TIN MINING IN SEWARD PENINSULA.

By GEORGE L. HARRINGTON.

SUMMARY OF MINING OPERATIONS.

A résumé of the history of tin mining in Alaska up to 1914 has been compiled by Eakin,[1] and the following summary of operations up to that date is largely abstracted from his report.

Stream tin was first found on Buhner Creek, a tributary of Anikovik River, in 1900, and there has been some production of cassiterite from placer operations in the York region since 1902. In 1911 a dredge was installed on Buck Creek which has been in operation each season since. Two dredges were installed on Anikovik River in 1914 for the recovery of both gold and cassiterite but were operated only during that and the following season. A second dredge was installed on Buck Creek in 1915 and has worked each summer since that date. The machinery of one of the dredges on Anikovik River was removed from the hull in 1916 and installed on a dredge on Swanson Creek, a tributary of Agiapuk River. The hull was carried out to sea by high water and lost. The other dredge on Anikovik River was idle in both 1916 and 1917.

Collier states[2] that "small specimens of stream tin have been found in the northern part of Seward Peninsula, from Cape Prince of Wales to the south shore of Kotzebue Sound, and in the southern part of the peninsula the ore has been found in several streams of the Nome district."

Hess mentions[3] that Goldbottom Creek in the Nome district, Fred Gulch, north of Mount Distin, Dick Creek, Old Glory, and a "few other creeks of the Arctic slope east of Ears Mountain carry some stream tin."

Cassiterite lodes were discovered at Cape Mountain in 1902 and on Lost River the following year. Mining operations have been carried on at both localities ever since, although in a somewhat desultory fashion. Two stamp mills have been erected at Tin City to handle ore from two properties, and a small tonnage has been produced, but both properties have been idle for several years. At Lost

[1] Eakin, H. M., U. S. Geol. Survey Bull. 622, pp. 81–94, 1915.
[2] Collier, A. J., U. S. Geol. Survey Bull. 259, p. 126, 1905.
[3] Hess, F. L., U. S. Geol. Survey Bull. 284, p. 157, 1906.

River assessment work has been done annually for a number of years on a group of claims, and a fair stage of development has been reached. This property has been leased to different corporations which did some mining, milling the ore in a small test mill at the mine on Cassiterite Creek. In 1917 lumber and machinery for a mill at this property was at Teller, but the only assessment work was done at the mine.

Assessment work has been done for a number of years on several lode prospects at several places in western Seward Peninsula. By far the largest proportion of the Alaskan tin production has come from the placer operations on Buck Creek or from Grouse Creek, into which it flows. A small production of placer tin has been made from Cassiterite Creek.[1] Placer tin has also been recovered in the Yukon-Tanana region in the Hot Springs district, and a small production has been made in the Ruby district. Investigations of the possibilities of the tin production of these two districts were made in 1917 by Theodore Chapin, and his reports appear in another chapter of this volume.

Investigations of the tin deposits of the York region have been made by a number of Geological Survey parties, the scope ranging from hasty reconnaissance trips to obtain the new facts revealed by mining developments to detailed studies of the one occurrence. The most complete of these studies were made by Collier and later by Knopf, in whose reports will be found a description of most of the essential features covering the geologic occurrence of the cassiterite. The following publications deal primarily with the tin deposits of Seward Peninsula:

Brooks, A. H., A new occurrence of cassiterite in Alaska: Science, new ser., vol. 13, No. 328, p. 593, 1901.

Brooks, A. H., An occurrence of stream tin in the York region, Alaska: U. S. Geol. Survey Mineral Resources, 1900, p. 270, 1901.

Collier, A. J., The tin deposits of the York region, Alaska: U. S. Geol. Survey Bull. 229, 1904.

Collier, A. J., Recent developments of Alaska tin deposits: U. S. Geol. Survey Bull. 259, pp. 120–127, 1905.

Hess, F. L., The York tin region: U. S. Geol. Survey Bull. 284, pp. 145–157, 1906.

Knopf, Adolph, Geology of the Seward Peninsula tin deposits, Alaska: U. S. Geol. Survey Bull. 358, 1908.

Hess, F. L., Mineral resources of Alaska, 1911: U. S. Geol. Survey Bull. 520, pp. 89–92, 1912.

Eakin, H. M., Tin mining in Alaska: U. S. Geol. Survey Bull. 622, pp. 81–94, 1915.

The following publications contain only incidental references to the occurrence of tin in the same region:

[1] Eakin, H. M., op. cit., p. 89.

Brooks, A. H., A reconnaissance of the Cape Nome and adjacent gold fields of Seward Peninsula, Alaska: U. S. Geol. Survey Special Pub., pp. 132–139, 1901.

Collier, A. J., A reconnaissance of the northwestern part of Seward Peninsula, Alaska: U. S. Geol. Survey Prof. Paper 2, pp. 49–51, 1902.

A demand for a knowledge of the present possibilities of production of both the lode and placer tin deposits of the York region, resulting from the urgent need of tin, and the desire to find a source of this metal nearer than the Asiatic deposits led to the somewhat brief reconnaissance of portions of the York region in 1917. This report aims to present briefly the data obtained regarding developments and possibilities of production rather than to present geologic facts which have been given in the reports already cited, especially those of Collier, Knopf, and Eakin.

Acknowledgments are due and gladly given for courtesies received from Mr. T. A. Peterson, of the York Dredging Co., and Mr. A. Graham, of the American Tin Dredging Co., on Buck Creek, and Mr. William O'Brien on Lost River. Information regarding the tin deposits of Ear Mountain was received from Mr. T. Winfield, of Teller. Mr. Fred Hinton, of Teller, gave the writer his information regarding developments at Tin City.

CASSITERITE LODES.

Other work seriously curtailed the scope of the tin investigations in 1917, so that it was not possible to visit either Ear Mountain or Tin City. A superficial examination of the lode prospects near Potato Mountain was made, and portions of two days were spent on Lost River.

LOST RIVER.

In September, 1917, about 150 feet of additional drifts had been driven since Eakin visited the property in 1914. He says concerning the development on Cassiterite Creek at the Cassiterite and Ida Bell lodes:[1]

> The maximum width developed is 23 feet, and the average width is estimated at 12 feet, from the evidence afforded by numerous crosscuts along about 1,100 feet of drifts. The extreme limits of development work embrace a horizontal distance of 1,420 feet and a vertical distance of 410 feet above the creek bottom. The indications point to the persistence of the lode in form and character below the creek level, and no special mining difficulties at depth are indicated.
>
> Some strong veins carrying tin crop out 300 feet north of the Cassiterite lode and dip 45° S. The lode itself dips 85° in the same direction, and if these dips persist the veins should meet the lode at a depth of about 300 feet below the creek level.
>
> Developments on the Cassiterite lode in July, 1914, consisted of 1,094 feet of drifts on five levels, besides a number of crosscuts, and an upraise of 108 feet between the first and second levels east.

[1] Eakin, H. M., op. cit., pp. 86, 87.

About 2,000 tons of ore taken from the first and second levels east lies on the dump at the portal of the lower adit.

The test mill of the Lost River mine plant has operated for two successive seasons. The dump, containing about 2,000 tons of run-of-mine ore, was sampled by trenching entirely across its center and milling all the ore as it came. The results of the test probably indicate very closely the general tenor of the dump as a whole and of a large body of minable ore blocked out by the developments indicated.

The managers report that about 4 per cent of concentrates were obtained from the ore milled during the two seasons and that no notable variation was observable at any period of operation. The concentrates are very clean and are said to contain an average of 62.31 per cent of metallic tin and 11.08 per cent of metallic tungsten.

The Ida Bell lode strikes northeast and intersects the Cassiterite lode at the surface 700 feet west of the creek and 225 feet above creek level. Its dip is approximately 90°. It is wider than the Cassiterite lode, ranging from 25 to 35 feet. Developments on this lode include a 70-foot adit and a 60-foot winze sunk at its extremity.

Like the Cassiterite lode, the Ida Bell is a quartz porphyry dike, but the pronounced alteration of the former is not here duplicated. For the most part the lode consists of firm, slightly altered quartz porphyry intricately traversed by thin, rich veinlets with cassiterite as the only conspicuous valuable mineral. The ore is reported to be of good quality, but owing to its hardness it will require different treatment from that adapted to the Cassiterite lode ores, which are soft. Further development of this part of the mine will await a higher development of the reduction plant.

Development work since 1914 had been mainly on the east side of the creek; that for 1917 contemplated the enlarging of the main haulageway of the lowest level of the mine.

This property has sufficient ore either mined and on the dump or developed so that production could be commenced as soon as a mill is installed. Milling machinery and the necessary lumber for the erection of a mill building were at Teller in 1917. It is probable that this equipment could be most easily hauled to the mine during the winter, for the road from the mouth of Lost River to the mine crosses the river by fords severals times and would be impassable at high stages of the water. Where it is above high-water stages, this road is in good condition. If a great amount of hauling was to be done it would probably be economical to build a road on the east side of the creek, which would involve comparatively little work.

For summer work hydroelectric installation would probably prove most satisfactory. For year-round operation, however, auxiliary power would be needed, which would be most economically furnished by internal-combustion engines, using crude oil or distillate as fuel. No timber other than driftwood on the beach is available for fuel. Timber for the mines must be shipped in.

In addition to cassiterite the ore contains considerable wolframite, which may equal the cassiterite in amount. It adds materially to the

value recovered from the ore. The two minerals should be separated before smelting.

This property appears to offer the greatest hope of an increased production of tin, but although it is sufficiently developed to warrant the installation of a small mill, after thorough sampling and after data have been obtained as to costs of production, the output in the next few years is not likely to amount to more than a very small percentage of the country's needs.

EAR MOUNTAIN.

The lode deposits of Ear Mountain, together with their earliest geologic features, have been described by Knopf.[1] A considerable amount of prospecting has been done in this vicinity, and there has been some development work since Knopf's visit. This work has for the most part amounted only to the annual assessment work necessary to maintain title to the claims.

This area is much more difficult of access than Lost River, for it is 12 miles from Shishmaref Inlet—a large lagoon of shallow water navigable only to very shallow-draft boats. Light-draft steamers must unload at least 1½ miles from the entrance to the lagoon. On account of these conditions, a considerably higher grade of ore must be found in this locality than on the south side of Seward Peninsula in order to make mining profitable.

POTATO MOUNTAIN.

A number of open cuts have been made on the tops of the hills near Potato Mountain, some of which are said to have shown good ore in the bottom. Bedrock has, however, been covered by the caving in of the sides of the prospect pits. The geologic features of the deposits of this area are described by Knopf.[2] Since Knopf's visit a number of other cuts and prospect holes have been dug. A short tunnel, which shows some stringers of quartz with cassiterite, has also been driven. Prospecting has failed to afford any indications of the extent of the ore bodies shown in the openings.

This prospect lies about 16 miles from York. A road which has been in use for teaming supplies for the Buck Creek dredges since 1911, runs within about 2 miles of the prospect. The road lies mostly along the watercourses of Anikovik River and Grouse and Buck creeks, crossing and recrossing them, and consequently is not especially good for heavy hauling.

Until further development has taken place the possibilities of the production of this property can not be stated. Under present con-

[1] Knopf, Adolph, op. cit., pp. 25–32.
[2] Idem, pp. 32–35.

ditions it would take at least two or three years before any production could be made.

CAPE MOUNTAIN.

A considerable amount of work was done for a number of years near Cape Mountain. A study of these deposits also was made by Knopf and a description of them is contained in his report.[1]

Two properties have been extensively prospected by tunnels, shafts, and winzes, and a number of other claims have had a small amount of work done on them.

On the property formerly belonging to the Bartels Tin Mining Co., which was later sold to the Empire Tin Mining Co. and still later is said to have been sold at marshal's sale to Fred Hinton, of Teller, there are about 1,255 feet of tunnels and winzes. Knopf states[2] that at the time of his visit an 18-inch belt of tin ore about 400 feet from the mouth of the tunnel had not been exploited. A few tons of ore were milled in 1914 from the North Star claim, but the place in the workings from which it was obtained is not known. Some of the ore is said to run very high in cassiterite, but the reported average of such ore as is developed is about 3 or 4 per cent. The property includes a small mill, containing three stamps and a table. This group of claims has been patented and no work has been done since 1914.

Although a considerable length of tunnels, cross drifts, and winzes has been driven on this property, there appears not to have been development commensurate with the labor expended. Probably the claims of the group contain some bodies of good tin ore, but the development has failed to outline them, and further work is necessary before a statement of the potentialities of the property can be made.

On the property of the United States Tin Mining Co. a shaft has been sunk on a quartz ledge and a rather long tunnel driven in hard granite to intersect this ledge. A mill has been erected near the beach at Tin City to handle ore from this property. The claims are patented, but no work has been done on them for a number of years.

Sufficient data are not at hand to warrant any statement as to possibilities of production from the group of claims held by this company. However, as no work has been done for some time, notwithstanding the prices prevailing for tin in recent years, it may reasonably be inferred that the stage in development has not yet been reached where any appreciable production can be counted on in the near future.

---

[1] Knopf, Adloph, op. cit., pp. 35–41.
[2] Idem, p. 40.

OTHER LODES.

In addition to the properties above mentioned, there are a number of other prospects in the York region, including Brooks Mountain and others than those already mentioned in the vicinity of Cape Mountain. The work on these properties has been of a desultory character and of relatively small amount. They appear to be negligible in any consideration of the possibilities of the production of tin.

Besides the lodes which are being worked for tin mainly or chiefly, tin could possibly be recovered as an accessory mineral from other lodes in the York region. There are a number of silver-lead prospects on Lost River, on two of which some work was done during the summer of 1917. A third on Rapid Creek, a tributary of Lost River, is said to be extensively developed. At the Southern Cross lode tunnel on Lost River, opposite the mouth of Tin Creek, assays are said to show a small percentage of tin and tungsten, which probably occur as cassiterite and wolframite. In any treatment of the ores involving concentration on tables these minerals would be recovered. It is not known whether or not cassiterite occurs at the other prospects. The output of tin as a by-product of these lodes will probably be small.

CASSITERITE PLACERS.

LOST RIVER.

A small production of placer tin was made one year on Cassiterite Creek, and it is said that a considerable amount of residual placer tin occurs on the slope of the hill near the mine. If hydroelectric power was used on this property and the water flumed to the mill, this ground could be sluiced and the tin recovered.

EAR MOUNTAIN.

A number of the creeks that head in Ear Mountain carry placer tin. Knopf[1] states that nuggets of cassiterite several inches in diameter can be picked off the bedrock riffles of Eldorado Creek, but on account of the small body of gravel the creek offers no placer possibilities.

The gravels on Tuttle Creek are said to carry 5 ounces of cassiterite to the pan, but their extent is not known, so that the opportunity for commercial placer development can not be stated. If the gravels are as rich as reported a small sluicing plant could possibly operate successfully. Transportation of supplies to this locality, however, involves a haul to the edge of Shishmaref Inlet and ship-

[1] Knopf, Adolph, op. cit., p. 26.

ment across this lagoon to Sarichef Island, where during favorable weather, small coasting schooners lay offshore and pick up or deliver freight.

BUCK CREEK.

By far the largest production of tin in the York region has been from the placers of Buck Creek, although during 1916 and 1917 the York Dredging Co. was operating on Grouse Creek, into which Buck Creek flows. The dredge of the American Tin Dredging Co. operated on Buck Creek. The area of placer ground on both streams suitable for working with a dredge is small, and a very few more seasons of work will exhaust the deposits. Sutter Creek was being prospected during the summer with a view to dredging, but this also is a short stream and would afford not over two or possibly three seasons' work with a dredge. There is a possibility that a considerable amount of ground above the limits of dredging operations can be worked profitably by shoveling or scraping into sluice boxes. The amount that could be recovered in any one season is small, for the supply of water for sluicing is not great and the scope of operations would depend largely upon the quantity of water available.

During the summer of 1917 two men took out a few tons of cassiterite from Iron Creek, a short tributary of Sutter Creek, heading against Buck Creek in the saddle just east of Potato Mountain. It is estimated that the gravels, which are 4 or 5 feet deep, carry about 15 pounds of tin to the cubic yard for a width of 15 to 20 feet. Placer ground on this creek extends not over a mile, and the upper limits of operations had been nearly reached in 1917, at a point where the stream valley becomes very narrow and the amount of gravel negligible in amount. Water for sluicing was scarce, and an intermittent supply for sluicing was obtained by building a small dam, which gave a full sluice head for a sufficient length of time to permit the successful washing of the gravel. Three boxes, 8 inches wide, were used, and the grade was 10 inches to the box length. Iron riffles were employed.

In all about 26 men were engaged during the year on Iron, Buck, and Grouse creeks in the production of placer tin. Two dredges and one plant shoveling in were operated.

ANIKOVIK RIVER.

No production of placer tin has been made on Anikovik River since 1916. The one dredge on this stream was idle in 1917 also. Assessment work was done on a number of claims. Data are not available to warrant any statement as to their placer possibilities.

SUMMARY.

Lode mining in 1917 was confined to development work on Lost River and Ear Mountain without any production. Lost River is believed to have possibilities as a producer of lode tin. Further development is necessary at other properties.

Placer mining in 1917 was limited to the vicinity of Buck Creek. About 300 tons a year appears to be the limit of production for this area, and this production will be limited to a period of not over five years; after that time there will be production of only a few tons annually from sluicing operations. Placers may be developed in the vicinity of Ear Mountain, but the production in this vicinity will be small. On Lost River a few tons of residual placer tin may be recovered when water is available for sluicing. Anikovik River has a greater area of stream gravels which may be dredged than any of the other placers. A bedrock of finger slates, in a nearly vertical attitude and with numerous reefs, may interpose difficulties in dredging, involving a loss of some cassiterite and probably a considerable amount of the gold. The possibilities of the stream can not be stated.

GRAPHITE MINING IN SEWARD PENINSULA.

By George L. Harrington.

The graphite deposits of Seward Peninsula have long been known, but a number of factors have hitherto prevented their exploitation and development.

Gold has so long occupied the dominant position in the mineral production of the district that other minerals have been but little considered by the miner. Moreover, gold mining possesses an exceptional advantage in that the product has usually an immediate local market through banks and merchants, at a reasonably high percentage of its value, the base price remaining constant. With other minerals, and especially with graphite, it has been necessary to obtain a higher grade of product than that which results directly from mining operations. With graphite hand sorting at the mine and further treatment after shipment to Seattle or San Francisco has been necessary before the material could be marketed. A system of treatment had to be developed and a market found for the refined product after tests had demonstrated its adaptability to certain uses and its unsuitability for others. The rather small market on the Pacific coast and the distance to the eastern market have also affected the output. Low prices until recently have been an additional drawback to mining in Alaska, where comparatively high prices for supplies and labor prevail. The high prices in 1917, combined with the fact that wages and southbound freight charges had increased but little, appeared to warrant extensive development of the deposits, provided a market could be developed.

