MINERAL RESOURCES OF ALASKA, 1916.

By ALFRED H. BROOKS and others.

PREFACE.

By ALFRED H. BROOKS.

This volume is the thirteenth of a series of annual bulletins [1] treating of the mining industry of Alaska and summarizing the results achieved during the year in the investigation of the mineral resources of the Territory. In preparing these reports the aim is prompt publication of the most important economic results of the year. The short time available for their preparation does not permit full office study of the field notes and specimens, and some of the statements made here may be subject to modification when the study has been completed. Those interested in any particular district are therefore urged to procure a copy of the complete report on that district as soon as it is available.

This volume, like those previously issued, contains both preliminary statements on investigations made during the year and summaries of the condition of the mining industry, including statistics of mineral production. It is intended that this series of reports shall serve as convenient reference works on the mining industry for the years which they cover. Lack of funds prevents a visit to every mining district each year by a member of the Survey, and therefore the data used in preparing the summary on mining development are in part based on information gleaned from various reliable sources.

Again, as for many years in the past, the writer is under great obligation to residents of the Territory for valuable data. Those who have thus aided include the many mine operators who have made reports on production as well as developments. It is a matter of surprise and regret to the writer that there are still some Alaskan

[1] The preceding volumes in this series are U. S. Geol. Survey Bulls. 259, 284, 314, 345, 379, 442, 480, 520, 542, 592, 622, and 642.

mineral producers who fail to respond to requests for information. Many prospectors, Federal officials, engineers, and officers of transportation and commercial companies have contributed valuable data. It is impracticable to enumerate all who have aided in this work, but it is right to state that without the assistance of these public-spirited citizens it would be impossible to prepare this report. Special acknowledgments should be made to the Director and other officers of the Mint; the officers of the Alaska customs service; Wells Fargo Express Co.; Thomas Riggs, jr., of the Alaskan Engineering Commission; the Alaska Mexican Gold Mining Co., Alaska United Gold Mining Co., and Alaska Treadwell Gold Mining Co., of Treadwell; B. L. Thane, F. B. Hyder, and J. Fazard, of Juneau; Stephen Birch, of Kennicott; George M. Esterly, of Nizina; W. Peterson and S. E. Wagner, of Susitna; A. H. McNeer, of Seward; G. R. Goshaw, and J. M. McLennan, of Chisana; J. L. Abrams, of Fortymile; John R. Kemp, of Steel Creek; J. J. Hillard and U. G. Myers, of Eagle; F. A. Reynolds, of Circle; R. C. Wood, A. Bruning, J. A. Fairborn, Falcon Joslin, First National Bank, American National Bank, and Tanana Valley Railroad, of Fairbanks; E. E. James, of Richardson; G. W. Ledger, of Rampart; S. S. Rowell, of Hot Springs; W. A. Vinal, H. Fothergill, and Henry Howard, of Ophir; C. P. Wood, of Iditarod; J. C. Felix, of Hughes; O. R. Williams, of Nolan; P. T. Hanigsman, of Bethel; William Loiselle and A. Steiker, of Quinhagak; R. W. J. Reed and G. A. Adams, of Nome; and John D. Flannigan, of Council.

The arrangement and manner of treatment in this volume are the same as in those previously issued. First, papers of a general character are presented, followed by those treating of special districts, arranged geographically from south to north. This bulletin contains 15 papers by 11 authors. One of these papers deals with administrative matters, one is a general summary of the mining industry, and the remainder deal more specifically with the mineral resources of certain districts. In the geologic papers emphasis is laid on the conclusions that are of immediate interest to the miner. These conclusions are discussed here briefly but will be more fully treated in reports now in preparation. The need of prompt publication requires that the illustrations in this volume be of the simplest kind.

ADMINISTRATIVE REPORT.

By ALFRED H. BROOKS.

INTRODUCTION.

Twelve parties were engaged during 1916 in Alaska surveys and investigations. The length of field season ranged from 3 to 12 months, being determined by the character of the work and by the climatic conditions prevailing in different parts of the Territory. The parties included 11 geologists, 4 topographers, 1 engineer, and 28 packers, cooks, and other auxiliaries. Seven of the parties were engaged in geologic surveys, three in topographic surveys, one in combined topographic and geologic work, and one in stream gaging. The areas covered by reconnaissance geologic surveys on a scale of 1:250,000 (4 miles to an inch) amount to 5,100 square miles; by detailed geologic surveys on a scale of 1:62,500 (1 mile to an inch), 636 square miles. Much of the time of the geologists was devoted to the investigation of special problems relating to mineral occurrence, the results of which can not be expressed in terms of area. About 9,700 square miles was covered by reconnaissance topographic surveys, on a scale of 1:250,000 (4 miles to the inch), and 65 square miles by detailed topographic surveys, on a scale of 1:62,500 (1 mile to an inch). In cooperation with the Forest Service, stream gaging in southeastern Alaska was also continued.

With increased knowledge of Alaska's geology and the new facts made available by mining operations, it has become necessary to revise some of the previous interpretations of the geology, especially those made before accurate base maps were available. Therefore the revision of some of the mapping of the earlier years is of vital importance, and to this work some of the investigations of each year are devoted. In 1916 an area of 36 square miles adjacent to Juneau, previously surveyed geologically on a scale of 1:62,500, was mapped on the larger scale of 1:24,000. The geologic mapping of about 1,500 square miles on a scale of 1:250,000 was also revised.

To state the work geographically, four parties worked in southeastern Alaska, one in the Copper River region, two on Prince William Sound, four in the Yukon basin, and one in general investigations in the Yukon basin and Seward Peninsula. Among the important

results of the year were the completion of the detailed topographic and geologic survey of Juneau and vicinity, the completion of the reconnaissance geologic survey of the southern part of the Ketchikan district, and the detailed geologic survey of a part of the Nenana coal field.

The following table shows the allotments, including both field and office work, of the total appropriation of $100,000 for the fiscal year 1916 to the regions investigated. In addition to this, a balance of about $6,000 from last year's appropriation was expended in equipping parties for the season's field work. In preparing this table the general office expenses are apportioned to the several allotments, account being taken of variations in character of work. The results are expressed in round numbers. Salaries of the permanent staff are included up to the end of the fiscal year 1917, but expenses other than these include only the cost of field and office work during 1916. The "general investigations" include, with other things, the cost of collecting mineral statistics and of office work relating to the field investigations of previous seasons. A balance of about $6,000 will be utilized for equipping the field parties in 1917.

Approximate geographic distribution of appropriation for Alaska investigations, 1916.

Southeastern Alaska	$22,500
Copper River	7,000
Prince William Sound	14,500
Yukon basin	42,500
Seward Peninsula	1,000
General investigations	6,500
To be allotted to field work, 1917	6,000
	100,000

In the following table the approximate amount of money devoted to each class of investigations and surveys is indicated. It is not possible to give the exact figures, as the same party, or even the same man, may have carried on the different kinds of work, but this statement will serve to elucidate a later table, which will summarize the complete areal surveys.

Approximate allotments to different kinds of surveys and investigations, 1916.

Reconnaissance geologic surveys	$15,000
Detailed geologic surveys	20,000
Special geologic investigations	11,600
Reconnaissance topographic surveys	19,000
Detailed topographic surveys	4,500
Investigations of water resources	4,900
Collection of mineral statistics	1,600
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation	17,400
To be allotted to field work, 1917	6,000
	100,000

Allotments for salaries and field expenses, 1916.

Scientific and technical salaries	$39,843
Field expenses	37,615
Clerical and office salaries	16,542
To be allotted to field work, 1917	6,000
	100,000

The following table exhibits the progress of investigations in Alaska and the annual grant of funds since systematic surveys were begun in 1898. It should be noted that a varying amount is spent each year on special investigations that yield results which can not be expressed in terms of area.

Progress of surveys in Alaska, 1898–1916.

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[a]					Investigations of water resources (gaging stations maintained part of year).
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500 and larger; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*		
1898	$46,189	9,500	.....	.....	12,840	2,070	.....	.....	.....	.....
1899	25,000	6,000	.....	.....	8,690	.....	.....	.....	.....	.....
1900	60,000	3,300	6,700	.....	630	11,150	.....	.....	.....	.....
1901	60,000	6,200	5,800	.....	10,200	5,450	.....	.....	.....	.....
1902	60,000	6,950	10,050	.....	8,330	11,970	96	.....	.....	.....
1903	60,000	5,000	8,000	96	.....	15,000	.....	.....	.....	.....
1904	60,000	4,050	3,500	.....	800	6,480	480	86	19	.....
1905	80,000	4,000	4,100	536	.....	4,880	787	202	28	.....
1906	80,000	5,000	4,000	421	.....	13,500	40	.....	.....	14
1907	80,000	2,600	1,400	442	.....	6,120	501	95	16	48
1908	80,000	2,000	2,850	604	.....	3,980	427	76	9	53
1909	90,000	6,100	5,500	450	6,190	5,170	444	.....	.....	81
1910	90,000	.....	8,635	321	.....	13,815	36	.....	.....	69
1911	100,000	8,000	10,550	496	.....	14,460	246	.....	.....	68
1912	90,000	.....	2,000	525	.....	.....	298	.....	.....	69
1913	100,000	3,500	2,950	180	3,400	2,535	287	.....	.....	.....
1914	100,000	1,000	7,700	325	600	10,300	10	.....	.....	.....
1915	100,000	.....	10,700	200	.....	10,400	12	3	2	9
1916	100,000	.....	5,100	636	.....	9,700	67	.....	.....	20
	1,461,189	73,200	99,535	5,232	51,680	146,980	3,731	453	74	.....
Percentage of total area of Alaska	.....	12.48	16.80	0.89	8.81	25.05	0.64	.....	.....	.....

[a] The Coast and Geodetic Survey, International Boundary Survey, and General Land Office have also made topographic surveys in Alaska. The areas covered by these surveys are of course not included in these totals.

GEOGRAPHIC DISTRIBUTION OF INVESTIGATIONS.

GENERAL WORK.

The writer was engaged in office work until July 24, when he started for Alaska. He joined Mr. Chapin at Ketchikan on August 2 and devoted the next two weeks to a study of the geology of the Ketchikan district. The time from August 19 to 26 was spent in the Juneau district with Mr. Spencer and Mr. Eakin. Here a conference was also had with Mr. Canfield. A study of the geology of the Latouche district of Prince William Sound was made in company with Mr. Johnson from August 30 to September 10. A brief visit was then made to Anchorage, and several more days were spent at Juneau on the return trip. Seattle was reached on September 24.

During the calendar year 1916 the writer devoted 56 days of his time in the office to geologic studies, 24 days to the critical reading and revision of manuscripts, 13 days to the writing of the progress report, 10 days to field plans, 8 days to mineral statistics, 5 days to proof reading, and 4 days to preparation of the annual press bulletin on mining in Alaska.

Besides doing his field work, to be referred to below, G. C. Martin devoted considerable time to continuing the preparation of a monograph on the Mesozoic rocks of Alaska. The writer was absent from the office for the month of May, and during this time Mr. Martin was engaged chiefly in executive work as acting geologist in charge of the division.

R. H. Sargent continued the general supervision of the Alaska topographic surveys and map compilation, in addition to carrying on his own field work.

E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during the writer's absence in the field. He also continued to assist in collecting statistics of production of precious metals in Alaska.

During the last six years J. W. Bagley has been investigating the use of phototopographic methods in Alaska surveys. He has devised both methods and instruments in this work, the utility of which has been proved by actual use. During 1916 he prepared a report containing the results of this work (see p. 10), which is intended for those who may find use for phototopographic methods in other fields.

SOUTHEASTERN ALASKA.

The geologic reconnaissance survey of the southern half of the Ketchikan district, begun in 1913 and continued in 1915, was completed in 1916. These investigations were made by Theodore Chapin, who devoted the time between May 20 and September 20 to the work.

In addition to revising the previous geologic mapping, an area of about 500 square miles was surveyed on a reconnaissance scale. Considerable time was also devoted to a study of the ore deposits and investigation of mining developments. An account of the latter is contained in another part of this report.

The making of a detailed base map of the region adjacent to Juneau, which was begun in 1914, was completed in 1916. The large scale adopted, 1:24,000 (about 2.64 inches to the mile), the ruggedness of the region, and the heavy timber and adverse climatic conditions have made this survey exceedingly difficult and expensive. The area covered is 36 square miles, of which 12½ square miles was surveyed in 1916. Owing to the high cost of the survey it has been necessarily confined to those areas which are of greatest present economic importance. D. C. Witherspoon, who did this work, was engaged in field work from May 29 to September 27, inclusive.

The area covered by the base map above referred to was surveyed geologically during 1916 by A. C. Spencer and H. M. Eakin, who also made a detailed investigation of the ore deposits. Field work was begun on July 11 and continued until October 6, covering an area of 36 square miles. Mr. Eakin also devoted about three weeks to a study of the Porcupine placer district. This district had not been investigated by a geologist since 1903, and in that time some new developments had been made. Mr. Eakin also devoted about a week to collecting data on mining developments in the less accessible parts of the Juneau district. The results of these two investigations are summarized in another part of this volume.

The investigation of the water resources of southeastern Alaska, begun in 1915 under a cooperative agreement with the Forest Service, was continued throughout 1916. G. H. Canfield, who had charge of this work, maintained 8 automatic gages throughout the year. In addition to these gages 12 others were installed in cooperation with different individuals and corporations. The results are briefly summarized in another section of this report. This work could not have been carried on without the cordial cooperation of the Forest Service, many members of which have given substantial aid; particular acknowledgment should be made to W. G. Weigle, special agent at Ketchikan, and to Leonard Lundgren, district engineer at Portland Oreg.

COPPER RIVER REGION.

Though much the larger part of the Chitina basin has been covered by geologic surveys, there are still many unsolved problems relating to the stratigraphy, structure, and ore deposits. These can be solved only by a more or less intensive study of special areas, and to this task F. H. Moffit was assigned. He devoted the time from June 23 to September 29 to this work. In addition to making a special study he

also made geologic reconnaissance surveys of about 300 square miles. The preliminary report of the results of this work is contained an another part of this volume.

PRINCE WILLIAM SOUND.

The rapid development of mining in the Prince William Sound region has made a demand for further surveys and investigations. During 1916 B. L. Johnson made a somewhat detailed survey of the Latouche district, in which he covered an area of about 400 square miles. He also made some investigations of the mining developments in other parts of the Prince William Sound region, the results of which are presented in another part of this volume. Mr. Johnson devoted the time from June 11 to October 18 to this work.

J. W. Bagley began topographic reconnaissance surveys in the Port Wells district of the Prince William Sound region on June 8 and extended these surveys eastward, continuing his field work until September 12. He covered an area of 1,900 square miles on a scale of 1:250,000, using phototopographic methods. In addition to this, he surveyed in detail (scale 1:62,500) an area of 65 square miles lying adjacent to Jack Bay, this work connecting the previously mapped areas of the Ellamar and Port Valdez districts.

YUKON BASIN.

G. C. Martin, assisted by A. G. Maddren and R. M. Overbeck, made a detailed geologic survey of the western part of the Nenana coal field. The base map was provided for this work by the surveys made by the General Land Office. The field work extended from June 16 to August 24, and the total area surveyed was 236 square miles on a scale of 1:62,500.

S. R. Capps and C. E. Giffin were charged with the duty of making a reconnaissance survey of the Kantishna placer district. The surveys were begun on Nenana River and were extended eastward to include the Kantishna district and southward to the crest line of the Alaska Range. Mr. Capps, who had charge of the geologic investigations, began work on June 26 and continued until August 25, surveying an area of about 1,000 square miles on a scale of 1:250,000. He also revised previous geologic mapping over an area of about 2,000 square miles. The preliminary report of the results of this work is contained in another part of this volume. Mr. Giffin began the topographic survey on June 26 and completed it on August 29. He covered an area of 4,500 square miles, using phototopographic methods.

The important developments in the Tolovana district led to an investigation of this field during 1916. J. B. Mertie, jr., who was detailed for this investigation, began field work on July 7 and con-

tinued until August 4. Besides studying the placers he made a geologic reconnaissance map of about 240 square miles. The time from August 8 to 31 was devoted by Mr. Mertie to an investigation of the ore deposits of the Fairbanks district. In this field he devoted special attention to the occurrence of tungsten. The results of these investigations are presented elsewhere in this volume.

Important mining developments in the Marshall district of the lower Yukon have made an urgent demand for a survey of this field. Therefore a combined geologic and topographic party under the direction of R. H. Sargent, with G. L. Harrington as geologist, was assigned to this field. This party began work on June 16 and continued until September 6. The topographic and geologic surveys cover an area of some 3,300 square miles. The results of the study of the placers are presented elsewhere in this volume.

SEWARD PENINSULA.

J. B. Mertie, jr., was detailed to make a supplementary investigation of the lodes in the Nome and other districts of the Seward Peninsula. He devoted the time from September 19 to October 13 to this work and paid special heed to the tungsten and antimony deposits. In addition he collected data on mining developments. The results of his work are presented elsewhere in this volume.

COLLECTION OF STATISTICS.

The collection of the statistics of precious metal production in Alaska, begun by the writer in 1905, has been continued each year. In spite of every effort made there are still a large number of mine operators who fail to make returns. This is to the great disadvantage of the mineral industry, as it decreases the accuracy of the figures on production for the different districts. Fortunately other sources of information are available, and, thanks to the public spirit shown by many residents of the Territory, it is possible to obtain data on which reliable estimates of mineral production can be based. Until all the mine operators make returns, however, it is not possible to obtain entirely accurate figures. The nonreporting operators are chiefly placer miners, for practically all the gold and copper lode operators make annual returns of output.

As has been the practice in the past, a press bulletin was issued on January 1 summarizing the estimates of mineral production and mining developments of the previous year. Though the figures of production then published vary somewhat from the final figures included in this report, yet they were near enough to the truth to serve the immediate purpose of those interested in the mining industry of Alaska. The prompt publication makes the data available when most needed.

PUBLICATIONS.

During 1916 the Survey published four bulletins and one water-supply paper relating to Alaska. In addition, one bulletin is in press, and twelve reports, including this volume, were in progress at the end of the year. Two topographic maps were published during the year, and one is in press.

REPORTS ISSUED.

BULLETIN 630. The Chisana-White River district, Alaska, by S. R. Capps; including geologic and topographic reconnaissance maps.

BULLETIN 631. The Yukon-Koyukuk region, Alaska, by H. M. Eakin; including geologic and topographic reconnaissance maps.

BULLETIN 642. Mineral resources of Alaska: Report on progress of investigations in 1915, by A. H. Brooks and others; including new edition of map showing distribution of mineral resources in Alaska.

BULLETIN 649. The antimony deposits of Alaska, by A. H. Brooks.

WATER-SUPPLY PAPER 372. A water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport.

REPORTS IN PRESS.

