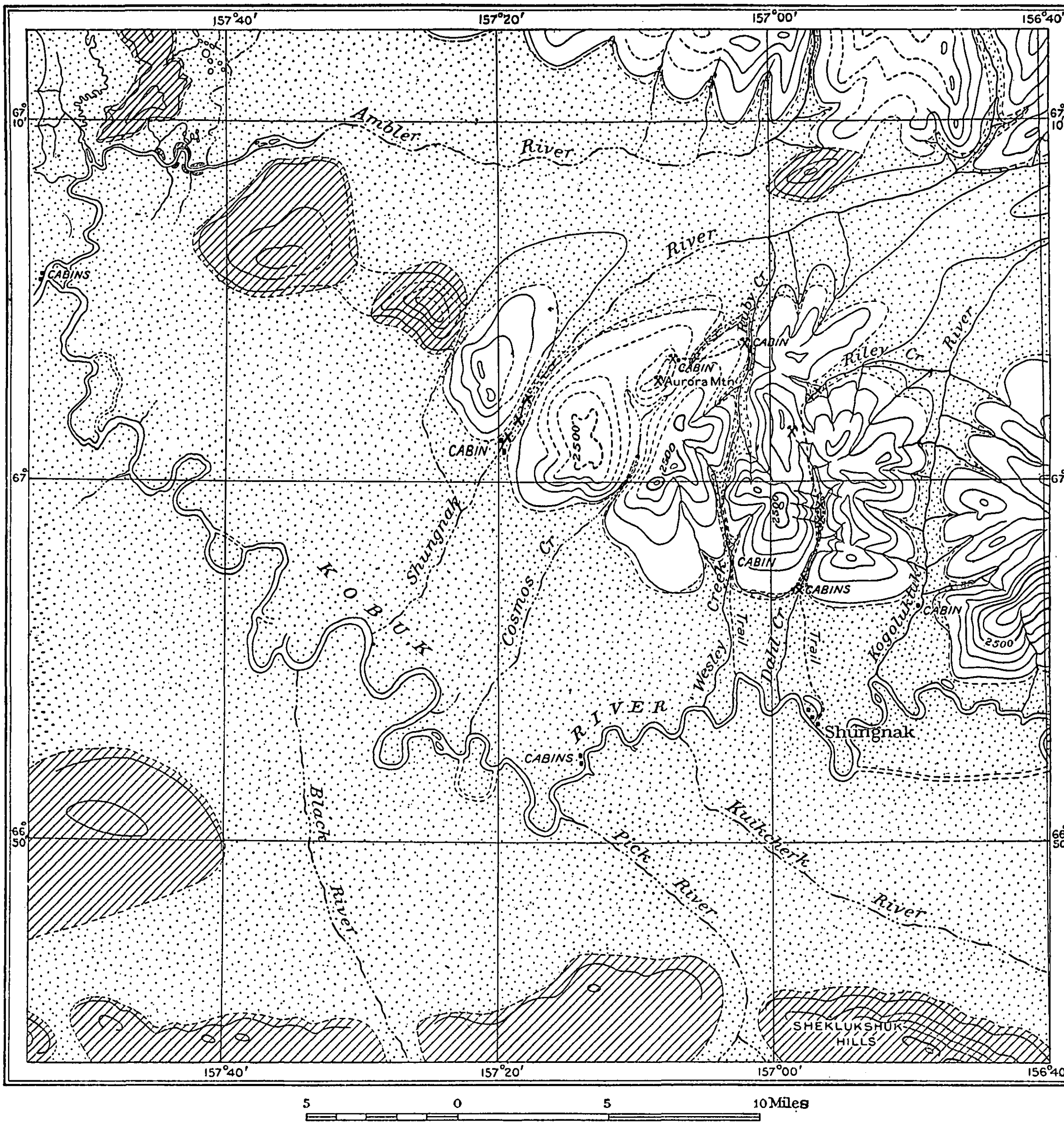
The Kobuk lowland, so called from the large river which traverses it, is from 10 to 15 miles wide and has an average elevation of 200 to 400 feet above the sea. The highlands which bound this lowland to the north and south rise rather abruptly from the nearly featureless plain and emphasize by their sharpness the plain's slight relief. The flood plain of the Kobuk occupies a width of several miles along the central part of the lowlands, distinguished by the occurrence of numerous bayous and crescentic lakes marking former courses of the river. The higher parts of the lowlands on either side slope from the bordering hills toward the river, descending to the slightly lower level of the flood plain with more or less distinct bluffs. The surface of such parts of the lowlands is not altogether smooth, as locally there are lakes of irregular shape and small size.

North of the Kobuk lowland, as already noted, a range of hills, in places 3,000 feet or more in height, rises abruptly and forms a strip of highland 10 to 12 miles wide toward the east but gradually narrowing toward the west as it approaches the junction of the Kobuk and the Ambler. No name has been given to these hills, though they appear to be the continuation of Lieut. Stoney's Schwatka Mountains.[1] Owing, however, to the misconception that existed as to the general topography and to the fact that the name as applied does not separate this front range from the main range to the north, it has been proposed to call the feature above described the Cosmos Hills. This name is given because Stoney's winter camp on the Kobuk was called Fort Cosmos and the stream near his camp, which heads in these hills, was also called by this name. These hills are characterized by a general east-west trend but are considerably dissected, so that the higher points are irregularly distributed.

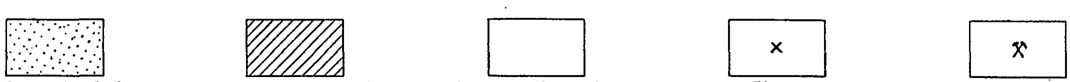
Beyond the Cosmos Hills is a lowland not so extensive as the Kobuk lowland but still a marked topographic feature. To the west this lowland is drained by Ambler River, but to the east it is traversed by Shungnak and Kogoluktuk rivers and it persists even farther east, if scattered observations and reports are to be trusted. Even where it does not contain a large stream this lowland is still preserved and it is believed to be a significant structural feature. A particularly clear illustration of a portion of the lowland without existing streams is shown by the area between Ambler and Shungnak rivers. At this place the distance between the two streams is about 3 miles and the elevation of the divide between the two is not over 200 feet. In order to have a short descriptive term for this feature it will be called the northern lowland.

North of the northern lowland the mountains rise steeply to heights of 3,000 to 4,000 feet above the main streams, so that their relative relief is strong. Only the southern margin of these mountains is included within the mapped area. From a study of Stoney's map it is evident that this highland belongs to the group of hills named by him the Baird Mountains, and by this name they will be

[1] Stoney, G. M., Naval explorations in Alaska, Annapolis, 1900, map.



LEGEND



Sand, gravel, and silt, fluviatile, lacustrine, and glacial origin

Mesozoic-Tertiary rocks Sandstones, conglomerates, and shales

Metamorphic complex Schists, limestones, slates with some sheared igneous rocks

Placer

Lode prospect

GEOLOGIC SKETCH MAP OF SHUNGNAK REGION.

called in this report. Serrate crest lines and deeply intrenched valleys characterize these mountains and give a rugged, inhospitable appearance to the landscape.

DRAINAGE.

The drainage of the Shungnak region presents a number of different types of streams, many of which have a complex history. The master stream is the Kobuk, which heads in the hills far to the east and flows westward, receiving tributaries that head in the highland areas along its course. The Kobuk is a large river, having a width near Shungnak of 600 to 800 feet and a current of 2 to 4 miles an hour; the depth varies, being in many places as much as 15 to 20 feet. It has a meandering course through the lowland and many of its deserted channels form sloughs and oxbow lakes. The strength of the current is sufficient, however, to make it an easy river to descend, and above the delta even one unfamiliar with the river finds little difficulty in avoiding blind channels. Within the mapped areas there are no rapids or treacherous stretches.

Kogoluktuk, Shungnak, and Ambler rivers are the largest tributaries to the Kobuk from the north. All these streams head in the Baird Mountains and flow in glacially sculptured valleys, receiving many tributaries until the southern face of the mountains is reached. Thence they traverse the northern lowland and then flow in rocky canyons through the highlands of the Cosmos Hills, later traversing the Kobuk lowland to join the main stream. This course, transverse to the dominant geologic structure and also to the topographic structure, indicates the complex history that made such drainage possible. Some suggestions as to the origin of this peculiar drainage are given on page 287, where the course is explained as in large measure due to glaciation and structure.

All these streams carry large volumes of water during the early spring and summer and with the exception of the easternmost are not fordable during ordinary seasons. Owing to their heading in the high mountains they derive a large amount of water from melting snow and so maintain a more constant flow than the streams not having a similar supply. In the highlands their courses are comparatively straight, but in the Kobuk lowland some of them meander in irregular curves. Low falls and rapids occur on these streams as they traverse the Cosmos Hills; in fact, the name Kogoluktuk is said to mean in the native language "river with falls."

The larger streams entering the Kobuk from the south have not been explored, and little is known of their geography except from the reports of natives. Kuikcherk, Pick, and Black rivers are the three largest streams, and probably all of them head in the Sheklukshuk

Range. They are smaller than the northern tributaries because they drain smaller basins and also because the lower hills in which they head are not so effective in snow storage as the higher Baird Mountains to the north. In their lower courses these streams are rather sluggish and their water is in large measure derived from the tundra through which they flow. The dark swamp water is suggested by the name Black River, given by Stoney in 1886 to the westernmost of these streams.

In addition to the larger tributaries there are many smaller streams originating in the highlands and entering the main stream independently or joining one of the larger branches. The streams from the Cosmos Hills show many intricacies, as they join the transverse-flowing streams, such as Kogoluktuk and Shungnak rivers. Thus many streams heading on the north side of these hills flow northward to the northern lowland or a transverse stream, where they turn abruptly and cross the range and thus enter the Kobuk. One of the best examples of this feature is Ruby Creek, which heads within 3 to 4 miles of the Kobuk lowland but flows northward for 7 to 8 miles before joining the Shungnak; thence its waters are carried southwest for about 20 miles before reaching the Kobuk. This condition prevails in spite of the fact that near its head there is to the south a pass not over 400 feet above the Kobuk, which has evidently been occupied by former drainage.

Passes similar to the one described at the head of Ruby Creek, although at somewhat higher elevation, are found at the head of many of the other streams. For instance, Cosmos Creek heads practically on the southern slopes of the northern lowland but flows southward across the range to join the Kobuk. These examples serve to show that many of the valleys through the Cosmos Hills have been eroded by agencies other than the existing streams and that the present rivers have had their courses in large measure determined by this earlier topography. It is believed that these passes and transverse valleys are best explained not as due to antecedent streams which persisted or failed to cross the Cosmos Hills during the possible deformation of the region but as due to drainage modifications induced by glaciation in the Baird Mountains and contiguous territory in comparatively recent time.

CLIMATE.

There are but few data as to the meteorologic conditions prevailing in the Shungnak region, though there are more observations here than in other parts of the Kobuk Valley. Mendenhall summarized the available temperature observations as follows:[1]

[1] Mendenhall, W. C., Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska: Prof. Paper U. S. Geol. Survey No. 10, 1902, pp. 54-55.

Summary of temperature observations on Kobuk River, 1885–1899.

Date	Minimum.	Maximum.	Mean.	Authority.
1885.				
July	32	70	49	Lieut. Stoney.
August	32	68	47	Do.
August	35.5	68	48	W.L.Poto, U.S.Geol. Survey.
September	5	69	39	Lieut. Stoney.
October	−4	46	16	Do.
November	−44	15	−9.5	Do.
December	−65	29	−12.4	Do.
1886.				
January	−70	31	−12.4	Do.
February	−65	26	−22.5	Do.
March	−38	36	−3.8	Do.
April	−22	49	13	Do.
May	14	65	35	Do.
June	32	74	49	Do.
1898.				
July			57.6	McElwaine.
August			50.15	Do.
1899.				
February	−67	10	34.27	

As the mean annual temperature of the region is far below the freezing point, the presence of ice exerts an important control on the length of time that placer deposits can be worked. Snow may be expected in the highlands during almost any month of the year. According to Cantwell [1] the hills west of the Ambler were snow covered on August 9, 1885, and in 1910 the hills above 2,000 feet in elevation east of the Kogoluktuk were covered with snow on July 20. In 1885, according to Stoney, [2] ice had formed on most of the small streams by September 23 and along the main streams by the 25th. By October 18 the main river was frozen so that it could be crossed. Freezing continued until in February the ice had a maximum thickness of 5⅓ feet. On May 19, 1886, the ice along the banks of the Kobuk began to crack, and by June 6 of that year the river was free of ice. Joseph Grinnell,[3] who spent the fall of 1898 and the spring of 1899 a little west of the Shungnak region, reported that on October 15 the Kobuk was full of ice and by the 21st the ice was a foot thick. In the following spring the ice began to break on May 24, and by the 31st the river was free. It should be noted, however, that while the river itself breaks by June 1, Kotzebue Sound remains frozen until the first week or so of July, and therefore communication with the outside world is seldom established before the later part of July or even the first of August.

No instrumental determination of the precipitation is available and but few observations even as to the number of rainy days have been made. W. L. Poto,[4] a member of the Mendenhall party, is

[1] Cantwell, J. C., Exploration of the Kowak River, Alaska: Report of the cruise of the Revenue Marine steamer *Corwin* in the Arctic Ocean in the year 1885, Washington, 1887, p. 47.

[2] Stoney, G. M., Naval explorations in Alaska, Annapolis, 1900.