These deposits were described by Moffit[1] as follows:

> Graphite is abundant in some of the black schist beds belonging to the Nome and Kigluaik groups and gives them their characteristic color but is not known in a form to make it of economic importance within the Nome and Grand Central quadrangles. Just north of the Grand Central area, however, in the headwater areas of Grand Central River and Windy Creek, especially in the vicinity of the divide between these two streams, are graphite deposits of considerable size. Their occurrence, as well as that of graphite on the north side of the Kigluaik Range west of Cobblestone River, has been known for a long time, but only recently have they received especial attention from prospectors.

[1] Moffit, F. H., Geology of the Nome and Grand Central quadrangles, Alaska: U. S. Geol. Survey Bull. 533, pp. 135–136, 1913.

A sharp ridge made up of biotite schist striking east and west and intruded by dikes and sills of coarse granitic rock or pegmatite rises on the south from the saddle between the Grand Central and Windy Creek. Some of the schist is highly graphitic, the graphite appearing as abundant small scales on the cleavage surface and much of it not being distinguishable on casual examination from flakes of biotite. Locally graphite is segregated in beds or much flattened lenticular masses that conform in direction with the schist cleavage and reach thicknesses of 6, 8, or even 18 inches. These beds include thin layers of schist containing numerous large garnets and much quartz. The raw graphite found at this place is heavier than the higher grades of graphite, owing to its included quartz.

The sills and dikes of pegmatite cutting the schist also contain graphite, which is associated with them in such a way as to suggest a close relationship between the intrusives and the graphite. Graphite appears to be an original mineral in the pegmatite as well as to be associated with it in the schist. At one place about 8 inches of solid graphite is included between a pegmatite sill and the overlying schist. The steep slopes of the mountain are strewn with graphite fragments, which, owing to the fact that they are much lighter in weight than either the schist or the pegmatite, appear more abundantly on the surface, especially in gullies where water has brought about a rough sorting. One block, with dimensions of approximately 7 feet, 6 feet, and 30 inches, consists of about equal thicknesses of schist and apparently almost pure graphite.

The graphite-bearing schist extends eastward beyond the east fork of Grand Central River and westward across Windy Creek and the head of Cobblestone River to the region south of Imuruk Basin, in which the graphite is even more extensively developed than in the locality described and from which a number of commercial shipments have been made.

Development work has been chiefly confined to those deposits on the north side of the Kigluaik or Sawtooth Range, west of Cobblestone River. Most of the work has been limited to two groups of claims, those of the Alaska Graphite Mining Co. and those of the Uncle Sam Alaska Mining Syndicate. The claims of the first group lie about 4 miles east of Graphite Bay, an arm of Imuruk Basin, and 2 miles west of Cobblestone River. The camp of the other group is 2 miles south of Graphite Bay and about 2 miles west of the camp of the Alaska Graphite Mining Co.

From Graphite Bay there is a moderately gently sloping gravel plain that extends up to the camps, the upper part of the slope being somewhat steeper than the lower part. The plain is formed of the gravels and alluvial débris, which were brought down from the higher parts of the range, and talus in interstream areas. Streams flow for short distances in V-shaped valleys, up to 50 feet deep through the talus accumulations, then their valleys widen and coalesce with the frontal plain of the range.

At an elevation of 500 feet a distinct change in topography marks the contact of the talus and alluvial material with the underlying schists and gneisses, which form the steep north slope of the Kigluaik Range. Graphite lenses are found along this steep slope for

several miles west of Cobblestone River. Development work has been confined to those outcrops which lie between elevations of 500 and 1,000 feet, although there are said to be other lenses higher up the slope. In September, when this area was visited, recent snows extended down to about 750 feet, preventing any geologic work above that elevation.

The lenses of graphite occur in association with quartz schists that carry biotite, but garnetiferous schists that carry some calcite are also locally present. Some of the quartz schists have the appearance of beds of metamorphosed sandstone. Tourmaline was noted in small grains in the graphite at one locality. Granitic rocks appear to make up a portion of the core of the range. The general trend of the schists in which the graphite occurs is a little north of west, and the dip is 60°–75° N. Locally there are two or three series of graphite lenses which are parallel in strike and dip, but it can not be positively stated, without further very detailed studies, that they represent more than one horizon which may have been repeated by faulting or close folding.

The topographic situation and nearness to water transportation have favored development work at these deposits, in comparison with those which are said to occur for several miles eastward, extending along the front of the range beyond Cobblestone River, and appearing on the hill slopes or in the stream valleys which are incised into the range.

The first claims were staked in 1900, but in the succeeding years little has been done until recently except assessment work. Small shipments have been made from time to time for making mill tests or for samples of the material, but no steady production has been maintained. About 120 tons were shipped by the Uncle Sam Alaska Graphite Mining Syndicate in 1912,[1] but no shipment has been made by this company since. Assessment work has, however, been done on the nine claims of the group. As the lenses dip with the slope of the hillside, but more steeply, little work has been necessary to prove the existence of the bodies, and the assessment work has therefore taken the form of open cuts, from each of which a few sacks of graphite have been taken, so that there is now sacked and ready for shipping a considerable amount of hand-sorted graphite. Some of this graphite will require resacking before shipping. Two short tunnels have been driven on claims of this group. The development work to date has shown the presence of a number of lenses of graphite which may be continuous, but their size and continuity have not been proved.

A small frame bunk house is the only building on the property.

[1] Mertie, J. B., jr., U. S. Geol. Survey Bull. 662, p. 449, 1917.

The property now being worked by the Alaska Graphite Co. consists of five claims which were staked in 1905 and three claims which were staked by N. Tweet in 1915 or 1916. In 1906 the bunk house on the property was built, and the following year about 35 tons of graphite was picked from the talus on the steep hillside and shipped. Other smaller shipments followed in succeeding years.

Several tons of graphite were mined in 1916 but not shipped. In 1917 a large portion of the time of the seven men employed was consumed in making and repairing the road to Graphite Bay, as the unusually rainy weather during August made it necessary to corduroy the roads with alders, the only material at hand. In spite of this delay, however, a considerable tonnage of hand-picked graphite was mined from an open cut and shipped to San Francisco, together with that which was mined the previous year.

Most of the production of 1916 and 1917 was made from an open pit about a hundred yards west of Glacier Creek, the first stream west of Cobblestone River. As exposed in the pit, the lens on which the mining was done had a width of 4 to 6 feet of graphite, the impurities in which consisted of thin seams of quartz and schist. It appears in the bottom of the cut for a length of 30 feet, and the footwall has a height of about 20 feet. The graphite, which is exposed at one end of the cut, has a greater horizontal dimension than that given, and its vertical dimension has not been determined. On the east side of Glacier Creek a lens or series of closely spaced lenses of graphite that has a total vertical height of 400 feet or more is exposed. A few small open cuts afford some indications of a thickness which is comparable to that in the pit that is being worked.

An 8-inch hydraulic pipe 400 feet long serves to convey the graphite from the pit to the loading station, 150 feet lower. Hand-sorting is done at the pit, and there are a number of tons of low-grade graphite on the dump.

Transportation from the mine to Graphite Bay is by trucks drawn by a gasoline caterpillar tractor. At Graphite Bay the graphite is loaded on scows, which are towed to Teller, and there it is loaded on ocean steamers.

In addition to the open pit near Glacier Creek there are a number of short tunnels and open cuts about a quarter or half a mile west of Glacier Creek, near the bunk house and cook tent of the company, from which there has been some production in previous years.

On the steep hillside between the pit and bunk house are a number of exposures of graphite, but little development work has been done to afford an indication of the size of the bodies. Some of these bodies, so far as can be told on a surface partly obscured by talus, are at least 100 feet long, 50 feet wide, and a foot or more thick.

There appears to be an opportunity for the development of a large amount of graphite from these deposits. Transportation problems are relatively simple. If a sufficient tonnage is mined aerial trams, possibly of a gravity type, might be used from one or both properties. For smaller tonnage good roads could be easily constructed for team or power haulage, and the power required for hauling loads would be small, on account of the generally uniform downhill slope to the shipping point. Graphite Bay affords a good shallow harbor, for numerous small coves and islands give protection from storms.

If a mill should be erected at either property hydroelectric installations would probably prove the more economical for summer operations, power being derived from some of the small streams which cross the claims. For winter operations other power would be necessary.

THE GOLD AND PLATINUM PLACERS OF THE KIWALIK-KOYUK REGION.

By GEORGE L. HARRINGTON.

INTRODUCTION.

The principal work of the Geological Survey in the general region of the Kiwalik and Koyuk basins was done by three parties, those of Peters and Mendenhall,[1] who in 1900 ascended the Koyuk; of Witherspoon and Moffit,[2] who mapped both topographically and geologically the region south of Kotzebue Sound; and of Smith and Eakin,[3] who mapped the area between Nulato, on the Yukon, and Council. In addition data in regard to water resources have been obtained through the work of F. F. Henshaw[4] in 1907 and 1909 and some geologic notes were also obtained by Mendenhall[5] at the close of the field season of 1901, when he visited the shores of Kotzebue Sound.

The following report is based upon the reports of the earlier workers in this field, supplemented by data obtained by the writer during August, 1917, when he spent a few days in the vicinity of Candle, two days on Bear Creek, and about two weeks in the study of the gold and platinum placers of Sweepstakes and Dime creeks.

No additional information was obtained regarding the region outside of the Kiwalik, Bear Creek, and Koyuk drainage, but for the sake of completeness the drainage and geologic features of the adjacent region are shown on the accompanying map (Pl. X).

The kindly hospitality of the miners and prospectors of the region is gladly and gratefully acknowledged by the writer, for without their assistance it would not have been possible to carry out the investigations so easily or so speedily.

[1] Mendenhall, W. C., A reconnaissance in the Norton Bay region, Alaska, in 1900: U. S. Geol. Survey Special Pub., 1901.

[2] Moffit, F. H., The Fairhaven gold placers, Seward Peninsula, Alaska: U. S. Geol. Survey Bull. 247, 1905.

[3] Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, Alaska: U. S. Geol. Survey Bull. 449, 1911.

[4] Henshaw, F. F., and Parker, G. L., Surface-water supply of Seward Peninsula, Alaska: U. S. Geol. Survey Water-Supply Paper 314, 1913.

[5] Mendenhall, W. C., Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska: U. S. Geol. Survey Prof. Paper 10, 1902.

GEOLOGY.

GENERAL FEATURES.

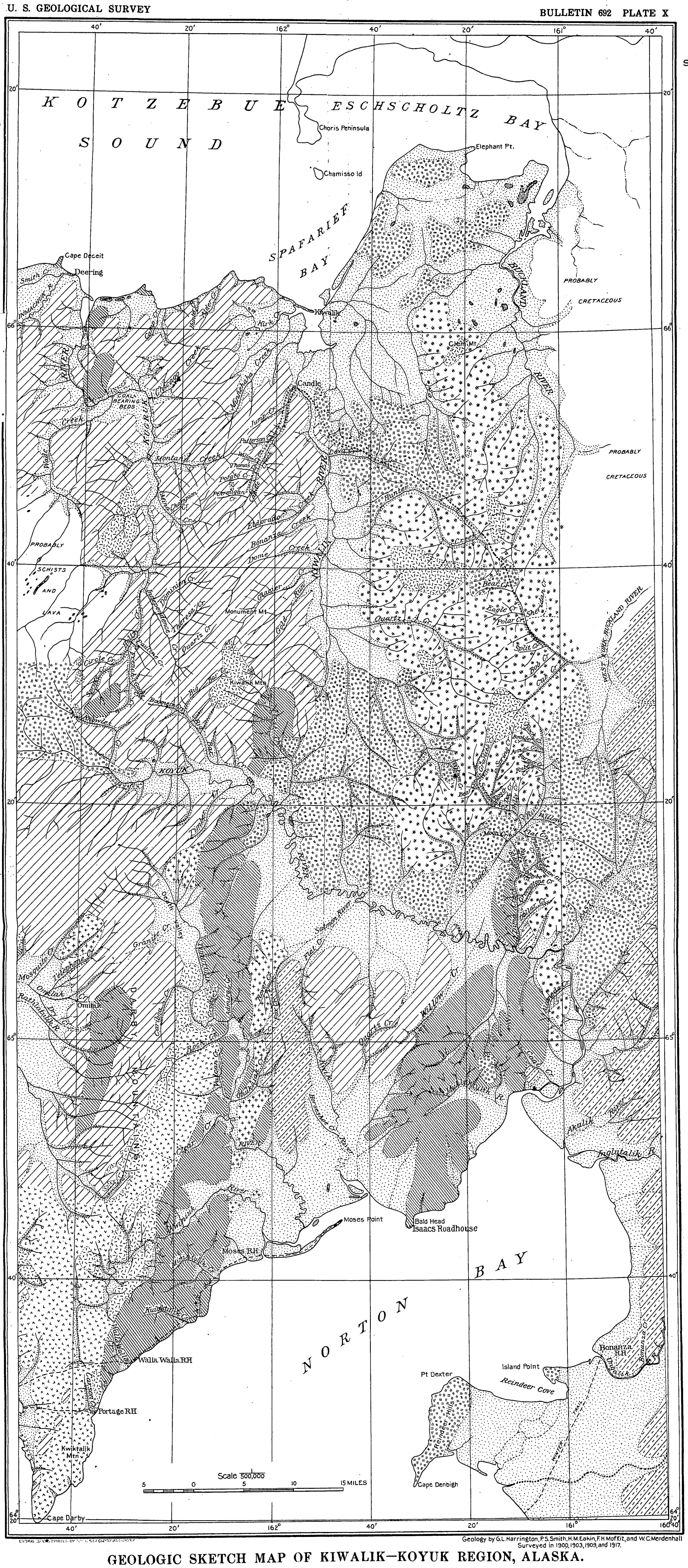
The region covered by this report contains a number of geologic units. As far as possible these units have been mapped separately, but lack of outcrop and the brevity of the time spent not only by the writer but by other Survey parties engaged in geologic investigations in this region have prevented the obtaining of the information necessary for accurate mapping. Errors of detail may therefore occur, but the main geologic features will be found essentially as mapped. (See Pl. X.) For the sake of completeness, the map is made larger than necessary to cover the work in 1917 in order to show the broader areal relations, which have been elucidated by the work of previous investigators.

The oldest rocks of the region are the series of Paleozoic or older schists, slates, and limestones, which, in the northern portion of the area, appear mainly west of the Kiwalik, although to the east of this river some outcrops are known. The series extends south to Golofnin Sound, where it includes also some metamorphosed igneous rocks.

A series of andesitic volcanic rocks, which embraces some waterland tuffs and includes flows and breccias, occupies much of the area north of the Koyuk between the Kiwalik and the Buckland. These rocks have suffered some alteration, owing in part to weathering and in part to the stresses to which they have been subjected. Upon these and the other rocks Cretaceous sediments were deposited in large areas east of the East Fork of the Koyuk and of the West Fork of the Buckland, and in much smaller areas west of these streams. These rocks for the most part show considerable deformation of the beds, and although slaty cleavage has been developed in argillitic rock types, none show schistosity.

At several geologic periods igneous activity has been manifested in this region by different types of intrusions, each intrusion resulting in the deformation of some of the older rocks. Of this character are the greenstones of the Fish and Tubutolik river valleys, and the granites, monzonites, syenites, and diorites, which are found more or less widely distributed throughout the region, in many places, as at Kiwalik and Granite mountains, making up the highest points, or as in Bendeleben and Darby mountains constituting an integral part of those ranges.

After the deformation of the Cretaceous beds, which probably occurred during early Tertiary time and was caused by intrusions such as those of Granite Mountain, there appears to have been periods of alternate elevation and depression of the land surface with respect to sea level, but these movements have been of regional rather than local character, and though there may have been some slight



EXPLANATION

SEDIMENTARY ROCKS

NONMETAMORPHIC

- Unconsolidated deposits (*Sand, gravel, silt of fluvial, glacial, and marine origin*) — QUATERNARY (POSSIBLY INCLUDING SOME LATE TERTIARY)
- Shaktolik group and Ungalik conglomerate (*Sandstones, slate, conglomerate, and shale*) — CRETACEOUS

METAMORPHIC

- Paleozoic rocks (*Largely limestone and dolomite, with black slate in southern part of area*) — CARBONIFEROUS(?), DEVONIAN, AND SILURIAN
- Undifferentiated metamorphic rocks (*Mainly quartz schist, and thin limestones; probably includes some igneous rocks*) — MAINLY PRE-SILURIAN POSSIBLY PRE-CAMBRIAN

IGNEOUS ROCKS

NONMETAMORPHIC

- Basalt (*Vesicular lava*) — TERTIARY AND RECENT
- Granite, monzonite, syenite, and diorite
- Andesitic tuffs and flows; includes also later basalt and diabase north of Bear Creek not separately mapped
- Nonmetamorphic intrusive rocks, largely granitic, and related effusive rocks not separately mapped — PRE-CRETACEOUS

METAMORPHIC

- Greenstone and greenstone schist — POST-CARBONIFEROUS

- Gold placer mine
- Coal prospect or mine
- Strike and dip

Geology by G.L. Harrington, P.S. Smith, H.M. Eakin, F.H. Moffit, and W.C. Mendenhall
Surveyed in 1900, 1903, 1909, and 1917.

GEOLOGIC SKETCH MAP OF KIWALIK—KOYUK REGION, ALASKA.

tilting of the land surface there has been no folding. During later Tertiary time vegetal material accumulated to form lignite beds such as those at the head of the Kiwalik. Somewhat later in the Tertiary period or early in the Quaternary period lavas covered much of the terrane of what is now the base of Seward Peninsula and may have covered some of the region now occupied by Norton Bay.

The events of the Quaternary period are so involved that it will require much more detailed studies than it has been possible to make to work out the complex history of the unconsolidated deposits of that period. Oscillations of the land surface have caused inundations, and each change of base-level has affected the topography. The stream valleys were overflowed by the sea, which later withdrew either partly or wholly. In those areas not inundated, and in the inundated areas after their emergence, the processes of erosion normal to subarctic climates, including frost disintegration and soil flow, have been active. There has resulted an almost universal cover of Quaternary deposits, which ranges in thickness from a few inches to 200 feet or more. In a general way the covering due to rock disintegration in place and to solifluction has been mapped with the underlying bedrock, and only those deposits of alluvial or marine origin have been represented on the map.