BULLETIN 657. The use of the panoramic camera in topographic surveying, with notes on the application of photogrammetry to aerial surveys, by J. W. Bagley. (Published Apr. 20, 1917.)

BULLETIN 655. The Lake Clark-Central Kuskokwim region, by P. S. Smith.

WATER-SUPPLY PAPER 418. The mineral springs of Alaska, by G. A. Waring.

REPORTS FOR WHICH ILLUSTRATIONS ARE BEING PREPARED.

The Canning River region of northern Alaska, by E. de K. Leffingwell.

The Nelchina-Susitna region, by Theodore Chapin.

The Cosna-Nowitna region, by Theodore Chapin.

The upper Chitina Valley, by F. H. Moffit.

REPORTS IN PREPARATION.

The marble resources of southeastern Alaska, by E. F. Burchard.

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

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

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

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

Geology of the region along the international boundary from Porcupine River to the Arctic Ocean, by A. G. Maddren.

TOPOGRAPHIC MAPS ISSUED.

Reconnaissance map of Yukon-Koyukuk region and adjacent territory, by H. M. Eakin, D. C. Witherspoon, and R. B. Oliver; scale, 1:500,000; contour interval, 400 feet. (Plate I, Bulletin 631.)

Reconnaissance map of Chisana-White River district, by C. E. Giffin; scale, 1:250,000; contour interval, 200 feet. (Plate I, Bulletin 630.)

TOPOGRAPHIC MAPS IN PRESS.

Lower Matanuska Valley, by R. H. Sargent; scale, 1:62,500; contour interval, 50 feet. Sale edition.

THE ALASKAN MINING INDUSTRY IN 1916.

By ALFRED H. BROOKS.

GENERAL FEATURES.

In 1916 Alaska mines yielded a mineral output valued at $48,632,138. The output in 1915, which was greater than that of any previous year, had a value of $32,854,229, and therefore the increase in 1916 was over $15,700,000, or nearly 50 per cent. Although this enormous increase was due in great part to the large tonnage and high price of copper, yet nearly all other minerals were produced in greater quantities than in the previous year.

It can not be expected that Alaska will continue to produce so much mineral wealth each year, yet the large amount of preparation made in 1916 for lode and placer mining and the development of the coal-mining industry, now assured, give promise of a continuous healthy growth to the mining industry of the Territory. This is especially true of the Pacific coast region and of the territory served by railroads built or under construction.

The principal facts relating to Alaska's annual production are graphically presented on Plate II (p. 12). This shows that the small beginning of Alaska's great mining industry was made in 1880,[1] when about $20,000 worth of gold was won from the Juneau placers. During 37 years of mining the value of the annual mineral output has grown to nearly $50,000,000. This growth has not been uniform, especially after 1898, when the yield of gold from the placers became a large element in the value of the total annual mineral output. For many years the fluctuation in total annual value was a reflection of the condition of the placer-mining industry. Since 1910 the variation in value of the copper output has also been an important element in determining the curve of mineral production.

Some silver has always been recovered incidentally to the mining of Alaskan gold. During the last 20 years tin, copper, marble, gypsum, and other mineral products have helped to swell the value of the mineral output. Up to 1898 the value of the mineral production other than that of the gold is so small that it can not be shown on the scale of the accompanying diagram (Pl. II).

[1] A little placer mining was done in the Sumdum and Windham bays region between 1875 and 1880, but there is no reliable record of the amount of gold produced.

Though it is generally assumed that the annual gold output of the Territory has been derived largely from placer mines, this is not entirely true. From the time that lode mining began in 1883 until the discovery of the rich placers of Nome in 1898 the value of the gold output from the lodes was greater than that of the placers. Throughout this period the total annual gold production of Alaska was steadied by the output of the great Treadwell group of mines. It is for this reason that the curve of mineral production (Pl. II) shows but few fluctuations during the first 20 years of mining.

With the discovery of the Nome gold field in 1898 the Alaskan mining industry passed into a second phase of its evolution. In this epoch the output of the placers played a dominating part in the value of the annual production, which fluctuated greatly from year to year. The first peak in mineral production was reached in 1900 and was due to the gold from Seward Peninsula. A second was reached in 1906, when a large production from the Fairbanks placer mines was added to that of Seward Peninsula. Had it not been for the rapid successive discovery of such camps as Nome, Fairbanks, Iditarod, Hot Springs, Ruby, and others, the gold output would not have been maintained. The development of a new camp at about the time of the decline of the output from an older camp prevented much greater fluctuation in the annual product than actually took place. This period was an era both of wasteful mining and excessive speculation. Placer mining was regarded more as a gamble than as a legitimate business. Many rich claims were gutted without thought of the future. Few operators looked forward to the day when the bonanzas would be worked out and a continuation of the placer-mining industry would depend on the exploitation of larger bodies of gravel with a gold content too low to be profitably handled by the crude methods then in general use.

From this epoch of bonanza placer mining Alaska is gradually emerging, the first step being the installation of large dredges on Seward Peninsula, which began in 1905. Since then many others have been installed on the peninsula, and dredge mining is becoming an important industry in other parts of the Territory. There has also been a general improvement in placer-mining methods in all of the older placer districts and a consequent steadying of the annual production. As a result, the curve of Alaska's annual placer gold production has shown comparatively little variation during the last four years. The maintenance of a large annual output of placer gold seems assured, though it does not necessarily follow that the minimum output has been reached. There is still a large percentage of gold won from bonanza deposits which have no great extent. Until the annual gold placer production is derived largely from the exploitation

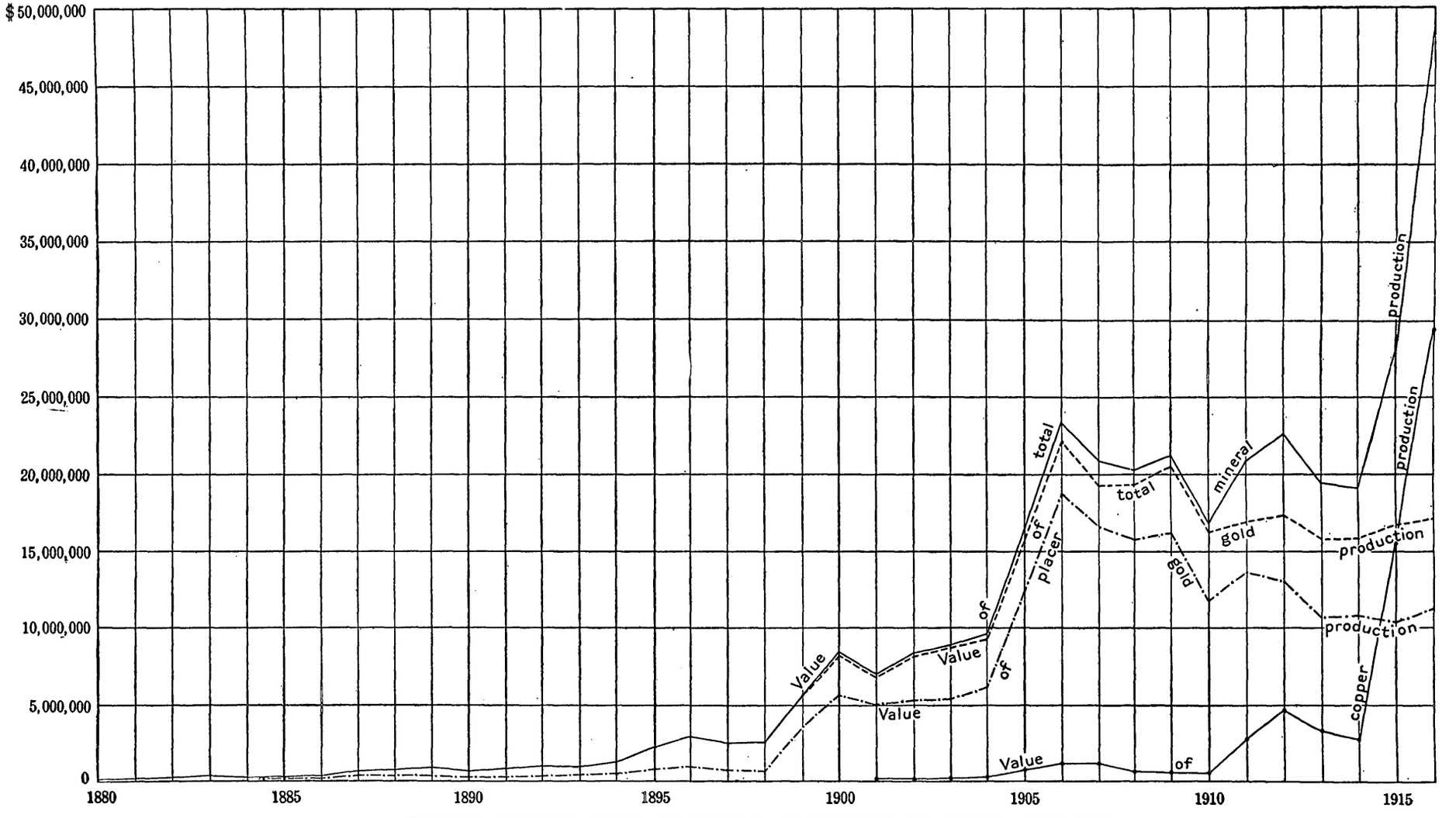


DIAGRAM SHOWING VALUE OF MINERAL PRODUCTION OF ALASKA, 1880-1916.

on a large scale of extensive deposits, fluctuations in annual output are to be expected.

The annual fluctuation in value of Alaska's copper output reflects the variation in the price of copper. This acts directly, in determining the value of the copper actually produced, and indirectly because when copper is high a number of mines are operated that are idle during periods of low price. The abnormally high price of copper during the last two years accounts in large measure for the very high upward grade of the curve of copper production (Pl. II) as well as of the curve of total mineral production. There is no question, however, that though this curve is abnormal and can not be taken as a measure of future value, yet there is every assurance that Alaska will continue to make a large annual copper output, even under normal market conditions.

There was an increase in 1916, compared with the previous year, of the output from both the Alaskan placer and lode gold mines. In spite of the curtailment of stibnite mining when the price of antimony dropped in midsummer, a larger quantity was mined in 1916 than in 1915. For the first time in its history Alaska produced tungsten, scheelite ores having been mined in the Fairbanks and Nome districts during 1916. The tin production was about the same as in the previous year. There was some increase of lead production, and for the first time a small output of platinum from Alaskan mines.

The completion of the Government railroad to the lower end of the Matanuska coal field (see Pl. I, in pocket) encouraged the opening of two small mines, which produced some bituminous coal for local use. A little bituminous coal was also mined at the southwest end of the Bering River field. There was an increased output of lignitic coals compared with previous years from several small mines. Steps were taken to develop bituminous coal mines on a larger scale, and these developments, together with the receipt by the Interior Department of applications for leases in both the Bering River and Matanuska coal fields, give assurance of the beginnings of an Alaskan coal-mining industry. The production of coal in Alaska will stimulate all other branches of mining. As the Alaskan oil lands are withdrawn from entry and no provision has been made for leasing them, no large development of Alaskan petroleum has taken place. The only petroleum company operating in Alaska, in the Katalla field, increased its development work in 1916, compared with 1915.

In addition to the minerals mentioned above, marble and gypsum were produced on about the same scale as in previous years. Development work was done on deposits of molybdenite, chromic iron ore, and graphite. Some graphite was mined on Seward Peninsula but was not shipped.

The statistics for Alaska's mineral production in 1915 and 1916 are given in the subjoined table. The output of marble, gypsum, petroleum, etc., is given as a single item, because a separate listing might reveal the production of individual properties.

Mineral output of Alaska, 1915 and 1916.

	1915		1916		Increase in 1916.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	807,966	$16,702,144	834,067.87	$17,241,713	26,101.87	$539,569
Silver.....do....	1,071,782	543,393	1,379,261	907,554	307,479	364,161
Copper.....pounds..	86,509,312	15,139,129	119,602,028	29,484,291	33,092,716	14,345,162
Tin, metallic.....tons..	102	78,846	139	121,000	37	42,154
Antimony, crude ore....do....	833	74,000	1,458	134,000	625	60,000
Lead.....short tons..	437	41,118	820	109,120	383	68,002
Coal.....do....	1,400	3,300	12,200	55,000	10,800	51,700
Marble, gypsum, petroleum, platinum, tungsten, etc.....	.....	[a] 272,299	.....	579,500	.....	307,201
Total.....	.....	32,854,229	.....	48,632,178	.....	15,777,949

[a] No platinum or tungsten included.

Productive mining began in Alaska in 1880, when the Juneau gold placers were first exploited. It is estimated that since that time mineral wealth has been produced to the value of nearly $350,000,000. This output, by years and substances, is summarized in the following table:

Value of total mineral production of Alaska, 1880–1916.

By years.				By substances.	
1880–1890	$4,686,714	1904	$9,569,715	Gold	$278,100,656
1891	916,920	1905	16,480,762	Silver	3,729,465
1892	1,098,400	1906	23,378,428	Copper	64,403,872
1893	1,051,610	1907	20,850,235	Tin	579,852
1894	1,312,567	1908	20,145,632	Antimony	208,000
1895	2,388,042	1909	21,146,953	Lead	217,380
1896	2,981,877	1910	16,887,244	Coal	420,833
1897	2,540,401	1911	20,691,241	Marble, gypsum, petroleum, etc.	1,925,871
1898	2,587,815	1912	22,536,849		349,585,929
1899	5,706,226	1913	19,476,356		
1900	8,241,734	1914	19,065,666		
1901	7,010,838	1915	32,854,229		
1902	8,403,153	1916	48,632,178		
1903	8,944,134				
			349,585,929		

GOLD, SILVER, AND COPPER.

The following table gives an estimate of the total production of gold, silver, and copper since the beginning of mining in 1880. For the earlier years, especially for silver, the figures are probably far from being correct, but they are based on the best information now available.

Production of gold, silver, and copper in Alaska, 1880–1916.

Year.	Gold.		Silver.		Copper.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.	Quantity (pounds).	Value.
1880	967	$20,000			3,933	$826
1881	1,935	40,000			.....	.....
1882	7,256	150,000			.....	.....
1883	14,561	301,000			.....	.....
1884	9,724	201,000	10,320	$11,146	.....	.....
1885	14,512	300,000			.....	.....
1886	21,575	446,000			.....	.....
1887	32,653	675,000			.....	.....
1888	41,119	850,000	2,320	2,181	.....	.....
1889	43,538	900,000	8,000	7,490	.....	.....
1890	36,862	762,000	7,500	6,071	.....	.....
1891	43,538	900,000	8,000	7,920	.....	.....
1892	52,215	1,080,000	8,000	7,000	.....	.....
1893	50,213	1,038,000	8,400	6,570	.....	.....
1894	62,017	1,282,000	22,261	14,257	.....	.....
1895	112,642	2,328,500	67,200	44,222	.....	.....
1896	138,401	2,861,000	145,300	99,087	.....	.....
1897	118,011	2,439,500	116,400	70,741	.....	.....
1898	121,760	2,517,000	92,400	54,575	.....	.....
1899	270,997	5,602,000	140,100	84,276	.....	.....
1900	395,030	8,166,000	73,300	45,494	.....	.....
1901	335,369	6,932,700	47,900	28,598	250,000	40,000
1902	400,709	8,283,400	92,000	48,590	360,000	41,400
1903	420,069	8,683,600	143,600	77,843	1,200,000	156,000
1904	443,115	9,160,000	198,700	114,934	2,043,586	275,676
1905	756,101	15,630,000	132,174	80,165	4,805,236	749,617
1906	1,066,030	22.036,794	203,500	136,345	5,871,811	1,133,260
1907	936,043	19,349,743	149,784	98,857	6,308,786	1,261,757
1908	933,290	19,292,818	135,672	71,906	4,585,362	605,267
1909	987,417	20,411,716	147,950	76,934	4,124,705	536,211
1910	780,131	16,126,749	157,850	85,239	4,241,689	538,095
1911	815,276	16,853,256	460,231	243,923	27,267,878	3,408,485
1912	829,436	17,145,951	515,186	316,839	29,230,491	4,823,031
1913	755,947	15,626,813	362,563	218,988	21,659,958	3,357,293
1914	762,596	15,764,259	394,805	218,327	21,450,628	2,852,934
1915	807,966	16,702,144	1,071,782	543,393	86,509,312	15,139,129
1916	834,068	17,241,713	1,379,171	907,554	119,602,028	29,484,291
	13,453,119	278,100,656	6,302,459	3,729,465	339,515,403	64,403,872

The subjoined table gives an estimate, based on the best available data, of the source of the gold and silver produced in Alaska since mining began in 1880. About $65,100,000 worth of gold, or nearly one-third of the total estimated output, was produced before 1905, and there is but scant information about its source. For the period since that time fairly complete statistical returns are available, and it is probable that the figures presented in the following table are near enough to the truth to be valuable. The figures given for the silver recovered from placer gold and from siliceous ores are probably less accurate than those for the gold. Copper mining did not begin in Alaska until 1901, and the figures for gold and silver derived from this industry, as now presented, are therefore a close approximation to the actual output.

Estimate of sources of gold and silver produced in Alaska, 1880–1916.

	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*	
Siliceous ores	3,844,404	$79,470,900	1,096,238	$731,256
Copper ores	62,731	1,296,764	3,567,308	2,089,519
Placers	9,545,984	197,332,992	1,638,913	908,690
	13,453,119	278,100,656	6,302,459	3,729,465

The above table shows that about 28 per cent of the total gold production of Alaska has been obtained from the auriferous lode mines (siliceous ores). In 1916 the lode-gold production was 38 per cent; in 1915, 37 per cent; in 1914, 32 per cent; in 1913, 31.6 per cent; and in 1912, 29 per cent. In the following table the production of precious metals has been distributed as to sources:

Sources of gold, silver, and copper produced in Alaska, 1916.

	Total quantity.	Gold.		Silver.		Copper.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.	*Fine ounces.*		*Fine ounces.*		*Pounds.*	
Siliceous ores	3,448,798	286,028.60	$5,912,736	110,050	$72,413	.....	.....
Copper ores	617,264	9,141.77	188,977	1,207,121	794,286	119,602,028	$29,484,291
Placers	.....	538,897.50	11,140,000	62,090	40,855	.....	.....
	4,066,062	834,067.87	17,241,713	1,379,261	907,554	119,602,028	29,484,291

The enormous copper output from Alaskan mines in 1916—a total of 119,602,028 pounds, valued at $29,484,291—has already been mentioned. During the year 18 copper mines were operated, compared with 13 in 1915—nine in the Ketchikan district, six in the Prince William Sound district, and three in the Chitina district. The great output from the Kennecott and Jumbo mines, in the Chitina district, overshadowed all other operations. Had the transportation companies and smelters been able to handle the ore, however, many of the smaller copper mines on the coast would have made a much greater output. The average copper content of the ores mined was 9.7 per cent, and the value of gold and silver recovered about $1.60 to the ton. The average for 1915 was 11.7 per cent copper and $1.65 to the ton in gold and silver.