[3] Grinnell, Joseph, Gold hunting in Alaska, Chicago, D. C. Cook Publishing Co., 1901, pp. 79–84.

[4] Mendenhall, W. C., op. cit., p. 55.

quoted as recording 15 rainy days during August, 1885, and McElwaine[1] reported for June, July, August, and September, 1898, 16, 11, 18, and 12 rainy days, respectively. During 1910 the authors were in the Shungnak region from July 22 to August 11, inclusive, and the number of rainy days and duration of precipitation were as follows:

Precipitation in the Shungnak region, July 22 to August 11, 1910.

July 22	Showers and rain.
July 24	Rain in evening.
July 25	Rain all day.
July 26	Rain all day.
July 28	Mist and rain; heavy rain in evening.
July 29	Rain.
July 30	Heavy mist in morning.
Aug. 2	Rain.
Aug. 3	Rain in morning; showers in afternoon.
Aug. 4	Heavy mist and rain.
Aug. 5	Rain and heavy mist.
Aug. 6	Rain.
Aug. 7	Rain.
Aug. 8	Threatening in morning; cleared later.
Aug. 9	Rain all night; foggy in morning; showers in afternoon.

From this it will be seen that of the 21 days spent in the Shungnak region 15 were marked by showers or rain. It should, however, be noted that last year was exceptionally wet, and therefore the figures by no means represent average conditions. There is, on the other hand, little room to doubt that most of the precipitation comes during the summer, so that July and August are usually the wettest months

VEGETATION AND ANIMALS.

Owing to its high northern latitude the Shungnak region has a typically subarctic flora. Timber is found mainly along the larger streams and does not extend on the mountain sides to any considerable elevation. Spruce and birch are practically the only trees that grow to sufficient size for lumber, and only spruce is large enough for cabin logs or sluice boxes. Stoney[2] notes that the largest spruce tree seen by him in the whole Kobuk Valley was near Cosmos Creek. It measured 80 inches in circumference at the base and 68 inches at a height of 6 feet above the ground and was 80 feet tall. This was an unusually large tree, however, and the average spruce does not exceed a foot in diameter. In the higher parts of the region even spruce is wanting, and the prospector is compelled to resort to scrubby willows and alders for fuel.

Berries are exceedingly abundant on the unforested slopes of the highlands and on many parts of the lowlands. Blueberries are

[1] Mendenhall, W. C., op. cit., p. 54.

[2] Stoney, G. M., op. cit., p. 83.

particularly plentiful on the higher parts of the Kobuk lowland where trees and bushes are absent. Salmon berries are found on all parts of the lowlands and are so plentiful that people and animals depend on them for food. Some currants and cranberries were seen, but they are not as abundant as the two other kinds of berries.

Grasses for stock are found on the lower hill slopes and on the surface of the lowlands. Mendenhall[1] notes rye grass, blue grass or redtop, and a variety of bunch grass as the more usual species. Horses show a strong liking for the so-called goose grass, an equisetum, but it seems to contain little nourishment. The grasses flourish particularly in the neighborhood of the old settlements and camps and quickly spring up in the burned-over areas. None of the grasses seem to stand frost well and all appear to wither and lose their strength-giving qualities as soon as freezing nights begin. This is probably due to their exceedingly quick rank growth.

There are but few game animals now in the Shungnak region except bear. These are found mostly back in the hills or along the unfrequented streams. Both black and brown bears are reported. Caribou have been shot at several places within the region, but they are not numerous and the natives have to travel far to obtain their supply. There is, however, a herd of reindeer in the Sheklukshuk Hills and strays from this herd have probably been taken for wild caribou. Small fur-bearing animals, such as fox, mink, and marten, are occasionally caught, but they are found in no great numbers and are becoming scarcer each year.

Fish are abundant in almost all the streams. Salmon is one of the most important food supplies. These fish are particularly abundant in the Kobuk and during the last week of July and the early part of August native fishing camps are established at several places, especially just above the mouths of Kollyoksok and Black rivers. A large white fish, known to the natives as "she," is also caught in the Kobuk and is much prized for food. Grayling can be found in almost all the side streams and mountain brooks. Trout, probably salmon trout, weighing as much as 3 or 4 pounds each were caught in Dahl Creek and are reported from many of the other streams.

Many birds are found in the Shungnak region. Most important for food are ptarmigan, spruce hens, and ducks. Owing to the cold climate these can be kept for months during the winter without spoiling. Beside these game birds many song and other birds are either summer visitors or live permanently in the region. Grinnell[2] gives a list of the birds wintering in the region near the mouth of the Ambler, noted by him, as follows: Pine grosbeak, redpoll, spruce grouse, ptarmigan, three-toed woodpecker, jay, and chickadee. The

[1] Mendenhall, W. C., op. cit., p. 57.

[2] Grinnell, Joseph, Gold hunting in Alaska, pp. 58-60.

same writer states that the first bird from the south arrived in 1899 on April 22. After that date many familiar birds, such as sparrows, thrushes, sandpipers, robins, loons, and blackbirds, came to the region for the summer.

SETTLEMENTS AND POPULATION.

In 1910 there were only about a dozen white people in the entire Shungnak region, though in 1898, when a rush to the Kobuk was in progress, there were several hundred. The only village at the present time is Shungnak, where the United States commissioner and recorder for the district formerly lived and where a post office is maintained during the six winter months. A Friends mission has also located there. The town is the headquarters of the Government schoolteacher and superintendent of the reindeer herd. There is a small store kept by a trader, but usually not many supplies are kept in stock, so that by the end of the winter they are practically exhausted. Around this white settlement a group of native camps has grown up and before the fishing season commences over a hundred natives are settled within a short distance of the white men's cabins.

Three or four prospectors are now living on Dahl Creek and Shungnak River. On the former stream four or five cabins, several of which are now deserted, are located near the southern face of the Cosmos Hills, and on Shungnak River is a similarly located cabin. On Dahl Creek, 2 miles or so above the lower cabins, are prospectors' camps. These are the only inhabited white men's cabins in the region, but there are many others now deserted along both the Kobuk and its tributaries. Some of these deserted cabins are located as follows: Near the head of Riley Creek, near the forks of Ruby Creek, on the slopes of the valley of the left fork of Ruby Creek, on Wesley Creek, near the lower end of the canyon, on the lower part of the Kogoluktuk, and at scattered intervals along the Kobuk, the largest number at any one place being near the mouth of the Ambler.

The largest settlement of natives is, as already noted, near Shungnak, but there are also smaller settlements along the Kobuk. The largest of these is probably the one called Kalla, near the mouth of Kollyoksok River. It is impossible to give any accurate estimate of the native population, for during the summer many are away on hunting or fishing trips or go down the river to Kotzebue. Mr. Robert Samms, the missionary on Kotzebue Sound, after a careful estimate during the winter of 1898, placed the number at 500. According to the governor's report for 1910,[1] the enrollment of children at the Shungnak school during 1909 was 61, and this of course represented only a small part of the native population of even the Shungnak region.

[1] Report of the governor of Alaska for 1909, Washington, 1910, p. 20.

Most of the travel in the region is by boats during the summer and by dog teams during the winter, so that good trails are more or less lacking. However, owing to the need of communication between the mining camps and Shungnak during all seasons of the year, the United States commissioner wisely had certain prisoners build a trail from the town to the upper placer diggings on Dahl Creek. Another trail has been built from the Kobuk, near the mouth of Wesley Creek, to the mine near the forks of Ruby Creek. A boiler was taken over this trail by dog team in the winter, so it has been well leveled and brushed out, but it is not very good for summer travel. Connecting with this is a well-marked trail from Dahl Creek to Wesley Creek along the southern slopes of the Cosmos Hills.

These are the only marked trails in the region, but horses may be taken through the hills or the lowlands back from the larger streams by one experienced in Alaska travel. The Survey outfit was carried by pack animals, and it was possible to go practically at will where the work required.[1]

DESCRIPTIVE AND HISTORICAL GEOLOGY.

GENERAL STATEMENT.

Only a small part of the Shungnak region has been seen in detail, so that the description of the geology is necessarily confined to the larger subdivisions, and no attempt has been made to map more than three main groups into which the rocks and surface deposits naturally fall. These are the metamorphic rocks, both sedimentary and igneous, the Mesozoic and Tertiary (?) rocks, and the unconsolidated sands, gravels, and glacial detritus. Such a classification serves not only to differentiate the rocks on lithologic and textural grounds, but it also places them in historical order, beginning with the earliest and closing with the latest deposits. Not only are the geologic features described, but the history of the region is traced as far as the structure and lithology give insight into past conditions.

METAMORPHIC ROCKS.

The oldest rocks in the region belong to the metamorphic complex. The greatest areas of this group are in the Cosmos Hills and the Baird Mountains. In these localities several hundred square miles are underlain by these rocks. In the highlands south of the Kobuk these rocks do not occur, but they are believed to extend for several score miles north of the mapped area, and east and west they probably continue uninterruptedly from Seward Peninsula through the headwaters of the Koyukuk to the Yukon. Rocks of different

[1] The efficient and competent manner in which the Survey horses were taken through the region was due to the untiring activity and skill of the head packer, A. G. Winegarden, of Montana, to whom the writers desire to publicly express their thanks.

composition, age, and modes of origin are grouped together in this metamorphic complex, which is termed a complex mainly because so little work has been done to determine its stratigraphy rather than because it is undeterminable. Both sedimentary and igneous rocks are represented in this group. Though the former occupy a greater area, it is impossible as yet to state the relative proportion of each.

The sedimentary rocks of metamorphic character are quartzose schists, crystalline limestones, and sheared conglomerates. The quartzose schists, as their name implies, are composed mainly of quartz and mica or chlorite. They can not be distinguished by the eye from many of the rocks of Seward Peninsula. The amount of shearing and attendant metamorphism has had an important effect upon the physical character of the rocks; thus in places they are schistose, with wavy or knotted cleavage, and secondary minerals such as mica have been but sparingly developed. In this group are the black graphitic quartzose slates so commonly found in the vicinity of the productive placers in Seward Peninsula. Slates and schists of this type are found near the lower placers on Dahl Creek where the stream leaves the Cosmos Hills and on the divide between that stream and Riley and Ruby creeks. Smaller areas are also found at other places and there seems to be a rather close connection between this rock and the placers. In most places there are a great number of quartz veins and lenses in the graphitic slates and schists, ranging from microscopic filaments to masses 2 or 3 feet in width and traceable for several hundred feet along the strike. Veins of this sort are particularly numerous on the divide between Dahl and Riley creeks, and the whole hillside from the divide to the latter stream is covered with a heavy quartz float, many of the pieces weighing a hundred pounds or more.

Bluish-white crystalline limestones are closely associated with the schists of sedimentary origin. They also have been deformed, and their irregular distribution clearly indicates that they have been subjected to pronounced dislocation. It is therefore not always possible to make out with certainty their relations to the other metamorphic rocks of the region. In the area between Wesley and Ruby creeks it is certain that the limestone overlies the black slates and schists, and the same relation is shown on the central part of Dahl Creek. There is, however, a possibility that the apparent relation may have been induced by faulting, so that the stratigraphic succession may not be as suggested.

No definite information as to the age of the limestones was obtained, as fossils have been in large measure destroyed by metamorphism. In the float in the central part of Dahl Creek, not far from an outcrop of a down-faulted block of limestone, indistinct corals were found in a limestone bowlder. These were too poorly preserved to permit specific determination but were of precisely the same appearance as fossils collected in 1909 from the limestones along the eastern flanks of the Darby Range in southeastern Seward Peninsula that were identified as Devonian and Carboniferous.[1] Another similarity between these limestones and some of those of Seward Peninsula was the strong petroliferous odor emitted when freshly broken. The limestones with these particular characteristics were dark, nearly black in color, with interlaminated bluish-white bands, the whole somewhat crystalline.

The schistose conglomerates that were observed in the region are especially developed in the southern part of the Cosmos Hills. In this locality the conglomerate occupies a strip about 2 miles wide trending in a general east-west direction and has a southward dip. Although the relations to the other metamorphic rocks are not perfectly clear, the direction of dip indicates that the conglomerates overlie the schists and slates. Further evidence in support of this interpretation is afforded by the fact that recognizable pebbles of black slate and of chloritic schist, together with numerous quartz pebbles, make up the conglomerate. These pebbles prove by their presence that schists and slates with quartz veins were in existence and had been eroded before the deposition of the conglomerate, and they suggest an unconformable relation between these rocks and the conglomerate. No pebbles of limestone were recognized, and the structure is not sufficiently definite to prove whether the limestones antedate the conglomerate or not.

On the succeeding page another conglomerate is noted, but it should be distinctly understood that the one described above and included in this section dealing with the metamorphic rocks is thoroughly sheared and schistose throughout its extent and can in no way be explained by the small amount of deformation to which the later-described conglomerate has been subjected. Not only have the pebbles composed of the softer rocks been deformed, but even the quartz pebbles have been pulled out and elongated, so that now they are many times their original length. Many pebbles 3 inches long were recognized, but this measurement, however, should not be interpreted as showing maximum distortions, for by excessive elongation the pebble form becomes more and more obliterated, so that finally it can not be recognized.