PALEOZOIC ROCKS.

The Paleozoic rocks in the northern part of the region have been described by Moffit[1] as follows:

> Under the head of "Metamorphic series" are grouped together a number of rock types of widely different character, the relationships of which are difficult to establish clearly, and the ages of which are in doubt. They possess the common characteristics of having been in all cases greatly altered from their original condition at the time of consolidation. The changes include the folding of the beds and the production of secondary structures, such as schistosity, cleavage, jointing, or faulting, resulting from pressure and the various movements of the rock mass; the recrystallization of the mineral constituents and the development of new minerals; the infiltration of quartz, giving the numerous veins, stringers, and lenses of that mineral which are so frequent in the outcrops and are so important in some places because of their gold content; the peculiarities of structure due to the intrusion of large masses of igneous rock; and other less noticeable features. The series includes massive and thin-bedded crystalline limestones and marbles, banded black and gray slates, and a variety of schistose rocks, both sedimentary and igneous, among which are micaceous, graphitic, quartzose, chloritic, felspathic, and amphibolitic phases.

In the mapping, as far as practicable, the limestones have been shown separately from the other Paleozoic rocks. In the area visited during the summer of 1917 the Paleozoic rocks were seen only in

[1] Moffit, F. H., The Fairhaven gold placers, Seward Peninsula, Alaska: U. S. Geol. Survey Bull. 247, p. 19, 1905.

the vicinity of Candle and in the Haycock Ridge between Dime Creek and the Landing. At both places the strike is about N. 20° E., and the dip is nearly vertical or steeply to the west. Schist pebbles were also seen in the gravels of Wilson Creek, at the head of the Kiwalik drainage, although no outcrops were noted. A few pebbles of slate and schist were taken from the bottoms of prospect holes on Little Eldorado Creek, and schist was seen at a few places on the east slope of the ridge farther south. The rounded knobs from which Haycock Ridge derived its name are of a light-gray schistose limestone. It is flanked on the east by a metamorphosed argillitic rock. The gravels on the claims below Discovery on Dime Creek contain slate pebbles which may be derived from them or which may represent a somewhat metamorphosed phase of some of the more argillaceous Cretaceous rocks.

No reliable estimate of the thickness of this group of rocks can be made, for although they are in places nearly vertical in attitude, and horizontal distance would therefore ordinarily afford an approximation of their thickness, they are badly faulted and show some folding, so that probably there has been much duplication of bedding.

Definite age determinations have not been possible for the individual members of the Paleozoic. From the earlier work of Smith and Eakin [1] there appears to be ground for the belief that these rocks range in age from pre-Silurian and possibly pre-Cambrian to Carboniferous, and that the greenstones which intrude them are probably Devonian or Carboniferous.

ANDESITIC TUFFS, FLOWS, AND BRECCIAS.

In the region extending from the Koyuk, near the East Fork, northward along the Buckland-Kiwalik divide, is a complex series of volcanic rocks, chiefly andesitic in character but also including diabases and peridotites. These rocks occupy one of the areas mapped by Smith and Eakin [2] as "undifferentiated, nonmetamorphic intrusives and effusives." In the northern part of the Buckland-Kiwalik area they were grouped in mapping by Moffit [3] with the much later basalts. In the present report the basalts have been partly separated in mapping, but north of Quartz Creek the data at hand are not sufficient to warrant an attempt at separation, and the andesites as mapped, therefore, include areas of the later basalts.

A number of different phases occur in this series in a section that was examined for several hundred feet along Sweepstakes Creek.

[1] Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, Alaska: U. S. Geol. Survey Bull. 449, pp. 93–95, 1911.

[2] Idem, pl. 6.

[3] Moffit, F. H., op. cit., pl. 3.

Typical graywacke beds appear, together with conglomerates and tuffaceous rock, yet they are composed of fragments of the near-by distinctively effusive andesites or of essentially the same minerals. These rocks, which are sedimentary in origin, are not greatly different in appearance from the effusive types, and it is not always possible to separate the two without recourse to a microscopic examination of thin sections. Practically all are dark gray, usually with a strong greenish tinge. Porphyritic facies are fairly common and the coarser grained of these are locally known as "diorite." Different degrees of metamorphism have been suffered by the series in different parts of the area; west of Granite Creek, between it and the bend of Sweepstakes Creek, and half a mile below the Hot Springs on Spring Creek, the rocks have been deformed and appear to be much jointed, faulted, and sheared and to have a considerable development of quartz and calcite veins. Elsewhere they have suffered little deformation, as at the head of Greenstone Creek, where they can not be readily distinguished from the much later basalts, which here are less vesicular than usual.

One of the features of a phase of these rocks on Dime and Sweepstakes creeks is the weathering along closely spaced joints, so that it is difficult to get a fresh fracture surface, as the rock tends to break along the joints. The brownish-black weathered surface is termed "burnt rock" or "burnt lava" by the miners.

Typically these rocks consist of phenocrysts of plagioclase, chiefly andesine, and augite in a finer groundmass of similar composition, and accessory magnetite is usually present. Ilmenite and olivine may be present also in some specimens. Secondary minerals give the rock its green color and consist largely of chlorite and some hornblende.

With the rocks of this composition, which are essentially extrusive in character, intrusive rocks are closely associated in some small areas. The intrusives are generally of a more basic character and include gabbros, diabases, and peridotites, the last characterized by their dark color, as they consist essentially of olivine and a dark pyroxene. From these rocks the platinum is probably derived, as well as the chrome spinel, which together with the olivine appears in the concentrates wherever platinum has been found in this area.

Several factors prevent the determination of the attitude of these rocks. Exposures in undisturbed outcrops are not especially common and where present are generally massive, showing little or no structural features. On Sweepstakes Creek, on some of the sedimentary beds, strikes ranging from northeast to east and steep northerly dips were observed. These rocks are much disturbed, as shown by the exposures on Spring Creek, yet from their wide distribution and the general lack of infolded older or younger geologic

units, it is apparent that the series must have a maximum thickness of several thousand feet.

Data as to the age of these rocks do not permit a statement of the exact time of their formation. They are younger than the Paleozoic rocks and older than the Cretaceous sediments, so that they may be very late Paleozoic or early or middle Mesozoic. As the basic coarsely granular intrusives in this series are not known to occur elsewhere, they are probably closely related in age to the rocks in which they occur.

GRANITES, SYENITES, AND DIORITES.

The granitic rocks in the southern portion of the area have been described by Mendenhall[1] and by Smith and Eakin,[2] and those in the northern portion by Moffit.[3] Only one area of these rocks was seen by the writer, the intrusive mass which forms Granite Mountain. Moffit[4] describes these rocks as follows:

> Hornblende is the prevailing dark mineral of the granites, but at times biotite takes its place. By a decrease in the amount of quartz the granites approach syenites in composition, such phases being characterized by the abundance and large size of orthoclase crystals, which usually show Carlsbad twinning and have a roughly parallel arrangement, with the small intervening spaces filled with hornblende, biotite, and a small amount of quartz. Titanite is abundant.

Moffit[4] also describes a garnet pyroxene malignite which is related to the syenitic rocks just mentioned. Similar types appear in the gravels of Cub Creek, and black garnets (melanite) from the same source are very common in the concentrates from Rube Creek and less so in those from Sweepstakes. Coarsely porphyritic rocks of approximately the same nature are found on Sweepstakes Creek near the mouth of Granite. Near the hot springs on Spring Creek the rock is a typical diorite, composed essentially of plagioclase feldspars and hornblende, together with small amounts of accessory constituents.

Dikes of syenitic type cut the andesite series, so that the dikes are the younger. From the fact that the pebbles of the Cretaceous conglomerate[5] along the East Fork-Buckland divide are similar in character to these igneous rocks, their pre-Cretaceous age appears to be well established. Possibly, however, some of the types are pre-Cretaceous, whereas others were not intruded until later and are approximately synchronous with the deformation of the Cretaceous sediments.

---

[1] Mendenhall, W. C., Reconnaissance in the Norton Bay region, Alaska, in 1900: U. S. Geol. Survey Special Pub., p. 204, 1901.

[2] Smith, P. S., and Eakin, H. M., op. cit., pp. 64–70.

[3] Moffit, F. H., The Fairhaven gold placers, Seward Peninsula, Alaska: U. S. Geol. Bull. 247, pp. 27–30, 1905.

[4] Idem, p. 29.

[5] Smith, P. S., and Eakin, H. M., op. cit., p. 56.

CRETACEOUS SEDIMENTARY ROCKS.

From a study of the distribution of the Cretaceous rocks of western Alaska it appears that at the beginning of the Cretaceous period a broad valley or embayment occupied much of the area east of the Darby Mountains, which included much of the Koyuk, lower Yukon, Innoko, and lower Kuskokwim valleys. Scattered through this wide area were small land areas, such as the Kaiyuh Mountains and their northeastern extension, as well as minor elevated points, which for a time furnished material for the vast amount of sediments of this age but which were later covered by transported silts and sands derived from other sources. In this region the presence of the early Cretaceous has not been proved. During that epoch it probably constituted a portion of the land surface. During later Cretaceous time, however, by a subsidence of the region now occupied by rocks of that age, the sea gradually encroached upon the land areas. Where the coasts were bold and rocky, like much of the present southern coast of Seward Peninsula between the mouth of the Kwiniuk River and Topkok Head, conglomerates were deposited. The offshore deposits were sands, and the zone of conglomerates was relatively narrow. Where the sea encroached upon delta areas, as at the mouth of the Tubutulik or Kwik or the much larger deltas of streams corresponding to the Yukon, much finer sediments were laid down, such as fine sands and silts, which later by consolidation formed sandstones, shales, and slates. The offshore deposits were practically all shales, some of which were somewhat calcareous. The coal beds of this age were probably accumulated in swampy areas but little above sea level, where the climatic conditions of that time particularly favored vegetal growth and accumulation.

The distribution of the Cretaceous sediments is indicated on the map (Pl. X), but several areas, such as the small areas on Peace River and the coal-bearing bed of the Kugruk, have not been delineated.

Several types of deposits are illustrated by the rocks in the valley of Dime Creek, or near it. At the mouth of Silver Gulch the conglomerates represent the near-shore or beach deposits along a coast, the rocks of which were Paleozoic limestones and slates. The pebbles of the conglomerate are largely of these two lithologic types. Farther out in the valley of Dime Creek much finer grained rocks appear. They are highly calcareous, showing that the probable source of a large portion of the grains composing them was the limestone. Quartz grains and clayey material make up most of the remainder of the sandstones.

The grits and fine conglomerates found near the landing are characterized by the presence of great numbers of small white rounded quartz pebbles. It appears likely that these sediments represent either

stream or offshore deposits. Quartz veins in the Paleozoic rocks were the source of the pebbles.

In the valley of Peace River a little evidence of the former presence of Cretaceous rocks is found, and it is probable that detailed examinations of all the exposures, and of fragments of bedrock from the numerous prospect holes would reveal a much wider occurrence of these sediments than the present mapping indicates. On Flat Creek fragments of sandstone were seen on the dump of a prospect hole, and on Moon Creek, less than half a mile from the river, another dump showed fragments of slate and many white pebbles similar to those in the grits. These pebbles were probably of local origin, rather than stream-borne gravels.

The other areas of Cretaceous rocks have been described by Smith and Eakin [1] and are essentially the same in character as in the vicinity of Dime Creek. Fossil plants [2] from the Kwik-Tubutulik divide serve to establish the Cretaceous age of the series. Moffit [3] correlates the beds associated with the coal on the Kugruk with those of the Koyuk.

TERTIARY ROCKS.

It is not known how long sedimentation continued after the close of the Cretaceous. In near-by regions there is reason to believe that it was uninterrupted until well into the Eocene. By that time a considerable thickness of Cretaceous beds had accumulated, a large portion of which has since been eroded. At or near the close of the Eocene, however, earth movements of considerable magnitude took place [4] in different parts of Alaska, and this region was affected by them. Igneous intrusions along the axes of the folds accompanied this diastrophism. Some of the rocks of the Granite Mountain area, already described, and the accompanying dikes, which are found on Bear and Candle creeks, may be of this character.

Smith and Eakin [5] describe a series of rocks which range in character from augite andesite to augite diorite in the vicinity of Christmas Mountain, and on the Shaktolik quartz porphyry was found by them. These rocks are post-Cretaceous.

The topography formed by these intrusions and the earth movements was much more rugged than that of the present, and consequently there was little or no deposition of terrestrial sediments until quite late in the Tertiary, when land forms comparable in character with those now found had been developed. In some of the basins of

[1] Smith, P. S., and Eakin, H. M., op. cit., pp. 54–60.
[2] Idem, p. 56.
[3] Moffit, F. H., op. cit. p. 26.
[4] Brooks, A. H., The geography and geology of Alaska: U. S. Geol. Survey Prof. Paper 45, p. 266, 1906.
[5] Smith, P. S., and Eakin, H. M., op. cit., pp. 70–71.

that time terrestrial deposits were formed. It is not possible to state the extent of these deposits, both on account of the small amount of field work and on account of their great resemblance to alluvial material of considerably later age. One area has been described by Smith and Eakin[1] as occurring on the Rathlatulik. Another small area was observed by the writer on Wilson Creek, one of the headwater streams of the Kiwalik. At both areas are deposits of lignite in association with clays.

On Wilson Creek the lignite is several feet thick and contains squeezed and carbonized tree trunks of small size. Overlying it is a bluish clay, which is oxidized to yellow on the surface. This clay has crept or flowed over the lignite until it has almost completely covered it. A small amount of lignite had been mined and the opening showed that the bed was at about the level of the creek. Apparently overlying the clay were basalt flows, which crop out on the west bank of the stream about 75 yards or less from it. About 200 yards farther downstream, at a second small cropping, a thickness of 6 or 8 inches of lignite was exposed. Neither the rocks above or below it were exposed, and the lignite was partly covered by moss and other vegetation.

There is no direct evidence of the age of these deposits, whether Tertiary or Quaternary. From the fact that they are apparently older than the basalts, which are believed to have been extruded during the late Tertiary or early Quaternary, an assumption of late Tertiary age is made.

BASALTS.

Vesicular basalts, generally containing olivine and in places, as at St. Michael, associated with tuffs, are widely distributed in western Alaska, especially at the base of Seward Peninsula and the near-by regions to the south. In the Kiwalik-Koyuk region they occupy areas comparable in size with those of any other lithologic unit and form the divides between the Koyuk and the Buckland, the Koyuk and the Kiwalik, and the divide at the heads of the Koyuk, Kuzitrin, and Goodhope. They probably occupy considerably larger areas along the Kiwalik-Buckland divide than the map shows, and formerly their extent was certainly much greater than now. Thus, the entire valley of Peace River may have been filled, so that the areas on either side of the river near Moon Creek were continuous, and, indeed, the three large areas already mentioned may have been continuous. The basalts would thus have filled the entire valley of the Koyuk and extended south to include the area north of the Mukluktulik and that on the Tubutulik. Possibly the area at the head of the Koyuk had a different source and did not reach the other flows.

[1] Smith, P. S., and Eakin, H. M., op. cit., p. 140.

Whether there was a connection between these flows and those on the south side of Norton Sound has not been proved.

Concerning the lavas along the Koyuk, Mendenhall[1] states:

> The lava is a green, gray, or black rock, the color depending in part upon its freshness. It is compact or vesicular and usually porphyritic, olivine being the most conspicuous of the phenocrysts, although plagioclase is recognizable megascopically in some instances. Sometimes the vesicles are filled with opal; more frequently they are without filling. The rock varies in texture, having sometimes a very glassy groundmass and in other cases showing a coarse, well-defined, interstitial arrangement with almost no glass. * * * The basalt beds have not been disturbed since they were poured out. They are horizontal wherever their attitude is determinable and overlie all the other rocks.

Moffit,[2] after describing the lavas west of the Kugruk, says:

> The basalts and diabases of the area west of Kiwalik River are somewhat different in occurrence from those previously described, in that they are found at considerably higher elevations and apparently are not directly connected with those of the more western area. The hills facing Kiwalik River on the east are largely made up of lavas in which the diabases predominate over the basalts. Sheeted flows do not occur frequently, and under the microscope the rock is seen at times to be somewhat altered.

Whether the Kiwalik-Buckland-Koyuk flows were connected with those at the head of the Koyuk is not readily apparent. Probably the lavas were discharged from different vents, even though the Koyuk from its source to its mouth was once filled. From the features which have been described by Moffit it appears likely that some of the lavas from the vents at the head of the Koyuk are relatively recent. On the lower Koyuk, however, there is the evidence of the erosion of a thickness of 200 feet or more of these rocks from the valley of Peace River, by a relatively small stream, which, however, probably had a gradient much greater than it now possesses. Valleys cut since the extrusion of the lava have been filled to a depth of nearly 200 feet with gravel, and new channels, such as the present course of the Koyuk, were again cut. From this evidence it is apparent that the lavas must have been extruded in either Tertiary or very early Quaternary time.

QUATERNARY DEPOSITS.

Since the extravasation of the lavas, which in this area at least probably occurred in late Tertiary time, there have been oscillations of this portion of the earth's crust which have caused the submersion and emergence of the land surface and which were possibly repeated several times. These movements took place with little or no attendant warping or folding. From the forms of the valleys and the

[1] Mendenhall, W. C., A reconnaissance in the Norton Bay region, Alaska, in 1900: U. S. Geol. Survey Special Pub., p. 206, 1901.

[2] Moffit, F. H., op. cit., p. 34.

depths of gravels, which in places lie well below sea level, it is apparent that the land surface once stood at least 50 feet or more higher than it does at present with regard to sea level. An elevation of 100 feet, which is by no means improbable, would now make a land surface of Norton Bay and much of Norton Sound.

Throughout the Quaternary period erosion was in progress wherever the land lay above sea level. From the erosional débris a complex series of imbricated unconsolidated marine and alluvial deposits was formed through surface oscillations and filled the lowlands and stream valleys. Sections of these deposits are obtainable only from prospect holes and show alternations of sand and gravel. In places their thickness is more than 200 feet. On Dime Creek holes over 100 feet deep have been sunk. In some of these holes fragments of shells have been found, but the fragments are not of a nature to permit a determination of their character and age.

The older gravels are indistinguishable from those that occur along the present stream courses and beaches, so that possibly some of them may antedate the extrusion of the basalts, but until more definite information is at hand as to the age of both the basalts and the older gravels, it appears logical to assume that the basalts are of Tertiary age and that the gravels, some of which contain basalt pebbles, are of Quaternary age.