Twenty-nine gold-lode mines, large and small, were operated in 1916—one less than in 1915. The value of the lode-gold output decreased from $6,069,023 in 1915 to $5,912,736 in 1916. Southeastern Alaska, especially the Juneau district, is still the only center of large quartz-mining developments in the Territory. Next in importance is the Willow Creek lode district. There was also con-

siderable gold-lode mining on Prince William Sound, but a very decided falling off of this industry in the Fairbanks district. Lode-mine owners of Fairbanks are awaiting the cheapening of operating costs, especially of fuel, which will be brought about by the Government railroad. Of the producing mines eight were in southeastern Alaska, five on Prince William Sound, four on Kenai Peninsula, four in the Willow Creek district, and eight in the Fairbanks district. In 1916 the average value of the gold and silver contents for all siliceous ores mined was $1.70 a ton; the average for 1915 was $2.79 a ton. These averages reflect the dominance in the total lode production of the large tonnage produced from the low-grade ores of the Juneau district.

In 1915 about 4,400 men were employed in the Alaskan lode-mining industry. Accurate figures on the number employed in 1916 are not available at this writing, but it probably was at least 5,000.

The value of the placer gold produced in 1916 was about $11,140,000; in 1915 it was $10,480,000. All the older placer districts, except Fairbanks, have maintained or increased their gold output compared with the previous year. The increased output is, however, to be credited chiefly to the newly developed Marshall and Tolovana districts. It is estimated that about 650 placer mines were operated in the summer of 1916 and 215 during the previous winter, but many for only a part of the season. About 4,050 men were engaged in productive placer mining in the summer and 880 in the winter. In addition, probably 1,000 men were engaged in prospecting or other nonproductive work relating to placer mining. The only new placer-bearing area discovered during 1916 was in the Tolstoi Creek basin, in the southern part of the Innoko district, and here but little productive mining was done. There were, however, notable developments of gold placers in the Marshall and Tolovana districts and in the Dime Creek region of the southeastern part of Seward Peninsula.

In accordance with past practice, a table is given here to show approximately the total bulk of gravel mined annually and the value of the gold recovered per cubic yard. The table is based in part on returns made by placer-mine operators and in part on certain assumptions which do not now admit of proof but which are supported by a large number of facts. Therefore, although the table is only approximately correct, it indicates the order of magnitude of the true figures.

Estimated amount of gravel sluiced in Alaskan placer mines and value of gold recovered, 1908–1916.

Year.	Total quantity of gravel.	Value of gold recovered per cubic yard.	Year.	Total quantity of gravel.	Value of gold recovered per cubic yard.
	Cubic yards.			*Cubic yards.*	
1908	4,275,000	$3.74	1913	6,800,000	$1.57
1909	4,418,000	3.66	1914	8,500,000	1.26
1910	4,036,000	2.97	1915	8,100,000	1.29
1911	5,790,000	2.17	1916	7,100,000	1.57
1912	7,050,000	1.70			

The above table shows that during the last nine years there has been a decline in the average gold content of the gravels mined. This is a reflection of the improved methods of placer mining that are being introduced, especially in the use of dredges. If data were available on the average gold recovery previous to 1908 a far greater decline would be noted. The rise of the average recovery in 1916 compared with 1915 is due largely to the fact that the Alaskan dredges were for the most part working on far richer placers. This change is also influenced by the fact that in 1916, as compared with 1915, a larger percentage of the placer gold came from the rich deposits of newer districts, such as Hot Springs, Tolovana, and Koyukuk. In these districts gold recoveries of $7 to $20 a cubic yard are not uncommon. In the final analysis the movement of the miners toward the richer placers, made evident by the average recoveries for 1915 and 1916, is the result of the present economic conditions, which, as will be shown below, affect gold mining more adversely than any other industry.

Thirty-four gold dredges were operated in Alaska in 1916, one less than in 1915. The dredging companies employed about 440 men. Four dredges were built during the year. Twenty-seven dredges were in Seward Peninsula, three in the Iditarod, and one each in the Ruby, Fairbanks, Circle, and Yentna districts. These dredges produced about $2,679,000 worth of gold and handled about 3,900,000 cubic yards of gravel. In 1915 the 35 dredges handled about 4,600,000 cubic yards of gravel and made a gold recovery worth $2,330,000. The average gold recovery per cubic yard was about 69 cents in 1916 and 51 cents in 1915. The gold dredges of Seward Peninsula made an average recovery of 53 cents a cubic yard in 1916 and 35 cents in 1915. The dredges of the Alaska Yukon districts are working on placers of relatively high gold tenor. The value of gold recovery per cubic yard in 1916 was about 85 cents; in 1915, about 80 cents.

The above statements do not encourage the hope of an immediate expansion of the dredging industry of Alaska. During the last three years there has been a decrease in the number of dredges operated,

and the gold output from this source has been maintained by the production of a few machines working on relatively rich placers. Dredging companies in Seward Peninsula, which have in the past mined gravels of lesser gold tenor, have in part ceased operations, and there is now a general tendency throughout Alaska to limit the installation of dredges to relatively rich placers. This is no doubt due in large part to present economic conditions, by which the gold-mining industry suffers most, for the value of the product is relatively less than under normal conditions, and yet, as in other industries, the cost of operation is increased by high prices.

There are in Alaska many placers rich enough to be dredged under present adverse conditions, and the exploitation of these placers will continue more extensively than in the past. The best hope for a permanent dredging industry, however, is in the mining of the large bodies of auriferous gravels whose gold tenor is too low to be attractive to operators under present economic conditions.

Though dredges were built for use in the Alaska Yukon as early as 1898 and at Nome in 1900, this method of placer mining did not reach a profitable stage until 1903, when two small dredges were successfully operated in Seward Peninsula. Dredging began in the Fortymile district in 1907; in the Iditarod, Birch Creek, and Fairbanks districts in 1912, and in the Yentna district in 1916. Up to the end of 1916 gold to the value of $15,110,000 has been mined by dredges. The distribution of this output by years is shown in the following table:

Estimate of gold produced from dredge mining in Alaska, 1903–1916.

Year.	Number of dredges operated.	Value of gold output.	Year.	Number of dredges operated.	Value of gold output.
1903	2	$20,000	1911	27	$1,500,000
1904	3	25,000	1912	38	2,200,000
1905	3	40,000	1913	36	2,200,000
1906	3	120,000	1914	42	2,350,000
1907	4	250,000	1915	35	2,330,000
1908	4	171,000	1916	34	2,679,000
1909	14	425,000			
1910	18	800,000			15,110,000

TIN.

The Alaskan mines produced 139 tons of metallic tin, valued at $121,000, in 1916, compared with 102 tons, valued at $78,846, in 1915. Most of this tin came from the York district, in Seward Peninsula, where four dredges were operated in 1916, of which two were working on gravels carrying gold as well as tin. Considerable development work was done on the tin lodes of the York district, notably at the Lost River mine. As in the past, much stream tin was recovered from the gold placer mines of the Hot Springs district. The following table shows the Alaskan tin production by years:

Tin produced in Alaska, 1902–1916.

Year.	Quantity (tons of metallic tin).	Value.	Year.	Quantity (tons of metallic tin).	Value.
1902	15	$8,000	1911	61	$52,798
1903	25	14,000	1912	130	96,000
1904	14	8,000	1913	69	44,103
1905	6	4,000	1914	104	66,560
1906	34	38,640	1915	102	78,846
1907	22	16,752	1916	139	121,000
1908	25	15,180			
1909	11	7,638		767	579,852
1910	10	8,335			

LEAD.

Though silver-lead ores are found in many parts of Alaska no deposits of them have yet been opened on a commercial basis. The lead production is therefore still only incidental to the mining of ores chiefly valuable for other metals. Some test shipments of galena ore were made from several deposits in 1916, and these, with the much larger recovery of lead from gold ores, made a total output of 820 tons of lead, valued at $109,120, compared with a production in 1915 of 437 tons, valued at $41,118. The following table shows the lead production of Alaska, so far as it can be determined from available data:

Estimate of lead produced in Alaska, 1892–1916.

Year.	Quantity (tons).	Value.	Year.	Quantity (tons).	Value.
1892	30	$2,400	1906	30	$3,420
1893	40	3,040	1907	30	3,180
1894	35	2,310	1908	40	3,360
1895	20	1,320	1909	69	5,934
1896	30	1,800	1910	75	6,600
1897	30	2,160	1911	51	4,590
1898	30	2,240	1912	45	4,050
1899	35	3,150	1913	6	528
1900	40	3,440	1914	28	1,344
1901	40	3,440	1915	437	41,118
1902	30	2,460	1916	820	109,120
1903	30	2,520			
1904	30	2,580		2,081	218,724
1905	30	2,620			

ANTIMONY.

The mining of antimony ore (stibnite) began in Alaska in 1915 and was continued on about the same scale throughout the first half of 1916. The drop in the price of antimony during midsummer put an end to most of these operations. About 1,458 short tons of crude ore, valued at $134,000, was mined in 1916. The output in 1915 was 833 tons, valued at $74,000. Most of this antimony ore came from two mines in the Fairbanks district, where two other mines also made a small production. Stibnite ore was also pro-

duced from ore mined in the Nome district, but no shipments were made. A more detailed account of antimony mining at Fairbanks and Nome will be found in another section of this report.

TUNGSTEN.

Though scheelite has long been known to occur in some of the Alaskan placers, until the last two years the demand for it has not been sufficient to encourage its recovery. The recent high price of tungsten has induced Alaskan miners to turn their attention to scheelite deposits. In the fall of 1915 a scheelite-bearing vein was discovered in the Fairbanks district, and its development began. Later two other scheelite-bearing veins were found in the same district. During the winter some of these scheelite ores were treated in a local mill and the concentrates were shipped out by parcel post. Scheelite mining was continued during the summer, and the crude ore was shipped out by steamer. Considerable scheelite was also recovered from some of the gold placers at Nome, and a little was produced in other districts. It is estimated that about 47 tons of scheelite concentrates, including a little wolframite, were produced in Alaska during 1916, for which the producers received about $109,300. A more detailed description of tungsten mining in Alaska is given elsewhere in this report.

PLATINUM.

Platinum has been reported in association with gold placers at many widely separated localities in Alaska. Some of the reported occurrences after investigation have proved not to contain platinum; at others small quantities of the metal have been found in concentrates from placer-mining operations. Traces of platinum have also been found in a copper-bearing lode in the Ketchikan district.

In 1916 the value of the crude platinum recovered from placer mines of the west coast was from $60 to $70 an ounce. This high price both stimulated the search for platinum deposits and led mine operators to examine their concentrates for platinum. Complete returns on platinum production are lacking, but the evidence in hand indicates that between 10 and 12 ounces was recovered from Alaska placers in 1916. This came from Dime Creek, in the Koyuk district of Seward Peninsula; from Bear Creek, in the Fairhaven district of Seward Peninsula; and from Slate Creek, in the Chistochina district of the upper Copper River basin. In view of the present great demand for platinum it seems desirable to summarize the rather scant data relating to Alaskan platinum deposits. The localities where platinum is known to occur will be described and also those where it has been reported, even though the report has not yet been verified.

Traces of platinum and palladium have recently been found in association with the copper ores of the Goodro mine, on Prince of Wales Island in the Ketchikan district. This copper-bearing lode has been described by Knopf [1] as "a heavy green dioritic rock, containing much biotite and, as the main copper-bearing mineral, scattered particles of bornite, with which are associated sporadic blebs of chalcocite and chalcopyrite." Wright,[2] who has mapped the geology of the Goodro deposits, describes the country rock as a gabbro, a marginal phase of the diorite widely distributed in the district. In regard to the distribution of the Goodro type of copper deposits, Wright [3] says: "Irregular disseminated bodies of copper ore occur in an intrusive belt of gabbro that extends along the northeast side of the salt chuck at the head of Kasaan Bay, extending northwestward and averaging about a mile in width. Copper ore has been found at only a few places in this intrusive belt and has been mined only at the Goodro mine." In other words, the geologic conditions existing at the Goodro mine are probably repeated at other localities. If the Goodro ore proves to carry platinum in commercial quantity an examination of deposits of similar types for platinum is justified.

No platinum has been found in any other lode deposits of Alaska. Some very basic intrusive rocks (peridotite) of the general type with which platinum deposits occur are present in the southern part of Kenai Peninsula, but so far as known these have not been examined for platinum. Chromite ore occurs in association with some of these intrusives, deposits having been found at Red Mountain,[4] 7 miles from Seldovia, and near Port Chatham. It is not intended to imply that these deposits carry any platinum, but only that their geology is such as to justify their examination for this metal. However, chromite-bearing veins have also been found near Ruth Creek, in the Tolovana district, and the gold placers of this district carry chromite but no platinum.

A little platinum has been won from the Slate Creek placers of the Chistochina district, in the Copper River basin. It has long been known that a little osmium and iridium occur in the placers of Miller Gulch, also in the Chistochina district.[5] Many years ago it was reported that platinum occurred in the gravels of Nadina River, also in the Copper River basin. A careful study of these deposits by Mendenhall [6] failed to reveal any platinum.

[1] Knopf, Adolph, Mining in southeastern Alaska: U. S. Geol. Survey Bull. 442, p. 141, 1910.

[2] Wright, C. W., Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska: U. S. Geol. Survey Prof. Paper 87, pp. 75, 86, 87, 99, 1915.

[3] Idem, p. 86.

[4] Martin, G. C., Johnson, B. L., and Grant, U. S., Geology and mineral resources of Kenai Peninsula, Alaska: U. S. Geol. Survey Bull. 587, pp. 237–238, 1915.

[5] Mendenhall, W. C., Geology of the central Copper River region, Alaska: U. S. Geol. Survey Prof. Paper 41, p. 123, 1905.

[6] Idem, pp. 121–122.

Many of the beach placers of the Pacific coast belt have been reported to carry platinum. It seems pretty definitely established that at least small quantities of platinum occur in the beach placers of Lituya Bay. It was long ago reported that a little platinum occurred in the beach placers of Yakutat Bay. This report has not been confirmed, for an examination of the auriferous beach sands from the north end of Khantaak Island [1] failed to reveal the presence of platinum. No platinum has been found in the beach placers of Yakataga.[2] Platinum has been reported to occur in some of the beach placers of Kodiak Island. The only sample tested from this region was taken from the "7-mile beach" near Uyak, and this revealed no trace of platinum. A little platinum is said to occur in the beach placers near the mouth of Red River, Kodiak Island.

The presence of platinum has been reported in the gold placers of Colorado Creek, on Kenai Peninsula, also on Kahiltna River, in the Yentna district. No samples from these localities have been examined by the Survey, but the writer is indebted to Prof. Herschel C. Parker for the information that as the result of drilling of auriferous gravels in the Kahiltna River valley in the search for dredging ground, considerable alluvial platinum was found, including some nuggets the size of the head of a match. Basic intrusive rocks of the type with which platinum is sometimes found associated occur in the Alaska Range,[3] in which Kahiltna River has its source. No other occurrence of platinum has been reported from the Yentna district, but the amount found in the Kahiltna River gravels justifies a further search for it. Its occurrence in the river gravels suggests that it may be more abundant in the gravels of some of the tributary streams.

Many years ago a trace of platinum was obtained from some concentrates procured by placer mining in the Fortymile district. The exact locality of this specimen is unknown. As only a very few grains of platinum were obtained, this information has no direct commercial value. It is desirable, however, for the placer operators in the Fortymile district to have the concentrates from mining examined for platinum.

A specimen sent to the Geological Survey by J. S. Pitcher and reported to be concentrates from placer mining on Boob Creek, in the Innoko district, was found to contain some platinum and palladium. Boob Creek, the scene of new placer-mining developments in 1916, flows into Mastodon Creek, which is tributary to Tolstoi Creek, an easterly confluent of Innoko River. Little is known of the local geology, and nothing of the extent of the deposit in which

[1] Brown, J. S., Report on auriferous sands from Yakutat Bay: Nat. Geog. Mag., vol. 3, pp. 196–198, 1891.
[2] Maddren, A. G., Mineral deposits of the Yakataga district: U. S. Geol. Survey Bull. 592, p. 137, 1914.
[3] Brooks, A. H., The Mount McKinley region: U. S. Geol. Survey Prof. Paper 70, pp. 104, 147–148, 1911.

the platinum was found. In the general region there is known to be an older series made up of limestones, with some greenstones, and a younger Mesozoic succession of conglomerate, sandstone, and shale. The Mesozoic rocks are intruded by granite and diorite rocks with some pyroxenite.[1] It is probable that the placer platinum is derived from bedrock deposits associated with the pyroxenite, which is a dark-green, very heavy igneous rock.

One of the most promising finds of platinum reported in Alaska is on Dime Creek, in the Koyuk district of the southeastern part of Seward Peninsula. A little gold mining was done on Dime Creek in 1915, and seven or eight plants were operated in 1916. Incidentally to this gold output several ounces of platinum was recovered, and this without any attempt to seek out deposits valuable for platinum. According to the report of prospectors the platinum appears to have been derived from an area of greenstones. These greenstones are probably the altered intrusive rocks in Paleozoic sediments described by Smith and Eakin.[2] No examination has been made of this platinum occurrence by the Survey, but the facts stated indicate that the metal may be present in sufficiently large quantities to warrant its systematic recovery. Platinum has also been found in the placers of Bear Creek, in the Fairhaven district, which includes the northeastern part of Seward Peninsula. No details regarding this occurrence are known. Most of the Bear Creek drainage basin lies in a region of volcanic and intrusive rocks.[3]

The facts above given indicate that at several widely separated localities in Alaska the gold placers carry sufficient platinum to justify special search for it. Some of these placers may even prove to be of greater value for their platinum than for their gold content. In any event, the placer miners should carefully examine the concentrates from their operations. The Geological Survey will be glad to make qualitative tests for platinum of concentrates submitted for that purpose. In districts where extensive placer mining has been carried on the presence of any considerable platinum in the concentrates is not likely to be overlooked. Its presence may, however, be known to the purchaser of the gold and not to the miner. It is also possible that platinum occurs where there is little or no gold. Therefore the prospector will do well to examine all his concentrates for platinum, even if no gold is present. So far as known, the most likely place for platinum is in regions of very basic igneous rocks. These can be recognized by their dark-green color and their great

[1] Eakin, H. M., The Iditarod-Ruby region, Alaska: U. S. Geol. Survey Bull. 578, pl. 3, 1914. Mertie, J. B., Mineral resources of the Ruby-Kuskokwim region: U. S. Geol. Survey Bull. 642, p. 251, 1916, and unpublished notes.

[2] 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. 61-64, 1911.

[3] Moffit, F. H., The Fairhaven gold placers, Seward Peninsula, Alaska: U. S. Geol. Survey Bull. 247, pp. 63-64, 1905.

weight. They are heavier than the ordinary diorite or granite so common in Alaska. Some of them are coarsely crystalline; others are fine grained. In places they are altered to serpentine, a light-green fibrous rock.