Igneous rocks that have been subjected to pronounced deformation and consequent metamorphism have also been recognized in the Shungnak region, but the exposures examined were poor. An outcrop of greenish schists belonging to this group extends for some distance along the ridge between Cosmos and Wesley creeks a mile or

[1] Smith, P. S., and Eakin, H. M., Geology of southeastern Seward Peninsula and the Nulato-Norton Bay region: Bull. U. S. Geol. Survey No. 449, 1911, p. 48.

so south of Iron Mountain. It appears to cut the underlying slate and forms a sill between that rock and the overlying limestone. So far as observed it does not cut the limestone nor does that rock show any contact effects. Metamorphism, however, has proceeded to such lengths that these criteria are not definitive. These older igneous rocks have a schistose structure, are greenish in color, and consist mainly of greenish chlorite and plagioclase feldspar, the latter as a rule completely recrystallized. They bear a close resemblance to the metamorphic greenstone schists of Seward Peninsula and are believed to have had a similar history and origin.

Taken as a whole, the metamorphic rocks show that two or possibly three periods of deposition have taken place. Two of these may have been separated by a period of metamorphism and erosion. Veins were injected prior to the deposition of the conglomerate and its subsequent metamorphism. Though it is by no means certain that there was an earlier period of metamorphism before the veins were formed, such a conclusion seems to be indicated. Igneous activity also occurred. Its extent has not been determined, but it does not seem to have been connected with the formation of valuable mineral deposits. The metamorphic rocks, with the exception of the conglomerates, seem to be mineralized and they are believed to be the ones in which deposits of metallic minerals are to be sought and from which the placers have been derived.

MESOZOIC AND TERTIARY (?) ROCKS.

A vast area south of the Kobuk, represented within the Shungnak region by the Sheklukshuk Hills, is occupied by sedimentary rocks assigned to the Cretaceous. As has already been stated, these hills have not been explored within the mapped area by members of the Survey, and as there is no description in the literature knowledge of them has been gained only by explorations east of the Shungnak region and by the long-range recognition of certain characteristics elsewhere studied in more detail. From these observations it appears that many of the higher points and a large part of the range consist of conglomerates with some sandstones, the relative proportion of the latter increasing toward the south. These beds have been folded and faulted, but in no place has schistosity of a marked character or of extensive development been seen. Emphasis is placed upon this feature because it is important in separating these newer rocks from the sheared conglomerates of the metamorphic complex.

The pebbles composing the lower part of this group have been derived from the older rocks and present a great diversity of lithology. Quartz derived from veins and lenses in the schists forms the larger number of fragments. This is probably due not so much to the abundance of the quartz in the schists as to its greater hardness, which prevented rapid destruction. A large part of the finer material found in similar rocks farther east seems to be of volcanic origin, and the rocks contain abundant plagioclase and ferromagnesian minerals.

These more recent rocks occupy a part of the northern lowland and occur on the flanks of the bordering hills. These rocks in the lower part of the Ambler basin are described as follows by Mendenhall:[1]

> Along the lower course of the Ambler outcrops were examined which consisted of a series of conglomerates, soft cross-bedded sandstones, and shales which were often carbonaceous and carried obscure remains of plant stems. Some phases of the conglomerate are made up wholly of material derived directly from the mica schists and but little sorted. White vein quartz, somewhat rounded, furnishes most of the material for the pebbles, which are embedded in a matrix consisting chiefly of fine muscovite and chlorite foils. These beds make up the low hills between the lower Redstone and the Ambler and between the latter stream and the Kowak [Kobuk]. Similar beds associated with limestone are reported by Mr. Prindle along the middle course of Shingurk Creek [Shungnak River].

Fossils have not been found in any of these rocks within the mapped area. Mendenhall,[2] however, on the basis of their lithology and similarity to fossiliferous beds on the lower part of the Kobuk, assigned the beds in the lower part of the Ambler to the Tertiary system. In the light of the further evidence afforded by the surveys of 1909 and 1910 in the region south of the Kobuk, whereby a great Cretaceous area was outlined, it has seemed probable that these beds belong to the Mesozoic rather than to the younger era. According to this interpretation, the metamorphosed sediments on the south side of the Kobuk are part of the uninterrupted Cretaceous area that extends southward to the region beyond the mouth of Kuskokwim River and from Seward Peninsula on the west to Melozitna River on the east. The sediments in the northern lowland are considered to mark an infolded or infaulted block as the region of greater mountain-building stresses, the Baird Mountains, is approached. If, on the other hand, the younger rocks in the northern lowland are Tertiary, they may mark local basins eroded in the metamorphic and Mesozoic rocks in which later sediments have been deposited. Further investigation is needed to determine these points, but the question of age has little or no bearing upon the mineral resources.

In the region to the east igneous rocks cutting the Mesozoic and Tertiary (?) sediments have been recognized. Owing to the slight study of the later rocks in the Shungnak region no igneous rocks in place have been recorded, although they undoubtedly exist. It is highly probable that some of the unmetamorphosed basic dikes found cutting the metamorphic rocks may have been intruded during Mesozoic and Tertiary (?) time, but their upper age limit could

[1] Mendenhall, W. C., Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska: Prof. Paper U. S. Geol. Survey No. 10, 1902, p. 41.

[2] Idem, p. 42.

not be determined owing to the absence of late sedimentary beds of known age. The types of igneous rock to be expected from analogy with the more fully studied regions are basic volcanic rocks such as flows and tuffs, mainly of andesitic composition. Some granitic intrusions also have been recognized, but if the evidence afforded by the eastern part of Seward Peninsula is applicable here most of the granitic intrusions were pre-Cretaceous.

Veins are practically lacking in the Mesozoic and Tertiary (?) areas, and consequently mineral deposits requiring veins for the derivation of their valuable constituents should not be sought for in areas occupied exclusively by this group of rocks. The only economic resources likely to occur in these areas are coal beds, but, as will be shown in the section dealing with the economic geology of the region (p. 304), these resources are probably not sufficiently valuable to tempt expensive investigation.

UNCONSOLIDATED DEPOSITS.

Although the hard-rock geology is of prime importance, the placer miner is most intimately interested in the unconsolidated sands and gravels in which valuable mineral deposits may be sought. There are many different conditions under which the unconsolidated deposits were formed, and in order to understand these it is necessary to point out the recent history of the region, especially as regards the agencies. In order to do this the physiography of the region will be treated from the close of the latest period of mountain building down to the present.

TERTIARY AND RECENT HISTORY.

At the close of the last great mountain-building period, highlands trending in general east and west had been formed in the region between the Kobuk and Noatak. Probably the Mesozoic and Tertiary (?) sediments covered this range and metamorphic rocks were practically absent from the surface. Owing to the great elevation, erosion was more active in the high mountains than in the lower areas and consequently sooner removed the surficial covering. The drainage originally trended at right angles to the mountain range, and consequently the streams flowed north toward the ancient Noatak or south toward the Kobuk. The deformation, however, by no means resulted in a single anticline but was marked by several subordinate parallel ridges with intervening synclines or down-faulted areas. Each of these influenced the drainage and longitudinal valleys resulted. The northern lowland is interpreted as marking one of these constructional low areas where the Mesozoic and Tertiary (?) sediments had been relatively least elevated. The

Kobuk lowland probably marks another such area. After the drainage had been well established on this relief, valleys were eroded and the surface no longer corresponded to the constructional surface because the rivers were striving to cut their courses down and all the other processes of erosion were reducing the country to slopes appropriate to degradational processes. Thus, while the general position of the larger units of the region had been outlined by the mountain building, the present topography probably nowhere shows any vestiges of the actual surface that was produced by this process.

When the surface of the region had been carved to one somewhat remotely resembling that of the present, either a climatic or some other change capable of producing glaciation in the highland areas took place. In this period of glaciation and in the succeeding time which extends down to the present the unconsolidated deposits treated in this report were laid down. Although sands and gravels undoubtedly were deposited earlier than the period of glaciation, they have not been recognized in this region. In this report, therefore, two classes of deposits are described—first, those of glacial origin and, second, those formed after the period of glaciation, which for convenience are called stream gravels. This nomenclature is not entirely appropriate, for the glacial deposits were in many places transported by streams and have water-laid rather than ice-laid characters.

GLACIAL DEPOSITS.

During the period of maximum glaciation the ice centering in the highlands of the Baird Mountains on the north flowed down the existing valleys and covered the lowland areas. During the advance most of the former valley fillings of gravel were eroded and transported by the glaciers. The maximum extent of the glaciers has not been determined, owing to the lack not only of detailed studies but even of exploratory surveys over much of the region. Ice extended down the Kogoluktuk Valley, across the northern lowland, through the Cosmos Hills, and even into the Kobuk Valley. The Ambler Valley was also occupied by glaciers, at least as far as the Kobuk. Mendenhall [1] states:

> About 2 miles above the mouth of the Ambler River, on its left bank, occurs a deposit of blue bowlder clay 25 feet in thickness. Blocks and pebbles of dark crystalline limestone, much greenstone, and relatively small amounts of conglomerate and sandstone are scattered through the clay, and these bowlders are sometimes subangular and finely striated. The rocks of the lower course of the Ambler are sandstones and conglomerates, so that the greater part of the coarser material in the clay has been transported at least some miles. Overlying the clay are deposits about 100 feet in thickness of irregularly stratified yellow sands and clays without coarse material. The lower portion of this deposit at least is to be regarded as a true ground moraine, thus proving the extension of the Ambler Valley glacier to beyond this point.

[1] Mendenhall, W. C., op. cit., p. 48.

The proof of the extension of the Kogoluktuk Valley glacier, at least as far as the Kobuk lowland, is afforded by the distinct morainic topography of the knobs and kettles as far south as the lower cabin. No definite proof of the amount of ice in the Kobuk Valley has been obtained, but the effect on some of the streams indicates a body of ice of considerable extent. No frontal moraines of the glacier that occupied the Kobuk Valley have been recorded, although recessional moraines of the tributary streams are sharp and definite.

Attendant upon the advance of the ice was the blocking of preexisting drainage and the consequent discharge of water by unnatural channels. This continued through the period of maximum glaciation and even into the closing stages, so long as free discharge was prevented. Marking these obstructions are deposits of unconsolidated material laid down behind the ice barriers in temporary lakes or quiet water. Narrow gorges through the hills also attest the effect of past obstruction of the drainage. Except the passes of the larger streams, such as the Kogoluktuk and possibly the Shungnak, which were occupied by ice, the low passes through the Cosmos Hills were probably spillways for the impounded water that was not able to pass out by its normal course by way of the northern lowland, owing to the presence of the Ambler and the other glaciers.

Not only were deposits formed in those places where obstructions caused diversion of drainage, but even where a free discharge was permitted glacially eroded materials were deposited beyond the front of the ice. It is at present impossible to indicate just how extensive were the modifications of the topography produced by this enormous outwash of material. Without doubt much of the higher parts of the Kobuk and northern lowlands is formed of this group of deposits, though definite criteria are now unrecognizable, as the gravels have been partly transported by running water. The problems connected with the glacial occupation of the region are of importance in the search for productive placers as well as in deciphering the details which are of more purely scientific interest.

From the nature of the agency involved in gathering and transporting the materials that compose the glacial deposits, certain facts concerning the general character of these deposits may be inferred. First, owing to the lack of sorting action by glaciers during transportation deposits directly formed by glaciers generally consist of a heterogeneous collection of material unaffected by gravitative selection. Second, owing to the way a glacier acquires the materials it transports and its great erosive power, the deposits it makes are, as a whole, less weathered than those formed by rivers. The rocks are ground down or plucked bodily from the bed, so that a rock flour results from the erosion rather than a separation of the constituent rock minerals. Although the above statements apply only to deposits formed directly by glaciers, they require but slight modifications to fit the indirect deposits formed as outwash from the front of the ice. They are, therefore, important principles which will be referred to later in discussing the possible extension of the auriferous placers (p. 298).

STREAM GRAVELS.

With the disappearance of glaciation the drainage modifications that had become established were continued and the temporary features due only to the ice occupation were abandoned. As a result channels marking short-lived discharges, now unoccupied by streams, are represented by passes such as that between Wesley and Ruby creeks or by the divide at the head of Cosmos Creek. With the development of the new drainage the streams were in some places forced to excavate part of the glacial filling of their valleys; in other places glacial erosion had deepened the valleys so that stream deposition took place; in still other places glacial modification was so slight that the streams flow almost on the preglacial surfaces.

In those stream valleys where glacial deposits have been formed and subsequently in part excavated, bowlders derived from rocks outside of the local drainage basin in which they now occur are found in the gravels, together with fragments which have not traveled so far. In the excavation of the valleys by the present streams the changed relation of the drainage is such that in many places the stream has not stopped its downcutting after incising its course through the unconsolidated deposits but has cut down into bedrock, forming a narrow gorge. In these places the gravels are relatively thin and are derived largely from the local rocks, although the harder and larger blocks from the older, higher gravels may occasionally be found. The incision of the present streams in narrow rocky gorges may be seen in many places where previous glacial filling is not indicated. Thus the Dahl Creek valley seems not to have received any such additional material from outside sources. This valley has a rocky trench near its base, in which the stream flows, and an older, more open valley above.

The unconsolidated deposits formed by these streams therefore present a great diversity of types. In one type the materials have been derived from basins outside the one in which they now occur, but although they have been transported a long way the sorting has been but slight. In another type, although the material is not of local origin, the earlier deposits have been so thoroughly rehandled by streams that considerable sorting has been effected. In still another type the unconsolidated deposits consist only of materials that have been derived from the basin in which they occur and transported and deposited only by streams. Each of these different types can, therefore, in a measure be recognized by the size, shape, and lithology of its component materials. The recognition and the realization of the significance of the different characters presented by the different types of unconsolidated deposits are of importance to the placer miner, for certain types of deposits are more likely to contain profitable placers than others.