In addition to those deposits of alluvial or marine origin, unconsolidated débris and organic deposits cover much of the surface. Mechanical disintegration through different phases of weathering produces an angular rock talus on all uncovered slopes; this material is gradually transported to the bottoms of the valleys by solifluction, of which gravity and the action of frost appear to be the principal forces. A large number of the gentler slopes show the lobate forms which characterize soil flows, and the scarps at their front may be exceptionally as much as 6 to 10 feet high, but normally are 1 to 2 feet.

Except on the very steepest slopes and on some of the strongly wind-swept higher ridges there is an almost universal covering of vegetation, largely mosses and lichens. This vegetation serves to hold moisture and also to prevent the melting of the underlying frozen, moisture-saturated peaty material, thus perpetuating the conditions most favorable for growths of this kind. As a result extensive bogs cover much of the area, on the broad, flat-topped ridges at moderate elevations as well as in the lowlands. In the flatter areas there is a tendency toward an accumulation of peat, but on the slopes, the vegetation is disturbed by the soil movements and shows less tendency to accumulate.

MINERAL RESOURCES.

HISTORY OF MINING DEVELOPMENT.

Soon after the discovery of gold at Nome there was active prospecting over much of the more readily accessible streams of Seward Peninsula, and Candle Creek was staked[1] during July, 1901. Bear Creek was staked and recorded in August of the same year but is said to have been staked though not recorded[1] in 1900.

Mining has resulted in a considerable production yearly from Candle Creek. The annual output from Bear Creek has shown considerable variation; in some years little or no production was made.

In the basin of the Koyuk some prospecting has been done on a number of streams during the period from 1899 or 1900[2] up to the present. A summary of this work up to 1909 is included in the report of Smith and Eakin.[3] Until that time no workable placers had been discovered in the Koyuk region. In 1909 some prospecting had been done on Peace River near the mouth of Sweepstakes Creek, and in the fall of that year Sweepstakes Creek was staked for about 9 miles, practically its entire length, by S. B. Smith and several associates. After prospecting for a number of years, the title to the lower 4 miles of the creek was allowed to lapse. Gold valued at a few thousand dollars is said to have been taken out from this creek in 1910, and an average annual production between $4,000 and $5,000 is reported for the period from 1910 to 1917, inclusive.

In 1910 Dime Creek was staked and some prospecting was done on some of the lower claims, but no commercial placer ground was discovered. Rube Creek, then called Diamond Creek, is also said to have been staked the same year, and a small amount of prospecting was done but with negative results. No further work was done by the original holders of this ground, and their title was lost. In 1915 Dime Creek was again prospected, and gold was discovered at the mouth of Eldorado Creek on April 4. On the hypothesis that the gold had been derived from the metamorphic rocks which form the divide between Peace River and Dime Creek, the discoverers staked the first claims on Eldorado Creek, leaving what proved to be the richest ground open to staking by later comers, who staked not only the creek but the first and second tier bench claims, on both the right and left limits of Dime Creek. Many of its smaller tributaries

[1] Moffit, F. H., The Fairhaven gold placers, Seward Peninsula, Alaska: U. S. Geol. Survey Bull. 247, p. 50, 1905.

[2] Mendenhall, W. C., A reconnaissance in the Norton Bay region, Alaska, in 1900: U. S. Geol. Survey Special Pub., p. 212, 1901.

[3] Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, Alaska: U. S. Geol. Survey Bull. 449, pp. 110–115, 1911.

have also been staked, as have a number of the near-by tributary streams and gulches of both Koyuk and Peace rivers, as well as some of the tributaries of Sweepstakes Creek. A number of claims were staked on Rube Creek and some small gulches tributary to it on March 31, 1917.

When the first claims were staked on Sweepstakes and later on Dime Creek, recording had to be done at Council, as the Koyuk Basin lay within the limits of the Council City precinct. To facilitate recording, however, a new precinct was formed by dividing the Council City precinct into the Council City and the Koyuk precincts. The Koyuk precinct, as defined by a decree of the court dated December 28, 1916, includes the drainage basins of the Inglutalik, Koyuk, and Kwik rivers, as well as a few small streams that lie between the Inglutalik and Kwik and that flow into Norton Bay.

ECONOMIC CONDITIONS.

MEANS OF COMMUNICATION.

Candle, on the northern side of the peninsula, is located on Kiwalik River, about 7 miles from the town of Kiwalik, at the mouth of the river, where supplies are brought in summer by small coastwise vessels from Nome or by the larger freighters direct from San Francisco or Seattle. They are carried up the river in shallow-draft power scows. The effects of the higher tides are sometimes noted at Candle. On the other hand, at normal or low stages of water, if a south wind is blowing, considerable difficulty may be experienced in reaching Candle by boat, for the wind may be sufficient to overcome the effects of the incoming tide. In summer the mail is brought from Nome by a small coasting vessel, on a two or three weeks' schedule, which may be lengthened to nearly a month by unfavorable conditions. In winter communication and transportation of the mail is by dog team, and the mail is on a fortnightly schedule. There is a telephone line from Candle to Nome, and a local line from Candle out to Candle Creek.

Bear Creek is about 40 miles from Candle, with which it is connected by a wagon trail that is poorly defined on some of the wide, flat-topped tundra-covered ridges over which it runs. Most of the mining supplies are brought to Bear Creek in the spring by horse team and sled, although some supplies are brought in by wagon during the summer. Mail for this creek goes to Candle.

It is about 15 miles from Bear Creek over Granite Mountain to Sweepstakes Creek, at the mouth of Granite Creek, about 10 miles from Sweepstakes to the road house on Dime Creek, and about 7 miles from there to the place known as Dime Landing, or simply "the Landing," on Koyuk River. A number of small gasoline

schooners, some of which made an effort to maintain a 6-day round-trip schedule, afford frequent communication between Nome, Golofnin (Cheenik), and the Landing. During the summer of 1917 mails were brought on a monthly schedule to Golofnin from Nome and St. Michael and carried from there to the Koyuk. Haycock post office is located at the mining center on Dime Creek. Freighting was done from the Landing to the creek over two very soft trails. The miners on Sweepstakes got in most of their supplies during the winter, but some freighting was also done by wagon during the summer.

SUPPLIES.

A large part of the supplies for both Candle and Dime creeks are brought from Nome. The local rate from Nome to Kiwalik was $20; that from Seattle to Kiwalik on general merchandise in 1917 was $19 for less than car-lot shipments and $14 for car lots, not including lighterage. Freight from Kiwalik to Candle was $5 a ton. From Candle to the mouth of Patterson Creek (claim 19 above Discovery), the summer rate was 2½ cents a pound. A considerable amount of the tonnage of supplies to all the creeks in the area consists of gasolene and distillate for use of the engines used in pumping or on the dredge on Candle Creek. A fairly good wagon road to the mining plants makes summer freighting at Candle but little more difficult than that to many mining camps in the States. Supplies are hauled as far as possible in winter.

Supplies are obtained on the Koyuk from both Nome and Golofnin, and the freight rate from Nome to the Landing on the Koyuk is $20 a ton. An example of the effect of poor roads on the cost of haulage is shown by the fact that the summer rate from the Landing to Dime Creek is 4 cents a pound, when the hauling is done over the extremely poor and rough roads across the tundra, whereas the winter rate is 1 cent a pound, when the hauling is done by sleds and the roads are fairly good. The cost of freight from Seattle to Nome, when added to the charges just mentioned, makes prices at Dime Creek about 6 cents a pound higher than those in Seattle through transportation charges alone. At one of the stores on the creek the following prices were charged in August, 1917: Potatoes, 12 cents; flour, 12 cents; bacon, 60 cents; ham, 50 cents; sugar, 16½ cents a pound. A road is to be constructed by the Territorial Road Commission from the Landing to the center of mining operations on Dime Creek, and this should reduce the cost of transportation considerably.

During the winter and spring of 1916–17 supplies were difficult to obtain, largely on account of the shortage of teams for hauling. In the fall of 1917 conditions had improved, for in addition to two or three teams used for private hauling there were two teams engaged

in freighting, and it was reported that others were coming. If a shortage occurs during the winter, supplies could be freighted from Golofnin.

Little wild game, except ducks and geese, is to be found in this region. Rabbits are sometimes plentiful. Ptarmigan are scarce. Occasionally bear are seen, but not often. The few caribou that are reported here have probably strayed from one of the reindeer herds which are pastured near by.

In the smaller streams, where mining operation have not muddied the water, both grayling and trout are found. In the larger streams salmon are caught and dried for dog feed.

TIMBER AND COAL.

A scanty growth of spruce covers parts of eastern Seward Peninsula, and good-sized trees are found along the high, well-drained banks of the larger streams up to about 400 feet elevation or possibly a little higher. There is no timber in the vicinity of Candle, although it grows on the upper part of the Kiwalik and Buckland rivers. In the Koyuk basin good-sized timber, suitable for ginpoles or masts for mining, is found along some of the larger tributaries, such as Peace River and the East Fork. Timber is present for only a short distance up Sweepstakes Creek. A fair growth is said to have once fringed Dime Creek, but this has been removed and there now remains only scattered stunted trees common to poorly drained and boggy hillsides, although some of the steeper-sided valleys, where the drainage is better, support timber which furnishes excellent fuel, and even house logs are obtained. A large number of logs of good size will be required in the construction of the road from the Landing to Dime Creek, and this will materially decrease the available timber.

Gasoline and distillate are used generally wherever pumping is to be done and on the dredge on Candle Creek. Coal is the principal fuel used in the vicinity of Candle, but on Dime Creek its use appears to be confined mainly to domestic purposes at present. Within a very short time it will be necessary, on account of the scarcity of timber, to use coal or oil for power and thawing in mining operations also. It appears likely that the production of gold in 1917 would have been somewhat larger had there been a sufficient number of teams to haul wood for fuel during the spring and early in the summer, and mining operations could then have been carried on much later than they were. It is said that some wood was hauled by dog teams. The cost of wood at the boilers ranged from $16 to $20 a cord.

Lignite is obtainable in the Candle district from the vicinity of Chicago Creek, on the Kugruk. This coal formerly sold at about $30 in Candle, but none had been brought from the mine in 1915, 1916, or

1917, and bituminous coal, which had been shipped in, was used. It cost about twice as much as the Kugruk coal but was rated about twice as high for steaming. Coal of a generally similar character is found near the mouth of the Koyuk, just about at sea level, where one 4-foot seam is said to be exposed. Near by is a 2-foot seam, and several seams of a few inches in width also occur. In this connection it is interesting to note that a fragment of coal was picked up from the dump of a prospect hole at about claim 9 below Discovery on Dime Creek, together with some angular sandstone pebbles, indicating that the coal series is probably present in this general vicinity. An analysis of the coal at the mouth of the Koyuk, made for Mr. John La Montaigne, is given for comparison with that from the Kugruk.

Analyses of coal from Seward Peninsula.

	Koyuk coal.	Kugruk coal.[a]
Fixed carbon	39.87	33.58
Volatile combustible	33.94	38.15
Moisture	19.89	24.92
Ash	5.86	3.85
Sulphur	.44	.68
	100.00	101.18

[a] Analysis made in laboratory of the Geological Survey. See Moffit, F. H., The Fairhaven gold placers, Seward Peninsula, Alaska: U. S. Geol. Survey Bull. 247, p. 67, 1905.

The locality on the Koyuk was not visited, but it is said to be near or at tidewater, and some difficulty might be had at times in mining on account of flooding the workings. This coal is about 20 miles from the scene of mining operations on Dime Creek, and winter haulage should present little difficulty. Summer haulage might be attempted by boating the coal up to the Landing in scows and hauling it by wagon from there. If the deposit is workable, it should furnish a fuel at least as good as wood at about the same price a ton as the wood costs a cord.

Another possible source of fuel is the lignite on Wilson Creek, one of the headwater tributaries of Kiwalik River. This deposit lies about 2 or 3 miles from Sweepstakes Creek, and is therefore between 12 and 14 miles from Dime Creek. A small opening has been made on the lignite, but it was badly caved at the time of the writer's visit and but little could be told of the nature of the bed or its extent. It lies on the west bank of the creek, and apparently has a slight dip into the bank and upstream. The lignite is extremely fibrous and contains tree stems, in some of which the annular rings are still plainly discernible, the wood apparently being altered but little, although it appears carbonized. A thickness of 3 feet was exposed in the face by digging, but from the occurrence of the coal in the

caved-in adit, it appears that the total thickness is much greater, 7 or 8 feet or even more not being improbable. Overlying the coal is a very stiff gummy clay, and apparently overlying the clay are basaltic lavas. The lignite was exposed along the stream for a distance of about 15 feet, but most of it was covered by the clay, which had crept down over it. Fragments of the lignite appear below the outcrop in the stream gravels for several yards. About 200 yards downstream a second outcrop shows a thickness of a few inches, but the thickness of the deposit may be much more than this.

It has been used to a small extent for domestic purposes and seems to be quite satisfactory. No tests had been made, so far as known, of its suitability for making steam.

WATER.

As in many other parts of Seward Peninsula, the question of a water supply in this region is serious, and numerous expedients have been adopted to utilize the water that is available. Ditches have been constructed and pumps are used to some extent, probably much more than in most Alaskan mining districts. Where winter work is done, a large part of the sluicing of the winter dumps is done with the flood waters which result from the melting of the winter snows.

In the vicinity of Candle the problem is especially serious. A ditch from west-side tributaries of the Kiwalik furnishes water for hydraulicking operations on John Bull Hill, near Candle, but at times during the season the ditch carries so little water that mining is impossible. The same conditions prevail on Candle Creek and its tributaries, but the dredge can operate in its pond, even though but little additional water is coming in. Those plants which pump water are somewhat better off than those which depend on ditch water for sluicing, although some losses of gold are probably entailed in the use of dirty water. On the benches there is difficulty in getting water, and often short ditches are cut in the face of the hillsides to catch the run-off for use in sluicing, in connection with the water obtained from some of the small depressions. At times Patterson Creek carries considerable water, and this has been utilized in mining.

It is said that if water was available, it would pay to groundsluice off the overburden from a number of claims on the benches and to rework the old piles of tailings as well. It may be possible to work some of this ground with water from the Kiwalik ditch after the exhaustion of the placer gravels upon which the ditch company is now operating, but rather extensive surveys would be necessary in order to determine how much of the Candle Creek benches could be worked in this manner.

On Bear Creek the problem of water supply is much less serious than elsewhere, largely because the water for the ditch and other mining plants is taken from streams that head in a high ridge on which there is a much greater and more frequent precipitation than elsewhere in the region. In dry seasons, however, even on this creek a shortage of water is sometimes felt. Aside from the operations of the ditch company, mining is being done on the beds of small streams which usually furnish sufficient water for sluicing the auriferous gravels as they are shoveled into the boxes.

In a general way the conditions on Sweepstakes Creek are analogous to those on Bear Creek, for the streams that head in the high peak of Granite Mountain usually have a flow of water sufficient for all the operations now being carried on. The same conditions prevail in part on Rube Creek and other tributaries of Peace River, but the flow of these streams is normally only moderate in amount, and difficulty may arise in protracted periods of dry weather in getting sufficient water to carry on mining operations, if more than one or two plants are at work, unless additional supplies are obtained from near-by creeks.

On Dime Creek the conditions as regards water supply somewhat resemble those on Candle Creek, and conservation and complete utilization are aimed at. The latest claims staked on the benches are confronted with the greatest problems, for the rights of the earlier staker to creek water which may be brought onto the benches must be observed, and recourse is had, therefore, to numerous expedients, such as pumping the dirty water from the creek or digging wing ditches on the hillside above to collect spring and summer run-off. The supply of water of these systems is frequently augmented by the construction of ditches to one or more small draws or pups. A fairly satisfactory supply of water is obtained in this way for sluicing winter dumps, but for continuous summer work it will prove far from satisfactory. Stripping operations by groundsluicing are practically limited to those claims which have ditch water obtained from the creek, or which pump the water from and return it to the creek.

WAGES AND LABOR CONDITIONS.

The wages common to most Alaskan camps, $5 a day and board and higher wages to hoistmen and blacksmiths, are also paid in this region. Both at Candle and at Dime Creek most of the mining is done during the winter, and only a subordinate amount during the summer, although there is some prospecting in the summer. On Candle Creek most of the summer work is done on the shallow ground of the creek. On Bear and Sweepstakes creeks only summer open-cut work is done. On Dime Creek summer operations were confined to three plants which were open cutting and to a small amount of

underground work, largely of a nature preparatory to winter mining. A considerable amount of prospecting and ditch construction was also done.

At Candle but few men were idle who wanted employment, for the road-repair work engaged most of those who had worked in the mines during the winter. On Dime Creek a number of men were idle during August.

GOLD PLACERS.

PHYSIOGRAPHY.

The origin of the placers is so intimately connected with the physiographic history of the region that it is appropriate to discuss this feature in connection with the placers, and an interpretation of the topographic forms may throw some light on the mode of concentration of these deposits.

A striking topographic feature in many parts of the region between Eschscholtz Bay and Norton Bay is the terraced character of many of the hills and mountains. These terraces attain the greatest prominence in areas of massive, well-indurated rocks like the granites or the series of agglomerates, tuffs, and flows of an andesitic character which lie chiefly north of the Koyuk. Moffit[1] states "that a given bench could often be traced from one locality to another, but the contour interval [used in the topographic mapping] was too great to permit any extended correlation of levels." The areas of older metamorphic rocks do not present this terraced appearance, although broad flat-topped or very smooth-crowned ridges are predominant. It is possible, although by no means certain, that these flat-topped ridges correspond to the terraces in the more resistant rocks and with the terraces represent marine benches. If so, there is lacking the confirmatory evidence of widely distributed beach pebbles, such as might be expected if the benches were water cut. Although Moffit[2] states that on some of the upper tributaries of the Kiwalik and on Old Glory Creek elevated benches of gravel were seen at an altitude of about 500 or 600 feet above sea level, the presence of gravels on the terraces is unusual, for he says:[1]

> The floors of the benches are usually covered with débris, which is angular or rounded, and is probably due to weathering rather than to grinding by water currents. The edges of the benches are made up of angular blocks produced by the action of the frost on the bedrock, now only occasionally visible. The blocks appear not to have been moved any considerable distance but simply to have tumbled down and formed a talus along the front of the rock wall, which they now conceal in nearly all cases.

[1] Moffit, F. H., The Fairhaven gold placers, Seward Peninsula, Alaska: U. S. Geol. Survey Bull. 247, p. 44, 1905.

[2] Idem, p. 40.