MISCELLANEOUS METALLIFEROUS DEPOSITS.

Some prospecting was done during 1916 on the chromite deposits near Seldovia and Port Chatham, in the southwestern part of Kenai Peninsula. A chromite-bearing vein was found by J. B. Mertie in the Tolovana placer district and is described by him in another section of this volume. No direct report has been received about the quicksilver deposits of the lower Kuskokwim basin.[1] It is known, however, that developments were continued at the Parks mine and that several other quicksilver deposits were prospected.

Some work was done on a molybdenite deposit on the White Pass Railroad, about 25 miles from Skagway. The owners report that the developments consist of a 10-foot shaft and a 25-foot adit and that the deposit occurs in a broad zone of mineralization in a country rock of granite. Molybdenite has also been found on Canyon Creek, a northerly tributary of the Chitina, about 50 miles from the Copper River Railroad at McCarthy,[2] and on Lemesurier Island, in Icy Strait.[3] So far as known no developments were made on these two deposits during 1916. A copper-bearing lode, which is reported to carry nickel and a little cobalt, has been discovered and developed near Pinta Cove, on the west side of Chichagof Island. The Survey has received a specimen of nickel-bearing ore which is said to be from a lode near Spirit Mountain, in the lower Copper River region.

COAL MINING.

In 1916 about 12,200 net tons of coal, valued at $55,000, was mined in Alaska; in 1915 the output was 1,400 tons, valued at $3,300. Most of the coal mined in 1916 came from the Doherty mine, in the Matanuska field; from the Bluff Point mine, on Cook Inlet; and from the Short Creek mine, in the Yentna district. Some coal was also taken from the La Duke mine, in the Matanuska field, and from the McDonald mine, in the Bering River field. (See Pl. I, in pocket.) A little coal was mined on Chicago Creek, in Seward Peninsula, and one small shipment of coal was made to Nome from the Corwin mine, in the Cape Lisburne field.

The most important event of the year to the Alaskan coal industry was the opening of the Bering River and Matanuska fields for leasing under the new law. These two fields were subdivided into leasing

[1] For information regarding these deposits, see Smith, P. S., and Maddren, A. G., Quicksilver deposits of the Kuskokwim region: U. S. Geol. Survey Bull. 622, pp. 272-291, 1915.

[2] Brooks, A. H., The Alaskan mining industry in 1915: U. S. Geol. Survey Bull. 642, p. 54, 1916.

[3] Knopf, Adolph, The Sitka mining district, Alaska: U. S. Geol. Survey Bull. 504, p. 17, 1912.

units by the Bureau of Mines in 1915. In 1916 the Geological Survey made a detailed geologic survey of the western part of the Nenana coal field, thus acquiring the information necessary for subdividing this field into leasing units. The Interior Department has received a number of applications for leases in both the Matanuska and Bering River fields. The lower end of the Matanuska field was reached by the Government railroad in the summer of 1916, and an extension of the line into the heart of the field is now being built. It is also hoped that the Nenana field may be made accessible by railroad at an early date. This will make it possible to supply Fairbanks and other Yukon camps with the cheap fuel urgently needed by the gold mining industry. The small amount of coal produced at the McDonald mine, on Bering Lake, in the Bering River field, was sold in a local market. A survey was made and some construction work done on a railroad to be built from Goose Point, on Bering River, to Canyon Creek, in the Bering River field. Goose Point is accessible to barges from Controller Bay by way of the lower reaches of Bering River, which is a tidal estuary. This railroad will be about 17 miles in length and is intended for coal traffic.

The subjoined table shows the coal consumption of Alaska, including both imports and local production, since 1899. Most of the coal used up to 1916 was lignite. There was in 1906 a small production of bituminous coal from the seaward end of the Bering River field. The table does not include 855 tons of coal mined in the Bering River field in 1912 and 1,100 tons mined in the Matanuska field in 1913 for test by the United States Navy. Most of the coal shipped to Alaska is bituminous, but a little is anthracite.

Coal consumed in Alaska, 1899 to 1916, in short tons.

Year.	Imported from States, chiefly bituminous from Washington.	Produced in Alaska, chiefly subbituminous and lignite.	Total domestic, chiefly from Washington.	Total foreign coal, chiefly bituminous from British Columbia.[a]	Total coal consumed.
1899	10,000	1,200	11,200	50,120	61,320
1900	15,048	1,200	16,248	56,623	72,871
1901	24,000	1,300	25,300	77,674	102,974
1902	40,000	2,212	42,212	68,363	110,575
1903	64,626	1,447	66,073	60,605	126,678
1904	36,689	1,694	38,383	76,815	115,198
1905	67,713	3,774	71,487	72,567	144,054
1906	69,493	5,541	75,034	47,590	122,624
1907	46,246	10,139	56,385	88,596	144,981
1908	23,893	3,107	27,000	72,831	99,831
1909	33,112	2,800	35,912	74,316	110,228
1910	32,138	1,000	33,138	73,904	107,042
1911	32,255	900	33,155	88,573	121,728
1912	27,767	355	28,122	59,804	87,926
1913	61,666	2,300	63,966	60,600	124,566
1914	41,509	.....	41,509	21,882	63,391
1915	46,329	1,400	47,729	36,878	84,607
1916	44,934	[b] 12,200	57,134	36,454	93,588
	717,418	52,569	769,987	1,124,195	1,894,182

[a] By fiscal years ending June 30.
[b] Estimated. About 75 per cent of this production is bituminous.

With the opening of the high-grade coal deposits of the Bering River and Matanuska fields the question of a market for these fuels becomes important. This matter was discussed at some length in a publication issued seven years ago.[1] The general analysis of the fuel market on the Pacific seaboard there presented still holds true. Time has not been available, however, to collect the necessary data on which to base an estimate of the present market for Alaskan coal. Since 1910 the Alaskan coal consumption has declined, owing to an increased use of oil. (See table, p. 40.)

It seems desirable to summarize briefly the information available regarding coal consumption in the Pacific States,[2] where Alaskan fuel must find its principal export market. It need hardly be added that under present industrial conditions coal production and distribution vary greatly from year to year. No data relating to this matter for 1916 are available, but even if they were it would probably be better to use the figures for 1915 for the purpose of estimating a possible coal market, as the coal trade in that year was in a far more normal condition than in 1916. The subjoined table, based on Lesher's report, presents the coal consumption of the three Pacific Coast States. The railroad coal is separated from that used for other purposes, as the data do not permit a definite statement that it was all burned in the State to which it is credited. The railroad consumption of fuel, as given in the table, represents the coal mined or purchased by the railroads in these States.

Coal consumption in Pacific Coast States, 1915, in net tons.

	Washington.	Oregon.	California.
Total consumption, except railroads	1,087,684	342,963	332,472
Used by railroads	1,149,446	5,000	.....
Imports	128,239	1,454	284,225
	2,365,369	349,417	616,697

The above table shows that 3,311,483 tons of coal was consumed in the Pacific Coast States during 1915. No data are available for the years immediately preceding, but the consumption for the same group of States in 1908 is estimated to have been 4,372,300 tons.[3] This falling off is of course due to the greatly increased use of California oil. The petroleum output of the California fields was 44,854,737 barrels in 1908 and 86,591,535 barrels in 1915.[4]

[1] Brooks, A. H., Alaska coal and its utilization: U. S. Geol. Survey Bull. 442, pp. 47-100, 1910; reprinted as Bull. 442-J, 1914.

[2] Lesher, C. E., Coal in 1915, Part B, Distribution and consumption: U. S. Geol. Survey Mineral Resources, 1915, pt. 2, pp. 433-513, 1916.

[3] Northrop, J. D., Petroleum in 1915: U. S. Geol. Survey Mineral Resources, 1915, pt. 2, p. 706, 1916.

[4] Brooks, A. H., op. cit., pp. 84-85.

Another factor in the west coast coal trade is the opening of the Panama Canal. Up to the present time the shipments through the canal to the west coast have been chiefly naval coal, with some anthracite and probably a little blacksmith coal. In 1915 about 144,000 tons[1] reached the west coast through the canal. No doubt under normal conditions the eastern coal will seek a market on the Pacific seaboard by the canal route and may compete directly with coal shipped from Alaska.

As the Alaskan coal could not be sold east of the mountains, owing to the long railway haul, it is desirable to estimate the coal consumption on the Pacific slope. No exact data are available on which to base such an estimate. It is possible, however, to arrive at approximate figures based on certain assumptions, and this has been done with the help of Mr. Lesher. In making this estimate it is assumed that all the coal from the Roslyn field of central Washington is consumed east of the mountains and that the same is true of the coal shipped to Washington and Oregon from the Montana, Utah, and Wyoming fields. The results are presented below, together with the Alaskan coal consumption (p. 26).

Estimate of coal consumption of the Pacific slope, 1915, in net tons.

California	610,000
Oregon	300,000
Washington	2,300,000
Alaska	90,000
	3,300,000

The high-grade coals of Alaska are of better quality than any others found on the Pacific seaboard. They should be of special value for the bunker trade. The increased use of oil-burning engines on ocean vessels is illustrated by the subjoined table, in which the bunker trade for the years 1908 and 1915 is compared. This table is based on data furnished by Mr. Lesher. As the statistics on bunker consumption are not entirely complete the figures for 1915 are in part based on estimates. Of the 319,000 tons of bunker coal consumed in 1915 about 180,000 tons was consumed by vessels engaged in foreign trade. This does not include about 85,000 tons of coal furnished to vessels in the Hawaiian Islands.

[1] Lesher, C. E., op. cit. This does not include shipments to Manila, 23,668 tons, and to Honolulu, 11,846 tons.

Bunker coal supplied to steamers in ports of Pacific Coast States and Alaska in 1909 and 1915, in net tons.

	1909	1915 [a]	Decrease.
California ports	186,287	170,000	16,000
Oregon ports	17,426	5,000	12,000
Washington ports	406,564	136,000	271,000
Alaska ports	15,009	8,000	7,000
	625,286	319,000	306,000

[a] Estimated.

Both the Matanuska and Bering River coal fields contain high-grade coking coals. As there is a scarcity of coking coal on the west coast Alaska coke should find a ready market. The figures for coal consumption on the Pacific slope presented in a previous table (p. 28) included that manufactured into coke. It will be well, however, to present the coke consumption by States.[1]

Coke consumed in Pacific Coast States in 1915, in net tons.

	Domestic.	Foreign.	Total.
California	42,268	15,849	58,117
Oregon	1,283	.....	1,283
Washington	78,815	1,033	79,848
	122,366	16,882	139,248

Of the domestic coke shown in the above table about 65,000 tons was furnace coke. There are no data on the use to which the imported coke was put. Most of the domestic furnace coke used on the west coast is from the State of Washington, but a little is brought by rail from Utah, Colorado, and New Mexico.

The annual consumption of coke on the west coast has not changed greatly for some years. In 1908 California, Oregon, and Washington consumed about 126,000 tons;[2] in 1915, 139,000 tons. About 217,000 tons of coal was utilized in manufacturing the 139,000 tons of coke in 1915.

Both the Matanuska and Bering River coal fields contain considerable anthracite. So far as known, most of this Alaskan anthracite is more or less crushed and probably will not produce a large percentage of lump coal. There is also a good deal of the high-grade bituminous coal which is crushed, and one of the important problems in connection with finding a market for the Alaskan fuel is the economic utilization of this crushed coal.

Lesher [3] has estimated that in 1915 the Pacific Coast States consumed in all only 2,600 tons of domestic anthracite. In addition to

[1] Lesher, C. E., Coke in 1915: U. S. Geol. Survey Mineral Resources, 1915, pt. 2, pp. 515–558, 1916.

[2] Brooks, A. H., Alaska coal and its utilization: U. S. Geol. Survey Bull. 442, p. 86, 1910.

[3] Lesher, C. E., Coal in 1915, Part B, Distribution and consumption: U. S. Geol. Survey Mineral Resources, 1915, pt. 2, pp. 488, 491, 492, 1916.

this there was imported 740 tons of coal which was classed as anthracite but about the classification of which there is some question. Be that as it may, the total annual consumption of anthracite along the Pacific seaboard amounts to only a few thousand tons. Therefore, if Alaskan anthracite is mined, a market for coal of this class will have to be built up. The most promising immediate market for anthracite would seem to be in the Territory itself.

British Columbia coal, notably that from Vancouver Island, is an important factor in the fuel market of the Pacific Coast States. Therefore the following official data relating to the British Columbia coal production are here included:

Coal produced in British Columbia, 1913 and 1914, in tons.[a]

	Vancouver Island.	Nicola and Princeton.	Crowsnest and East Kootenay.	Total.
1913.				
Sold for consumption in Canada	715,259	276,528	319,856	1,311,643
Sold for export to United States	107,885	.....	590,935	698,820
Total sales	823,144	276,528	910,791	2,010,463
Used for making coke or brick	.....	.....	485,271	485,271
Used for colliery consumption, etc	104,736	17,903	96,047	218,686
Total production	927,880	294,431	1,492,109	2,714,420
1914.				
Sold for consumption in Canada	674,928	134,995	159,598	969,521
Sold for export to United States	236,004	3,006	436,109	675,119
Total sales	910,932	138,001	595,707	1,644,640
Used for making coke or brick	.....	.....	398,117	398,117
Used for colliery consumption, etc	106,751	17,391	72,900	197,042
Total production	1,017,683	155,392	1,066,724	2,239,799

[a] McLeish, John, Annual report on the mineral production of Canada during the calendar year 1914: Canada Dept. Mines, Mines Branch, Pub. 384, p. 232, 1915.

The figures for production in 1913 probably represent more normal conditions of the British Columbia coal-mining industry than those for 1914, when the industry was more or less affected by the war. In 1915 British Columbia produced 2,089,966 tons of coal and 275, 375 tons of coke.[1] Details regarding the source of this coal by districts and its distribution are lacking at this writing.

The Vancouver Island coals for which statistics are given in the above table "are high-volatile bituminous coals of fair quality."[2] They are, however, inferior to the bituminous coals of the Matanuska and Bering River fields of Alaska. These are the coals with which the Alaskan coal may come into direct competition.

[1] McLeish, John, Preliminary report on the mineral production of Canada during the calendar year 1915: Canada Dept. Mines, Mines Branch, Pub. 408, pp. 19-20, 1916.

[2] Dowling, D. B., Coal fields of British Columbia: Canada Geol. Survey Mem. 69, p. 69, Ottawa, 1915.

PETROLEUM.

INTRODUCTION.

Petroleum seepages are known in Alaska at four localities, all on the Pacific seaboard. These, named from east to west, are Yakataga; Katalla, on Controller Bay; Iniskin Bay, on Cook Inlet; and Cold Bay, on Alaska Peninsula. A petroleum residue has been found near Smith Bay, on the Arctic coast, and seepages are reported to occur near Wainwright Inlet, about 100 miles west of this locality. At Katalla, Cold Bay, and Iniskin Bay there has been some drilling for oil, and in the Katalla field several productive wells have been opened.

The discovery of oil seepages in different parts of the Yukon basin, notably in the Tanana Valley, has been reported at different times. These occurrences, so far as investigated, have all proved to be those skims of oxide of iron which, especially in combination with marsh gas, simulate seepages of petroleum. Those examined occur in alluvial deposits. Some have been encountered in placer mining, where shafts have been sunk below the level of permanent ground frost. As prospectors have been frequently misled by such occurrences into the belief that they had found petroleum seepages, the following note describing simple tests, for which the writer is indebted to Mr. David White, is included:

> Among the most important surface indications of the presence of oil and gas deposits are films of oil on water, oil seeps or springs, gas emanations, asphaltic deposits, lenticular accumulations of rock salt or sulphur, and rocks saturated with oil and emitting the odor of petroleum. However, most of these indications should be examined critically with respect to genuineness as well as natural source, especially under certain conditions, and they may require the scrutiny of a specialist in geology or petroleum chemistry. In most of the supposed petroleum seepages the oil-like substance is in reality iron oxide, which commonly forms an iridescent film on the surface of water, especially in marshy places. It can be readily recognized by the fact that it will not burn, and when stirred with a stick breaks into flakes and does not cover the water evenly, like an oil film. It also lacks the odor of petroleum, and if a little is put on a piece of muslin and pressed with a hot flatiron the familiar iron stain is formed. Another simple test for determining the nature of the film is to absorb some of the substance in a blanket or burlap and after allowing it to dry to set fire to it. If the substance is petroleum it will burn with a long, vigorous flame and will give forth the odor of petroleum.

The constantly increasing demand for petroleum, especially refining oils such as occur in Alaska, has renewed interest in the oil fields of the Territory. This has led to a demand for the information about these fields, which is scattered through a number of Survey publications, some of them now out of stock. A brief summary of what is known of these fields seems timely, for there is no official report that deals with the entire subject. The following

compilation,[1] though it contains but little new information, will, it is hoped, be useful to those who are interested in these fields. It has been prepared principally from reports by G. C. Martin, who has investigated the Katalla, Cook Inlet, and Alaska Peninsula oil fields. A. G. Maddren has also made a reconnaissance of the Yakataga oil fields. The data here presented are taken largely from the following publications:

*Martin, G. C., The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits: U. S. Geol. Survey Bull. 250, pp. 9–27, 1905. 15 cents.

*Martin, G. C., Geology and mineral resources of the Controller Bay region, Alaska: U. S. Geol. Survey Bull. 335, pp. 112–130, 1908. 70 cents.

Martin, G. C., and Katz, F. J., A geologic reconnaissance of the Iliamna region, Alaska: U. S. Geol. Survey Bull. 485, pp. 126–130, 1912.

*Maddren, A. G., Mineral deposits of the Yakataga district: U. S. Geol. Survey Bull. 592, pp. 143–147, 1914. 60 cents.