The physical condition of the stream gravels with respect to cementation by permanent frost has an important bearing on mining and prospecting, but the data available are not adequate for a thorough analysis of the problem. Practically all the shallow gravels are not permanently frozen. The thicker deposits, especially those in which there is a large amount of clay, and some of the bench gravels are probably frozen. In natural sections, such as occur along streams, definite evidence is not obtainable, for where the sun and air can reach the material thawing takes place. Thus a section of the gravels near the old cabin on the Kogoluktuk showed 4 feet of uncemented and unfrozen gravels overlain by 3 feet of frozen muck, which in turn was overlain by a cover of vegetation and frost litter. The upper frozen layer was so covered by the mat of vegetation which had been undermined by the river that it was protected from the sun and air, whereas the lower gravels were not.

The presence or absence of permanent frost seems to be in large measure determined by the effectiveness of subsurface drainage. Such drainage is best in well-rounded gravel deposits at an elevation above the streams and is poorest in those deposits containing a large percentage of clay or silt and lying below the level of the groundwater table. The fact that the mean annual temperature as determined from the mean of Stoney's observations (quoted on p. 277) is less than 16° F., or 16° below the freezing point, makes it possible to explain permanent frost in this region as due to existing climatic conditions.

ECONOMIC GEOLOGY.

HISTORY AND GENERAL STATEMENT.

The gold excitement which followed the Klondike discoveries caused a general influx of prospectors and others into all parts of Alaska. Every little while a new camp would be reported and a rush to the new diggings would be started. During 1898 such a stampede into the Kobuk occurred. Many of these gold seekers were unequipped for the difficulties encountered, and as they failed to find enormously rich placers they spent the winter loafing in their shacks and when reports of the rich strikes at Nome and on the Koyukuk reached them they struck out for the new fields. An account of the experiences of one of the disappointed gold seekers on the Kobuk[1]

[1] Grinnell, Joseph, Gold hunting in Alaska, Chicago, D. C. Cook Publishing Co., 1901.

gives a realistic picture of what was almost the universal condition in the region during 1898 and the early part of 1899.

With the opening of navigation in 1899 almost all the prospectors who could do so left the Kobuk and reported the region as worthless. A few prospectors have stayed with their claims and have each year taken out enough gold to live on and do a little more prospecting, buoyed up by the hope of a rich strike. It is probable that between $50,000 and $75,000 in gold has been produced since 1898. There is an enormous region to prospect, however, and with scanty means and small outfits progress has been slow. Attempts have been made, so far unsuccessfully, to interest outside men in financing different projects.

Not only have placers attracted the attention of the prospectors, but lodes of gold, copper, and silver-lead have been located and some development work done. No production has been made and there has not been enough exploitation to demonstrate satisfactorily the character or extent of the ore bodies.

The economic conditions imposed by the geographic position of the Shungnak region have exercised and must always exercise a control that will prevent working deposits which in a milder climate and in more accessible regions could be successfully mined. It is not possible to evaluate these factors, but a brief consideration of even the single item of wages may indicate the relatively high costs that must be met.

In the Shungnak region practically no white men are working for wages, so that there are no accurate data on this subject. From the fact, however, that ordinary pick and shovel miners demand $7.50 a day and board at the Squirrel River diggings, nearly 200 miles down the river, and consequently nearer civilization, there is small reason why miners in the Shungnak region should receive less. It is true that some of the placer miners pay natives $4 a day and board, but as a placer miner can work for only 60 to 80 days a year and must in that time gain sufficient to live for the other 275 days or so, $7.50 a day is by no means an excessive wage. The short season, of course, will be in part nullified if lode mines or deep placers are discovered which would give employment during the winter months. These, however, would probably not afford employment for all the miners required for open-season mining. Some decrease in living expenses is, of course, to be expected as transportation facilities are improved. As the country raises practically no foodstuffs and probably can not, it is necessary to import everything. The long distance that such supplies must be carried, the frequent handling required, and the short season available for water transportation make it improbable that any considerable reduction can be made in this item. Consequently, as these charges must be met by wages, the apparently high cost of labor must be regarded as an almost inevitable result of the isolated position of the region.

GOLD PLACERS.

From the foregoing statements concerning the number of miners in the Shungnak region, it is evident that placer mining is not carried on extensively and the production from the region is but little more than enough to pay wages to the few men employed. The main placer developments are on the streams heading in or flowing through the Cosmos Hills, namely, Dahl Creek, Shungnak River, and Riley Creek, a tributary of Kogoluktuk River. Each of these will in turn be described and the general placer resources of the region noted.

DAHL CREEK PLACERS.

Dahl Creek is a stream 7 to 8 miles long, the lower 3 miles or so of its course being through the Kobuk lowland, the middle 2 or 3 miles in a narrow rocky gorge, and the upper mile or two in a rather open valley. The placers that have been worked are located near the southern face of the Cosmos Hills and in the central part of the valley, where the junction of three small side streams with Dahl Creek has made a small flat. During the time that the Survey party was in the region no work was in progress on any of these claims, but mining had been carried on earlier in the season at both places and had been in progress for several years in the past.

The bedrock under the unconsolidated deposits here is black slate and schist with numerous small veins of quartz and in places some sulphide mineralization. The bedrock breaks into rectangular blocks of small size and the joint faces are often iron stained. The dominant strike is across the creek and thus the rocks make natural riffles for catching the gold. The slope of the bedrock surface is rather low, so that some difficulty is experienced in disposing of the tailings from mining. Near the lower group of claims schistose conglomerate outcrops but does not form bedrock under the productive placers. Limestone occurs near the placer ground in the middle part of Dahl Creek, but although float from this rock is found in the gravels it does not come down as far as the creek and does not form any of the surface on which gravel accumulation took place. Igneous rocks of a dense texture and greenish glassy color were noted upstream from the placers, but though these rocks have furnished many of the bowlders in the placer deposits they do not seem to have been connected with the mineralization and did not contribute valuable minerals to the placers.

Only the creek gravels have been mined on Dahl Creek. These average about 4 feet deep. In places they are only a foot or so thick but in others they are as much as 8 feet. Holes sunk on some of the low benches on either side of the stream have shown unconsolidated deposits 15 feet thick. Practically all the stream gravels are unfrozen, except for seasonal frost, but some of the low benches that have been prospected are reported to be permanently frozen.

The gravels in the productive placers are typical creek gravels, consisting of well-rounded pebbles with only a small amount of muck. Large, somewhat angular bowlders, most of which are of local derivation, are numerous in the gravels and cause a good deal of trouble in the mining operations. One of these large bowlders a short distance below the placers, near the southern face of the Cosmos Hills, measured 14 feet in length. It is made of the sheared conglomerate and has not been transported far. Many smaller bowlders occur directly in the auriferous gravels, however, and it is necessary to blast them out of the way.

The pay streaks differ in no essential respect from the overburden. They are usually from 1 to 2 feet in thickness and practically all the values lie in and on bedrock. The distribution of the auriferous gravels is very irregular, and it has been impossible to trace successfully any continuous pay streak. The values occur in pockets which when exhausted give no clue as to their relation to other rich spots. Such a distribution seems to indicate that values were either laid down more or less evenly and then dispersed by a change in the discharge of the creek, or else that the gold was originally deposited by a stream having strong variations in transporting ability.

Owing to the irregular distribution of the gold, statements of the value per cubic yard are of little significance. When a rich spot is found, several hundred dollars may be taken out in a few days, but at other times only a dollar or so a day can be made. Figures for the total production are also unsatisfactory, but they give a more accurate estimate of the value of the ground. The returns are not complete and probably exaggerate the amount of gold recovered, but they are an index of the size and present importance of the creek. According to the returns from the miners, in no year has Dahl Creek produced more than $10,000, and probably half this amount is nearer a correct estimate for the average production during the last six years. If this assumption is correct, not over $30,000 has been taken from this creek since its discovery.

Only a small amount of Dahl Creek gold was studied, so that a full description can not be given. The gold examined from the upstream group of placers was of a reddish to brass-yellow color. The pieces were small and some were distinctly spongy and had fairly sharp outlines, as if they had not been transported far from their place of origin. Some wire gold was also seen, but it was rare. Nuggets of considerable size have also been found in this part of Dahl Creek. One of these was seen which had a gold content worth about $65. It was a fairly well worn piece and had a considerable amount of greasy-looking milky quartz attached. Assays are reported to have shown gold value of about $16.20 an ounce.

Among the concentrates from the Dahl Creek placers magnetite is the most abundant mineral. There is also a small amount of chromite, some of the pieces being a foot or so in diameter. Garnets are almost entirely absent. The occurrence of native silver in the concentrates has been reported and pieces nearly an inch in diameter have been examined. The silver seems to be particularly free from admixture with other metallic minerals such as copper or lead; a small amount of cadmium, however, was recognized by blowpipe examination. No evidence was procured as to the bedrock source of the silver.

Mining is done by pick and shovel methods and the gold is won by passing the gravels through sluice boxes of whipsawed lumber. Owing to the high transportation charges, machinery would be expensive to install, and owing to the character of the gravels and their tenor, few mechanical devices could be successfully operated. Short ditches provide the necessary head for sluicing, and there is almost always a sufficient water supply to meet the demand.

From the physical features of the gold and the distribution and other characters of the auriferous alluvium, it seems probable that the gold has been derived from a source within the Dahl Creek basin, especially from the areas occupied by the black slates and schists. It is believed that the source of the mineralization is the quartz veins which are so abundant in this formation.

Some prospect holes have been sunk near Dahl Creek close to the southern front of the Cosmos Hills or the northern margin of the Kobuk lowland. The returns, however, have been insufficient to warrant development and the holes have been allowed to cave, so that it was impossible to examine a section of the gravels. It was reported by prospectors that the bedrock surface slopes southward at a high angle below the lower cabins, so that shafts even 40 feet deep failed to reach bedrock. In this lower part of Dahl Creek the stream is flowing through the unconsolidated deposits of the Kobuk lowland. The absence of any shallow placers in this part of its course seems to indicate that the upper parts of the gravels of the lowland area do not contain sufficient gold to form economic deposits where subjected to the sorting of such streams as Dahl Creek.

KOGOLUKTUK RIVER.

Sparsely disseminated colors of gold have been reported from many parts of the Kogoluktuk basin, but the only stream on which placers have been mined is Riley Creek. This is a tributary from the west, heading against the Dahl Creek divide and flowing first north and then east to join the Kogoluktuk. Placer ground has been mined in a desultory way by parties of one to three men on the headwaters of this stream since 1908. Mining was in progress here when the region was visited by members of the Survey in the early part of August, 1910, but soon afterward was abandoned for the season.

The placers occur in a region of black slates, limestones, and a few intrusive igneous rocks. The bedrock is similar to that of the placers on Dahl Creek except that limestones are much more numerous. Evidences of deformation and dislocation are pronounced and the stratigraphic succession of the rocks has not been determined. Quartz veins are particularly numerous in the black slates that form the bedrock under the ground that has been worked and are believed to be closely associated with the formation of the productive placers.

In the placers typical stream gravels are practically lacking. Sections show angular slide and slightly worn unconsolidated deposits of local origin in which are irregularly distributed bowlders from outside basins. Most of these foreign bowlders are of large size and are mainly igneous rocks belonging to the group of greenstones and associated rocks. They are generally well worn and probably have been brought into their present position by the combined action of ice and water during the closing stages of the glaciation of the northern lowland. Although these greenstone bowlders are found in the placers they are in no way connected with the origin of the gold, and their distribution, except as marking former glacio-fluviatile conditions, is of no economic significance.

The gold occurs mainly in the crevices of the bedrock and in the angular unconsolidated material lying on top of the bedrock. In the part of the deposit that is mined large bowlders are less numerous than in the upper 2 or 3 feet of the deposit, but there are many bowlders even in the pay streak. The whole character of the material in which the gold is found is more like that of residual placers than that of ordinary creek placers.

The slight amount of transportation that the auriferous material has undergone is also indicated by the shape and quality of the gold. Practically all the pieces examined were sharp and angular and many had small particles of quartz attached. No large nuggets have been reported from these claims. Pieces worth as much as 50 cents were seen, and a few worth $2 to $3 were reported. The gold is bright and in an average sample the pieces were worth from one-tenth cent to 2 cents each. The individual particles are spongy and consequently appear, to one not used to the run of placer gold, to be worth much more than is actually the case. The precise assay value of the gold was not learned, but it was understood to be about $16.25 an ounce.

Accurate estimates as to the total production are not available, but from the amount of ground that has been mined during the last three years and its reported tenor it is believed that not much more than a thousand dollars a year in gold has been won.

Mining costs are high and the Riley Creek placers are unfavorably situated for economic development. The two greatest obstacles to cheap mining are the absence of a sufficient water supply and the presence of large bowlders. The latter trouble, however, is not so serious as the lack of water, for few of the bowlders are so large that they can not be rolled back by hand or got rid of by undermining. Practically the only water available is derived from the melting snow on the northward-facing slope of the divide between Dahl and Riley creeks. Furrows parallel with the contour have been dug on the hill slope to collect the surface and shallow seepage water formed from the melting snow banks. From these furrows the water is led down the hillside and impounded behind a sod dam. Thence it is led by a short ditch and hydraulic hose to the sluice boxes. So slow is the collection of water that under favorable conditions it takes about 3½ hours to collect enough for 1½ hours' sluicing. No water, of course, can be spared for groundsluicing. Even shoveling into the sluice boxes can only be done for four or five periods a day. During wet weather the reservoir fills up more rapidly and so relatively longer periods of sluicing are possible.