If these terraces were formed by wave erosion the gravel and sand which were produced in the incision of the benches have been largely if not wholly removed from most of them, although, as already cited, some of the high-lying gravels still remain. It is somewhat difficult to believe that wave-cut terraces would still present such definite scarps as are found at even the highest elevations, and that erosion took place of sufficient magnitude to remove all the unconsolidated beach débris which had been formed in cutting the benches as the sea encroached by stages upon the land surface. If it is assumed that some of the terraces were cut as the land surface emerged from the sea, an even longer period of endurance of the highest terraces is thereby postulated. It may therefore be possible that some at least of the terraces owe their origin to some other cause, although it is believed that the land surface has been depressed to a depth of several hundred feet below sea level. In the Yukon-Koyukuk region similar high terraces have been ascribed by Eakin[1] to a process termed "altiplanation," a phase of solifluction that under certain conditions finds expression in terrace-like forms and flattened summits. Until definite proof of a marine origin is obtained, it appears logical in this region also to accept Eakin's hypothesis of origin for the highest of the terraces, although the sea probably covered the land to a height of 500 or 600 feet and carved the land forms to that elevation. Stream erosion has greatly modified the topography since emergence, and the tendency has been to restore the former topography by sweeping out the unconsolidated sediments from the filled valleys. On the hillsides solifluction has been an important agent in the transportation of the débris to the bottoms of the valleys, where it was removed by the streams.

The numerous exposures of basaltic lavas afford some indication of the topography which existed previous to their extravasation. It appears likely that at that time a very mature topography had been developed and the country was nearly base-leveled. It may be that the extrusion of the lavas occurred shortly after the emergence of the land surface nearly to its present level, when many of the valleys were nearly if not quite filled with gravels and sands resulting from inundation. Drainageways had been established, however, and it was down these that the lavas took their course. At the head of Bear Creek, they are found at an elevation of about 1,200 feet, and this appears to be about the maximum height reached, except in the area at the head of the Koyuk, from which it is likely that a very considerable part of the lavas came. There may also have been vents for these lavas somewhere on the Buckland-Kiwalik divide. Moffit[2]

[1] Eakin, H. M., The Yukon-Koyukuk region, Alaska: U. S. Geol. Survey Bull. 631, p. 78, 1916.

[2] Moffit, F. H., op. cit., pp. 32–33.

describes the topographic changes due to the lava flows in the following terms:

Important modifications of the drainage were brought about by the extrusion of the lava, which occupied the depressions and flowed down the valleys in broad rivers of molten rock. At times the cooling of the advancing front wall dammed back the flow and forced it over the low, rounded divides between the watercourses into the next valley beyond, or formed a lake [of molten lava] which finally overflowed the obstruction and resumed its original course, only to repeat the process a little farther on.

In this way islands of bare ground were left between the great finger-like protrusions along the edge of the sheet. At the same time a shifting of the watercourses was brought about, for when not of sufficient volume to fill it the lava occupied the lowest part of the valley and the waters sought a new channel parallel to the old one, along the edge of the hardened flow. A number of lakes and ponds also owe their existence to the damming of streams by lava, among which may be mentioned Lake Imuruk, the largest body of fresh water on the peninsula.

Observations made by Collier on Noxapaga River showed these more recent lavas overlying gravels which are cemented near the contact by indurated clays and contain pebbles of an older flow—conclusive evidence that considerable time must have elapsed between the first outbreaks and the solidification of the flows just described. The source from which the recent basalts of Noxapaga and Kuzitrin rivers were discharged lies to the southwest of Lake Imuruk, this being shown by the scattered lava cones as well as by the direction of movement of the flows themselves.

On the upper part of Koyuk River a similar relation of basalts and gravels was observed by Mendenhall. He found on the truncated edges of the schists 5 feet of gravel, made up of schist, vein quartz, and granite; this in turn was covered by an undisturbed horizontal sheet of olivine basalt, which had been but little affected by the erosive action of the stream since it came to rest, and was therefore believed by him to be of Pleistocene age.

No evidence of flows as recent as those between Noxapaga and Kuzitrin rivers was seen by the writer in the country toward the northeast, where the lavas have been subjected to weathering for a much longer time and have suffered correspondingly. In the region south of Kotzebue Sound it is probable that a drainage system differing very little from the present one and containing a considerable body of gravels was invaded and partly filled by the basic lavas, which formed a sheet of no great thickness across the valleys. The present streams then resumed their work and cut down through the thin lava sheet, uncovered again the older channels, and left the conspicuous rim of lava now seen surrounding many of the valleys. In evidence of this may be mentioned the fact that the lavas in almost all cases appear well up on the sides of the narrow valleys, and that there is no indication that they ever covered the higher hills above the valleys. In one instance, at the west end of the big bend of Kugruk River, the lavas appear at the water's edge; in all other cases, as far as observed by the writer, they are above the streams, which at present occupy channels in the older metamorphic schists and limestones. It should be stated, however, that no contact of lavas overlying gravels, such as that described by Mendenhall and Collier, was observed in the region, since the great quantity of broken blocks, thrown down largely by the action of the frost, prevented a view of the base of the flows. This condition also prevented any accurate determination of the thickness of the lava, though two flat-topped hills of it south of the upper part of Cottonwood Creek have an elevation of 60 feet

above the plain on which they rest. In the one nearer the Cottonwood the base is formed by some 8 feet of agglomerate containing boulders of basalt. This relation of the lavas to the gravels is a question of some interest, since, if the ideas here advanced are correct, it is possible that valuable placer gravels may be present somewhere beneath the lavas.

Where the lava rim was seen on the Kiwalik, about a mile above Candle, it was a far less pronounced feature than in the areas to the west that are described by Moffit. At the headwaters of the Kiwalik, on Wilson Creek across the divide from Sweepstakes, and at the head of Moon Creek on the west side of Peace River, the basalt caps the hills, and on the east side of the river opposite Moon Creek it appears nearly to the crest of the ridge. In places at each of these three occurrences there appears a distinct scarp or rim, but elsewhere the presence of the basalt is only indicated by the numerous large angular pieces of the rock which cover the very gentle slopes. Wherever bedrock was seen in the banks of Peace River it consisted of the much older series of andesitic tuffs and flows, generally overlain by unconsolidated gravels. At the head of the Kiwalik, the basalt appears to overlie clay beds above a bed of very fibrous lignite.

It appears likely from the distribution of the basalts that they once covered the gravels which occupied the valleys of Peace River and Sweepstakes Creek, but west of Peace River and north of Sweepstakes Creek they have since been removed by erosion. Moffit[1] states that the presence of the lava on Candle Creek is shown by fragments in the gravel and on the hill slopes and by a few outcrops. It probably also filled the valley of Kiwalik River from Candle up to a point between the mouths of Lava and Hunter creeks. It is likely that detailed work would reveal the presence of remnants of this flow on the west side of the Kiwalik also.

None of the recent basalts are found on Bear Creek except at its head, where their position indicates that if Bear Creek flowed in its present valley at the time of their extrusion a lava stream must certainly have flowed down this depression. They are not now present in this valley, so far as known.

In like manner, basalts occur on the divide between Dime Creek and Peace River, west of Eldorado Creek, and at the head of Flat Creek in positions which indicate that they would have flowed down a depression corresponding to the present valley of Dime Creek had it existed at the time of their extrusion. These basalts have been removed without leaving a trace of their former presence except the olivine found in the heavy sands of the clean-ups.

The presence of the lava on the divide between Mukluktulik River and Kenwood Creek indicates from its position that it must once have been connected with the basalt areas to the north in the Koyuk basin.

[1] Moffit, F. H., op. cit., p. 61.

A measure of the amount of erosion since the extrusion of the lavas is afforded by these numerous flows. An interpretation of the age relations is presented on page 381.

CANDLE CREEK.

Candle Creek has been one of the large gold-producing creeks of Seward Peninsula for many years. The earliest workings were on creek claims, and mining operations in summer are still largely confined to the creek, although some of the more shallow benches are now being worked by open-cut methods. After the discovery of the creek placers, prospecting revealed the presence of valuable ground on the benches, and deposits of such gravels have been worked there for a number of years.

The bedrock in the lower claims is mainly schist, but on the bench claims it is in many places a coarsely porphyritic andesite. It is said that on the upper bench the pay streak follows rather closely the contact between the andesite and the schist. On the creek claims, according to Moffit:[1]

> Schist (often coarse and angular, at times finely divided) forms much the larger part of the gravels in the channel. Quartz-vein stuff with some limestone makes up the remainder. An ice bed of variable thickness, which measures about 12 feet near Patterson Creek and extends to the west of the stream channel several hundred feet, overlies the gravels in the bottom of the valley. The tendency of the débris on the slopes of either side of the valley to slide down toward the creek is shown by the bulging up of the clay from the bottom of the cuts and by the closing in of the sides. In consequence of this tendency the gravels are usually much disturbed and there is no uniformity in the sections. At the mouth of Patterson Creek there are from 6 to 8 feet of gravel and slide resting on a blue-clay bedrock; at Willow Creek the gravels measure from 5 to 8 feet; on a bench claim below Patterson Creek the gravels are not so thick—4 or 5 feet of fine schist, "chicken feed," is covered by 10 or 12 feet of ice and 2 feet of muck; on a bench claim nearly 1,000 feet west of Candle Creek a 33-foot hole put down with a thawer gave the following section:
>
> *Section near Candle Creek.*
>
> | | Feet. |
> |---|---|
> | Muck | 3 |
> | Slide consisting of yellowish and reddish quartz sand with "chicken feed" (finely ground schist) | 28 |
> | Sand | 1 |
> | Gravel with rounded quartz pebbles | 1 |
> | Bedrock, yellowish clay with pieces of lava. | |

The gold on the creek claims, where the bedrock is schist, is flattened and black; that taken from bench claims, where andesite is the bedrock, is said usually to be bright. "Iron stones," rounded pebbles of hematite or limonite, are generally found in close asso-

[1] Moffit, F. H., op. cit., p. 61.

ciation with the richer deposits. Other minerals found in the sluice boxes in the clean-up includes arsenopyrite, pyrite, galena, chalcopyrite, magnetite, ilmenite, rutile, zircon, garnet, and cerusite. Of these minerals, arsenopyrite appeared to make up far the largest proportion on a claim near the mouth of Patterson Creek. The chalcopyrite occurs in association with the galena in the same grains. Some of the galena is coated with cerusite. These minerals are found also in the cuts of the Keewalik Mining Co. on John Bull Hill south of Candle, but the iron oxides appear to predominate and occur in well-rounded grains or small pebbles. In addition to the minerals above mentioned, shot coated with lead oxide are found with the heavy sands.

About 12 small plants, employing in all about 30 men, were at work during the winter of 1916–17, either engaged in mining or in prospecting on Candle Creek and its tributaries, including 11 men who worked on Jump Creek. In summer about 55 men were engaged in mining, about half of them with two of the eleven plants that were operating. Power scrapers were used on a number of claims. On some it was necessary to pump water in order to get sufficient elevation and suitable grade for the boxes, as well as dumping room for tailings. One dredge was in operation, and two plants hydraulicked the overburden and the auriferous gravels. China pumps were used on some of the creek claims to remove water from the pits.

The dredge was operating on claim No. 5 above Discovery. Another dredge was to be moved to the creek during the winter of 1917–18. These dredges will operate on the creek claims, and some of the ground will be reworked.

It is said that many of the bench claims contain sufficient gold in the tailings from former operations to warrant reworking if water could be obtained. Considerable losses were entailed in washing the clayey gravels by the methods previously used, largely because of insufficient water. Projects have been proposed for getting water on these claims by the construction of a ditch, but the high initial expense has served to delay the carrying out of any of these plans while the ownership of the ground to be worked is as widely distributed as at present.

BEAR CREEK.

Bear Creek is tributary to Buckland River on the northern drainage slope of Seward Peninsula. Gold has been mined on the main creek and two of its tributaries, Sheridan and Cub creeks. The first claims recorded were staked in 1901 and some work was done later on the richest gravels, Moffit[1] stating that in 1903 about $10,000

[1] Moffit, F. H., op. cit., p. 64

was taken out. Concerning the later developments, Smith and Eakin [1] give the following information:

> From 1903 to 1907 a little desultory prospecting and mining was done, but during the latter year the building of a ditch along the west slope of the valley revived interest in the region. The small precipitation of 1908, however, prevented any extensive use of the new ditch, and in 1909 there was no evidence that productive mining was in progress.

Since 1909 changes in ownership have taken place, and in addition to the hydraulicking plant of the former ditch company there has been installed a hydraulic elevator of the open-flume type, which operated in 1916 and 1917. This plant was working on Bear Creek near the mouth of Split. In 1917 two men were engaged in open-cut work on a beach claim near this plant, one man was open cutting on a claim about a mile below, and one man was working on an open cut on Sheridan Creek. In addition some assessment work was done on a number of other claims on Bear Creek, and Cub Creek had been restaked recently, although no work had been done on it early in August.

For the most part, the bedrock is a series of altered andesite tuffs and flows, but intrusive rocks of a more basic character are associated with them, for pebbles of diabase were seen in the creek gravels. Probably the platinum that is obtained in small amount on Bear Creek is derived from rocks of this character. In addition to the basic intrusives there are numerous dikes of acidic intrusives; fresh andesite dikes, which cut the metamorphosed andesitic rocks, were seen on the hills north of Split Creek, and pebbles of syenite and diorite were noted below the mouths of small streams between Split and Cub creeks. In the bed of the main stream dikes were seen, but they were so badly weathered that their original nature was not determinable. The bedrock on the lower part of Cub Creek is of the metamorphosed andesite series, but a large proportion of the boulders of the creek are composed of porphyritic syenite, monzonite, or diorite, and some of them carry the brown garnet melanite. These rock types correspond to those described by Moffit [2] as occurring in the vicinity of Granite Mountain. Pyritic mineralization, of which the deposition of the gold is a phase, accompanied the intrusion of these rocks.

The bedrock surface in the creek is extremely irregular, and its unevenness appears to prevent large-scale operations by methods other than those now being used. A considerable portion of the gold lies close to bedrock, and it must therefore be thoroughly cleaned for successful mining. In the concentrates found in the clean-ups by far

[1] Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region: U. S. Geol. Survey Bull. 449, pp. 125–126, 1911.

[2] Moffit, F. H., op. cit., pp. 29–30.

the largest proportion of the heavy sands consist of the iron oxides, magnetite and hematite. The magnetite is easily removed by the magnet, but the hematite gives some trouble, as it is not readily separable from the gold. In addition to these minerals smaller amounts of limonite, ilmenite, pyrite, garnet, olivine, and some of the lighter silicates are also found. Of special interest in connection with the platinum is the occurrence of rounded grains and perfect octahedra of a chrome spinel, which resembles magnetite but is only very faintly magnetite, and in addition appears to have a more vitreous rather than metallic luster. A similar association of minerals is found on Sheridan Creek, where the geologic conditions are essentially the same as those on the main stream.

RUBE CREEK.

Rube Creek is a small stream that enters Peace River from the west about 7 or 8 miles above Sweepstakes Creek. It flows close to the base of the mountain mass that lies to the south, so that there is less workable placer ground, either stream or bench, on that side than on the north, where between Rube and Farmer creeks there is a sloping tundra plain in which these two streams have only slightly intrenched themselves. A number of claims have been staked on both creeks as well as on some of the tributaries of Rube Creek from the south. Most of the work in August, 1917, had been done on a group of claims on Rube Creek, where a ditch had been dug and two open cuts had been made. Most of the work of development had been done on the lower cut, which was about 100 feet long and from 3 to 8 feet deep. Gold is found on a false bedrock, an impervious clayey stratum, and in the superjacent 2 to 3 feet of gravel. Overlying the pay gravel is an uneven thickness of barren gravel and sand, which is overlain by 2 feet or more of muck and vegetation. North of Rube Creek the depth to bedrock is greater, and in one section 6 feet or more of ice containing a small amount of gray-blue muck is exposed below the surface covering of vegetation. At one place several alternating thin layers of gravel and muck were noted. These layers were probably formed by the deposition of the gravels on the moss-covered surface by successive spring overflows, and the accumulation of moss and finer material on the surface between flows.

Pannings from the pay gravels showed several colors to the pan of bright gold, somewhat less flaky than that on Dime Creek. No platinum was seen in the pannings, but it is said to be found. The heavy sands include an unusual amount of black garnet. Besides the lighter silicates, hematite, olivine, zircon, and chrome spinel are also present. Only a few grains of the chrome spinel were seen.

In one of the bare patches between Rube and Farmer creeks a pan of dirt was washed and showed a few fine colors. The minerals in

the concentrates were essentially the same as those on Rube Creek, the black garnet being conspicuous.

SWEEPSTAKES CREEK.

Sweepstakes Creek is the main tributary of Peace River from the west, and at their junction the two streams are about the same size. It is untimbered except near Peace River. Like Rube Creek it flows close to its south bank, and there is a very gentle slope on the north side.

During the summer four plants, which employed about 12 men, were in operation. Work was done on rather widely separated claims, extending from the mouth of Bear Gulch, about 2 miles below Discovery claim, which is near the forks of Sweepstakes, to claim No. 10 above Discovery. The ground is shallow, and open-cutting is practiced. A large part of the overburden of muck and vegetation, as well as the upper part of the gravels, is sluiced off, and the auriferous gravels are then shoveled into a line of sluice boxes.

On the upper claims worked the depth to bedrock is about 6 feet, the upper 2 feet of which consists largely of muck and vegetation. The material on this claim contains many angular fragments of rock, 8 inches or larger in dimensions and comparatively little rounded gravel.

On the lower claims the depth to bedrock is somewhat greater, ranging from 7 to 15 feet, of which the gravels make up from 4 to 9 feet. The gravel is well rounded and relatively small, although some boulders are present. The bedrock is similar in character to that of most of the material of the gravels and is somewhat decomposed, so that often the bedrock is excavated to a depth of a few inches and put through the sluice boxes also, in order to prevent the loss of gold.

On most of the creek the bedrock consists of the metamorphosed andesite series, but there are places where the much older metamorphic rocks seem to underlie the auriferous gravels. Elsewhere, as near the mouth of Granite Creek and on the uppermost claims being worked, syenitic rocks appear.

Platinum, comparable in the ratio of its occurrence with the gold to that on Dime Creek, is found on the Circle claim at the mouth of Bear Gulch, and pannings from Bear Gulch are also said to carry considerable amounts of this metal. It was not reported in the gold from the upper claims.

The heavy sands include magnetite, olivine, brown and red garnets, zircon, hematite, and a small amount of ilmenite. Chrome spinel is present also in considerable amounts, and it is probably derived from the same source as the platinum.