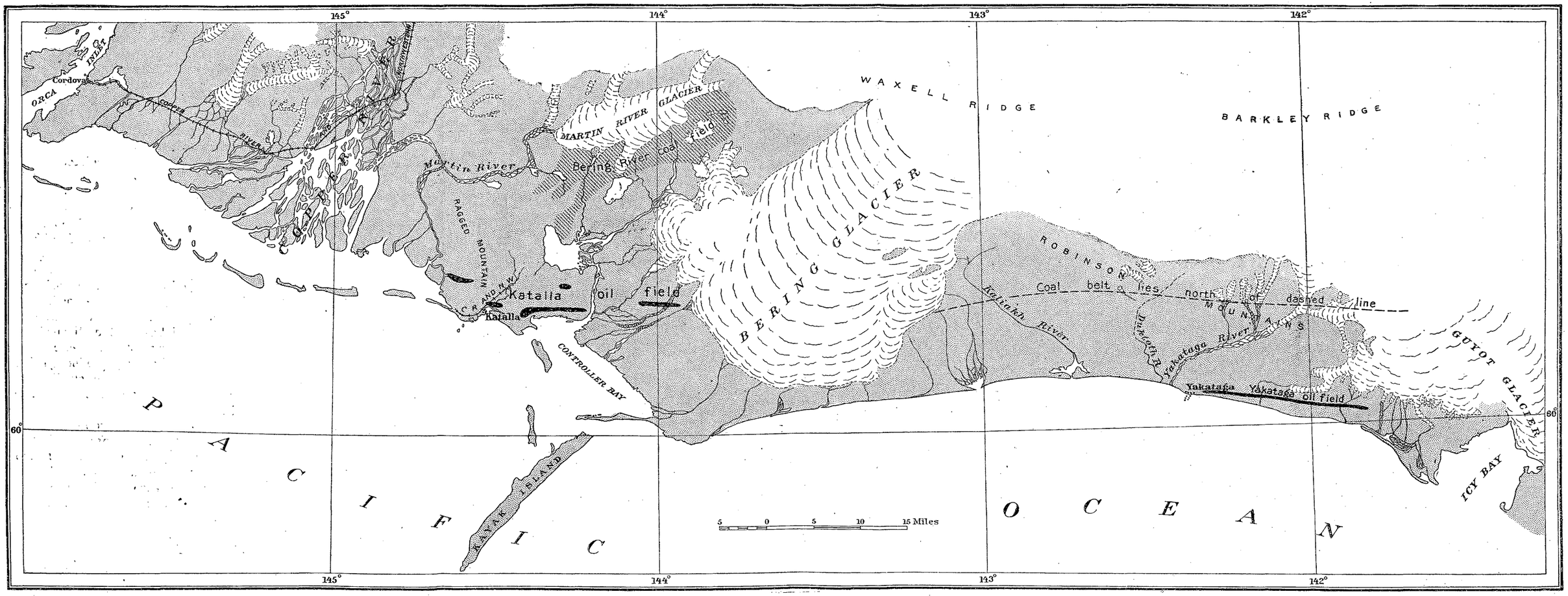
The publications marked with an asterisk (*) are out of stock at the Geological Survey but can be purchased of the Superintendent of Documents, Washington, D. C., at the prices indicated.

KATALLA FIELD.

The Katalla field is marked by a series of seepages and gas springs distributed through an eastward-trending belt about 25 miles long and from 4 to 8 miles wide. (See Pl. III.) This zone skirts the north shore of Controller Bay. To the east it extends into the alluvial flats of Bering River and to the west into the flats of Copper River. An oil seepage has been reported still farther west, on Hinchinbrook Island, but this occurrence has not been verified. The field lies in part on the southern slope of a densely timbered highland, whose summits reach 1,200 to 2,000 feet above the sea, and in part on the flats adjacent to the shore line. Drilling has been done at several localities in this belt, but the productive wells are limited to that part of it lying between the town of Katalla and Bering River.

The surface rocks are a series of intensely folded and faulted shales, sandstones, and conglomerates, with some small basalt or diabase dikes and sills. The general structural trend is about N. 20° E., and the line of seepages lies diagonal to this trend. As much of the field is masked with a dense growth of vegetation, details are lacking on the minor features of structure. Certain seepages or groups of seepages are closely associated with faults or with subordinate anticlines. No definite law of association of the petroleum with tectonic features, however, has yet been established.

[1] This statement is in part a reprint of Brooks, A. H., The petroleum fields of Alaska: Am. Inst. Min. Eng. Trans., vol. 51, pp. 611–619, 1916.



MAP SHOWING LOCATION OF KATALLA AND YAKATAGA OIL FIELDS.

West of Katalla seepages belonging to the same belt have been found in surface rocks or more or less metamorphosed graywackes and slates.

The shale, sandstone, and conglomerate series is of Tertiary age and probably older than the Tertiary coal measures of the Bering River field, which lies about 25 miles to the northeast. All these Tertiary beds are undoubtedly younger than the metamorphosed graywackes and slates, which may be of Mesozoic or Paleozoic age.

It is evident from the above discussion that the source of the oil is unknown. A source in the metamorphic graywackes is of course very improbable. It may be derived from the Tertiary beds or from strata not exposed at the surface. A possible explanation of the seepages in the metamorphic rocks is that these have been thrust over younger oil-bearing strata.

Katalla, the distributing point in this field, is a small settlement at which freight can be landed from scows only during favorable conditions of the wind. During the period of oil excitement some use was made of Controller Bay, 15 miles east of Katalla. Within its shelter ships discharged on scows, and these were landed at the mouth of Bering River. Plans have been formulated for developing the Bering coal field by a branch from the Copper River Railroad, connecting with tidewater at Cordova, on Prince William Sound. (See Pl. III.) Another plan contemplates the building of a railway from a terminal on Controller Bay. Either plan could be made to serve the Katalla field with but little additional expense. Controller Bay could also be used as a petroleum-shipping point, without the agency of a railroad, by building short pipe lines to tidewater. There is ample timber available for structural purposes.

The Katalla seepages were known as early as 1880 but appear not to have attracted any particular attention until about 1897. The first drilling was done in 1901, and a number of holes were sunk during the next three or four years. Some oil was found, but no gushers, and operators were soon drawn away by the California oil excitement. A little oil was pumped from some of these wells in 1907 to supply fuel for railroad construction then in progress near Katalla. In 1911 a small refinery was built near Katalla and supplied with oil from near-by wells. The product found a ready sale at Katalla and on Prince William Sound. This enterprise led to more drilling in this field. Meanwhile, in 1910 all Alaskan oil land was withdrawn from entry, and it has remained in this status ever since. This discouraged all new enterprises, but assessment work is reported to have been kept up on some claims. Patent was granted to a small tract in the new Katalla field, which had been located previous to the withdrawal. This constitutes the only Alaskan oil land to which the Government

has relinquished title. Production has continued up to the present time from this land, and its output represents the only petroleum production in the Territory. In 1916 the company owning this land was reorganized under the name St. Elias Oil Co. and undertook more systematic development. Several wells were cleaned out and connected for pumping. By this means the production was increased to about 30 or 40 barrels a day, obtained from six wells. Preparations were also made to drill some new holes. Plans for developments in this field during 1917 are also being formulated by another company.

In all about 26 holes have been drilled in the Katalla field, of which at least a dozen have struck some oil. The deepest well is about 1,600 feet deep, but the geology of the field is so complex that the actual depth is not significant of the position of an oil pool. Some natural gas was encountered in the drilling.

YAKATAGA FIELD.

The Yakataga petroleum field lies about 80 miles east of Katalla. (See Pl. III.) Here a series of seepages marks a zone about 20 miles in length and half a mile to 2 miles from the beach. The extension of this line to the west carries it into the Pacific, and to the east into an unexplored and ice-covered region tributary to Icy Bay. Prospectors report the presence of a strong oil seepage near Yahtse River, about 15 miles east of the locality to which the belt has been actually traced. There is also a less definite report of the occurrence of seepages along the mountain front between Yakutat and Lituya Bay, about 200 miles east of Yakataga. What little is known of the geology of this region lends some support to this rumor.

The line of Yakataga seepages lies for the most part in a series of short valleys separated from the coastal plain by a low-wooded ridge and drained by streams whose courses are transverse to this ridge. About a dozen seepages have been found, most of which are little more than exudations along joint cracks. One, however, on Johnston Creek is roughly estimated to discharge a barrel or more of petroleum a day.

So far as determined, all these seepages lie along a sharp anticline whose southern limb is about vertical and whose northern limb dips inland at 15° to 45°. The exposed rocks consist of sandstone overlain by fine-textured shale of Oligocene or lower Miocene age. No drilling has been done in this field, so that there is no information at hand as to the underground geologic conditions. Speculation as to the source of the petroleum is therefore futile.

The Yakataga field is now almost inaccessible, as all landings must be made on a beach exposed to the full sweep of the Pacific. Most of the freight for the few placer miners in the district is brought from

Katalla by launch when the winds are favorable to a landing. The overland route along the beach is difficult, though it probably could be utilized for a pipe line or a narrow-gage railroad. The marked recession of a glacier at the east end of the field during the last few years has revealed a small indentation known as Icy Bay, in which shelter may possibly be had, though at present it is in part blocked by ice cakes. If the glacier continues to retreat, the Yakataga field will probably be rendered accessible. There is abundant timber suitable for structural purposes in the district.

Oil claims were staked in the Yakataga field as early as 1897 or 1898, but none of them have been patented. It is reported that up to very recently at least some kind of assessment work was done on these claims, but there has been no drilling. In 1898 a survey for a pipe line was made from Controller Bay to Yakataga.

INISKIN BAY FIELD.

Iniskin Bay is an indentation about 12 miles deep, which, with Chinitna Bay on the north, blocks out an irregular-shaped peninsula on the west shore of Cook Inlet. (See Pl. IV.) The more or less even shore line of this peninsula is broken on the southwest by two small indentations—Oil Bay and Dry Bay. Petroleum seepages have been found in this field near Iniskin, Oil, and Dry bays.

The bedrock of the field is a fine-grained sandstone, with which are interbedded some clay shales. Some beds of conglomerate occur in the sandstone, one of which forms the basal member of the formation, and near the head of Iniskin Bay this bed rests on sheared igneous rocks. The sandstone and the associated sediments, which are of Middle Jurassic age, have a thickness of about 1,100 feet. They are overlain by a shale formation with intercalated conglomerate. The seepages occur in the eastern limb of a broad anticline which has been somewhat faulted. Drilling has not gone deep enough to indicate whether the altered igneous rocks underlie the whole field as they do at the western margin. The evidence in hand points to the conclusion that the sandstone is the source of the petroleum.

The field is readily accessible from the good harbors lying both north and south. These are occasionally blocked by ice floes but are usually accessible throughout the year. There is some timber in the district, but this is chiefly of an inferior quality. Timber could be brought from other parts of the Cook Inlet region, however, at no great expense.

The oil seepages of Iniskin Bay appear to have been known to the Russians before the acquisition of Alaska by the United States. The first well was drilled in this field near Oil Bay in 1898 and is

reported to have reached a depth of 1,000 feet. Gas is said to have been found at a depth of 190 feet and oil at 700 feet, with an estimated flow of 50 barrels a day. On drilling deeper a strong water pressure cut off the flow of oil. A little oil and gas were encountered in a second well, drilled in 1904, which was abandoned at a depth of 450 feet on account of caving of the shale which was penetrated. A third well near by was sunk to a depth of 930 feet. At about 770 feet three thin oil sands were pierced, which are estimated to have yielded 10 barrels a day. A little drilling was done during 1905 and 1906, but of the results there is no record. No work has been done in the field since 1906.

ALASKA PENINSULA.

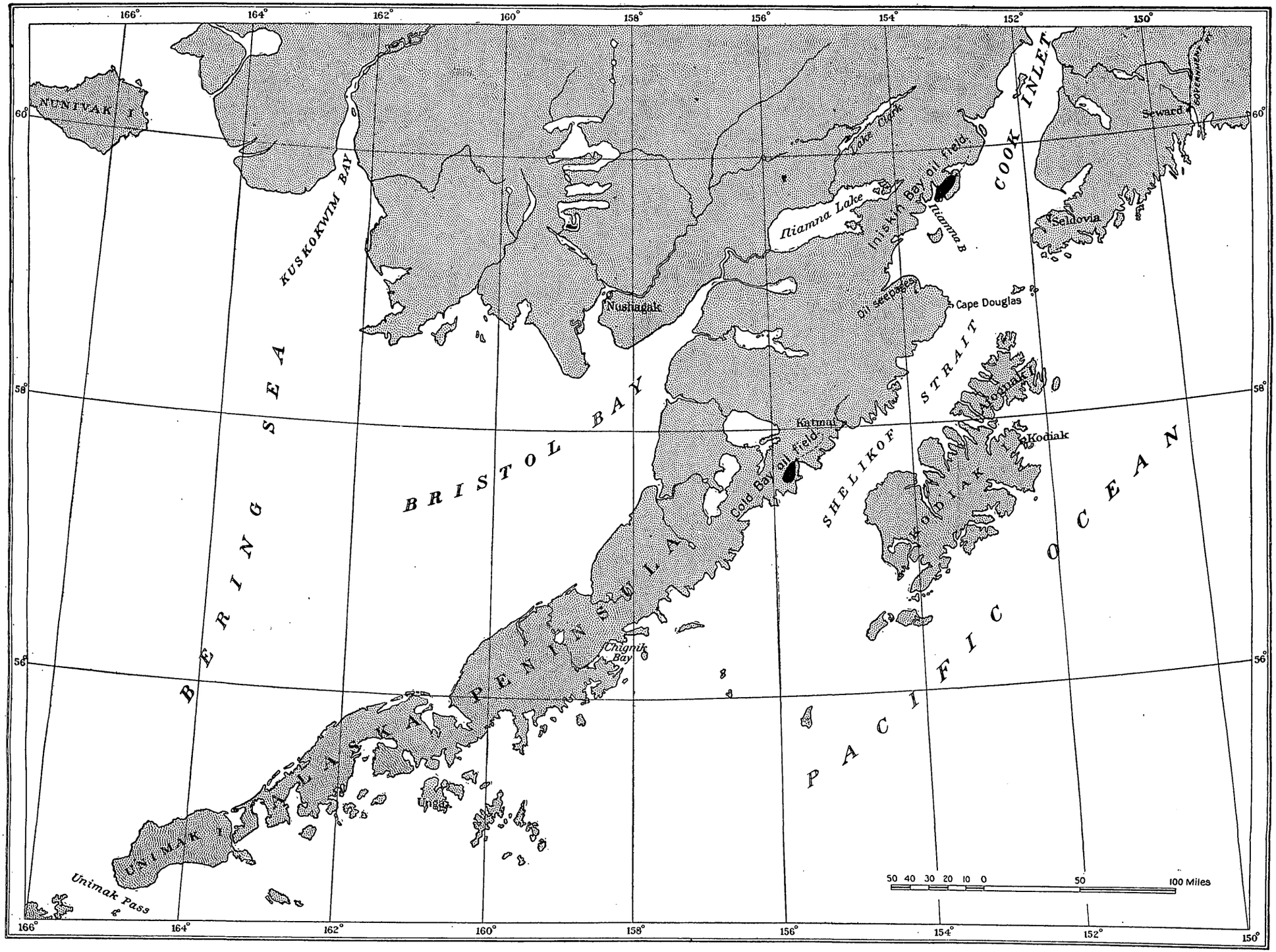
Petroleum seepages on Alaska Peninsula were known to the Russians previous to 1866. Occasional references, though indefinite as to locality, are found in the earlier literature dealing with Alaska, but apparently no thought was given to their possible commercial importance until the Alaska oil boom started, about 1900. The only drilling done on the peninsula is at Cold Bay, described below. Oil seepages have been found at the base of the peninsula near Kamishak Bay, west of Cape Douglas, and reported near Becharof Lake. The area between these localities is not explored.

Cold Bay is an indentation on the Pacific shore of the Alaska Peninsula nearly opposite the south end of Kodiak Island. (See Pl. IV.) The adjacent area, which is untimbered, consists of rounded hills rising to altitudes of less than 1,000 feet. Above these rise some higher peaks, made up chiefly of volcanic rocks.

The country rock of the area in which the seepages occur is a sandstone and shale formation carrying a little limestone; it is of Middle Jurassic age and about 2,000 feet thick. It is underlain by shale, limestone, and chert (Triassic) and overlain by Middle Jurassic arkose conglomerate, sandstone, and shale. The youngest rocks of the district are volcanic, chiefly andesite and basalt. It is a significant fact that the oil-bearing member of this series is of the same age as the oil-bearing beds of the Iniskin Bay field. The main structural features are broad, open folds whose axes parallel the coast, trending about northeast. The dips of the strata do not generally exceed 15°. Some faults have also been noted.

There are a number of oil seepages in this field, some of which are strong. At one of these seepages there is a considerable flow of gas.

The harbor at Cold Bay is open throughout the year, and the contour of the region makes it readily accessible. There is no timber in the district.



MAP SHOWING LOCATION OF INISKIN BAY AND COLD BAY OIL FIELDS.

Two wells were drilled in the Cold Bay field in 1903 and 1904. One of them reached a depth of 1,500 feet and is reported to have pierced several oil sands. No drilling has been done in this field since 1905.

ARCTIC COAST.

E. de K. Leffingwell, who spent several years exploring the north coast of Alaska, has reported the occurrence of petroleum residue about 100 miles east of Point Barrow. (See Pl. I, in pocket.) Mr. Leffingwell describes this material as occurring near Smith Bay,[1] in a mound several hundred yards in diameter and standing about 150 feet above the level of the tundra. It contains considerable vegetable matter and silt, but appears to be the residue of a petroleum containing an asphaltic base. Nothing is known of the geology at this locality, but in the general province in which it occurs there is a series of horizontal Tertiary sediments overlying gently folded Mesozoic sediments.

An oil seepage is reported to have been discovered in 1914 near Wainwright Inlet, about 100 miles west of Smith Bay. If this report is true it suggests that there may be an east-west oil-bearing belt traversing this part of the Arctic coastal plain. Both Smith Bay and Wainwright Inlet are shallow lagoons that are locked in ice for at least 10 months of the year. Even if an oil pool were found in this northern field, the conditions of transportation would prohibit present commercial development.

CHARACTER OF THE PETROLEUM.

Alaskan petroleum, so far as its quality is known, is a refining oil similar to that of Pennsylvania, and has a high percentage of volatile compounds, a paraffin base, and but little sulphur. The accompanying table will serve to indicate the quality of the oil from the Katalla, Yakataga, Iniskin, and Cold Bay fields. All the samples from the Yakataga, Cold Bay, and Iniskin fields and part of those from the Katalla field, however, are from seepages in which there has been some loss of the volatile compounds.

[1] Brooks, A. H, The mining industry [of Alaska] in 1908: U. S. Geol. Survey Bull. 379, pp. 61, 62, 1909.

Summary of analyses and tests of Katalla and Yakataga petroleum.