After the period of sluicing and while the reservoir is refilling the miners clean away the large bowlders and get everything in readiness for the next time that the water has accumulated. The large bowlders are not cleaned but are simply rolled upon the part of the claim already worked out. In order to use the water effectively the sluice boxes are made only about half the ordinary width and were formerly set on a pitch of 1 inch in 12 inches. Subsequently, however, in order to take care of the tailings and lessen the height to which the gravels were shoveled, a pitch of 1 to 15 was adopted.

The Riley Creek placers that have been worked seem to derive their gold content from the rocks exposed in the immediate vicinity. They are so situated that they have no adequate water supply and bowlders are so numerous that the placer can be developed only at great expense. Farther downstream, where the water supply might more nearly meet the demands, thicker overlying deposits and large bowlders are probably present. The absence of especially effective sorting in this part of the basin suggests that placers will be of distinctly local importance. The whole Kogoluktuk basin, so far as indicated by the conditions on Riley Creek, seems to promise only localized placers of irregular distribution, workable as pockets rather than as extensive deposits.

SHUNGNAK RIVER.

Placer mining on Shungnak River has been carried on for a mile or so below the narrow canyon in which this stream traverses the Cosmos Hills. Work has been in progress here during the open season almost uninterruptedly since 1898. Only two or three parties of three or four men each have attempted mining during any one year, and in 1910 only one placer camp of one white man and two or three natives was in operation. The use of native labor is an interesting experiment, and although it is reported that white men can do more work the wages paid the natives (about $4 a day and board) are so much lower that the difference in efficiency is compensated for.

Bedrock in the productive part of the river is mainly black slate and schist, but other sedimentary and igneous rocks occur at no considerable distance from the placers. Limestones occur near the head or northern end of the canyon but are not closely associated with the deposits of auriferous alluvium. The igneous rocks in proximity to the placer mines are composed mainly of serpentine, are of a dark-green color, and contain scattered particles of magnetite. These rocks have been sometimes mistaken for jade, and it is probably owing to this error that the whites have reported the name Shungnak to mean jade in the native language.

Most of the mining has been done near the southern face of the Cosmos Hills, where small flats permit turning the stream aside by wing dams. The gravels mined are generally shallow. The upper 2 feet or so is stripped off and the lower part only is put through the sluice boxes. The overburden is made up of typical river gravels with some large bowlders irregularly distributed throughout. It is not known whether the valley of Shungnak River through the Cosmos Hills was at one time occupied by ice, but it is certain that glacially eroded and transported bowlders have been brought in by glacio-fluviatile action and form part of the reworked material of the unconsolidated deposits.

The auriferous gravels are rather irregularly distributed and therefore mining has been in the nature of pocket hunting in those places where the water could be handled. The gravels are unfrozen, and in a measure this is a disadvantage, as it allows much water to seep into the pits. During high water the miners are sometimes driven out of the workings. The values are found in the lower part of the unconsolidated deposits and in the crevices of the bedrock, especially where the bedrock is black slate.

The larger part of the gold found in the placers of the Shungnak is in small pieces worth from one-half cent to 3 cents, but nuggets worth about $40 have been found, although they are by no means numerous. The gold is of a reddish color, and although not rusty it is not bright and shiny but has a dead luster. Its assay value is reported to be $16.70 an ounce. The form of the gold is very characteristic and is distinct from that of the gold from any other part of the Shungnak region, the little pieces being like shot flattened with a hammer.

Among the concentrates collected with the gold magnetite is by far the most abundant mineral. This is probably derived from the basic intrusive dikes which cut the metamorphic rocks. Garnet, or so-called ruby, is almost entirely absent from the gravels. Small nuggets of copper and also of silver are sometimes found in the sluice boxes. Some of the silver nuggets are nearly an inch in diameter and contain but very small amounts of other metals as impurities. No clue as to the origin of the silver was obtained, but the copper nuggets were probably derived from the zone of rock impregnated with copper sulphide near the limestone-schist contact, an example of which is described in more detail on pages 300–302.

Statistics of the production from the Shungnak River placers have not been kept, and estimates prepared by interested parties are not reliable. It is improbable that the annual production amounts to more than a few thousand dollars in gold, and a liberal figure for the total production from this river would not be more than $50,000.

SUMMARY.

The amount of development and the estimated production indicate that the gold placers discovered are not extensive or highly profitable. The gold seems in general to be of local origin and this necessarily curtails the area in which productive placers may be sought to the Cosmos Hills and the Baird Mountains. The general effect of the glaciation of the region has been to disperse auriferous deposits that might previously have been formed and so destroy rather than produce commercially valuable placers. Where glacial and attendant glacio-fluviatile action did not entirely remove the auriferous deposits it undoubtedly partly eroded and transported them, and this fact probably accounts for a good deal of the irregularity of distribution. The disadvantageous economic situation due to geographic and trade conditions does not need to be discussed at length here, but these conditions are necessarily deterrent factors in the development of these placers.

LODE DEPOSITS OF METALLIC MINERALS.

At the present time no lodes have been developed to a producing stage in the region and there are very few places where even prospecting has amounted to much more than the annual assessment work stipulated by law. As is usual, much of the trouble has been due to the prospectors overburdening themselves with more claims than they could handle, so that their efforts have not been concentrated on any particular place. Consequently, so far as affording information about the lodes is concerned the prospecting has been largely valueless, and one examining the region is forced to rely mainly on natural exposures of the possible lode deposits. There are indications of mineralization at many places, but the general inaccessibility of the region and the high valuation set on many of the prospects do not invite the investment of outside capital. Without abundant funds the developments are hampered and many of those attempted are ill directed.

GOLD LODES.

On the divide between Dahl and Riley creeks, as has already been noted, there are numerous veins in the black slates and schists. Most of these veins are small stringers, but some lenses 18 inches to 2 feet in width were noted. In one vein in particular on this divide specks of gold are reported in the quartz and a shallow prospect hole had been dug. The broken quartz from this hole had been panned and numerous small particles of gold are said to have been obtained. On the northern slopes of this ridge and continuing as far as the placers on Riley Creek there is heavy quartz float all over the surface. In many pieces of the float fine gold is visible and some containing several dollars' worth of gold are reported to have been found. The auriferous quartz from this place is mostly of a dense texture and a greasy white color. Sulphides are almost entirely absent. In this respect the veins resemble those of Seward Peninsula. In places the quartz is iron stained, but the discoloration is not present everywhere or in considerable amounts. The quartz in places shows indications of a comb structure and does not seem to have been recrystallized or badly smashed. On account of these characters it is believed that the veins from which this quartz was derived belong to a series formed later than the maximum period of regional metamorphism. This interpretation is further supported by the greater continuity of these veins as compared with those in the oldest schists of Seward Peninsula. It is believed that these quartz veins are intimately connected with the local placers on Riley Creek and that they are the sources from which the placer gold was derived.

An attempt to interest outside people in developing this gold quartz has so far proved unsuccessful. From the character of the exposures of quartz veins in the immediate vicinity it appears that the treatment of the vein material would require the handling and milling of a large amount of the country rock as well, and this would necessarily reduce the gold tenor. The question whether these veins can be worked is answerable only by careful and extensive sampling of the kind of material that must be mined and milled if the project is developed commercially. It is evident that picked specimens are absolutely worthless in arriving at the valuation, and samples of the vein material alone are likewise misleading.

There are many other places where veins similar to those at the head of Dahl Creek have been seen, and it is by no means improbable that they, too, carry some free gold, although in the hurried examination it escaped detection. These veins are more numerous in the areas occupied by the black slates, especially near the base of the limestones. This distribution appears to be dependent upon the physical features of the slates, but the deposition of gold may have been due to chemical reactions induced by the presence of carbonaceous material throughout these rocks.

COPPER PROSPECTS.

At two places attempts have been made to prospect copper leads, but at neither place have the explorations been sufficient to determine the extent or other geologic relations of the ore. One of these projects is located on the west side of Ruby Creek about 6 miles from the junction of that stream with Shungnak River. The other lies west of the left fork of Ruby Creek, near the head of Cosmos Creek. A low limestone hill, locally known as Aurora Mountain, is the center around which the claims at the latter locality are grouped, and this name will therefore be used to designate that locality.

Copper-bearing leads on Ruby Creek have been known for many years and were critically examined in 1906 by experts in private employ to determine their commercial value. Conditions at that time prevented the purchase of the properties, and only a small amount of work has been done recently. Owing to the length of time that has elapsed since active work was in progress, many of the pits and open cuts have caved and filled to such an extent that they afford poor opportunity for examining the deposits and adjacent rocks. In this part of the Ruby Creek valley on the lower slopes there is a heavy covering of talus and vegetation, so that without pits and other sections many important facts are indeterminable.

Mineralization on Ruby Creek appears to be confined to a brecciated zone or zones in the limestones. Sulphides have been deposited in the open spaces thus formed and the ore-bearing solutions have penetrated the limestone along the many cracks and crevices and in part replaced it. There is some brecciated dolomite at the mine, and it also has been replaced and intersected by sulphides. The sulphides of economic importance are mainly bornite and chalcopyrite, but galena and iron pyrite were also noted. In the surficial part of the deposit both the blue and the green copper carbonates are common. Limonite, derived from the weathering of the pyrite, in several places forms a gossan, or "iron hat," several feet thick over the sulphide-impregnated limestone. It is reported that the weathered material when panned yields colors of gold. Average pans of the gossan from an open cut above the main workings are said to give from 1 to 3 cents in gold. Assays are said to have yielded as much as 11 per cent of copper, but no details were obtained as to the manner in which the samples were taken.

The main developments on the northernmost property consist of an adit and two open cuts. The mouth of the adit is only a few feet above the high-water level of the creek. The tunnel has been driven about 40 feet through a much slickensided and fractured limestone, in places showing mineralization. Two short drifts, totaling only about 30 feet in length, followed especially strong indications of mineralization but evidently soon passed out of rich ore. The walls stand fairly well, but caving of the surface has so blocked the mouth of the adit that there is 12 to 18 inches of water standing on the track. A boiler was brought in from the Kobuk by way of the low pass at the head of Wesley Creek by a team of 70 dogs. When work was started a homemade mine car was used to tram the broken rock away from the working face, but a new automatic dumping car has since been installed. Wooden rails are, however, still in use. Natives have been employed as muckers and for the simpler mining operations and are said to have given satisfaction.

On the hill at an elevation of about 150 feet above the adit an open cut about 30 feet long and 10 feet or so wide had stripped the surface and had cut into the bedrock to a depth of 5 to 7 feet. Most of this pit was covered with caved surficial material so that little could be seen. The mineralization seemed to be essentially the same as that exposed in the adit. In the open cut although the bedrock is limestone it differs in some respects from that exposed in the tunnel, for none of the dolomitic phase was recognized and in places it seemed to be darker and suggested correlation with a higher horizon. However, there has been so much dislocation that the structure was not determinable and in the absence of fossils the above suggestion is to be regarded as little better than a guess.

At about the same elevation above Ruby Creek as the adit already described and 200 to 300 yards southeast of the open cut on the hill another open cut about 30 feet long has uncovered a zone of mineralization. The mode of occurrence is essentially the same as at the two other places, but only the upper weathered portion has been exposed. Copper minerals are less abundant here, but there is more limonite. Sulphides were but sparingly seen; the iron occurred mainly as oxide and the copper mainly as carbonate. It is reported that samples of the ore from this cut have a higher accessory gold content than that from either of the two other places.

About 3 miles west of the Ruby Creek copper leads is Aurora Mountain. The geologic structure at this place is essentially synclinal; brecciated and deformed limestone forming the top of the hill lies above a series of dark slates and schists that form the lower slopes. Near the contact between the two rock groups but occurring almost invariably within the limestone are indications of sulphide mineralization. The surface of the hill is so covered with frost-riven talus of limestone that except in artificial cuts the rocks are not exposed in place. Here and there copper carbonate float is found in considerable abundance.

Developments on Aurora Mountain consist mainly in finding places where the copper float is particularly abundant and then digging a hole through the overlying mantle of detritus. The only prospecting of this sort that has been carried to any considerable extent is on the northeastern slope of the hill about 300 feet above the contact of the limestone and schists. Exploration at this place at first consisted in sinking a shaft on the uphill side of a particularly conspicuous area of carbonate float. At the time this place was visited in 1910 the shaft was partly filled with water and its walls were so covered with ice that they could not be examined. It was reported that the shaft was about 22 feet deep and intersected a fairly promising copper lead about midway between the surface and the bottom. The bottom of the shaft is also said to have shown some good ore. Samples from the lower part of the shaft show bornite and chalcopyrite as well as carbonates.

Owing to the difficulty of mining the shaft was abandoned and a crosscut at about 250 feet lower elevation was commenced to connect with the deepened shaft. This adit is now in about 30 feet, and it will be necessary to extend it over 250 feet to reach a point directly underneath the shaft. Throughout its length the adit is in barren brecciated limestone, in few places showing any mineralization. Slickensiding is evident at many places, but although the amount of throw was not determined it probably was not very great, as different rocks were not brought into juxtaposition. In spite of the brecciation and faulting the rock stands well, and it has been necessary to timber only the entrance to the adit where it passes through the surface detritus.