DIME CREEK.

Dime Creek is tributary to Koyule River from the northeast between Peace River and East Fork. The first claims were staked in 1910 by Sam Smith and his associates. Prospect holes were sunk on the lower claims, but the results obtained did not warrant further operations, and the claims were abandoned. On April 4, 1915, gold was discovered near the mouth of Little Eldorado Creek by Tom Moon and Henry Ryan. There resulted a stampede to the creek; and, after what were supposed to be the good claims on Little Eldorado Creek were staked, the late comers took first the creek claims and then the bench claims on Dime Creek as well as its tributaries, and claims were also staked in the basins of near-by streams. A production of about $3,000 is said to have been made from three claims [1] during that year. Neither machinery nor supplies were near at hand, and they had to be brought from Golofnin or Nome, so that no considerable production was made until the following year. It has been estimated [2] that the production of 1916 was about $100,000 from eight claims.

In 1917 about 17 plants in operation on 16 claims employed a total of 85 men. It is believed that the production from winter and summer operations was about $150,000. In addition to the gold about 35 ounces of platinum was produced. It is said that on the creek and bench claims at the lower end of Dime Creek there is about 1 ounce of platinum to each $5,000 of gold; on the upper claims this ratio is considerably higher, so that it may amount to as much as 1 ounce to each $2,000 in gold.

The following analysis of platinum from Dime Creek was made by R. C. Wells in the laboratory of the Geological Survey:

Analysis of platinum from Dime Creek, Seward Peninsula.

Gold	0.6
Silver	9.5
Lead	1.4
Platinum	71.5
Iridium (?)	3.8
Palladium	.9
Copper	.1
Rhodium	.9
Iron	6.1
Osmiridium, silica, and undetermined	3.4
Nickel	trace
	98.2

[1] Brooks, A. H., The Alaskan mining industry in 1915: U. S. Geol. Survey Bull. 642, p. 70, 1916.

[2] Mertie, J. B., Lode and placer mining on Seward Peninsula, Alaska: U. S. Geol. Survey Bull. 662, p. 454, 1917.

The highest values that have been reported for the gold from this creek are $19.84 and $19.88 a fine ounce. The fineness of the gold worth $19.88 an ounce was 961 parts gold and 32 parts silver.

The depth to bedrock differs considerably. In a general way the claims at the upper end of the creek are somewhat more shallow than those farther downstream, and the depth to bedrock increases still more on claims as far down as claims 8 or 9 below Discovery. Where mining is being carried on, from claim 7 above to claim 1 below, the depths range from 10 or 12 feet to about 30 feet on the creek claims. On the right limit benches the depths range from 6 to 10 feet; on the left limit, the first tier opposite claim 2 above, the depths are about the same but increase downstream, so that on the second tier bench opposite Discovery the depths to bedrock range from 25 to 50 feet. Bedrock lies a little higher than the present surface of the stream. The section made known by mining operations differs according to the depths of the holes. Normally, however, there is a gravel layer from 2 to 8 feet in thickness overlain by a few feet of muck and ice, which in turn is covered by about 1 or 2 feet of vegetation and peaty material. In some of the deeper holes, especially on the benches, there is a layer of angular rocks and clayey material which appears to be largely hillside talus. This is locally known as "slide" and contains little, if any, rounded gravel. All the ground worked is frozen.

Summer operations were largely confined to open-cut work, prospecting, repairing of ditches, and getting equipment and supplies for winter work. A few small plants that were worked during the summer hoisted with a windlass. There appears to be little reason why, if it is possible to obtain fuel and other supplies, deep mining should not be carried on during the summer, as well as in winter. Open cutting was in progress in August, 1917, on three claims; one plant used ditch water for stripping and sluicing, one pumped from Dime Creek, and the third supplemented water that was pumped from the creek by ditch water when it was available. A large proportion of the overburden of the auriferous gravels on these claims consisted of muck and ice below a protective mantle of vegetation. When this covering had been removed even a small amount of water was effective in stripping.

The gold is found mostly on or near bedrock, but some is distributed through 2 or 3 feet of gravel, so that it is necessary to mine and sluice this amount of material. The amount ranges from 50 cents to over $2 a square foot of bedrock mined. Though the pay streak on the creek claims is fairly well defined, it may in places be divided and on the bench claims there appear to be several lines along which concentration has taken place, as though effected by wave action along beaches at successive stages of elevation or de-

pression of the land surface. Further data are required to prove this hypothesis, which can best be obtained from actual mining operations and observations as to the lineal continuity of pay streaks. In association with the gold and platinum in the sands from clean-ups a number of heavy minerals have been found. These minerals include a little magnetite, hematite, and limonite, and large amounts of chrome spinel and olivine, together with some pyroxene. Garnets are found, although rarely. Rutile was noted from one of the left-limit second-tier bench claims.

Bedrock on the creek consists largely of the metamorphosed andesite series. The older slates and limestones appear, however, on the west side of the creek, and Little Eldorado Creek follows along the contact.

At the mouth of Silver Gulch a Cretaceous conglomerate, which contains pebbles of limestone and slate, appears in the stream banks, and with Cretaceous shale and sandstone forms the bedrock of most of the creek claims below this tributary.

Pebbles of glassy lava in the stream gravels indicate that somewhere on the creek this rock forms the bedrock. The olivine and pyroxene, which are green and greenish-black minerals in the heavy sands, may have been derived from the recent basaltic lavas which occur along the divide between Dime Creek and Flat Creek, as well as on the ridge between Dime Creek and Peace River, and probably once occupied or covered Dime Creek valley, or they may have been derived, together with the chrome spinel, from a peridotite at the head of Dime Creek. This rock probably is the source of the platinum also, and the fact that the platinum grains are so rounded affords an indication of the distance traveled and the amount of abrasion to which they have been subjected. Grains of platinum from the upper claims appeared more commonly to be angular, although even there a large proportion is shotlike.

A composite sample of chrome spinel from several claims on Dime Creek and a sample of concentrates from the left-limit second-tier bench claim opposite Discovery, Dime Creek, were analyzed by Chase Palmer in the laboratory of the United States Geological Survey and were found to contain 51.14 and 15.42 per cent of chromic oxide (Cr_2O_3), respectively.

LODE PROSPECTS.

There has been but little attempt at lode mining within this region, probably largely on account of the poor exposures, except along streams throughout much of the area. In the mountainous areas at the heads of the larger streams exposures are somewhat better, but the difficulties of transportation are such that even moderately rich ores could scarcely be worked at a profit except on a large scale and after the completion of roads or railroads to them.

Only two prospects are known to the writer. What is known as the Beltz prospect consists of ten or more small open cuts on the north side of Split Creek, a tributary of Bear Creek. These lie at an average elevation of about 700 feet above the mouth of Split Creek. The pits are badly caved and filled with talus from the slope, so that it was not possible to obtain any data on width, dip, or strike of the vein. Near some of these pits vein quartz was seen, which carried some copper as chalcopyrite. The weathering of the chalcopyrite had caused the rock to appear rusty from the iron oxide with small patches of green copper carbonate. There does not appear ever to have been any production of ore from this property, and it is not possible to make any statement of its potentialities.

On the Kugruk about a quarter of a mile east of the mouth of Independence Creek there is an argentiferous lead prospect owned by Perkeypile & Ford, which was not visited. Considerable development work is said to have been done on this property by open cuts, tunnels, and winzes. In addition to lead and silver assays show a considerable percentage of zinc, traces of copper, and a small amount of gold.

Transportation of supplies to this prospect and of the ore or concentrates from it appear to be the controlling factors in this development. Candle, 25 miles distant, is the nearest town to which supplies could be brought, although it is possible that they could be brought up the Kugruk to a point somewhat nearer. The future of this property appears to be dependent upon the proving of a sufficiently large ore body to warrant the construction of a road or railroad from the mine to Candle or Deering for the economic handling of supplies and ore. If a road was built to Candle, advantage could probably be taken of that already constructed up Candle Creek. For a small plant winter transportation of both supplies and ore would doubtless prove most economical. Coal for fuel and power could be obtained on the Kugruk within 15 or 20 miles.

COAL.

The workable deposits of coal in this area have already been quite fully discussed under the consideration of the economic factors that affect the mining of placer gold. (See pp. 383-385.) In addition to these occurrences small deposits are also known at the head of Hunter Creek and near the mouth of the Buckland. Nothing further is known regarding these deposits.

HOT SPRINGS.

A slight depression on a bench 50 feet above the west bank of Spring Creek, about half a mile above the forks, contains hot springs which rise up through angular fragments of diorite and metamorphosed andesite. Several basins have been artificially excavated,

and the water, most of which comes from a spring at the upper end of the series, flows successively through these basins. The temperature is such that the hand can be held in the uppermost pool without discomfort and is probably about 105° F. The lower pools are slightly cooler. South of the main spring is a small seep. In the basins is a considerable growth of red, yellow, pink, and green algae. There is a slight odor of sulphur dioxide in the vicinity. The rocks over which the spring waters flow have a thin white tasteless coating, but there are no deposits of siliceous or calcareous material. Bubbles of an odorless, noninflammable gas, probably carbon dioxide, rise almost constantly in the pool of the principal spring.

In the bank of the stream just below the spring is a small outcrop of a gray hornblende diorite, which is intrusive in the andesitic series. It appears likely that the spring is fed by atmospheric water, which falls on the upper slopes of Granite Mountain and follows joints and fissures in the rocks down to the zone where it acquires its heat and then rises along another fissure to form the spring. The water is tasteless and odorless and fairly potable after cooling, although a trifle "flat." No utilization has been made of the springs.

SOURCE OF VALUABLE PLACER MINERALS.

The essential facts concerning the source of the placers have been included in the preceding discussion. It may, however, be well to summarize briefly the main features of their origin.

The origin of the gold is attributed to syenitic and dioritic intrusions and possibly on Candle Creek to the more porphyritic andesite. At Candle Creek a portion of the gold of the placers is also probably to be attributed to the breaking down of auriferous quartz veins in the older metamorphic rocks. In a general way, there seems to have been comparatively little quartz deposited in veins accompanying the deposition of the gold, but the quartz was deposited in thin fissures in the older andesites and metamorphic series. The gold was concentrated in the placers along marine beaches or along stream valleys; some deposits were undoubtedly subjected to both beach and stream concentration.

The platinum, which is found in the placers on Bear, Sweepstakes, and Dime creeks, and of which a few grains are reported from Candle Creek differs in origin from the gold in that it is a constituent of the basic igneous rock and is not due to an intrusion later than the platinum-bearing rock. The history of its concentration in placers is essentially the same as that of the gold with which it occurs. The chrome spinel and probably some of the olivine found in the platiniferous placers were derived from the same rock as the platinum.

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.

The maps whose price is stated are sold by the Geological Survey and not by the Superintendent of Documents. On an order amounting to $5 or more at the retail price a discount of 40 per cent is allowed.

GENERAL.

REPORTS.

* The geography and geology of Alaska, a summary of existing knowledge, by A. H. Brooks, with a section on climate, by Cleveland Abbe, jr., and a topographic map and description thereof, by R. U. Goode. Professional Paper 45, 1906, 327 pp. No copies available. May be consulted at many public libraries.

*Placer mining in Alaska in 1904, by A. H. Brooks. In Bulletin 259, 1905, pp. 18–31. 15 cents.

The mining industry in 1905, by A. H. Brooks. In Bulletin 284, 1906, pp. 4–9.

* The mining industry in 1906, by A. H. Brooks. In Bulletin 314, 1907, pp. 19–39. 30 cents.

* The mining industry in 1907, by A. H. Brooks. In Bulletin 345, 1908, pp. 30–53. 45 cents.

* The mining industry in 1908, by A. H. Brooks. In Bulletin 379, 1909, pp. 21–62. 50 cents.

*The mining industry in 1909, by A. H. Brooks. In Bulletin 442, 1910, pp. 20–46. 40 cents.

The mining industry in 1910, by A. H. Brooks. In Bulletin 480, 1911, pp. 21–42.

The mining industry in 1911, by A. H. Brooks. In Bulletin 520, 1912, pp. 19–44. 50 cents.

The mining industry in 1912, by A. H. Brooks. In Bulletin 542, 1913, pp. 18–51.

* The Alaskan mining industry in 1913, by A. H. Brooks. In Bulletin 592, 1914, pp. 45–74. 60 cents.

The Alaskan mining industry in 1914, by A. H. Brooks. In Bulletin 622, 1915, pp. 15–68.

The Alaskan mining industry in 1915, by A. H. Brooks. In Bulletin 642, 1916, pp. 17–72.

The Alaskan mining industry in 1916, by A. H. Brooks. In Bulletin 662, 1917, pp. 11–62.

The Alaskan mining industry in 1917, by G. C. Martin. In Bulletin 692, 1918, pp. 11–42.

Railway routes, by A. H. Brooks. In Bulletin 284, 1906, pp. 10–17.

Railway routes from the Pacific seaboard to Fairbanks, Alaska, by A. H. Brooks. In Bulletin 520, 1912, pp. 45–88.

*Geologic features of Alaskan metalliferous lodes, by A. H. Brooks. In Bulletin 480, 1911, pp. 43–93.

*The mineral deposits of Alaska, by A. H. Brooks. In Bulletin 592, 1914, pp. 18–44.

*The future of gold placer mining in Alaska, by A. H. Brooks. In Bulletin 622, 1915, pp. 69–79.

*Tin resources of Alaska, by F. L. Hess. In Bulletin 520, 1912, pp. 89–92. 50 cents.

*The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. Bulletin 250, 1905, 64 pp. 15 cents.

Alaska coal and its utilization, by A. H. Brooks. Bulletin 442–J, reprinted 1914.

*The possible use of peat fuel in Alaska, by C. A. Davis. In Bulletin 379, 1909, pp. 63–66. 50 cents.

*The preparation and use of peat as a fuel, by C. A. Davis. In Bulletin 442, 1910, pp. 101–132. 40 cents.

*Methods and costs of gravel and placer mining in Alaska, by C. W. Purington. Bulletin 263, 1905, 362 pp. No copies available. (Abstract in Bulletin 259, 1905, pp. 32–46.)

*Prospecting and mining gold placers in Alaska, by J. P. Hutchins. In Bulletin 345, 1908, pp. 54–77. 45 cents.

*Geographic dictionary of Alaska, by Marcus Baker; second edition prepared by James McCormick. Bulletin 299, 1906, 690 pp. 50 cents.

Tin mining in Alaska, by H. M. Eakin. In Bulletin 622, 1915, pp. 81–94.

Antimony deposits of Alaska, by A. H. Brooks. Bulletin 649, 1916, 67 pp.

The use of the panoramic camera in topographic surveying, by J. W. Bagley. Bulletin 657, 1917, 88 pp.

The mineral springs of Alaska, by G. A. Waring. Water-Supply Paper 418, 1917, 114 pp.

Alaska's mineral supplies, by A. H. Brooks. Bulletin 666–P, pp. 1–14.

TOPOGRAPHIC MAPS.

Map of Alaska (A); scale 1:5,000,000; 1912, by A. H. Brooks. 20 cents retail or 12 cents wholesale.

Map of Alaska (B); scale 1:1,500,000; 1915, by A. H. Brooks and R. H. Sargent. 80 cents retail or 48 cents wholesale.

Map of Alaska (C); scale 1:12,000,000; 1916. 1 cent retail or five for 3 cents wholesale.

Map of Alaska showing distribution of mineral deposits; scale 1:5,000,000; by A. H. Brooks. 20 cents retail or 12 cents wholesale. New editions included in Bulletins 642 and 662.

Index map of Alaska, including list of publications; scale 1:5,000,000; by A. H. Brooks. Free.

SOUTHEASTERN ALASKA.

REPORTS.

*The Porcupine placer district, Alaska, by C. W. Wright. Bulletin 236, 1904, 35 pp. 15 cents.

*Economic developments in southeastern Alaska, by F. E. and C. W. Wright. In Bulletin 259, 1905, pp. 47–68. 15 cents.

*The Juneau gold belt, Alaska, by A. C. Spencer, pp. 1–137, and a reconnaissance of Admiralty Island, Alaska, by C. W. Wright, pp. 138–154. Bulletin 287, 1906, 161 pp. 75 cents.

Lode mining in southeastern Alaska, by F. E. and C. W. Wright. In Bulletin 284, 1906, pp. 30–53.

Nonmetallic deposits of southeastern Alaska, by C. W. Wright. In Bulletin 284, 1906, pp. 54–60.

Lode mining in southeastern Alaska, by C. W. Wright. In Bulletin 314, 1907, pp. 47–72.

Nonmetalliferous mineral resources of southeastern Alaska, by C. W. Wright. In Bulletin 314, 1907, pp. 73–81.

Reconnaissance on the Pacific coast from Yakutat to Alsek River, by Eliot Blackwelder. In Bulletin 314, 1907, pp. 82–88.

*Lode mining in southeastern Alaska, 1907, by C. W. Wright. In Bulletin 345, 1908, pp. 78–97. 45 cents.

*The building stones and materials of southeastern Alaska, by C. W. Wright. In Bulletin 345, 1908, pp. 116–126. 45 cents.

*The Ketchikan and Wrangell mining districts, Alaska, by F. E. and C. W. Wright. Bulletin 347, 1908, 210 pp. 60 cents.

*The Yakutat Bay region, Alaska; Physiography and glacial geology, by R. S. Tarr; Areal geology, by R. S. Tarr and B. S. Butler. Professional Paper 64, 1909, 186 pp. 50 cents.

*Mining in southeastern Alaska, by C. W. Wright. In Bulletin 379, 1909, pp. 67–86. 50 cents.

*Mining in southeastern Alaska, by Adolph Knopf. In Bulletin 442, 1910, pp. 133–143. 40 cents.

*Occurrence of iron ore near Haines, by Adolph Knopf. In Bulletin 442, 1910, pp. 144–146. 40 cents.

*Report of water-power reconnaissance in southeastern Alaska, by J. C. Hoyt. In Bulletin 442, 1910, pp. 147–157. 40 cents.

Geology of the Berners Bay region, Alaska, by Adolph Knopf. Bulletin 446, 1911, 58 pp.

Mining in southeastern Alaska, by Adolph Knopf. In Bulletin 480, 1911, pp. 94–102.

The Eagle River region, by Adolph Knopf. In Bulletin 480, 1911, pp. 103–111.

The Eagle River region, southeastern Alaska, by Adolph Knopf. Bulletin 502, 1912, 61 pp.