Locality.	Color.	Gravity.		Flashing point (°F.).	Benzine (per cent).	Kerosene, (per cent).	Lubricating oil (per cent).	Residue, coke, and loss (per cent).
		Specific.	Baumé (°).					
KATALLA FIELD.								
Katalla, well 10[a]		0.8280	39.1		21.0	51.0	28.0	
Katalla, well 10[b]		.7558	45.9		38.5	31.0	21.5	9.0
Katalla, well 10[c]	Light green	.7957	45.9	70–80	38.5	31.0	21.5	9.0
Do		.800			34.2	34.4	16.5	14.5
Katalla, well 10[d]	Dark red	.802		60				
Do	do	.790		60				
(?)[d]		.869				19.0	78.6	1.7
(?)[d]		.914				9.0	87.6	2.7
(?)[d]		.800			24.8	53.9	16.7	1.2
Katalla Meadow [d]	Dark brown	.929		240				
Do		.901		156				
Do		.874		156				
Do		.869		152				
Do		.961		266				
Burls Creek [d]	Dark red-brown	.942		234				
YAKATAGA FIELD.								
Johnston Creek [d e]	Dark brown	.964		200				
Do	do	.879		178				
Poule Creek [d e]	do	.970		250				
Do	do	.881		67				
Do	do	.914		156				
Crooked Creek [d e]	do	.921		172				
Oil Creek [d e]	do	.855		108				
Yakogelty [d e]	do	.937		246				
Morrison Creek [d e]	do	.991		270				
Argyll Creek, Icy Bay [d e]	do	.962		310				

[a] Sample collected by G. C. Martin, test by Penniman & Browne, U. S. Geol. Survey Bull. 335, p. 121, 1908.
[b] Oliphant, F. H., The Production of petroleum in 1902: U. S. Geol. Survey Mineral Resources, 1902, p. 583, 1903.
[c] Stoess, P. C., The Kayak coal and oil fields of Alaska: Min. and Sci. Press, vol. 87, p. 65, 1903.
[d] Redwood, Boverton, Petroleum, vol. 1, 2d ed., p. 198, 1906.
[e] The exact localities of seepages where these samples were taken are not known, but they are believed to be in the Yakataga field.

Tests of samples of seepage petroleum from Oil Bay and Cold Bay.[a]

[Penniman & Browne, analysts.]

	Oil Bay.	Cold Bay.
Specific gravity at 60° F	0.9557 (16.5° B.)	0.9547 (16.6° B.)
Distillation by Engler's method:		
Initial boiling point °C.	230	225
Burning oil (distillation up to 300° C., under atmospheric pressure) per cent.	13.2 (29.5° B.)	13.3 (29.6° B.)
Lubricating oils (spindle oils) (120 millimeters pressure, up to 300° C.) per cent.	39.2 (22.6° B.)	28.3 (23.8° B.)
Lubricating oils (120 millimeters pressure, 300°–350° C.) per cent.	19.6 (17.9° B.)	18.3 (18° B.)
Paraffin oils (by destructive distillation under atmospheric pressure) per cent.	22.4 (20.4° B.)	32.4 (20.4° B.)
Coke and loss do.	5.6	8.1
Total sulphur do.	.098	.116

[a] Martin, G. C., The petroleum fields of the Pacific coast of Alaska: U. S. Geol. Survey Bull. 250, p. 59, 1905.

The distillation of the lubricating oils under diminished pressure, corresponding to refinery practice, was carried on until signs of decomposition set in. The resulting residue was unsuitable for making cylinder stock and was therefore distilled for paraffin oils. These paraffin oils contain a considerable quantity of solid paraffin. It was not practicable to determine the amount of the material with the small amount of oil at our disposal.

The iodine absorption of the oils and distillates has been determined by Hanus's method (solution standing 4 hours), and is here tabulated:

	Oil Bay.	Cold Bay.
Burning oil.....per cent of iodine..	17.8	17.2
Lubricating oil.....do....	26.2	27.2
Heavy lubricating oil.....do....	35.8	35.2

These iodine numbers upon the lubricating oils were obtained upon the samples. For comparison, samples of similar oils were obtained from the Standard Oil Co., and the iodine numbers determined as follows:

Light distilled lubricating oil (spindle oil)...per cent of iodine.. 32
Dark lubricating oil (engine oil).....do.... 45.4

The burning oils were tested in a small lamp and found to give a good flame. All the oil was consumed without incrusting the wick or corroding the burner.

The sample of crude oil from Cold Bay was distilled in such a way as to give the maximum yield of burning oil; under these conditions 52.2 per cent of fair quality burning oil was obtained.

The oils are entirely similar; both have paraffin bases, and the products of distillation are "sweet." We are informed that these samples are "seepage oils." If a sufficient yield can be obtained by drilling a very suitable oil for refinery purposes may be expected, containing a very much larger quantity of the more desirable lighter products.

SUMMARY AND CONCLUSIONS.

The Katalla field is a region of closely folded and faulted Tertiary rocks, possibly comparable in its structure to the California fields. Much of the drilling in this field was done without any regard to geologic structure, and but few good logs are available. The presence of oil is indicated by the success achieved, but it will require further drilling to determine the presence or absence of large pools. At Yakataga the structure of the oil-bearing formation appears to be much simpler, and it ought to be possible to test the field without a very large amount of drilling.

In both the Iniskin and Cold Bay fields Middle Jurassic sandstone forms the country rock in the oil-bearing area. The open folding should be favorable to oil pools; on the other hand, some faulting has been observed. There is reason to believe that the oil-bearing formation found in these two fields may have a wider distribution in the Alaska Peninsula. Whether it carries petroleum at other localities has not been determined. On the whole, there is good hope of finding petroleum in the Alaska Peninsula.

As the Alaskan petroleum is a refining oil similar to that of Pennsylvania it should be able to compete with the product from California in spite of the higher cost of operation. The high cost is due in part to conditions of transportation which it is possible to improve The present market for petroleum of the Alaskan grade justifies the systematic prospecting of the more accessible fields of the Territory.

This work will of course not be undertaken until Alaskan oil lands are thrown open to exploitation. Meanwhile large quantities of petroleum and petroleum products are annually shipped to Alaska, as shown by the following table. The total value of the shipments of petroleum and petroleum products to Alaska was $1,277,319 in 1916 and $904,369 in 1915.[1]

Petroleum products shipped to Alaska from other parts of the United States, 1905–1916, in gallons.[a]

Year.	Oil used for fuel, including crude oil, gas oil, residuum, etc.	Gasoline, including all lighter products of distillation.	Illuminating oil.	Lubricating oil.
1905	2,715,974	713,496	627,391	83,319
1906	2,688,940	580,978	568,033	83,992
1907	9,104,300	636,881	510,145	100,145
1908	11,891,375	939,424	566,598	94,542
1909	14,119,102	746,930	531,727	85,687
1910	19,143,091	788,154	620,972	104,512
1911	20,878,843	1,238,865	423,750	100,141
1912	15,523,555	2,736,739	672,176	154,565
1913	15,682,412	1,735,658	661,656	150,918
1914	18,601,384	2,878,723	731,146	191,876
1915	16,910,012	2,413,962	513,075	271,981
1916	23,555,811	2,844,801	732,369	373,046
	170,814,799	18,254,611	7,165,038	1,794,714

[a] Compiled from Monthly Summary of Foreign Commerce of the United States, 1905 to 1916, Bureau of Foreign and Domestic Commerce.

STRUCTURAL MATERIAL, ETC.

One large marble quarry was operated in 1916 at Tokeen, in the Ketchikan district, and a small one in the Wrangell district. Gypsum mining on Chichagof Island, Sitka district, continued on about the same scale as in the previous year. Work was continued on a barite deposit located at Lime Point, on the west side of Prince of Wales Island.[2] The construction of a reduction plant for this mine was begun at Sulzer in 1916. Assessment work was done on a barite deposit in the Wrangell district.[3] No barite was shipped from Alaska in 1916. Development work was continued on two graphite deposits—one belonging to the Uncle Sam Alaska Mining Syndicate and the other to the Alaska Graphite Co.—in the Kigluaik Mountains, 5 to 10 miles south of the Imuruk Basin.[4] Though no graphite was shipped, there was a considerable production. The Alaska-Graphite Co. has built a wharf at tidewater and in 1916 brought in a caterpillar tractor to haul the graphite from the mine. The truck did not arrive in time for use during 1916.

[1] Monthly Summary of Foreign Commerce of the United States, December, 1916, p. 73, 1917.

[2] Chapin, Theodore, Mining developments in southeastern Alaska: U. S. Geol. Survey Bull. 642, p. 104, 1916.

[3] Burchard, E. F., A barite deposit near Wrangell: U. S. Geol. Survey Bull. 592, pp. 109–117, 1914.

[4] Smith, P. S., Investigations of the mineral deposits of Seward Peninsula: U. S. Geol. Survey Bull. 345, p. 250, 1908; Recent developments in southern Seward Peninsula: U. S. Geol. Survey Bull. 379, pp. 300–301, 1909.

REVIEW BY DISTRICTS.

The subjoined review is intended to summarize briefly the principal developments in all the districts. Owing to the failure of some operators to make reports, the information at hand about mining in some of the districts is scant, and some are treated at greater length in other sections of this volume. The space here devoted to any district is therefore not necessarily an indication of its relative importance. The arrangement is geographic, from south to north.

SOUTHEASTERN ALASKA.

Eight gold lode mines, nine copper mines, three placer mines, two marble quarries, and one gypsum mine were operated in southeastern Alaska in 1916. The value of the mineral production from these mines is as follows: Gold, $5,524,940; copper (3,526,700 pounds), $867,570; silver, marble, lead, gypsum, etc., $639,500; total, $7,032,010. In 1915 minerals to the value of $6,090,571 were produced in southeastern Alaska.

As in the past, much the largest mining operations were in the Juneau district. All the productive copper mining of southeastern Alaska was in the Ketchikan district, but there was some prospecting for copper in the Wrangell district. Placer mining in 1916 was limited to the Porcupine district. Mining developments in all these districts are described elsewhere in this report.

The Chichagof gold mine continued to be the only productive property in the Sitka district during 1916. Its workings include two shafts 1,020 and 820 feet deep, a 3,900-foot adit, and 11,650 feet of drifts. Of these workings 5,250 feet was opened in 1916. The 20-stamp mill was operated the entire year; the 10-stamp mill, owing to shortage of water power, only for 236 days.

At the near-by Hurst property two adits, aggregating some 400 feet in length, have been driven. The developments in 1916 consisted in the driving of crosscuts on the lower level. A lode deposit about 17 miles north of the Chichagof mine, near Pinta Cove, was opened by the Juneau Sea Level Copper Mining Co. A specimen of ore received from the owners of this property showed it to be pyrrhotite with chalcopyrite. Besides copper the owners report the ore to carry both nickel and a small amount of cobalt. In 1916 a shaft was sunk on the deposits to a depth of 75 feet and a crosscut driven for 75 feet, which is said to reveal a lode 27 feet wide. This deposit has not been examined by any Survey geologist.

YAKUTAT AND LITUYA BAY REGION.

As in the past, gold beach-placer mining continued in a small way in the Yakataga district during 1916. Beach placers were first found at Lituya Bay in 1886 and were mined for a number of years

by means of rockers. This region is so difficult of access that it has of late attracted but few prospectors, but in 1916 there was some revival of interest in this field. Only a brief statement about this region has been published by the Survey,[1] and as this is in a publication now out of stock it is here reprinted:

Lituya Bay forms a deep indentation in the coast line 50 miles to the northwest of Cross Sound. Although it is an excellent harbor, a bar composed of large boulders and gravel wash almost locks the entrance, and through the boat channel, which is but 100 feet in width, the tide rushes at great velocity, so that it is dangerous to enter except at slack water during calm weather.

The lowlands flanking the abrupt mountain slopes at the head of the bay are composed of Pliocene conglomerate and shale beds carrying narrow seams of coal, the latter of no commercial importance. These strata overlie a belt of slates and greenstones, which in turn overlie the metamorphic schists exposed along the precipitous shore at the head of the bay. The mountain range in the background is composed essentially of an intrusive granodiorite. Indications of mineralization were observed in these schists bordering the granite belt, and from them the placer gold occurring in the beach sands along the coast is supposed to have originated.

The auriferous beach sands are distributed along the Pacific shore to the northwest of the bay for a distance of about 10 miles, and similar occurrences are reported at Yakutat. These auriferous deposits consist of black and ruby sands, occurring in layers from a few inches to a few feet thick and extending in places for 100 yards back from tidewater. The black or magnetite sands are by far the richest, and a pan test gave numerous fine colors ranging from a fraction of a cent to several cents in value.

At a point 4 miles northwest of Lituya Bay a river which flows nearly parallel with the shore for about 3 miles enters the ocean, and here the fine wash which is derived from the mountain streams and carried in suspension is deposited by the counteraction of the surf against the stream current. During periods of high tide and storms these auriferous sands are concentrated by the waves in layers high up on the beach. Since 1890 these deposits have been worked at intervals and are reported to have produced in 1891 $15,000. In later years even higher returns are said to have been obtained, but no authentic statements could be procured.

In 1901 the Lituya Bay Gold Mining Co. built a large warehouse and flumes and installed machinery to conduct large-scale operations, but the limited extent of the pay streaks and lack of near-by water for power and hydraulicking purposes prevented it from furthering the work to a successful outcome. Small parties of miners, however, at different periods have worked these deposits with shovel, sluice box, and rockers to good advantage and report that the auriferous beds yielded from $5 to $10 a day per man. The presence of gold in these sands appears to warrant a thorough prospecting of the mineral-bearing schists which traverse the head of Lituya Bay and parallel the coast line.

It is reported that in 1916 a number of beach miners worked in the Lituya Bay region, and that some gold-bearing gravels have been found in the streams tributary to Lituya Bay. As it also appears to be pretty definitely established that some of the beach sands carry a little platinum, further prospecting is justified.

[1] Wright, F. E. and C. W., Lode mining in southeastern Alaska: U. S. Geol. Survey Bull. 314, pp. 64-65, 1907.

COPPER RIVER REGION.

Mining in the Copper River region during 1916, as in the preceding year, included the development of copper mines in the Kotsina-Chitina copper belt and placer mining in the Nizina and Chitina districts. There was also some prospecting of gold lodes and placers in the Tiekel district and a little placer mining in the Bremner and Nelchina districts. The copper production of this region was much larger than in the previous year. Three mines—the Bonanza-Kennecott, Jumbo-Kennecott, and Mother Lode—were operated on a productive basis throughout the year, but shipments from the Mother Lode were limited to the winter. Considerable development work was done on half a dozen other copper properties, and at several some ore was incidentally mined. Some of this ore will be sledded to the railroad during the winter, but none is directly accessible in the summer. In addition to systematic development assessment work was done on a number of other copper claims. On the whole there was far more mining development in the copper belt than in the preceding year. A specimen of ore carrying nickel, said to be from Spirit Mountain, in the lower Copper River region, was received by the Survey. Details regarding mining in the copper belt and in the auriferous deposits of the Tiekel River region are presented in another part of this volume by F. H. Moffit.

About 30 placer mines were operated in the Copper River basin in 1916, employing 180 men, and these produced gold to the value of $290,000. Seven hydraulic plants were operated in the Nizina district, of which one, at the mouth of Rex Creek, was installed during 1916. As in the past, the largest mining operations were on Chititu Creek and its tributaries and on Rex Creek. In the Chistochina district two hydraulic placer mines were operated. Each of these was equipped with three giants, one being used to remove tailings. One of these plants, on the West Fork of the Chistochina, was built in 1916. It is supplied with water brought through 4,000 feet of ditch and flumes. Drilling was done for testing dredging ground on a group of claims on Jackpot Creek, at the head of the Chistochina. The largest operations in the Chistochina district were on Slate Creek, on the West Fork of the Chistochina. The discovery of platinum in the Slate Creek placers is mentioned on page 22.

Some prospecting was done during 1916 on copper deposits on Rainy Creek, a tributary to the upper Delta River. This deposit actually lies within the Yukon basin, but as it is most accessible from the Copper River side of the divide, it is proper to refer to it under this heading. The deposits are reported to be extensive but to carry only small amounts of copper with a little gold. One specimen obtained from A. H. McNeer showed the rock to be a mineralized

diorite carrying several sulphides, including chalcopyrite and possibly pyrrhotite. Another specimen from the same source proved to be a metamorphic rock, possibly an altered limestone made up of epidote, garnet, chlorite, and disseminated sulphides. To judge from these two specimens the ore seems to be of contact-metamorphic origin.

PRINCE WILLIAM SOUND.

The value of the total mineral production of Prince William Sound in 1916 was $2,975,263, compared with $1,340,996 in 1915. Eight copper mines and ten gold mines and prospects, large and small, were operated during the year. As in the past, the tonnage of gold ore mined was very small compared with that of copper ore. The Beatson-Bonanza, Ellamar, and Midas mines were the largest copper producers, and the Granite and Ramsay-Rutherford mines the largest lode-gold producers. There was a revival of interest during the year in the auriferous lodes of the McKinley Lake district, which is not far from the railroad and about 20 miles from Cordova. Plans were made for systematic prospecting in this field. Details regarding mining on Prince William Sound are presented in another chapter of this volume.

KENAI PENINSULA.

The improvements made during 1916 on the old Alaska Northern Railroad, now in Government ownership, have stimulated prospecting in Kenai Peninsula. This railroad, leading inland from the town of Seward, traverses the northeastern part of the peninsula, and when connection is made with the railroad at Anchorage will be part of the through line from the Pacific seaboard to Fairbanks. Wagon roads and trails connect the railroad with the principal localities of gold mining on Kenai Peninsula.

Though work was done on a number of large placer-mining projects during 1916, there was no increase in placer production as compared with the previous year. Gold-lode mining was limited to development work on a number of properties besides those on which only the required assessment work was done. Incidental to this development some ore was recovered and treated in several small mills and arrastres.

Returns from the placer mines of Kenai Peninsula are not complete at this writing. The best information available indicates that the placer-gold output in 1916 had a value of about $70,000, or the same as that of 1915. This was produced chiefly from about 15 mines, employing about 100 men. The largest operations were on Crow and Resurrection creeks. Of the total number of mines, six were operated by hydraulic methods. Considerable work preparatory to hydraulic operations was done on claims on Canyon, Lynx,

and Bear creeks. Seven lode properties on Kenai Peninsula produced about 700 tons of ore, which yielded gold to the value of about $17,000. The property of the Kenai Alaska Gold Co. was leased and operated for a part of the season. A lease was taken on the Primrose mine, some developments made, and a little ore treated in a small mill installed during 1916. The Lucky Strike mine was operated on a small scale from June to October. Work was continued on an adit, which was driven to a length of 150 feet. The ore was treated in a 1-stamp prospecting mill. Some work was done at the Grant Lake mine, and the ore was treated in an arrastre. Arrastres were also used in treating ore from the Whistler and Gilpatrick properties. Considerable work was done on the James and Ronan claims, in the Moose Pass district, and the ore was treated in an arrastre. Some preliminary work was also done at the old Skeen-Lechner mine, with a view to making it productive. It is reported that an auriferous quartz lode has been discovered near Tustumena Lake and developed by a 100-foot adit. It is also reported that a promising ledge located on Palmer Creek has been developed by an open cut. The ore is said to carry free gold, sulphides, and considerable galena.

COOK INLET.

In 1916 productive mining on Cook Inlet was practically confined to the Bluff Point coal mine, on the west side of Kenai Peninsula, to which reference is made on page 25, and to the development of the placers on Lewis River, incidentally to which a little gold was produced.