Analyses by Thomas Price & Co.[1] of picked specimens of the bornite are reported to show 0.04 ounce of gold per ton, worth about 82 cents, and 1.4 ounces of silver per ton, worth about 91 cents, in addition to the copper content. Assays by the same analysts of chalcopyrite from Aurora Mountain yielded 0.01 ounce of gold per ton, worth about 20 cents, and a trace of silver in addition to the copper. Neither at Ruby Creek nor at Aurora Mountain, however, does the sulphide mineralization seem to have produced auriferous placers. In Ruby Creek colors of gold have been found, but at Aurora Mountain no placer gold has been reported in the stream gravels.

Although the Ruby Creek and Aurora Mountain localities are the only ones where prospecting has been carried on, there is probably similar mineralization at many other places. In fact, mineralization near the contact of certain of the limestones and schists has been recognized all the way from Seward Peninsula to this region. So far prospecting has failed to show that any of these deposits either in Seward Peninsula or in the Kobuk region are workable.

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[1] Lloyd, L., unpublished letter.

Until the mode of origin and the general characters of ore bodies of this type are fully understood it seems unwise to do much dead work, such as running long crosscuts to intersect a possible ore body in depth. Even after a considerable body of ore has been disclosed a careful scrutiny of the costs of mining in this remote and rather inaccessible region should be made before expensive permanent mining machinery is installed. Although these facts should not discourage intelligent prospecting, they should serve as a warning that the search is likely to be expensive, as the cost of preliminary investigation will be high.

OTHER METALLIC RESOURCES.

Galena has been found in small quantities associated with the copper sulphides at both Ruby Creek and Aurora Mountain. A small amount of vein quartz and some brecciated and recrystallized dolomite with galena was seen near the high hill west of Wesley Creek. A shallow prospect hole has been sunk on this stringer, but so far the indications are not at all promising.

At many places magnetite in masses as much as a hundred pounds or so in weight has been found on the surface, especially near the limestone-schist contacts. Float of this sort is particularly abundant on the slopes of the sharp conical hill locally known as Iron Mountain, east of the pass between Cosmos Creek and the left fork of Ruby Creek. Specimens from this place show a nearly pure magnetite with here and there drusy cavities lined with small octahedral crystals of this mineral. As the magnetite has not been seen in place, speculation as to its origin is hardly warranted. There are no near-by igneous rocks, so it seems improbable that these bodies are due to contact-metamorphic effects. Owing to the occurrence of limonite and hematite bodies in similar limestones in the Solomon region of Seward Peninsula a tentative suggestion is that the magnetite of the Shungnak region may have been formed by the metamorphism of similar iron oxides which were laid down either contemporaneously with the inclosing limestones or earlier than the great period of dynamic metamorphism. The magnetite shows no signs of having been sheared, so it must have been either entirely recrystallized or deposited subsequent to the period of regional deformation.

Whatever theory of origin of these ores proves to be the true explanation probably matters little, for the deposits so far as known have but slight economic value. The high operating costs coupled with the absence of large ore bodies will necessarily deter capital from undertaking their development.

DEPOSITS OF NONMETALLIC MINERALS.

The geographic isolation of the Shungnak region has prevented and will probably for a long time prevent the development of any of the nonmetallic resources except such as can be consumed near the place where they are produced. Of these resources the water supply is the one most necessary for local uses, but so far it has been little developed. If mining of gold and other metallic minerals increases in the region, this source of power may become of great value. At the present time, however, placer mining is conducted on so small a scale that either a sufficient water supply can be secured by short ditches or the claims can not afford to pay for an adequate supply.

In the Mesozoic and Tertiary (?) areas of the Sheklukshuk Hills and of the northern lowland some coal has been reported. The chances of finding deposits of sufficient value to be used at places more than a short distance from the veins seem to be poor. This opinion is based on the fact that on the Kobuk a coal bed belonging in this same series of rocks, exposed on the banks of the river and situated almost 200 miles nearer ocean transportation, has not proved commercially valuable, although attempts to mine it have been made at intervals ever since 1886. Although probably none of the coals that may be found in the Shungnak region will support extensive industry, their value for local consumption may be sufficient to warrant the search for coal in the areas of Mesozoic and Tertiary(?) rocks near productive metal mines.

Some attempts have been made to mine asbestos. This mineral is found in more or less close association with the greenstone intrusives. Several holes have been made in ledges of this rock on the east side of Dahl Creek above the upper placer mines, and samples of the asbestos have been submitted to manufacturers. It is reported, however, that the asbestos although of good color has slight tenacity, so it is not suitable for making high-grade articles and therefore commands a low price. For ordinary purposes this asbestos is well suited, but the small amount paid for this grade is not sufficient to pay the transportation charges. Furthermore, the amount so far known is small, and it would therefore be expensive to mine.

In almost all the streams of the Shungnak region north of the Kobuk bowlders of a hard green, slightly translucent rock are plentiful. These are commonly called jade, but this determination is probably incorrect. A complete examination has not been made, but some pieces are undoubtedly serpentine, others are green quartzite, and still others are probably nephrite. The last-named mineral is closely akin to jadeite but is an amphibole instead of a pyroxene and is not of gem quality. It is doubtful whether any jade of value occurs in this region, for of all the material from the Kobuk so far examined by the experts at the National Museum none was jade. Even in the so-called jade no pieces of gem quality were seen. The imperfections are due to rock cleavage and to the presence of a metallic iron mineral, probably magnetite. The cleavage causes the mineral to split into thin layers, which makes cutting difficult and the surface flake off; the magnetite spoils the translucency and gives the stone a spotted appearance.

SUMMARY.

In concluding this report on the economic geology of the Shungnak region certain generalizations already expressed or implied seem of sufficient importance to bear repetition. At the present time the developments are on a small scale and their production is almost negligible. Prospecting has been inadequate to test the region thoroughly, but it has been commensurate with the number of men and capital available. The future of the region seems to depend more upon the auriferous deposits than upon the nonmetallic resources or the lodes of the base metals. Therefore unless placers of a type different from those now worked are found in the gravels of the lowland areas there is only a small field for prospecting and this is limited mainly to the Cosmos Hills. The geographic conditions affecting the economic future of the Shungnak region will continue to impose limitations that only especially rich deposits will be able to overcome. For these reasons, although a small and perhaps increasing production may be expected, the region as a whole does not seem to hold forth any great promise of large enterprises. It should be stated, however, that although the region may not rival the better-known camps it appears from the observations made in 1910 to have resources capable of supporting a small community, so that some prospectors and miners will find a profitable field for exploration.

THE SQUIRREL RIVER PLACERS.

By Philip S. Smith.

INTRODUCTION.

During the later part of the open season of 1909 a new field of productive gold placers was discovered in the Kobuk mining district, Alaska. Although this camp is still in the early stages of development and although the production so far has been small, the promise held out to miners in this little-exploited field is attracting attention. The following observations were made in August, 1910, during a few days' visit to the new camp and are necessarily incomplete.

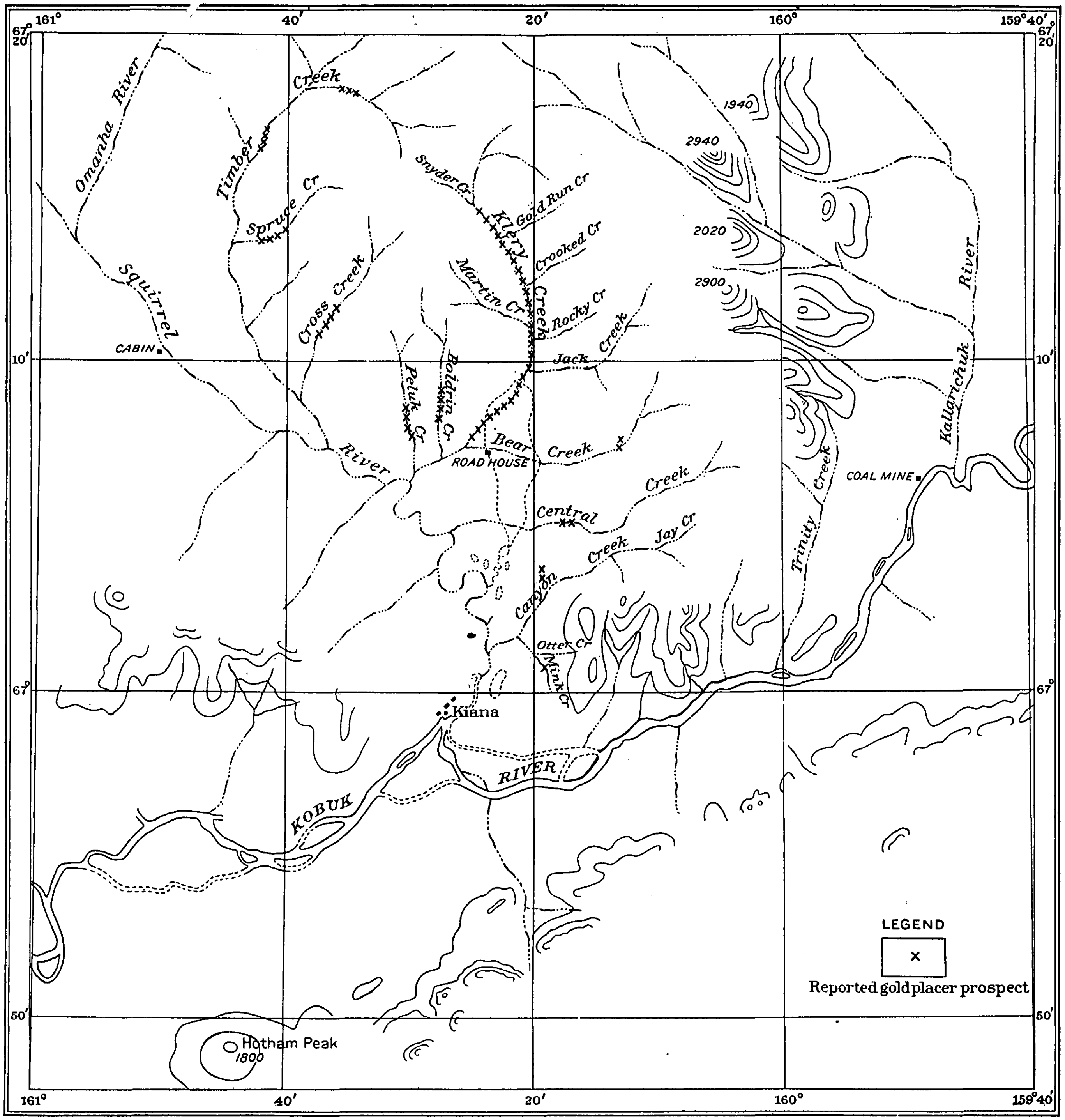
ROUTES AND ACCESSIBILITY OF REGION.

The productive area so far discovered is in the lower part of the Squirrel River basin.

The general position of this region with respect to better-known parts of northwestern Alaska is shown by figure 19 (p. 272). A larger-scale map of the eastern part of this field forms Plate XIII. This map is based mainly on surveys by Reaburn in 1901[1] and reports by prospectors, most notably John Tyapay, one of the original locators of Klery Creek, together with such notes as were collected during the writer's recent visit. But small cartographic precision can be claimed for this map, though the representation of the relation of the streams to one another is approximately correct. In such an undescribed region even a sketch map of this sort may be of service to the prospector and will certainly make the local nomenclature used in this paper much more easily understood.

Squirrel River is tributary to the Kobuk from the north, about 42 miles in an air line from Hotham Inlet or 60 miles from the nearest coast settlement, Kotzebue. Owing, however, to the circuitous course of the Kobuk and the approach to its mouth the distance to be traveled is 28 miles from Kotzebue to the mouth of the Kobuk and 68 miles from this point to Squirrel River, or a total of nearly 100 miles from Kotzebue. In the winter, when the region is ice-

[1] Mendenhall, W. C., Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska: Prof. Paper U. S. Geol. Survey No. 10, 1902.



SKETCH MAP OF SOUTHEASTERN PART OF SQUIRREL RIVER BASIN.

bound, access is much easier than during the summer, when countless sloughs and "niggerhead" tundra preclude overland travel.

Kotzebue is the seaport of the entire Kobuk region and is normally the home of a missionary and family, three white traders, a few boatmen and mechanics, and a small settlement of natives. After the break-up in the spring, however, missionaries, school-teachers, and prospectors, together with a great number of natives from all the neighboring rivers, congregate for trading and fishing in preparation for the coming winter, so that during July and August there are 600 to 700 people living in the town, which then stretches for more than 3 miles along the coast. A mail-boat service from Nome to this place is maintained every 10 days during the summer. The boats, however, are only 30 to 50 ton schooners with auxiliary gasoline power, and the passenger accommodations are cramped and inadequate, although the food is good. The trip from Nome by one of these boats takes about three days, as stops are made at many way points, and the charges in 1910 were $25 apiece for passengers and about $20 a ton for freight. It is not possible to use boats drawing more than 5 to 6 feet of water, as the channel up to Kotzebue is narrow, crooked, and shallow. Some larger boats from Seattle enter Kotzebue Sound, but they can not approach nearer than Cape Blossom, which is 10 to 12 miles south of the town of Kotzebue. In the winter a mail service by dog sledge once a month is maintained from Nome overland to Candle and Kiwalik and thence along the coast and on the sea ice to Kotzebue.