The Sitka mining district, Alaska, by Adolph Knopf. Bulletin 504, 1912, 32 pp.

The earthquakes at Yakutat Bay, Alaska, in September, 1899, by R. S. Tarr and Lawrence Martin, with a preface by G. K. Gilbert. Professional Paper 69, 1912, 135 pp.

Marble resources of Ketchikan and Wrangell districts, by E. F. Burchard. In Bulletin 542, 1913, pp. 52–77.

Marble resources of the Juneau, Skagway, and Sitka districts, by E. F. Burchard. In Bulletin 592, 1914, pp. 95–107.

A barite deposit near Wrangell, by E. F. Burchard. In Bulletin 592, 1914, pp. 109–117.

*Lode mining in the Ketchikan district, by P. S. Smith. In Bulletin 592, 1914, pp. 75–94. 60 cents.

The geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska, by C. W. Wright. Professional Paper 87, 1915, 110 pp.

Mining in the Juneau region, by H. M. Eakin. In Bulletin 622, 1915, pp. 95–102.

Notes on the geology of Gravina Island, Alaska, by P. S. Smith. In Professional Paper 95, 1916, pp. 97–105.

Mining in southeastern Alaska, by Theodore Chapin. In Bulletin 642, 1916, pp. 73–104.

Water-power investigations in southeastern Alaska, by G. H. Canfield. In Bulletin 642, 1916, pp. 105–127.

Mining developments in the Ketchikan and Wrangell districts, by Theodore Chapin. In Bulletin 662, 1917, pp. 63–75.

Lode mining in the Juneau gold belt, by H. M. Eakin. In Bulletin 662, 1917, pp. 71–92.

Gold placer mining in the Porcupine district, by H. M. Eakin. In Bulletin 662, 1917, pp. 93–100.

Water-power investigations in southeastern Alaska, by G. H. Canfield. In Bulletin 662, 1917, pp. 101–154.

Water-power investigations in southeastern Alaska, by G. H. Canfield. In Bulletin 692, 1919, pp. 43–83.

The structure and stratigraphy of Gravina and Revillagigedo islands, Alaska, by Theodore Chapin. In Professional Paper 120–D, 1918, pp. 83–100.

Mining developments in the Ketchikan mining district, by Theodore Chapin, In Bulletin 692, 1919, pp. 85–89.

The geology and mineral resources of the west coast of Chichagof Island, by R. M. Overbeck. In Bulletin 692, 1919, pp. 91–136.

In preparation.

Marble deposits of southeastern Alaska, by E. F. Burchard. Bulletin 682.

The Porcupine district, by H. M. Eakin. Bulletin 699.

The Juneau district, by A. C. Spencer and H. M. Eakin.

Geology of the Glacier Bay and Lituya region, Alaska, by F. E. and C. W. Wright.

The Ketchikan district, Alaska, by Theodore Chapin.

TOPOGRAPHIC MAPS.

*Juneau gold belt, Alaska; scale, 1:250,000; compiled. In *Bulletin 287. 75 cents. Not issued separately.

Juneau special (No. 581A); scale, 1:62,500; by W. J. Peters. 10 cents retail or 6 cents wholesale.

Berners Bay special (No. 581B); scale, 1:62,500; by R. B. Oliver. 10 cents retail or 6 cents wholesale.

Kasaan Peninsula, Prince of Wales Island (No. 540A); scale, 1:62,500; by D. C. Witherspoon, R. H. Sargent, and J. W. Bagley. 10 cents retail or 6 cents wholesale. Also contained in Professional Paper 87.

Copper Mountain and vicinity, Prince of Wales Island (No. 540B); scale, 1:62,500; by R. H. Sargent. 10 cents retail or 6 cents wholesale. Also contained in Professional Paper 87.

Eagle River region (No. 581C); scale, 1:62,500; by J. W. Bagley, C. E. Giffin, and R. E. Johnson. In Bulletin 502. Not issued separately.

Juneau and vicinity (No. 581D); scale, 1:24,000; contour interval, 50 feet; by D. C. Witherspoon. 10 cents.

CONTROLLER BAY, PRINCE WILLIAM SOUND, AND COPPER RIVER REGIONS.

REPORTS.

*The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. Bulletin 250, 1905, 64 pp. 15 cents.

*Geology of the central Copper River region, Alaska, by W. C. Mendenhall. Professional Paper 41, 1905, 133 pp. 50 cents.

*Geology and mineral resources of Controller Bay region, Alaska, by G. C. Martin. Bulletin 335, 1908, 141 pp. 70 cents.

*Notes on copper prospects of Prince William Sound, by F. H. Moffit. In Bulletin 345, 1908, pp. 176–178. 45 cents.

Mineral resources of the Kotsina-Chitina region, by F. H. Moffit and A. G. Maddren. Bulletin 374, 1909, 103 pp.

*Copper mining and prospecting on Prince William Sound, by U. S. Grant and D. F. Higgins, jr. In Bulletin 379, 1909, pp. 78–96. 50 cents.

*Gold on Prince William Sound, by U. S. Grant. In Bulletin 379, 1909, p. 97. 50 cents.

Mining in the Kotsina-Chitina, Chistochina, and Valdez Creek regions, by F. H. Moffit. In Bulletin 379, 1909, pp. 153–160.

Mineral resources of the Nabesna-White River district, by F. H. Moffit and Adolph Knopf; with a section on the Quaternary, by S. R. Capps. Bulletin 417, 1910, 64 pp.

Mining in the Chitina district, by F. H. Moffit. In Bulletin 442, 1910, pp. 158–163.

Mining and prospecting on Prince William Sound in 1909, by U. S. Grant. In Bulletin 442, 1910, pp. 164–165.

Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska, by U. S. Grant and D. F. Higgins. Bulletin 443, 1910, 89 pp.

Geology and mineral resources of the Nizina district, Alaska, by F. H. Moffit and S. R. Capps. Bulletin 448, 1911, 111 pp.

Headwater regions of Gulkana and Susitna rivers, Alaska, with accounts of the Valdez Creek and Chistochina placer districts, by F. H. Moffit. Bulletin 498, 1912, 82 pp.

*The Chitina district, by F. H. Moffit. In Bulletin 520, 1912, pp. 105–107. 50 cents.

*Gold deposits near Valdez, by A. H. Brooks. In Bulletin 520, 1912, pp. 108–130. 50 cents.

Coastal glaciers of Prince William Sound and Kenai Peninsula, Alaska, by U. S. Grant and D. F. Higgins. Bulletin 526, 1913, 75 pp.

The McKinley Lake district, by Theodore Chapin. In Bulletin 542, 1913, pp. 78–80.

Mining in Chitina Valley, by F. H. Moffit. In Bulletin 542, 1913, pp. 81–85.

Mineral deposits of the Ellamar district, by S. R. Capps and B. L. Johnson. In Bulletin 542, 1913, pp. 86–124.

The mineral deposits of the Yakataga region, by A. G. Maddren. In Bulletin 592, 1914, pp. 119–154.

*Preliminary report on water power of south-central Alaska, by C. E. Ellsworth and R. W. Davenport. In Bulletin 592, 1914, pp. 155–194.

The Port Wells gold lode district, by B. L. Johnson. In Bulletin 592, 1914, pp. 195–236.

Mining on Prince William Sound, by B. L. Johnson. In Bulletin 592, 1914, pp. 237–244.

Geology of the Hanagita-Bremner region, by F. H. Moffit. Bulletin 576, 1915, 56 pp.

The geology and mineral resources of Kenai Peninsula, by G. C. Martin, B. L. Johnson, and U. S. Grant. Bulletin 587, 1915, 243 pp.

Mineral deposits of the Kotsina-Kuskulana district, with notes on mining in Chitina Valley, by F. H. Moffit. In Bulletin 622, 1915, pp. 103–117.

Auriferous gravels of the Nelchina-Susitna region, by Theodore Chapin. In Bulletin 622, 1915, pp. 118–130.

Mining on Prince William Sound, by B. L. Johnson. In Bulletin 622, 1915, pp. 131–139.

The gold and copper deposits of the Port Valdez district, by B. L. Johnson. In Bulletin 622, 1915, pp. 140–188.

The Ellamar district, by S. R. Capps and B. L. Johnson. Bulletin 605, 125 pp.

A water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport. Water-Supply Paper 372, 173 pp.

Mineral resources of the upper Chitina Valley, by F. H. Moffit. In Bulletin 642, 1916, pp. 129–136.

Mining on Prince William Sound, by B. L. Johnson. In Bulletin 642, 1916, pp. 137–145.

Mining in the lower Copper River basin, by F. H. Moffit. In Bulletin 662, 1917, pp. 155–182.

Retreat of Barry Glacier, Port Wells, Prince William Sound, Alaska, between 1910 and 1914, by B. L. Johnson. In Professional Paper 98, 1916, pp. 35–36.

Mining on Prince William Sound, by B. L. Johnson. In Bulletin 662, 1917, pp. 183–192.

Copper deposits of the Latouche and Knight Island districts, Prince William Sound, by B. L. Johnson. In Bulletin 662, 1917, pp. 193–220.

The Nelchina-Susitna region, by Theodore Chapin. Bulletin 668, 1918, 67 pp.

The upper Chitina Valley, by F. H. Moffit, with a description of the igneous rocks, by R. M. Overbeck. Bulletin 675, 1918, 82 pp.

Platinum-bearing auriferous gravels of Chistochina River, by Theodore Chapin. In Bulletin 692, 1919, pp. 137–141.

Mining in Prince William Sound, by B. L. Johnson. In Bulletin 692, 1919, pp. 143–151.

Mineral resources of Jack Bay district and vicinity, by B. L. Johnson. In Bulletin 692, 1919, pp. 153–173.

Mining in central and northern Kenai Peninsula in 1917, by B. L. Johnson. In Bulletin 692, 1919, pp. 175–186.

In preparation.

The Kotsina-Kuskulana district, by F. H. Moffit.

The Latouche and Knight Island districts, Prince William Sound, Alaska, by B. L. Johnson.

The Valdez-Jack Bay district, Prince William Sound, Alaska, by B. L. Johnson.

The Yakataga region, by A. G. Maddren.

TOPOGRAPHIC MAPS.

Central Copper River region, reconnaissance map; scale, 1:250,000; by T. G. Gerdine. In *Professional Paper 41. 50 cents. Not issued separately.

Headwater regions of Copper, Nabesna, and Chisana rivers, reconnaissance map; scale, 1:250,000; by D. C. Witherspoon, T. G. Gerdine, and W. J. Peters. In *Professional Paper 41. 50 cents. Not issued separately.

Controller Bay region (No. 601A); scale, 1:62,500; by E. G. Hamilton and W. R. Hill. 35 cents retail or 21 cents wholesale. Also published in *Bulletin 335. 70 cents.

Chitina quadrangle (No. 601), reconnaissance map; scale, 1:250,000; by T. G. Gerdine, D. C. Witherspoon, and others. 50 cents retail or 30 cents wholesale. Also published in Bulletin 576.

Nizina district (No. 601B); scale, 1:62,500; by D. C. Witherspoon and R. M. La Follette. In Bulletin 448. Not issued separately.

Headwater regions of Gulkana and Susitna rivers; scale, 1:250,000; by D. C. Witherspoon, J. W. Bagley, and C. E. Giffin. In Bulletin 498. Not issued separately.

Prince William Sound; scale, 1:500,000; compiled. In Bulletin 526. Not issued separately.

Port Valdez district (No. 602B); scale, 1:62,500; by J. W. Bagley. 20 cents retail or 12 cents wholesale.

The Bering River coal fields; scale, 1:62,500; by G. C. Martin. 25 cents retail or 15 cents wholesale.

The Ellamar district (No. 602D); scale, 1:62,500; by R. H. Sargent and C. E. Giffin. Published in Bulletin 605. Not issued separately.

Nelchina-Susitna region; scale, 1:250,000; by J. W. Bagley, T. G. Gerdine, and others. In Bulletin 668. Not issued separately.

Upper Chitina Valley, reconnaissance map; scale, 1:250,000; contour interval, 200 feet; by International Boundary Commission, F. H. Moffit, D. C. Witherspoon, and T. G. Gerdine. In Bulletin 675. Not issued separately.

In preparation.

The Kotsina-Kuskulana district (No. 601C); scale, 1:62,500; by D. C. Witherspoon.

The Port Wells region; scale, 1:250,000; by J. W. Bagley.

Jack Bay district; scale, 1:62,500; by J. W. Bagley.

COOK INLET AND SUSITNA REGION.

REPORTS.

*The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. Bulletin 250, 1905, 64 pp. 15 cents.

*Gold placers of Turnagain Arm, Cook Inlet, by F. H. Moffit. In Bulletin 259, 1905, pp. 90–99. 15 cents.

*Mineral resources of the Kenai Peninsula, Alaska, by F. H. Moffit and R. W. Stone. Bulletin 277, 1906, 80 pp.

*Gold placers of the Mulchatna, by F. J. Katz. In Bulletin 442, 1910, pp. 201–202. 40 cents.

*Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska, by Sidney Paige and Adolph Knopf. Bulletin 327, 1907, 71 pp.

The Mount McKinley region, Alaska, by A. H. Brooks, with descriptions of the igneous rocks and of the Bonnifield and Kantishna districts, by L. M. Prindle. Professional Paper 70, 1911, 234 pp.

A geologic reconnaissance of the Iliamna region, Alaska, by G. C. Martin and F. J. Katz. Bulletin 485, 1912, 138 pp.

Geology and coal fields of the lower Matanuska Valley, Alaska, by G. C. Martin and F. J. Katz. Bulletin 500, 1912, 98 pp.

The Yentna district, Alaska, by S. R. Capps. Bulletin 534, 1913, 75 pp.

Gold lodes and placers of the Willow Creek district, by S. R. Capps. In Bulletin 592, 1914, pp. 245–272.

Mineral resources of the upper Matanuska and Nelchina valleys, by G. C. Martin and J. B. Mertie, jr. In Bulletin 592, 1914, pp. 273–300.

Preliminary report on the Broad Pass region, by F. H. Moffit. In Bulletin 592, 1914, pp. 301–306.

Mining in the Valdez Creek placer district, by F. H. Moffit. In Bulletin 592, 1914, pp. 307–308.

The geology and mineral resources of Kenai Peninsula, Alaska, by G. C. Martin B. L. Johnson, and U. S. Grant. Bulletin 587, 1915, 243 pp.

The Willow Creek district, by S. R. Capps. Bulletin 607, 1915, 86 pp.

The Broad Pass region, by F. H. Moffit and J. E. Pogue. Bulletin 608, 1915. 80 pp.

Auriferous gravels of the Nelchina-Susitna region, by Theodore Chapin. In Bulletin 622, 1915, pp. 118–130.

The Turnagain-Knik region, by S. R. Capps. In Bulletin 642, 1916, pp. 147–194.

Gold mining in the Willow Creek district, by S. R. Capps. In Bulletin 642, 1916, pp. 195–200.

The Nelchina-Susitna region, by Theodore Chapin. Bulletin 668, 1918, 67 pp.

Mineral resources of the upper Chulitna region, by S. R. Capps. In Bulletin 692, 1919, pp. 207–232.

Gold lode mining in the Willow Creek district, by S. R. Capps. In Bulletin 692, 1919, pp. 177–186.

Mineral resources of the western Talkeetna Mountains, by S. R. Capps. In Bulletin 692, 1919, pp. 187–205.

Platinum-bearing gold placers of Kahiltna Valley, by J. B. Mertie, jr. In Bulletin 692, 1919, pp. 233–264.

Chromite deposits of Alaska, by J. B. Mertie, jr. In Bulletin 692, 1919, pp. 265–267.

Geologic problems at the Matanuska coal mines, by G. C. Martin. In Bulletin 692, 1919, pp. 269–282.

In preparation.

The geology of upper Matanuska basin, by G. C. Martin.

The western Talkeetna Mountains, Alaska, by S. R. Capps.

TOPOGRAPHIC MAPS.

Kenai Peninsula, southern portion; scale, 1:500,000; compiled. In Bulletin 526. Not issued separately.

Matanuska and Talkeetna region, reconnaissance map; scale, 1:250,000; by T. G. Gerdine and R. H. Sargent. In *Bulletin 327. 25 cents. Not issued separately.

Lower Matanuska Valley; scale, 1:62,500; by R. H. Sargent. In Bulletin 500. Not issued separately.

Yentna district, reconnaissance map; scale, 1:250,000; by R. W. Porter. Revised edition. In Bulletin 534. Not issued separately.

Mount McKinley region, reconnaissance map; scale, 1:625,000; by D. L. Reaburn. In Professional Paper 70. Not issued separately.

Kenai Peninsula, reconnaissance map; scale, 1:250,000; by R. H. Sargent, J. W. Bagley, and others. In Bulletin 587. Not issued separately.

Moose Pass and vicinity (602C); scale, 1:62,500; by J. W. Bagley. In Bulletin 587. Not issued separately.

The Willow Creek district; scale, 1:62,500; by C. E. Giffin. In Bulletin 607. Not issued separately.

The Broad Pass region; scale, 1:250,000; by J. W. Bagley. In Bulletin 608. Not issued separately.

Lower Matanuska Valley (602A); scale, 1:62,500; contour interval, 50 feet; by R. H. Sargent. 10 cents.

Nelchina-Susitna region; scale, 1:250,000; by J. W. Bagley. In Bulletin 668. Not issued separately.

SOUTHWESTERN ALASKA.

REPORTS.

*A reconnaissance in southwestern Alaska, by J. E. Spurr. In Twentieth Annual Report, pt. 7, 1900, pp. 31–264. $1.80.

*Gold mine on Unalaska Island, by A. J. Collier. In Bulletin 259, 1905, pp. 102–103. 15 cents.

*The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. Bulletin 250, 1905, 64 pp. 15 cents.

Geology and mineral resources of parts of Alaska Peninsula, by W. W. Atwood. Bulletin 467, 1911, 137 pp.

A geologic reconnaissance of the Iliamna region, Alaska, by G. C. Martin and F. J. Katz. Bulletin 485, 1912, 138 pp.

Mineral deposits of Kodiak and the neighboring islands, by G. C. Martin. In Bulletin 542, 1913, pp. 125–136.

The Lake Clark-Central Kuskokwim region, by P. S. Smith. Bulletin 655, 1918, 162 pp.

The beach placers of the west coast of Kodiak Island, Alaska, by A. G. Maddren. In Bulletin 692, 1919, pp. 299–319.

Sulphur on Unalaska and Akun islands and near Stepovak Bay, Alaska, by A. G. Maddren. In Bulletin 692, 1919, pp. 283–298.