It has long been known that auriferous gravels occur on some of the streams tributary from the northwest to the upper part of Cook Inlet. In 1902 an unsuccessful attempt was made to mine the gravels on Beluga River by hydraulic methods. The project was badly managed, and its failure may have been due to this fact. In 1909 some drilling for dredging ground was done on Beluga River, the results of which are not known, but no dredge was installed. Several years ago some excitement was caused by the discovery of placer gold on either Lewis or Theodore River. The excitement soon died out, but prospecting continued in this region.

The geology, so far as known, is simple.[1] The group of highlands which lies west of the lower Susitna River, and of which Mount Susitna is the highest peak, are made up chiefly or entirely of granodiorite. It is in this highland area that the gold-bearing streams rise. In this general province the margins of the granodiorite masses are favorable localities for the occurrence of mineralization. A belt of Tertiary sediments made up of conglomerates, sandstones, and shales trends northeast from Tyonek. This passes under gravels

[1] Brooks, A. H. The Mount McKinley region: U. S. Geol. Survey Prof. Paper 70, pp. 95, 143, pl. 9, 1911.

but has been recognized on Beluga River. The reports of prospectors indicate that the same formation stretches underneath the gravel sheet northeast of the Beluga and occurs on the flanks of the Susitna highland. These are probably the rocks which the prospectors describe as "cement gravels." Some gold of the placers of the Yentna district has been found resting on similar rocks.

Back of Tyonek and near Beluga River the Tertiary rocks are for the most part deeply buried in terrace gravels. The margin of this gravel sheet is marked by a scarp which skirts the shores of Cook Inlet from Tyonek to Beluga River, then trends inland. This scarp has not been traced very far beyond Beluga River, but probably crosses Theodore River about 10 miles from the coast. The upper gravels of Lewis River, referred to below, are probably an easterly extension of the same formation.

The following notes on Lewis River are based largely on information furnished by Mr. Samuel E. Wagner. In 1916 the mining developments were, so far as known, all on Lewis River, which flows into Cook Inlet a few miles west of the Susitna River delta.[1] Lewis River is reported to be about 25 miles in length and to include auriferous gravels along about 5 miles of its course. The mouth of the river can easily be reached by launch from Anchorage, only 40 miles distant. Good timber is abundant in this region.

Lewis River is described as heading in a broad, flat basin about 2 miles wide. Here the country rock is reported to be granite. Below this basin the walls converge and mark a well-defined valley which continues for 4 or 5 miles downstream to the point where the river debouches on an alluvial coastal plain, 10 miles from Cook Inlet. The developed claims lie chiefly in the constricted portion of the valley, and here the river is said to have sufficient grade for placer mining.

In 1916 some drilling for placer ground was done near the edge of the flats where Lewis River reaches the plain. Here 36 holes are reported to have been sunk and bedrock to have been reached at a depth of 12 to 22 feet. The character of the bedrock was not learned. For about 2 miles above the flats this bedrock of the river is said to be "cement gravel," which is probably a Tertiary gravel. In this stretch of the river the gravels are said to range in thickness from more than 15 feet near the flats to about 3 feet 2 miles above. On the Daisy and Bessie claims a small hydraulic plant was installed in 1916, water being provided by a ditch about 1,500 feet long. The gold here mined is coarse and rough, one $3 nugget having been found. Above the belt of conglomerate the valley walls are made up of granite, but bedrock has not

[1] It is not certain that the river marked as Lewis on official maps is the one so named by the prospectors. It may be that the "Lewis River" of the prospectors is the one called "Theodore River" on the maps. See Topographic reconnaissance map of Kenai Peninsula: U. S. Geol. Survey Bull. 587, pl. 2, 1915.

been reached by mining operations. On the Granite claim, in this granite belt, an open cut was made to a depth of 18 feet but did not reach bedrock. The upper part of the alluvium is coarse gravel, and below is finer material in which good prospects are said to have been found. The gold is fine but angular, and the large pieces have quartz attached to them. The owner of the claims believes that there is a deep channel here and is directing development work toward its discovery. The same general conditions are believed to hold in the remainder of the gold-bearing zone, which has been traced only to the upper basin already mentioned.

Development work was done in 1916 on about eight placer mines on Lewis River, besides the drilling on the flats. About 30 men were engaged in this work. Most of the development has not gone beyond the prospecting stage, but over $2,000 worth of gold was won incidentally to these operations. The gold is reported to have a value of $18.66 an ounce.

ANCHORAGE-MATANUSKA REGION.

The only productive mines in the Matanuska region during 1916 were the two small coal mines referred to on page 25. A low-grade deposit of chalcopyrite ore has been found on Moose Creek, about 8 or 9 miles from Matanuska, and similar deposits are said to have been found on King River. It has long been known that there was some mineralization along the margin of the granodiorite mass of the Talkeetna Mountains. It would therefore not be surprising if metalliferous lodes were found in this region. This mineralized area has a similar geologic position to that of the lodes of the Willow Creek district. In the Willow Creek area, however, the chief metal of the ores is gold, while in the Talkeetna area it is copper. There is an unconfirmed report of the finding of some tin ore in the basin of Eklutna River, tributary to the upper part of Knik Arm.

WILLOW CREEK DISTRICT.

There was much activity in the Willow Creek lode district during 1916. Developments there were stimulated both by the success achieved in several mining ventures and by the fact that railway construction in 1917 will make the district readily accessible from the town of Anchorage.

Though much more development work was done than in the preceding year, most of the mines had not reached a productive basis. Four lode mines were operated in 1916 and milled 12,180 tons of ore, yielding $299,183 worth of gold and $966 worth of silver. About 150 men were employed in these mines. A little gold was also recovered in 1916 from placers of Willow Creek incidentally to the annual assess-

ment work. In 1915 three lode mines were operated in the Willow Creek district and produced 6,717 tons of ore from which gold was recovered to the value of $247,267.

The Alaska Free Gold mine was operated from May to October. It is reported that ore was found on the Tomboy lode 100 feet below the old workings. The property is equipped with two Chilean mills, two crushers, and a cyanide plant. Water power is used, supplemented by a gasoline engine.

The Independence mine was operated from May to September. Underground development during the year consisted principally in the driving of a 300-foot adit designed to crosscut the ore body in depth and a new tram built to connect the lower level with the mill. The equipment consists of a Chilean mill, a crusher, and concentrating tables.

The Gold Bullion mine, equipped with a 12-stamp mill, concentrating tables, and cyanide plant, was operated from June to October. About 1,500 feet of underground work was done during 1915. This consisted chiefly of adits, crosscuts, and raises located for the purpose of blocking out ore.

An adit was driven on the Mabel mine for a distance of 150 feet, and some ore was treated in a small Chilean mill installed on the property in 1915. It is reported that a molybdenite-bearing vein was discovered near the Mabel claim in 1916.

The Talkeetna Mining Co., successor to the Matanuska Mining Co., in 1916 drove four adits on its property, aggregating about 140 feet in length, besides tracing the lode by open cuts. Preparations were made for installing a Chilean mill in 1917. In addition to that recorded above considerable prospecting and development work, the details of which are lacking at this writing, was done in the Willow Creek district.

YENTNA DISTRICT.

The most important event of the year's mining in the Yentna placer district was the installation of a dredge on Cache Creek. The material for this dredge was brought up Susitna and Yentna rivers to McDougal in the fall of 1915 and then sledded to Cache Creek during the following winter. The dredge [1] was operated from July 9 to October 1. It is equipped with 65 close-connected buckets, each having a capacity of 7 cubic feet, and, as thus equipped, can dig 30 feet below the water line. The dredge has a daily capacity of 3,000 cubic yards, but in view of the shallowness of the ground, the average depth being only 6 feet, it is expected by the management that an average of only 2,000 cubic yards will be attained. The dredge is equipped with a 250-horsepower tubular boiler. A peculiar

[1] Smith, Sumner, The Cache Creek dredge: Min. and Sci. Press, vol. 113, pp. 908-909, 1916.

feature of the dredge is that fuel is provided from a lignitic coal bed near by. This is the only dredge in Alaska which utilizes local coal. Some boulders have been encountered in the gravels but have not seriously interfered with mining operations. Two companies were engaged in drilling dredging ground on Kahiltna River. The discovery of platinum in the Kahiltna is mentioned on page 23.

Owing to a shortage of water in the early part of the season placer mining was not as extensive as in some previous years. Complete returns are not yet available, but it is estimated that about 20 mines were operated for at least part of the summer and that these employed about 85 men and recovered gold to the value of about $60,000. The operated mines were pretty well scattered over the entire district and included a number of small hydraulic plants. A hydraulic plant was installed on lower Nugget Creek in 1916. Claims on both Peters and Spencer creeks were prospected during the summer with a view to installing hydraulic plants.

UPPER SUSITNA BASIN.

About 30 men were engaged in prospecting in the Broad Pass region. Discoveries of large bodies of low-grade ores have been reported, but these reports have not been verified through field examination by Survey geologists. The ores are said to include gold, silver, lead, and copper. It is also reported that gold and copper bearing veins have been discovered in the Talkeetna River basin near the Sheep Creek basin. One large hydraulic plant was operated on Valdez Creek, and a smaller one on its tributary Lucky Gulch. There was also some systematic prospecting on White Creek, a tributary of Valdez Creek.

SOUTHWESTERN ALASKA.

Some developments were continued on the copper deposits of the Iliamna region, notably on the McNeil claims, near Kamishak Bay from which a test shipment of ore was made, but as yet there are no producing mines in this field. A small cyaniding plant has been installed and operated to handle the old tailings of the Apollo mine on Unga Island.

It is reported that auriferous quartz was discovered in 1916 on the south side of Unga Island about 3 miles from the old Apollo mine. The ledges are said to be very wide and to carry gold. Specimens from one of these ledges, received through the courtesy of Mr. James R. Hayden, indicate that it is made up of sheared volcanic rock, which has been mineralized. The information at hand therefore indicates that the deposit is a shear zone in the andesite lavas that form the country rock of this part of Unga Island.[1] Silicification

[1] Atwood, W. W., Geology and mineral resources of parts of the Alaska Peninsula: U. S. Geol. Survey Bull. 467, pl. 8, 1911.

and some mineralization have apparently taken place along such a shear zone or system of shear zones. This occurrence is not unlike that of the Apollo mine, which has been described as a "reticulated vein or zone of fracture in a country rock of andesite or dacite." [1] At the Apollo mine, however, there is a well-defined ore shoot of high tenor. The Apollo ore, moreover, carries much galena, whereas galena is reported not to occur in the newly discovered lodes. The current reports indicate that at least three different parallel lodes have been found at this locality.

Some auriferous gravels were found in 1916 on the east side of Alaska Peninsula, between Cold and Katmai bays. It appears that the placers were found on only one creek, and the output was only a few hundred dollars. The discovery, so far as known, is of importance only in marking a new locality where auriferous mineralization has taken place. Beach placer mining was continued on Kodiak and Popof islands.

YUKON BASIN.

GENERAL FEATURES.

The value of the placer-gold output of the Alaska Yukon districts in 1916 is estimated to have been $7,550,000, compared with $7,050,000 in 1915. About 390 placer mines were operated in the summer of 1916, giving employment to about 2,560 men, and about 150 placer mines were operated in the winter, employing about 680 men. Several small lode mines were productive in the Yukon basin in 1916, all in the Fairbanks district. The following table gives the estimated gold output of the principal Yukon placer camps:

Estimated value of gold production from placers of Yukon basin, 1916.

Iditarod	$1,950,000	Marshall	$320,000
Fairbanks	1,800,000	Circle	300,000
Ruby	850,000	All others	510,000
Hot Springs	800,000		
Tolovana	700,000		7,550,000
Koyukuk	320,000		

The Yukon placer mines also produced $29,189 worth of silver in 1916. The above figures do not include the output of the lode mines, which in 1916 produced gold and silver to the value of $39,478. There was also a small output of tin from the Hot Springs district, and considerable tungsten and antimony ore was shipped from the Fairbanks district. (See pp. 20–21.) The total value of the entire mineral production from the Alaska Yukon in 1916 was $7,839,757; that of 1915 was $7,423,352. Since mining began in 1880 the Alaska Yukon has produced minerals to the value of $104,050,000, most of which has been derived from the gold placers.

[1] Idem, p. 126.

FAIRBANKS DISTRICT.

Placer-gold mining began in the Fairbanks district in 1903. The first productive auriferous lode mining was in 1910. Antimony was mined in 1915 and 1916 and tungsten mining began in 1916. Some silver has been won, incidentally to gold mining, and in 1916 a little silver-bearing galena ore was produced. The total value of the entire mineral output up to the close of 1916 is $68,993,000. Much the larger part of this amount represents the value of the placer gold produced, which is shown by years in the subjoined table. In addition to the actual production of the district, about $1,000,000 worth of gold mined in tributary areas annually passes through Fairbanks.

Placer gold and silver produced in the Fairbanks district, 1903–1916.

Year.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.
1903	1,935.00	$40,000	348	$188
1904	29,025.00	600,000	5,225	2,821
1905	290,250.00	6,000,000	52,245	28,212
1906	435,375.00	9,000,000	78,367	42,318
1907	387,000.00	8,000,000	69,660	37,616
1908	445,050.00	9,200,000	79,909	43,151
1909	466,818.75	9,650,000	84,027	45,375
1910	295,087.50	6,100,000	53,116	28,683
1911	217,687.50	4,500,000	52,245	27,690
1912	200,756.25	4,150,000	48,182	29,632
1913	159,637.50	3,300,000	20,274	12,245
1914	120,937.50	2,500,000	29,024	16,050
1915	118,518.75	2,450,000	28,444	14,421
1916	87,075.00	1,800,000	11,058	7,276
	3,255,153.75	67,290,000	612,124	335,678

The data relating to the source of the gold by creeks are not very accurate. An attempt has been made in the following table, however, to distribute the total placer-gold production of the Fairbanks district by the creeks on which the mines are located:

Approximate distribution of gold produced in Fairbanks district, 1903–1916.

Cleary Creek and tributaries	$22,620,000
Goldstream Creek and tributaries	13,500,000
Ester Creek and tributaries	10,960,000
Dome Creek and tributaries	7,770,000
Fairbanks Creek and tributaries	7,250,000
Vault Creek and tributaries	2,570,000
Little Eldorado Creek	1,980,000
All other creeks	640,000
	67,290,000

Both gold placer and lode production are on the decline in the Fairbanks district. Now that railroad connection with tidewater is assured, mine owners have generally adopted the policy of waiting until mining costs are reduced before embarking in any large enter-

prises. Besides lowering freight rates the railroad will bring in the Nenana lignitic coal and thus afford a cheap fuel, which is all-important in the mining industry because the price of wood is now almost prohibitive to any operations except the mining of rich placers. Though some discoveries of rich gravels are made year by year, the days of bonanza mining in the district will soon be almost a thing of the past.

Some work was done in 1916 preparatory to larger mining enterprises, but there are as yet but few of these projects, and these will take considerable time to reach a productive basis. Therefore the immediate outlook is for a further decline in gold production. This decline, however, will be only temporary, for there are in the district large reserves of auriferous gravels that can be profitably mined by the use of proper equipment.

There are few data for determining the placer-gold reserves of the Fairbanks district. Prindle and Katz [1] in 1908 made a rough estimate of the placer-gold reserves. They considered that of the then known creek gravels deposits aggregating about 75 miles were gold placers that could be profitably exploited. A moderate estimate indicates that these placers contained gold to the value of about $100,000,000. As about $67,000,000 worth of gold has been mined up to the present time, this would now leave only about $33,000,000 in the placers. Though some allowance was made in this estimate for placers that could not be mined under conditions existing in 1908, there was no attempt to determine the ultimate recovery of gold from the placers of the Fairbanks district. In 1908 the average recovery of gold per cubic yard in the Fairbanks district was $5.53. At that time much the larger part of the mining was done by underground methods, the most expensive form of mining. In 1914 the average gold recovery per cubic yard in the district was $3.31; [2] in 1916 it was about $3. This reduction in recovery shows that methods have been developed to work at a profit placers which in 1908 had no commercial value. Cheaper fuel will permit still further reductions in operating costs. More important, however, to the future of the district will be the introduction of mining plants, notably power excavators of some kind and probably dredges. The possibilities of this form of mining are illustrated by the history of placer mining in Seward Peninsula. There the average gold recovery per cubic yard for the nine years of mining ending with 1906 was about $5.95 a cubic yard.[3] Since then the use of dredges has reduced the average recovery to about 53 cents a cubic yard (1916).

[1] Prindle, L. M., and Katz, F. J., Geology of the Fairbanks district: U. S. Geol. Survey Bull. 525, pp. 114-115, 1913.

[2] Brooks, A. H., The future of gold-placer mining in Alaska: U. S. Geol. Survey Bull. 622, p. 75, 1915.

[3] Brooks, A. H., The gold placers of parts of Seward Peninsula, Alaska: U. S. Geol. Survey Bull. 328, p. 136, 1908.

It is not intended to imply that placer mining at Fairbanks, where much of the placer ground is deep and where nearly all the gravels are permanently frozen, can be done at as low a cost as in Seward Peninsula. But if placers carrying only $1 a cubic yard can be profitably mined the gold reserves of the Fairbanks district have a value of probably several times the $33,000,000 which has been cited above as the value of the gold content of the gravels that can be mined under present conditions. Therefore, though the prospect of immediately increasing the Fairbanks production of placer gold is not very encouraging, yet there can be no question that the district will in time again increase its output and that mining will continue for many years after the exhaustion of the rich deposits now being worked. There is no reason for pessimism in regard to the placer-mining industry of the Fairbanks district, yet it is high time that systematic prospecting of the extensive deposits of low-grade auriferous gravels was undertaken.

It is even more difficult to forecast the future of the gold-lode mining industry of the Fairbanks district. Auriferous mineralization has occurred over a considerable area. A number of small rich gold veins have been worked at a profit. A much larger number of lodes have been found on which comparatively little development work has been done, and some of them are certainly worthy of careful prospecting. There is no reason to believe that any greater irregularity in distribution of value will be found at greater depths than has already been found below the zone of oxidation, which in most places in the district is not many feet deep. There are some larger zones of mineralization which may prove to be workable at a profit if developed on an extensive scale. This can only be determined by a more systematic prospecting than has yet been undertaken. These facts indicate that under the improved industrial conditions which will be brought about by the construction of the railroad a gold-lode mining industry will be developed.

During the last two years considerable antimony (stibnite) and tungsten (scheelite) ore has been mined and shipped. This has been possible because of the great demand for and value of these minerals caused by the present industrial conditions. It remains to be determined whether these ores can compete with others in the market under normal conditions. It is possible that if large deposits are opened under the present stimulus profitable mining might be continued under a normal market after railroad communication becomes available.

Mining operations in the Fairbanks district during 1916 included placer mining on a large scale and a little gold-lode mining, besides the production of considerable antimony ore (stibnite), tungsten ore (scheelite), and a little galena. The value of the total mineral output

from the district, including the silver won incidentally to gold mining in 1916, is about $2,040,800. An important event of the year was the decision of the Bureau of Mines to establish a mine experiment station at Fairbanks.