In the summer freight and passengers from Kotzebue for the Squirrel River diggings are transshipped to small gasoline launches or scows which draw only 2 feet of water or less and after crossing Hotham Inlet go up the Kobuk as far as the junction of Kobuk and Squirrel rivers. This trip takes from one to two days, depending on the stage of water and the load, and the charges are $15 apiece for passengers and about $15 a ton for freight. A short distance above the junction of the two streams is a small settlement formerly called Squirrel City but subsequently renamed Kiana. Here are a score or so of log cabins, a store and restaurant, and many native families engaged in fishing. It was understood that before the freeze-up two more stores were to be opened at Kiana and the recording office for the Noatak-Kobuk precinct was to be established at this place. The houses cling to the steeply incised valley walls, and there is but little drained flat land available on which the town can develop. Timber is scanty in the immediate neighborhood but can be floated down the Kobuk from points farther upstream where it is more abundant. Logs suitable for cabins were sold for a dollar a piece delivered in the water alongside the town. Water for domestic use is taken from Squirrel River and is likely to be contaminated unless care is exercised, but no other supply is available. Prices for staple articles in 1910 were high in Kiana owing to the cost of getting supplies into the region, the loss attendant upon the many rehandlings, and the lack of active competition.

To continue the journey to the placer diggings the next stage is by small boat from Kiana up Squirrel River. The country between the river and the hills is wet and swampy, and though during high water light-draft launches can go for many miles above the settlement, ordinarily the trip can be best made by dory or other boat drawing not over 6 or 8 inches of water. By this method Squirrel River is ascended for about 7 miles to a slough which makes off toward the north and east and which at the time of the visit by the Survey geologist was so shallow near its junction with Squirrel River that the dory, containing only about 500 pounds of freight, had to be partly unloaded and hauled over the shallow riffles by men lifting on each side of the boat. Finally the slough enters a nearly round lake between one-fourth and one-half mile in diameter, which is the nearest point by water to the placer diggings. The freight charges from Kiana to this place are 2 cents a pound. Several tents had been put up on the shores of the lake by some of the miners for their own accommodations, so that a traveler could obtain shelter. From the lake it is about 7 miles over rolling slopes to the placers that are being worked, but midway there is a road house where board and lodging can be had at a dollar a meal or bed. A freighter with two horses, employed mainly by one of the mining companies, makes more or less regular trips from the lake to the diggings. The trail is over very soft ground, where even the foot traveler is most of the time half-leg deep in muck and water, but the freighter is able to carry loads of 700 to 1,000 pounds in a two-horse wagon at a rate of about a cent a mile a pound. Although horses and wagons are used on this trail, one inexperienced in the country should be warned that only a thoroughly competent driver with horses long accustomed to the peculiar and treacherous footing can successfully make the trip. Furthermore, the cost of keeping horses in the region is great, for they must be fed oats, which cost from $100 to $150 a ton.

CLIMATE.

In addition to the difficulty of reaching the region in the summer time and the high cost of transportation, the shortness of the open season exercises a marked influence on the economic problems. The entire basin of Squirrel River lies north of the Arctic Circle, so that freezing weather prevails during much of the year. According to reports the ice is seldom out of Kotzebue Sound so that Kotzebue can be reached before the middle of July, and by the middle of September the rivers are frozen; it is unsafe to count on a much later season, though there have been years when the sound near Kotzebue was not closed before October. Therefore the open season is practically limited to two months, or about 60 days. Even during this period, however, snow and ice form. During 1910 on the night of August 15–16 ice formed on the sides of the streams and on the stagnant pools at an elevation of not more than 200 to 300 feet above the sea. On August 18 the hills around Squirrel River basin were covered with snow far down their slopes, though their tops do not reach elevations of more than 2,000 to 3,000 feet.

DRAINAGE AND RELIEF.

Little is known about the geography and geology of the Squirrel River basin. The main river probably heads against the Noatak basin on the north and the drainage into Hotham Inlet on the south. Broad flood plains traversed by sloughs and marshes occupy the lowlands from 1 to 3 miles wide on each side of the river and appear to be due mainly to the filling of a more deeply eroded older valley by thick deposits of gravel. Beyond the bottom lands the valley walls slope more or less abruptly to merge with the uplands. Even on the valley slopes, however, there are thick deposits of gravel which extend to elevations of several hundred feet above the normal level of Squirrel River. These deposits are recognizable not only in the Squirrel River basin but also for considerable distances along the Kobuk both eastward and westward.

The larger tributaries to Squirrel River, some of which are 30 to 40 miles long, in their headward portions flow on steep gradients over exposures of bedrock slightly covered with recent creek gravels. Farther down, however, benches, in part rock-cut and in part built of gravels, mark former stream levels below which the present tributaries are incised. In this portion the streams flow in rock-walled canyons, some of which are a hundred feet or more deep. Still farther downstream the creeks debouch from the hilly country and traverse the lowlands of the main river. In this part of their courses the streams are slow and have tortuous meanders and abandoned earlier channels forming sloughs that make approach difficult; no bedrock is exposed and probably it is at a considerable depth below the surface.

Little of the upland of the region was examined, so that only a most general description can be given. Viewed from a distance, however, the sky line is more or less irregular, but in general the elevations of the summits are between 2,000 and 3,000 feet. The ridges as a rule show but small undissected areas, the elevation in the main being the result of the erosive activities on the two sides of the divides. Along the summits of the higher ridges pinnacles of fantastically weathered rocks make prominent landmarks and afford excellent exposures of country rock.

VEGETATION AND GAME.

Throughout the region the vegetation is typically subarctic and arctic. All the trees show more or less stunting and the number of species is relatively few. Near the larger streams spruce forms a narrow fringe of dark green a few hundred yards in width. Few of the trees are more than a foot in diameter at the base and they taper rapidly toward the top. A few birches grow on the well-drained gravel terraces along the Kobuk, but they are not abundant in the Squirrel River basin. The white and the black birch are used as timber; the prostrate birch, which is of much wider distribution, is too small to be used even for fuel. Willow and alder are found along the smaller streams and necessarily will be an important source of fuel on many of the more remote creeks where spruce is lacking. The larger part of the basin is devoid of trees of any kind and the only vegetation on all the near-by flats and the lower hill slopes is rank grass and moss. Although the grass in places is abundant, it grows so rapidly during the long summer day and is so full of water that it does not make good feed for horses. When touched with frost, the grass seems to lose the little nourishment it had when green and stock dependent upon it rapidly lose strength.

Undoubtedly in the more remote parts of the Squirrel River basin large game, such as bear and caribou, may be found, but in the parts near the placer diggings this is not the case, and there are few indications that there has been much game in the region in the recent past. Ptarmigan and water birds, however, are abundant, and may be approached sufficiently close to obtain a considerable number, but it is believed that they are not to be entirely depended upon for food. Fish are numerous in all the streams. Salmon by the hundreds are caught in dragnets in the Kobuk and lower Squirrel River, and grayling may be had in almost all the smaller streams. So abundant are the fish that they may be safely counted on for food. The grayling will usually take either fly or bait hooks, salmon eggs on the eye of a grayling making the best bait.

GENERAL GEOLOGY.

Geologically the region presents many of the same features that are seen in parts of Seward Peninsula to the southwest. The rocks of the region, so far as known, belong in the group of metamorphic schists and limestones referred in Seward Peninsula to the Nome group. No further light was obtained as to the age of these rocks, but little hesitation is felt in assigning them to the Paleozoic or earlier periods. Schists of a variety of different characters were seen in the vicinity of the productive placers. Practically all the schists contain large amounts of chlorite, but some are dominantly quartzose and others are calcareous.

METAMORPHIC ROCKS.

The quartz schists are of two main types; one is a rather fine grained slaty schist of dark, nearly black color, with some carbonaceous material which is, in part at least, graphite; the other type is free from carbon, and the rock in fresh specimens is greenish gray, with mica or chlorite as the principal mineral observed on the cleavage surface and quartz the principal mineral observed transverse to that direction. The carbonaceous phase is lithologically similar to the Hurrah slate of the Solomon and Casadepaga region and the Kuzitrin formation of central Seward Peninsula, especially south of the Bendeleben-Kigluiak Mountains and in the southern part of the Kougarok district.

The calcareous schists, as their name implies, have a high lime content and are more or less schistose. All phases between a slightly sheared limestone and a thoroughly recrystallized schist are represented in this field. In the more schistose varieties there is an abundance of chlorite and mica flakes which increase proportionately as the lime content decreases. A yellow weathering color is in general characteristic of these calcareous schists, and topographically they do not form as prominent ridges as the limestones or some of the more quartzose schists. Some of the calcareous schists undoubtedly represent old sediments deposited contemporaneously with the sandstones which form the quartzose schists, for they appear to be interbedded with them. Some, however, are the sheared equivalents of the limestones, and these may belong to younger horizons than the quartzose schists.

Slightly sheared and metamorphosed limestones, similar in lithologic character to the thick limestones found in the vicinity of all the productive Seward Peninsula placer deposits, are recognized in the Squirrel River basin. In this district, as in the region to the southwest, these rocks make bare white hills practically devoid of vegetation, forming notable landmarks for long distances. Although minerals and structures due to dynamic deformation are developed in places throughout these limestones, the amount of metamorphism does not seem to be as great as in the quartzose schists and some of the calcareous schists. For this reason it seems probable that an unconformity exists between the heavy limestones and the metamorphic schists. This fact has not been definitely proved but seems to be indicated not only by the different amounts of metamorphism but also by the areal distribution of the limestones. No fossils have been found in the limestones of this region, and the prospector should be urged to save any traces of organisms that may be found in the rocks, as they may give a clue to many important problems.

IGNEOUS ROCKS.

In addition to the sedimentary rocks described there are also some formed by igneous agencies. These rocks are mainly the greenstones and greenstone schists. Only a few exposures of these rocks were seen, but the close similarity of the other rocks to those of Seward Peninsula suggests that probably, with more extensive study of the region, these old igneous rocks will be found to be fairly numerous. All the greenstones are more or less sheared and metamorphosed and were therefore introduced in the period preceding the great deformation of the region. None of the granites noted in parts of Seward Peninsula have been observed in this region, and there does not seem to be much probability that these more recent rocks have been injected in the neighborhood of the productive placers.

ECONOMIC GEOLOGY.

COMMERCIAL CONDITIONS.

As has already been noted, the developments in the Squirrel River region have been small, and although gold prospects are said to have been found on eight or ten tributaries of Squirrel River mining was in progress on only one of the streams, namely, Klery Creek. It is difficult to believe that this is the only place where productive placers exist, for conditions analogous to those on Klery Creek are reported at several other places in this basin. With further prospecting undoubtedly other places may be found as rich as the known ground on Klery Creek. There is, however, a strong tendency of prospectors to hold ground on a proved creek and prospect the adjacent areas only when driven to it by the exhaustion of the known ground or the inability to secure claims on a certain creek. Furthermore, the field in which placers may be expected to occur covers a large area, which takes time and money to prospect, and as yet there are but few men in the region and most of these have not enough capital to undertake any extensive exploration. At the time the region was visited by the Survey geologist there were not over 50 men in the whole region and about a third of this number were employed on one claim. Capital had not taken hold of the region, and there were few opportunities to work for wages; consequently the camps were run on a partnership basis and few of the men were equipped with the necessary supplies to carry them for a year or so of unproductive labor in building drains, etc., preparatory to opening a property. Wages were said to be $7.50 a day and board for ordinary miners, but as there was only one company employing men and as that company was able to obtain all the help it needed at $5 a day the above figures are more or less fictitious. While the labor conditions will undoubtedly change if the camp proves successful, persons should be warned against going to Squirrel River if they have nothing but wages to depend on. In 1910 there was employment for only a few men, so that without supplies or funds the venture would be unsuccessful.

Furthermore, the usual wholesale staking of the region has tied up much of the available ground, so that unless the prospector goes to some distance from the productive creeks his chance of obtaining a claim by original location is slight. One is therefore compelled to go to a considerable distance from the proved ground or else buy or obtain a lay on a recorded claim. Any of these choices compels additional expense which the prospector should be prepared to meet. The unjustness of the system is well shown on Klery Creek, where 64 claims have been recorded above the Discovery claim and at least 20 below that point, and yet work has been done on only 10 of the claims and of these probably not more than four or five have produced a thousand dollars during the last year. This statement is not intended to discourage prospecting but only to point out the small amount of work really in progress.

PLACERS.

CREEK PLACERS.

As Klery Creek is the only stream on which mining is in progress and as two or three claims on this stream were seen in detail, a description of its placers will be given. It should be borne in mind that the general facts seen at the placers where mining is being done are to be expected in similar places throughout the field, and the facts learned by mining on one claim are helpful in the understanding of unprospected ground.

The most active work is in progress near the mouth of a small tributary, Jack Creek, a short distance above the Discovery claim. At this place there is a rock-cut gorge with a gravel-covered floor about 150 yards wide. On this floor the stream formerly followed the eastern side, but in order to allow mining the stream was turned to the other side by a roughly constructed dam. Owing to the exceptionally rainy season of 1910 the stream was abnormally high, and three times during the summer the dam was completely washed away by the floods and some of the sluice boxes with the gold in them were recovered only with difficulty. The upper 12 to 18 inches of gravel in the bed where the stream had been turned aside is removed by shoveling it aside and the larger bowlders are either rolled back upon worked-out ground or are pulled out of the way by a team of horses brought in the spring from the Inmachuk. This stripping is done rapidly and is carried down to a point where the gravels show some "sediment" or fine mud coating the pebbles and filling the interstices. None of this surface material is put through the sluice boxes, as repeated experiment has shown that it contains practically no gold. Between the upper foot or foot and a half of gravel that is stripped off and bedrock is 12 to 18 inches of gravel in which values are obtained. These gravels are typical river wash but have been less recently handled by the stream than the upper ones. The lower gravels, together with the upper 6 inches to a foot of disintegrated bedrock, are put through the sluice boxes and it is from them that the gold is won.