TOPOGRAPHIC MAPS.

Herendeen Bay and Unga Island region, reconnaissance map; scale, 1:250,000; by H. M. Eakin. In Bulletin 467. Not issued separately.

Chignik Bay region, reconnaissance map; scale, 1:250,000; by H. M. Eakin. In Bulletin 467. Not issued separately.

Iliamna region, reconnaissance map; scale, 1:250,000; by D. C. Witherspoon and C. E. Giffin. In Bulletin 485. Not issued separately.

*Kuskokwim River and Bristol Bay region; scale, 1:625,000; by W. S. Post. In Twentieth Annual Report, pt. 7. $1.80. Not issued separately.

Lake Clark-Central Kuskokwim region, reconnaissance map; scale, 1:250,000; by R. H. Sargent, D. C. Witherspoon, and C. E. Giffin. In Bulletin 655. Not issued separately.

YUKON AND KUSKOKWIM BASINS.

REPORTS.

*The coal resources of the Yukon, Alaska, by A. J. Collier. Bulletin 218, 1903, 71 pp. 15 cents.

*Occurrence of gold in the Yukon-Tanana region, by L. M. Prindle. In Bulletin 345, 1908, pp. 179–186. 45 cents.

The Fortymile quadrangle, Yukon-Tanana region, Alaska, by L. M. Prindle. Bulletin 375, 1909, 52 pp.

Water-supply investigations in Yukon-Tanana region, Alaska, 1907–8 (Fairbanks, Circle, and Rampart districts), by C. C. Covert and C. E. Ellsworth. Water-Supply Paper 228, 1909, 108 pp.

The Innoko gold placer district, Alaska, with accounts of the Central Kuskokwim Valley and the Ruby Creek and Gold Hill placers, by A. G. Maddren. Bulletin 410, 1910, 87 pp.

Mineral resources of Nabesna-White River district, by F. H. Moffit and Adolph Knopf, with a section on the Quaternary by S. R. Capps. Bulletin 417, 1910, 64 pp.

*Placer mining in the Yukon-Tanana region, by C. E. Ellsworth. In Bulletin 442, 1910, pp. 230–245. 40 cents.

*Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district, by B. L. Johnson. In Bulletin 442, 1910, pp. 246–250. 40 cents.

Placer mining in the Yukon-Tanana region, by C. E. Ellsworth and G. L. Parker. In Bulletin 480, 1911, pp. 153–172.

Gold placer-mining developments in the Innoko-Iditarod region, by A. G. Maddren. In Bulletin 480, 1911, pp. 236–270.

Placer mining in the Fortymile and Seventymile river districts, by E. A. Porter. In *Bulletin 520, 1912, pp. 211–218. 50 cents.

Placer mining in the Fairbanks and Circle districts, by C. E. Ellsworth. In *Bulletin 520, 1912, pp. 240–245. 50 cents.

Gold placers between Woodchopper and Fourth of July creeks, upper Yukon River, by L. M. Prindle and J. B. Mertie, jr. In *Bulletin 520, 1912, pp. 201–210. 50 cents.

The Bonnifield region, Alaska, by S. R. Capps. Bulletin 501, 1912, 162 pp.

A geologic reconnaissance of a part of the Rampart quadrangle, Alaska, by H. M. Eakin. Bulletin 535, 1913, 38 pp.

A geologic reconnaissance of the Fairbanks quadrangle, Alaska, by L. M. Prindle, with a detailed description of the Fairbanks district, by L. M. Prindle and F. J. Katz, and an account of lode mining near Fairbanks, by P. S. Smith. Bulletin 525, 1913, 220 pp.

The Koyukuk-Chandalar region, Alaska, by A. G. Maddren. Bulletin 532, 1913, 119 pp. Price 25 cents.

A geologic reconnaissance of the Circle quadrangle, Alaska, by L. M. Prindle. Bulletin 538, 1913, 82 pp.

Placer mining in the Yukon-Tanana region, by C. E. Ellsworth and R. W. Davenport. In Bulletin 542, 1913, pp. 203–222.

The Chisana placer district, by A. H. Brooks. In *Bulletin 592, 1914, pp. 309–320.

*Placer mining in the Yukon-Tanana region, by Theodore Chapin. In Bulletin 592, 1914, pp. 357–362. 60 cents.

*Lode developments near Fairbanks, by Theodore Chapin. In Bulletin 592, 1914, pp. 321–355. 60 cents.

Mineral resources of the Yukon-Koyukuk region, by H. M. Eakin. In *Bulletin 592, 1914, pp. 371–384.

The Iditarod-Ruby region, Alaska, by H. M. Eakin. Bulletin 578, 1914, 45 pp.

Surface water supply of the Yukon-Tanana region, 1907 to 1912, by C. E. Ellsworth and R. W. Davenport. Water-Supply Paper 342, 1915, 343 pp.

Mineral resources of the Chisana-White River district, by S. R. Capps. In Bulletin 622, 1915, pp. 189–228.

Mining in the Fairbanks district, by H. M. Eakin. In Bulletin 622, 1915, pp. 229–238.

Mining in the Hot Springs district, by H. M. Eakin. In Bulletin 622, 1915, pp. 239–245.

Mineral resources of the Lake Clark-Iditarod region, by P. S. Smith. In Bulletin 622, 1915, pp. 247–271.

Quicksilver deposits of the Kuskokwim region, by P. S. Smith and A. G. Maddren. In Bulletin 622, 1915, pp. 272–291.

Gold placers of the lower Kuskokwim, by A. G. Maddren. In Bulletin 622, 1915, pp. 292–360.

An ancient volcanic eruption in the upper Yukon Basin, by S. R. Capps. Professional Paper 95–D, 1915, pp. 59–64.

Preliminary report on Tolovana district, by A. H. Brooks. In Bulletin 642, 1916, pp. 201–209.

Exploration in the Cosna-Nowitna region, by H. M. Eakin. In Bulletin 642, 1916, pp. 211–222.

Mineral resources of the Ruby-Kuskokwim region, by J. B. Mertie, jr., and G. L. Harrington. In Bulletin 642, 1916, pp. 228–266.

The Chisana-White River district, by S. R. Capps. Bulletin 630, 1916, 130 pp.

The Yukon-Koyukuk region, by H. M. Eakin. Bulletin 631, 1916, 88 pp.

Mineral resources of the Kantishna region, by S. R. Capps. In Bulletin 662, 1917, pp. 279–331.

The gold placers of the Tolovana district, by J. B. Mertie, jr. In Bulletin 662, 1917, pp. 221–277.

Gold placers near the Nenana coal field, by A. G. Maddren. In Bulletin 662, 1917, pp. 363–402.

Lode mining in the Fairbanks district, by J. B. Mertie, jr. In Bulletin 662, 1917, pp. 403–424.

Lode deposits near the Nenana coal field, by R. M. Overbeck. In Bulletin 662, 1917, pp. 351–362.

Gold placers of the Anvik-Andreafski region, by G. L. Harrington. In Bulletin 662, 1917, pp. 333–349.

The Lake Clark-central Kuskokwim region, by P. S. Smith. Bulletin 655, 1918, 162 pp.

The Nenana coal field, by G. C. Martin. Bulletin 664, 1919, 54 pp.

The Cosna-Nowitna region, by H. M. Eakin. Bulletin 667, 1918, 54 pp.

The Anvik-Andreafski region, by G. L. Harrington. Bulletin 683, 1918, 70 pp.

The Kantishna district, by S. R. Capps. Bulletin 687, 1919, 116 pp.

Mining in the Fairbanks district, by Theodore Chapin. In Bulletin 692, 1919, pp. 321–327.

A molybdenite lode on Healy River, by Theodore Chapin. In Bulletin 692, 1919, p. 329.

Mining in the Hot Springs district, by Theodore Chapin. In Bulletin 692, 1919, pp. 331–335.

Tin deposits of the Ruby district, by Theodore Chapin. In Bulletin 692, 1919, p. 337.

The gold and platinum placers of the Tolstoi district, by G. L. Harrington. In Bulletin 692, 1919, pp. 339–351.

In preparation.

The Ruby-Kuskokwim region, by J. B. Mertie, jr., and G. L. Harrington.

The Lower Kuskokwim region, by A. G. Maddren.

A geologic reconnaissance in the northern part of the Yukon-Tanana region, Alaska, by Eliot Blackwelder.

TOPOGRAPHIC MAPS.

Circle quadrangle (No. 641): scale, 1:250,000; by T. G. Gerdine, D. C. Witherspoon, and others. 50 cents retail or 30 cents wholesale. Also in *Bulletin 295. 35 cents.

Fairbanks quadrangle (No. 642); scale, 1:250,000; by T. G. Gerdine, D. C. Witherspoon, R. B. Oliver, and J. W. Bagley. 50 cents retail or 30 cents wholesale. Also in *Bulletins 337 (25 cents) and 525.

Fortymile quadrangle (No. 640); scale, 1:250,000; by E. C. Barnard. 10 cents retail or 6 cents wholesale. Also in Bulletin 375.

Rampart quadrangle (No. 643); scale, 1:250,000; by D. C. Witherspoon and R. B. Oliver. 20 cents retail or 12 cents wholesale. Also in *Bulletin 337 (25 cents) and part in Bulletin 535.

Fairbanks special (No. 642A); scale, 1:62,500; by T. G. Gerdine and R. H. Sargent. 20 cents retail or 12 cents wholesale. Also in Bulletin 525.

Bonnifield region; scale, 1:250,000; by J. W. Bagley, D. C. Witherspoon, and C. E. Giffin. In Bulletin 501. Not issued separately.

Iditarod-Ruby region, reconnaissance map; scale, 1:250,000; by C. G. Anderson, W. S. Post, and others. In Bulletin 578. Not issued separately.

Middle Kuskokwim and lower Yukon region; scale, 1:500,000; by C. G. Anderson, W. S. Post, and others. In Bulletin 578. Not issued separately.

Chisana-White River region; scale, 1:250,000; by C. E. Giffin and D. C. Witherspoon. In Bulletin 630. Not issued separately.

Yukon-Koyukuk region; scale, 1:500,000; by H. M. Eakin. In Bulletin 631. Not issued separately.

Cosna-Nowitna region, reconnaissance map; scale, 1:250,000; by H. M. Eakin, C. E. Giffin, and R. B. Oliver. In Bulletin 667. Not issued separately.

Lake Clark-Central Kuskokwim region, reconnaissance map; scale, 1:250,000; by R. H. Sargent, D. C. Witherspoon, and C. E. Giffin. In Bulletin 655. Not issued separately.

Anvik-Andreafski region; scale, 1:250,000; by R. H. Sargent. In Bulletin 683. Not issued separately.

Marshall district; scale, 1:125,000; by R. H. Sargent. In Bulletin 683. Not issued separately.

Nenana-Kantishna region; scale, 1:250,000; by C. E. Giffin, J. W. Bagley, R. B. Oliver, and D. C. Witherspoon. In Bulletin 687. Not issued separately.

In preparation.

Lower Kuskokwim region; scale, 1:500,000; by A. G. Maddren.

Ruby district; scale, 1:250,000; by C. E. Giffin and R. H. Sargent.

Innoko-Iditarod region; scale, 1:250,000; by R. H. Sargent and C. E. Giffin.

SEWARD PENINSULA.

REPORTS.

The Fairhaven gold placers of Seward Peninsula, Alaska, by F. H. Moffit. Bulletin 247, 1905, 85 pp.

Gold mining on Seward Peninsula, by F. H. Moffit. In Bulletin 284, 1906, pp. 132–141.

The Kougarok region, by A. H. Brooks. In Bulletin 314, 1907, pp. 164–181.

Geology and mineral resources of Iron Creek, by P. S. Smith. In Bulletin 314, 1907, pp. 157–163.

The gold placers of parts of Seward Peninsula, Alaska, including the Nome, Council, Kougarok, Port Clarence, and Goodhope precincts, by A. J. Collier, F. L. Hess, P. S. Smith, and A. H. Brooks. Bulletin 328, 1908, 343 pp.

*Investigation of the mineral deposits of Seward Peninsula, by P. S. Smith. In Bulletin 345, 1908, pp. 206–250. 45 cents.

Geology of the Seward Peninsula tin deposits, by Adolph Knopf. Bulletin 358, 1908, 72 pp.

Recent developments in southern Seward Peninsula, by P. S. Smith. In *Bulletin 379, 1909, pp. 267–301.

*The Iron Creek region, by P. S. Smith. In Bulletin 379, 1909, pp. 302–354. 50 cents.

*Mining in the Fairhaven district, by F. F. Henshaw. In Bulletin 379, 1909, pp. 355–369. 50 cents.

Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula, Alaska, by P. S. Smith. Bulletin 433, 1910, 227 pp.

Mining in Seward Peninsula, by F. F. Henshaw. In *Bulletin 442, 1910, pp. 353–371.

A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, by P. S. Smith and H. M. Eakin. Bulletin 449, 1911, 146 pp.

*Notes on mining in Seward Peninsula, by P. S. Smith. In Bulletin 520, 1912, pp. 339–344. 50 cents.

Geology of the Nome and Grand Central quadrangles, Alaska, by F. H. Moffit. Bulletin 533, 1913, 140 pp.

*Surface water supply of Seward Peninsula, Alaska, by F. F. Henshaw and G. L. Parker, with a sketch of the geography and geology by P. S. Smith and a description of methods of placer mining by A. H. Brooks; including topographic reconnaissance map. Water-Supply Paper 314, 1913, 317 pp. 45 cents.

*Placer mining on Seward Peninsula, by Theodore Chapin. In Bulletin 592, 1914, pp. 385–396. 60 cents.

*Lode developments on Seward Peninsula, by Theodore Chapin. In Bulletin 592, 1914, pp. 397–407. 60 cents.

Iron-ore deposits near Nome, by H. M. Eakin. In Bulletin 622, 1915, pp. 361–365.

Placer mining in Seward Peninsula, by H. M. Eakin. In Bulletin 622, 1915, pp. 366–373.

Lode mining and prospecting on Seward Peninsula, by J. B. Mertie, jr. In Bulletin 662, 1917, pp. 425–449.

Placer mining on Seward Peninsula, by J. B. Mertie, jr. In Bulletin 662, 1917, pp. 451–458.

Tin mining in Seward Peninsula, by G. L. Harrington. In Bulletin 692, 1919, pp. 353–361.

Graphite mining in Seward Peninsula, by G. L. Harrington. In Bulletin 692, 1919, pp. 363–367.

The gold and platinum placers of the Kiwalik-Koyuk region, by G. L. Harrington. In Bulletin 692, 1919, pp. 369–400.

TOPOGRAPHIC MAPS.

Seward Peninsula; scale, 1:500,000; compiled from work of D. C. Witherspoon, T. G. Gerdine, and others, of the Geological Survey, and all available sources. In Water-Supply Paper 314. Not issued separately.

Seward Peninsula, northeastern portion, reconnaissance map (No. 655); scale, 1:250,000; by D. C. Witherspoon and C. E. Hill. 50 cents retail or 30 cents wholesale. Also in Bulletin 247.

Seward Peninsula, northwestern portion, reconnaissance map (No. 657); scale, 1:250,000; by T. G. Gerdine and D. C. Witherspoon. 50 cents retail or 30 cents wholesale. Also in Bulletin 328.

Seward Peninsula, southern portion, reconnaissance map (No. 656); scale, 1:250,000; by E. C. Barnard, T. G. Gerdine, and others. 50 cents retail or 30 cents wholesale. Also in Bulletin 328.

Seward Peninsula, southeastern portion, reconnaissance map (Nos. 655–656); scale, 1:250,000; by E. C. Barnard, D. L. Reaburn, H. M. Eakin, and others. In Bulletin 449. Not issued separately.

Nulato-Norton Bay region; scale, 1:500,000; by P. S. Smith, H. M. Eakin, and others. In Bulletin 449. Not issued separately.

Grand Central quadrangle (No. 646A); scale, 1:62,500; by T. G. Gerdine, R. B. Oliver, and W. R. Hill. 10 cents retail or 6 cents wholesale. Also in Bulletin 533.

Nome quadrangle (No. 646B); scale, 1:62,500; by T. G. Gerdine, R. B. Oliver, and W. R. Hill. 10 cents retail or 6 cents wholesale. Also in Bulletin 533.

Casadepaga quadrangle (No. 646C); scale, 1:62,500; by T. G. Gerdine, W. B. Corse, and B. A. Yoder. 10 cents retail or 6 cents wholesale. Also in Bulletin 433.

Solomon quadrangle (No. 646D); scale, 1:62,500; by T. G. Gerdine, W. B. Corse, and B. A. Yoder. 10 cents retail or 6 cents wholesale. Also in Bulletin 433.

NORTHERN ALASKA.

REPORTS.

*A reconnaissance in northern Alaska across the Rocky Mountains, along Koyukuk, John, Anaktuvuk, and Colville rivers and the Arctic coast to Cape Lisburne in 1901, by F. C. Schrader, with notes by W. J. Peters. Professional Paper 20, 1904, 139 pp. 40 cents.

*Geology and coal resources of the Cape Lisburne region, Alaska, by A. J. Collier. Bulletin 278, 1906, 54 pp. 15 cents.

Geologic investigations along the Canada-Alaska boundary, by A. G. Maddren. In *Bulletin 520, 1912, pp. 297–314.

The Noatak-Kobuk region, by P. S. Smith. Bulletin 536, 1913, 160 pp.

The Koyukuk-Chandalar region, Alaska, by A. G. Maddren. Bulletin 532, 1913, 119 pp.

The Canning River region of northern Alaska, by E. de K. Leffingwell Professional Paper 109, 1919, 251 pp.

TOPOGRAPHIC MAPS.

*Koyukuk River to mouth of Colville River, including John River; scale, 1:1,250,000; by W. J. Peters. In *Professional Paper 20. 40 cents. Not issued separately.

Koyukuk and Chandalar region, reconnaissance map; scale, 1:500,000; by T. G. Gerdine, D. L. Reaburn, D. C. Witherspoon, and A. G. Maddren. In Bulletin 532. Not issued separately.

Noatak-Kobuk region; scale, 1:500,000; by C. E. Giffin, D. L. Reaburn, H. M. Eakin, and others. In Bulletin 536. Not issued separately.

Canning River region; scale, 1:250,000; by E. de K. Leffingwell. In Professional Paper 109. Not issued separately.

North Arctic coast; scale, 1:1,000,000; by E. de K. Leffingwell. In Professional Paper 109. Not issued separately.

Martin Point to Thetis Island; scale, 1:125,000; by E. de K. Leffingwell. In Professional Paper 109. Not issued separately.

○