It is estimated that 115 placer mines were operated in the Fairbanks district during 1916. About 50 were working during the winter. About 650 men were employed in the summer and 250 in the winter. The best information available indicates that in all 600,000 cubic yards of gravel was sluiced. The largest single operation was that of the dredge on Fairbanks Creek, the only one operating in the district. The producing creeks, arranged in order of size of total production of their mines are Goldstream and its tributaries, including Pedro and Gilmore, Cleary and tributaries, Fairbanks and tributaries, Ester and Gold Hill, Dome, Eldorado, and Vault. About 80 deep mines were operated during the year, of which 25 were on Cleary Creek and Chatanika Flats. The large open-cut mines were for the most part equipped with steam scrapers, a method of mining which has proved very economical. There was a relative increase in the number of small plants compared with previous years. A few years ago deep mines that employed 30 to 50 men were not uncommon, and the average number was about 10. In 1916 but few deep mines employed more than 20 men, and the average number was less than 6. An average of 7 men were employed in open-cut mines during 1916.

There was but little gold-lode mining in the Fairbanks district during 1916. Probably the most significant event was the beginning of systematic large-scale prospecting of some lodes in the Eva Creek region. Seven lode mines made a small production; 1,111 short tons of ore was hoisted, and the value of the gold recovered was $39,376. Details regarding lode mining are presented by Mr. Mertie in another chapter of this report. The following table sets forth the Fairbanks lode production by years since this form of mining first began:

Lode gold and silver produced in the Fairbanks district, 1910–1916.

Year.	Crude ore (tons).	Gold.		Silver.	
		Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.
1910	148	841.19	$17,339	106	$57
1911	875	3,103.02	64,145	582	308
1912	4,708	9,416.54	194,657	1,578	971
1913	12,237	16,904.98	340,457	4,124	2,491
1914	6,526	10,904.75	225,421	2,209	1,222
1915	5,845	10,534.91	217,776	1,796	910
1916	1,111	1,904.81	39,376	140	92
	31,450	53,610.20	1,108,221	10,535	6,051

Scheelite, a tungsten ore, was first found at Fairbanks in the fall of 1915 near the head of Gilmore Creek. Development work was at once started, and some shipments of ore were made by parcel post during the winter of 1915–16. Meanwhile, other occurrences of scheelite had been found, and in the summer of 1916 an output from three different mines was obtained and some development work done on others. A part of the ore was shipped to Tacoma for concentration, but most of it was concentrated in one of the local mills. The total production, calculated in concentrates with a content of 60 per cent tungsten or better, is estimated to be 38,780 pounds. It is difficult to place a value on this product, but it seems that the producer received about $63,000 for the entire output.

The decline in the price of antimony during the spring and summer of 1916 led to the closing of most of the antimony mines in the Fairbanks district and discouraged further prospecting for such ore. Five mines were closed by August. One mine however, continued to operate during the summer. The production of antimony for the Fairbanks district is estimated to be 1,390 tons, and the tenor of the ore ranges from 55 to 65 per cent of antimony. For this the producer is estimated to have received about $130,000. Details regarding tungsten and antimony mining are presented by Mr. Mertie elsewhere in this report.

CHISANA DISTRICT.

A shortage of water in the Chisana district during the summer of 1916 hampered the sluicing, and hence the output of gold had a value of only $40,000, compared with $160,000 for the output of 1915. Twelve mines were operated during the summer of 1916, and two during the preceding winter, employing in summer about 40 men. The entire number of men engaged in both prospecting and mining was about 75. Eight of the producing mines are on Bonanza Creek; the others are on Big Eldorado, Little Eldorado, and Gold Run creeks. A hydraulic plant was installed on Bonanza Creek but was unable to operate on account of lack of water. The two deep mines worked in the winter are located on Skookum Gulch and Gold Run. The development of the district is much hampered by the fact that no trail has been built from McCarty, on the Copper River Railroad, the route usually followed by the miners.

FORTYMILE AND EAGLE DISTRICTS.

Mining operations in both the Fortymile and Eagle districts are chiefly on a small scale. This is shown by the fact that about 50 different mines were operated in this field during 1916, which produced gold to the value of about $75,000 and employed 115 men. During the winter about 15 deep mines were worked in the Fortymile

district and one on Barney Creek, in the Eagle district. Probably the most important event of the year was the finding of gold placers in the bench deposits of Fortymile River near the mouth of Steel Creek.

In the Eagle district a small hydraulic plant was installed on Alder Creek and preparations were made for similar installations on Crooked and Fourth of July creeks. Some systematic prospecting was also done by crosscutting on Seventymile River near Fox Creek and also between the falls and Barney Creek.

TOLOVANA DISTRICT.

The value of the gold produced in 1916 from the Tolovana district was about $700,000; the output in 1915 was worth $80,000. Most of this gold came from the deep placers on Livengood Creek, where about 15 mines were operated during the winter and 21 during the summer. One deep mine was operated on Myrtle Creek during the summer. About eight open-cut mines were operated on Olive, Ruth, Lillian, and Gertrude creeks. About 125 men were employed in mining during the winter and 360 during the summer. It is estimated that 130,000 cubic yards of gravel was sluiced during 1916. There was a little mining and more prospecting in the Tatalina region, also in the Tolovana district. Preparations were made for drilling some placers in this part of the district with a view of installing a dredge. A more detailed description of the Tolovana district, by Mr. Mertie, will be found in another part of this report.

CIRCLE PRECINCT.

The Circle precinct includes the Birch Creek district and the placers of Woodchopper, Beaver, and other creeks. About 27 small deep mines were worked in the winter, employing 60 men, and 40 during the summer, employing 150 men. These mines produced gold to the value of about $300,000. In 1915 about 50 mines were worked, employing 200 men and producing about $230,000. These figures show the general tendency toward operations on a larger scale. A shipment of wolframite, obtained from the placers of Deadwood creek, was made in 1916.

The largest single plant was the dredge on Mammoth Creek, which was operated for 96 days. Hydraulic plants were operated on Mastodon, Eagle, and Switch creeks throughout the open season. A new hydraulic plant was installed on Butte Creek but was operated only a short time on account of scarcity of water. Preparations were made for installing a hydraulic plant on Independence Creek. The largest number of operations were on Deadwood Creek, but these were chiefly on a small scale. Many of these mines were worked in the winter. Some prospecting was done on the lower part of Boulder Creek, a tributary of Crooked Creek. Here some good prospects are reported to have been found in the benches.

RAMPART DISTRICT.

During 1916 four mines were worked in the Rampart district in the winter, employing about 12 men, and eight in the summer, employing about 28 men. The value of the total gold output was about $40,000. This includes the production of Quail Creek, formerly in the Rampart district but now in the Tolovana district. Preparations were made for the installation of a hydraulic plant on Hunter Creek. The largest gold production came from Little Minook and Hunter creeks.

HOT SPRINGS DISTRICT.

The Hot Springs placer mines are estimated to have produced gold to the value of $800,000 in 1916 and $610,000 in 1915. Most of the mines were operated on a large scale, the total number operated being 16, and these employed 320 men. There was no productive work during the winter, but about 30 men were engaged in prospecting and development work. Much the largest operations were on Woodchopper Creek, where three plants were working during the summer. The placer here occupies a deep channel between 150 and 200 feet below the surface. The mines of the Eureka Creek region, which included two hydraulic plants, were the second largest producers. Here five mines were operated, employing some 30 men. Two mines, employing about 40 men, were operated in the Sullivan Creek region. On American Creek three mines were operated, employing 25 men. Some mining was also done on Cache and Idaho creeks. New discoveries of placer ground were made on Big and Little Boulder creeks, tributary to Fish Lake. This ground is said to be shallow, and though the gold content is not high, the owners believe that it can be profitably mined by hydraulic means. Considerable placer tin was recovered incidentally to gold mining.

RUBY DISTRICT.

The value of the gold produced in the Ruby district in 1916 is estimated to be $850,000. A small shipment of tin was made from the gold-bearing gravels of Midnight Creek, which are said to carry also some tungsten. Forty mines, employing about 325 men, were operated during the summer and about a dozen, employing about 40 men, during the previous winter. Most of the mining was of deep gravels by underground methods. The completion of a dredge on Greenstone Creek was the most important event of the year. It started operating late in July. As in 1915, the deep mines yielding the largest output were those on Long, Flat, and Poorman creeks and their tributaries. Four plants were operated on Spruce Creek, which is now an important producer of placer gold. Mining was also started in a small way on Fourth of July Creek.

In addition to those mentioned above there are also productive mines on Midnight, Birch, Elk, Swift, Tamarack, Timber, and Tenderfoot creeks and Bearpup Gulch. Gold was discovered in 1916 on the benches of Poorman Creek. A new type of prospecting drill mounted on a caterpillar tractor base was taken to Long in September for prospecting on Long and Basin creeks. Considerable work was done on the wagon road leading from Ruby to Long.

INNOKO DISTRICT.

It is estimated that the mines of the Innoko district produced gold to the value of $220,000 in 1916, compared with $190,000 for the output of 1915. About 35 mines were worked in the summer, employing about 140 men, and 15 in the winter, employing 30 men. The mines of Yankee Creek had the largest output and those of Gaines Creek second. The output of the mines on Little, Spruce, and Ophir creeks was about the same. Two steam scrapers were worked on Gaines Creek, two on Spruce Creek, and one on Ophir Creek. Prospecting was done on Yankee Creek for dredging ground. A new deposit of placer gold was found on a bench of Gaines Creek near the mouth of Little Creek. Fifteen small deep mines were operated on Little and Ophir creeks during the winter. The value of the total winter production was about $40,000.

In March, 1916, gold was discovered about 30 miles from Ophir on Boob Creek, a tributary of Mastodon Creek, which flows into Tolstoi Creek. The gravels are reported to be a few feet thick and covered with about 30 feet of overburden. Near-by shafts show 70 feet of overburden and a much greater thickness of gravel. This discovery created enough excitement to bring several hundred people to the camp. Most of these soon left without any systematic prospecting. Only one small plant is known to have been operated on a productive basis. The geology, so far as known, is favorable to the occurrence of placer ground, and it is not improbable that workable deposits may be found. A little platinum occurs in the Boob Creek placers. (See pp. 23–24.) The settlement of Tolstoi or Cooper has been established at the mouth of Mastodon Creek. At high water small launches can be run up Tolstoi Creek to this settlement, but at low water cargoes are discharged on Dishkakat River, about 2 miles from Cooper.

IDITAROD DISTRICT.

Mining in the Iditarod district in 1916 consisted chiefly, as in the past, in a few large operations. Fifteen placer mines were operated during the summer, but practically no mining was done in the winter. These employed about 400 men and produced gold to the value of $1,950,000; in the preceding year 24 mines were operated and the value of the gold output was $2,050,000. These plants included

three dredges, one drag-line excavator, four scrapers, and seven open-cut mines, operated chiefly by hydraulic methods. It is estimated that 1,580,000 cubic yards of gravel was excavated. This enormous yardage is due to the extensive dredging operations of the Yukon Gold Co. on Flat Creek and of Riley & Marston on Otter Creek. A new dredge was installed at the mouth of Black Creek near the end of the mining season. This dredge is of the flume type, has a 60 by 30 foot hull and is equipped with two 60-horsepower semi-Diesel engines. The bucket line is of the closed-link type and the buckets have a capacity of 2½ cubic feet. The Riley & Marston dredge was refitted with two 60-horsepower engines of the semi-Diesel type. As in the past the larger open-cut operations were on the heads of Flat, Happy, and Chicken creeks and near Discovery claim on Otter Creek.

KOYUKUK DISTRICT.

The Koyukuk district, including the placers of Indian River, is estimated to have produced gold to the value of $320,000 in 1916 and $290,000 in 1915. Fourteen mines were operated in the district during the winter, employing about 90 men, and produced gold to the value of about $240,000. A large part of this gold was taken out of a few rich claims on Hammond River and Nolan Creek. During the summer 29 mines were operated, of which 8 were in the Indian River region, employing 80 men. Aside from the output of Hammond River and Nolan Creek the larger part of the production came from Jay, Gold, Myrtle, and Porcupine creeks. Productive mining was also done on Vermont, Birch, California, Minnie, Smith, Emma, and other creeks. Good prospects are reported to have been found on the high bench claims of Nolan Creek. Some new placers were opened on Rye Creek, a tributary of Flat Creek, which flows into Wild River, but their value is still undetermined. There was considerable prospecting on the South Fork, where preparations were made for drilling.

MARSHALL DISTRICT.

In 1916 some rich placers were developed on Willow Creek, in the Marshall district, and as a consequence the value of the gold output rose from $25,000 in 1915 to $320,000 in 1916. This output came from seven mines, which employed about 100 men. Details regarding the mineral resources of the Marshall district are given in another section of this report.

SMALLER YUKON DISTRICTS.

About 10 men were engaged in mining in the Chandalar district on three claims and produced about $9,000. Some new placers are said to have been discovered on Squaw Creek. Developments were

continued at the lode mines, but the mill was not operated. There was a little mining in the Hosiana River region, but no discoveries of importance have been made.

The Richardson district, of the Tanana region, in 1916 produced gold to the value of about $80,000. Much of this came from Tenderfoot Creek, where seven mines were operated. There was also some mining on Banner and Buckeye creeks, and a little prospecting on Kenyon Creek, tributary to Healy River. A new locality of auriferous gravels is reported on Michigan and Granite creeks, both of which flow into the South Fork of Goodpaster River. Considerable prospecting was done on these creeks in 1916. The gravel on these creeks is said to be from 12 to 25 feet thick and the gold to be very coarse. One nugget valued at $9 has been found on Michigan Creek.

There were no large mining operations in either the Bonnifield or the Kantishna districts during 1916. About 60 men were engaged in placer mining in the two districts, and some production was made from 29 claims. The value of the total output is estimated to have been about $40,000. There was also some lode development in both districts. Details regarding the mineral resources of these two districts are given elsewhere in this volume.

KUSKOKWIM REGION.

The inadequate mail facilities make it very difficult to obtain statistics from the Kuskokwim region. From such data as are at hand it appears that the value of the gold output in 1916 was about $80,000. This came from as widely separated localities as Candle Creek, tributary to the Takotna, and the Goodnews Bay district. This gold was produced from about 25 mines, employing about 50 men. In addition there were a larger number of men engaged in prospecting and development work, incidentally to which some gold was produced.

There was also some mining of quicksilver ores in the lower Kuskokwim region, but no details have been learned. It is reported that some work was done on three or four quicksilver prospects, besides the continuation of development work at the Parks mine. A new discovery of rich placer ground in the Takotna district is reported, but details in regard to it are lacking at this writing. A dredge was shipped for use on Candle Creek but did not arrive at its destination. It is to be installed in 1917 for use on ground about 30 feet deep. A new area of auriferous gravels is reported to have been found in the Holitna River basin, tributary to the middle Kuskokwim.

In the Aniak River region mining was done on a smaller scale than in the preceding year owing to a shortage of water on Canyon Creek, the principal producer. Plans were made for drilling on Marvel Creek with the view of installing a dredge. A hydraulic plant

was installed on New York Creek at about the end of the season. A placer mine was worked on Mary Creek, a tributary of New York Creek. This is the first production on Mary Creek.

Mining was continued in a small way on Butte and Cowcow creeks, in the Goodnews Bay district. A steam scraping plant shipped to this district failed to reach its destination. A promising find of gold was made on Bear Creek, in the Goodnews Bay district.

Gold is widely distributed in the Kuskokwim basin. Although but few rich placers have been found, there appear to be many localities where there are considerable bodies of auriferous gravel that deserve systematic prospecting with the view of installing large plants. Some of this work has been done, but the operators have met with discouraging conditions as regards transportation. The steamer service to the mouth of the river is so irregular and so inadequate as to greatly increase the cost of all installations. These conditions are not as good as they were on the Yukon in the pre-Klondike days. If adequate ocean and river steamer service were available the Kuskokwim camps should make important contributions to the annual gold output of Alaska.

SEWARD PENINSULA.

The mines of Seward Peninsula produced gold to the value of about $2,950,000 in 1916 and $2,900,000 in 1915. The value of tin, tungsten, silver, and coal produced in 1916 was about $170,000; in 1915 it was $84,000. The value of the total gold production since mining began in 1897 is about $74,292,000. Nearly all this gold was taken from placers; up to the present time little has been produced from lodes. Silver, tin, etc., have been produced to the value of about $880,000. This makes the value of the total mineral output of Seward Peninsula to the end of 1916 $75,170,000.

The year 1916 was favorable to placer mining on account of ample water supply. As a consequence there were more mines operated than in 1915. It is estimated that, including the dredges, 148 mines were operated in 1916, compared with 120 in 1915. That many of the operations were on a small scale is made evident by the fact that about 1,000 men were employed in productive mining in 1916, compared with 1,200 in 1915. Twenty-seven gold dredges were operated in 1916, employing 260 men, and handled about 1,870,000 cubic yards of gravel, yielding gold to the value of about $985,000. In 1915 31 gold dredges were operated and handled about 3,000,000 cubic yards of gravel, yielding gold to the value of $1,050,000. These comparisons show that there was a tendency to limit dredge mining to richer gravels this year than in the preceding year. Evidence of this tendency can be expressed more directly by noting that the average gold recovery by dredges per cubic yard was 35 cents in

1915 and 53 cents in 1916. There are still large reserves of auriferous gravels on the peninsula that are believed to be rich enough to warrant exploitation by dredges. Most of the existing companies own but one dredge each, and it appears as if the time were ripe for stronger organizations to enter the field and introduce economies by mining on a large scale.

It is estimated that about 66 deep mines were operated on the peninsula during 1916. Many of these were operated in winter as well as summer. Besides the dredges about 70 open-cut mines, large and small, were in operation during the summer. Mining was done on a larger scale in the Koyuk district than in any previous year. The value of the gold produced in this district in 1915 was only $3,000, while that of the winter output alone in 1916 was $100,000. Complete returns on the summer operations in the Koyuk district are not yet available. In addition to the gold dredges two placer-tin dredges were operated in the York district. Developments were also continued on the Lost River tin-lode mine.

One of the important developments in 1916 was the beginning of the mining of tungsten (scheelite). At several localities the residual material of scheelite-bearing lodes was worked by placer-mining methods. Some scheelite was also recovered incidentally to the mining of placer gold.

Some antimony ore was mined at the Hed & Strang mines, and a part of this was shipped. Work was done on two graphite deposits in the Kigluaik Mountains. Some coal was mined at Chicago Creek for local use. Details in regard to mining development on the peninsula are contained in another chapter of this report by Mr. Mertie.

KOBUK REGION.

Placer mining continued in a small way during 1916 in the Kobuk region. Details in regard to it are lacking at this writing, but it is probable that the value of the gold output in 1916 was about the same as in 1915, estimated at $20,000.