Bedrock on this claim is mostly schist, but on the lower end of the claim and continuing downstream on the next adjacent claim is a massive, much-fractured, and contorted bluish-white limestone standing at a high angle and cutting transversely across the creek. The schist shows many different phases on the claim that is being mined. In part it is a dark graphitic slaty schist with numerous small veins and stringers of quartz. The bands of this schist are not more than a few feet in thickness and are interlaminated with somewhat calcareous and quartzose schists. Some of the latter schists are rusty yellow in color owing to the decomposition of some of their constituents. The iron mineral from which this limonite had been derived could not be determined, but it was probably in part pyrite. In at least one place on the claim a narrow band of limestone interlaminated with the schist was seen. From this description of the bedrock it is evident that lithologically the rocks are similar to those in the richer parts of the Nome region, in the Iron Creek basin, in the Kougarok, on Ophir and Melsing creeks near Council, in the Solomon and Casadepaga regions, and near Bluff. This resemblance is further strengthened by the relation of the schists at all these places to the heavy bluish-white limestones.

Several hundred ounces of gold from this claim was examined and the coarseness of the pieces was remarkable. Practically no fine gold was found and few if any pieces of the gold recovered were worth less than one-fourth of a cent. Several nuggets worth from $25 to $50 have been found, and while the writer was on the ground one nugget weighing nearly 7 ounces and worth about $125 was picked up in the gravel. In form the gold from this claim is chunky, or in nuggets, but a little wire gold was also seen, though no flaky or scaly gold was observed. The gold is dark but almost never black and shows few signs of recent movement. Although some of the corners have been rounded the gold as a whole does not appear to have traveled far. In fact, many pieces are sharp and angular as if but recently unlocked from the parent ledge. Some of the nuggets have pieces of the country rock still adhering to them. The most abundant mineral attached to the gold is quartz of the same physical aspect as the quartz in the strings and lenses in the schist. Black graphitic slaty schist is also attached to the gold in some of the specimens, and the way in which the gold forms filaments in this rock shows indisputably that some of the placer gold has been derived from this kind of country rock.

Estimates as to the value of this ground are of little use, for the nuggety character of the gold makes the tenor range between wide limits. It is reported that over 190 ounces was cleaned up from about six box lengths shortly before the visit by the Survey geologist, in 1910. At the time of the visit a clean-up of 120 ounces was made from about four and one-half box lengths. This is equal to a bedrock surface of about 500 square feet, so that the production from this cut was nearly $4.50 per square foot of bedrock. A working force of 15 men were able to strip and shovel into sluice boxes this amount of ground in a little over a day. The exact width of the pay streak is not known, for all the work so far has been only on the eastern side of the claim and the western margin of the productive ground has not been reached.

Water for sluicing is obtained from Klery Creek by running a hydraulic hose several hundred feet upstream and bringing the water thus obtained down on as flat a grade as can be maintained. This supply, however, does not furnish an adequate head, so that some other method will have to be used. But slight difficulty should be experienced in obtaining a satisfactory supply, for the volume is ample for the present demands. No accurate measurements of the volume of Klery Creek were made, but the fact that a crossing, even on a riffle, could not be made in less than 2½ feet of water, in a current of such speed that care had to be taken in keeping one's feet, shows that several thousand miner's inches is probably available during a season such as 1910. It should be noted, however, that last year was an abnormally wet one, and estimates based on observations during that time are undoubtedly above the average.

Few assays have been made of gold from this claim, but on a sample submitted to the assayer of the Nome Bank & Trust Co. a fineness of 888½ was determined. This would give a value of $18.37 an ounce.

In the concentrates collected with the gold in the sluice boxes magnetite is the most abundant mineral. This forms a much larger proportion of the concentrates than it does in those near Nome. Together with the magnetite are some ilmenite and a little pyrite and limonite. These iron minerals probably are derived mainly from the greenstones and greenstone schists, although the pyrite and its accompanying limonite may have come from veins in the schists or from the vicinity of the limestone-schist contact, a place frequently mineralized in other regions. Garnet, or so-called ruby, so commonly found in the concentrates from Seward Peninsula, is relatively rare and forms but a small proportion of the black sand. The small amount found is due to the absence of this mineral in the adjacent schists derived from igneous and sedimentary rocks. None of the rare heavy minerals have so far been recognized in the concentrates.

About a mile and a quarter upstream from this claim is another claim, where gold similar in physical character has been found. Work on this ground has been carried on by a crew of only four men and consisted mainly of dam building and bringing up a bedrock drain, so that only a small production had been made and the opportunity of examining a large amount of gold was not afforded. It seems certain, however, that the gold from this claim is of the same chunky character as on the lower claim, although the proportion of fine gold is larger and the nuggets, as a rule, weigh less. From the shape of the gold it is believed that it has not traveled far.

Midway between these two claims the gold is of an entirely different character, although the general geology shows no marked change except that the limestone is more remote and the canyon character of the valley is more pronounced. The gold from a claim in this locality is practically all in fine bright scales. No nuggets worth more than a few cents each have been recovered, though several hundred dollars' worth of gold have been won. The scales are all nearly of the same size, no flour gold being seen. All the flakes are of a bright gold color with no tarnished nor black coating. No pieces with quartz or other foreign material attached were seen. This gold was of the type locally known to the miners as "bar" gold and showed by its physical character that it had traveled much farther from the ledge from which it was derived than the gold either upstream or downstream from this place.

Gold similar to this "bar" gold has also been found downstream from the first-described claim. It is identical in all essential respects with the one just described and has probably had a similar history. The fact that this gold has traveled farther from its parent ledge is indicated by the higher assay value of the gold. It is not possible to give its precise assay value, for the sample that was tested was mixed with nugget gold from one of the claims farther upstream. This mixed sample, however, showed a higher gold content than the nugget gold previously quoted as worth $18.37 an ounce, so the difference is probably to be assigned to the greater fineness of the "bar" gold.

ORIGIN OF THE GOLD.

The distribution of the gold and the differences in the physical character presented by this mineral from the several claims in this stretch of about 2 miles present problems of economic importance. It is believed that the coarse nuggety gold on the two claims has been derived from near-by areas of bedrock and has therefore not traveled far from its source. Possibly some of it had been concentrated in earlier stages of the valley development and was subsequently reconcentrated in the present streams, but the movement of the gold by this process must have been relatively slight. On the other hand, the fine flaky gold found downstream from the areas of coarse gold seems to represent the smaller, lighter particles which, because of their size, have been carried farther from their source. Such a process of sorting is analogous to the well-known distribution of gold in a sluice box, where the larger, heavier particles are found toward the head end of the box and the smaller, lighter pieces near the foot or discharge end. According to this theory there are several localities of mineralization cut by Klery Creek, each being rather close to the areas of heavy gold, whereas in the intermediate regions the stream has not been so close to regions of as great mineralization and the gold has been derived from the areas upstream.

Too little is known about the region to determine beyond question whether the mineralization is confined to a single zone or whether there are a great number of mineralized zones, but from the number of places where gold has been reported in the Squirrel River basin it seems probable that there are at least several and possibly many zones of mineralization. Further study of this important question is necessary, for it affects the future of the region. Not only is it important in determining the probable area in which gold placers may be expected, but the information is also valuable in determining the trends of the placer ground. From the experience in Seward Peninsula it is believed that the contact of the heavy limestone and the graphitic or quartzose schists is one of the most favorable localities for searching for placer deposits in this group of rocks. This experience seems to be borne out in part by the work on Squirrel River, for the richest claim so far discovered has been near this contact. That there are other places where mineralization has been pronounced can not be doubted, and the prospector should therefore not place undue emphasis on the above suggestion.

BENCH GRAVELS.

So far only the shallow creek gravels in the stream beds have been exploited. There are, however, bench and high-level gravels in this region as well as the broad fillings of the main stream valleys which are possible sources of mineral wealth. None of these older gravels have been prospected as yet, and therefore suggestions as to their probable value or character are tentative and subject to revision when more information is obtained. The lower benches already noted as occurring at several different elevations above the tributary streams, such as Klery Creek, seem to have had essentially the same method of formation as the known auriferous creek gravels. It is therefore believed that where these benches have been developed in the neighborhood of bedrock mineralization they will produce placer gold. Most of the benches of this character on Klery Creek had but small length or breadth, so that only discontinuous deposits resulted. Such benches, however, may afford rich pockets of auriferous gravel which would well repay exploitation. Many of the benches seem to be covered with muck and turf, which suggests that the gravels are frozen and will require thawing apparatus.

The higher gravels, which are of wide extent and not only cover the lower slopes of the Squirrel River basin but also extend both up and down stream along the Kobuk, present problems much more difficult to interpret. The origin of these gravels can be determined only by a general survey of a large area in the lower part of the Kobuk Valley supplemented by numerous good sections of the deposits by means of prospect shafts. The character and distribution of these high-level gravels strongly suggest that they have not been formed by normal fluviatile action. There is a possibility that they may mark marine deposition, but it seems more probable that they are the outwash deposits from ancient glaciers that at one time occupied the more eastern part of the Kobuk Valley. If this interpretation is correct, there is small probability that economically profitable placers will be found in these gravels. Although outwash deposits may contain gold, it is believed that normally the valuable minerals are so disseminated that, except under conditions of subsequent concentration, they can not be profitably extracted. These high gravel-plain deposits consist largely of rolled quartz pebbles. No striated fragments or other marks of direct glaciation were observed. The physical condition of these gravels with respect to frost is not known. As a rule, gravel deposits at any considerable elevation above the adjacent streams are so well drained that they are not permanently frozen. At several places where these gravels are exposed in the valley walls of the tributary streams there are indications that they are not frozen. These places, however, do not give conclusive evidence of the conditions of the gravels in the intermediate area between two streams, where the gravels are not exposed to the light and air and where the ground-water level rises so that the gravels are not as well drained. From the character of the surface in some of these areas which are less well drained it seems certain that permanently frozen ground will be encountered.

No prospecting has been done in the deeper gravels that form part of the flood plain of Squirrel River, so that no definite information as to the presence of placer ground there is available. It is understood that prospectors have found colors of gold on many of the bars and in shallow holes which did not reach bedrock. The ground was frozen and the necessary machinery for exploring the deposits was not at hand, so that the deep ground was abandoned for the more easily worked shallow creek diggings. From the experiences on Seward Peninsula it seems questionable whether important placer deposits will be discovered in these flats. It should be reiterated, however, that the data for basing a decision are inadequate, and the above suggestion is little better than a guess warranted only by the desire to prevent the reckless expenditure of time and money on ill-considered projects.

SUMMARY OF CONCLUSIONS.

Taken as a whole, the Squirrel River region is one in which the small amount of prospecting already done has disclosed productive placers. The extent of these has not been determined, but it is believed that the region affords a good opportunity for industrious and capable prospectors. The rigors of the climate and the short working season are against the development of a large camp and should dissuade the incompetent from invading the new district in a "stampede." The similarity of the placers so far discovered to those in the more productive parts of Seward Peninsula gives faith in the future of the region. This belief would be further strengthened if prospecting should show the existence of valuable bench or deep deposits capable of supporting mining during the winter season. A large output in the near future is not expected, but adequate returns for intelligent and competent exploitation are indicated by the present results.

INDEX.

RECENT SURVEY PUBLICATIONS ON ALASKA.

[Arranged geographically. A complete list can be had on application.]

All these publications can be obtained or consulted in the following ways:

1. A limited number are delivered to the Director of the Survey, from whom they can be obtained free of charge (except certain maps) on application.

2. A certain number are delivered to Senators and Representatives in Congress for distribution.

3. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they can be had at prices slightly above cost. The publications marked with an asterisk (*) in this list are out of stock at the Survey, but can be purchased from the Superintendent of Documents at the prices stated.

4. Copies of all Government publications are furnished to the principal public libraries throughout the United States, where they can be consulted by those interested.

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Rampart quadrangle; scale, 1:250,000; by D. C. Witherspoon and R. B. Oliver. For sale at 10 cents a copy or $6 per hundred.

Fairbanks special map; scale, 1:62,500; by T. G. Gerdine and R. H. Sargent. For sale at 10 cents a copy or $6 per hundred.

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Topographic maps.

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Grand Central special, Seward Peninsula; scale, 1: 62,500; by T. G. Gerdine.

Nome special, Seward Peninsula; scale, 1: 62,500; by T. G. Gerdine.

Solomon quadrangle, Seward Peninsula; scale, 1: 62,500; by T. G. Gerdine.

The following maps are for sale at 25 cents a copy or $15 per hundred:

Seward Peninsula, northeastern portion of, topographic reconnaissance of; scale, 1:250,000; by T. G. Gerdine.

Seward Peninsula, northwestern portion of, topographic reconnaissance of; scale, 1:250,000; by T. G. Gerdine.

Seward Peninsula, southern portion of, topographic reconnaissance of; scale, 1:250,000; by T. G. Gerdine.

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